



REPAIR MANUAL

2Z ENGINE

FOREWORD

This repair manual explains the repair points of the 2Z model engine equipped on the Toyota Forklift Trucks.

Please make good use of this manual for your technical service.

This repair manual contains the latest information available as of January 1994. For any changes thereafter, Toyota reserves the right to make such changes in specifications and descriptions without incurring any obligation and without previous notice.

TOYOTA Material Handling Company

A Division of TOYOTA INDUSTRIES CORPORATION

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GENERAL

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SPECIFICATIONS

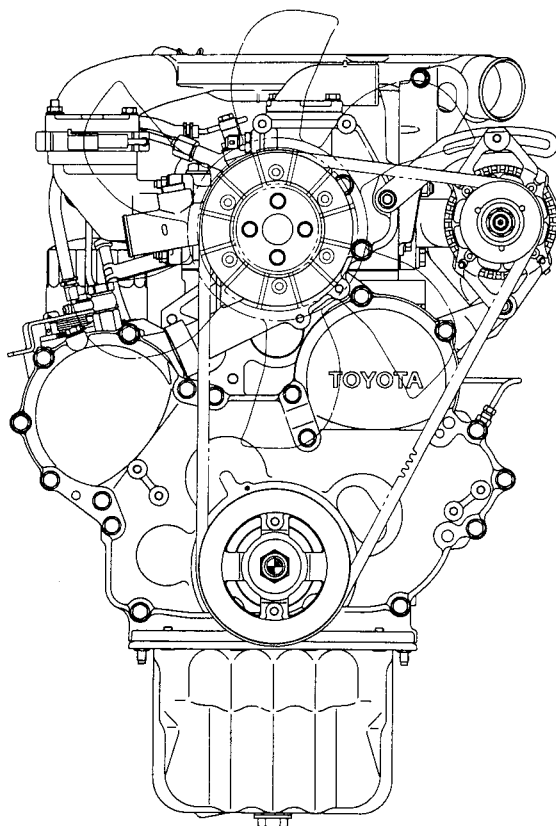
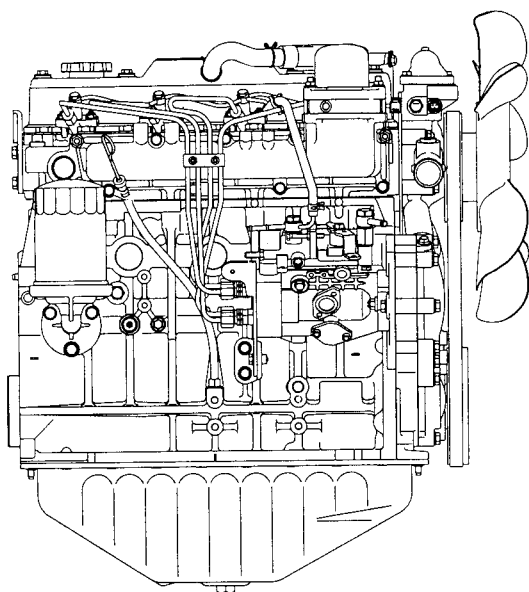
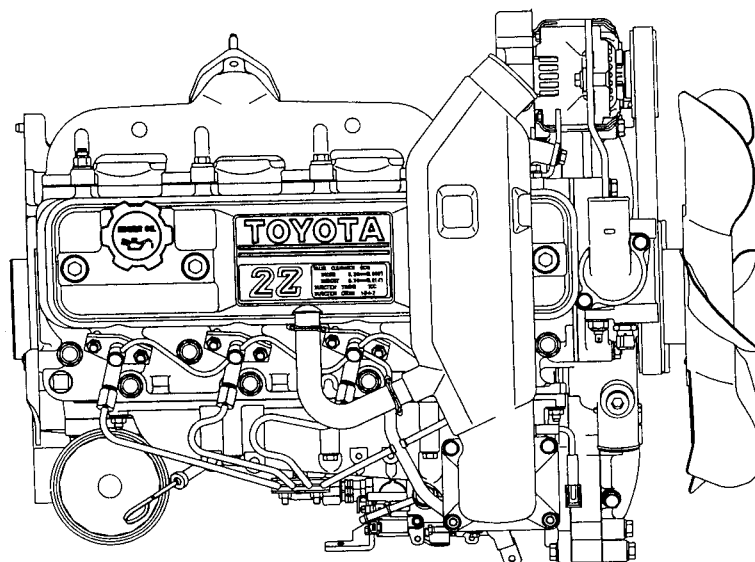
Engine model	2Z	
Type	Diesel	
Cycle	4	
Number of cylinders and arrangement	Inline 4 cylinders, vertical	
Injection order	1 – 3 – 4 – 2	
Starting method	Pinion shift or self starter	
Combustion chamber type	Direct injection	
Valve mechanism	Gear drive, OHV	
Bore x stroke	mm (in.)	98.0 x 115.0 (3.858 x 4.528)
Piston displacement	cc (cu·in)	3469 (211.69)
Compression ratio	*1	
Compression pressure	kPa (kgf/cm ²) [psi]/rpm	3230 (33) [469]/260
Maximum power	kW (PS)/rpm	*2
Maximum torque	N·m (kgf·m) [ft·lbf]/rpm	*3
No-load static maximum speed	rpm	See the repair manual for each model
Idling speed	rpm	See the repair manual for each model
Number of piston rings	Compression rings	2
	Oil ring	1
Intake valve opening & closing timing	Open	BTDC 16°
	Close	ABDC 36°
Exhaust valve opening and closing timing	Open	BBDC 52°
	Close	ATDC 14°
Ignition system	Compression ignition	
Injection timing	TDC/static (See page 1-6.)	
Oil pump type	Trochoid pump	
Engine oil amount ℓ (USgal)	Oil pan capacity	8.0 (2.11)
	Total capacity	9.0 (2.38)

*1, *2, *3:

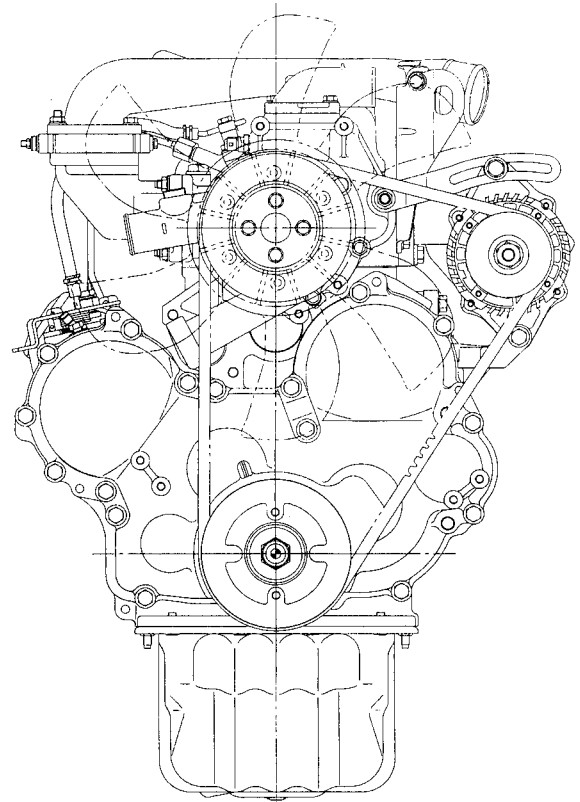
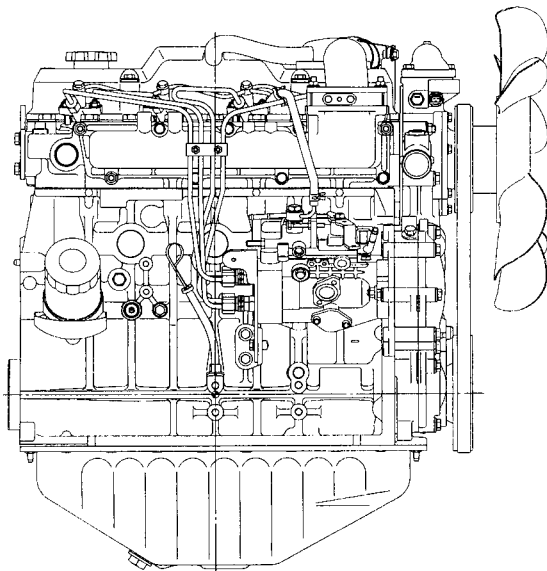
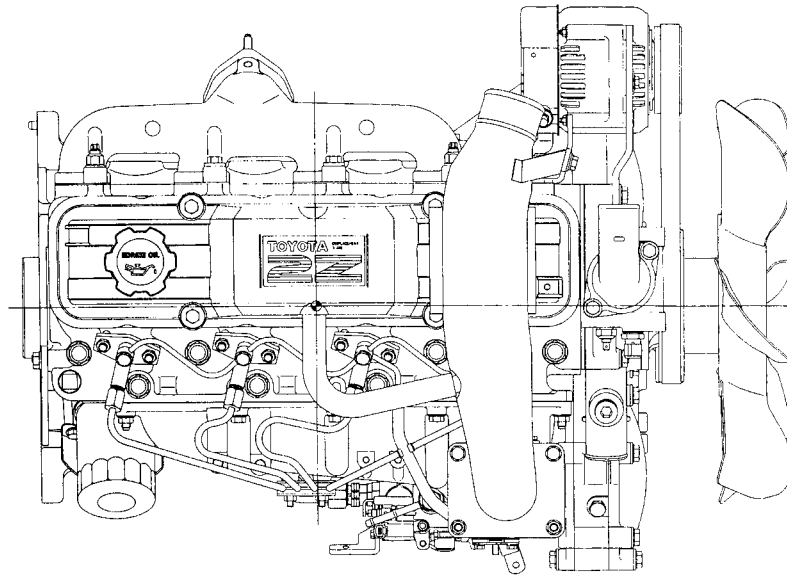
	2Z	2Z	2Z
	7FD20~J35: ~2002.10 7FDF20~JF35: ~2003.12 4SDK10, 42-2TD20-25: ~2003.8	7FD20~J35: 2002.11~ 4SDK10, 42-2TD20-25: 2003.9~	7FDF20~JF35: 2004.1~
Compression ratio	18.6	18.6	19.0
Maximum power kW (PS)/rpm	49(66)/2200	42(57)/2200	42(57)/2200
Maximum torque N·m (kgf·m) [ft·lbf]/rpm	216(22.0)[159]/1600	200(20.4)[148]/1600	200(20.4)[148]/1600

ENGINE EXTERIOR VIEWS

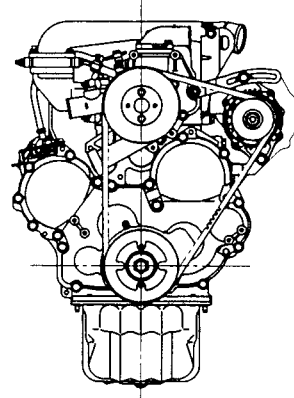
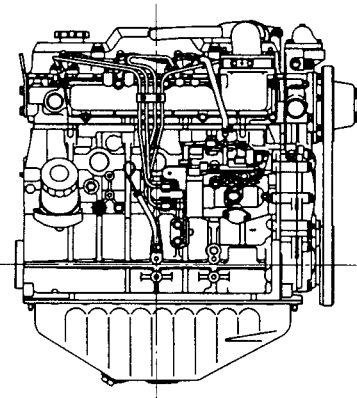
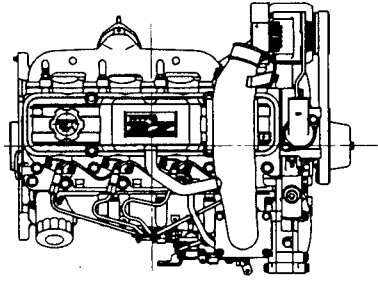
Until July 1998



Since August 1998

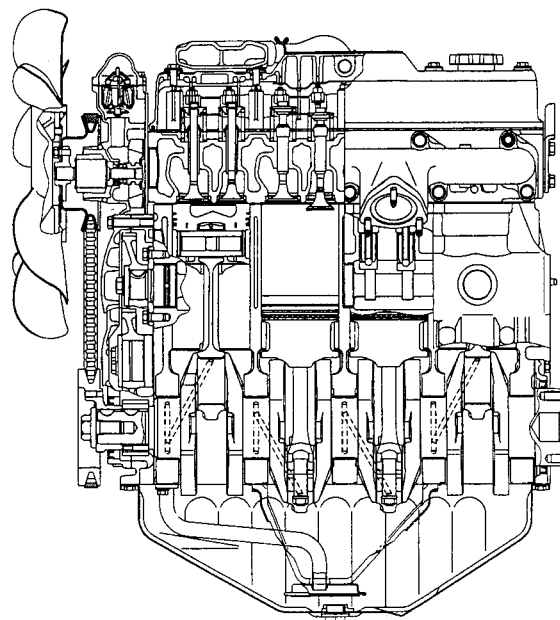
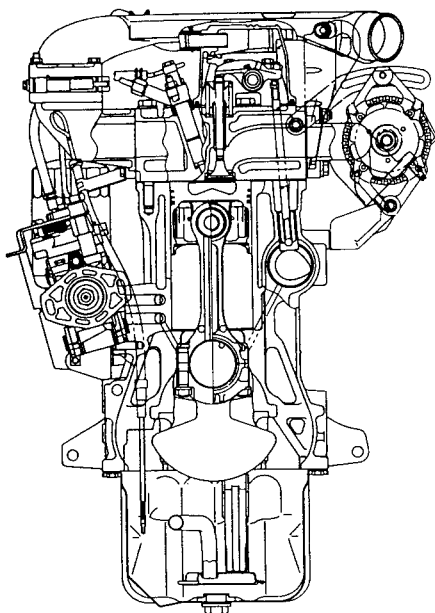


Since January 2004 (7FDF20~JF35)

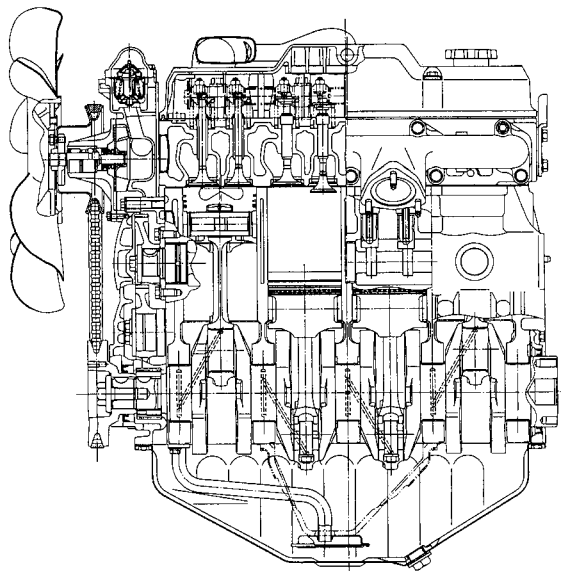
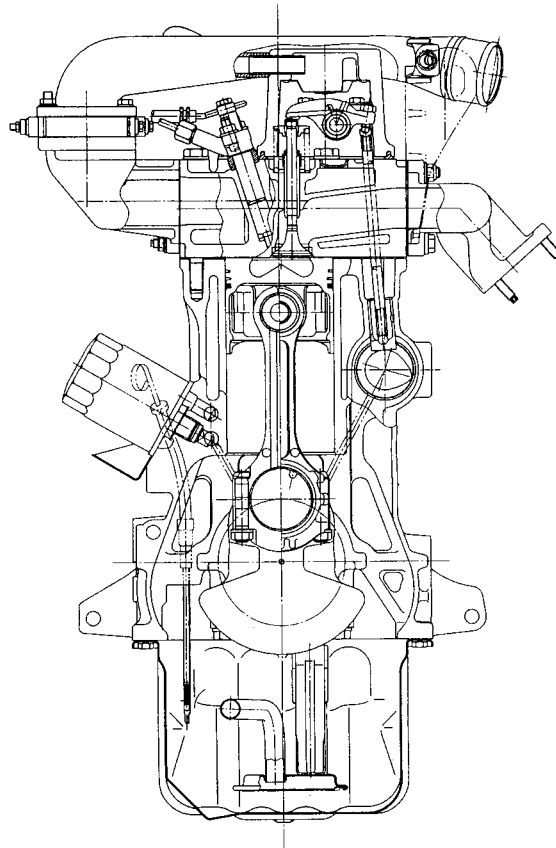


ENGINE SECTIONAL VIEWS

Until July 1998



Since August 1998



HOW TO USE THIS MANUAL

EXPLANATION RANGE OF REPAIR WORKS

Repair work is classified into 4 processes.

Process 1. Troubleshooting on the truck.

Process 2. Removal from the vehicle and installation.

Process 3. Disassembly and assembly/inspection/adjustment.

Process 4. Completion inspection.

This manual explains process 3.

For processes 1, 2 and process 4, please refer to the repair manual of the corresponding models.

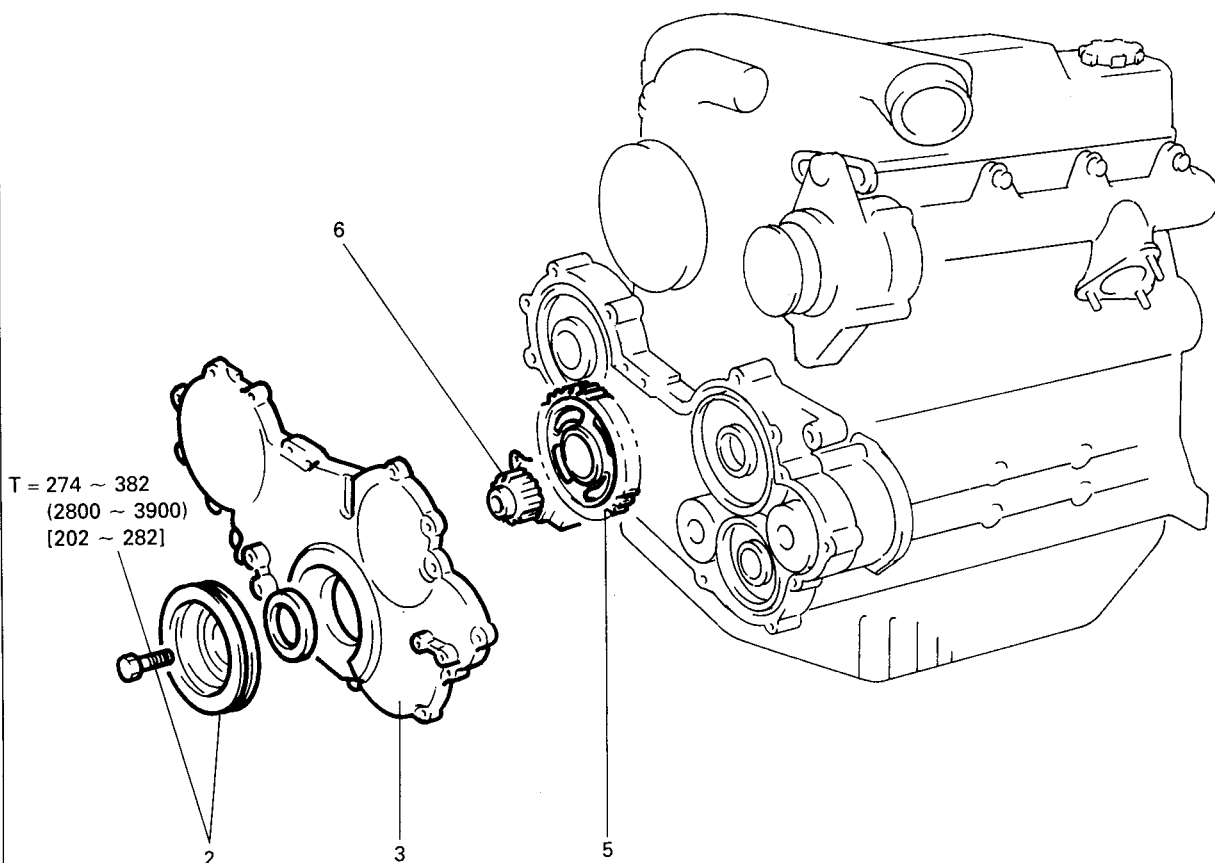
VIEWPOINT OF EXPLANATION CONTENTS

1. Working procedure

- (1) Components and a sectional view are shown at the beginning of each section to enable you to grasp the installed condition of each component.
- (2) Tightening torques are listed in diagrams showing the removal and installation procedures.

EXAMPLE

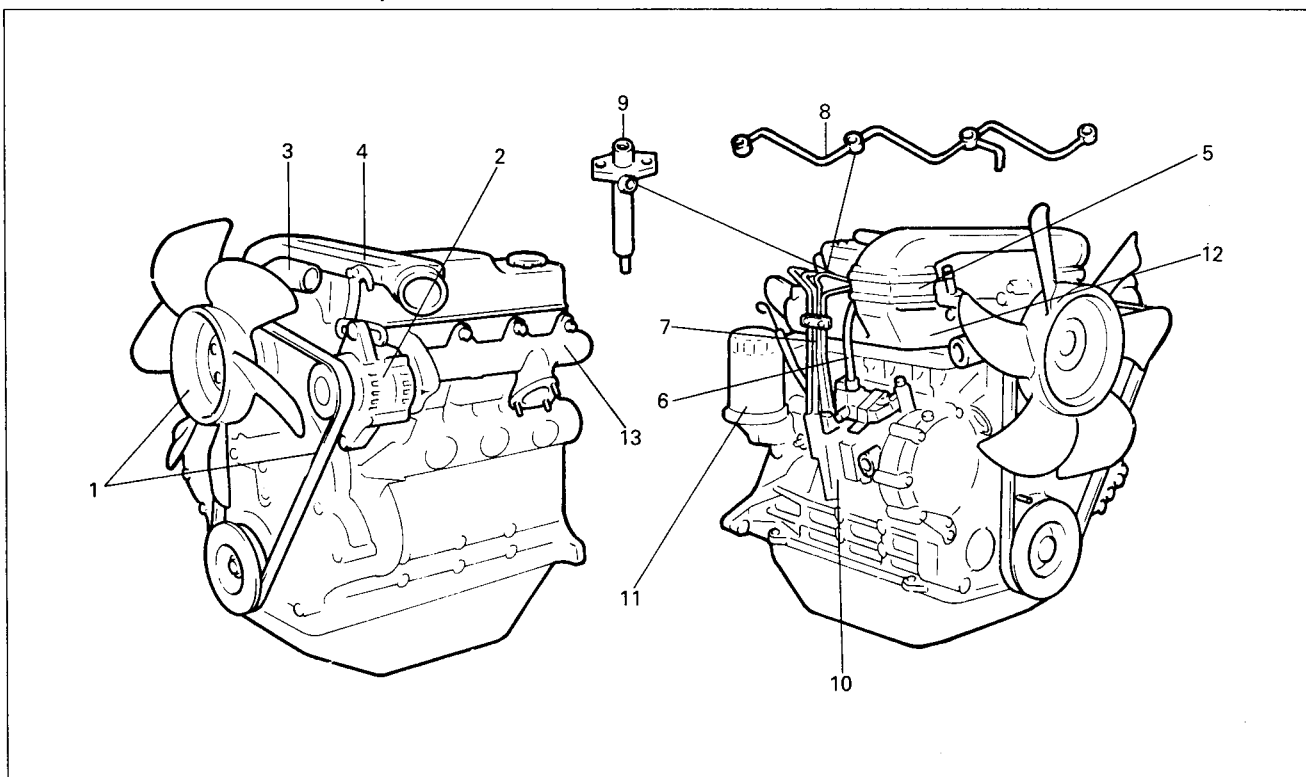
○○～○○Tightening torque: N·m (kg·cm) [ft·lb]



- (3) Parts removal and installation procedures use the numbers shown in the illustration. Important points in repair work are described as "point".
- (4) The description covers detailed repair methods, information, standards and cautions.

EXAMPLE

Illustrations on disassembly and ASSY



DISASSEMBLY PROCEDURE

Removal Procedure

- 1 Remove the fan pulley, and V-belt. **[Point 1]**
- 2 Remove the alternator.
- 3 Remove the water pump.
- ⋮

↑
Operation covered on the following page.

POINTS ON OPERATIONS

Removal: Points on disassembly operation

Installation: Points on assembly operation

Inspection: Points on inspection operation

2. Matters not covered in this manual

- (1) The following works are omitted in this manual. Be sure to carry them out in actual work.
 - ① Jacking and lifting works
 - ② Cleaning and washing of parts
 - ③ Visual check

SIGNAL WORD DEFINITION

- Caution:** Important matters of which negligence may cause accidents. Be sure to observe them.
- Note:** Important items of which negligence may cause accidents, or matters in operation procedure requiring special attention.
- Standard:** The permissible range in inspection or adjustment.
- Limit:** The maximum or minimum value of the criterion in inspection or adjustment.

ABBREVIATIONS

Abbreviation	Meaning	Abbreviation	Meaning
ASSY	Assembly	OHV	Overhead valve
BTDC	Before top dead center	R/M	Repair manual
EX	Exhaust	rpm	Revolution per minute
IN	Intake	SST	Special service tool
O/S	Over size	STD	Standard
OPT	Option	T =	Tightening torque
		U/S	Under size

REPAIR INSTRUCTIONS

1. SAFE OPERATION

- (1) Correctly wear protection tools (cap, safety glasses, gloves, safety shoes, etc.)
- (2) Do not touch the radiator, muffler, exhaust pipe and other engine related parts immediately after stopping the engine to prevent scalding.
- (3) Do not bring clothes, tools and others close to rotating parts during engine operation.
- (4) Remove the ignition key to prevent unexpected engine starting unless the engine operation is necessary.
Disconnect the battery cable from the negative terminal of the battery to prevent short circuit.
- (5) Be sure to use wire ropes of the correct size for hoisting a heavy material.
- (6) After jacking up, always support the frame with stands, etc.

2. PREPARATION BEFORE DISASSEMBLY

- (1) Prepare general tools, SST, measuring tools, oils, greases, and non-reusable parts.
- (2) When disassembling a complicated assembly, put punch or matching marks at places not affecting the function to facilitate reassembly operation.

3. CARE DURING DISASSEMBLY

- (1) Each time a part is removed, check the part for the installed state, deformation, damage, roughening and scratching.
- (2) Disassembled parts must be arranged orderly. Distinguish the parts to be replaced from the parts to be reused.
- (3) Parts to be reused must be cleaned and washed thoroughly.
- (4) Disassembly of hydraulic equipment must particularly be done in a clean place using clean tools.

4. INSPECTION AND MEASUREMENT

- (1) Detailed inspection, measurement and judgement must be carried out as required for parts to be reused.

5. INSTALLATION

- (1) Install correct parts according to the correct procedure and observing the determined standards (tightening torques, adjustment values, etc.)
- (2) Always use genuine parts for replacement of existing parts.
- (3) Always replace oil seals, O-rings, gaskets, cotter pins, etc., with new ones.
- (4) Coat seal packing on gasket depending on the places, coat oil on the sliding contact places, coat oil or grease at specified places, and coat MP grease on oil seal lips before reassembly.

6. ADJUSTMENTS AND OPERATION

- (1) Adjust to the service standard values by using gauges and testers.

7. Precoated parts

Precoated parts mean bolts, nuts, etc., that have been coated with a seal lock adhesive at the factory.

(1) Do not use precoated part in any of the following cases:

- ① When a precoated part is removed.
- ② When a precoated part is removed as a result of tightening torque check, etc.

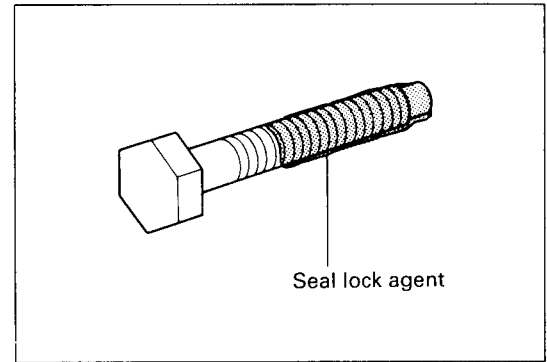
Note:

Check the torque with the lower limit of the tightening torque.

If it moves, retighten it according to the following procedure:

(2) Recoating of precoated parts

- ① Clean off the old adhesive from the bolt, nut or threads.
- ② Dry with compressed air.
- ③ Apply the specified seal lock adhesive to the bolt or nut threads.



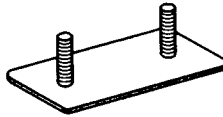
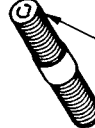
STANDARD BOLT AND NUT TIGHTENING TORQUES

How to judge tightening torque of a standard bolt or nut.

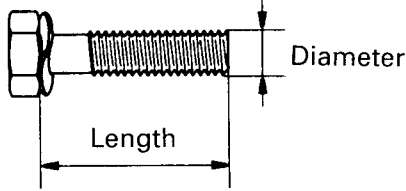
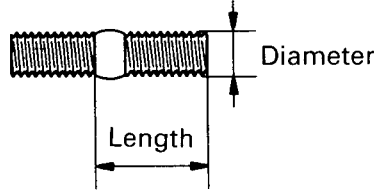
- How to judge tightening torque of a standard bolt.
Find out the type of the bolt from the list below.
Then, find the bolt tightening torque from the table.
- How to judge tightening torque of a standard nut.
The nut tightening torque can be judged from the bolt type. (See the item above.)

BOLT STRENGTH TYPE IDENTIFICATION METHOD

1. Identification by bolt shape

	Shape and class	Class
Hexagon head bolt	 Bolt head No.	4 = 4T 5 = 5T 6 = 6T 7 = 7T
	 No mark	4T
Hexagon flange bolt	 No mark	4T
Hexagon head bolt	 Two protruding lines	5T
Hexagon flange bolt	 Two protruding lines	6T
Hexagon head bolt	 Three protruding lines	7T
Welded bolt		4T
Stud bolt	 No mark	4T
	 Grooved	6T

2. Identification by part No.

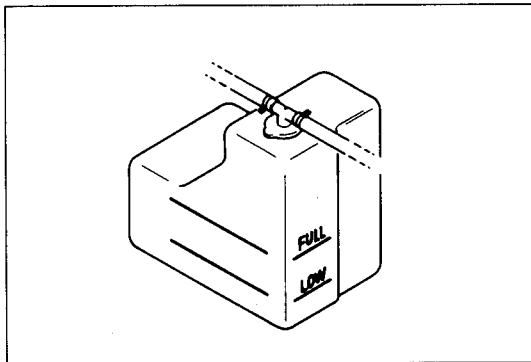
Hexagon head bolt	Part No. 91611-40625 Length (mm) Diameter (mm) Class 
Stud bolt	Part No. 92132-40614 Length (mm) Diameter (mm) Class 

TIGHTENING TORQUE TABLE

Class	Diameter mm	Pitch mm	Specified torque					
			Hexagon head bolt 			Hexagon flange bolt 		
			N·m	kg·cm	ft-lb	N·m	kg·cm	ft-lb
4T	6	1.0	5.4	55	48 in-lb	5.9	60	52 in-lb
	8	1.25	13	130	9	14	145	10
	10	1.25	25	260	19	28	290	21
	12	1.25	47	480	35	53	540	39
	14	1.5	75	760	55	83	850	61
	16	1.5	113	1150	83	–	–	–
5T	6	1.0	6.4	65	56 in-lb			
	8	1.25	16	160	12			
	10	1.25	32	330	24	–	–	–
	12	1.25	59	600	43			
	14	1.5	91	930	67			
	16	1.5	137	1400	101			
6T	6	1.0	7.8	80	69 in-lb	8.8	90	78 in-lb
	8	1.25	19	195	14	21	215	16
	10	1.25	39	400	29	43	440	32
	12	1.25	72	730	53	79	810	59
	14	1.5	–	–	–	123	1250	90
7T	6	1.0	11	110	8	12	120	9
	8	1.25	25	260	19	28	290	21
	10	1.25	52	530	38	58	590	43
	12	1.25	95	970	70	103	1050	76
	14	1.5	147	1500	108	167	1700	123
	16	1.5	226	2300	166	–	–	–

ENGINE TUNE-UP

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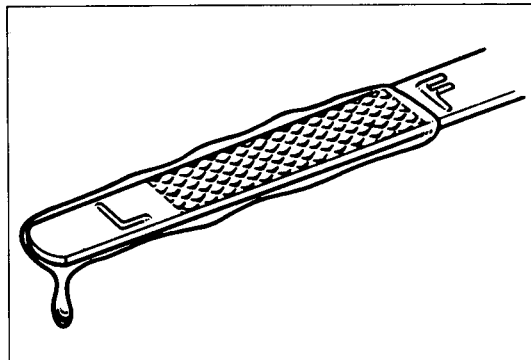
COOLANT INSPECTION

Standard:

The coolant level in the radiator reservoir tank must be between the FULL and LOW lines.
The LLC concentration must be 30% (50% in cold areas) and free of oil and other contamination.

Reference:

See the section on COOLING SYSTEM.



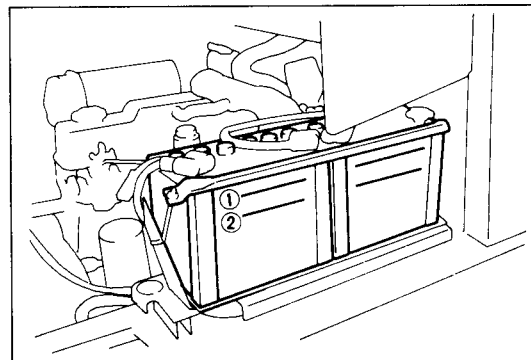
ENGINE OIL INSPECTION

Standard:

The oil level must be between the F and L marks on the dipstick. Oil must be free of heavy contamination and have proper viscosity. Oil must not contain coolant or light oil.

Oil amount: 9.0 l (2.38 US gal.)

Oil pan: 8.0 l (2.11 US gal.)



BATTERY ELECTROLYTE INSPECTION

Standard:

Electrolyte level:

Between the UPPER and LOWER levels

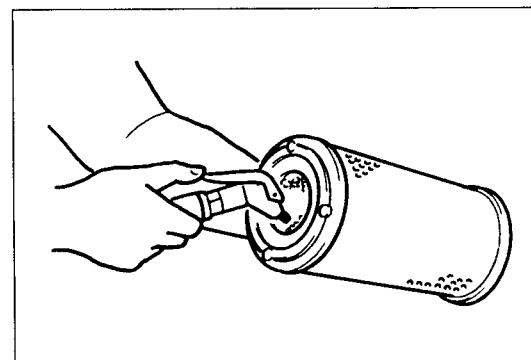
① UPPER LEVEL ② LOWER LEVEL

Specific gravity:

1.25 ~ 1.28 at 20°C (68°F)

Note:

If necessary, add distilled water.



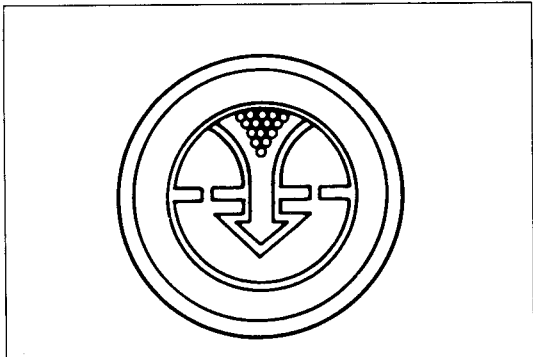
AIR CLEANER INSPECTION AND CLEANING

Air Cleaner Element Inspection and Cleaning

1. Check the air cleaner element for damage, fouling and clogging.
2. Clean the air cleaner element with compressed air.

Note:

The air pressure must be 686 kPa (7 kg/cm²) [99 psi] or lower.



Air Cleaner Case Cleaning

1. Clean the inside and outside of the case with a cloth.

CLOGGING WARNING SYSTEM INSPECTION

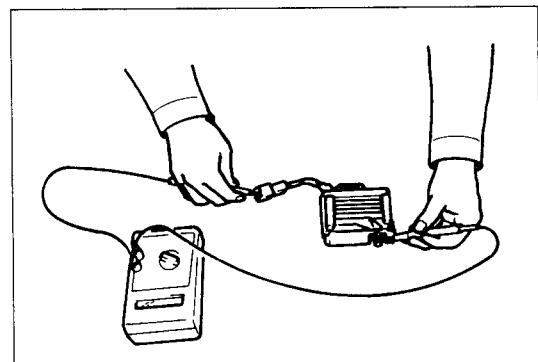
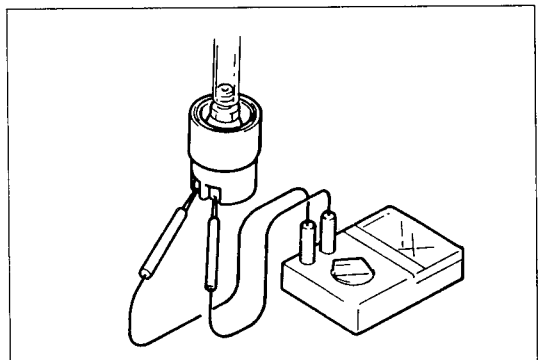
1. Inspection on the vehicle
Check that the air cleaner warning lamp on the instrument panel comes on when the ignition key switch is set to the ON position, and goes off when the engine is started.
2. Individual inspection
Check the vacuum switch for continuity when negative pressure is applied.

Standard:

Approx. 7473 ± 569 Pa (762 ± 58 mmAq,
56.0 ± 4.3 mmHg) or above – Continuity

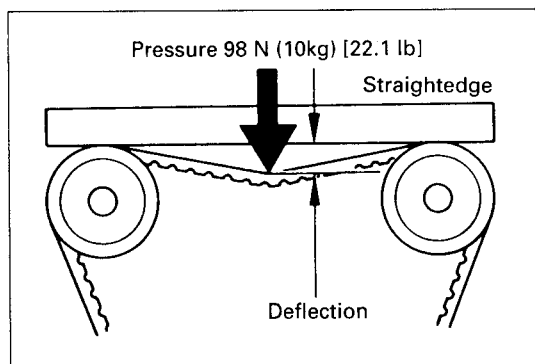
Note:

Do not apply negative pressure in excess of 9807 Pa (1000 mmAq, 72.0 mmHg) [0.0148 psi] to the vacuum switch.



INTAKE HEATER INSPECTION

1. Disconnect cables from the intake heater.
2. Check the intake heater for continuity.
Confirm continuity between the intake heater and terminals (body side).



V-BELT TENSION INSPECTION AND ADJUSTMENT

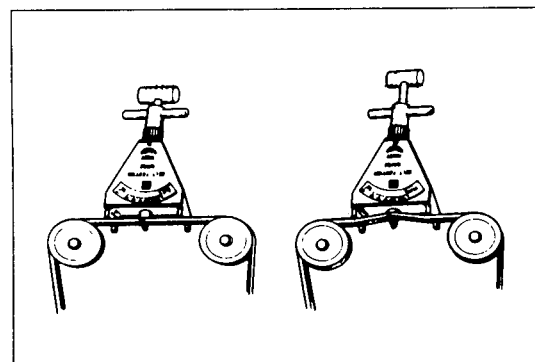
1. V-belt tension inspection
 - (1) Check if the belt is fitted correctly.
 - (2) Press the belt between the water pump and the alternator by a finger with a force of about 98 N (10 kg) [22.05 lb], and measure the amount of deflection.

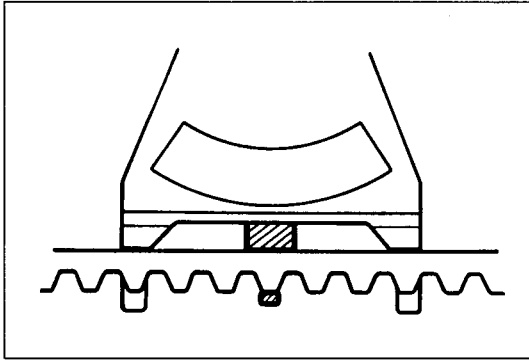
New belts: 7 ~ 9 mm (0.28 ~ 0.36 in.)

Belts in use: 8 ~ 13 mm (0.32 ~ 0.51 in.)

Notes:

- Measure the amount of deflection between the specified pulleys.
- When a new belt is fitted, adjust tension to the median of the standard for new belts.
- The standard for belts in use applies to belts that have been used for 5 minutes or longer.
- When refitting a belt that has been used for 5 minutes or longer, adjust tension to the median of the standard for belts in use.





Standard tension on a belt tension gauge
SST09216-00021

New belts:

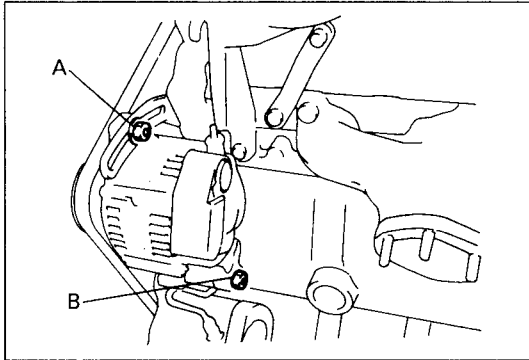
519 ~ 755 N (53 ~ 77 kg) [116.6 ~ 169.4 lb]

Belts in use:

323 ~ 559 N (33 ~ 57 kg) [72.6 ~ 125.4 lb]

Note:

Fit the belt tension gauge hooks to the belt crests to measure tension.

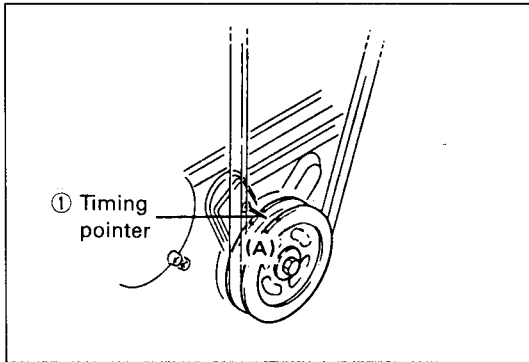


2. V-belt tension adjustment

- (1) Loosen alternator set bolt B and adjusting bolt A.
- (2) Tension the V-belt using a 300 to 400 mm (12 to 16 in.) long lever, and tighten bolt A.
- (3) Tighten bolt B, and recheck the belt tension.

Note:

Tensioning by a lever tends to cause variation from one mechanic to another. It must be followed by measurement of the deflection.



VALVE CLEARANCE INSPECTION AND ADJUSTMENT

1. Warm up the engine.

Standard:

Coolant temperature 75 ~ 85°C (167 ~ 185°F)

2. Check the valve clearance.

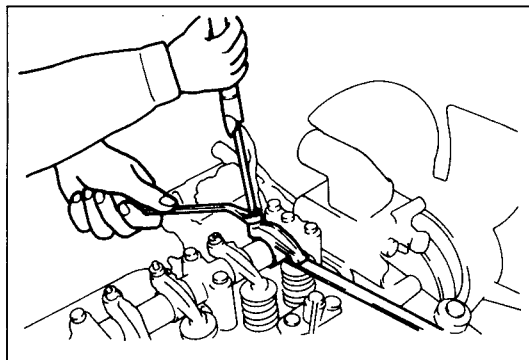
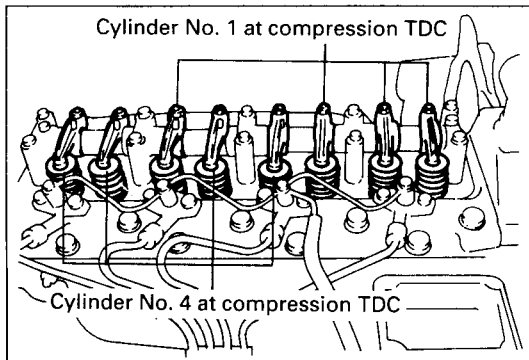
- (1) Turn the crankshaft in the forward direction as needed to set cylinder No. 1 to the TDC (A).
- (2) Measure the valve clearance as shown.

Standard:

IN: 0.15 ~ 0.25 mm (0.0059 ~ 0.0098 in.)
(hot engine)

EX: 0.31 ~ 0.41 mm (0.0122 ~ 0.0161 in.)
(hot engine)

- (3) Turn the crankshaft in the forward direction as needed to set cylinder No. 4 to the TDC.
- (4) Measure the valve clearance of the remaining valves.



3. Adjust valve clearance as needed.

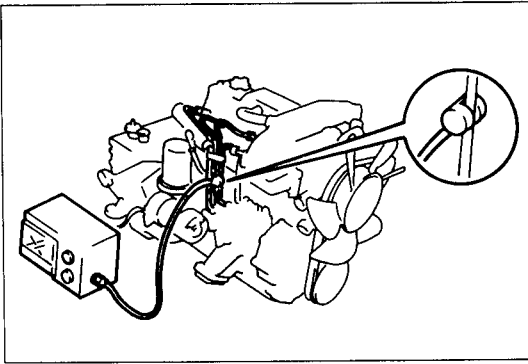
- (1) Loosen the lock nut and turn the adjusting screw as needed for adjustment.

Standard:

IN: 0.20 mm (0.0078 in.) (hot engine)

EX: 0.36 mm (0.0142 in.) (hot engine)

- (2) Tighten the lock nut and check the valve clearance again.



IDLE SPEED INSPECTION AND ADJUSTMENT

1. Warm up the engine.

Standard:

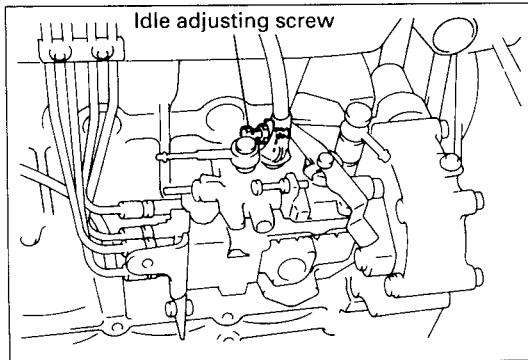
Coolant temperature 75 ~ 85°C (167 ~ 185°F)

2. Attach the tachometer.
3. Check the idle speed.
 - (1) Check that the accelerator wire returns, and confirm that the adjusting screw of the injection pump is touching the adjusting lever.
 - (2) Check the idle speed.

Standard:

Refer to the appropriate repair manuals.

4. Adjust the idle speed as needed.
 - (1) Loosen the lock nut and turn the adjusting screw as needed for adjustment.
 - (2) Tighten the lock nut and check the idle speed again.



NO-LOAD MAXIMUM ENGINE SPEED INSPECTION AND ADJUSTMENT

1. Warm up the engine.

Standard:

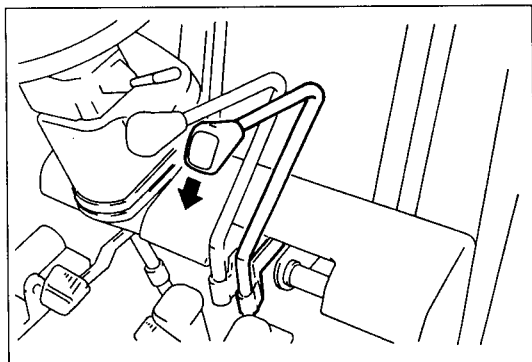
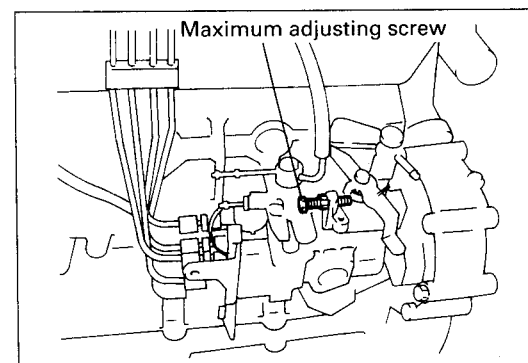
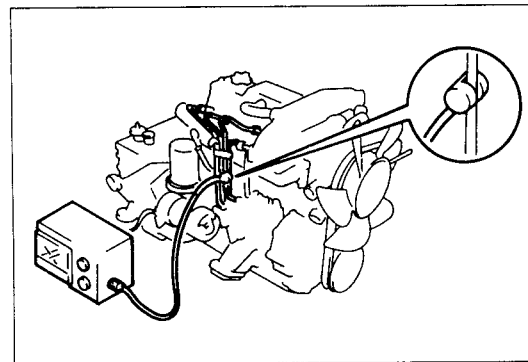
Coolant temperature 75 ~ 85°C (167 ~ 185°F)

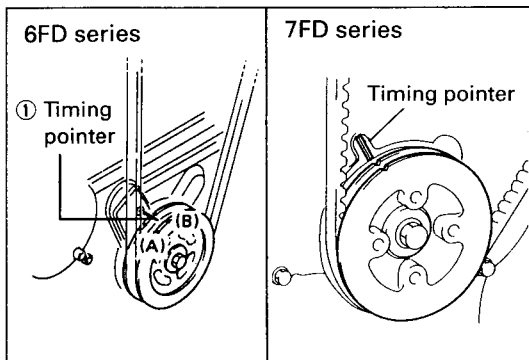
2. Attach the tachometer.
3. Check the no-load static maximum engine speed.
 - (1) With the engine stationary, depress the accelerator pedal to the floor and confirm that the adjusting lever is touching the maximum adjusting screw.
 - (2) Start the engine, depress the accelerator pedal to the floor and check the engine speed (no-load static maximum engine speed).

Standard:

Refer to the appropriate repair manuals.

4. Adjust the no-load static maximum engine speed. Unseal the set screw and turn it as needed for adjustment.
5. Check the no-load maximum engine speed.
 - (1) With the engine running at the maximum speed, operate the material handling levers and check the engine speed drop (relief down) at full relief.
Relief down at full relief: Within 200 rpm
 - (2) Seal the set screw.



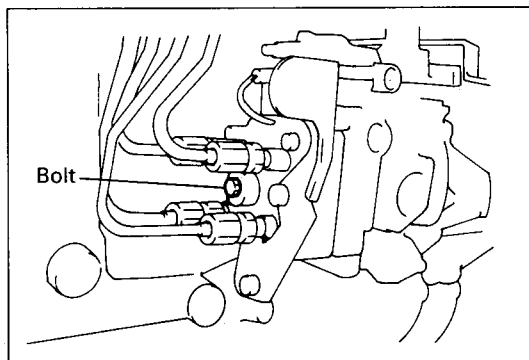


INJECTION TIMING INSPECTION AND ADJUSTMENT

1. Set cylinder No. 1 to the TDC (A). Align the TDC notch mark of the crank pulley with the timing pointer.

Note:

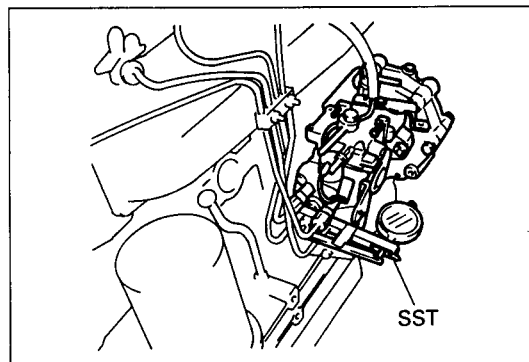
The other notch mark (B) on the crank pulley is for the inline type injection pump.



2. Remove the bolt at the rear end of the injection pump.
3. Set the SST and the dial gauge in the bolt hole.
SST 09240-32880-71 or 09275-76002-71
(09275-54010)

Note:

Prevent foreign matter or dust entrance during work.

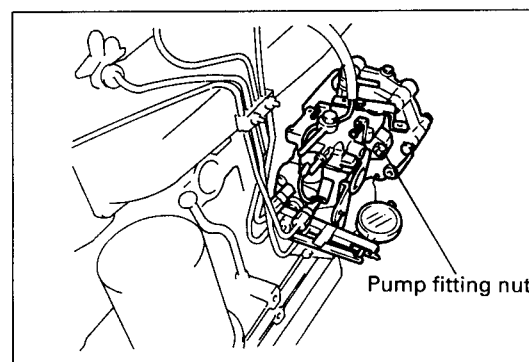
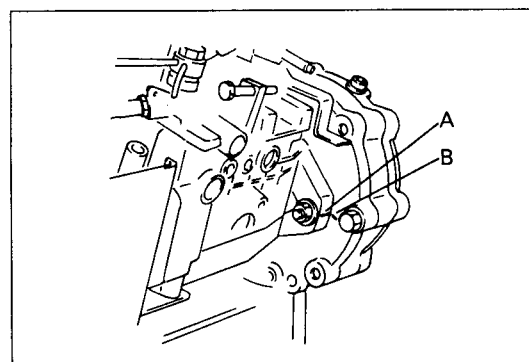


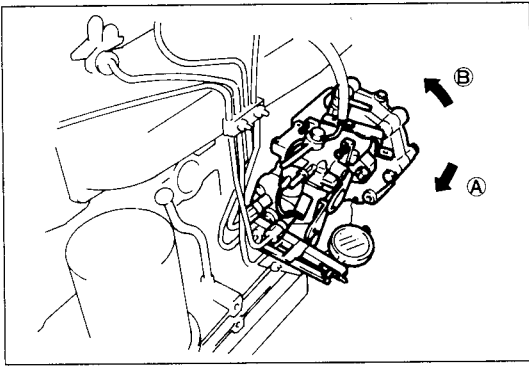
4. While observing the dial gauge reading, rotate the crankshaft in the reverse direction by a crank angle over 25° from the TDC of cylinder No. 1. When the dial gauge pointer deflection stops, set the dial gauge to 0.
5. Slowly rotate the crankshaft in the forward direction until cylinder No. 1 comes to the TDC again.
6. Read the dial gauge. The setting is correct if the reading meets the standard. If not, adjustment is needed.

Standard:

1.23 ~ 1.29mm (0.0484 ~ 0.0508in)	~ 1998.8	6FD20 ~ 30, 4SDK10, 42-2TD20-25
	~ 1999.6	6FDF20 ~ 30
	~ 2003.8	4SDK10, 42-2TD20-25
1.15 ~ 1.21mm (0.0452 ~ 0.0476in)	1998.8 ~ 2002.10	7FD20 ~ J35
	1999.6 ~ 2003.12	7FDF20 ~ JF35
0.77 ~ 0.83mm (0.0303 ~ 0.0327in)	2002.11 ~	7FD20 ~ J35
	2004.1 ~	7FDF20 ~ JF35
	2003.9 ~	4SDK10, 42-2TD20-25

7. Adjust the injection timing as needed.
 - (1) Check if the marks (A and B) on the timing gear case and the injection pump body are aligned with each other. If they are not aligned, check the amount of offset (to serve as a guide for adjustment).
 - (2) Disconnect the fuel pipe.
 - (3) Disconnect the overflow pipe.
 - (4) Loosen the injection pump set nut and the lower bracket.





- (5) Move the pump body as needed to adjust the injection timing.
 - 1 Move the pump body in direction **A** when the measured value in step 6 above was smaller than the standard.
 - 2 Move the pump body in direction **B** when the measured value in step 6 above was larger than the standard.
- (6) Tighten the injection pump set nut and the lower bracket, and check the injection timing again.
- (7) Tighten the loosened pipe joints.
8. After the injection timing inspection and adjustment, remove the SST and the dial gauge, and fit the bolt at the rear end of the pump.

Note:

Run the starter before a compression test to remove foreign matter from the cylinder.

COMPRESSION PRESSURE INSPECTION

Check the compression pressure of cylinders when the engine power is low, or it consumes oil or fuel more than necessary.

1. Warm up the engine.

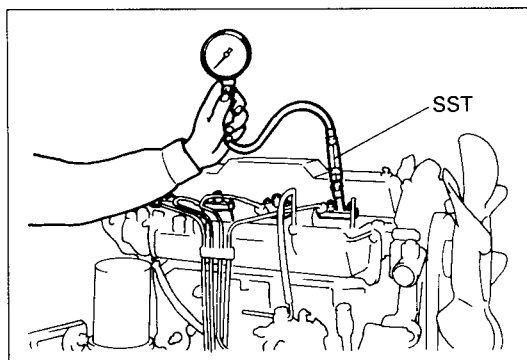
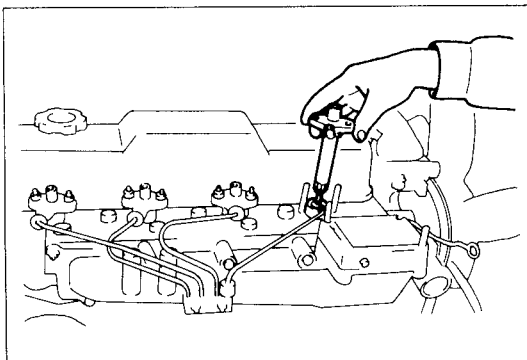
Standard:

Coolant temperature 75 ~ 85°C (167 ~ 185°F)

2. Disconnect the intake pipe.
3. Disconnect the injection pipe and nozzle leakage pipe.
4. Remove all nozzle holders and nozzles.
5. Check compression.

Note:

Run the starter before a compression test to empty the cylinder.



- (1) Fit the compression gauge attachment to the nozzle hole, and connect the compression gauge to the attachment.
SST 09992-00025
- (2) Crank the engine and measure the compression pressure.

Standard:

3230 kPa (33 kg/cm²) [470 psi] at 260 rpm

Limit:

1960 kPa (20 kg/cm²) [280 psi] at 260 rpm

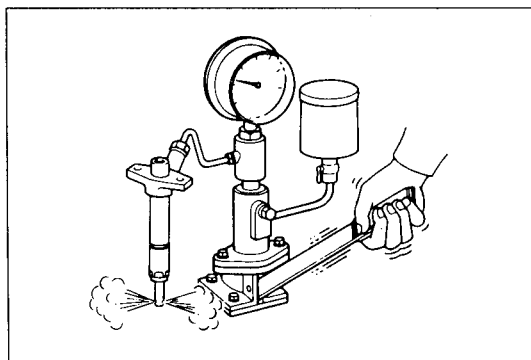
Note:

Use a fully charged battery to maintain the specified engine speed.

- (3) Repeat steps (1) and (2) for each cylinder.

Limit of difference between cylinders:
196 kPa (2 kg/cm²) [28 psi]

- (4) If the compression pressure in any cylinder is below the limit, or if the differential pressure between any two cylinders is larger than the limit, add a small amount of oil from the nozzle case and repeat steps (1) to (3).
- 1 If the pressure increases after oil addition, the piston ring and/or the cylinder bore may be worn.
 - 2 If the pressure remains low after oil addition, there may be a valve seizure, poor valve contact or pressure leakage from the gasket.



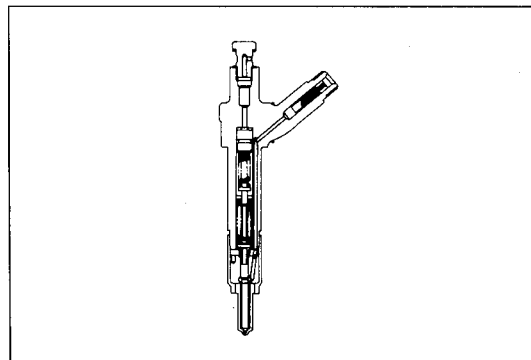
INJECTION NOZZLE INSPECTION AND ADJUSTMENT

1. Injection pressure inspection of injection nozzles
 - (1) Remove the injection nozzle.
 - (2) Fit the nozzle tester, operate the tester lever quickly to cause injection a few times to remove carbon deposits at the injection holes.
 - (3) Slowly press the tester lever to increase the pressure.
 - (4) Read the pressure at the moment the pressure drops suddenly.

Standard: 17700 kPa (180 kg/cm²) [2560 psi]

Reference:

If the standard is not met, adjust the injection pressure in reference to the section on FUEL SYSTEM.

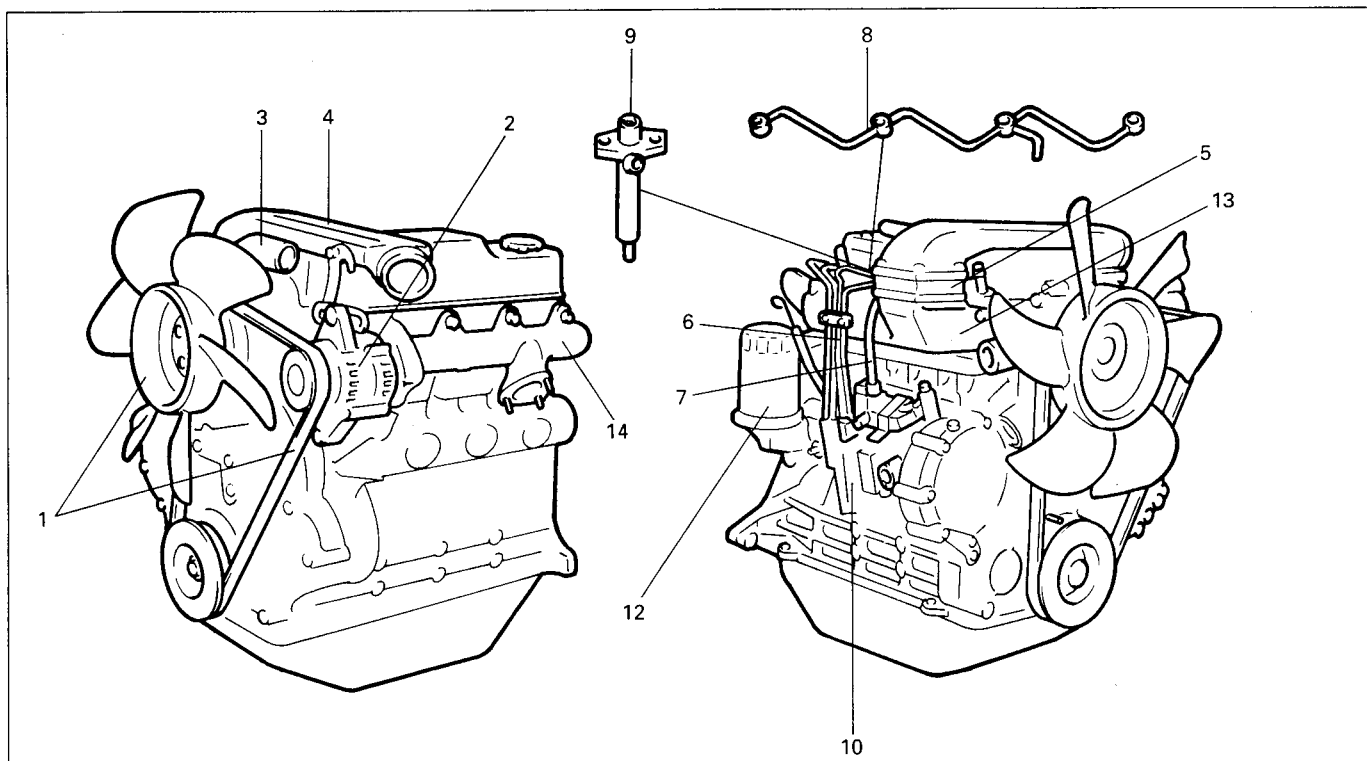


ENGINE OVERHAUL

	Page
ENGINE ACCESSORIES REMOVAL AND INSTALLATION	2-2
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ENGINE ACCESSORIES REMOVAL AND INSTALLATION

Clean the disassembled parts before inspection and reassembly.

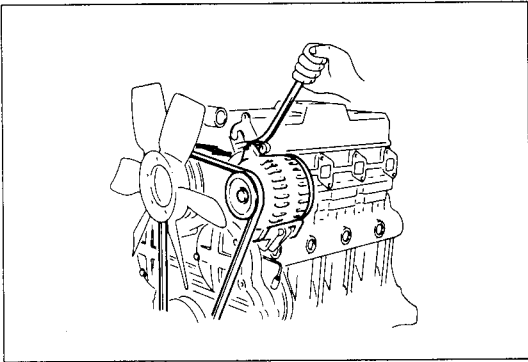


Removal Procedure

- 1 Remove the fan, fan pulley, and V-belt. **[Point 1]**
- 2 Remove the alternator.
- 3 Remove the water pump.
- 4 Remove the intake pipe.
- 5 Remove the intake heater.
- 6 Remove the fuel pipe.
- 7 Remove the injection hose.
- 8 Remove the nozzle leakage pipe.
- 9 Remove the injection nozzle. **[Point 2]**
- 10 Remove the injection pump with drive gear. **[Point 3]**
- 11 Remove the oil cooler piping. (7FDF20~JF30:2004.1~)
- 12 Remove the oil filter **[Point 4]**
- 13 Remove the intake manifold **[Point 5]**
- 14 Remove the exhaust manifold **[Point 6]**

Installation Procedure

Install components in the reverse order of removal.



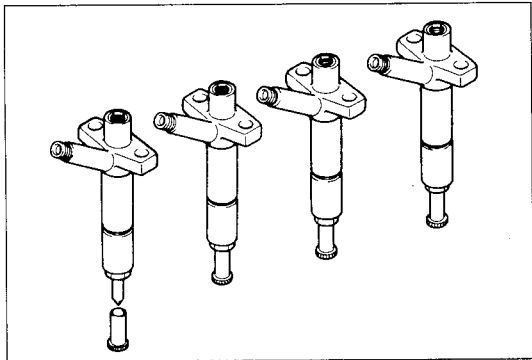
Point operations

[Point 1]

Installation: Adjust the fan belt tension at the alternator adjusting bar.

Reference:

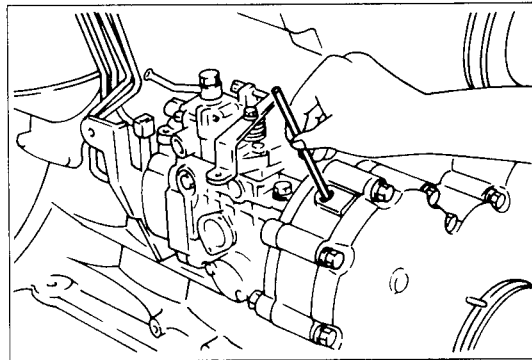
(See the section on 1-3 of ENGINE TUNE-UP about fan belt tension adjustment.)



[Point 2]

Disassembly: Protect the disassembled nozzles and keep them in the order of cylinders to ensure correct installation.

Installation: Always renew the nozzle gasket. The nozzle seat may be reused after thoroughly removing the carbon deposits.



[Point 3]

Disassembly:

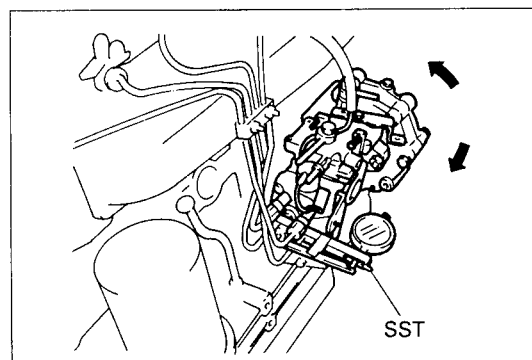
1. Bring cylinder No. 1 to the TDC and then return it a little for ease of work. If it is set at the TDC, the injection pump cam is lifted and makes work difficult.
2. Unbolt the timing gear cover and put matching marks using white paint, etc.

Installation:

1. Confirm that cylinder No. 1 is at a position returned a little from the TDC.
2. Correctly align the service hole in the timing gear cover with the matching mark on the pump drive gear.
3. Adjust the injection timing.

Note:

See the section on 1-6 ENGINE TUNE-UP.



[Point 4]

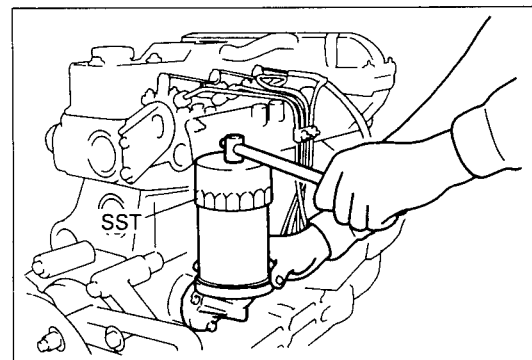
Until July 1998.

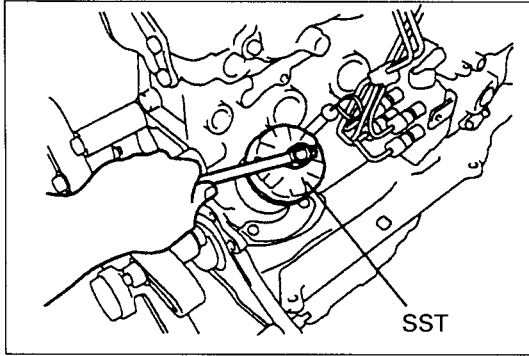
Disassembly: SST 09228-76008-71
(SST 09228-44011)

Installation: Apply a thin coat of engine oil to the O-ring and install the oil filter to the filter bracket by turning it by hand. Then, retighten the oil filter by 3/4 of a turn using SST.

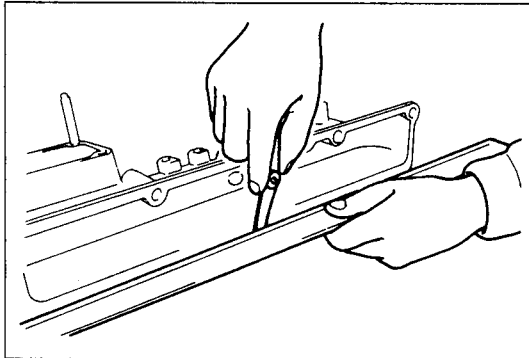
Note:

Clean the fitting surface before installation.





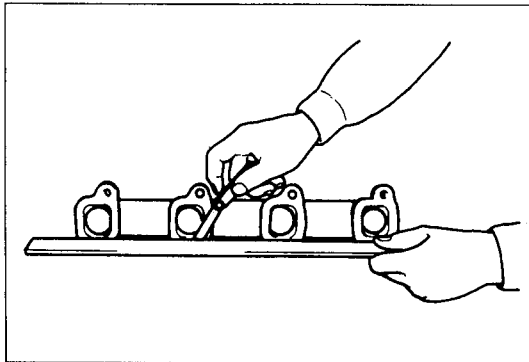
Since August 1998.
SST 09228-76004-71
(SST 09228-07501)



[Point 5]

Inspection: Check the intake manifold for distortion.

Limit: 0.4 mm (0.016 in.)



[Point 6]

Inspection: Check the exhaust manifold for distortion.

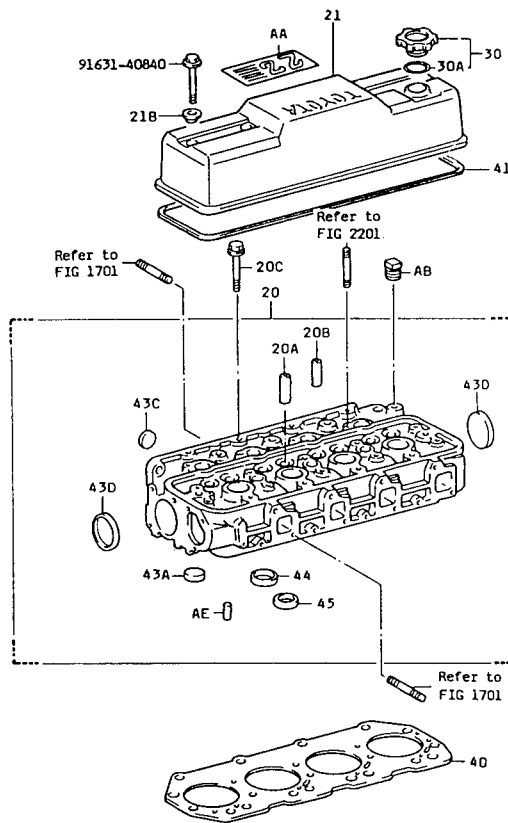
Limit: 0.4 mm (0.016 in.)

CYLINDER HEAD AND VALVE SYSTEM

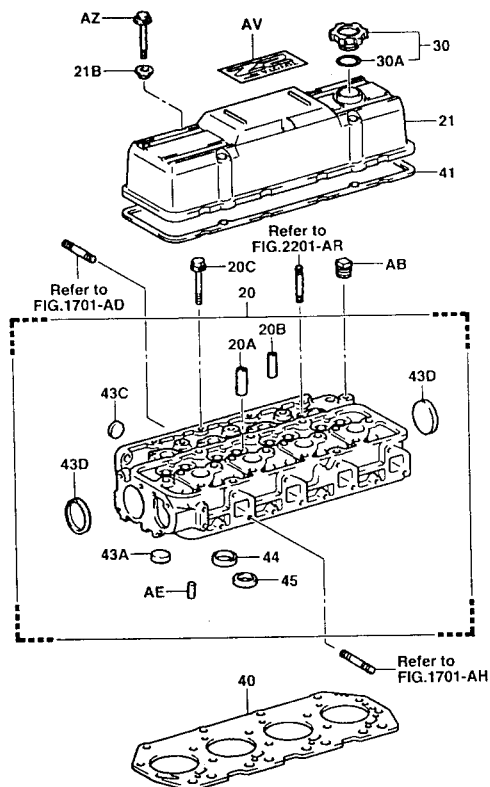
COMPONENTS

1104

~1998. 7



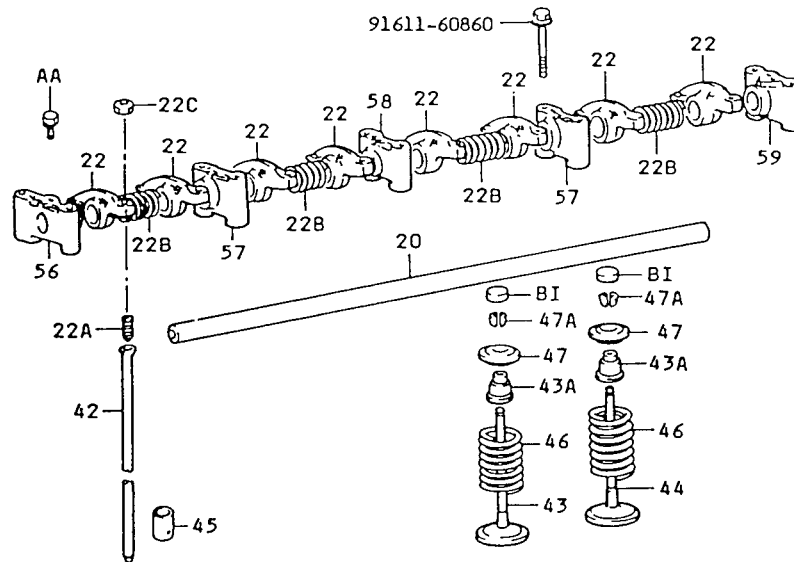
1998. 8~



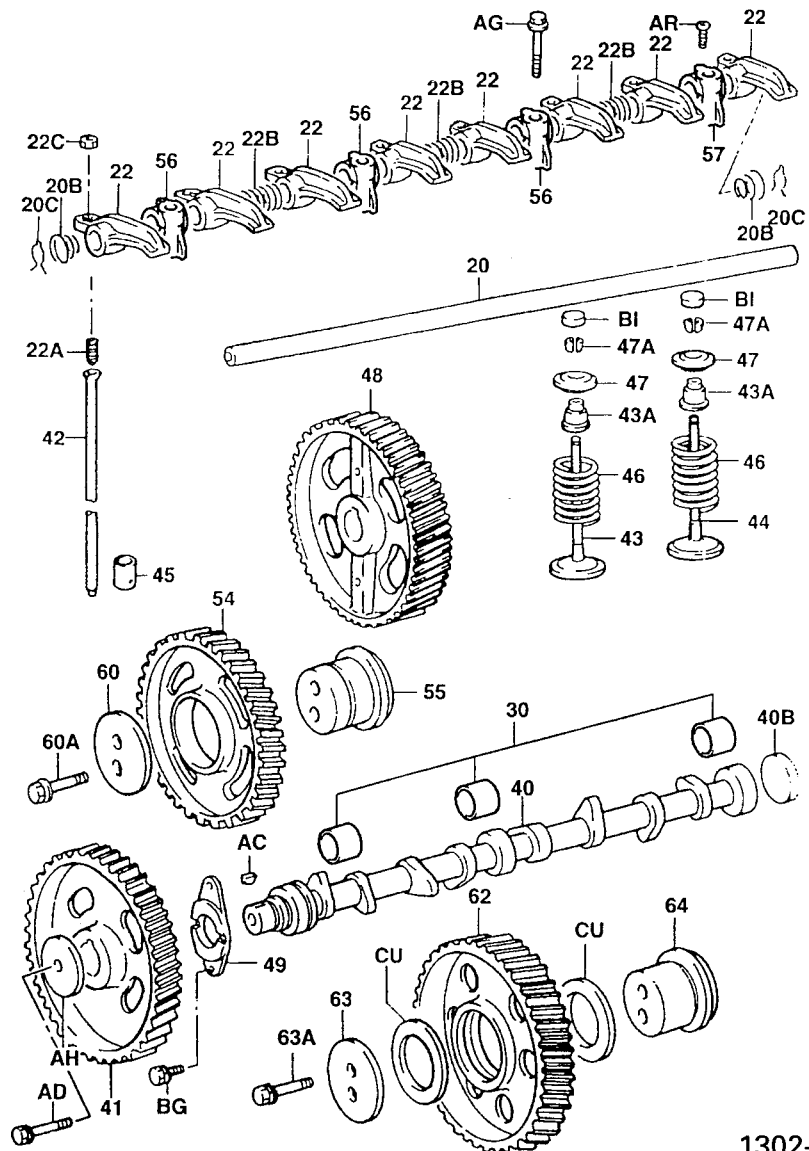
1104-099

1302

~1998. 7



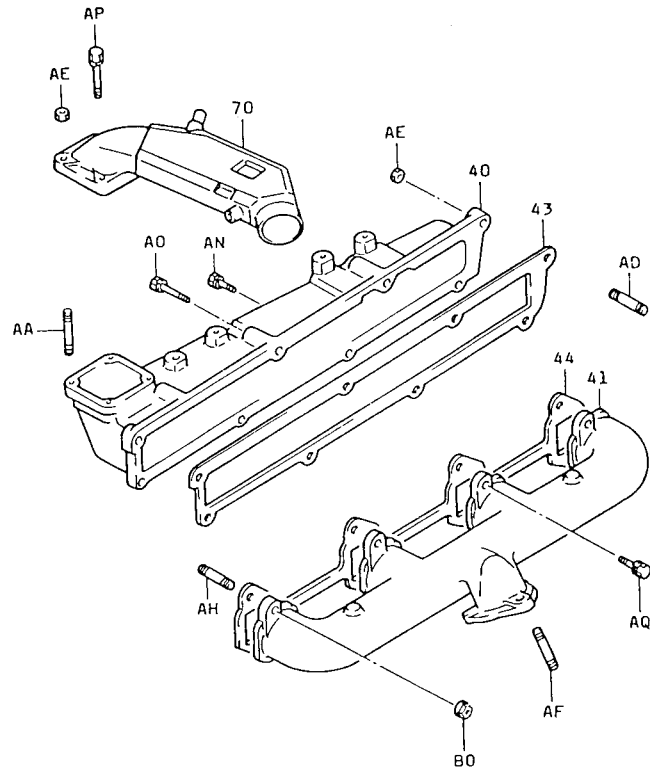
1998. 8~



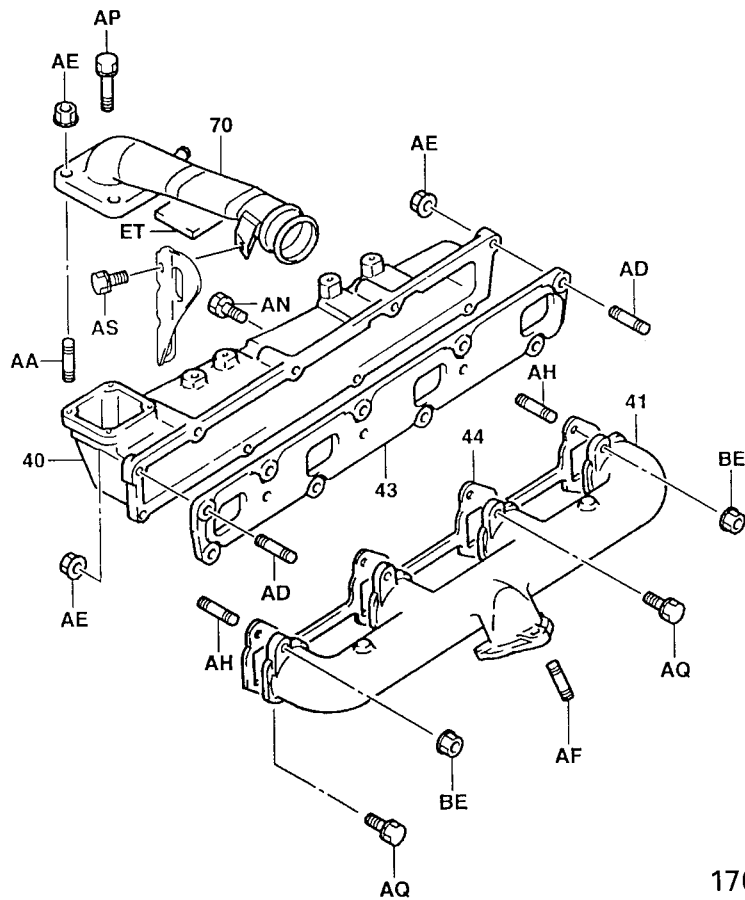
1302-091A

1701

~1998. 7



1998. 8~

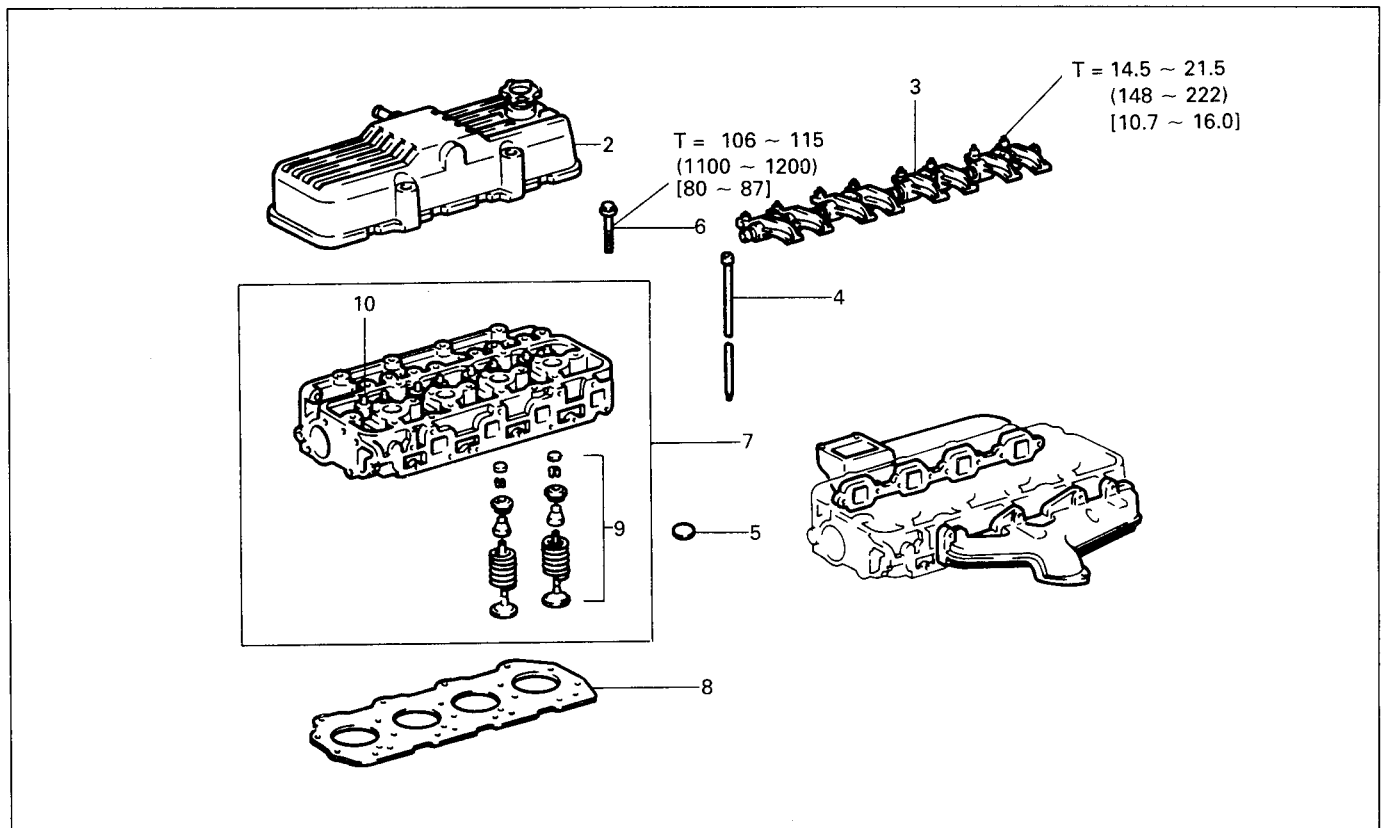


1701-115

CYLINDER HEAD REMOVAL AND INSTALLATION

Clean the disassembled parts before inspection and reassembly.

T = N·m (kg-cm) [ft-lb]



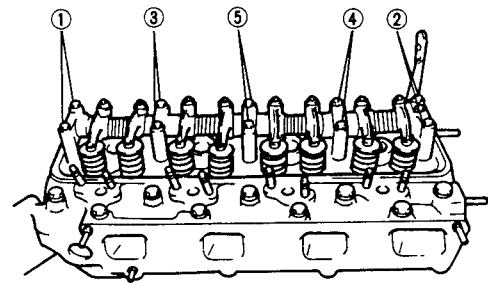
Removal Procedure

- 1 Remove items 1 to 9, 12 and 13 shown under ENGINE ACCESSORIES REMOVAL AND INSTALLATION.
- 2 Remove the cylinder head cover.
- 3 Remove the rocker shaft ASSY. **[Point 1]**
- 4 Remove the valve push rods. **[Point 2]**
- 5 Remove the valve stem caps. **[Point 3]**
- 6 Remove the cylinder head bolts. **[Point 4]**
- 7 Remove the cylinder head ASSY. **[Point 5]**
- 8 Remove the cylinder head gasket. **[Point 6]**
- 9 Remove the valve springs and valves. **[Point 7]**
- 10 Remove the valve stem oil seals. **[Point 8]**

Installation Procedure

Install components in the reverse order of removal.

6FD series



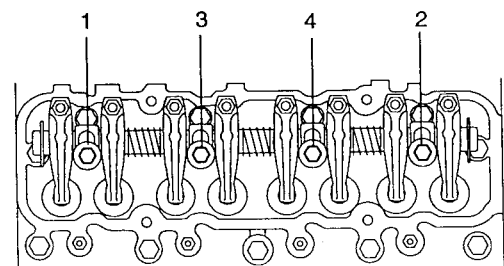
Point operations

[Point 1]

Disassembly: Loosen the support set bolts evenly in several steps in the order shown to the left.

Installation: Tighten the support set bolts evenly in several steps in the reverse order shown to the left.

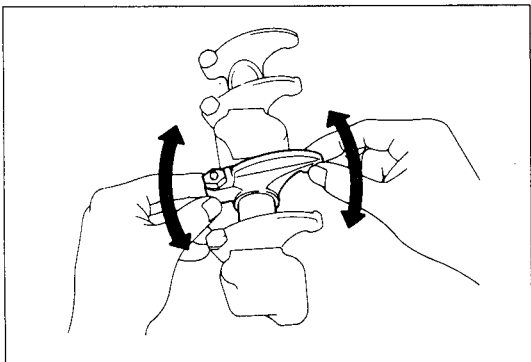
7FD series



Inspection:

1. Inspect the valve rocker arm ASSY.

- (1) Check the valve rocker arm for wear and damage on the contact area with the valve stem cap.
- (2) Repair minor scratches by polishing with an oil stone. Replace if worn or damaged beyond repair.
- (3) Move the rocker arm as shown and check the clearance between the rocker arm and the shaft. If the clearance is too large, disassemble and check the parts.



2. Check the oil clearance between the rocker arm and the rocker shaft.

- (1) Measure the inside diameter of the rocker arm.

Standard:

18.500 ~ 18.521 mm (0.72835 ~ 0.72917 in.)

Limit: 18.60 mm (0.7323 in.)

- (2) Measure the outside diameter of the rocker shaft.

Standard:

18.472 ~ 18.493 mm (0.72724 ~ 0.72807 in.)

Limit: 18.44 mm (0.7260 in.)

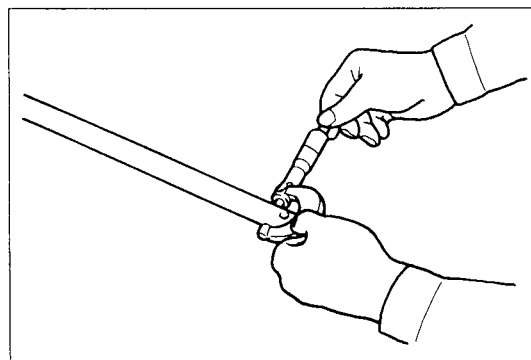
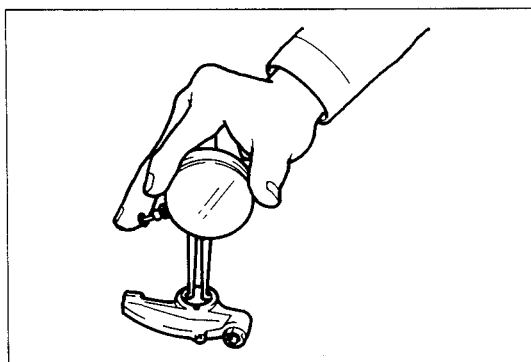
- (3) Calculate the oil clearance.

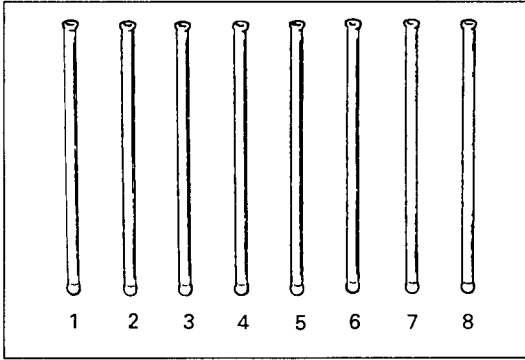
Standard:

0.007 ~ 0.049 mm (0.00028 ~ 0.00193 in.)

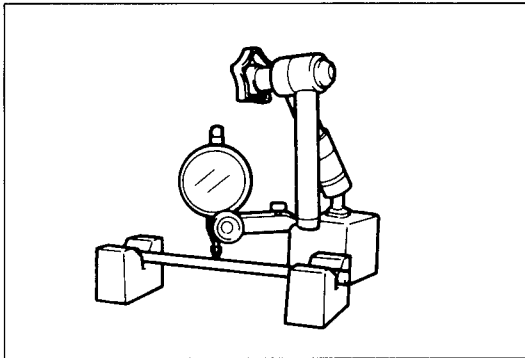
Limit: 0.16 mm (0.0063 in.)

If the limit is exceeded, replace the rocker arm or the rocker shaft.



**[Point 2]**

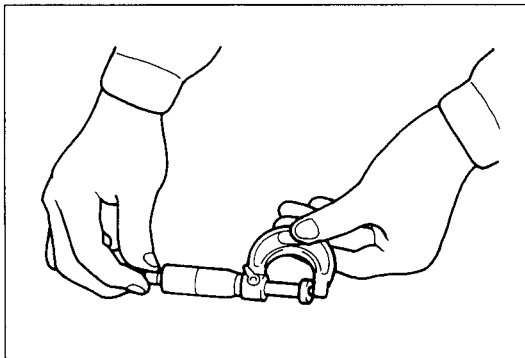
Disassembly: Keep the removed push rods carefully so they can be installed in a correct order.



Inspection: Check the push rods for bend. Measure the amount of bend per a full turn.

$$\text{Bend} = \frac{\text{Dial gauge deflection}}{2}$$

Limit: 0.25 mm (0.010 in.)

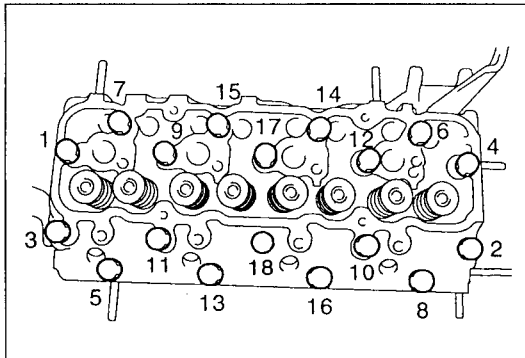
**[Point 3]**

Inspection:

1. Check the valve stem cap.
 - (1) Measure the thickness of the valve stem cap.

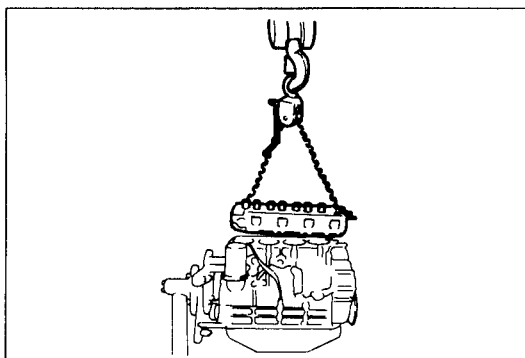
Standard: 1.31 ~ 1.49 mm (0.0547 ~ 0.0587 in.)

- (2) When a small scratch is found in contact areas with the rocker arm, repair it with an oil stone. If it is worn or damaged beyond repair, replace the valve stem cap.

**[Point 4]**

Disassembly: Untighten the cylinder head bolts evenly in 2 to 3 steps in the order shown to the left.

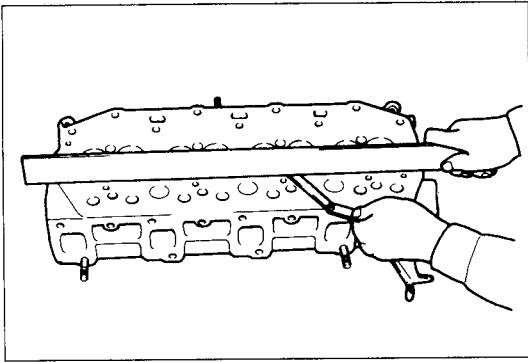
Installation: Tighten the cylinder head bolts evenly in 2 to 3 steps in the reverse order shown to the left.

**[Point 5]**

Disassembly: Separate the cylinder head from the cylinder block.

Note:

If necessary, pry the parts apart with a screwdriver, etc. Work carefully without damaging the cylinder head fitting surface.



Inspection:

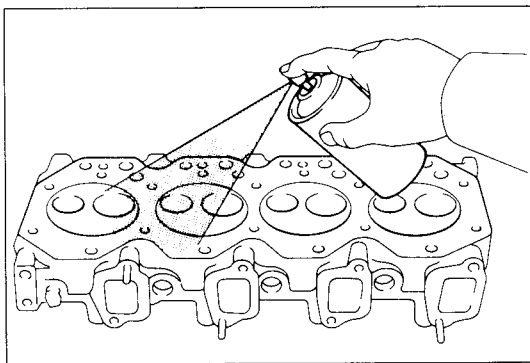
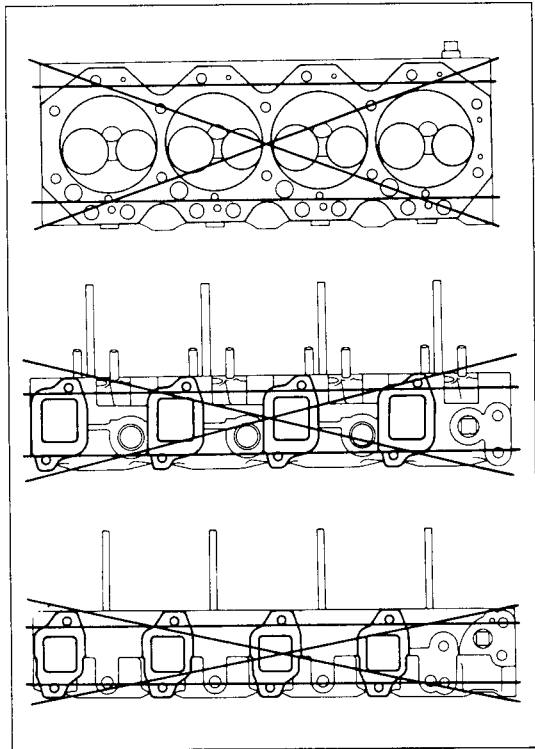
1. Check the cylinder head for distortion.
 - (1) Check distortion along the four edges and along the diagonal lines at the bottom of the cylinder head.

Limit: 0.15 mm (0.0059 in.)

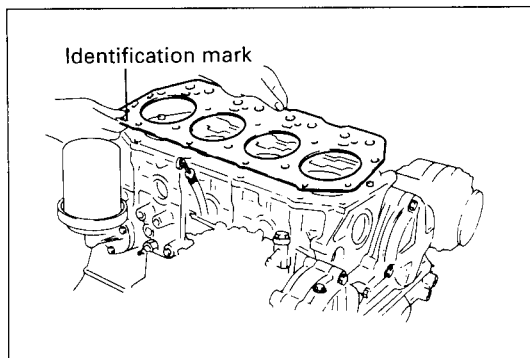
- (2) Check distortion in the manifold fitting surface.

Limit: 0.2 mm (0.008 in.)

If the limit is exceeded, repair or replace.



2. Check the cylinder head for cracks. Using the color check method (dye detection method), look for cracks in the combustion chamber, intake port, exhaust port, and the lower and upper cylinder head surfaces.



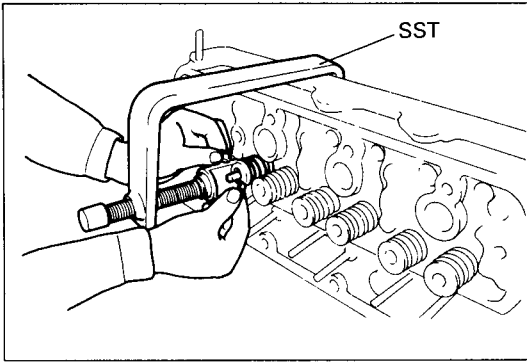
[Point 6]

Installation:

1. Always renew the gasket. Put the new gasket in the correct direction.

Note:

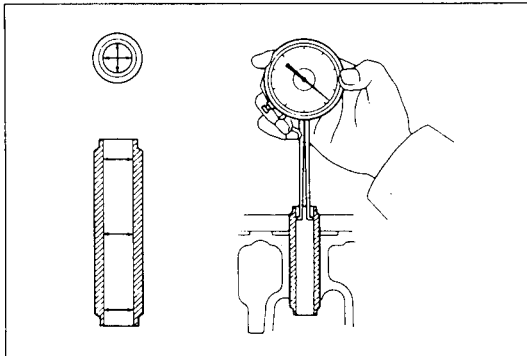
Replacement gaskets only have two holes.



[Point 7]

Disassembly and installation: SST 09202-76001-71
(SST 09202-43013)

Disassembly: Keep the removed parts in cylinder groups.



Inspection:

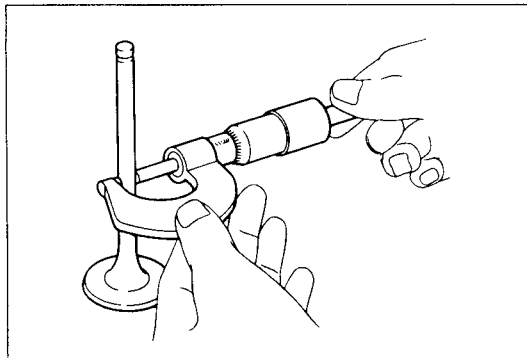
1. Check the oil clearance between the valve guide bushing and the valve stem.

(1) Measure the inside diameter of the valve guide bushing.

Standard:

IN: 9.01 ~ 9.03 mm (0.3547 ~ 0.3555 in.)

EX: 9.01 ~ 9.03 mm (0.3547 ~ 0.3555 in.)

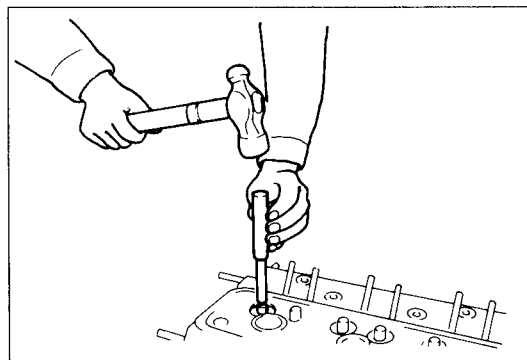


(2) Measure the outside diameter of the valve stem.

Standard:

IN: 8.97 ~ 8.99 mm (0.3531 ~ 0.3539 in.)

EX: 8.95 ~ 8.97 mm (0.3523 ~ 0.3531 in.)



(3) Calculate the oil clearance.

Standard:

IN: 0.02 ~ 0.06 mm (0.0008 ~ 0.0024 in.)

EX: 0.04 ~ 0.08 mm (0.0016 ~ 0.0031 in.)

Limit:

IN: 0.10 mm (0.0039 in.)

EX: 0.12 mm (0.0047 in.)

If the limits are exceeded, replace the valve stem or the valve guide bushing. If necessary, dress the inside diameter using a reamer until the standard oil clearance is met between the bushing and the valve stem.

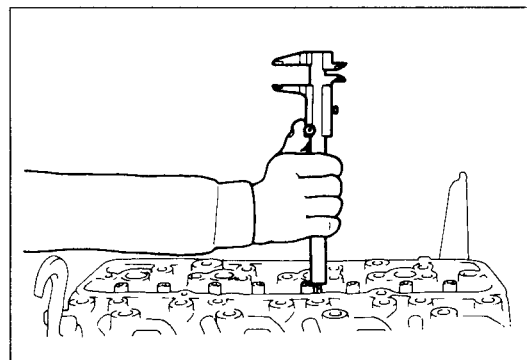
- Valve guide bushing replacement

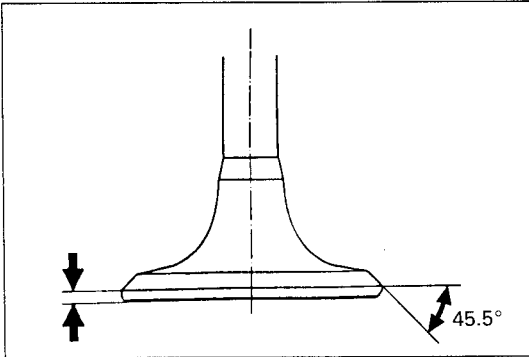
SST 09201-76006-71

(SST 09201-60011)

- Measure the amount of protrusion of the valve guide bushing.

Standard: 15.5 mm (0.610 in.)



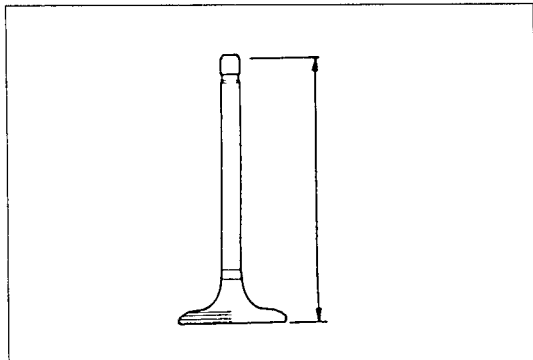


2. Valve inspection
(1) Measure the thickness of the valve head.

Limit:

IN: 0.9 mm (0.035 in.)

EX: 1.0 mm (0.039 in.)



- (2) Measure the overall length of the valve.

Standard:

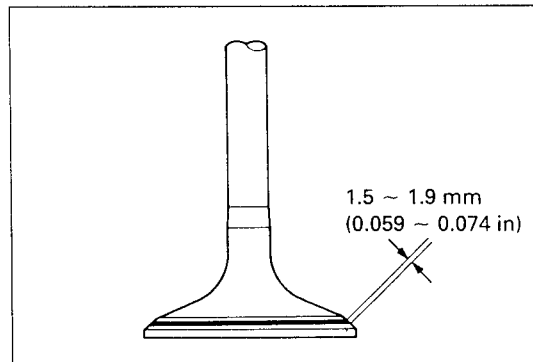
IN: 121.94 mm (4.8008 in.)

EX: 121.84 mm (4.7969 in.)

Limit:

IN: 121.3 mm (4.7756 in.)

EX: 121.2 mm (4.7717 in.)



3. Valve seat inspection
(1) Apply a thin coat of red lead on the valve face.
(2) Insert the valve into the valve guide bushing, and push the valve against the valve seat.

Note:

Do not rotate the valve while it is being pushed.

- (3) Check that the standard contact is met along the entire circumference.

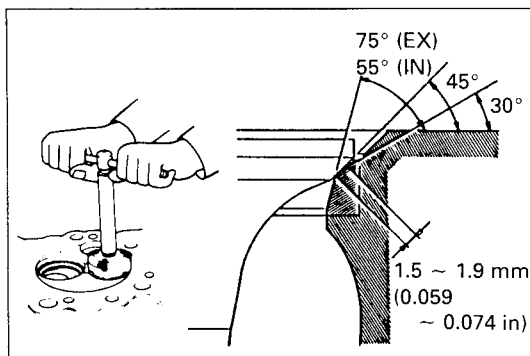
Standard:

IN, EX 1.5 ~ 1.9 mm (0.059 ~ 0.074 in.)

If the standard is not satisfy, replace the valve or correct the valve seat.

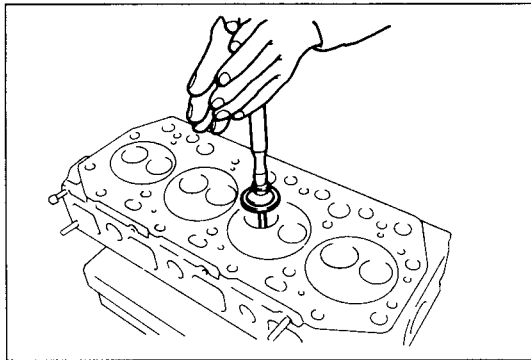
4. Valve seat correction

- (1) Use a 45° valve seat cutter for refacing.
(2) If the contact position is deviated inside, use a 55° cutter (for IN) or 75° cutter (for EX) for refacing. If the contact position is deviated outside, use a 30° cutter.



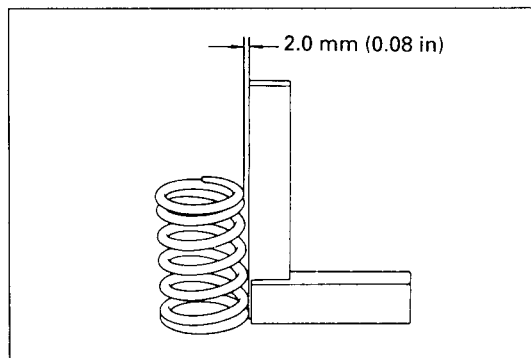
Notes:

- Use a cutter with a cemented carbide tip on the EX side.
- Proceed carefully while checking the valve contact positions and contact.
- Cut the face evenly without undulation by gradually releasing the force toward the end of refacing.
- Check the valve guide bushing before correction.



5. Valve lapping

- (1) Use a compound for fitting. Use red lead for checking uniform contact with the valve along the entire circumference.



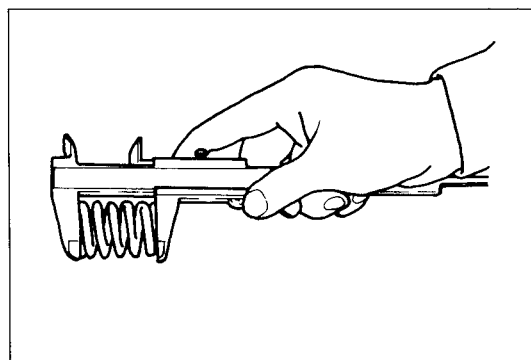
6. Compression spring inspection

- (1) Check squareness at the upper end of the spring.

Limit:

IN: 2.0 mm (0.08 in.)

EX: 2.0 mm (0.08 in.)



- (2) Measure the free length.

Standard:

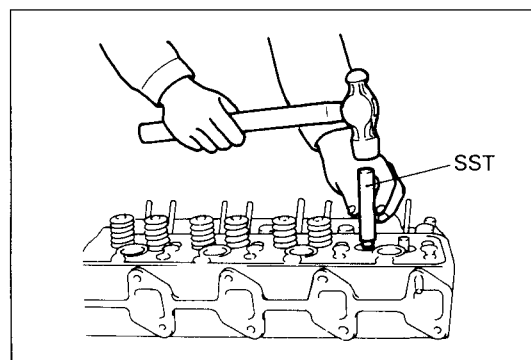
IN: 45.1 mm (1.776 in.)

EX: 45.1 mm (1.776 in.)

Limit:

IN: 44.5 mm (1.752 in.)

EX: 44.5 mm (1.752 in.)



[Point 8]

Disassembly: Pry oil seals off with a slight force using a flat blade screwdriver.

Installation:

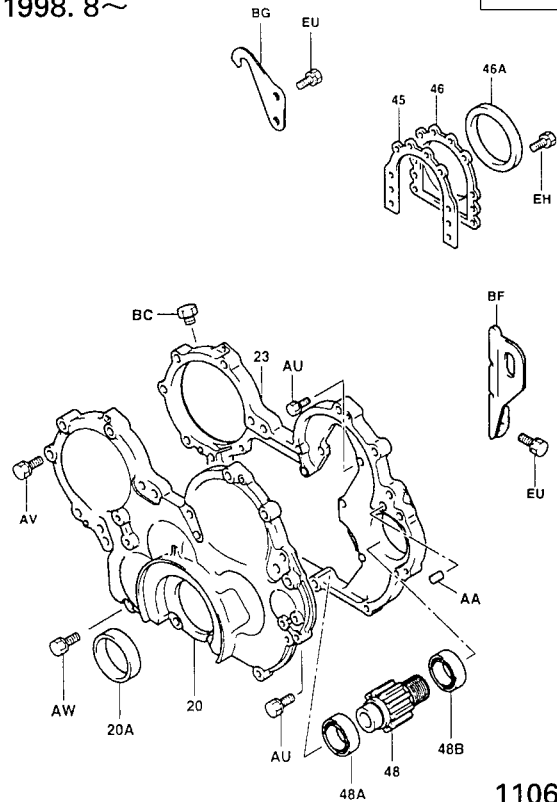
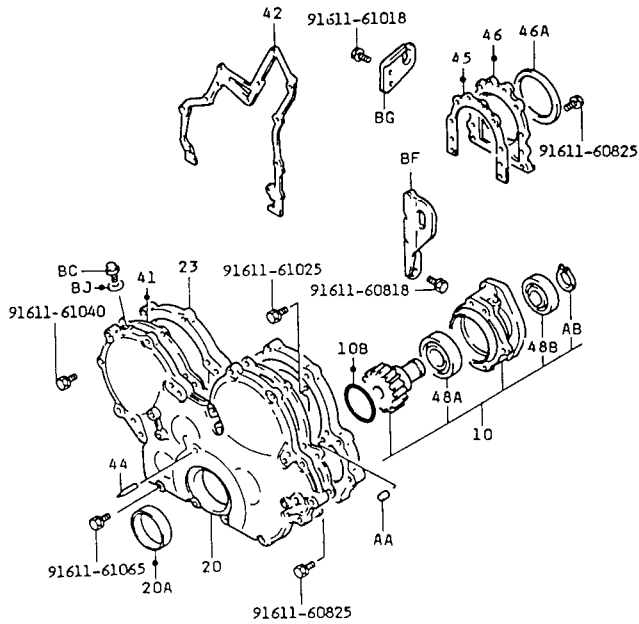
1. SST 09201-76005-71 (SST 09201-58010)
2. Coat engine oil on the lips of the new valve stem oil seal and the valve stem.

TIMING GEAR COMPONENTS

1106

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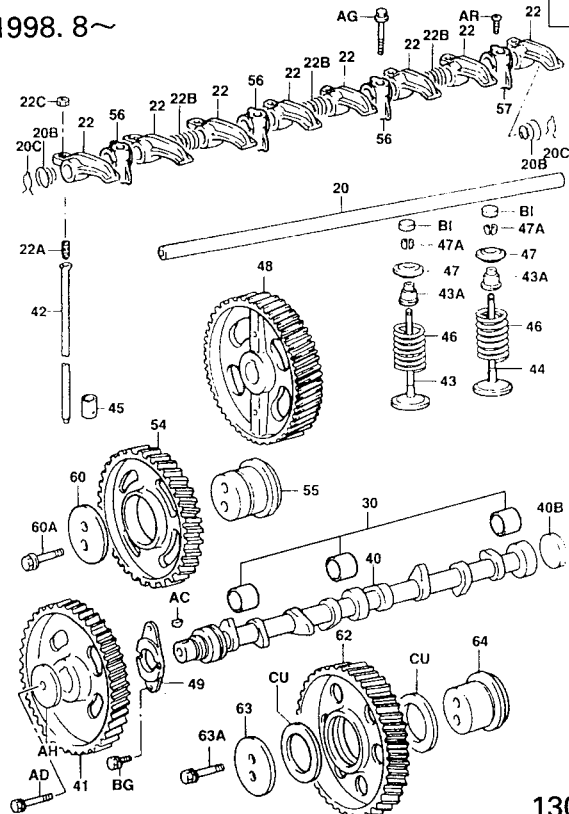
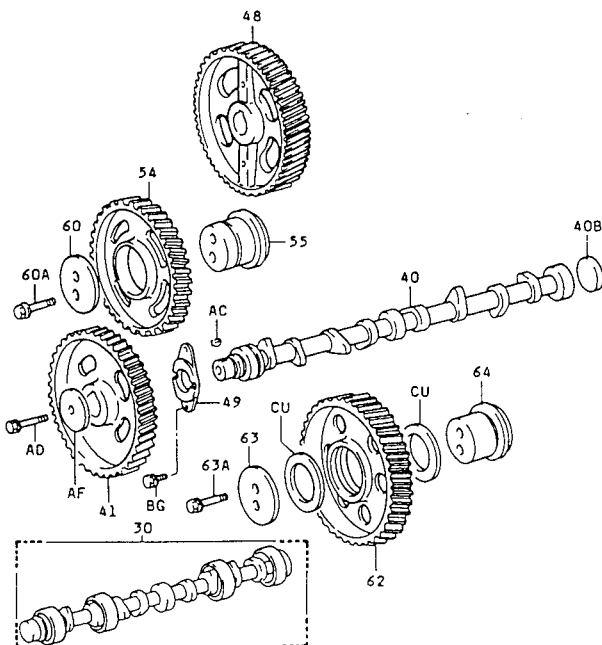


1106-121

~1998. 7

1998. 8~

1302

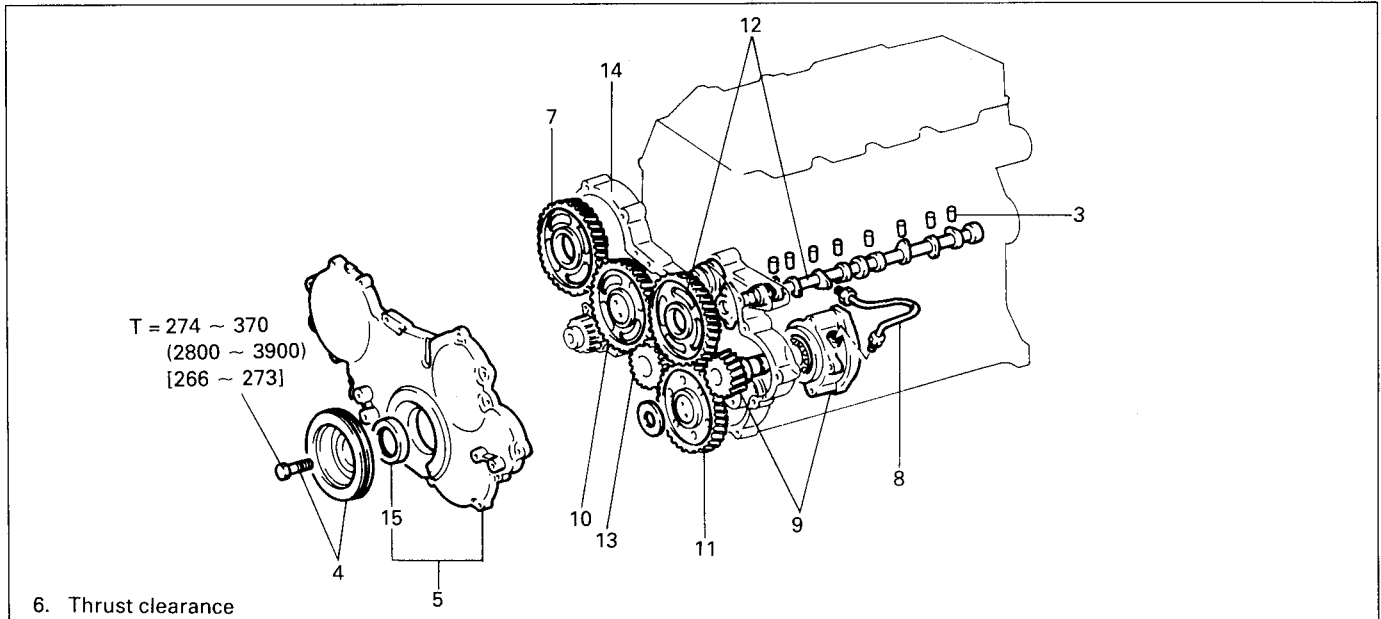


1302-091A

TIMING GEAR REMOVAL AND INSTALLATION

Clean disassembled parts before inspection and reassembly

T = N·m (kg-cm) [ft-lb]

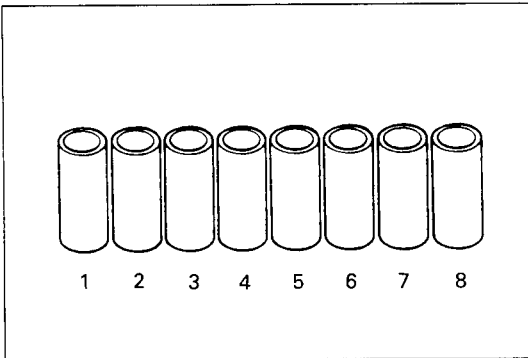


Removal Procedure

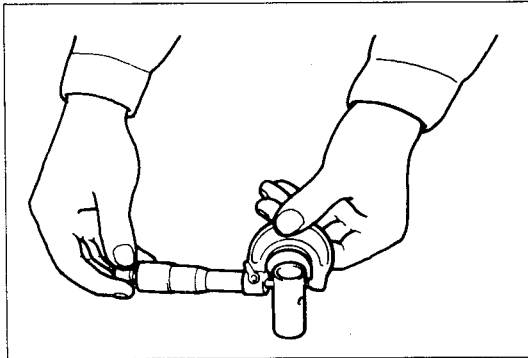
- 1 Remove the fan pulley, V-belt and alternator. (See P2-2)
- 2 Remove the cylinder head ASSY, intake and exhaust manifolds. (See P2-8)
- 3 Remove the valve lifter. **[Point 1]**
- 4 Remove the crankshaft pulley with set bolt. **[Point 2]**
- 5 Remove the timing gear cover. **[Point 11]**
- 6 Measure the backlash and thrust clearance. **[Point 3]**
- 7 Remove the injection pump with drive gear. **[Point 4]**
- 8 Disconnect the oil pipe.
- 9 Remove the PTO pump flange with drive gear. (Until July 1998) **[Point 5]**
Remove the PTO pump drive gear. (Since August 1998)
- 10 Remove idle gear No. 1 and shaft. **[Point 6]**
- 11 Remove idle gear No. 2 plate washer and shaft. **[Point 7]**
- 12 Remove the camshaft with timing gear. **[Point 8]**
- 13 Remove the crankshaft timing gear. **[Point 9]**
- 14 Remove the timing gear case. **[Point 11]**
- 15 Remove the front oil seal. **[Point 10]**

Installation Procedure

Install components in the reverse order of removal.

**[Point 1]**

Disassembly: Keep the removed valve lifters carefully so they can be installed in a correct order.



Inspection:

1. Check the valve lifter oil clearance.

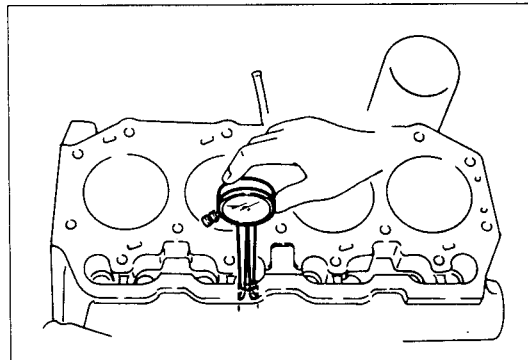
(1) Measure the outside diameter of the valve lifter.

Standard:

22.170 ~ 22.190 mm (0.8728 ~ 0.8736 in.)

O/S lifter standard:

22.220 ~ 22.235 mm (0.8748 ~ 0.8754 in.)



(2) Measure the inside diameter of the cylinder block lower hole.

Standard:

22.200 ~ 22.221 mm (0.87401 ~ 0.87484 in.)

(3) Calculate the valve lifter oil clearance.

Standard:

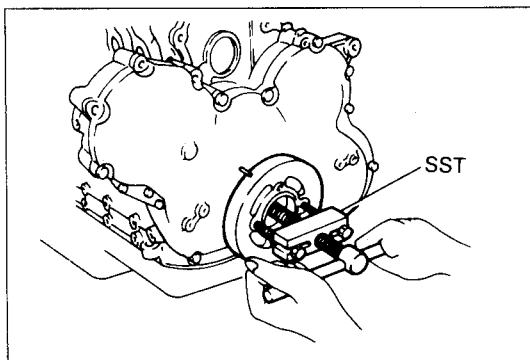
0.010 ~ 0.051 mm (0.00039 ~ 0.00201 in.)

Limit: 0.1 mm (0.004 in.)

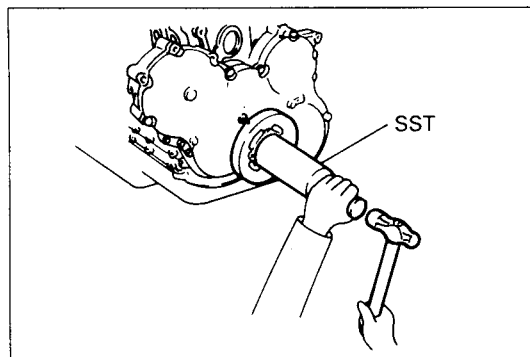
If the limit is exceeded, replace with STD or O/S valve lifter.

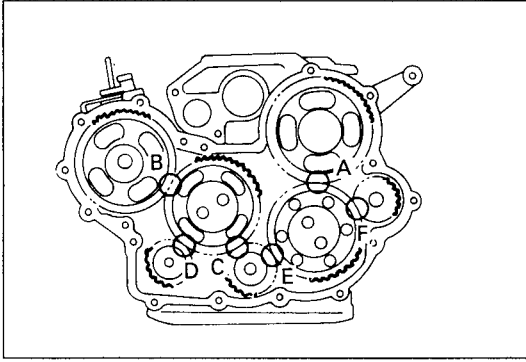
[Point 2]

Disassembly: SST 09213-76007-71
(SST 09213-60017)



Installation: SST 09150-10170-71



**[Point 3]**

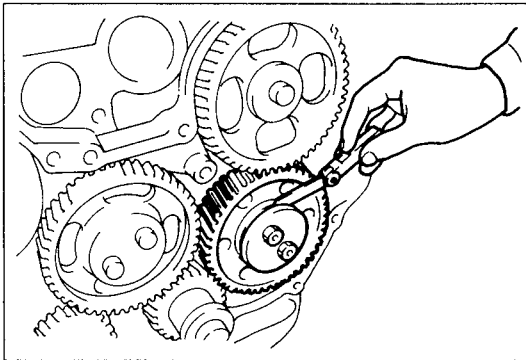
Inspection:

1. Measure gear backlash before removal and after installation.

Standard backlash and limit

mm (in.)

Measuring point	Standard	Limit
A	0.05 (0.0020)	0.3 (0.0012)
B	0.05 (0.0020)	0.3 (0.0012)
C	0.05 (0.0020)	0.3 (0.0012)
D	0.05 (0.0020)	0.3 (0.0012)
E	0.05 (0.0020)	0.3 (0.0012)
F	0.05 (0.0020)	0.3 (0.0012)



2. Measure thrust clearance of idle gear No. 1 and No. 2.

Standard:

No. 1: 0.03 ~ 0.09 mm (0.0012 ~ 0.0035 in.)

No. 2: 0.10 ~ 0.26 mm (0.0039 ~ 0.0102 in.)

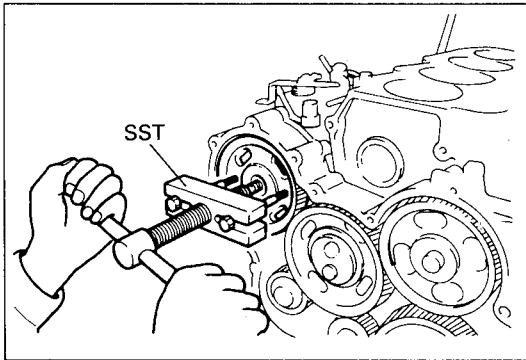
Limit:

No. 1: 0.3 mm (0.012 in.)

No. 2: 0.5 mm (0.020 in.)

[Point 4]

Disassembly: Replace the injection pump drive gear.
SST 09213-76007-71
(SST 09213-60017)

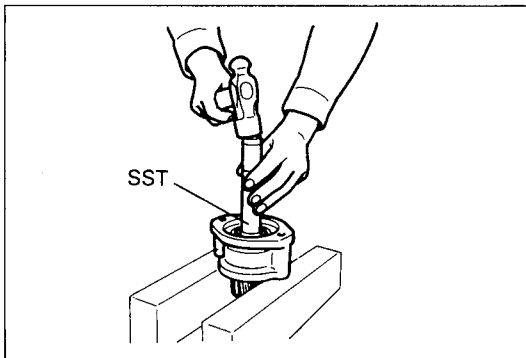
**[Point 5]**

Disassembly:

1. Remove the drive gear. (Until July 1998.)

SST 09620-76001-71

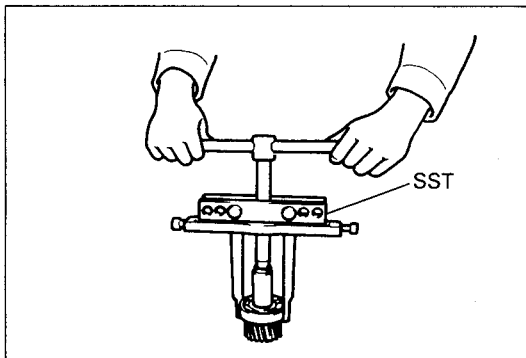
(SST 09620-30010)

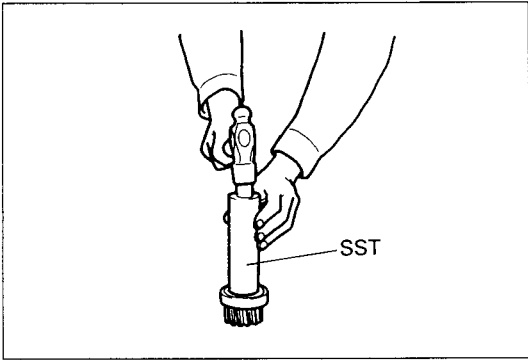


2. Remove the bearing.

SST 09950-76012-71

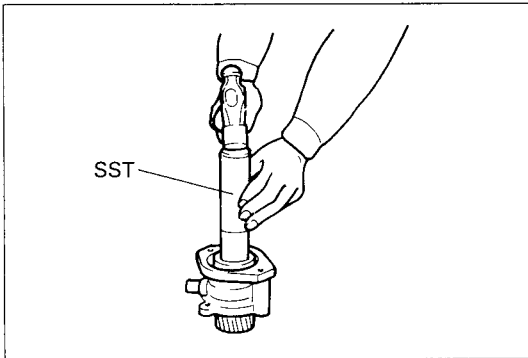
(SST 09950-20017)





Installation:

1. Install the bearing.
SST 09608-76009-71
(SST 09608-35014)



2. Install the drive gear with bearing.
SST 09608-76008-71
(SST 09608-30012)

[Points 6 and 7]

Inspection:

1. Check the idle gear oil clearance.
 - (1) Measure the inside diameter of the idle gear.

Standard:

- No. 1: 50.000 ~ 50.025 mm
(1.96700 ~ 1.96948 in.)
No. 2: 50.000 ~ 50.025 mm
(1.96700 ~ 1.96948 in.)

- (2) Measure the outside diameter of the idle gear shaft.

Standard:

- No. 1: 49.950 ~ 49.975 mm
(1.96653 ~ 1.9675 in.)
No. 2: 49.930 ~ 49.945 mm
(1.96574 ~ 1.96633 in.)

- (3) Calculate the oil clearance.

Standard:

- No. 1: 0.025 ~ 0.075 mm
(0.00098 ~ 0.00295 in.)
No. 2: 0.055 ~ 0.095 mm
(0.0217 ~ 0.00374 in.)

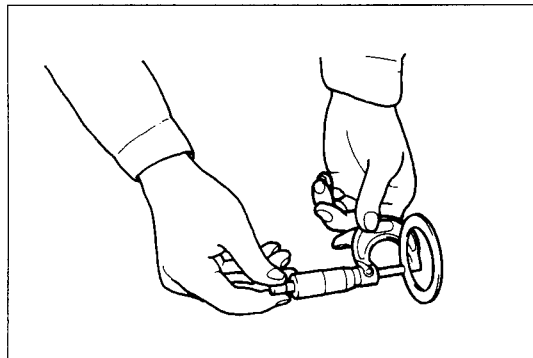
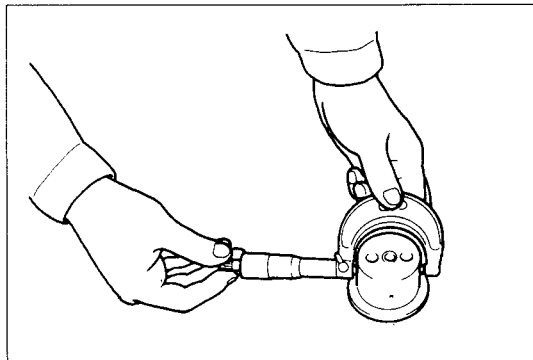
Limit: 0.3 mm (0.012 in.)

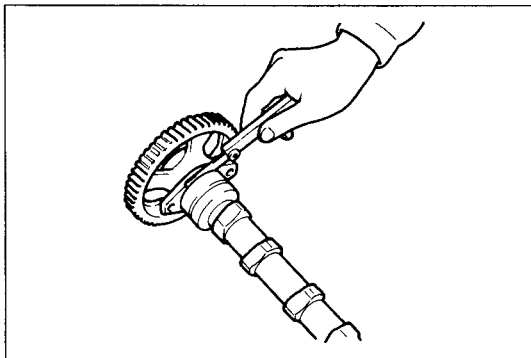
2. Measure the plate washer thickness.

Standard: 2.45 ~ 2.50 mm (0.0964 ~ 0.0984 in.)

Installation:

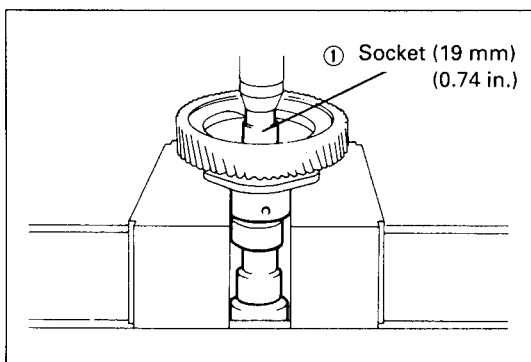
1. Install the idle gears. When doing so, align the sealed matching marks with the marks on the other gears.
2. After installing the plate washer of idle gear No. 2, confirm that the gear rotates.



**[Point 8]**

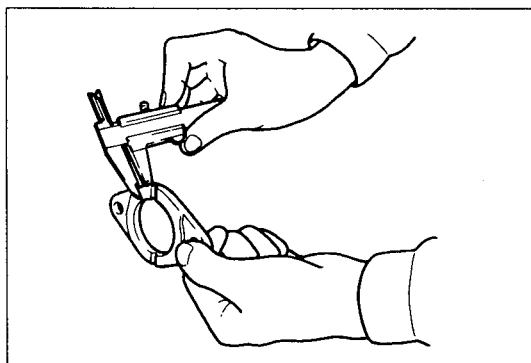
Inspection:

1. Check the camshaft thrust clearance.

Standard: 0.06 ~ 0.13 mm (0.0024 ~ 0.0051 in.)**Limit:** 0.3 mm (0.012 in.)

2. If the camshaft thrust clearance exceeds the limit, measure the thrust plate thickness.

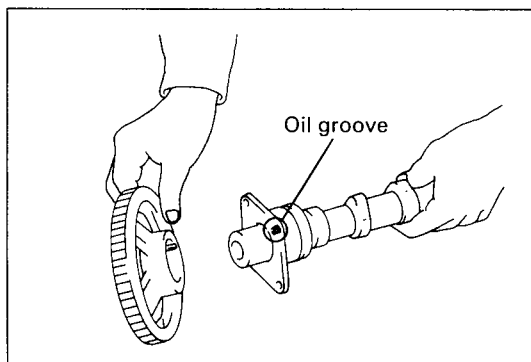
- (1) Remove the camshaft timing gear using a press.



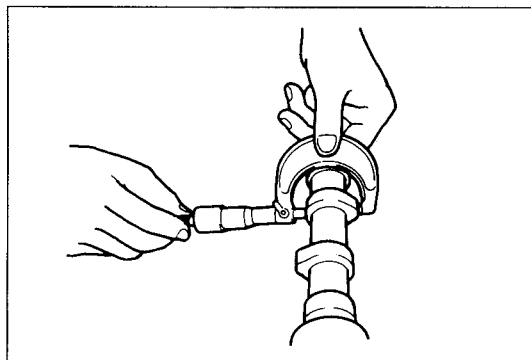
- (2) Measure the thrust plate thickness.

Standard: 6.97 ~ 7.00 mm (0.2744 ~ 0.2756 in.)

If the standard is not satisfy, replace the thrust plate.
If the standard is met, replace the camshaft or the camshaft timing gear.

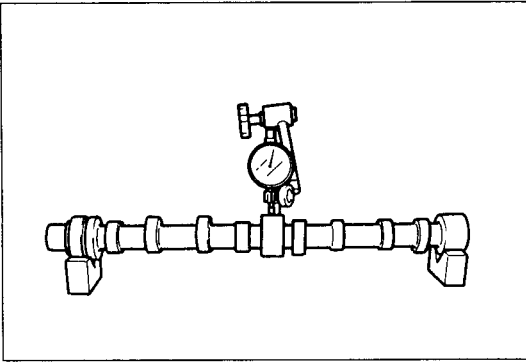


- (3) Install the thrust plate with the oil groove facing the gear.



3. Measure the cam height.

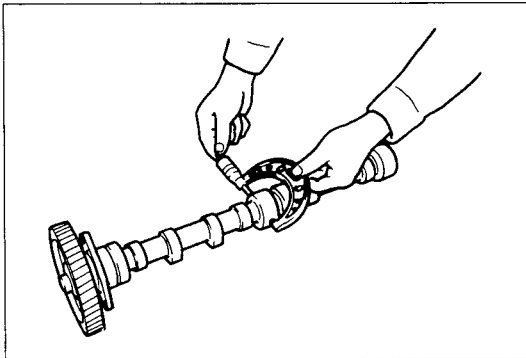
Standard:**IN:** 41.912 ~ 42.012 mm (1.65008 ~ 1.65401 in.)**EX:** 42.777 ~ 42.877 mm (1.68413 ~ 1.68807 in.)**Limit:****IN:** 41.45 mm (1.6319 in.)**EX:** 42.31 mm (1.6657 in.)



4. Check the camshaft for bend.

$$\text{Bend} = \frac{\text{Dial gauge deflection}}{2}$$

Limit: 0.04 mm (0.0016 in.)



5. Check the camshaft bearing oil clearance.

- (1) Measure the outside diameter of the camshaft journal.

Standard:

No. 1 (front) 51.151 ~ 51.170 mm
(2.01381 ~ 2.01456 in.)

No. 2 (center) 50.951 ~ 50.970 mm
(2.00594 ~ 2.00669 in.)

No. 3 (rear) 50.751 ~ 50.770 mm
(1.99807 ~ 1.99881 in.)

- (2) Measure the inside diameter of the camshaft bearing.

Standard:

No. 1 (front) 51.200 ~ 51.230 mm
(2.01574 ~ 2.01693 in.)

No. 2 (center) 51.000 ~ 51.030 mm
(2.00787 ~ 2.00905 in.)

No. 3 (rear) 50.800 ~ 50.830 mm
(2.00015 ~ 2.00118 in.)

- (3) Calculate the oil clearance.

Standard:

0.030 ~ 0.079 mm (0.00118 ~ 0.00311 in.)

Limit: 0.1 mm (0.0041 in.)

If the limit is exceeded, replace the bearing. If a serious streak or burnout is found on the camshaft journal, grind the camshaft journal and replace the bearing with a U/S bearing.

- (4) Remove the camshaft expansion plug.

SST 09215-76001-71

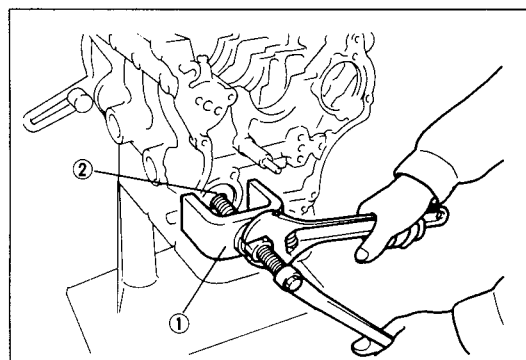
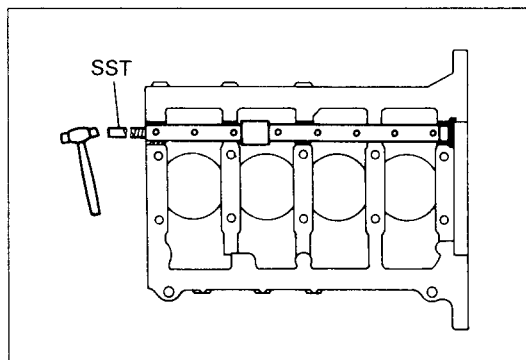
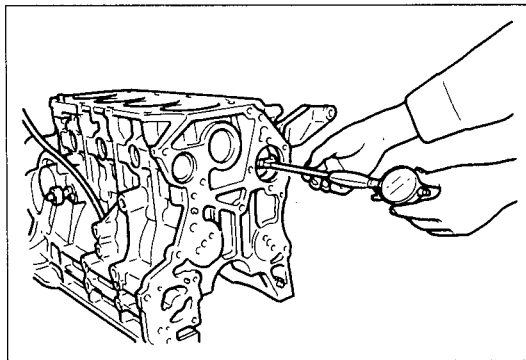
(SST 09215-00012)

- (5) Remove the camshaft bearing.

① : SST 09215-76001-71

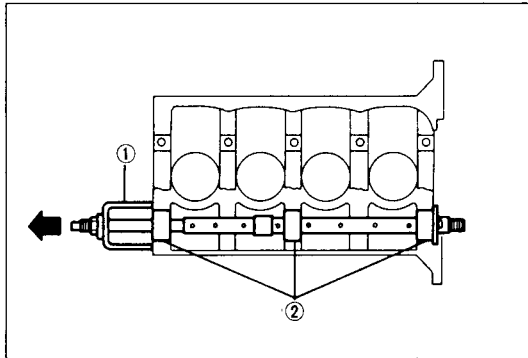
(SST 09215-00012)

② : SST 09112-23660-71



Camshaft bearing replacement

Bearing type	Standard outside diameter of camshaft journals mm (in.)		
	No. 1	No. 2	No. 3
STD	51.151 ~ 51.170 (2.01381 ~ 2.01456)	50.951 ~ 50.970 (2.00594 ~ 2.00669)	50.751 ~ 50.770 (1.99807 ~ 1.99881)
U/S	51.026 ~ 51.045 (2.00889 ~ 2.00964)	50.826 ~ 50.845 (2.00101 ~ 2.00177)	50.626 ~ 50.645 (1.99315 ~ 1.99389)
U/S	50.901 ~ 50.920 (2.00397 ~ 2.00472)	50.701 ~ 50.720 (1.99610 ~ 1.99685)	50.501 ~ 50.520 (1.98822 ~ 1.98897)



(6) Install the camshaft bearing.

① : SST 09215-76001-71

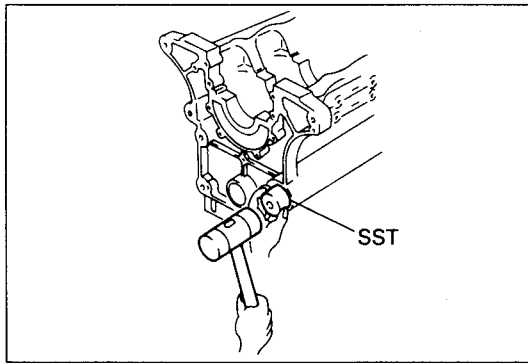
(SST 09215-00012)

② : SST 09112-23660-71

Notes:

• Align the oil holes of the bearing and of the cylinder block.

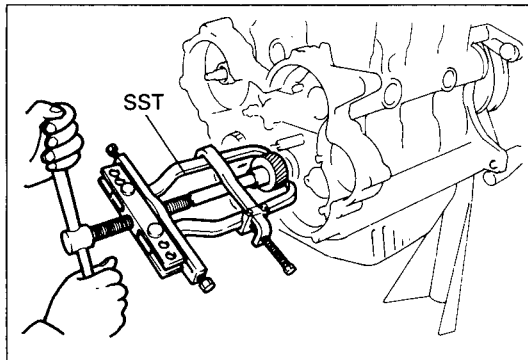
• Install camshaft bearing No. 1, 2, and 3 in this order.



(7) Install the camshaft expansion plug.

SST 09215-76001-71

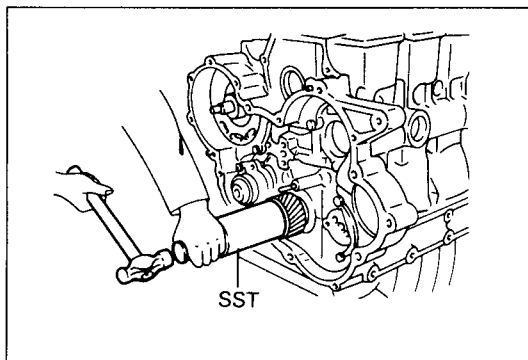
(SST 09215-00012)



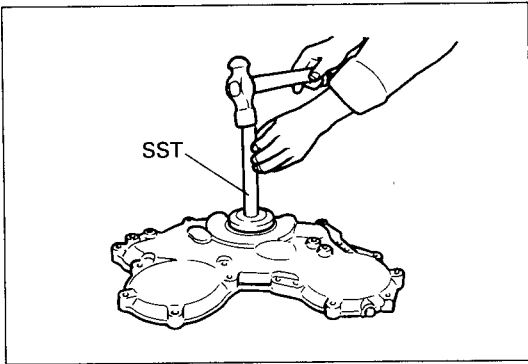
[Point 9]

Disassembly: SST 09950-76012-71

(SST 09950-20017)



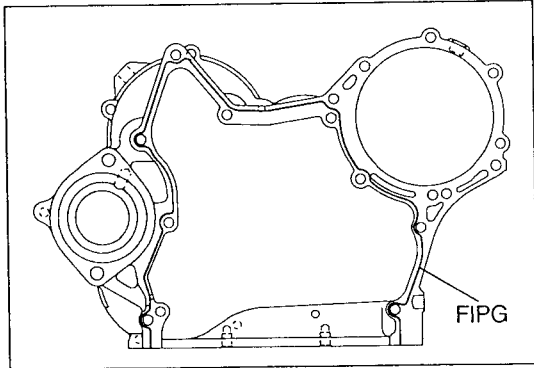
Installation: SST 09370-20270-71

**[Point 10]**

Installation: SST 09608-76009-71
(SST 09608-35014)

Note:

Apply a thin coat of MP grease on the oil seal lips.

**[Point 11]**

Installation: Install the gear cover and gear case.
1998.8~

- (1) Scrape off FIPG adhering to the cover, case and the cylinder block.
Remove the gasket very carefully to prevent gasket debris from entering the engine.
- (2) Apply a new coat of FIPG to the cover and case.
Part No. 08826-76001-71
(08826-00080)

Methods of coating and parts installation

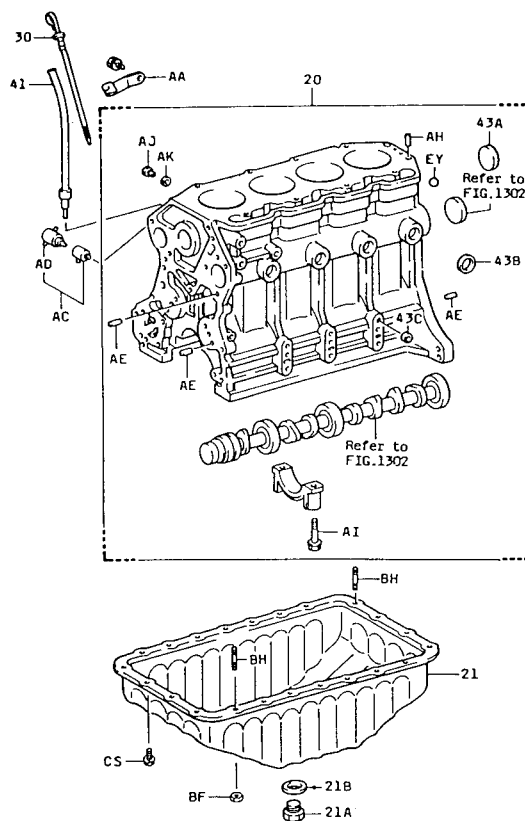
- ① Thoroughly clean parts and mating surfaces to keep them free of moisture and dirt.
- ② Coat FIPG on the part being installed.
Coat it inside bolt holes also.
- ③ Avoid overcoating or undercoating.
Always overlap the starting and ending coats.
- ④ Do not move parts after they are assembled by means of FIPG.
- ⑤ Assemble parts within three minutes after coating.
- ⑥ Allow at least 30 minutes before pouring coolant and oil and starting the engine.

CYLINDER BLOCK

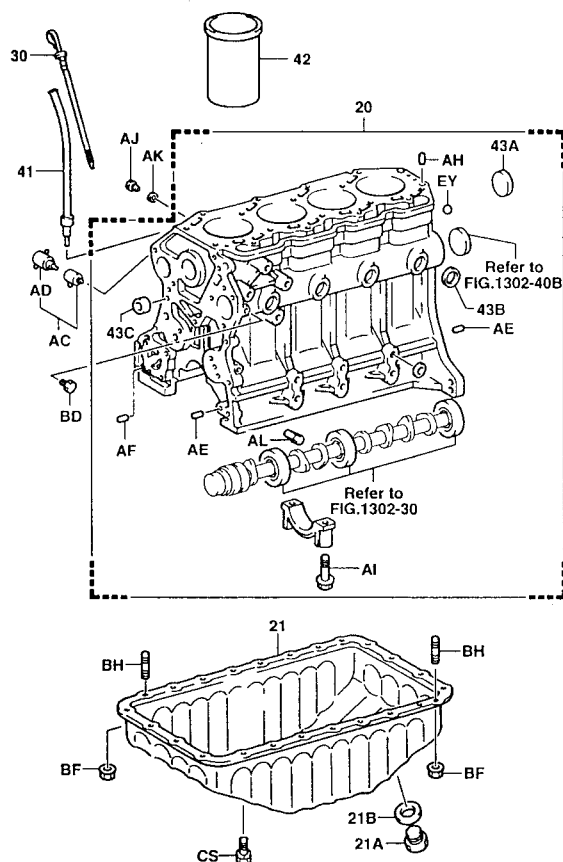
COMPONENTS

1105

~1998. 7

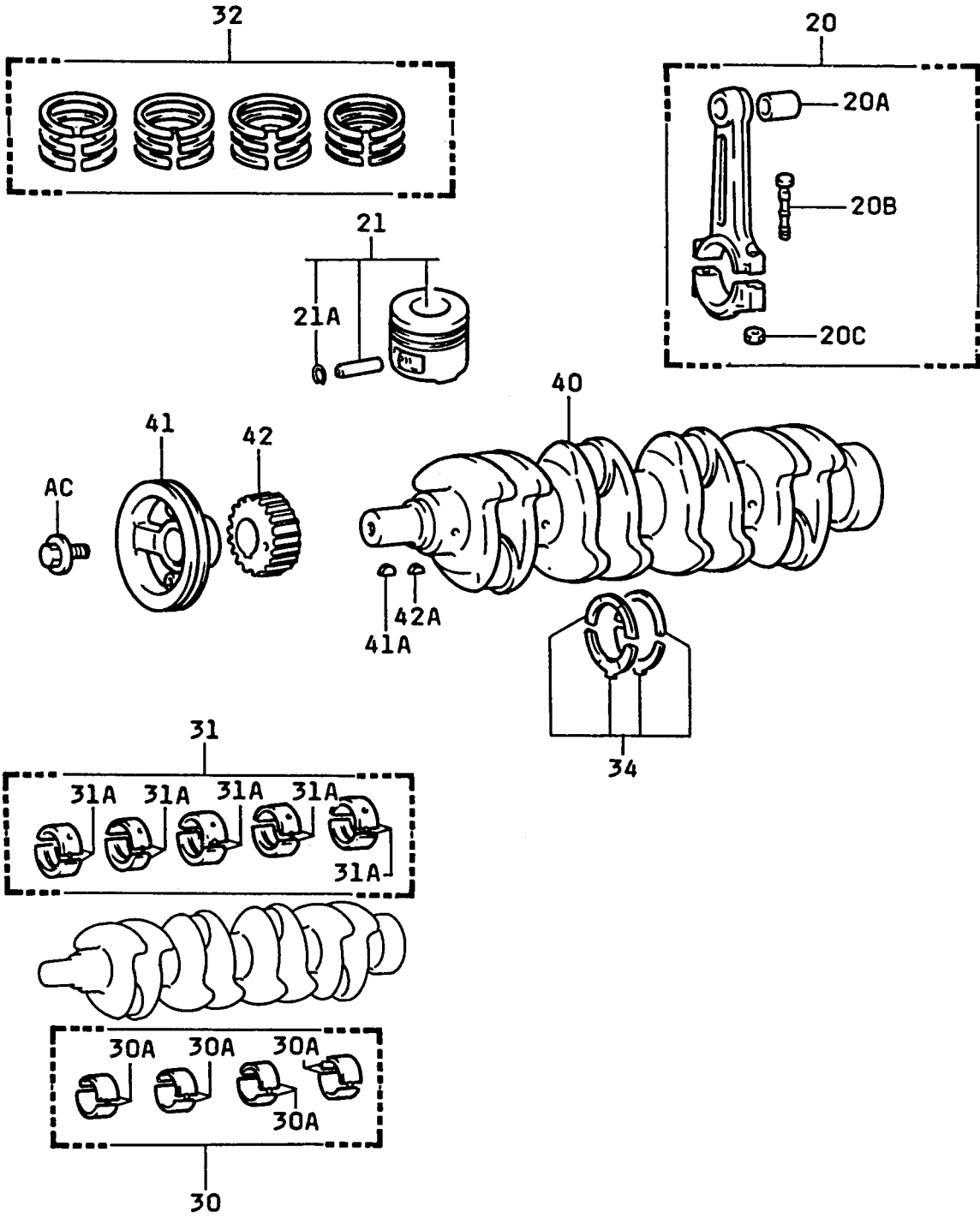


1998. 8~



1105-154B

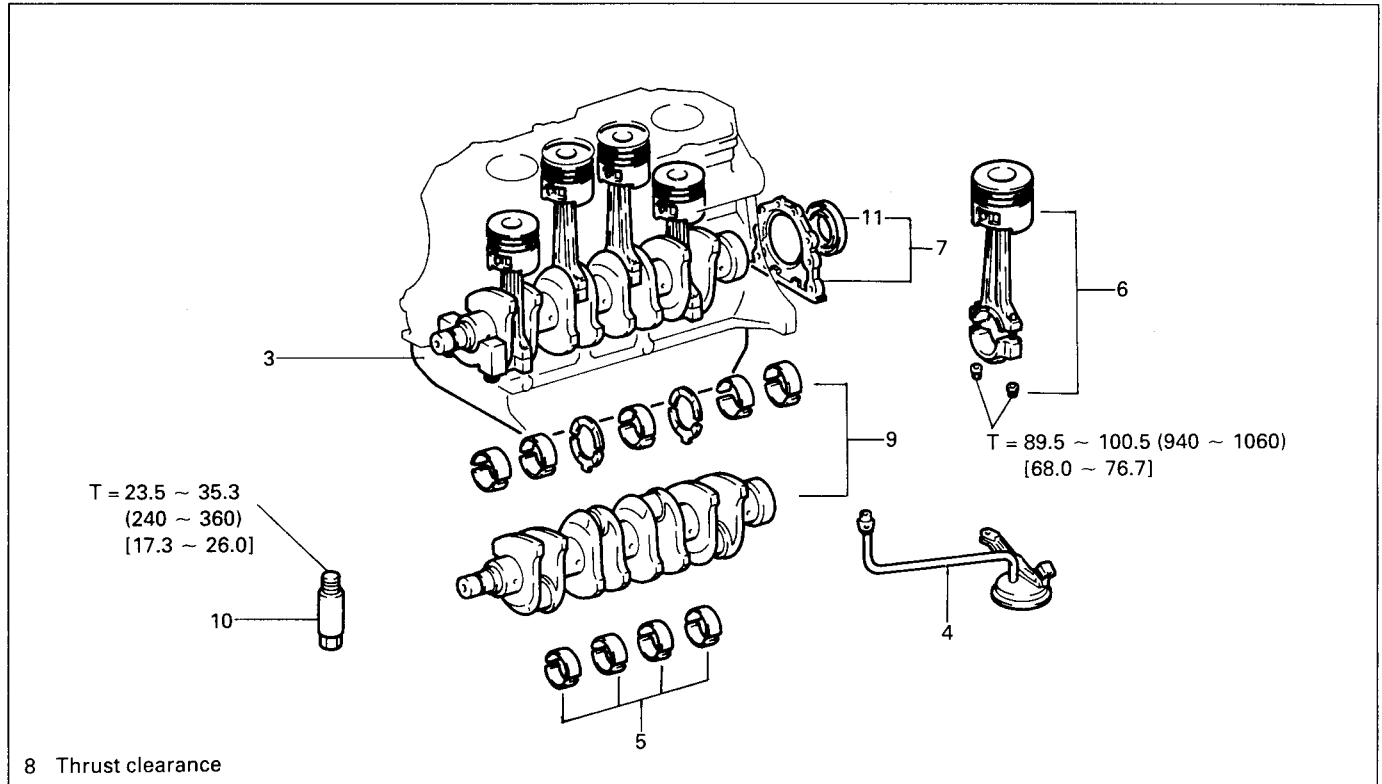
1301



CYLINDER BLOCK REMOVAL AND INSTALLATION

Clean the disassembled parts before inspection and reassemble

T = N·m (kg·cm) [ft·lb]

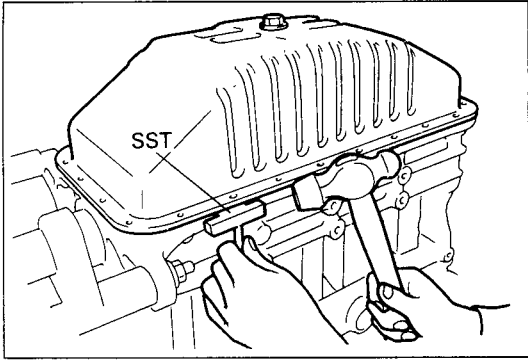


Removal Procedure

- 1 Remove the cylinder head ASSY. (See P2-8)
- 2 Remove the timing gears. (See P2-16)
- 3 Remove the oil pan. **[Point 1]**
- 4 Remove the oil strainer.
- 5 Remove the connecting rod cap with bearing. **[Point 2]**
- 6 Remove the piston with connecting rod. **[Point 3]**
- 7 Remove the rear oil seal retainer.
- 8 Measure the crankshaft thrust clearance. **[Point 4]**
- 9 Remove the crankshaft with cap, bearing, and thrust plate. **[Point 5]**
- 10 Remove the oil regulator.
- 11 Remove the rear oil seal. **[Point 6]**

Installation Procedure

Install components in the reverse order of removal.



Point Operations

[Point 1]

Disassembly: SST 09032-76001-71
(SST 09032-00100)

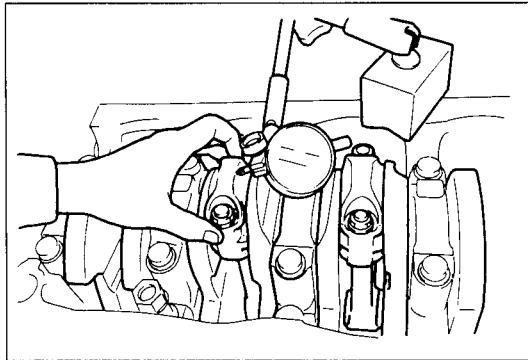
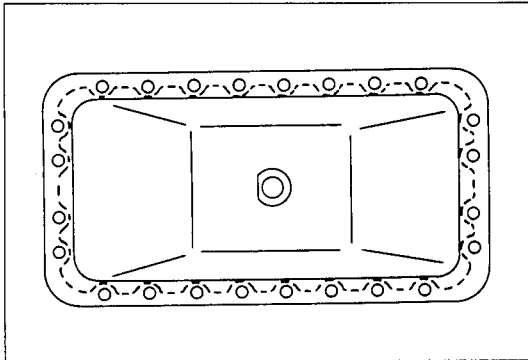
Notes:

- Work carefully without deforming the oil pan flange.
- Do not attempt prying with a screwdriver, etc.

Installation: Apply FIPG to the oil pan seal.
FIPG: 08826-76001-71
(08826-00080)

[Point 2]

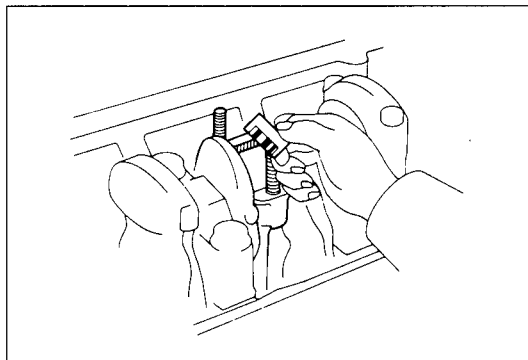
Disassembly: Keep removed parts in cylinder groups to ensure correct installation.



Inspection:

1. Measure thrust clearance of the connecting rod before removal.

Standard: 0.2 ~ 0.34 mm (0.008 ~ 0.0134 in.)
Limit: 0.3 mm (0.012 in.)

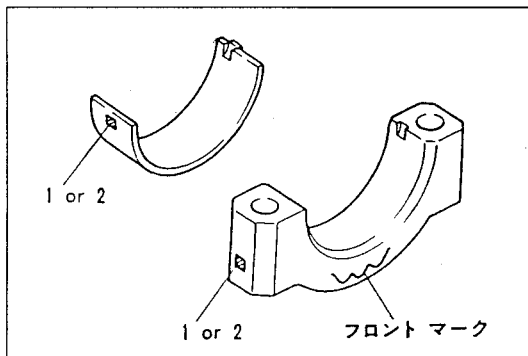


2. Measure oil clearance of the connecting rod bearing.

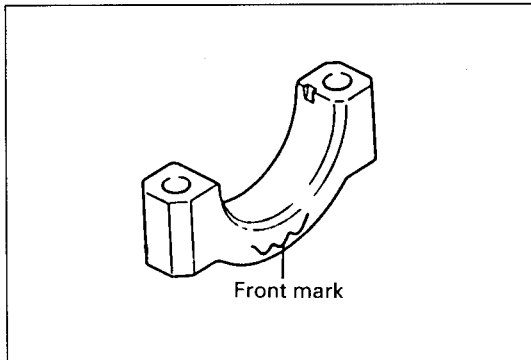
Standard: 0.03 ~ 0.07 mm (0.0012 ~ 0.0028 in.)
Limit: 0.1 mm (0.004 in.)

Notes:

- Do not rotate the crankshaft during measurement.
- If the limit is exceeded, replace the bearing. If a serious streak or damage is found on the bearing, grind the crankshaft and replace the bearing with a U/S bearing.



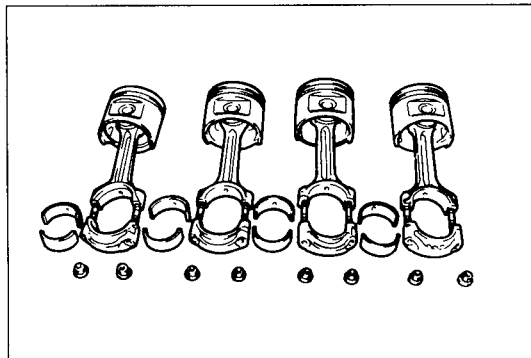
Bearing cap fitting code	Standard crankpin outside diameter mm (in.)
1	54.98 ~ 55.00 (2.1646 ~ 2.1654)
2	
U/S 0.25	54.74 ~ 54.75 (2.1551 ~ 2.1555)
U/S 0.50	54.49 ~ 54.50 (2.1453 ~ 2.1457)
U/S 0.75	54.24 ~ 54.25 (2.1354 ~ 2.1358)
U/s 1.00	53.99 ~ 54.00 (2.1256 ~ 2.1260)

**Installation:**

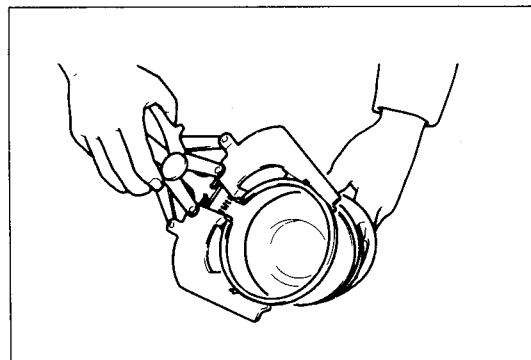
1. Install with the front mark of the bearing cap facing front.
2. Keep the back of the bearing free of foreign matter or oil.
3. Coat engine oil in the bearing bore.
4. Tighten left and right bolts alternately in 2 to 3 steps.

[Point 3]**Disassembly:**

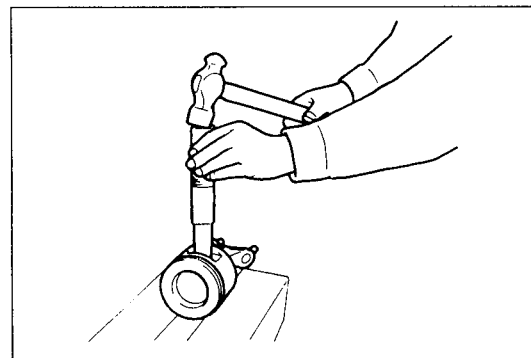
1. Keep the removed parts in cylinder groups to ensure correct installation.



2. Remove the piston rings and oil ring.



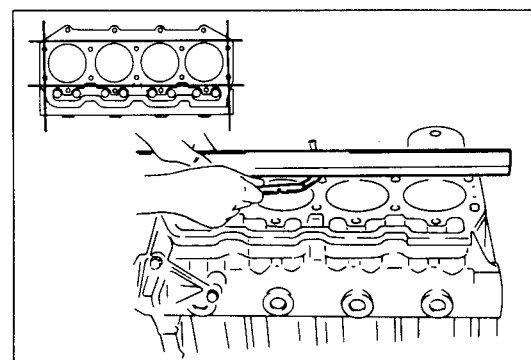
3. Remove the piston pin.

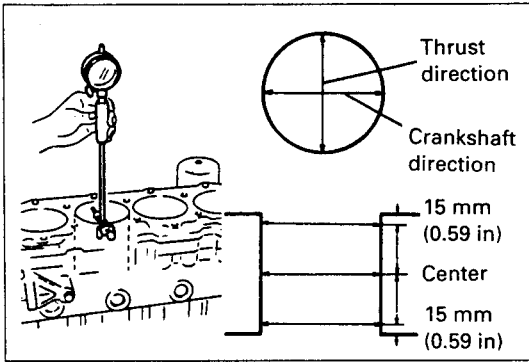
**Inspection:**

1. Check the cylinder block for distortion in the upper surface.

Limit: 0.1 mm (0.004 in.)

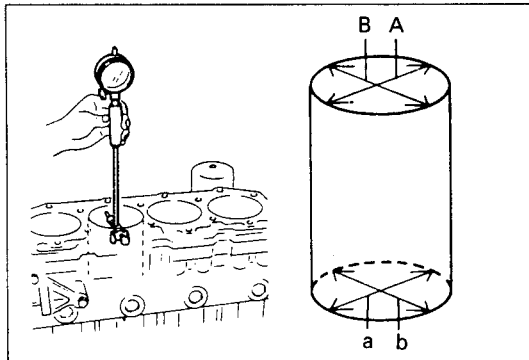
Confirm that the cylinder wall is free of serious scratches.





2. Measure the six dimensions as shown, and determine the difference between the maximum and minimum dimensions.

Limit: 0.2 mm (0.008 in.)



3. Check ellipticity and taper.

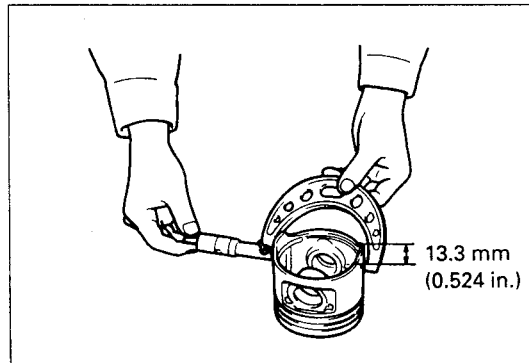
Ellipticity: A-B or a-b

Taper: A-a or B-b

Limit:

Ellipticity: 0.02 mm (0.0008 in.)

Taper: 0.02 mm (0.0008 in.)



4. Measure the piston clearance.

- (1) Measure the outside diameter of the piston.

Standard:

97.94 ~ 97.97 mm (3.8559 ~ 3.8571 in.)

Note:

Measure at a location vertical to the piston pin and 13.3 mm (0.524 in.) away from the piston bottom (skirt).

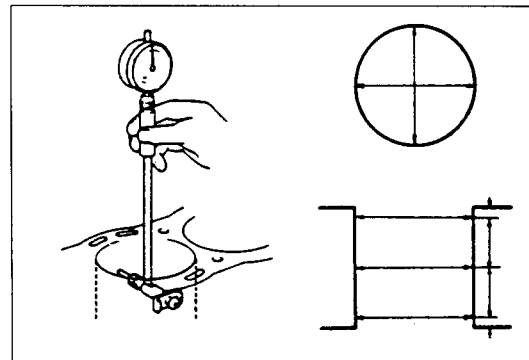
- (2) Measure the minimum inside diameter in the thrust direction of the cylinder.

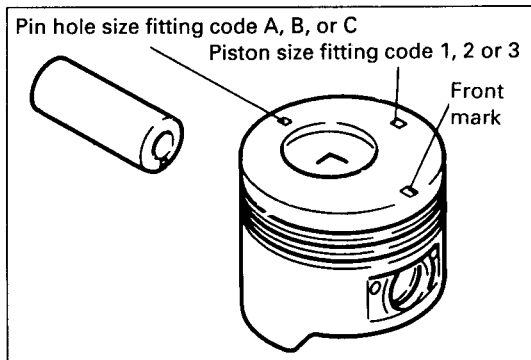
Standard: 98.00 ~ 98.03 mm (3.8583 ~ 3.8594 in.)

- (3) Measure the piston clearance.

Standard: 0.05 ~ 0.07 mm (0.0020 ~ 0.0028 in.)

Limit: 0.15 mm (0.0059 in.)

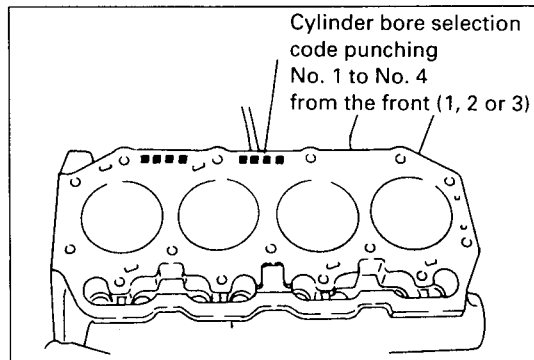




5. If the limit is exceeded in Inspection 2, 3, or 4, replace the piston, or bore the cylinder and install an O/S piston. If there is a wear larger than the limit for the O/S piston, use a repair liner (exclusive part).

(1) Piston replacement or cylinder boring

Piston type	Cylinder ID mm (in.)	Piston OD mm (in.)
STD1	98.00 ~ 98.01 (3.8583 ~ 3.8587)	97.94 ~ 97.95 (3.8559 ~ 3.8563)
STD2	98.01 ~ 98.02 (3.8587 ~ 3.8590)	97.95 ~ 97.96 (3.8563 ~ 3.8567)
STD3	98.02 ~ 98.03 (3.8590 ~ 3.8594)	97.96 ~ 97.97 (3.8567 ~ 3.8571)
O/S0.50	98.50 ~ 98.51 (3.8779 ~ 3.8783)	98.44 ~ 98.45 (3.8756 ~ 3.8760)
O/S1.00	99.00 ~ 99.01 (3.8976 ~ 3.8980)	98.94 ~ 98.95 (3.8953 ~ 3.8957)
O/S1.50	99.50 ~ 99.51 (3.9173 ~ 3.9177)	99.44 ~ 99.45 (3.9150 ~ 3.9154)



Notes:

- When boring the cylinder, select an appropriate O/S piston on the basis of the minimum inside diameter among all cylinders.

Bored dimension =

(O/S piston outside diameter) + (Oil clearance)

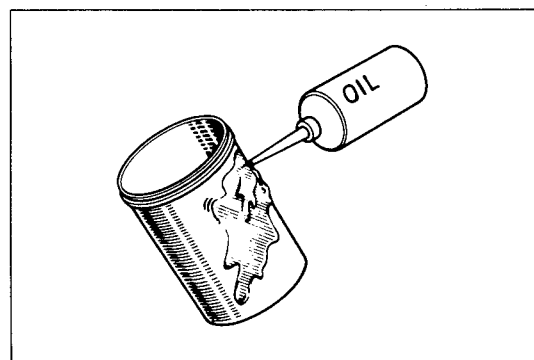
– (Boring margin)

Oil clearance:

0.05 ~ 0.07 mm (0.0020 ~ 0.0028 in.)

Boring margin: 0.02 mm (0.0008 in.)

- When cylinder boring is chosen, measure eccentricity, taper, difference in inside diameter, and piston clearance afterwards.



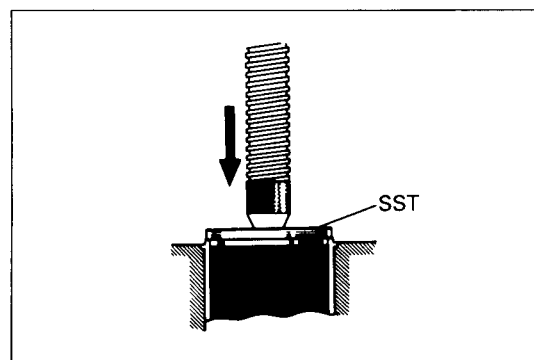
(2) Using the repair liner

Liner fitting code	Cylinder hole before liner mm (in.)	Cylinder liner outside diameter mm (in.)
A	101.000 ~ 101.015 (3.97637 ~ 3.97696)	101.030 ~ 101.045 (3.97755 ~ 3.97815)
B	101.015 ~ 101.030 (3.97696 ~ 3.97755)	101.045 ~ 101.060 (3.97815 ~ 3.97874)

- 1 Prepare the cylinder block upper surface and the cylinder bottom hole by machining for press-fitting liner.

Notes:

- Refer to 2-37 for the bored dimensions.
- When machining is completed, wash the area thoroughly and clean it using compressed air.

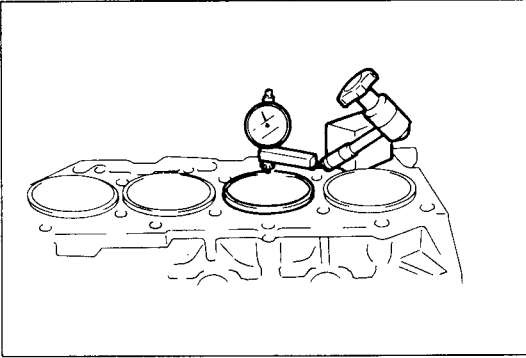


- 2 Coat engine oil on the liner surface.

- 3 Install liner using SST and a press.

SST 09218-76003-71

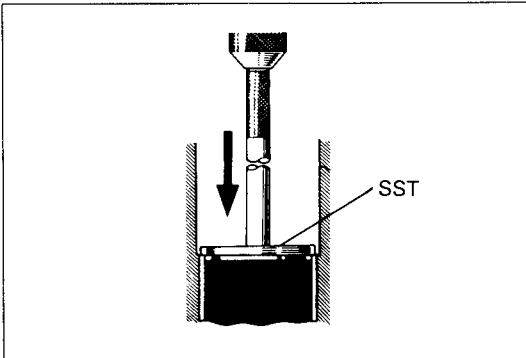
(SST 09218-56020)



- 4 Bore the cylinder after press-fitting, and measure the amount of protrusion.

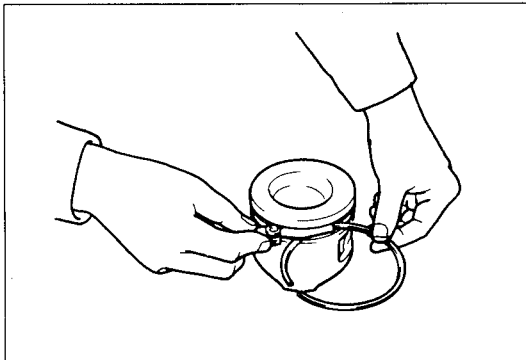
Standard:

0.03 ~ 0.10 mm (0.0012 ~ 0.0039 in.)



- 5 When replacing the cylinder liner, remove liner using SST and a press and follow steps 1 to 4 above.

SST 09111-23660-71



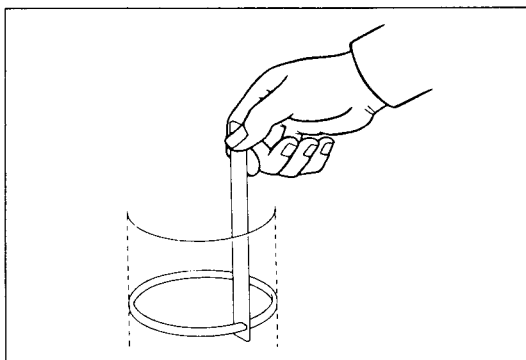
6. Measure the gap between the piston ring and the ring groove along the entire circumference of the piston.

Standard:

No. 1: 0.08 ~ 0.12 mm (0.0031 ~ 0.0047 in.)

No. 2: 0.04 ~ 0.08 mm (0.0016 ~ 0.0031 in.)

Oil ring: 0.03 ~ 0.07 mm (0.0012 ~ 0.0028 in.)



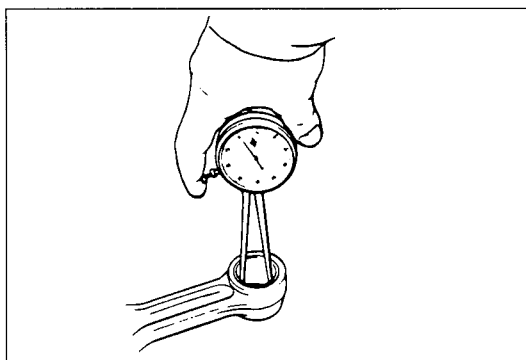
7. Measure the piston ring gap.

Standard:

No. 1: 0.30 ~ 0.45 mm (0.0118 ~ 0.0177 in.)

No. 2: 0.43 ~ 0.55 mm (0.0169 ~ 0.0217 in.)

Oil ring: 0.20 ~ 0.40 mm (0.0079 ~ 0.0157 in.)

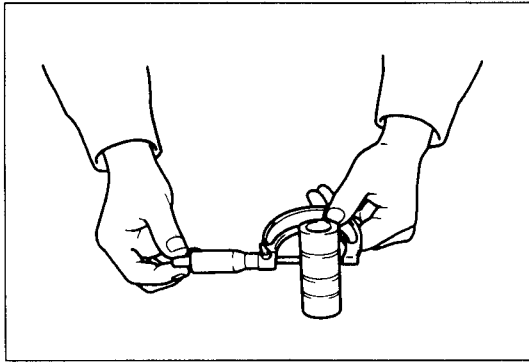


8. Measure the oil clearance of the connecting rod bushing.

- (1) Measure the inside diameter of the bushing.

Standard:

32.008 ~ 32.020 mm (1.26015 ~ 1.26063 in.)



- (2) Measure the outside of the piston pin.

Standard:

32.000 ~ 32.012 mm (1.25984 ~ 1.26031 in.)

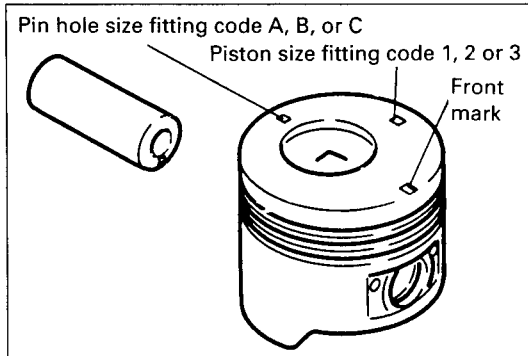
- (3) Calculate the oil clearance.

Standard:

0.004 ~ 0.012 mm (0.00015 ~ 0.00047 in.)

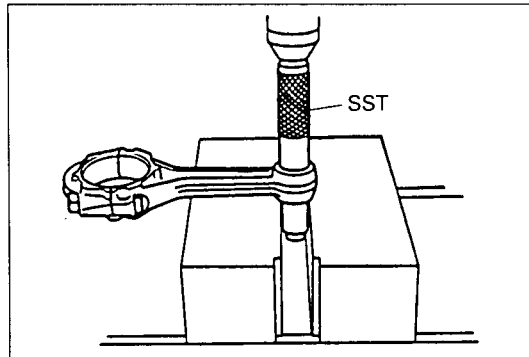
Limit: 0.05 mm (0.0020 in.)

< Reference >



Fitting code	Bushing inside diameter mm (in.)	Piston pin outside diameter mm (in.)
A	32.008 ~ 32.012 (1.26015 ~ 1.26031)	32.000 ~ 32.004 (1.25984 ~ 1.26000)
B	32.012 ~ 32.016 (1.26031 ~ 1.26047)	32.004 ~ 32.008 (1.26000 ~ 1.26015)
C	32.016 ~ 32.020 (1.26047 ~ 1.26063)	32.008 ~ 32.012 (1.26015 ~ 1.26031)

Replace the connecting rod bushing if the limit is exceeded.



9. Replace the connecting rod bushing.

- (1) Remove the bushing using SST and a press.

SST 09222-76003-71

(SST 09222-66010)

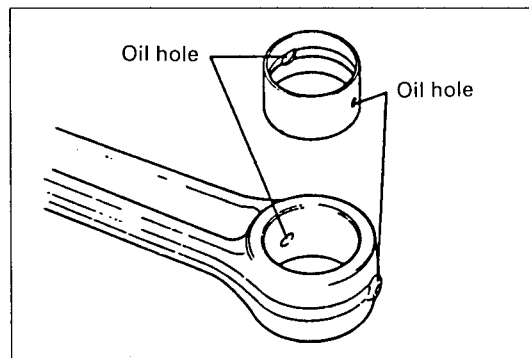
- (2) Install the bushing using SST and a press.

SST 09222-76003-71

(SST 09222-66010)

Note:

Align the oil holes of the connecting rod and of the bushing.



- (3) Confirm that the oil holes of the connecting rod and of the bushing are aligned correctly.

- (4) Using a reamer, finish the bushing until its inside diameter meets the standard.

Standard:

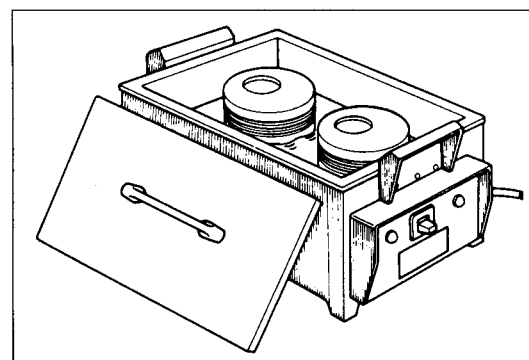
32.008 ~ 32.020 mm (1.2601 ~ 1.2606 in.)

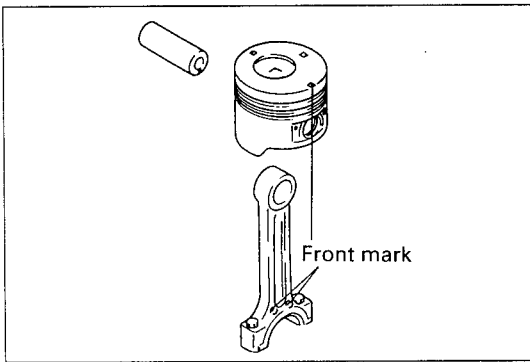
Installation:

1. Assemble the connecting rod.

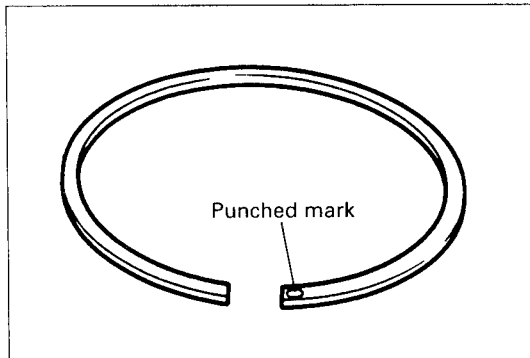
- (1) Fit the snap ring on one side.

- (2) Warm the piston to about 60°C.





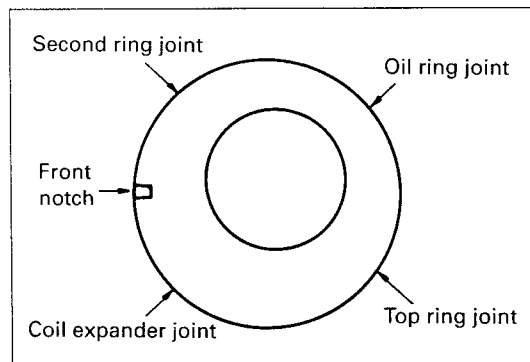
- (3) Align the front marks on the piston and the connecting rod.
- (4) Install the piston pin.



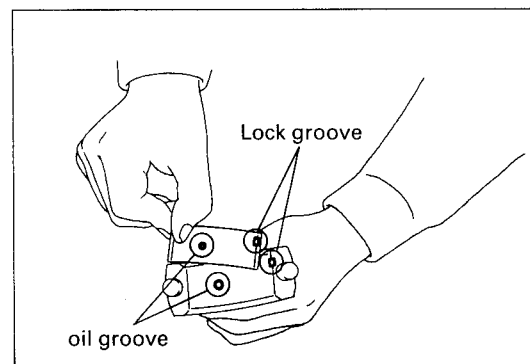
2. Install the piston rings with the punched marks facing upward.
Punched marks
Second ring ... 2T

Note:

Oil rings may be installed with either side facing upward.



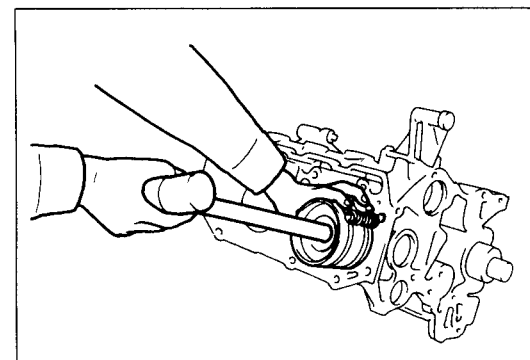
3. Position the ring joints as shown.



4. Install the bearing.
 - (1) Assemble the upper bearing by matching the connecting rod lock groove.
 - (2) Install the lower bearing by matching the bearing cap lock groove.

Notes:

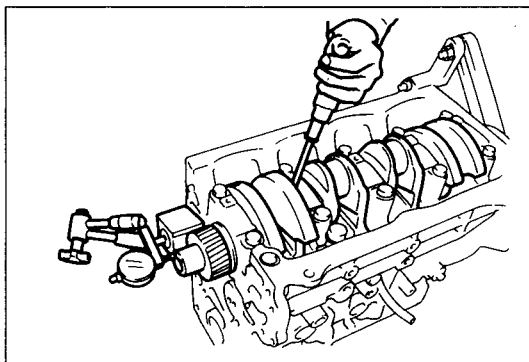
- Prevent foreign matter, oil, etc., from adhering to the bearing surface coming in contact with the connecting rod.
- Coat engine oil on the bearing bore.



5. Install the piston in the same cylinder it was removed from.

Notes:

- Fit a vinyl tube to the connecting rod bolt to protect it from damage.
- Install the piston with the front mark facing front.

**[Point 4]**

Inspection: Measure the crankshaft thrust clearance.

Standard:

0.04 ~ 0.25 mm (0.0016 ~ 0.0100 in.)

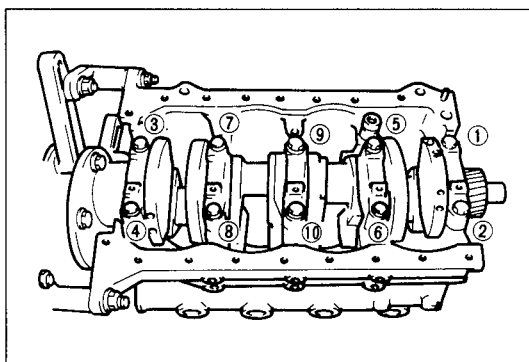
Limit: 0.3 mm (0.012 in.)

Note:

If the limit is exceeded, replace the thrust washer or crankshaft. Thrust washer thickness

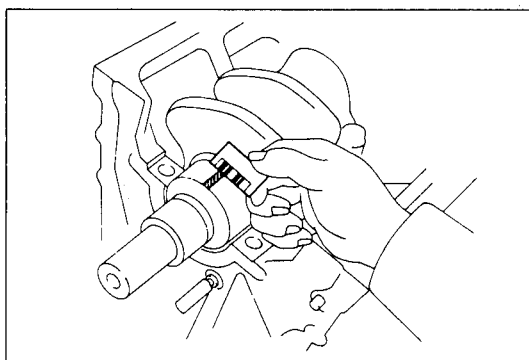
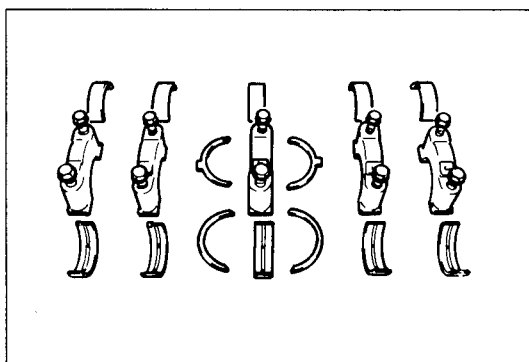
STD: 2.43 ~ 2.48 mm
(0.0957 ~ 0.0976 in.)

O/S: 0.125, 0.250 mm
(0.00492, 0.00984 in.)

**[Point 5]**

Disassembly:

1. Loosen the cap set bolts in the order shown to the left.
2. Keep the removed parts carefully so they can be installed in correct positions.



Inspection:

Until July 1998.

1. Measure the oil clearance before the crankshaft removal and installation.

Standard:

0.030 ~ 0.066 mm (0.00118 ~ 0.00260 in.)

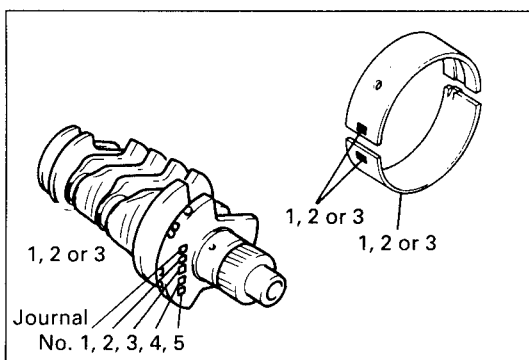
Limit: 0.1 mm (0.004 in.)

Note:

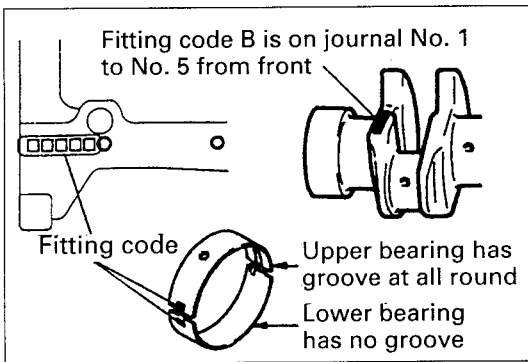
Do not rotate the crankshaft during measurement.

If the limit is exceeded, replace the bearing.

If a serious streak or damage is found, grind the crankshaft and replace the bearing with a U/S bearing.



Bearing cap fitting code	Crankshaft journal standard OD mm (in.)
1	73.98 ~ 74.00 (2.9126 ~ 2.9134)
2	
3	
U/S 0.25	73.74 ~ 73.75 (2.9031 ~ 2.9035)
U/S 0.50	73.49 ~ 73.50 (2.8933 ~ 2.8937)
U/S 0.75	73.24 ~ 73.25 (2.8835 ~ 2.8839)
U/S 1.00	72.99 ~ 73.00 (2.8736 ~ 2.8740)



From August 1998.

1. Measure the oil clearance before the crankshaft removal and installation.

Standard: 0.030 ~ 0.050 mm (0.00118 ~ 0.00197 in.)

Limit: 0.100 mm (0.00394 in.)

Bearing choice method

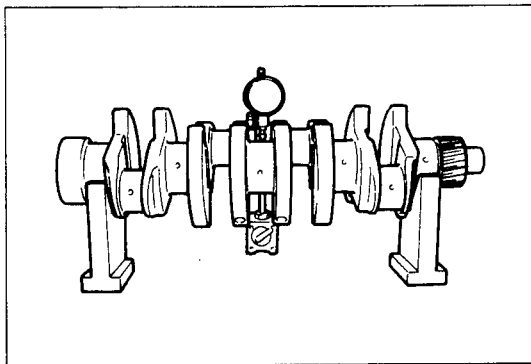
Choose the bearing by the fitting code in the tables.

C (Bearing fitting code) = A (Bearing bore fitting code) + B (Journal outside diameter fitting code)

A		B		C	
Fitting code	Bearing bore mm (in.)	Fitting code	Journal outside diameter mm (in.)	Fitting code	Bearing thickness mm (in.)
1	78.000 ~ 78.006 (3.07086 ~ 3.07110)	0	73.994 ~ 74.000 (2.91314 ~ 2.91338)	1	1.982 ~ 1.985 (0.07724 ~ 0.07815)
2	78.006 ~ 78.012 (3.07110 ~ 3.07133)	1	73.987 ~ 73.994 (2.91251 ~ 2.91314)	2	1.985 ~ 1.988 (0.07815 ~ 0.07827)
3	78.012 ~ 78.018 (3.07133 ~ 3.07157)	2	73.980 ~ 73.987 (2.91259 ~ 2.91251)	3	1.988 ~ 1.991 (0.07827 ~ 0.07839)
4	78.018 ~ 78.024 (3.07157 ~ 3.07180)			4	1.991 ~ 1.994 (0.07839 ~ 0.07850)
				5	1.994 ~ 1.997 (0.07850 ~ 0.07862)
				6	1.997 ~ 2.000 (0.07862 ~ 0.07874)

U/S Bearing

Bearing size	Journal outside diameter mm (in.)	Bearing thickness mm (in.)
U/S 0.25	73.740 ~ 73.750 (2.90314 ~ 2.90353)	2.104 ~ 2.110 (0.08283 ~ 0.08307)
U/S 0.50	73.490 ~ 73.500 (2.89330 ~ 2.89370)	2.229 ~ 2.235 (0.08776 ~ 0.08799)
U/S 0.75	73.240 ~ 73.250 (2.88346 ~ 2.88385)	2.354 ~ 2.360 (0.09268 ~ 0.09291)
U/S 1.00	72.990 ~ 73.000 (2.87362 ~ 2.87401)	2.479 ~ 2.485 (0.09760 ~ 0.09783)

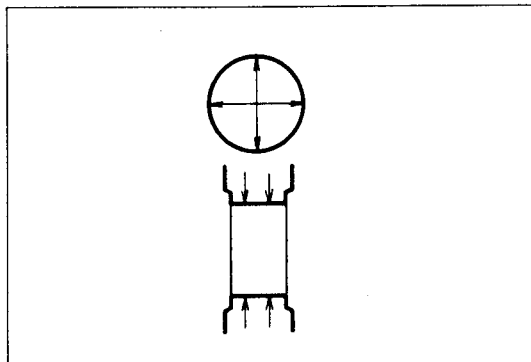


2. Crankshaft bend inspection

- (1) Measure the amount of bend per a full turn of the crankshaft.

$$\text{Bend} = \frac{\text{Dial gauge deflection}}{2}$$

Limit: 0.06 mm (0.0024 in.)



3. Crankshaft wear inspection

- (1) Measure the dimensions of the crankshaft journal as shown.

Standard:

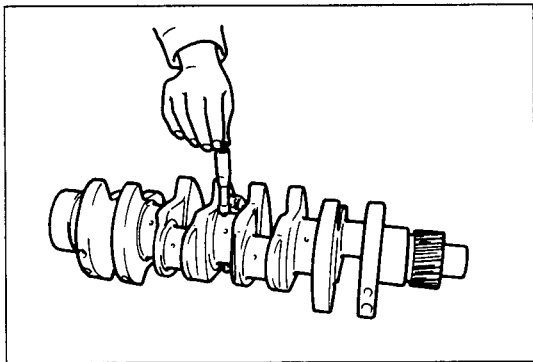
73.98 ~ 74.00 mm (2.9126 ~ 2.9134 in.)

- (2) Calculate the eclipticity and taper.

Limit:

Ellipticity: 0.02 mm (0.0008 in.)

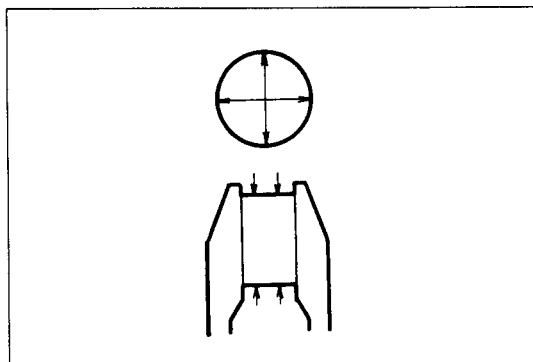
Taper: 0.05 mm (0.0020 in.)



- (3) Measure the dimensions of the crankshaft pin as shown.

Standard:

54.98 ~ 55.00 mm (2.1646 ~ 2.1654 in.)



- (4) Calculate the eclipticity and taper.

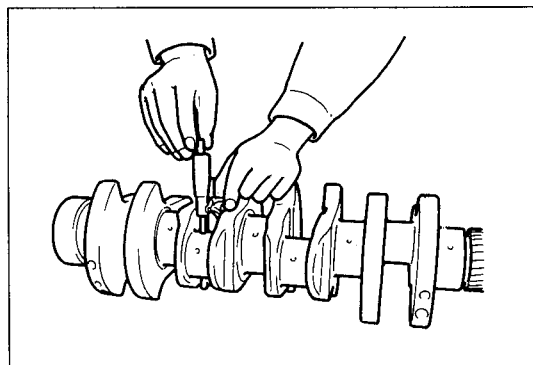
Limit:

Eclipticity: 0.02 mm (0.0008 in.)

Taper: 0.05 mm (0.0020 in.)

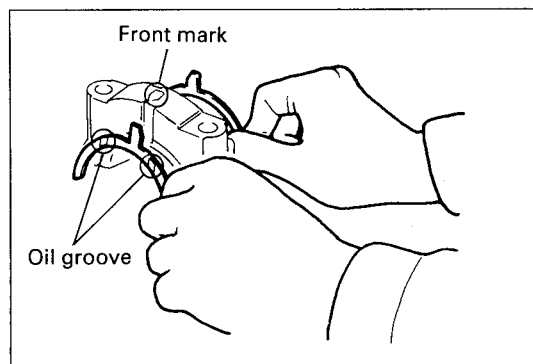
Note:

If the standard is not met or if the limit is exceeded, or if a serious streak or damage is found, grind the crankshaft and replace the bearing with a U/S bearing.



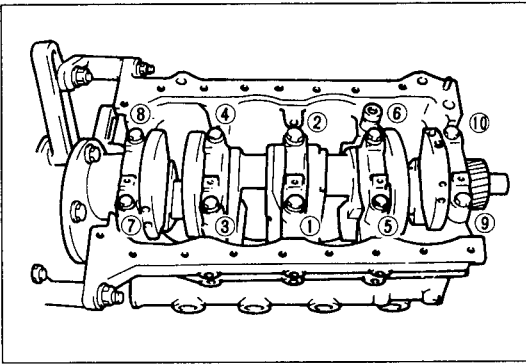
Bearing type	Finished outside diameter of crankshaft journal (mm)
U/S 0.25	73.74 ~ 73.75 (2.9031 ~ 2.9035)
U/S 0.50	73.49 ~ 73.50 (2.8933 ~ 2.8937)
U/S 0.75	73.24 ~ 73.25 (2.8835 ~ 2.8839)
U/S 1.00	72.99 ~ 73.00 (2.8736 ~ 2.8740)

Bearing type	Finished outside diameter of crankshaft pin (mm)
U/S 0.25	54.74 ~ 54.75 (2.1551 ~ 2.1555)
U/S 0.50	54.49 ~ 54.50 (2.1452 ~ 2.1457)
U/S 0.75	54.24 ~ 54.25 (2.1354 ~ 2.1358)
U/S 1.00	53.99 ~ 54.00 (2.1256 ~ 2.1260)



Installation:

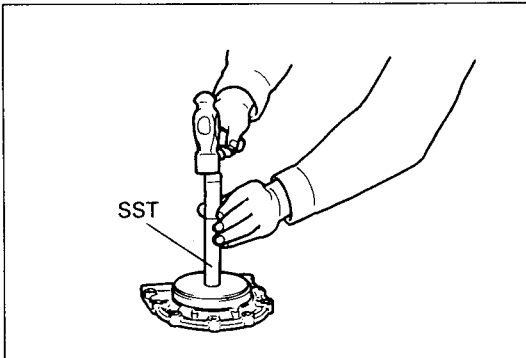
1. Install the thrust washer with the oil groove facing the crankshaft.
2. Install in the same place as before disassembly in reference to the front mark.

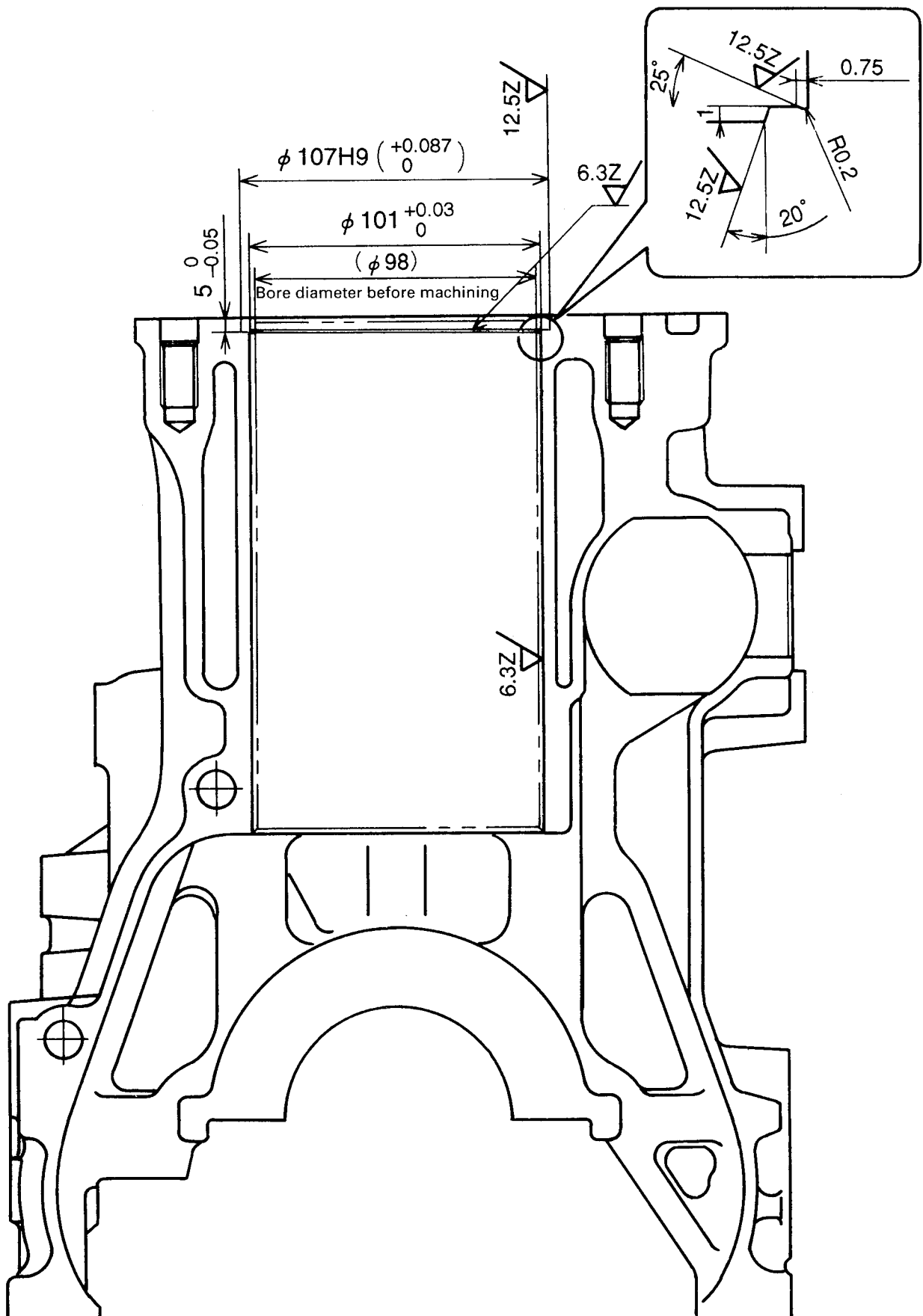


3. Tighten evenly in several steps and in the order as shown.

[Point 6]

Installation: SST 09320-10410-71



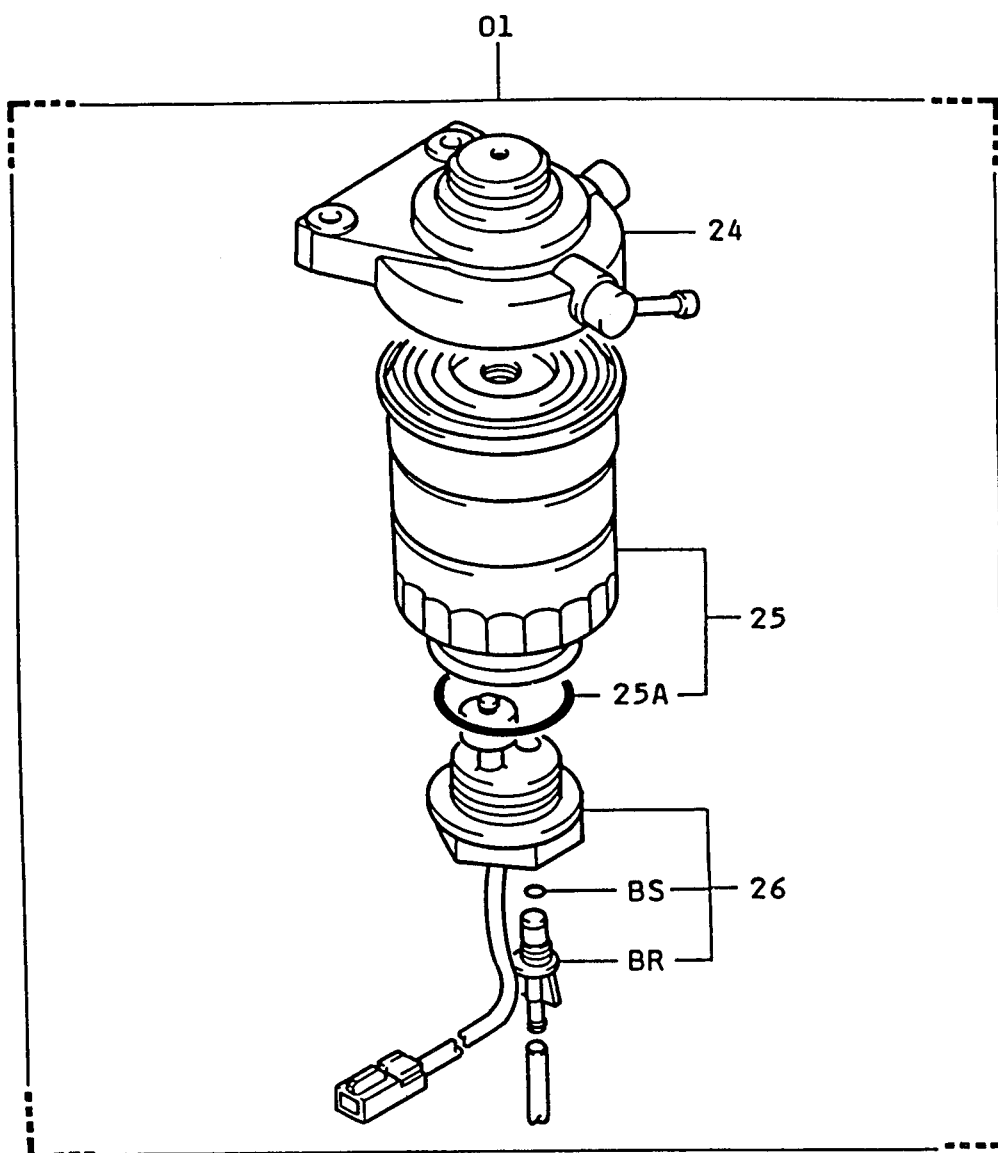
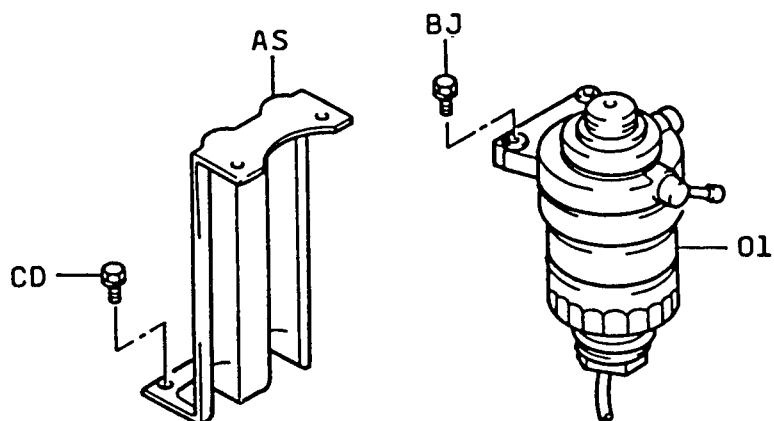
CYLINDER BLOCK BORE DIMENSIONS

FUEL SYSTEM

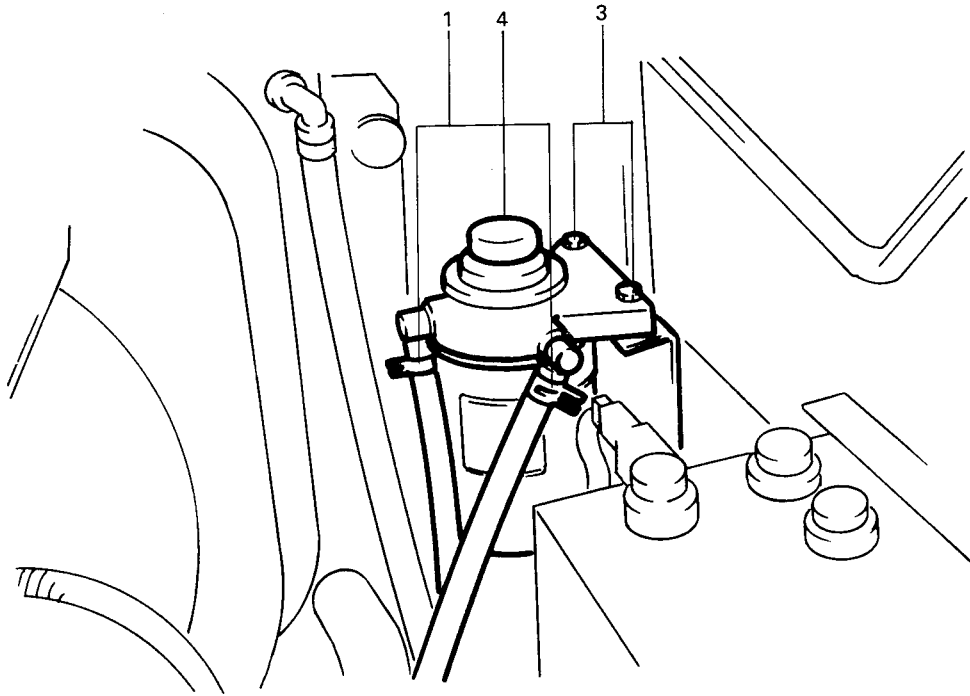
	Page
FUEL FILTER	3-2
COMPONENTS	3-2
FUEL FILTER REMOVAL AND INSTALLATION	3-3
INJECTION NOZZLE	3-5
COMPONENTS	3-5
INJECTION NOZZLE REMOVAL AND INSTALLATION	3-6
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FUEL FILTER COMPONENTS

2302



FUEL FILTER REMOVAL AND INSTALLATION



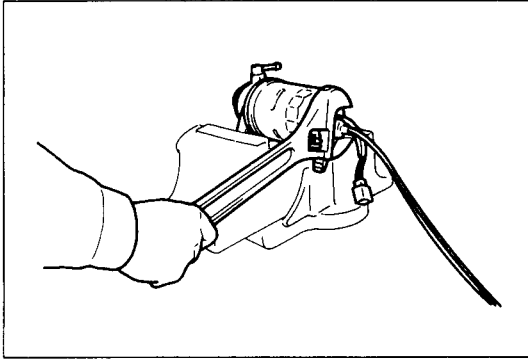
2. Wire

Removal Procedure

- 1 Remove hose clamp and disconnect fuel hose.
- 2 Disconnect wiring.
- 3 Remove the fuel filter set bolts.
- 4 Remove the fuel filter. **[Point 1]**

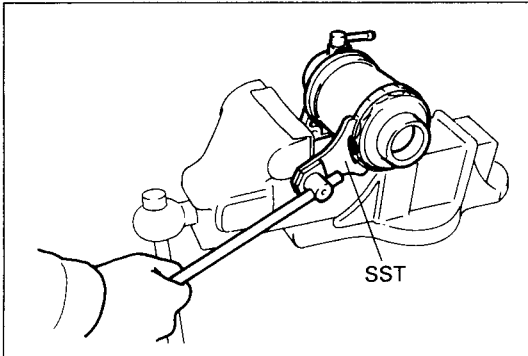
Installation Procedure

- 1 Install components in the reverse order of removal.
- 2 Bleed air from the fuel system. **[Point 2]**

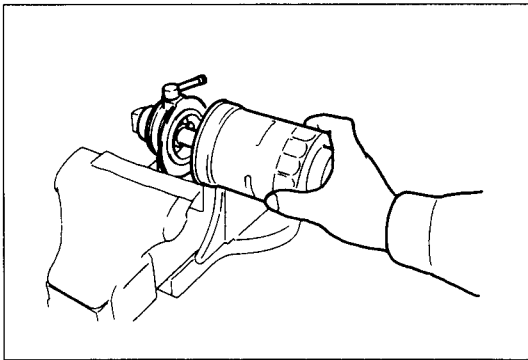
**[Point 1]**

Disassembly:

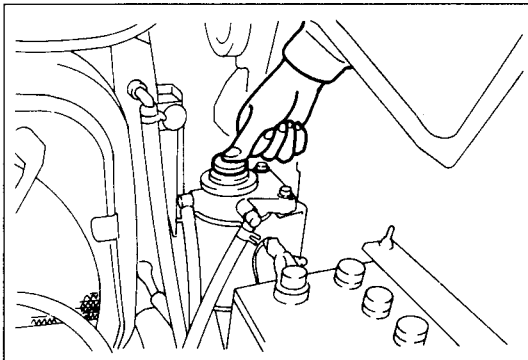
1. Remove the sedimenter.



2. SST 09228-76010-71
(SST 09228-64010)



Installation: Apply a thin coat of light oil on the O-ring of the fuel filter element.

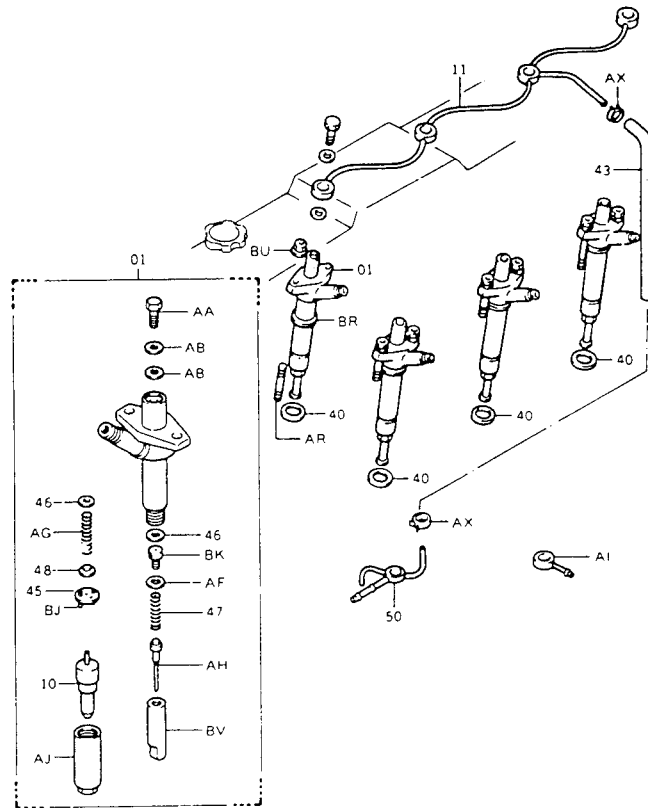
**[Point 2]**

Installation: After installation, operate the priming pump knob up and down until the knob movement becomes hard.

INJECTION NOZZLE COMPONENTS

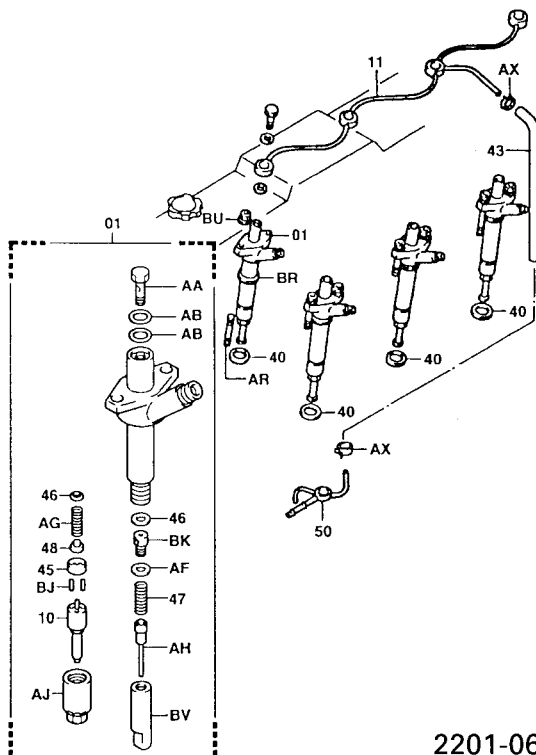
2201

~1998. 7

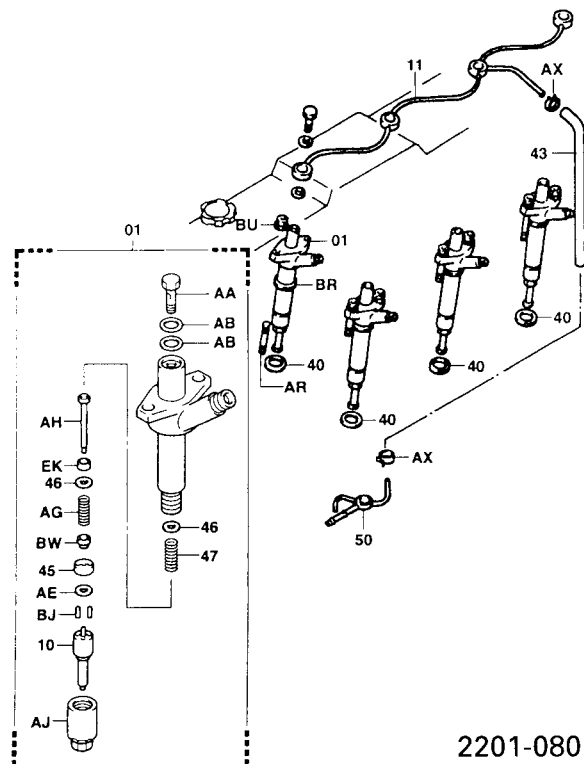


1998. 8~

7FD20~J35:2002.11~, 7FDF20~J35:2004.1~,
4SDK10, 42-2TD20-25:2003.9~



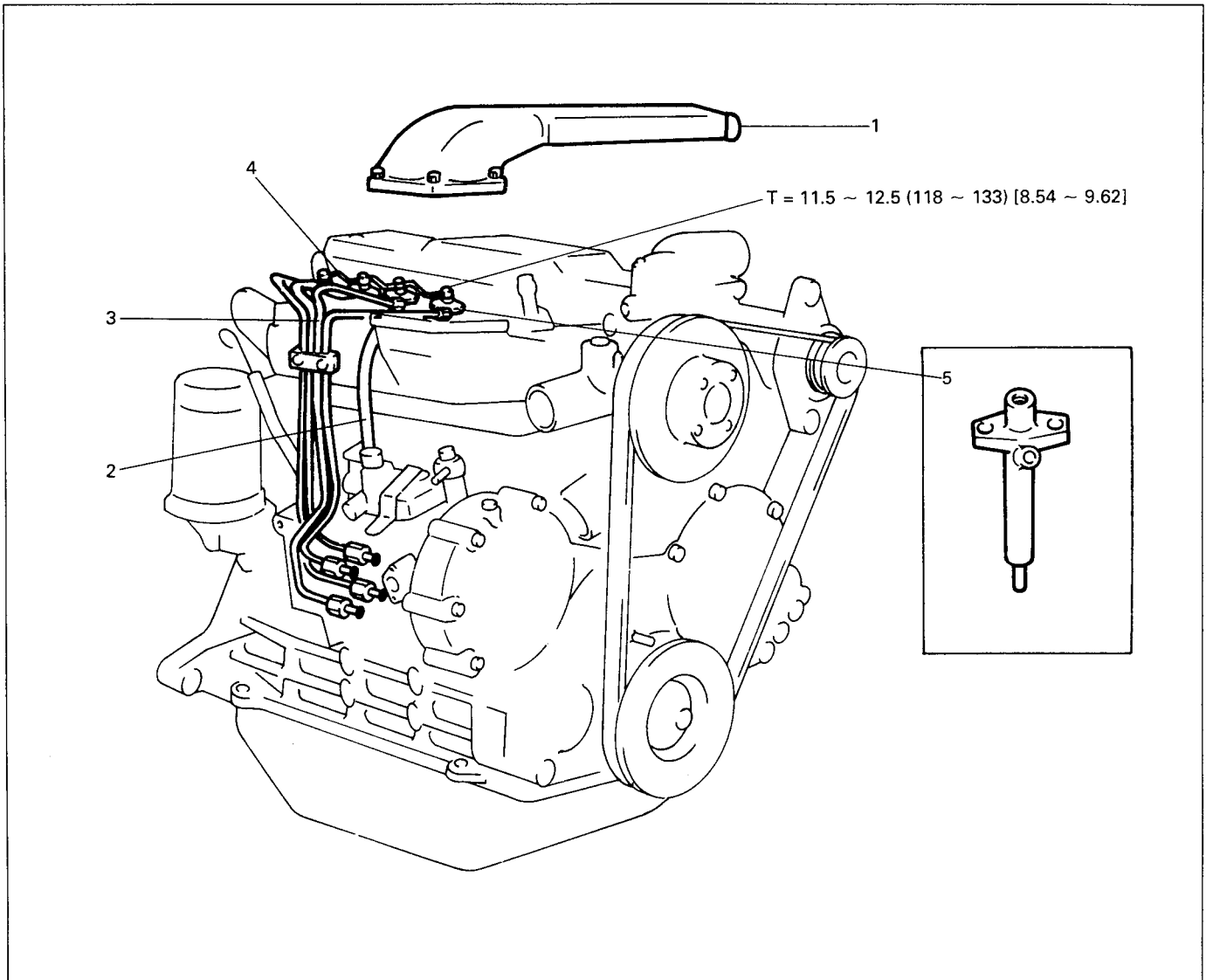
2201-068A



2201-080

INJECTION NOZZLE REMOVAL AND INSTALLATION

T = N.m (kg-cm) [ft-lb]



Removal Procedure

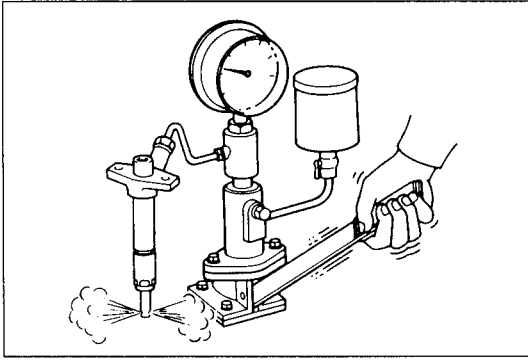
- 1 Disconnect the intake pipe.
- 2 Disconnect the fuel hose.
- 3 Disconnect the injection pipe.
- 4 Disconnect the nozzle linkage pipe.
- 5 Remove the injection nozzle ASSY.

Installation Procedure

Install components in the reverse order of removal.

Note:

Always renew the nozzle gasket.



Inspection:

1. Check the injection nozzle injection pressure.
 - (1) Attach the injection nozzle to the tester.
 - (2) Quickly operate the tester lever to cause a few injections and remove the carbon deposit at the nozzle outlet.
 - (3) Slowly push the tester lever to raise the pressure.
 - (4) Read the pressure gauge immediately when the rising pressure drops suddenly.

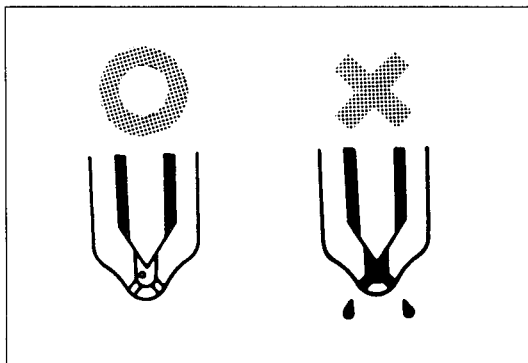
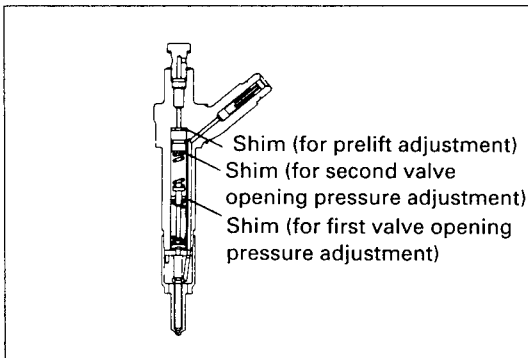
Standard:

17700 $\pm$ 500 kPa (180 $\pm$ 5 kg/cm²)
[2560 $\pm$ 71 psi]

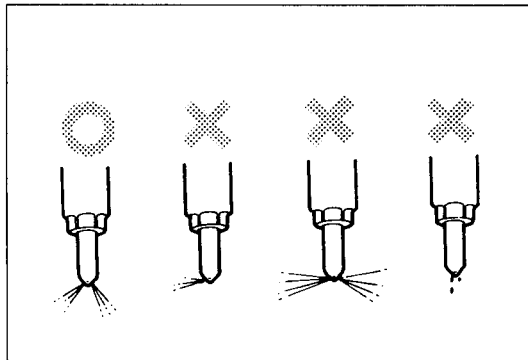
- (5) If the standard is not met, adjust accordingly.

Note:

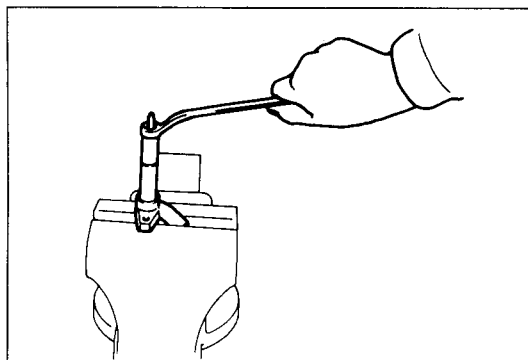
See the section on INJECTION PRESSURE ADJUSTMENT (page 3-9) about the method of injection nozzle adjustment.



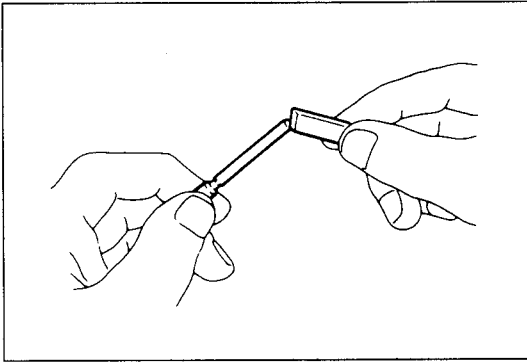
2. Check oil seal at the valve seat.
 - (1) Slowly push the tester lever until the pressure rises to approximately 15700 kPa (160 kg/cm²) [2280 psi]. Maintain the pressure for about 10 seconds, and confirm that the fuel is not leaking from the nozzle outlet or the retaining nut.
 - (2) If leaking, disassemble and clean the nozzle or replace it. Check again after replacement.



3. Check the spray pattern.

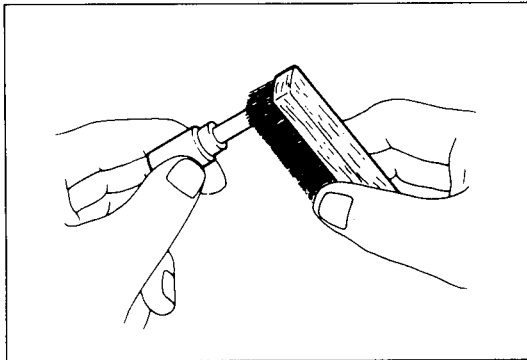


4. Disassemble, clean, and inspect the injection nozzle ASSY.

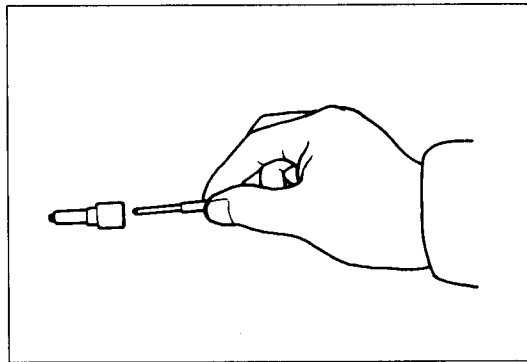


5. Clean the nozzle.

- (1) Use a small piece of hard wood and brass brush. Clean the nozzle with clean light oil.
- (2) Clean the carbon deposit at the nozzle needle tip using a small piece of hard wood.

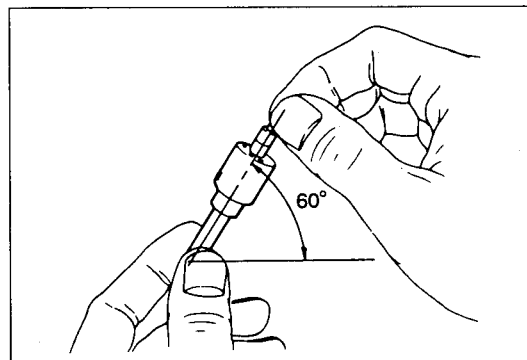


- (3) Clean the carbon deposit on the outside of the nozzle body using a brass brush.



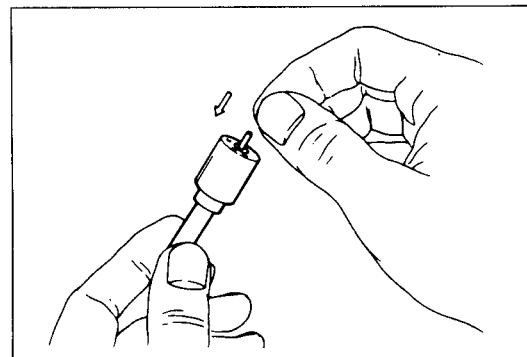
6. Check the nozzle appearance.

- (1) Check the nozzle body for cracks and corrosion.
- (2) Check the nozzle needle for damage and corrosion. If necessary, replace the nozzle ASSY.



7. Perform a sinking test.

- (1) Wash the nozzle needle with clean light oil.
- (2) Incline the nozzle body by about 60°, and expose about 1/3 of the needle.



- (3) Release the needle, and check that it sinks smoothly into the body by its own weight.
- (4) Repeat the test while rotating the needle a little at a time. If the needle does not sink at any point in the test, replace the body and needle as a set.

INJECTION PRESSURE ADJUSTMENT

1. Prelift adjustment

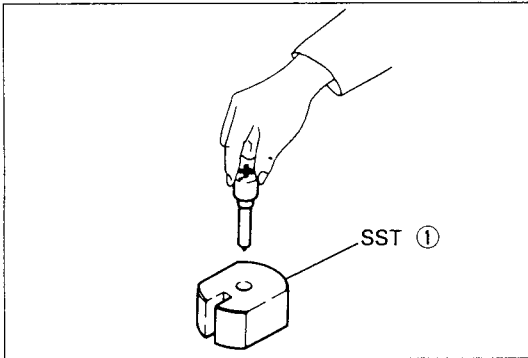
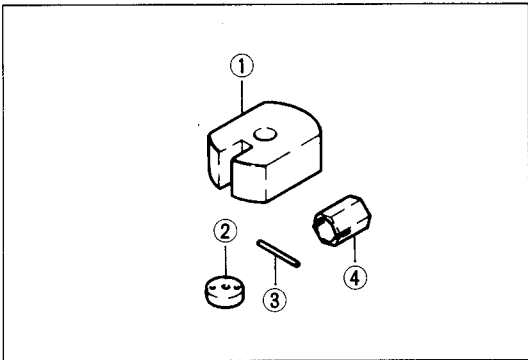
Note:

Measurement using a dial gauge must be performed on a surface plate.

(1) SST 09230-32880-71

- | | |
|--------|----------|
| ① Base | ② Holder |
| ③ Pin | ④ Plug |

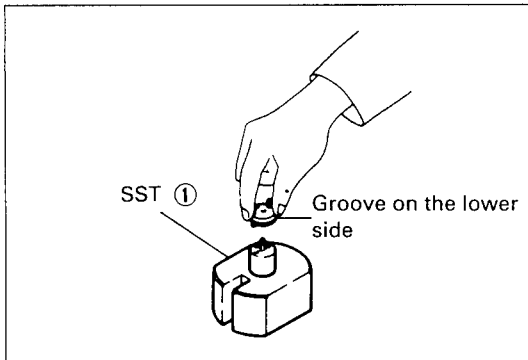
(2) Set the nozzle on SST ① .



(3) Attach a tip packing (with a straight pin) on the nozzle.

Note:

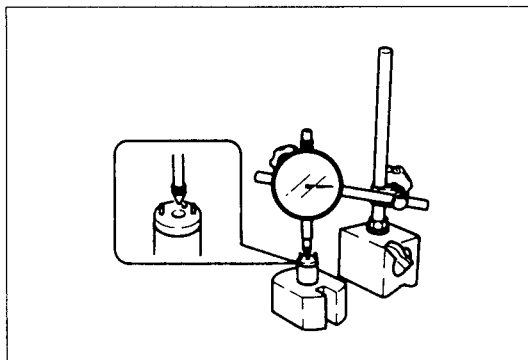
Attach the tip packing with the groove facing the nozzle.



(4) Set the dial gauge on the upper surface of the tip packing, and set the gauge to 0.

Note:

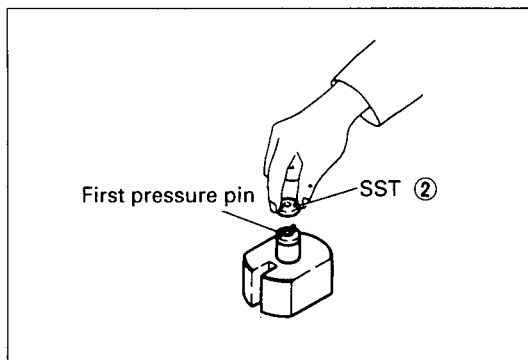
Set the dial gauge with the plunger being perpendicular to the surface plate.

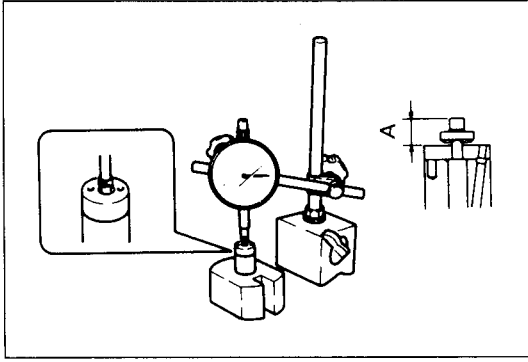


(5) Move the dial gauge together with the magnet base, and set the first pressure pin and SST ② .

Note:

Move the dial gauge very carefully; otherwise the setting may be altered.



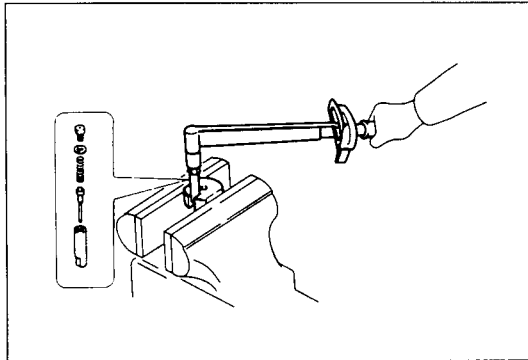


- (6) Set the dial gauge on the upper end surface of the first pressure pin, and measure dimension A.

Reference value A: 5.3 mm (0.209 in.)

Note:

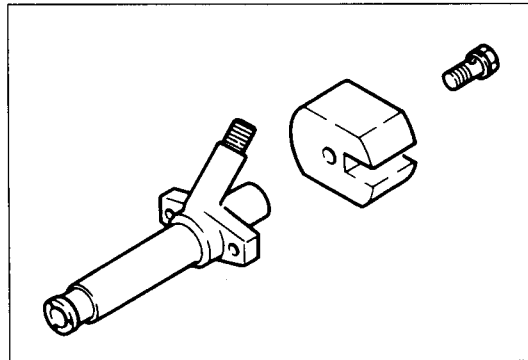
Measure several times and determine A.



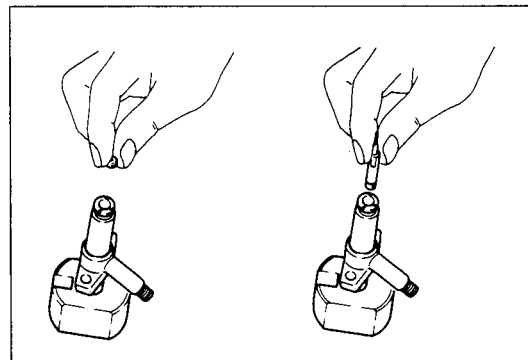
- (7) Assemble the capsule SUB-ASSY using SST ①, ③ and ④.

Reference:

If the shim thickness is unknown, use a 1.5 mm (0.059 in.) shim as a rule.



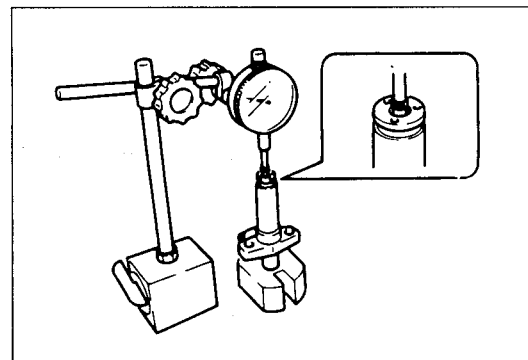
- (8) Set the nozzle holder body to SST ① using a hollow screw.



- (9) Install the shim and the capsule SUB-ASSY to the nozzle holder body.

Reference:

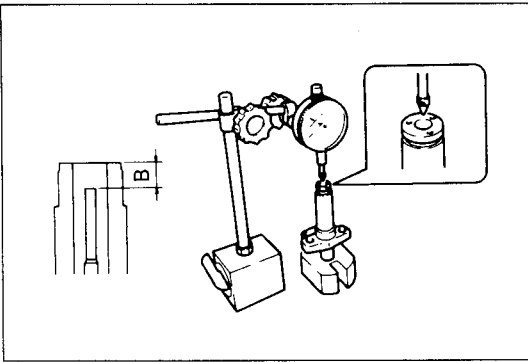
If the shim thickness is unknown, use a 1.5 mm (0.059 in.) shim as a rule.



- (10) Set the tip of the dial gauge at the tip of the second pressure pin inside the nozzle holder, and set the gauge to 0.

Note:

Set the dial gauge with the plunger being perpendicular to the surface plate.

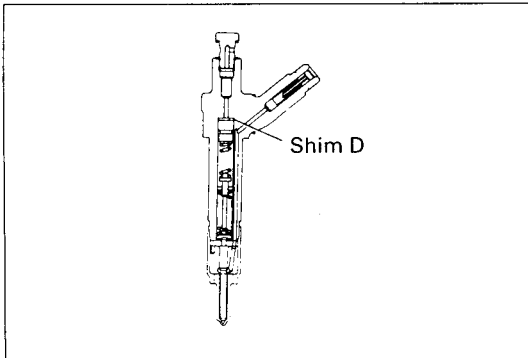


- (11) Set the dial gauge on the upper end surface of the nozzle holder body, and measure dimension B.

Reference value B: 5.39 mm (0.2122 in.)

Note:

Measure several times and determine B.



- (12) Calculate prelift C.

$$C = B - A$$

$$C = 5.39 - 5.3 \text{ mm (0.2122 - 0.209 in.)}$$

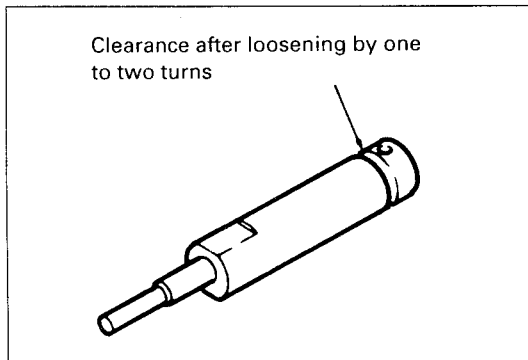
$$= 0.09 \text{ mm (0.0032 in.)}$$

Standard C:

$$0.070 \sim 0.11 \text{ mm (0.00276 \sim 0.00433 in.)}$$

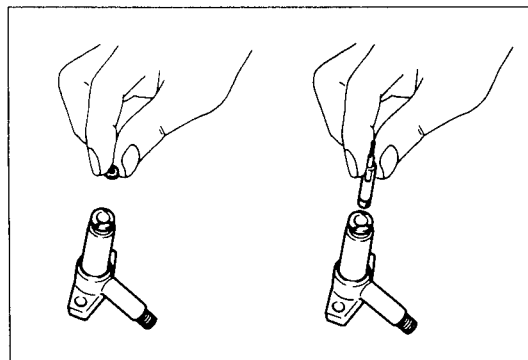
- (13) If the prelift differs from the standard, change shim D as needed.

Shim	Thinner ↔ Thicker
Prelift	Larger ↔ Smaller

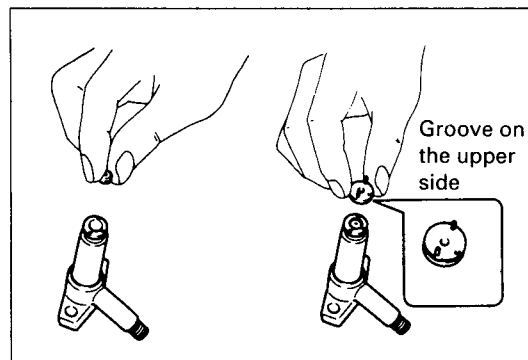


2. Second valve opening pressure adjustment

- (1) Loosen the capsule SUB-ASSY plug screw in the nozzle holder body until the prelift is 0 mm (0 in.).



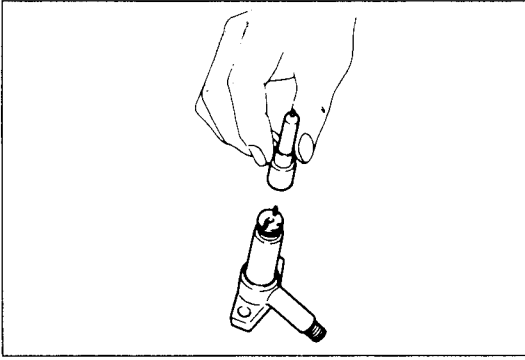
- (2) Attach the shim (after prelift adjustment) and the capsule SUB-ASSY (1) to the nozzle holder body.



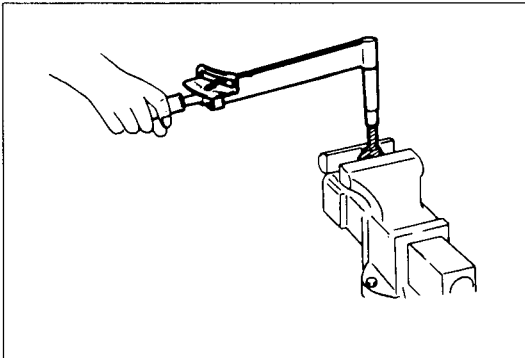
- (3) Attach the capsule SUB-ASSY · the first pressure pin and the tip packing (with a pin) to the nozzle holder body.

Notes:

- Do not install the first pressure spring and the shim for the first valve opening pressure adjustment.
- The grooved end of the tip packing must face the nozzle.

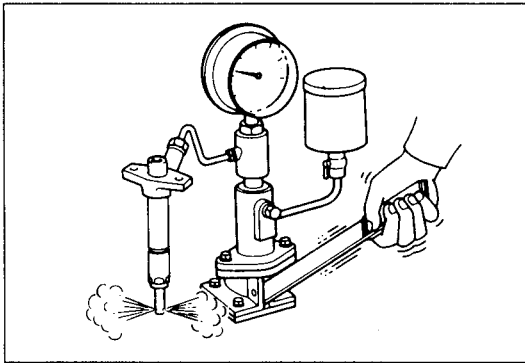


- (4) Attach the nozzle to the nozzle holder body.



- (5) Attach the retaining nut to the nozzle holder body.

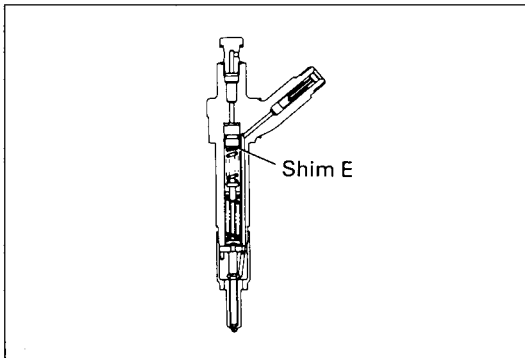
T = 29.4 ~ 39.2 N·m (300 ~ 400 kg·cm)
[21.7 ~ 28.9 ft·lb]



- (6) Measure the valve opening pressure using the nozzle hand tester.
 Second valve opening pressure

Standard:

9410 ± 290 kPa (96.0 ± 3.0 kg/cm²)
[1370 ± 43psi]



- (7) If the measured pressure in step (6) differs from the standard, change shim E as needed.

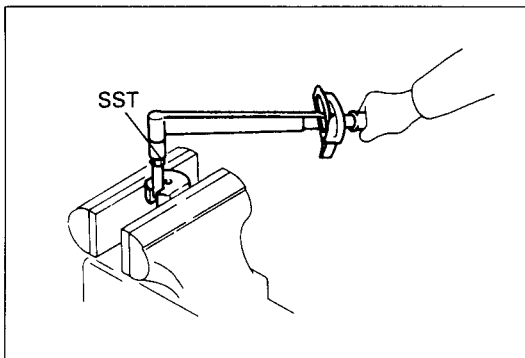
Shim	Thinner ↔ Thicker
Pressure	Smaller ↔ Larger

Note:

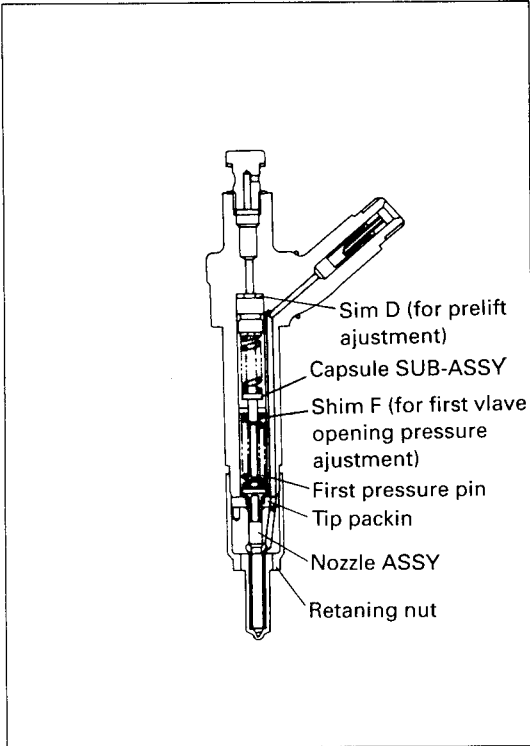
Loosen the plug screw when adjusting the valve opening pressure.

Reference:

A shim thickness change of 0.01 mm (0.0004 in.) causes a valve opening pressure change of 118 kPa (1.2 kg/cm²) [17.06 psi].



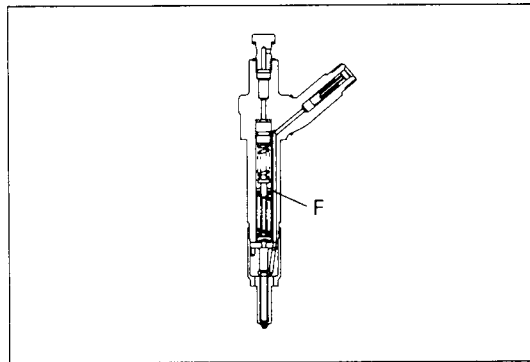
- (8) Tighten the plug screw after adjustment.
 SST ①



3. First valve opening pressure adjustment
 - (1) Assemble the nozzle holder using the shim (adjusted per steps 1 and 2) and the capsule SUB-ASSY.

Reference:

When the first valve opening pressure is unknown, use a 1.5 mm (0.059 in.) shim as a rule.



- (2) Measure the valve opening pressure using the nozzle hand tester.
First valve opening pressure

Standard:

**17700 ± 500 kPa (180 ± 5 kg/cm²)
[2560 ± 71 psi]**

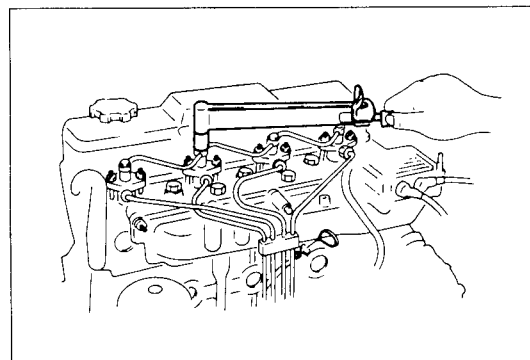
- (3) If the measured pressure in step (2) differs from the standard, change shim F as needed.

Shim	Thinner ↔ Thicker
Pressure	Smaller ↔ Larger

Reference:

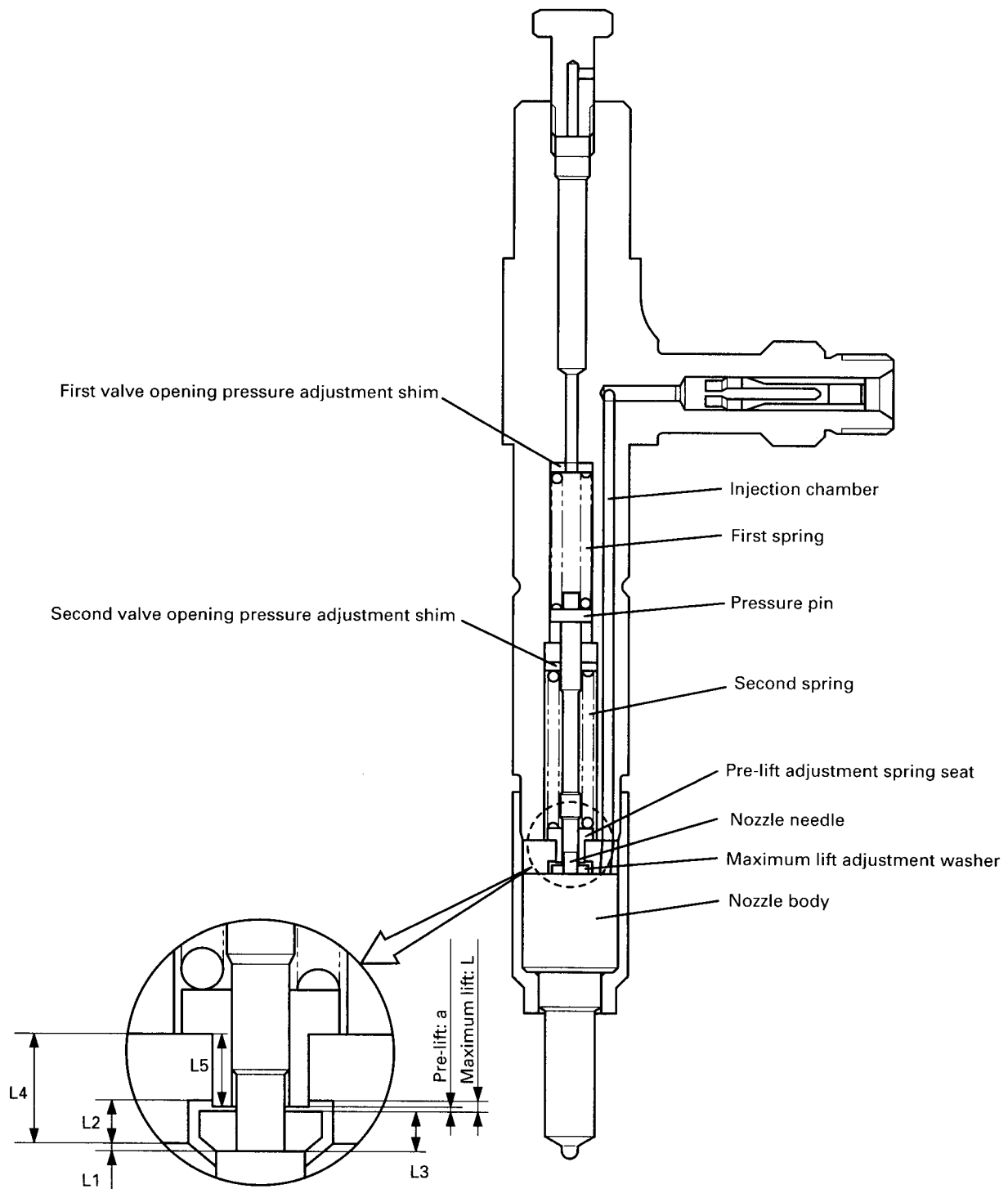
A shim thickness change of 0.01 mm (0.0004 in.) causes a valve opening pressure change of 118 kPa (1.2 kg/cm²) [17.1 psi].

Installation: Tighten the set nuts evenly and until the nuts touch the holder. Then, tighten them alternately for 1/4 of a turn each.



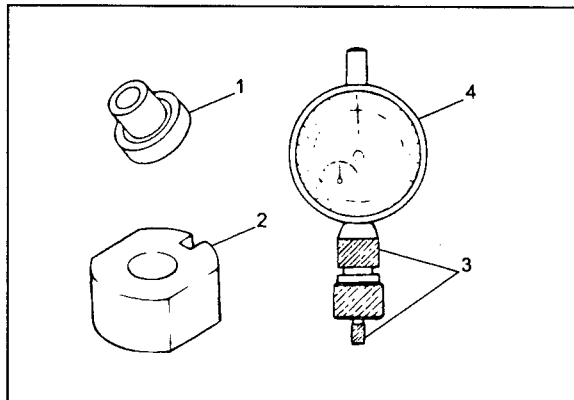
INJECTION PRESSURE ADJUSTMENT

(7FD20~J35: 2002.11~, 7FDF20~JF35: 2004.1~, 4SDK10, 42-2TD20-25: 2003.9~)

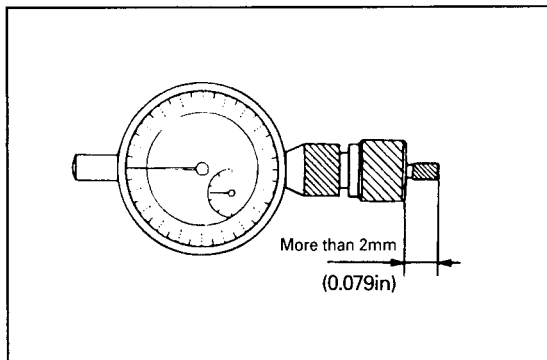
CONSTRUCTION DIAGRAM (Reinforced type)

ADJUSTMENT PROCEDURE (SUMMARY)

Adjustment Sequence	1. Maximum lift	2. Pre-lift	3. Second valve opening pressure	4. First valve opening pressure
Measurement method	Measure the needle recession dimension L1, the tip packing groove depth L2, and the maximum lift adjustment washer thickness L3, in order to calculate the maximum lift $(L1+L2)-L3$. Dimension L1 may be a negative value.	Measure the packing thickness L4 and the spring seat leg length L5 in order to calculate the pre-lift: $L4-L5-(L3-L1)$. Dimension L1 may be a negative value.	Pull out the first valve opening pressure adjustment shim, the first spring, and the pressure pin. Replace the pre-lift adjustment spring seat with the master spring seat (SST) and measure the valve opening pressure.	Assemble all parts and measure the valve opening pressure.
Adjustment method	Select a maximum lift adjustment washer.	Select a pre-lift adjustment spring seat.	Select a second valve opening pressure adjustment shim.	Select a first valve opening pressure adjustment shim.
Tools	• 2-spring base (SST) • Measure attachment (SST) • Dial gauge, Micrometer	• Micrometer	• Master spring seat (SST) • Nozzle hand tester	• Nozzle hand tester

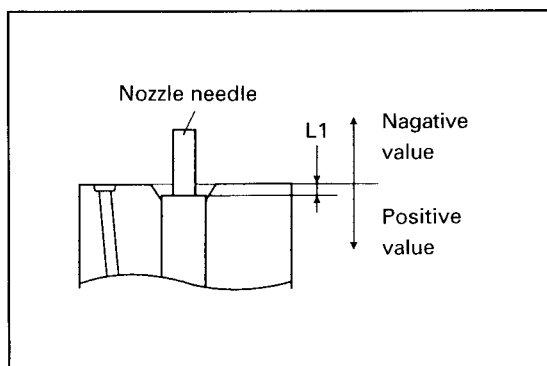
SST


No.	Name	Parts number
1	Master spring seat	09232-23320-71
2	2-spring base	09231-32880-71
3	Measure attachment	09233-23320-71
4	Dial gauge	09234-23320-71

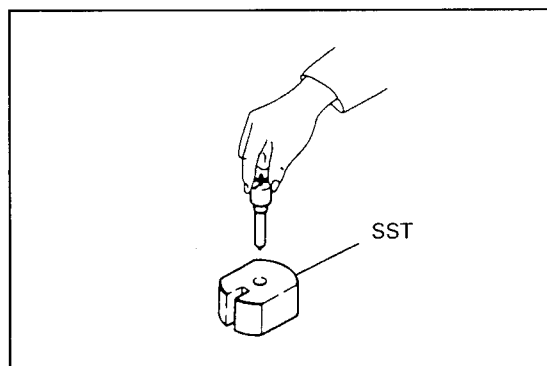


1. Maximum lift adjustment

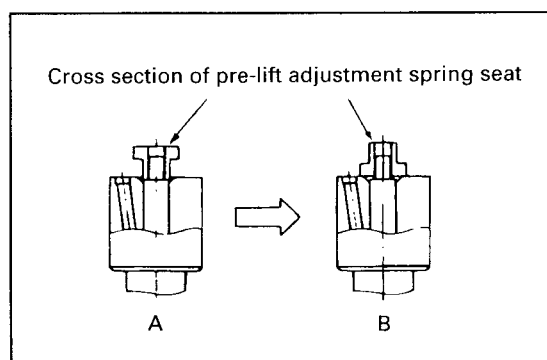
- (1) Attach the measure attachment (SST) to the dial gauge.



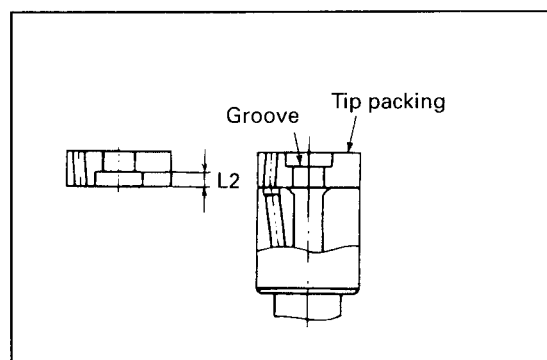
- (2) Measure the dimension L1.



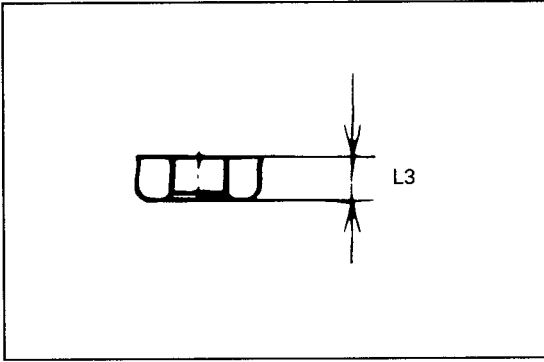
- ① Place the nozzle on the 2-spring base (SST).



- ② Place the pre-lift adjustment spring seat as indicated by "A" in the diagram.
- ③ Align the hole of the measure attachment (SST) with the pre-lift adjustment spring seat and set the graduation on the dial gauge to zero.
- ④ Place the pre-lift adjustment spring seat by facing it in the opposite direction ("B" in the diagram). Align the hole of the measure attachment (SST) with the pre-lift adjustment spring seat and measure L1.



- (3) Place the nozzle body (nozzle needle removed) on the 2-spring base (SST) and place the tip packing (groove facing up) as shown in the diagram.
- (4) On the 2-spring base (SST), set the graduation of the dial gauge to zero.
- (5) Place the nozzle of the dial gauge so that it comes in contact with the groove of the tip packing and measure L2.



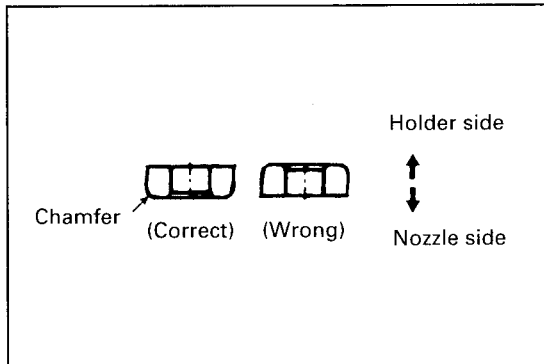
- (6) Using a micrometer, measure the thickness L3 of the maximum lift adjustment washer.

- (7) Calculate the maximum lift (L) according to the measured L1, L2, and L3.

$$L = (L1 + L2) - L3$$

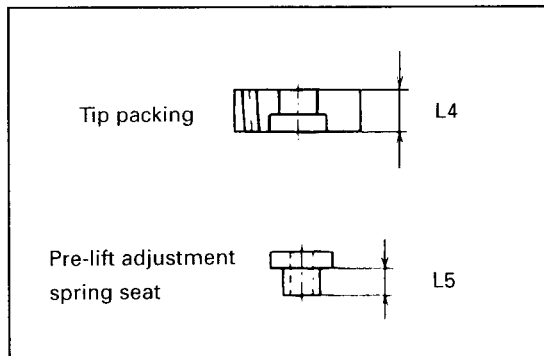
Standard: $L = 0.255 \pm 0.025$ mm
(0.0100 ± 0.001 in)

- (8) If the amount of maximum lift deviates from the specified value, adjust it by changing the maximum lift adjustment washer to one with a different thickness.



Note:

Make sure to install the maximum lift adjustment washer correctly (chamfer facing the nozzle), as it could lead to damage or other problems if it is installed upside down.



2. Pre-lift adjustment

- (1) Using a micrometer, measure the thickness L4 of the tip packing.

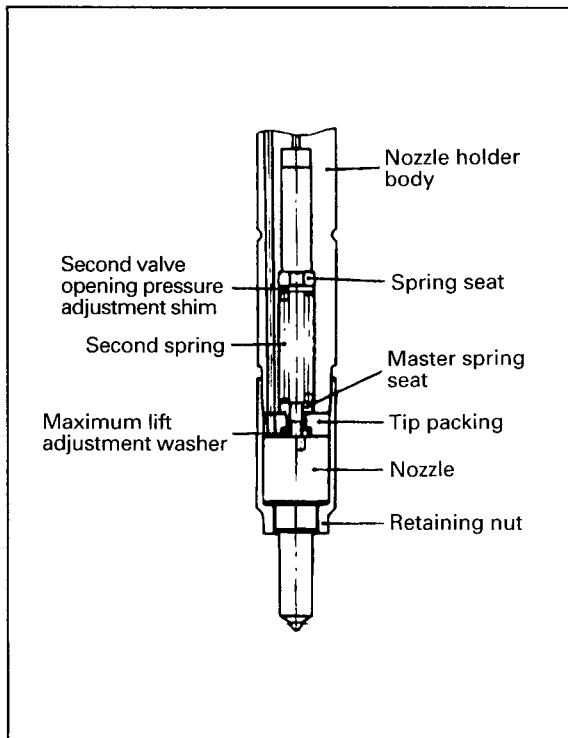
- (2) Using a micrometer, measure the length L5 of the leg of the pre-lift adjustment spring seat.

- (3) Calculate the amount of pre-lift (a) according to the measured L1, L3, L4, and L5.

$$a = L4 - L5 - (L3 - L1)$$

Standard: $a = 0.08 \pm 0.01$ mm
(0.0031 ± 0.0004 in)

- (4) If the amount of pre-lift deviates from the specified value, adjust it by changing the pre-lift adjustment spring seat to one with a different thickness.



3. Second valve opening pressure adjustment

- (1) In the nozzle holder body, install the spring seat, the second valve opening pressure adjustment shim, the second spring, master spring seat (SST), the straight pin, the tip packing, the maximum lift adjustment washer, and the nozzle. Then, tighten the retaining nut.

$$T = 24.5 \sim 34.3 \text{ N}\cdot\text{m} \text{ (250} \sim \text{350 kgf}\cdot\text{cm)} \\ [18.1 \sim 25.3 \text{ ft}\cdot\text{lbf}]$$

- (2) On the nozzle hand tester, install the nozzle and nozzle holder that were assembled in step "(1)", and measure the second valve opening pressure.

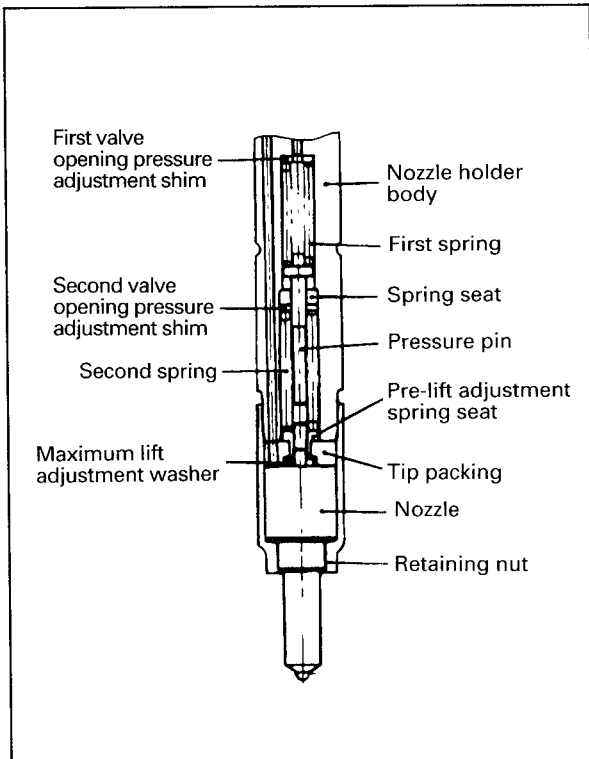
Second valve opening pressure :

$$\text{Standard: } 26.5 \pm 0.5 \text{ MPa (270kg} \pm \text{5kgf/cm}^2\text{)} \\ [3840 \pm 70 \text{ psi}]$$

- (3) If the pressure deviates from the specified value, adjust it by changing the second valve opening pressure adjustment shim to one with a different thickness.

Note:

Using a shim that is thicker by 0.05mm (0.0020in) increases the valve opening pressure by approximately 0.7MPa (7.6kgf/cm²) [108psi].



4. First valve opening pressure adjustment

- (1) In the nozzle holder body, install the first valve opening pressure adjustment shim, first spring, pressure pin, spring seat, second valve opening pressure adjustment shim, second spring, pre-lift adjustment spring seat, straight pin, the tip packing, nozzle maximum lift adjustment washer, and the nozzle. Then, tighten the retaining nut.

**T = 24.5~34.3 N·m (250~350 kgf·cm)
[18.1~25.3 ft·lbf]**

- (2) On the nozzle hand tester, install the nozzle and nozzle holder that were assembled in step "(1)", and measure the first valve opening pressure.

First valve opening pressure :

Standard: $17.7 \pm 0.5 \text{ MPa}$ ($180 \pm 5 \text{ kgf/cm}^2$) [$2560 \pm 70 \text{ psi}$]

- (3) If the pressure deviates from the specified value, adjust it by changing the first valve opening pressure adjustment shim to one with a different thickness.

Note:

Using a shim that is thicker by 0.05mm (0.0020in) increases the valve opening pressure by approximately 0.7MPa (7.6 kgf/cm^2) [108psi].

INJECTION PUMP

SPECIFICATIONS

Direction of rotation	Clockwise as viewed from the drive side
Order of injection	A-B-C-D
Injection interval	90°
Plunger diameter	12 mm (0.47 in.)
Cam lift	2.8 mm (0.11 in.)
Governor type	Mechanical
Timer	With *1 Without *2
Feed pump	Vane type (built-in type)
Lubrication method	Fuel lubrication
Fuel cut	Fuel cut by a solenoid

***1 (With) :**

All model : ~1998.7

7FDF20~J35 : 2001.12~

7FD20~J35, Others : 2002.11~

***2 (Without) :**

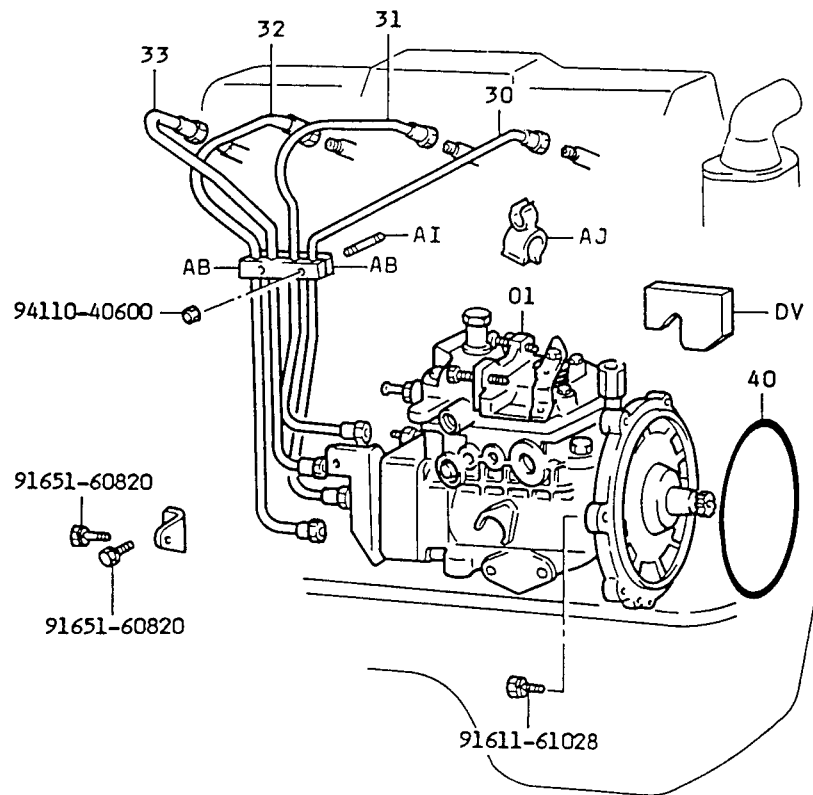
7FDF20~J35 : 1998.8~2001.11

7FD20~J35 : 1998.8~2002.10

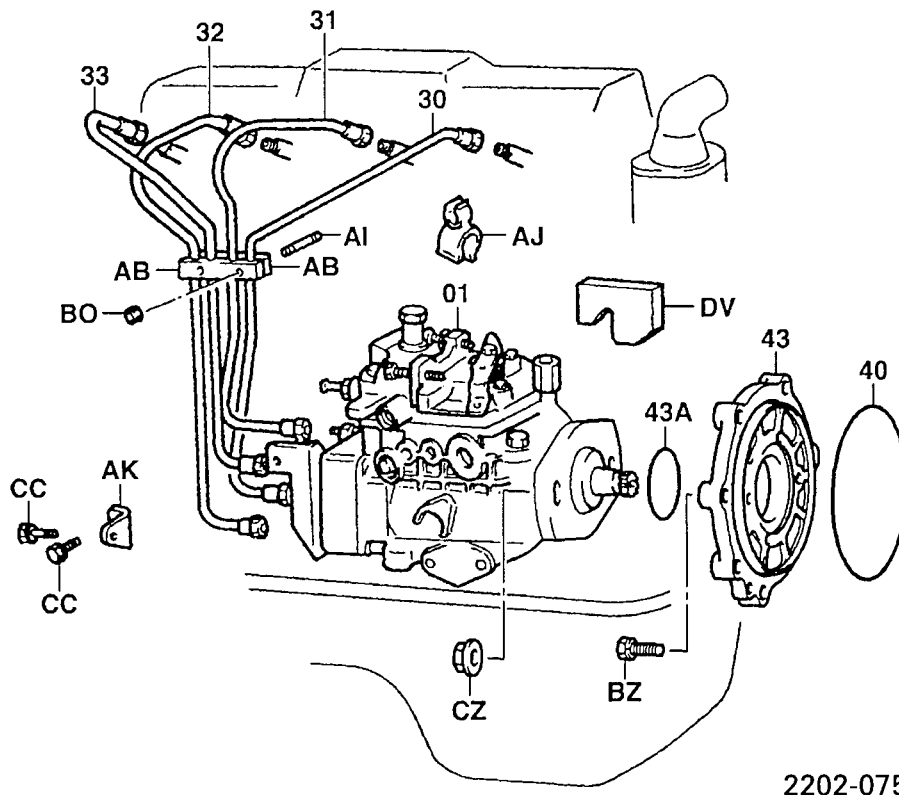
COMPONENTS

2202

~1998. 7

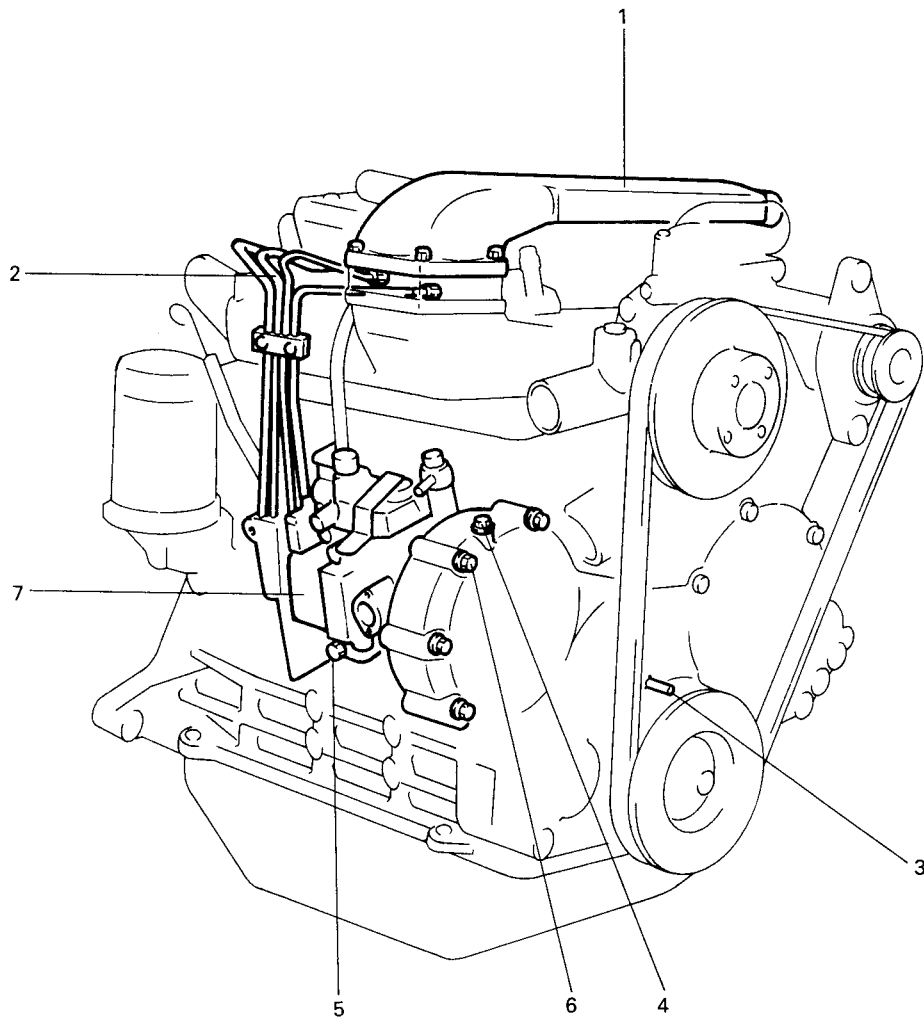


1998. 8~



2202-075

INJECTION PUMP REMOVAL AND INSTALLATION



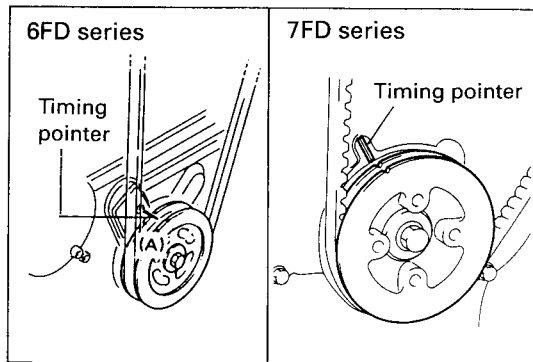
3 TDC

Removal Procedure

- 1 Disconnect the intake pipe.
- 2 Disconnect the injection pipe.
- 3 Set cylinder No. 1 to TDC. **[Point 1]**
- 4 Put a matching mark on the injection pump drive gear. **[Point 2]**
- 5 Remove the injection pump bracket set bolts.
- 6 Remove the injection pump set bolts.
- 7 Remove the injection pump ASSY with drive gear. **[Point 3]**

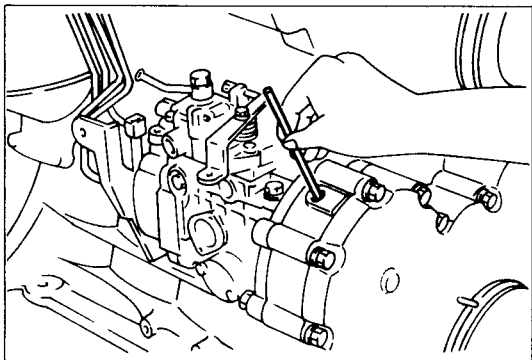
Installation Procedure

Install components in the reverse order of removal other than step 4.

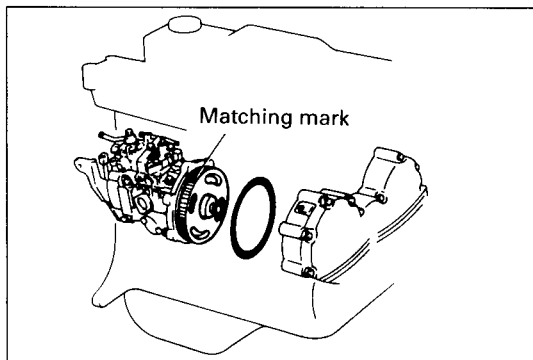
**[Point 1]**

Disassembly: Bring the cylinder to the TDC and then return it a little for ease of work. If it is set at the TDC (A), the injection pump cam is lifted and makes work difficult.

Installation: Attach the injection pump with the drive gear, and adjust the injection timing.

**[Point 2]**

Disassembly: Put a matching mark on the injection pump drive gear using a white paint, etc.

**[Point 3]**

Installation:

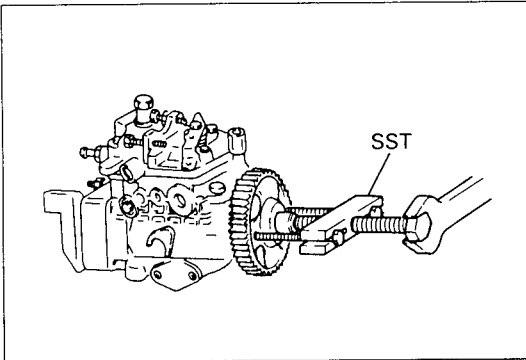
1. Align the matching mark with the hole on the timing gear case.
2. Apply a thin coat of MP grease on O-ring.

INJECTION PUMP DISASSEMBLY, INSPECTION AND INSTALLATION

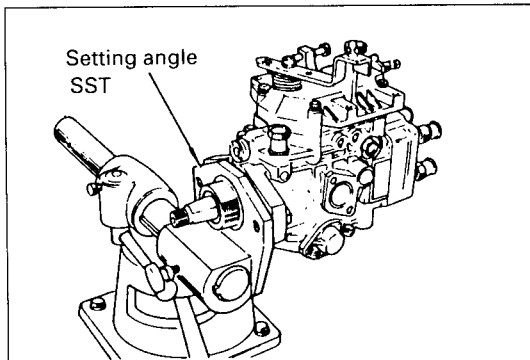
DISASSEMBLY

Notes:

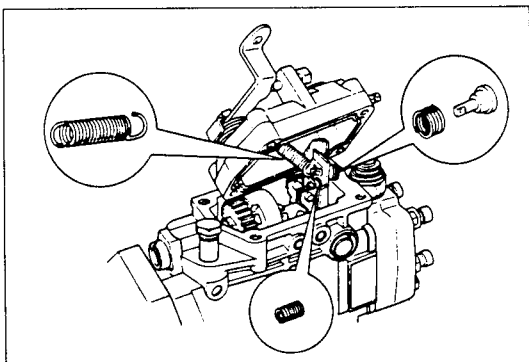
- Overhauling and adjustment will be recommended by injection pump repair shop.
- Wash outside of the injection pump. Clean the work bench and workshop for operation.
- Always measure and record the pump injection volume characteristics before disassembly. This information gives a clue as to the cause of any misadjustment or defective parts.
- While disassembling parts, check how they were installed and check them for any sign of deformation, damage, roughening and scratches.
- Arrange the removed parts in an orderly manner and distinguish parts to be renewed from those to the reused.



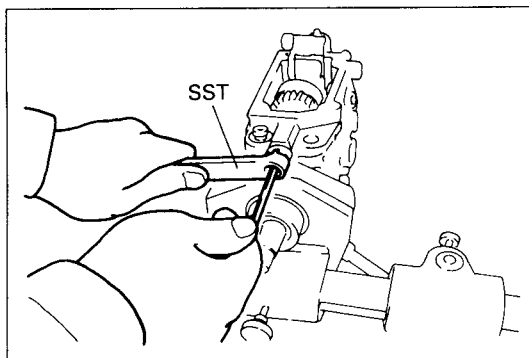
1. Remove the injection pump drive gear.
 - (1) Self locking nut
 - (2) Injection pump drive gear
SST 09213-76002-71
(SST 09213-31021)
 - (3) Injection pump cover
2. Remove the overflow screw and drain fuel.



3. Attach the pump using the pump mounting bench.
SST 09245-76001-71
(SST 09245-54010)



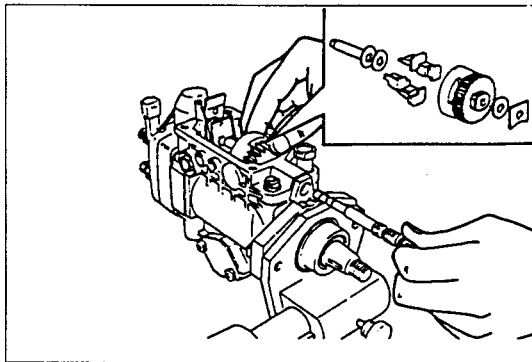
4. Remove the governor cover.
 - (1) Socket bolt
 - (2) Lift the governor cover, and disconnect the control spring from the governor spring seat.
 - (3) Damper spring
 - (4) Governor spring seat
 - (5) Control spring
 - (6) Governor cover



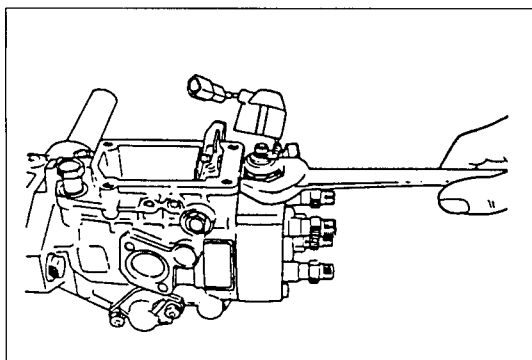
5. Remove the fuel inlet union.
6. Remove the governor shaft parts.
 - (1) Loosen the governor shaft lock nut.
SST 09260-76003-71
(SST 09260-54012)
 - (2) Loosen the governor shaft using a hexagon wrench.

Note:

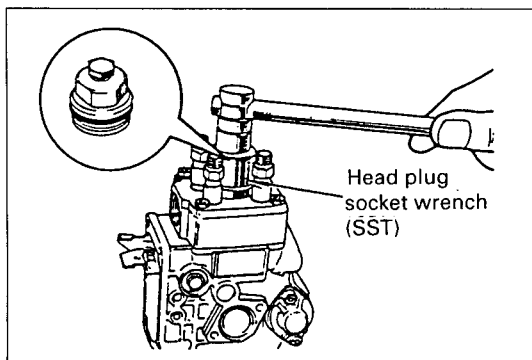
Note that the lock nut and the governor shaft have left-handed threads.



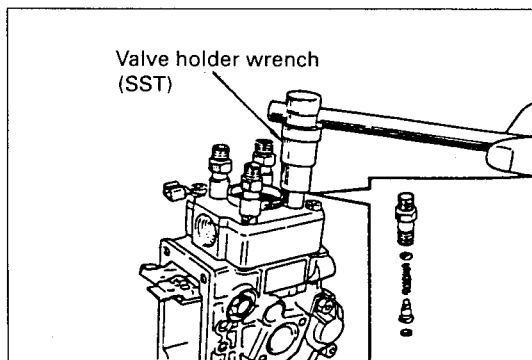
- (3) While extracting the governor shaft, remove the following parts as an ASSY:
 - Flyweight holder
 - Flyweight
 - Flyweight washer
 - Governor sleeve
- (4) Washer
- (5) Adjusting washer



7. Remove the solenoid.
 - (1) Boot
 - (2) Solenoid ASSY
 - (3) O-ring



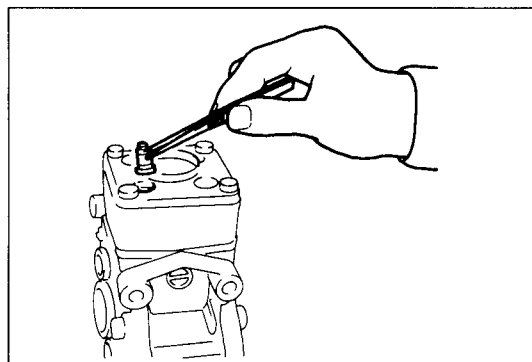
8. Remove the distributor head plug.
 - (1) Head plug
SST 09260-76003-71
(SST 09260-54012)
 - (2) O-ring.

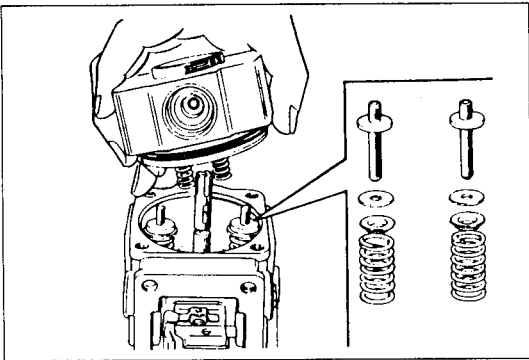


9. Remove the delivery valve.
 - (1) Delivery valve holder
SST 09260-76003-71
(SST 09260-54012)
 - (2) Valve spring seat
 - (3) Valve spring
 - (4) Delivery valve, valve seat
 - (5) Valve gasket

Notes:

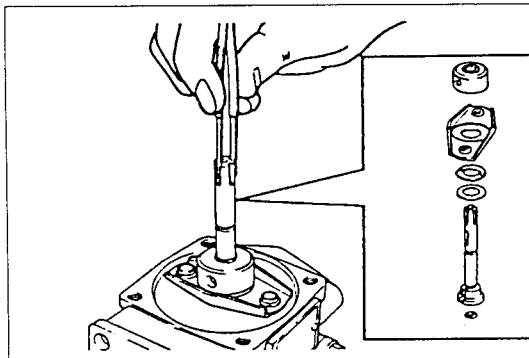
- Keep removed valves and valve seats in pairs per cylinder.
- Cylinder marks (A, B, C, D) are punched on the distributor heads.
- Keep delivery valves, delivery holders and other parts in groups for reinstallation in the same cylinders.





10. Remove the distributor head.

- (1) Distributor head
- (2) Lever support spring

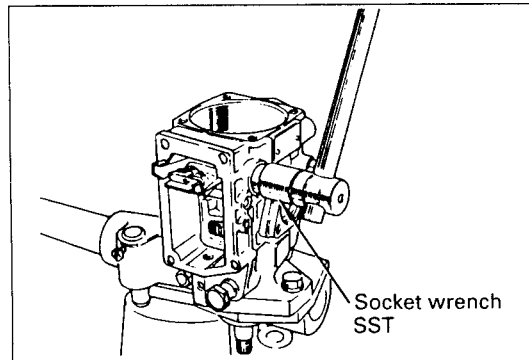


11. Remove the plunger.

- (1) Plunger spring guide
- (2) Plunger spring shim
- (3) Plunger spring lower seat
- (4) Plunger upper plate
- (5) Spill ring
- (6) Plunger spring lower seat
- (7) Plunger upper plate
- (8) Plunger lower plate
- (9) Plunger

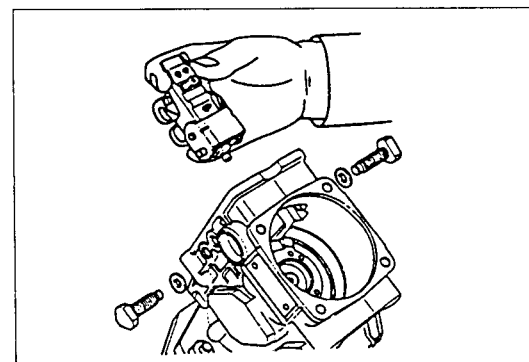
Note:

Do not lose adjusting shims under the plunger.

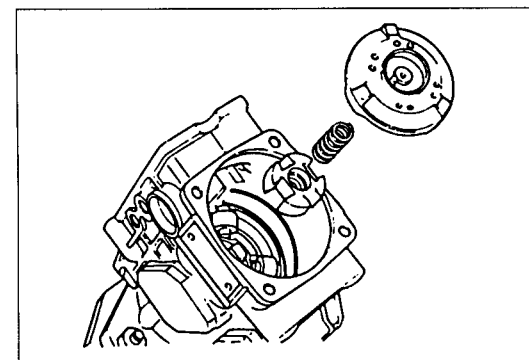


12. Remove the governor lever.

- (1) Supporter bolt
SST 09260-76003-71
(SST 09260-54012)

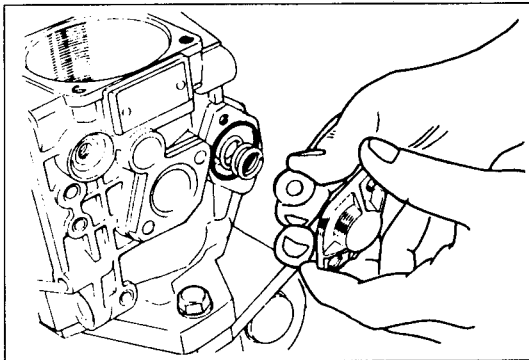


- (2) Governor lever

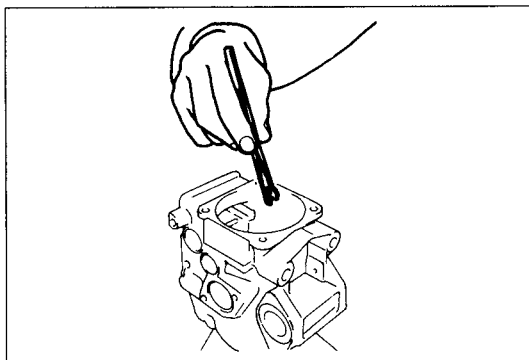


13. Remove the cam plate and coupling.

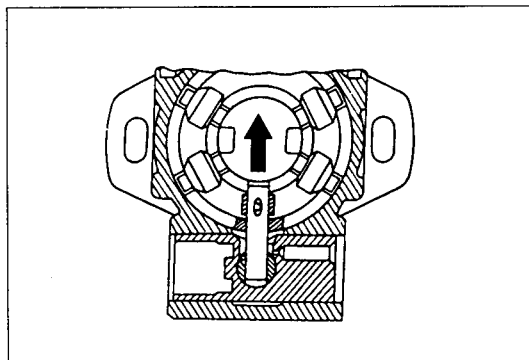
- (1) Cam plate
- (2) Plunger adjusting shim
- (3) Coupling spring
- (4) Coupling



14. Remove the timer spring.
- (1) Timer cover
 - (2) Timer spring
 - (3) Adjusting washers (2 pieces)
 - (4) O-ring



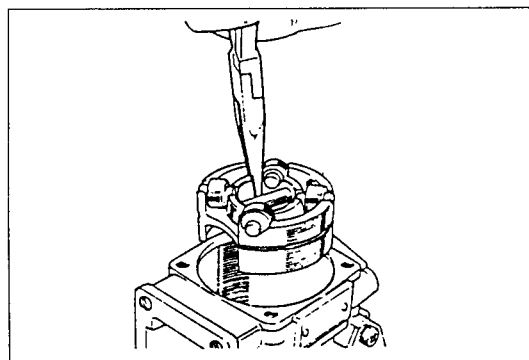
15. Remove the roller ring and timer piston.
- (1) Timer clip
 - (2) Stopper pin



- (3) Push the timer slide pin to the center of the roller ring.

Note:

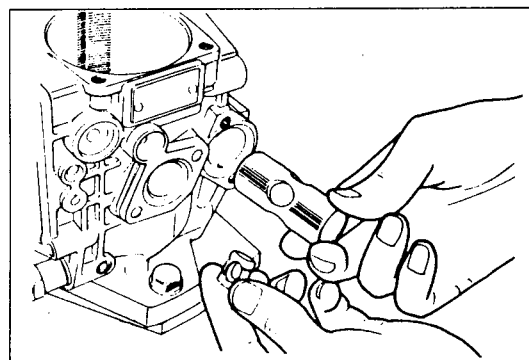
Offset the drive shaft pawl by 90° from the timer slide pin.



- (4) Roller ring SUB-ASSY

Note:

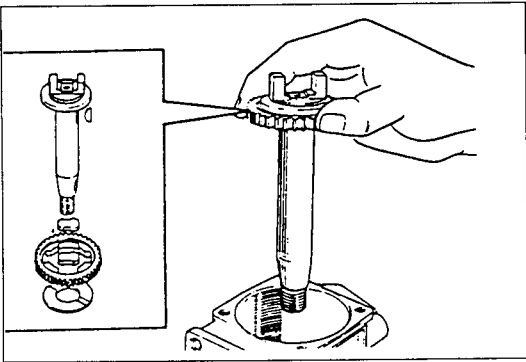
Do not drop the roller ring as the four rollers are installed in special heights. Reinstall them in the same combination and position.



- (5) Timer piston
(6) Timer sub-piston

Note:

Do not drop the timer sub-piston.

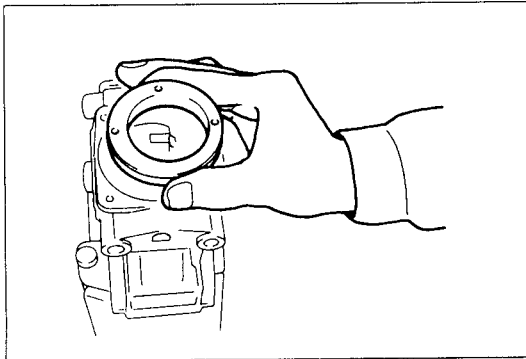


16. Remove the drive shaft.
(1) Extract the drive shaft upward.

Note:

Do not lose the feed pump drive key.

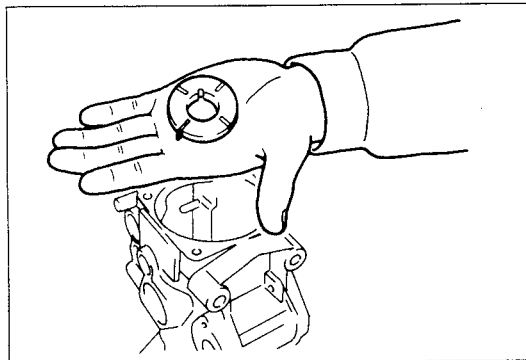
- (2) Disassemble the drive shaft (with gear).
- Drive shaft
 - Drive gear
 - Rubber joints (2 pieces)
 - Drive shaft washer
 - Drive shaft



17. Remove the feed pump parts.
(1) Feed pump cover set screw
(2) Feed pump cover
(3) Liner

Note:

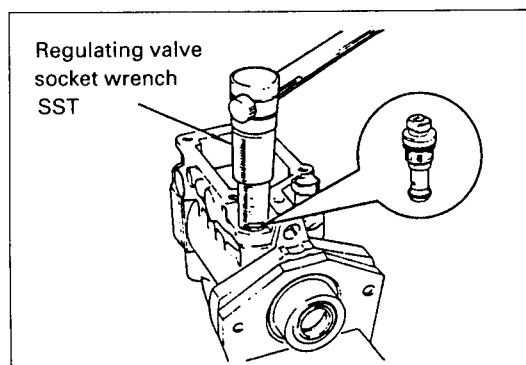
Make certain that the rotor and the blade remain inside at this time. Do not slant or pry.



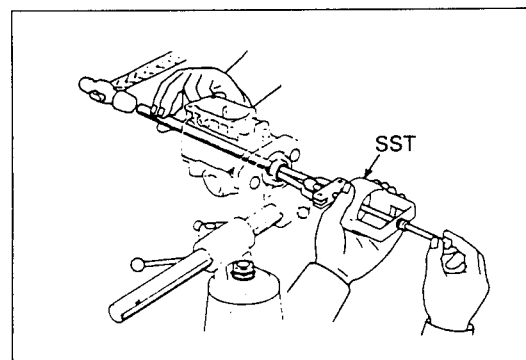
- (4) Rotor, blade

Notes:

- Do not alter the relative positions of the four blades and the rotor.
- When replacement is necessary, replace the rotor, blades and liner as a group.



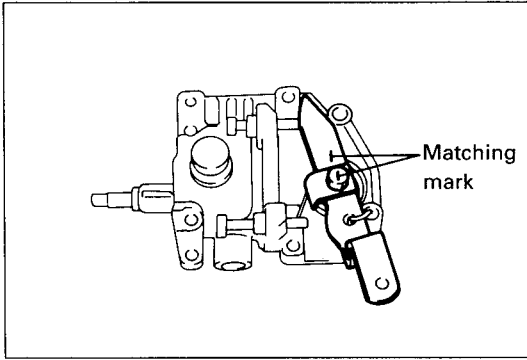
18. Remove the regulating valve.
(1) Regulating valve
SST 09260-76003-71
(SST 09260-54012)
(2) O-ring



19. Remove the oil seal.
SST 09612-76006-71
(SST 09612-65014)

Note:

Set SST as shown, and drive out the oil seal with a driving bar or other appropriate tool.



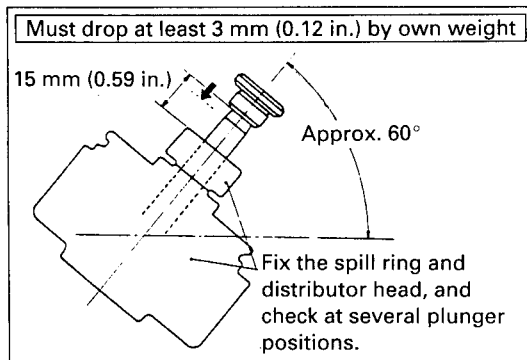
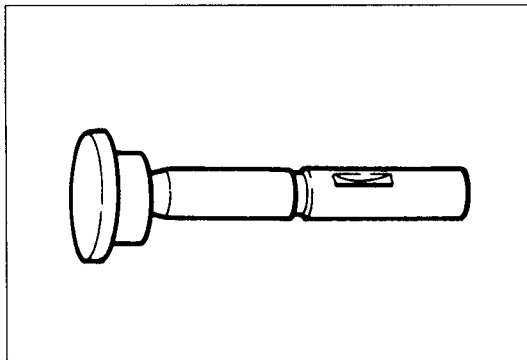
20. Remove the governor cover parts.

- (1) Align the lever shaft with the lever, and put matching marks.
- (2) Nut
- (3) Spring guide
- (4) Adjusting lever
- (5) Return spring
- (6) Extract the lever shaft to the inside.

INSPECTION

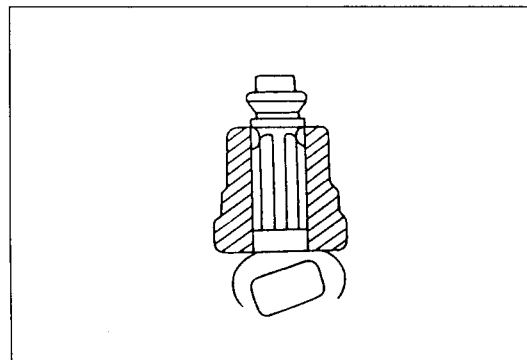
1. Inspect the plunger.

- (1) When wear, scratch, discoloration or other defect is found at the plunger lead, replace the plunger, spill ring and distributor head as a group.
- (2) Check the plunger sliding contact surfaces as follows:
 - 1 Slide the plunger 4 to 5 times in clean light oil.
 - 2 Tilt the distributor head 60°, and pull out the plunger by about 15 mm (0.59 in.).
 - 3 When the plunger is released gently, it must drop at least 3 mm (0.12 in.) by its own weight.
 - 4 Fix the spill ring and distributor head, and repeat steps 2 and 3 several times, each time rotating the plunger a little.
 - 5 If the plunger does not drop more than 3 mm (0.12 in.) by its own weight, replace the plunger, spill ring and distributor as a group.



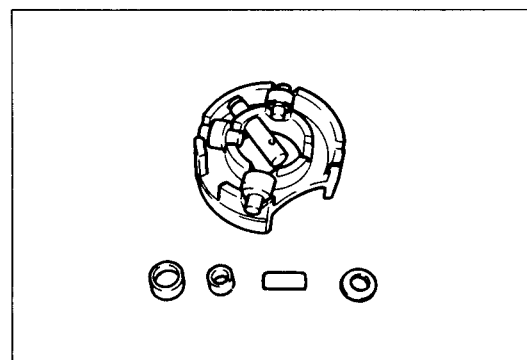
2. Inspect the delivery valve and holder.

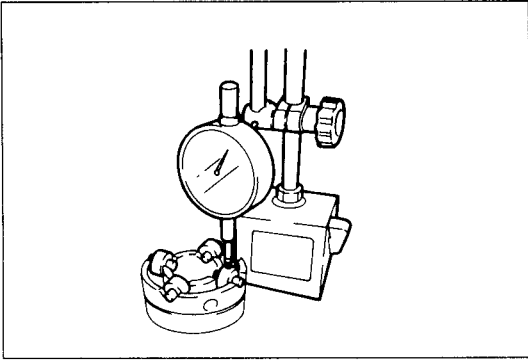
- (1) Check the valve seat surface and piston for scratch, dent and wear.
- (2) Check the delivery valve and holder for scratch in contact surfaces with high pressure pipe.
- (3) Check the suck-back action.
 - 1 Thoroughly wash the parts in light oil and do not wipe off the oil film. Close the lower part of the valve seat with a finger and lift the valve.
 - 2 The parts are in good condition if the valve stops at the relief valve when released.
 - 3 Replace the valve if it falls to the seat.



3. Inspect the roller ring.

- (1) If flaking, local wear or other flaw prohibiting reuse is found on the roller and roller pin, replace the roller ring ASSY.

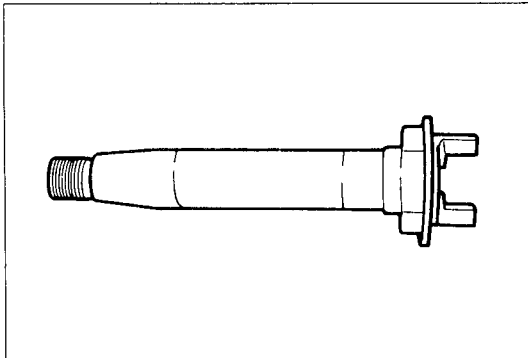




- (2) Measure the height of the four rollers using a dial gauge and calculate the dispersion.

Limit: 0.02 mm (0.0008 in.)

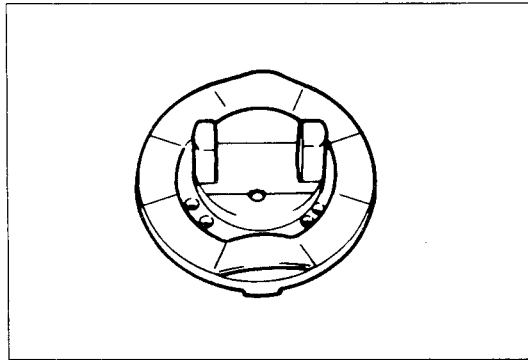
If the limit is exceeded, change the roller positions with one another and check the height dispersion again.



4. Inspect the drive shaft.

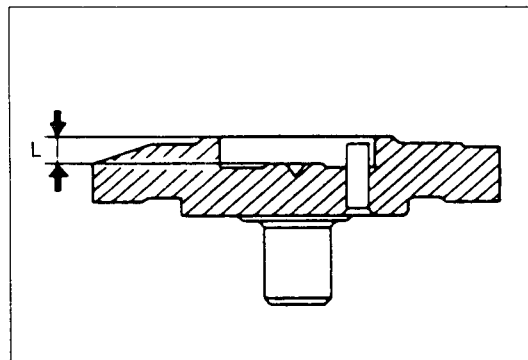
- (1) A free play is provided between the key and the key groove. Replace the drive shaft if the taper is damaged.
- (2) Measure the amount of wear in the oil seal contact surface.

Limit: 0.08 mm (0.0031 in.)



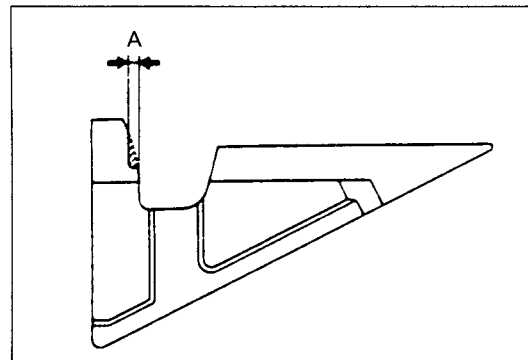
5. Inspect the cam plate.

- (1) Check the cam surface for flaking, local wear or damage.



- (2) Measure the amount of wear in the cam plate coming in contact with the plunger (measure dimension L using a vernier caliper).

Limit: 0.2 mm (0.008 in.)

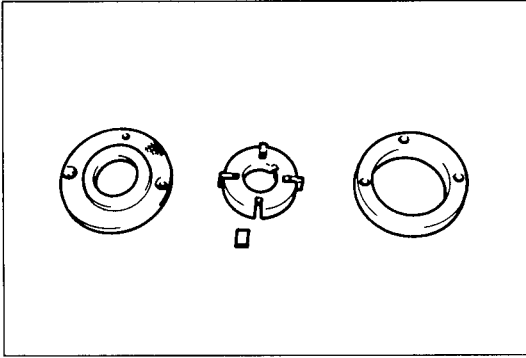


6. Inspect the flyweights.

- (1) Measure the amount of stepped wear at the flyweight surface coming in contact with the washer.

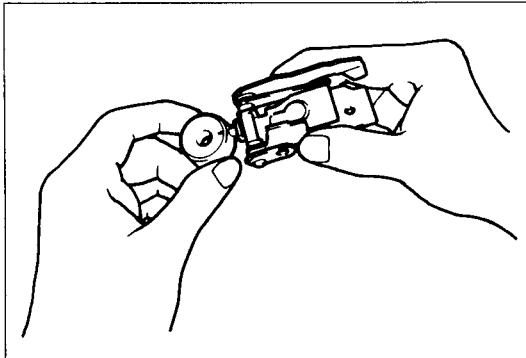
Limit A: 0.2 mm (0.008 in.)

If the limit is exceeded, replace all four parts as a group.



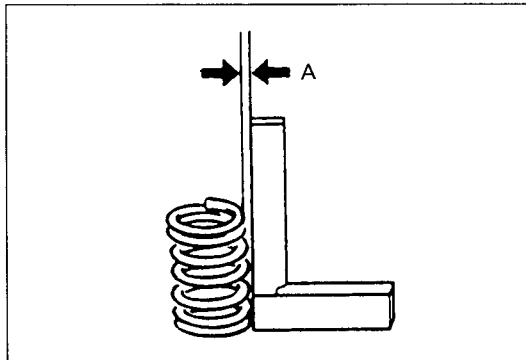
7. Inspect the feed pump.

- (1) Check the sliding surface for excessive wear or damage. If necessary, replace the feed pump ASSY.



8. Inspect the governor lever and spill ring.

- (1) Insert the governor lever ball pin into the hole in the spill ring. Check if the parts slide on each other smoothly.



9. Inspect the plunger springs.

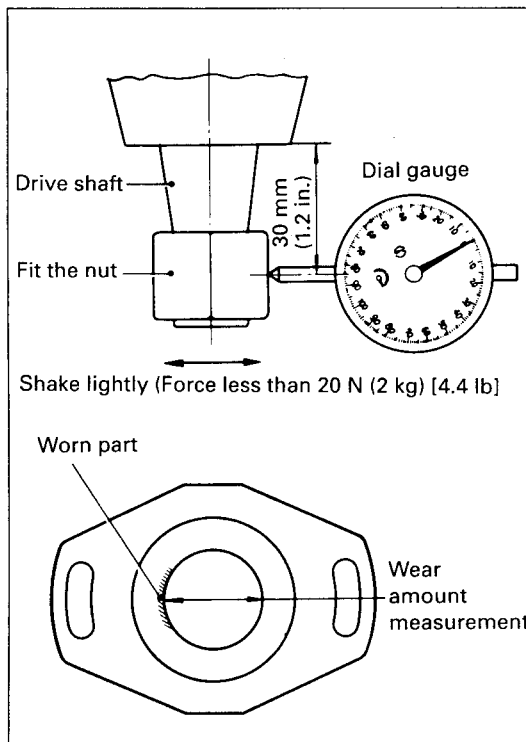
- (1) Replace if the surface is damaged.

Note:

Replace both springs simultaneously.

- (2) Squareness of the spring

Limit A: 2.0 mm (0.08 in.)



10. Inspect the pump housing.

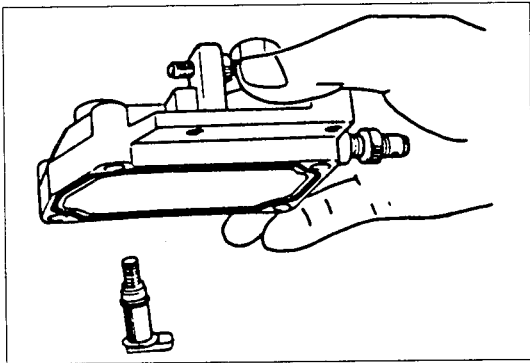
- (1) Check the feed pump for wear or scratch in the sliding surface.
- (2) Check the threads for damage.
- (3) Wear of the housing bushing
 - 1 Fit the nut on the drive shaft as illustrated. Lightly shake the drive shaft in the direction of wear (by a light push with a hand) and measure the amount of wear. If the wear exceeds the limit, replace the bushing and the pump housing. (Replacement of the bushing only is not allowed)

Bushing wear limit: 0.15 mm (0.0059 in.)

REASSEMBLY

Notes:

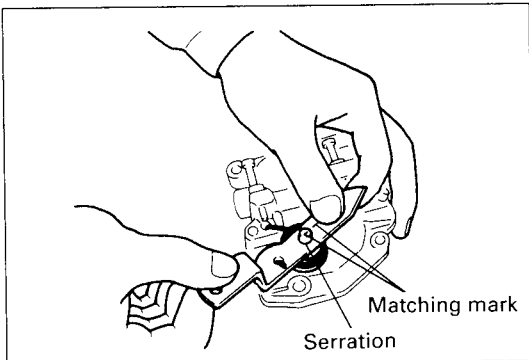
- Keep the work bench and work area clean to prevent dust and foreign matter from entering the pump during reassembly.
- Thoroughly wash parts in clean light oil before reassembly.
- Coat light oil in all sliding surfaces, O-rings and oil seals before ASSY.
- Always renew O-rings, nipple washers, gaskets and joint rubbers. Do not reuse them.



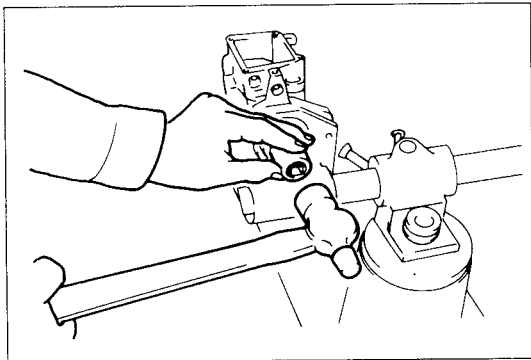
1. Assemble the adjusting lever parts.
 - (1) Assemble O-rings and washers to the lever shaft.
 - (2) Assemble parts in the lever shaft cover first.
 - (3) Return spring
 - (4) Adjusting lever

Notes:

- Align the matching marks on the adjusting lever and the lever shaft.
- One serration of the adjusting lever corresponds to 7.5° in the lever angle.
- When replacing the adjusting lever, select a new one having the same punched number.



- (5) Spring guide
- (6) Nut

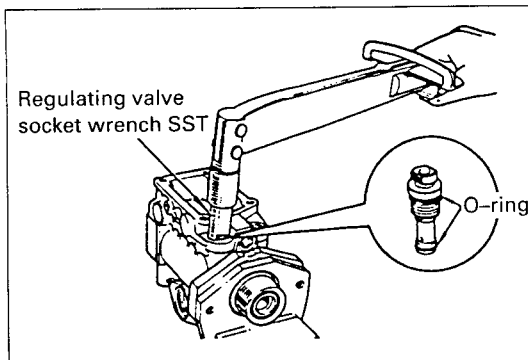


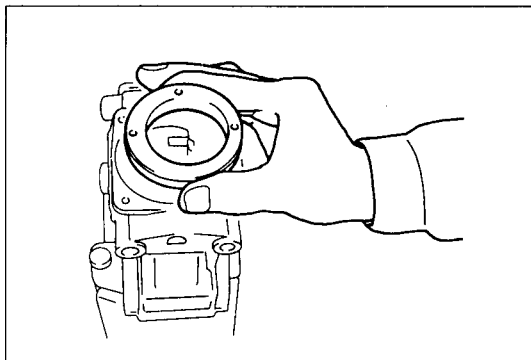
2. Install the pump housing in the pump stand.
SST 09245-76001-71
(SST 09245-54010)
3. Assemble the oil seal.

Note:

Use a 22 mm (0.866 in.) box and drive in the oil seal to the end surface of the pump body.

4. Assemble the regulating valve.
 - (1) Assemble O-ring to the regulating valve.
SST 09260-76003-71
(SST 09260-54012)
 - (2) Regulating valve.



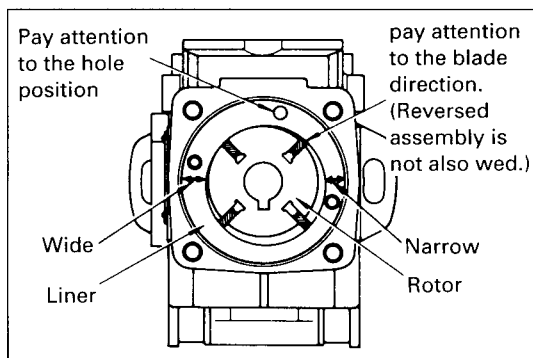


5. Assemble the feed pump parts.

(1) Liner

Note:

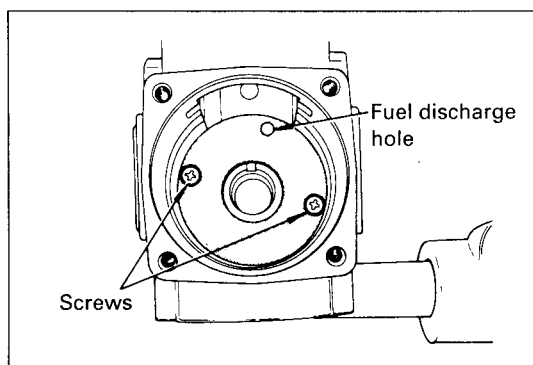
Assemble the liner in the specific direction as shown. If installed incorrectly (right and left, front and back), it will block fuel passage. (The step at the side must be at the top in the illustration.)



(2) Rotor, blades

Notes:

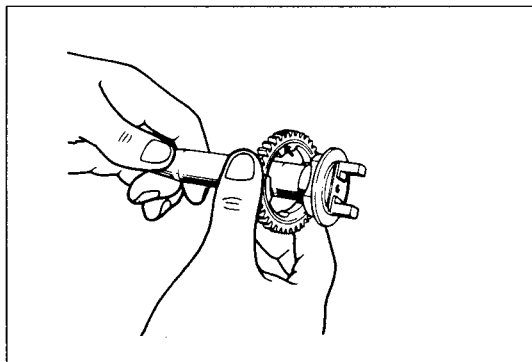
- Assemble the rotor and the blades with the grooved side facing inward as shown. Check that the rotor and the blades slide smoothly.
- When the feed pump replacement is required, replace the entire ASSY (rotor, blades and liner).



(3) Feed pump cover

Notes:

- Check the position of the fuel discharge hole on the feed pump cover. Never install the part in the reversed position.
- After the cover is assembled, check that the rotor slides smoothly in all four directions (vertical and horizontal directions).

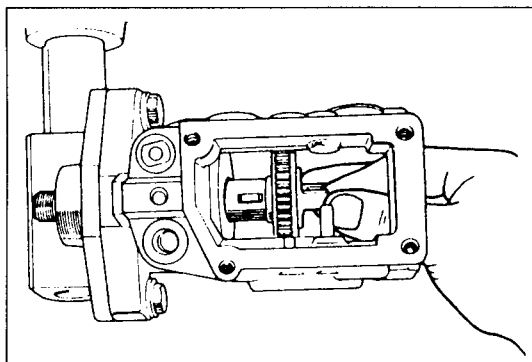


6. Assemble the drive shaft.

- (1) Assemble the governor drive gear to the drive shaft. Then insert a rubber joint into the gap between the drive shaft and the drive gear.

Notes:

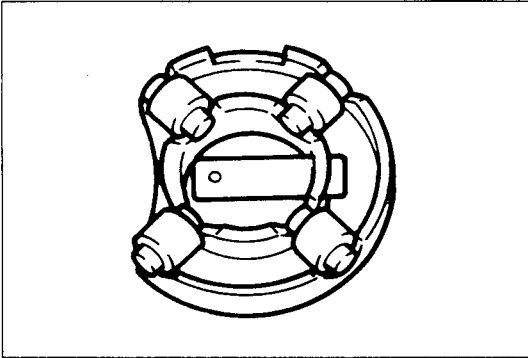
- Install the governor drive gear with the stepped surface facing the pawl of the drive shaft.
- Use a new rubber joint.



(2) Drive shaft washer, drive shaft ASSY, key

Notes:

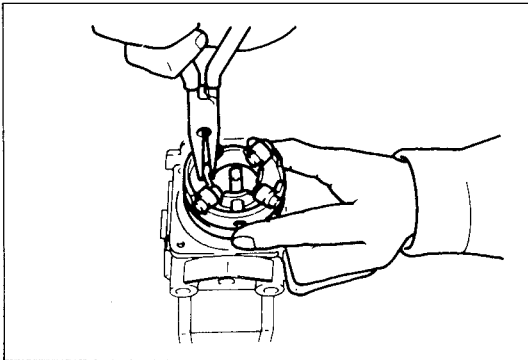
- Position the rotor with the key groove facing upward. Assemble the rotor drive key and thrust washer to the shaft, and assemble them along the rotor key groove.
- Check that the parts rotate smoothly after ASSY.



7. Assemble the roller ring.
- (1) Insert the timer slide pin into the roller ring ASSY.

Notes:

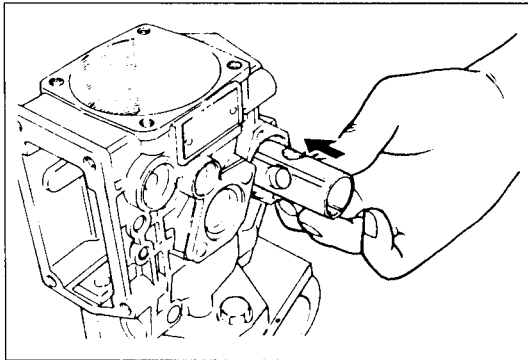
- Confirm that the curved surface of the washer at the roller of the roller ring is facing the periphery.
- Make certain that the slide pin is inserted to the center as shown.



- (2) Hold the pump vertically and assemble the roller ring ASSY as shown.

Notes:

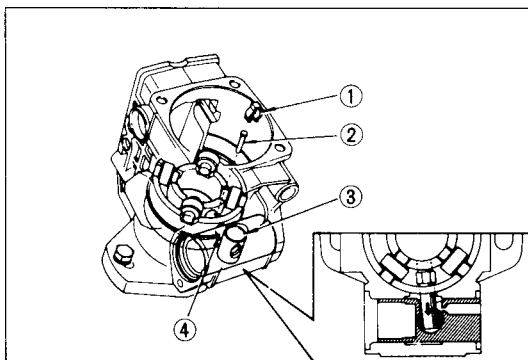
- Do not drop the roller.
- Assemble the roller ring with the notch facing the top of the pump housing.



8. Assemble the timer.
- (1) Assemble the sub-piston to the timer piston. Coat grease (Nippondenso Grease #50 or Timer Grease), and insert the parts into the pump housing.

Notes:

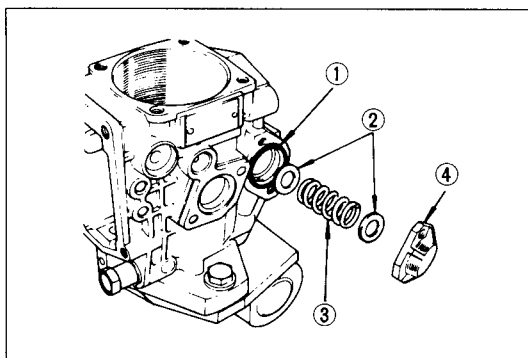
- The low pressure side (timer spring side) must be at the right side of the pump as viewed from the drive side. Confirm that the fuel inlet hole of the pump housing is on the low pressure side.
- Assemble the parts with the hole in the sub-piston facing the timer slide piston.



- (2) Insert the timer slide pin into the timer sub-piston. Assemble the stopper pin, and fit the clip.

Note:

Confirm that the timer piston slides smoothly.

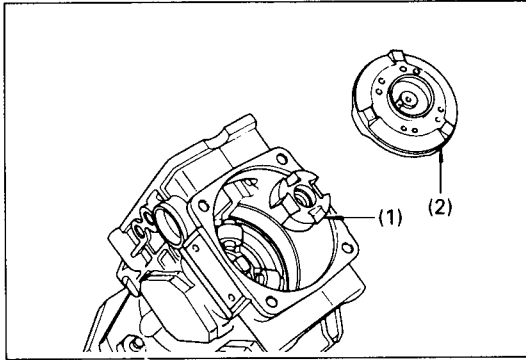


- (3) Assemble the following parts:

- ① O-ring
- ② Washers
- ③ Timer spring
- ④ Timer cover

Note:

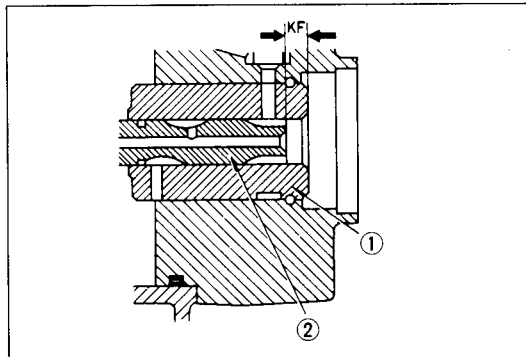
Install washers at both ends of the spring to thickness 0.5 mm (0.020 in) or more.



9. Assemble the coupling and cam plate.
 - (1) Coupling
 - (2) Assemble the cam plate with the pin in the same direction as the key groove in the drive shaft.

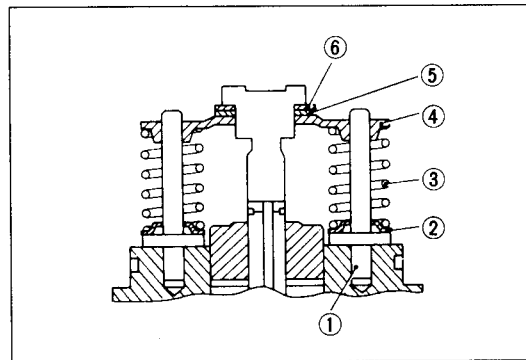
Notes:

- The cam plate pin and the drive shaft key groove must be aligned. Otherwise, the proper sequence of injection will be affected.
- Do not assemble the coupling spring at this point.



10. Adjust the plunger spring shim (measuring dimension KF).

- (1) Dimension KF is the distance from the end surface of the distributor cylinder ① to the end surface of the plunger ② head. The set length of the plunger spring can be altered by selective use of the plunger spring shim.

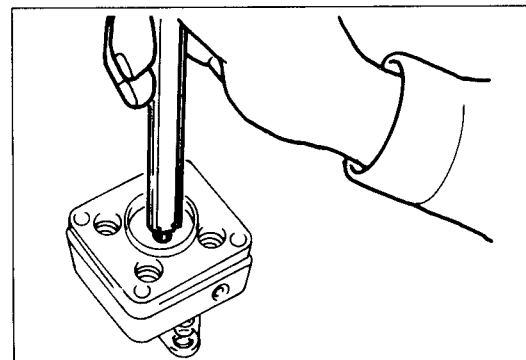


- (2) Assemble the following parts to the cylinder head:

- ① Plunger spring guide
- ② Upper spring seat
- ③ Plunger spring
- ④ Lower spring seat
- ⑤ Plunger upper plate
- ⑥ Plunger lower plate
- ⑦ Plunger

Notes:

- Do not assemble the plunger spring shim.
- Leave the spill ring removed.



- (3) Selective use of the plunger spring shim
Measure dimension KF when the plunger spring is released, and calculate the necessary shim thickness from the following equation:

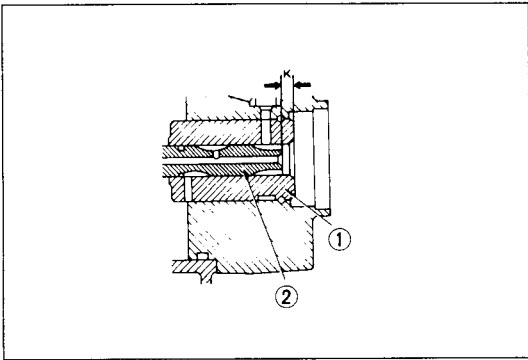
$$\text{Shim thickness} = 5.9 \text{ mm (0.232 in.)} - \text{dimension KF}$$

Notes:

- Use plunger spring shims of the same thickness on both sides (use two identical shims per pump).
- When shims of the appropriate thickness are not available, use shims of the next larger thickness.
- When a plunger spring replacement is required, replace both as a pair.

Size variation of plunger spring shims

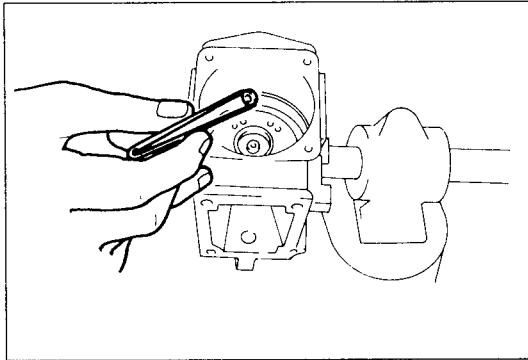
Thickness mm (in.)	
0.5 (0.020)	1.3 (0.051)
0.8 (0.031)	1.4 (0.055)
0.9 (0.035)	1.5 (0.059)
1.0 (0.039)	1.8 (0.071)
1.1 (0.043)	2.0 (0.079)
1.2 (0.047)	—



11. Adjust the plunger spring shim (measuring dimension K).

- (1) Dimension K is the distance from the end surface of the distributor cylinder ① as assembled to the end surface of the plunger ② head at the BDC of the plunger.

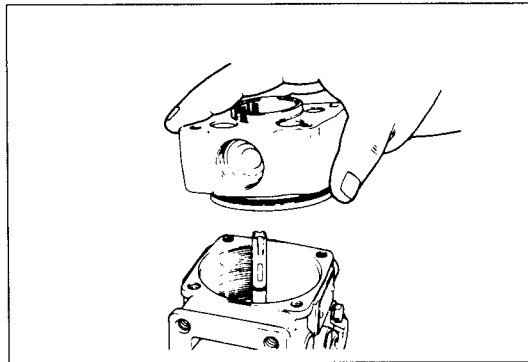
Dimension K can be altered by selective use of the plunger adjusting shim.



- (2) Insert a plunger shim of an appropriate thickness, and assemble the plunger with the cam plate drive pin fitted along the plunger groove.

Note:

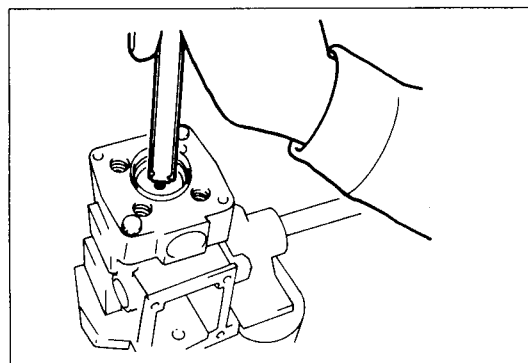
Do not coat grease on the plunger shim.



- (3) Insert the distributor head carefully, and bolt it in place.

Notes:

- Turn the drive shaft and check if the plunger rotates.
- The plunger will not rotate if the cam plate pin is not in the plunger groove. If this is the case, assemble them correctly.



- (4) Bring the plunger to the BDC and measure dimension K.

Standard: $K = 3.3 \pm 0.1 \text{ mm } (0.130 \pm 0.004 \text{ in.})$

Note:

Make sure the plunger is not raised during measurement.

Size variation of plunger shims

Thickness mm (in.)
1.9 (0.074)
2.2 (0.087)
2.4 (0.094)
2.7 (0.106)
2.9 (0.114)

- (5) Plunger shim selection
Compare the measured value with the standard, and select the appropriate shim thickness accordingly.

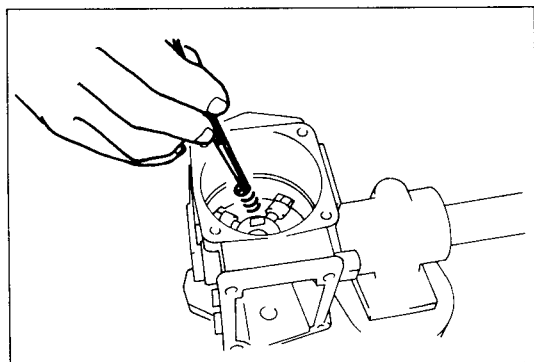
$$\text{Shim thickness (mm)} = t_1 + (t_2 - 3.3)$$

$$\text{(in.)} = t_1 + (t_2 - 0.13)$$

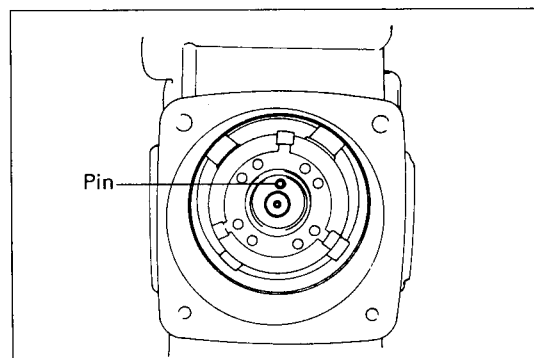
t_1 : Shim thickness during measurement

t_2 : Measured dimension

- (6) Remove the distributor head, plunger and cam plate again.



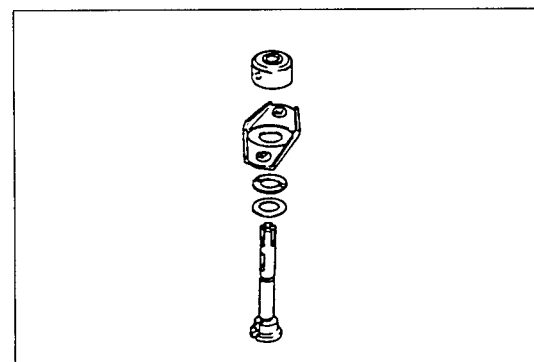
12. Assemble the coupling spring.



13. Assemble the cam plate.

Note:

The drive pin of the cam plate must be aligned with the key groove of the drive shaft. Otherwise, the proper seve pin of the cam plate must be aligned with the key groove of the drive shaft. Otherwise, the proper sequence of injection will be affected.

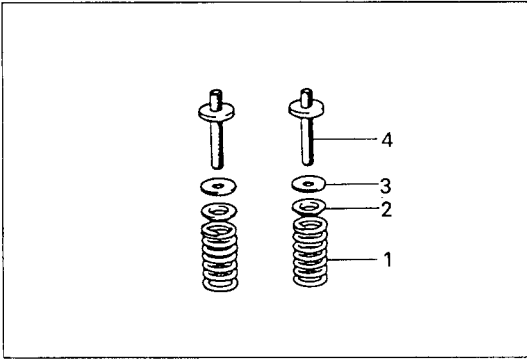


14. Assemble the plunger parts.

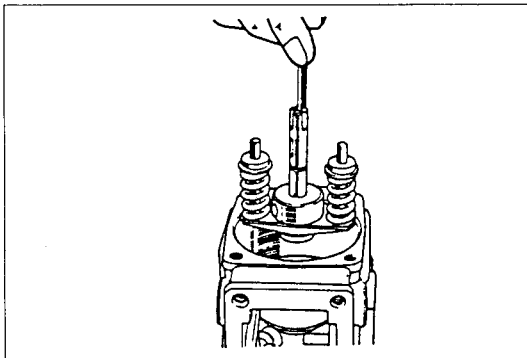
- (1) Assemble the following parts to the plunger:
- 1 Plunger lower plate
 - 2 Plunger upper plate (with an oil groove)
 - 3 Plunger spring lower seat
 - 4 Spill ring

Note:

Install the spill ring in such a way the end surface with a hole faces the cam plate.



- (2) Assemble the following parts to the plunger spring lower seat:
 - 1 Plunger spring
 - 2 Spring upper seat
 - 3 Plunger spring shim (selective use)
 - 4 Plunger spring guide



- (3) Plunger shim (selective use)

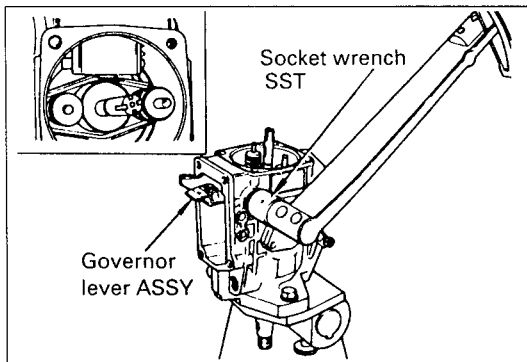
Note:

Do not coat grease on the plunger shim.

- (4) Assemble the plunger parts as shown.

Note:

The drive pin of the cam plate must fit in the groove at the plunger leg.



15. Assemble the governor lever.

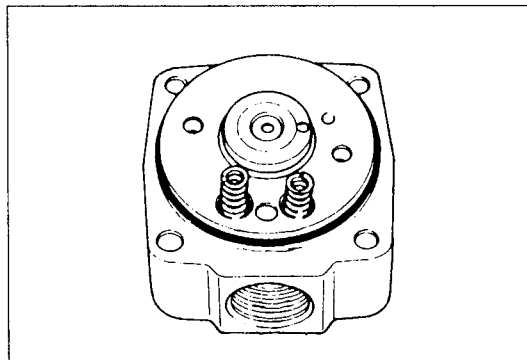
- (1) Governor lever

Note:

The ball pin of the governor lever must fit in the spill ring.

- (2) Support bolt
SST 09260-54012

**T = 9.8 N ~ 12.7 N·m (100 ~ 130 kg-cm)
[7.3 ~ 9.3 ft-lb]**



16. Assemble the distributor head.

- (1) Assemble the following parts to the distributor head:

- 1 O-ring
- 2 Lever support spring

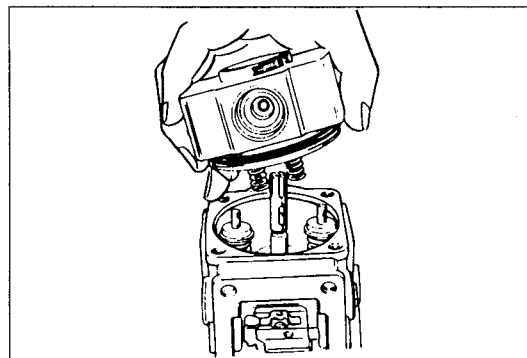
Note:

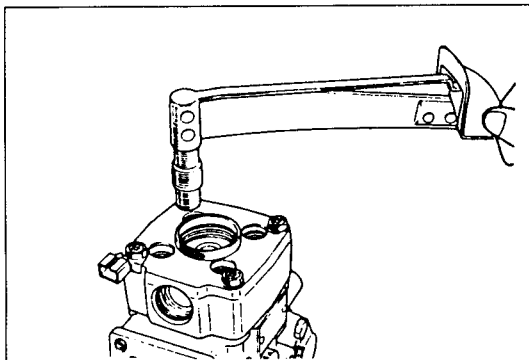
Apply grease (Nippondenso Grease #50 or Timer Grease) to the spring to adhere it to the distributor head.

- (2) Assemble the distributor head.

Notes:

- The lever support spring must face the governor lever.
- Push the distributor head by hand until it touches the O-ring.



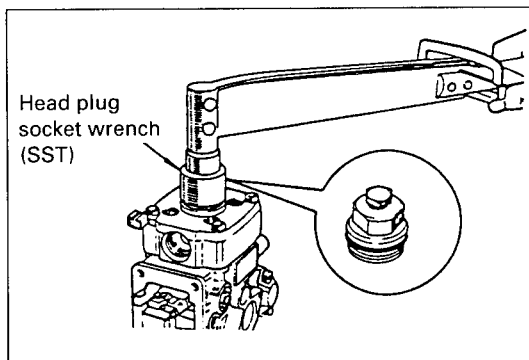


(3) Distributor head set bolts

$T = 10.8 \sim 12.7 \text{ N}\cdot\text{m}$ (110 ~ 130 kg-cm)
[8.0 ~ 9.3 ft-lb]

Notes:

- Tighten the four bolts evenly and alternately.
- Operate the governor lever and check that the spill ring follows smoothly.



17. Assemble the head plug.

(1) Assemble O-ring to the head plug.

(2) Head plug

SST 09260-76003-71

(SST 09260-54012)

$T = 58.8 \sim 78.4 \text{ N}\cdot\text{m}$ (600 ~ 800 kg-cm)
[43.4 ~ 57.6 ft-lb]

Note:

Always use new head plugs.

Until July 1998.

18. Assemble the delivery valve.

(1) Gasket

(2) Delivery valve

(3) Valve spring

(4) Spring seat

(5) Valve holder

SST 09260-76003-71

(SST 09260-54012)

$T = 44.1 \sim 53.9 \text{ N}\cdot\text{m}$ (450 ~ 550 kg-cm)
[32.5 ~ 39.7 ft-lb]

Notes:

- Always use new gaskets.
- When replacement is required, always replace the delivery valve and the valve seat as a group.

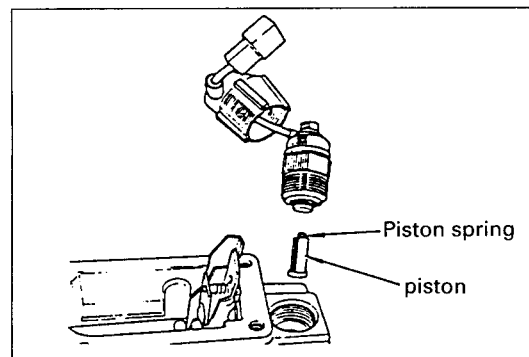
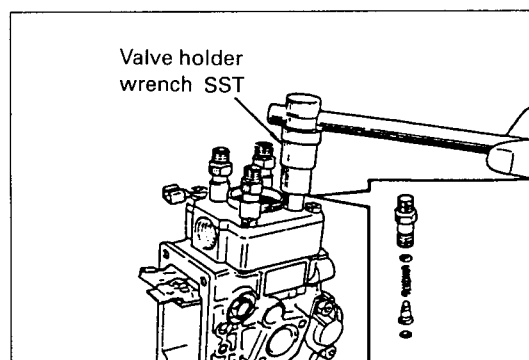
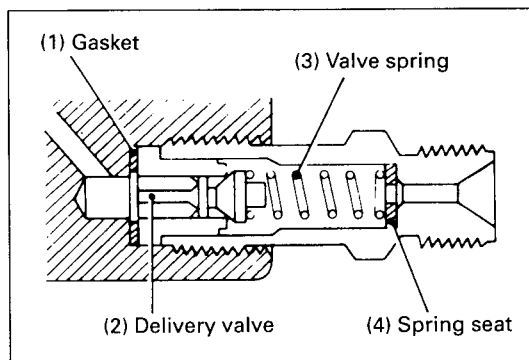
Since August 1998.

18. Assemble the delivery valve.

$T = 54.0 \sim 63.7 \text{ N}\cdot\text{m}$ (550 ~ 650 kgf-cm)
[39.8 ~ 47.0 ft-lbf]

Notes:

- Always use new gaskets.
- Replace the delivery valve as ASSY.



19. Assemble the solenoid.

(1) Assemble O-ring to the solenoid.

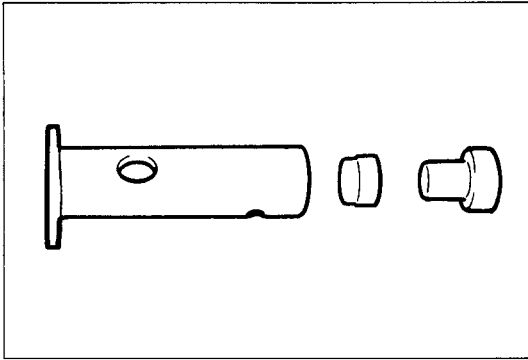
(2) Solenoid

$T = 19.6 \sim 24.5 \text{ N}\cdot\text{m}$ (200 ~ 250 kg-cm)
[14.5 ~ 18.0 ft-lb]

Note:

When assembling the solenoid, also assemble the piston and spring.

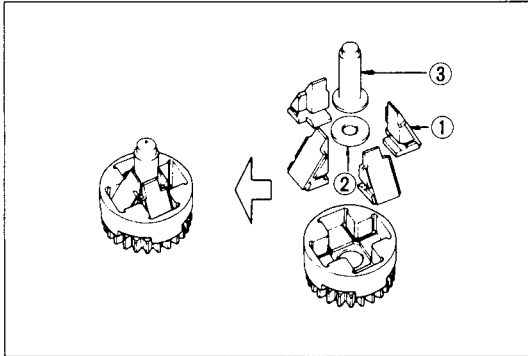
(3) Boot



20. Assemble the governor shaft parts.

- (1) Assemble the following parts to the governor sleeve:

- 1 Stop ring
- 2 Sleeve plug

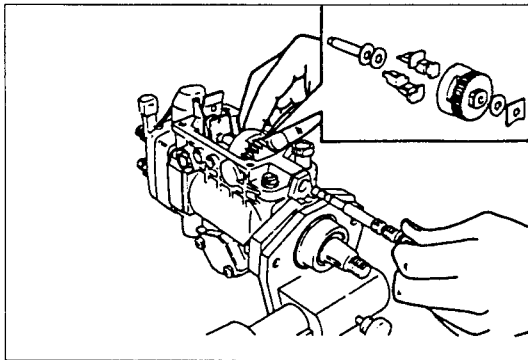


- (2) Assemble the following parts to the weight holder:

- 1 Flyweight
- 2 Flyweight washer
- 3 Governor sleeve

Note:

When flyweight replacement is required, always replace all four flyweights (per engine).



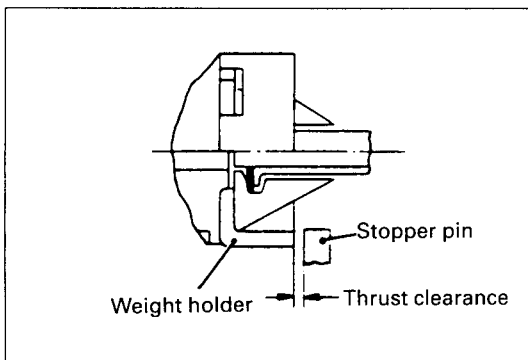
- (3) Assemble O-ring to the governor shaft.

- (4) Assemble the following parts:

- 1 Governor shaft
- 2 Adjusting washer
- 3 Washer
- 4 Governor flyweight ASSY

Note:

The governor shaft has left-hand threads.



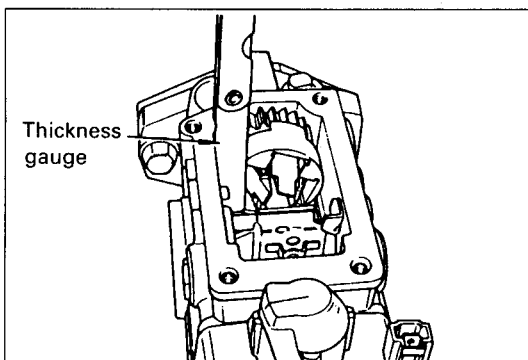
- (5) Using a thickness gauge, measure the thrust clearance of the flyweight holder.

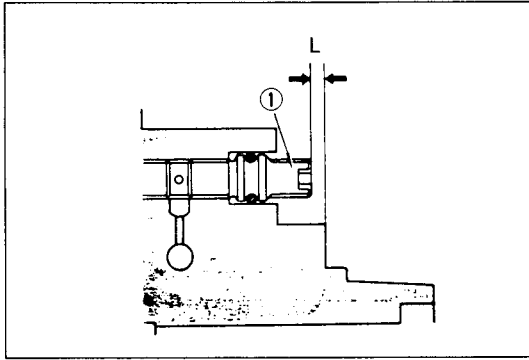
If the standard is not met, change the thickness of the adjusting washer as needed.

Thrust clearance 0.15 ~ 0.35 mm (0.0059 ~ 0.0138 in.) (over the entire circumference)

Size variation of adjusting washers

Thickness mm (in.)
1.05 (0.0413)
1.25 (0.0492)
1.45 (0.0571)
1.65 (0.0650)
1.85 (0.0728)



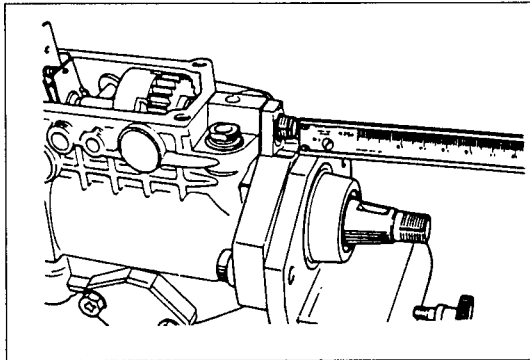


- (6) Adjust dimension L from the governor shaft ① tip to the end surface of the pump housing.

Standard: 1.5 ~ 2.5 mm (0.059 ~ 0.098 in.)

Note:

The governor shaft has left-hand threads.

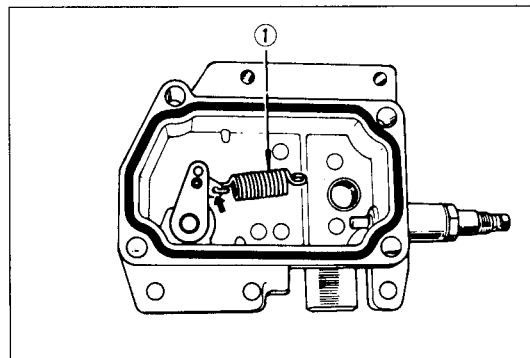
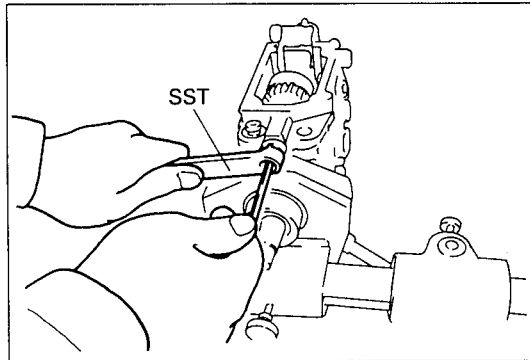


- (7) Governor shaft lock nut
SST 09260-76003-71
(SST 09260-54012)

T = 24.5 ~ 29.4 N·m (250 ~ 300 kg·cm)
[18.1 ~ 21.6 ft·lb]

Note:

The lock nut has left-hand threads.

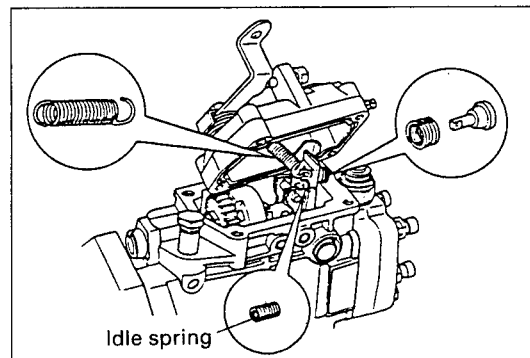


21. Assemble the governor cover.

- (1) Hook the control spring to the governor cover.

Note:

The open end of the control spring hook must be directed as shown.



- (2) Assemble the governor spring seat and damper spring to the tension lever, and hook the control spring in the hole in the spring seat.

Notes:

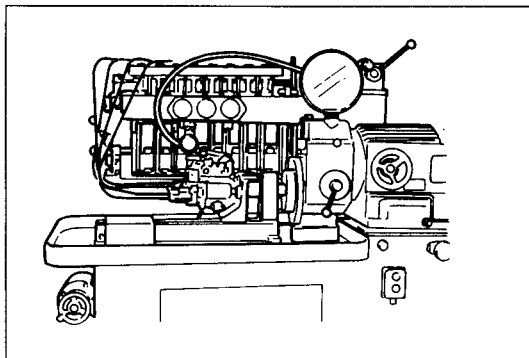
- Assemble the governor spring seat in the correct position.
- Always use new governor cover gaskets.

- (3) Socket bolts

AIRTIGHTNESS TEST

After assembly is completed, carry out an airtightness test in the following steps:

1. Install a blind plug to the overflow screw opening. Apply air pressure of about 147 kPa (1.5 kg/cm²) [21.33 psi] from the fuel inlet hole. Put the pump in oil until the overflow screw is in the oil, and check that air does not leak from any part of the pump.
2. Apply higher air pressure of about 490 kPa (5 kg/cm²) [71.1 psi] and repeat the test as illustrated above.

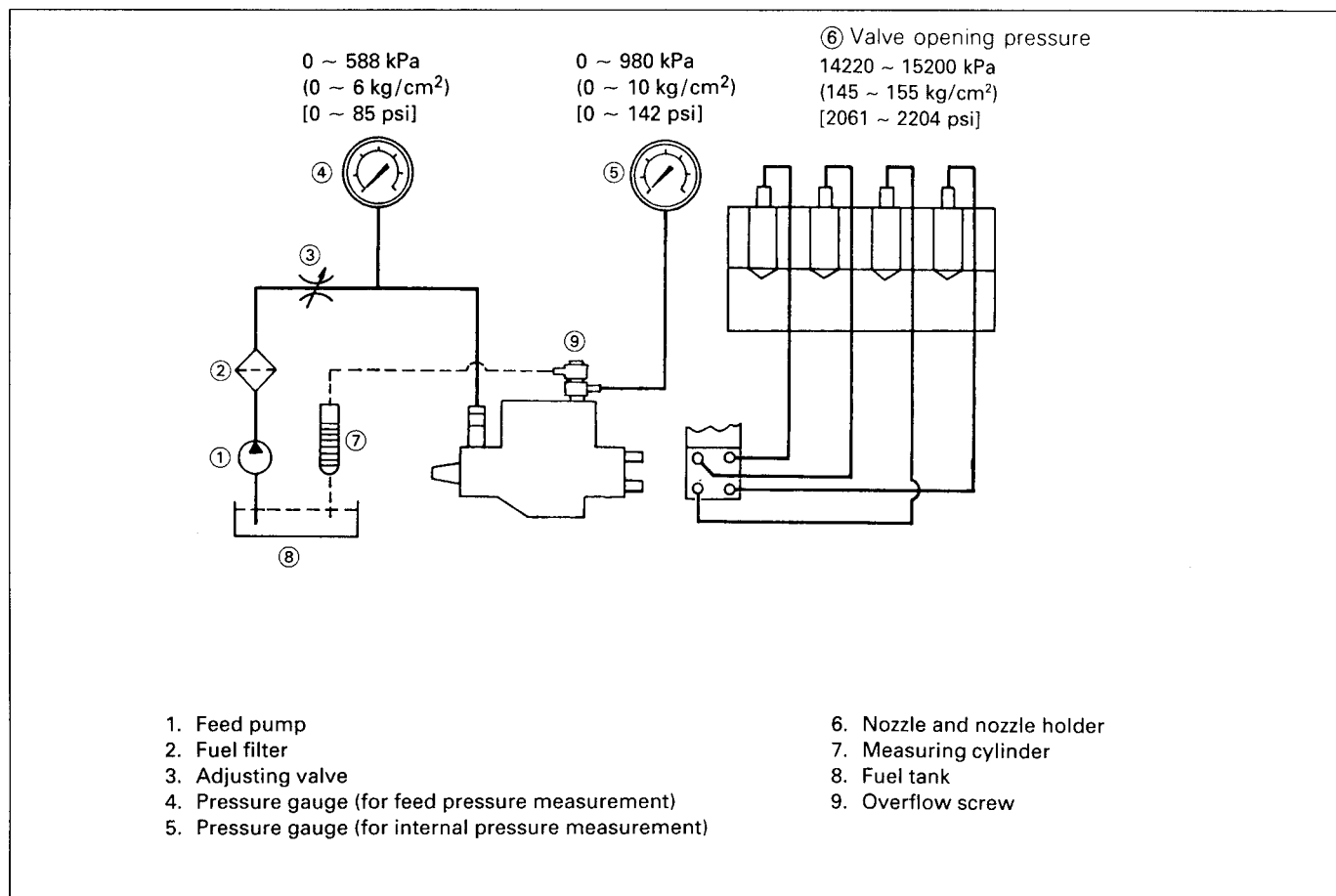


ADJUSTMENT

Sequence of adjustment

1. Pre-test inspection and preparation
2. Run-in operation
3. Temporary adjustment
4. Pump internal pressure adjustment
5. Overflow rate inspection
6. Timer adjustment
7. Full-load injection rate adjustment
8. Starting injection rate adjustment
9. Full-load injection rate check
10. High speed lever setting
11. Load sensing timer adjustment (~1998. 7)
12. Low speed lever setting

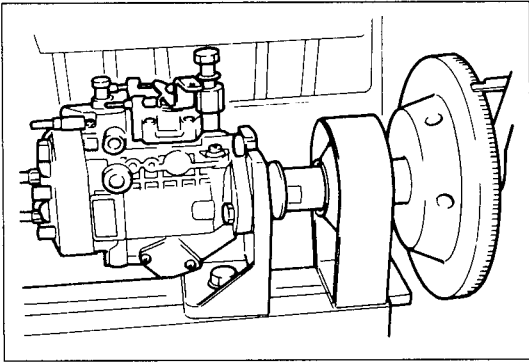
Pre-test inspection and preparation



Piping diagram for pump adjustment

Note:

- Adjustment will be recommended by injection pump repair shop.
- Please refer to 9-9B pages from 9-9U pages about an injection pump control value in the following production time.
7FD20~J35: 2002.11~, 7FDF20~JF35: 2004.1~, 4SDK10, 42-2TD20·25: 2003.9~



1. Measure the valve opening pressure of the test nozzle holder.

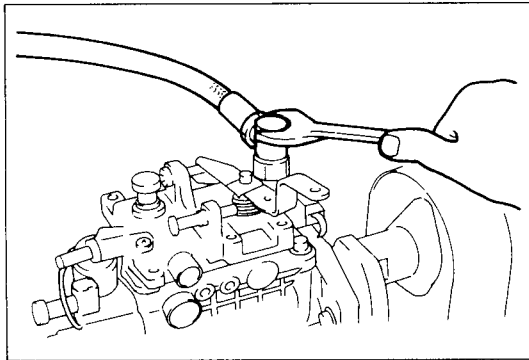
Valve opening pressure:

14220 ~ 15200 kPa (145 ~ 155 kg/cm²)
[2062 ~ 2204 psi]

2. Attach the pump to the tester.

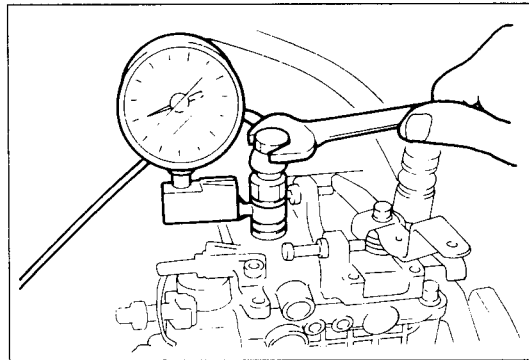
Note:

Check if the pump rotates smoothly when it is turned by hand.



3. Connect the high pressure pipe and the pressure gauge (for internal pressure measurement).

(1) Inlet hose

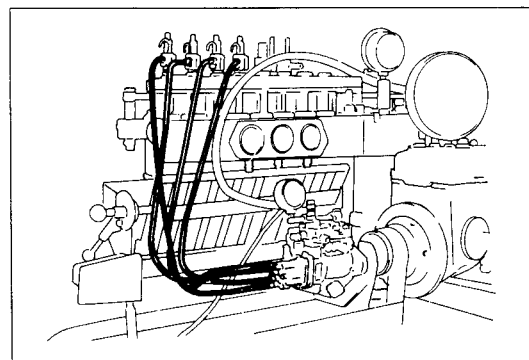


(2) Pressure gauge and overflow hose

Note:

Do not confuse the overflow screw with the inlet screw.

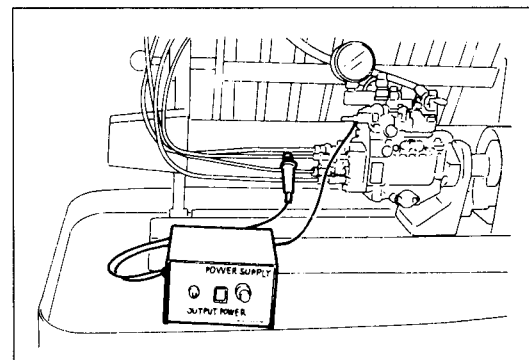
The overflow screw has "OUT" stamped on it.



(3) High pressure pipe

Use high pressure hose of the following specifications (Inside diameter x Outside diameter x length):

2.0 x 6.0 x 840 mm (0.079 x 0.236 x 33.071 in.)



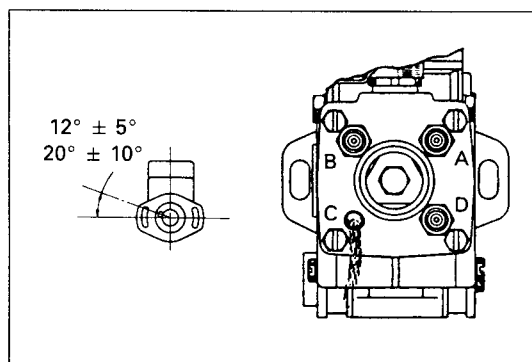
(4) Apply voltage (6V) to the fuel cut solenoid.

Run-in operation

1. Maintain fuel temperature at 40 to 45°C (104 to 113°F).
2. Adjust the feed pressure of the pump tester to 19.6 kPa (0.2 kg/cm²) [2.8 psi].
3. Operate the pump at low speed (300 rpm) until air inside the pump chamber is bled from the overflow pipe.
4. Maintain the adjusting lever at the FULL position using a spring or other appropriate tool. Raise the pump speed gradually and confirm that injection occurs at 1200 rpm. Wipe oil off from the pump surface so that oil leakage can be detected easily.
5. Carry out run-in operation of the pump in this condition at 1200 rpm for 5 minutes.

Note:

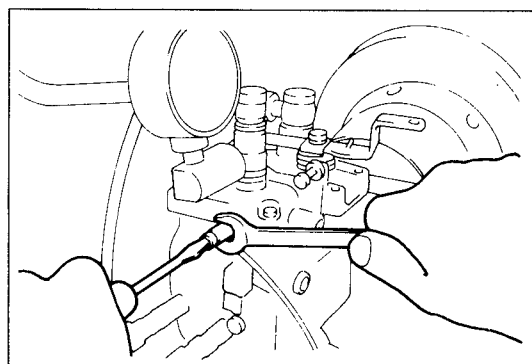
Turn the switch off immediately and check the pump if oil leakage, injection failure, unusual sound or other problem is found during operation.



6. Set the key groove of the drive shaft at the angle shown. Remove the delivery valve from cylinder C, apply a feed pressure of 19.6 kPa (0.2 kg/cm²) [2.8 psi], and confirm that fuel starts coming out.

Note:

Fuel will not come out from cylinder C if the cam plate is assembled incorrectly (offset by 180°). When this is the case, assemble the cam plate correctly.

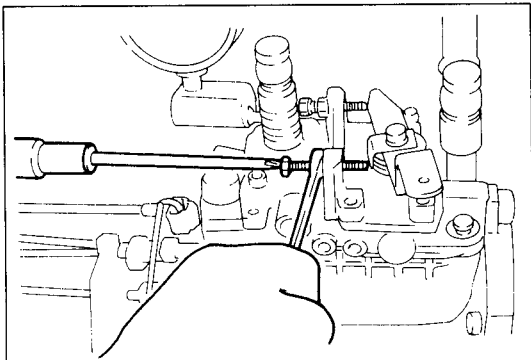


Temporary adjustment (lever at FULL position)

1. Temporary adjustment of the full-load standard injection rate.
Measure the injection rate at pump speed 800 rpm. When the standard is not met, turn the full-load set screw as necessary.

Standard:

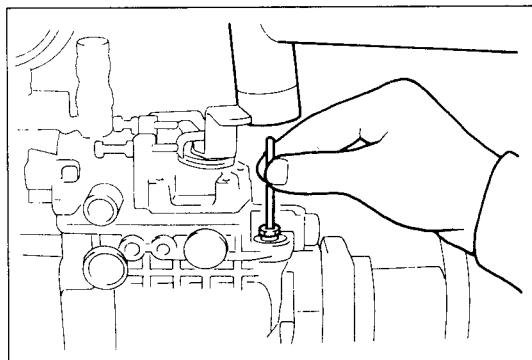
Model		Injection rate cm ³ (in ³)/ 200st. 1cyl
All	~1998. 7	10.3 ~ 11.1 (0.629 ~ 0.714)
7FD20~J35 (except DPF)	1998. 8~ 2002.10	10.5 ~ 10.9 (0.641 ~ 0.665)
7FDF20~J35 (except DPF)	1998. 8~	
7FD20~J35 (for DPF)	1998. 8~ 2002.10	9.9 ~ 10.3 (0.604 ~ 0.629)
7FDF20~J35 (for DPF)	1998. 8~	
7FD20~J35 (except DPF),Others	2002.11~	13.1 ~ 13.5 (0.799 ~ 0.824)
7FD20~J35 (for DPF)	2002.11~	12.2 ~ 12.6 (0.744 ~ 0.769)



2. Temporary adjustment of the high speed lever setting. Measure the injection rate at pump speed 1200 rpm. When the standard is not met, turn the maximum speed set screw as necessary.

Standard:

Model		Injection rate cm ³ (in ³)/ 200st. 1cyl
All	~1998. 7	3.0 ~ 5.0 (0.813 ~ 0.305)
7FD20~J35 (except DPF)	1998. 8~ 2002.10	1.3 ~ 2.7 (0.079 ~ 0.165)
7FDF20~J35 (except DPF)	1998. 8~	
7FD20~J35 (for DPF)	1998. 8~ 2002.10	1.3 ~ 2.7 (0.079 ~ 0.165)
7FDF20~J35 (for DPF)	1998. 8~	
7FD20~J35 (except DPF),Others	2002.11~	2.7 ~ 4.1 (0.165 ~ 0.250)
7FD20~J35 (for DPF)	2002.11~	2.7 ~ 4.1 (0.165 ~ 0.250)


**Pump internal pressure adjustment
(lever at FULL position)**

1. Measure the pressure at specified pump speeds.

Standard:

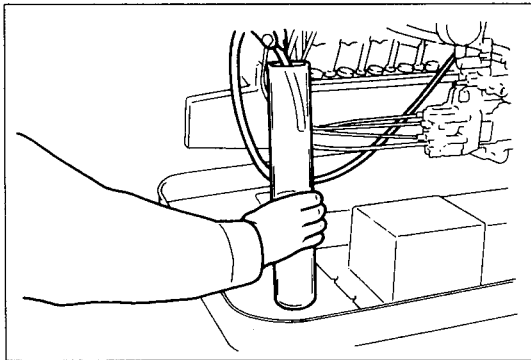
Pump speed rpm	Pump internal pressure		
	kPa	kg/cm ²	psi
400	284 ~ 343	2.9 ~ 3.5	41 ~ 50
1100	500 ~ 559	5.1 ~ 5.7	73 ~ 81

When the pressure is lower than the standard, put a round rod 3 to 4 mm (0.12 to 0.16 in.) in diameter against the regulating valve piston, and drive it in carefully as needed while reading the pressure gauge.

Note:

Do not overdrive.

When the pressure is higher than the standard, replace the regulating valve.



Overflow rate inspection (lever at FULL position)

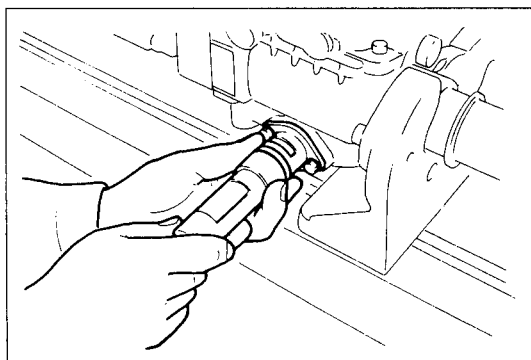
1. Measure the overflow rate at pump speed 400 rpm.

Standard:

133 ~ 242 cc/100 st (8.11 ~ 14.76 cu-in/100 st)

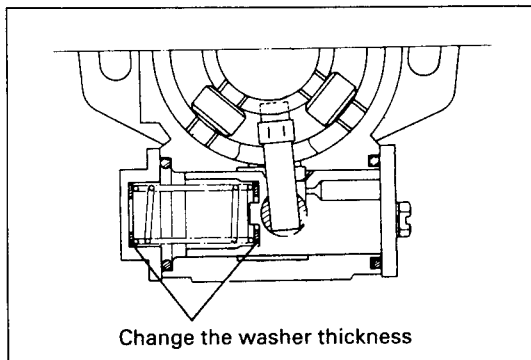
Note:

Always use the overflow screw attached to the pump.



Timer adjustment (lever at FULL position)

1. Remove the cover from the high pressure side (without a timer spring) of the timer. Attach the timer measuring device (Nippondenso Part No. 95905-10110) and set the zero point.



Size variation of timer adjusting washers

Thickness mm (in.)	
0.2 (0.008)	0.8 (0.031)
0.5 (0.020)	0.9 (0.035)
0.6 (0.024)	1.0 (0.039)
0.7 (0.028)	—

2. Measure the timer piston stroke at specified pump speeds.

Standard:

Model	Pump speed rpm	Piston stroke mm(in)
All (~1998. 7)	700	0.7 ~ 1.5 (0.028 ~ 0.059)
	900	1.6 ~ 2.4 (0.063 ~ 0.094)
	1000	2.5 ~ 3.3 (0.098 ~ 0.130)
7FDF 20~J35 (2001.12~)	900	0.15 ~ 0.95 (0.0059 ~ 0.037)
	1100	1.3 ~ 2.1 (0.051 ~ 0.083)
	1200	2.1 ~ 2.9 (0.083 ~ 0.114)
7FD 20~J35, Others (2002.11~)	1000	0.15 ~ 0.95 (0.0059 ~ 0.0374)
	1100	0.65 ~ 1.45 (0.0256 ~ 0.0571)
	1200	1.49 ~ 2.29 (0.0587 ~ 0.0902)

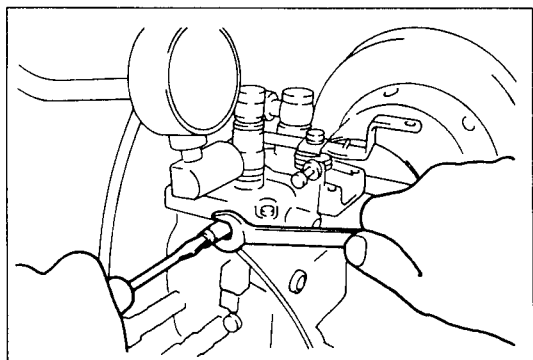
(Hysteresis to be 0.3 mm (0.012 in.) or less)

If the standard is not met, remove the timer cover (spring side), and alter the adjusting washer thickness as necessary at both ends of the timer spring.

Notes:

- Install washers at both ends of the timer spring.
- A larger washer thickness reduces the stroke; a smaller thickness increases the stroke.

Full-load injection rate adjustment (lever at FULL position)



1. Measure the injection rate at pump speed 800 rpm. If the standard is not met, adjust the rate by turning the full-load set screw as needed.

Standard:

Model		Injection rate cm ³ (in ³)/ 200st. 1cyl
All	~1998. 7	10.3 ~ 10.7 (0.629 ~ 0.630)
7FD20~J35 (except DPF)	1998. 8~ 2002.10	10.5 ~ 10.9 (0.641 ~ 0.665)
7FDF20~J35 (except DPF)	1998. 8~	↑
7FD20~J35 (for DPF)	1998. 8~ 2002.10	9.9 ~ 10.3 (0.604 ~ 0.629)
7FDF20~J35 (for DPF)	1998. 8~	↑
7FD20~J35 (except DPF), Others	2002.11~	13.1 ~ 13.5 (0.799 ~ 0.824)
7FD20~J35 (for DPF)	2002.11~	12.2 ~ 12.6 (0.744 ~ 0.769)

[Deviation 0.6cm³ (0.037in³) or less]

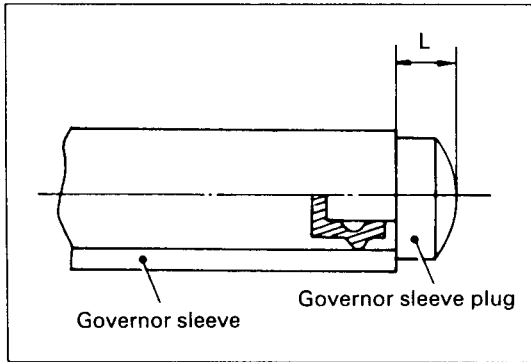
Startiong injection rate adjustment (lever at FULL position)

1. Measure the injection rate at pump speed 100 rpm.

Standard:

Model		Injection rate cm ³ (in ³)/ 200st. 1cyl
All	~1998. 7	14.2 ~ 18.6 (0.866 ~ 11.35)
7FD20~J35 (except DPF)	1998. 8~ 2002.10	11.0 ~ 14.6 (0.671 ~ 0.891)
7FDF20~J35 (except DPF)	1998. 8~	↑
7FD20~J35 (for DPF)	1998. 8~ 2002.10	↑
7FDF20~J35 (for DPF)	1998. 8~	↑
7FD20~J35 (except DPF), Others	2002.11~	8.4 ~ 12.0 (0.513 ~ 0.732)
7FD20~J35 (for DPF)	2002.11~	↑

[Deviation 1.6cm³ (0.098in³) or less]

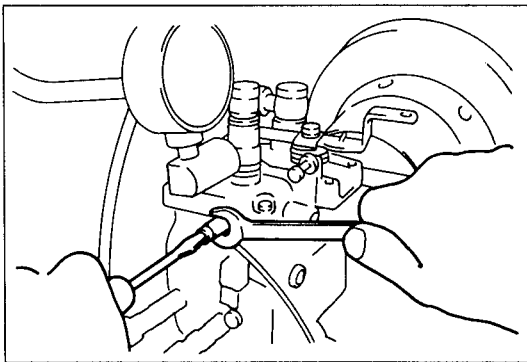


- If the standard is not met, adjust the rate by replacing the governor sleeve plug. An increase of dimension L of the governor sleeve by 0.2 mm (0.0079 in.) results in a decrease of the injection rate by 1.6 cc (0.098 cu. in.)/200st.

Size variation of governor sleeve plugs

Dimension L mm (in.)					
2.5 (0.098)	3.3 (0.130)	3.9 (0.154)	4.7 (0.185)	5.4 (0.213)	5.8 (0.228)
2.7 (0.106)	3.5 (0.138)	4.1 (0.161)	5.1 (0.201)	5.5 (0.217)	5.9 (0.232)
2.9 (0.114)	3.7 (0.146)	4.3 (0.169)	5.2 (0.205)	5.6 (0.220)	6.0 (0.236)
3.1 (0.122)	3.8 (0.150)	4.5 (0.177)	5.3 (0.209)	5.7 (0.224)	—

- If the deviation limit is not satisfy, replace the delivery valve, delivery valve spring, etc.



FULL-load injection rate confirmation

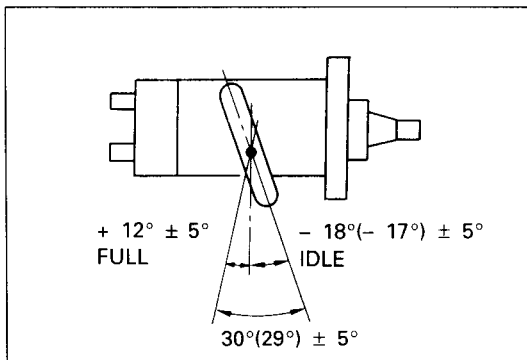
- Confirm the full-load standard injection rate complies with the standard shown below. If the standard is not met, adjust the rate by turning the full-load set screw as necessary.

Standard:
~1998. 7

Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/ 200st. 1cyl	Deviation cm ³ (in ³)
12° ± 5° (at FULL position)	1100	8.2 ~ 9.6 (0.500 ~ 0.589)	0.76 (0.0464) or less
	1000	9.8 ~ 10.6 (0.598 ~ 0.647)	
	600	9.5 ~ 10.7 (0.580 ~ 0.653)	
	500	9.3 ~ 10.3 (0.568 ~ 0.629)	
	400	9.4 ~ 11.2 (0.547 ~ 0.683)	

7FD20~J35 (except DPF): 1998.8 ~ 2002.10

7FDF20~J35 (except DPF): 1998.8 ~



Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/200st. 1cyl	Deviation cm ³ (in ³)
12° ± 5° (at FULL position)	1100	9.4 ~ 10.6 (0.573 ~ 0.647)	—
	500	9.1 ~ 10.1 (0.555 ~ 0.616)	0.76(0.0464) or less
	400	9.8 ~ 11.6 (0.590 ~ 0.708)	—

7FD20~J35 for DPF: 1998. 8~ 2002.10, 7FDF20~J35 for DPF: 1998. 8~

Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/ 200st. 1cyl	Deviation cm ³ (in ³)
12° ± 5° (at FULL position)	1100	8.8 ~ 10.0 (0.537 ~ 0.610)	—
	500	8.5 ~ 9.5 (0.519 ~ 0.580)	0.76 (0.0464) or less
	400	9.8 ~ 11.6 (0.590 ~ 0.708)	—

7FD20~J35 (except DPF model), Others: 2002.11~

Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/ 200st. 1cyl	Deviation cm ³ (in ³)
12° ± 5° (at FULL position)	1100	12.7 ~ 13.9 (0.775 ~ 0.848)	—
	500	8.4 ~ 9.4 (0.513 ~ 0.574)	0.76 (0.0464) or less
	400	7.9 ~ 9.7 (0.482 ~ 0.592)	—

7FD20~J35 for DPF: 2002.11~

Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/ 200st. 1cyl	Deviation cm ³ (in ³)
12° ± 5° (at FULL position)	1100	12.5 ~ 13.7 (0.763 ~ 0.836)	—
	500	7.7 ~ 8.7 (0.470 ~ 0.531)	0.76 (0.0464) or less
	400	7.9 ~ 9.7 (0.482 ~ 0.592)	—

2. If the deviation limit is exceeded, replace the delivery valve, delivery valve spring, etc., or check if the delivery valve gasket is fitted correctly.

High speed lever setting

1. Turn the maximum speed set screw as necessary so that the standard injection rate is met at the conditions shown below.

Standard:

~1998. 7

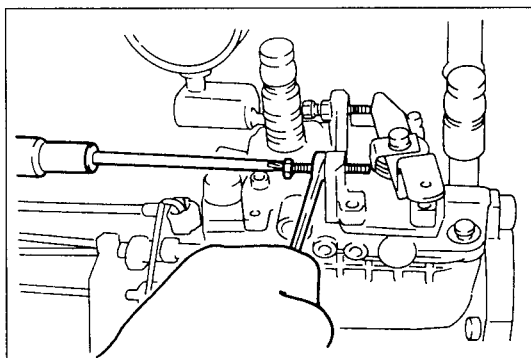
Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/ 200st. 1cyl	Note
12° ± 5° (at FULL position)	1200	3.2 ~ 4.8 (0.195 ~ 0.293)	High speed lever setting
	1150	6.2 ~ 8.8 (0.378 ~ 0.537)	Confirmation
	1300	0.6 (0.037) or less	Confirmation

7FD20~J35: 1998. 8~ 2002.10, 7FDF20~J35: 1998. 8~

Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/ 200st. 1cyl	Note
12° ± 5° (at FULL position)	1200	1.3 ~ 2.7 (0.079 ~ 0.165)	High speed lever setting
	1150	6.5 ~ 8.7 (0.397 ~ 0.531)	Confirmation
	1300	0.6 (0.037) or less	Confirmation

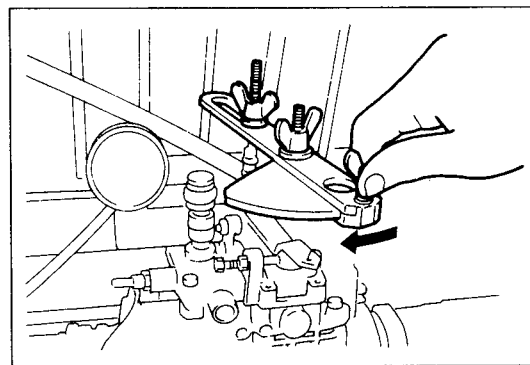
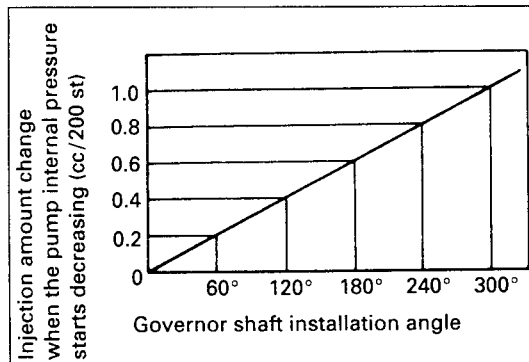
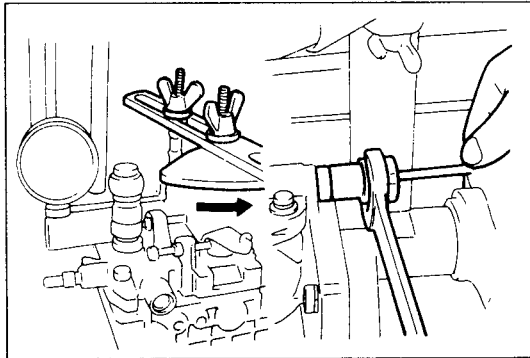
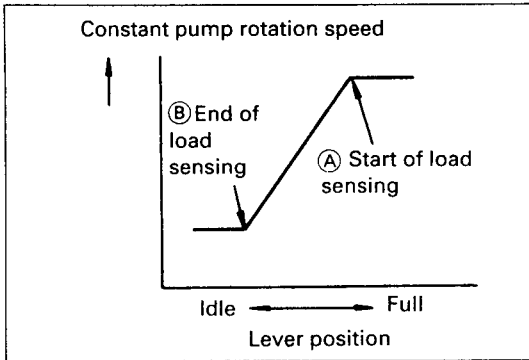
7FD20~J35, Others: 2002.11~

Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/ 200st. 1cyl	Note
12° ± 5° (at FULL position)	1200	2.7 ~ 4.1 (0.165 ~ 0.250)	High speed lever setting
	1150	11.7 ~ 13.9 (0.714 ~ 0.848)	Confirmation
	1300	0.6 (0.037) or less	Confirmation



Note:

Tightening the screw decreases the injection rate.



Load sensing timer adjustment (~1998. 7)

1. Threshold setting

- (1) Operate the pump at a specified speed. Slowly switch the adjusting lever from FULL to IDLE position, and maintain the lever at position A where the pump internal pressure begins to drop. Check if the standard injection rate is obtained at that position.

- (2) If the standard is not met, adjust the rate by turning the governor shaft. Set the lever again as in step 1 above, and check the injection rate.

Method of adjustment:

- When the injection rate is low
Turn the governor shaft clockwise.
- When the injection rate is high
Turn the governor shaft counterclockwise.

Lever angle	Pump speed rpm	Injection rate cm ³ /200st. (in ³ /200st.)	Note
Threshold	1100	q FULL - 0.8 ± 0.4 (q FULL - 0.049 ± 0.024)	By governor shaft
End of sensing	1100	q FULL - 2.4 ± 0.4 (q FULL - 0.146 ± 0.024)	Confirmation

q FULL: Injection rate (measured value) at pump speed 1100 rpm with the lever at FULL position
(Reference value) 9 ~ 10 cm³
(0.55 ~ 0.61 in³)

2. Setting the end of sensing

Operate the pump at a specified speed. Slowly switch the adjusting lever from IDLE to FULL position, and maintain the adjusting lever at position B where the pump internal pressure begins to rise (see the relative positions of the lever position and pump internal pressure). Check if the standard injection rate is obtained at that position.

Low speed lever setting

1. Free the adjusting lever.
2. Turn the idle set screw as necessary so that the standard injection rate is met at the conditions shown below.

Standard:
~1998. 7

Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/ 500st. 1cyl	Deviation cm ³ (in ³)	Note
- 18° ± 5° (at IDLE position)	380	3.0 ~ 6.0 (0.18 ~ 0.37)	1.5 (0.092)	Low speed lever setting
	500	2 (0.122) or less	-	Confirmation

1998. 8 ~ 2001.11

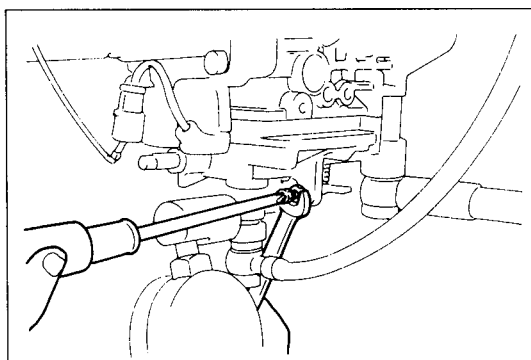
Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/ 500st. 1cyl	Deviation cm ³ (in ³)	Note
- 18° ± 5° (at IDLE position)	430	2.25 ~ 4.25 (0.1373 ~ 0.2594)	1.5 (0.092)	Low speed lever setting
	500	2.0 (0.122) or less	-	Confirmation

7FD20~J35:2001.12~2002.10, 7FDF20~J35:2001.12~

Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/ 500st. 1cyl	Deviation cm ³ (in ³)	Note
- 17° ± 5° (at IDLE position)	425	4.3 ~ 6.3 (0.262 ~ 0.384)	1.5 (0.092) or less	Low speed lever setting
	545	2.0 (0.122) or less	-	Confirmation

7FD20~J35, Others:2002.11~

Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/ 500st. 1cyl	Deviation cm ³ (in ³)	Note
- 17° ± 5° (at IDLE position)	425	1.3 ~ 3.3 (0.079 ~ 0.201)	1.5 (0.092) or less	Low speed lever setting
	545	2.0 (0.122) or less	-	Confirmation



Note:

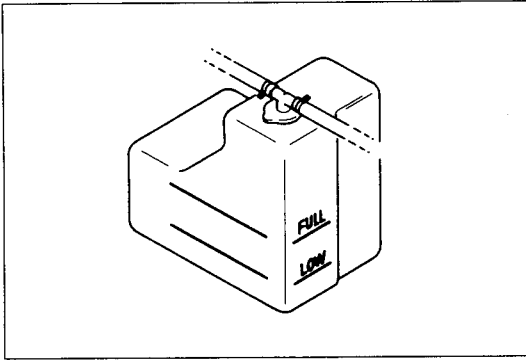
Tightening the screw increases the injection rate.

Confirmation after adjustment

1. After completion of adjustment, reduce the fuel cut solenoid voltage to 0V and confirm that the injection rate is zero at that voltage (at pump speed 100 rpm).
2. Check that the lever angle is 30° ± 5° (29° ± 5° (2001.12~)) between the IDLE and FULL positions.
3. Seal the full-load set screw and the maximum speed set screw.

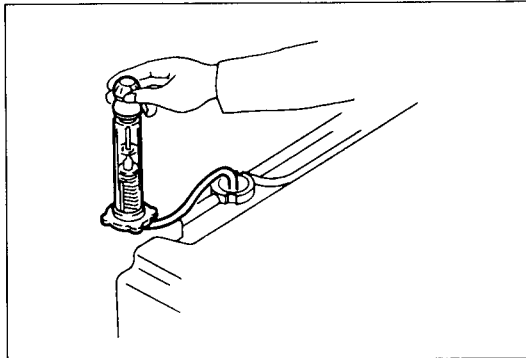
COOLING SYSTEM

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WATER PUMP REMOVAL AND INSTALLATION	4-4



COOLANT INSPECTION

1. Check the coolant level.
Confirm that the coolant level is somewhere between the FULL and LOW marks on the radiator reservoir tank.

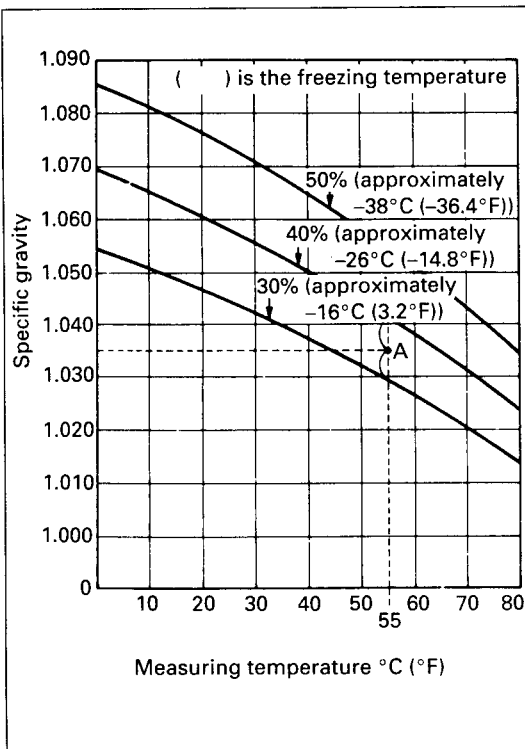


2. Measure the coolant concentration (LLC).
 - (1) Measure the coolant temperature and specific gravity.

Note:

The coolant concentration must be at least 30% (50% in cold areas).

- (2) Determine the coolant concentration from the graph.



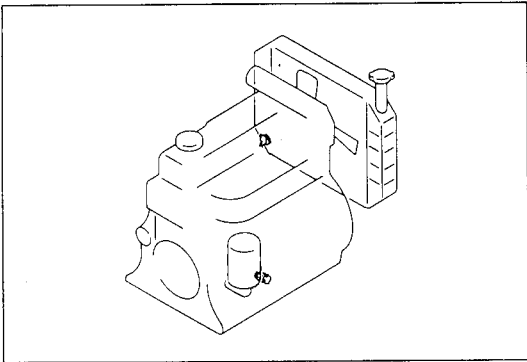
Reference:

This graph shows the relationship between the coolant temperature and specific gravity at coolant concentration 30%, 40% and 50%.

For instance, when the coolant temperature is 55°C (131°F) and specific gravity 1.035, the coolant concentration is determined as below.

Intersection A of the lines representing 55°C and 1.035 lies halfway between the curves representing 30% and 40%. Therefore, the concentration is about 35%.

3. Check the coolant quality.
Confirm that the coolant is free of oil or other contamination.



COOLANT REPLACEMENT

1. Drain the coolant.
 - (1) Open the radiator and engine drain cocks and drain the coolant.
 - (2) Drain the coolant from the reservoir tank.
2. Pour the coolant.
 - (1) Close the radiator and engine drain cocks, and pour coolant (LLC).

Coolant capacity:

See the repair manual for each model

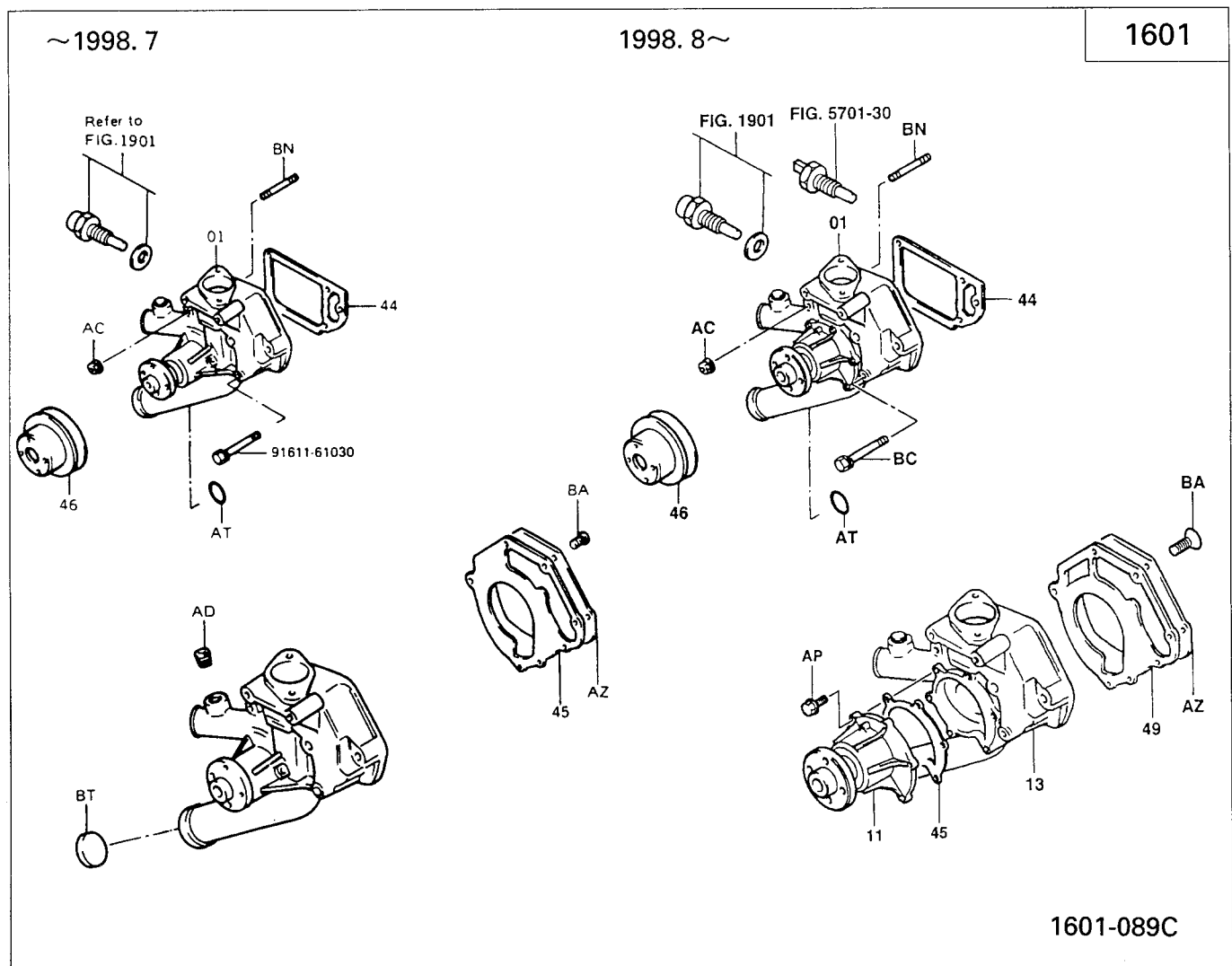
- (2) Warm up the engine, and check the coolant level.

Caution:

Remove the radiator cap carefully as it may spout steam and hot water.

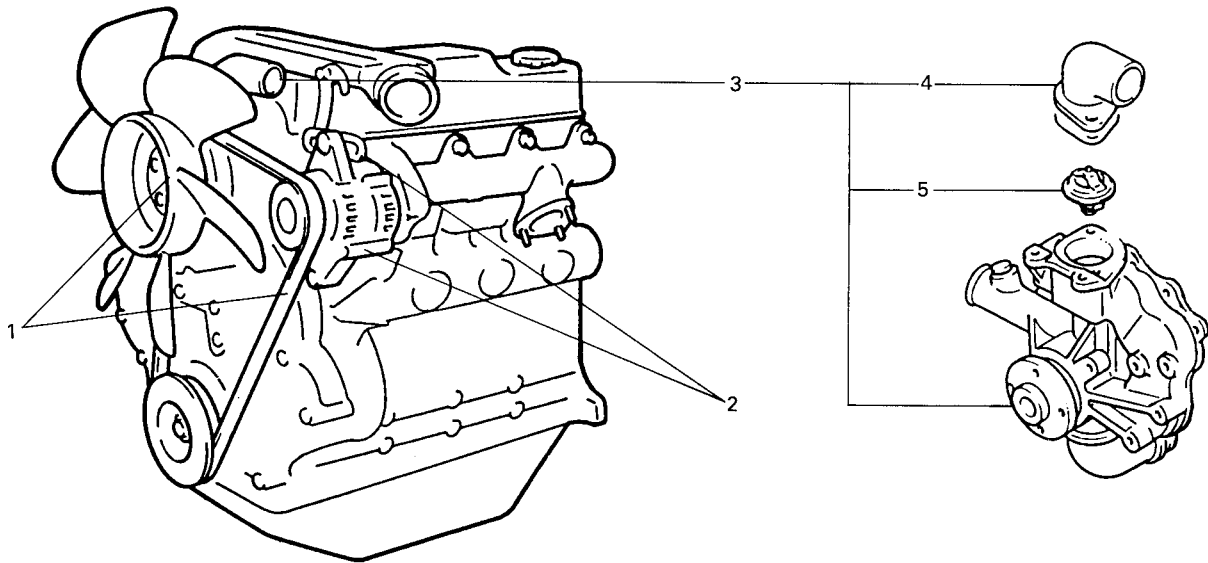
- (3) Add coolant as necessary.

WATER PUMP COMPONENTS



1601-089C

WATER PUMP REMOVAL AND INSTALLATION

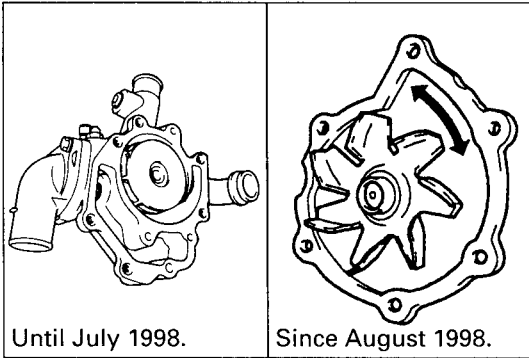


Removal Procedure

- 1 Remove the fan, fan pulley and V-belt.
- 2 Remove the alternator ASSY and adjusting bar.
- 3 Remove the water pump ASSY with outlet and thermostat. **[Point 1]**
- 4 Remove the water outlet.
- 5 Remove the thermostat. **[Point 2]**

Installation Procedure

Install components in the reverse order of removal.

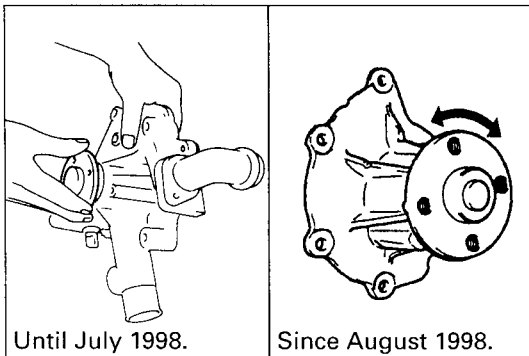


[Point Operations]

[Point 1]

Inspection:

1. Check the water pump rotors for cracks, damage and excessive rust.
2. Check the water pump bearing for unusual sound and resistance of revolution.



[Point 2]

Inspection:

1. Check the valve opening temperature and the fully-opened temperature.
 - (1) Put the thermostat in water and increase the water temperature while agitating.
 - (2) Measure the temperature at which the valve begins to open and at which it is fully opened.

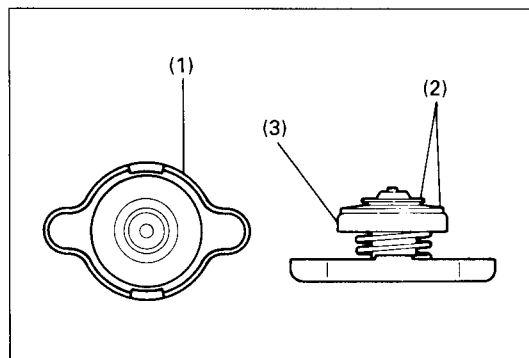
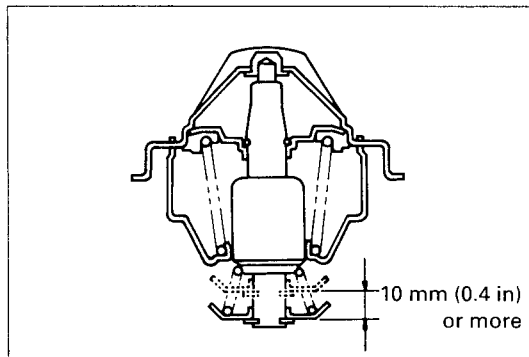
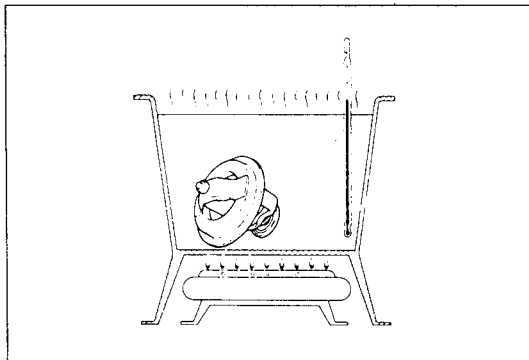
Standard:

Opening temperature 80 ~ 84°C (176 ~ 183°F)

Fully opened temperature 95°C (203°F)

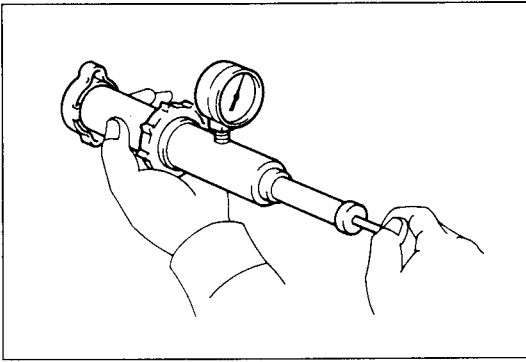
Fully-opened lift 10 mm (0.39 in.) or more.

2. Check the valve tightness.
If the valve is open at normal temperature or if the valve tightness is impaired, replace the valve.



On-vehicle inspection of the radiator

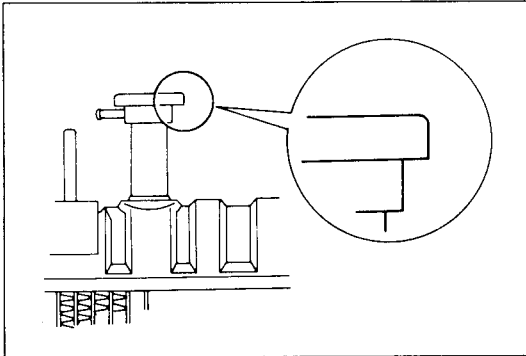
1. Check the radiator cap visually.
 - (1) Check the packing for crack or deformation.
 - (2) Check the valve and valve seat for deformation or dents.
 - (3) Check for scale deposits between the valve and the valve seat.



2. Measure the valve opening pressure of the radiator cap.
Fit a cap tester to the radiator cap. and measure the valve opening pressure.

Standard:

73.5 ~ 102.9 kPa (0.75 ~ 1.05 kg/cm²)
[10.7 ~ 14.9 psi]



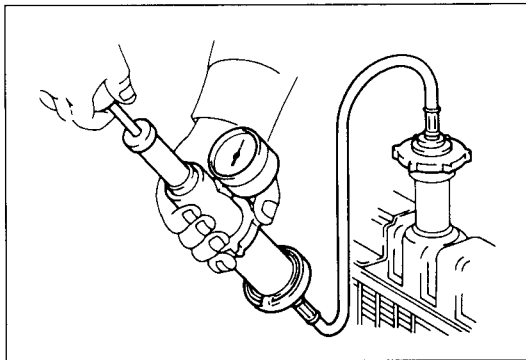
3. Check the neck filler (inlet port).
 - (1) Check the seal for deformation or dent.
 - (2) Warm up the engine.
 - (3) Stop the engine, apply pressure of 176 kPa (1.8 kg/cm²) [25.6 psi], and check the parts for leakage.

Notes:

- Always top up the radiator.
- Wipe off water from checking areas before inspection.
- Attach and detach the tester and operate the pump carefully to protect the radiator neck filler from deformation.

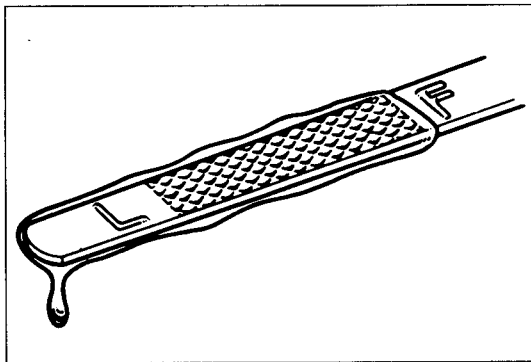
Cautions:

- When removing the tester, use cloth to prevent unexpected scalding by spouting coolant.



LUBRICATION SYSTEM

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ENGINE OIL AND OIL FILTER REPLACEMENT ..	5-2
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OIL PUMP REMOVAL AND INSTALLATION	5-5

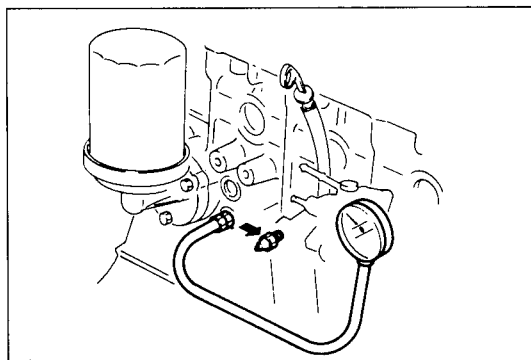


OIL PRESSURE INSPECTION

1. Check the oil.

Standard:

The oil level must be somewhere between the F and L marks on the level gauge. It must be free of excessive contamination, and have appropriate viscosity. It must not contain coolant, light oil or other foreign matter.



2. Check the oil pressure.
 - (1) Remove the oil pressure switch.
 - (2) Attach the oil pressure gauge. Instrument OPG-100 (by Banzai)
 - (3) Warm up the engine, and measure the oil pressure.

Condition:

Coolant temperature 75 ~ 85°C (167 ~ 185°F)

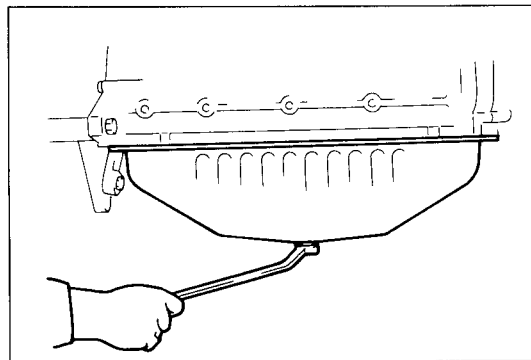
Standard:

At idle speed

78.4 kPa (0.8 kg/cm²) [11.4 psi] or more

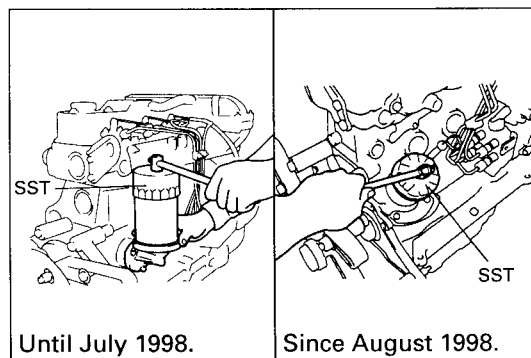
At 2200 rpm

392 kPa (4 kg/cm²) [56.9 psi] or more



ENGINE OIL AND OIL FILTER REPLACEMENT

1. Drain the oil.
 - (1) Remove the oil filler cap.
 - (2) Remove the oil drain plug and drain the oil.



2. Remove the oil filter. Until July 1998.

- (1) SST 09228-76008-71 (SST 09228-44011)

Since August 1998.

- (1) SST 09228-76004-71 (SST 09228-07501)

3. Remove the oil filter bracket, and install it using a new gasket.

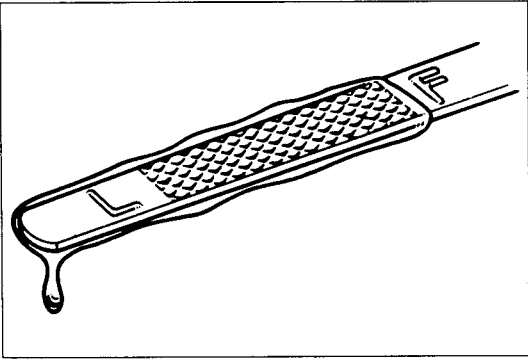
4. Install the oil filter.

- (1) Fit O-ring to the oil filter, and attach the oil filter to the filter bracket by turning it by hand.
- (2) Using SST, retighten the oil filter by 3/4 of a turn.

Notes :

- Apply a thin coat of engine oil to the O-ring.
- Clean the mounting surface.





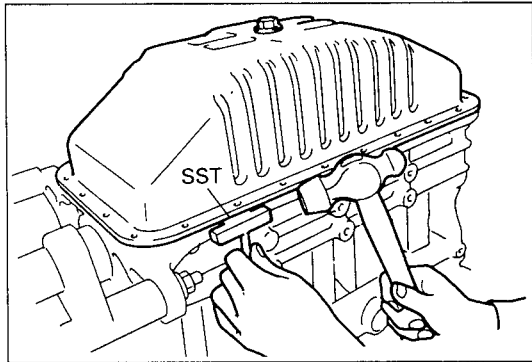
5. Pour engine oil.
 - (1) Install the oil drain plug using a new gasket.
 - (2) Pour oil.

Total capacity (F level) 9.0 ℓ (2.38 USgal)
Oil pan capacity 8.0 ℓ (2.11 USgal)

- (3) Fit the oil filler cap.
6. Check the oil amount.
 - (1) Check the amount by the oil level gauge.
7. Check oil leakage.
 - (1) Start the engine and check the system for oil leakage.
8. Check the oil amount.
 - (1) Check the oil level again after oil leakage check.

Note:

Stop the engine and wait for 3 minutes before performing inspection.

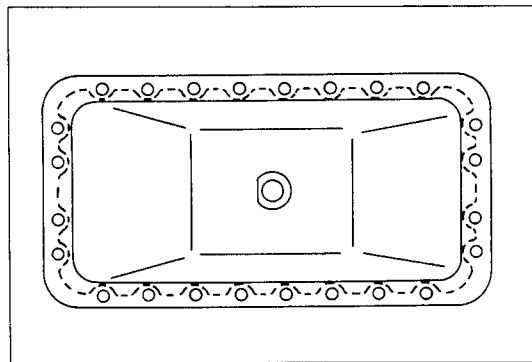


OIL STRAINER REMOVAL AND INSTALLATION

1. Detach the oil pan using a seal cutter.
SST 09032-00100

Notes :

- **Protect the oil pan flange from deformation.**
- **Never pry the oil pan with a screwdriver, etc.**



2. Remove the oil strainer.
3. Install the oil strainer.
4. Install the oil pan.
 - (1) Scrape off FIPG adhering to the oil pan and the cylinder block.
 - (2) Apply a new coat of FIPG to the oil pan.
Part No. 08826-76001-71
(08826-00080)

Methods of coating and parts installation

Note:

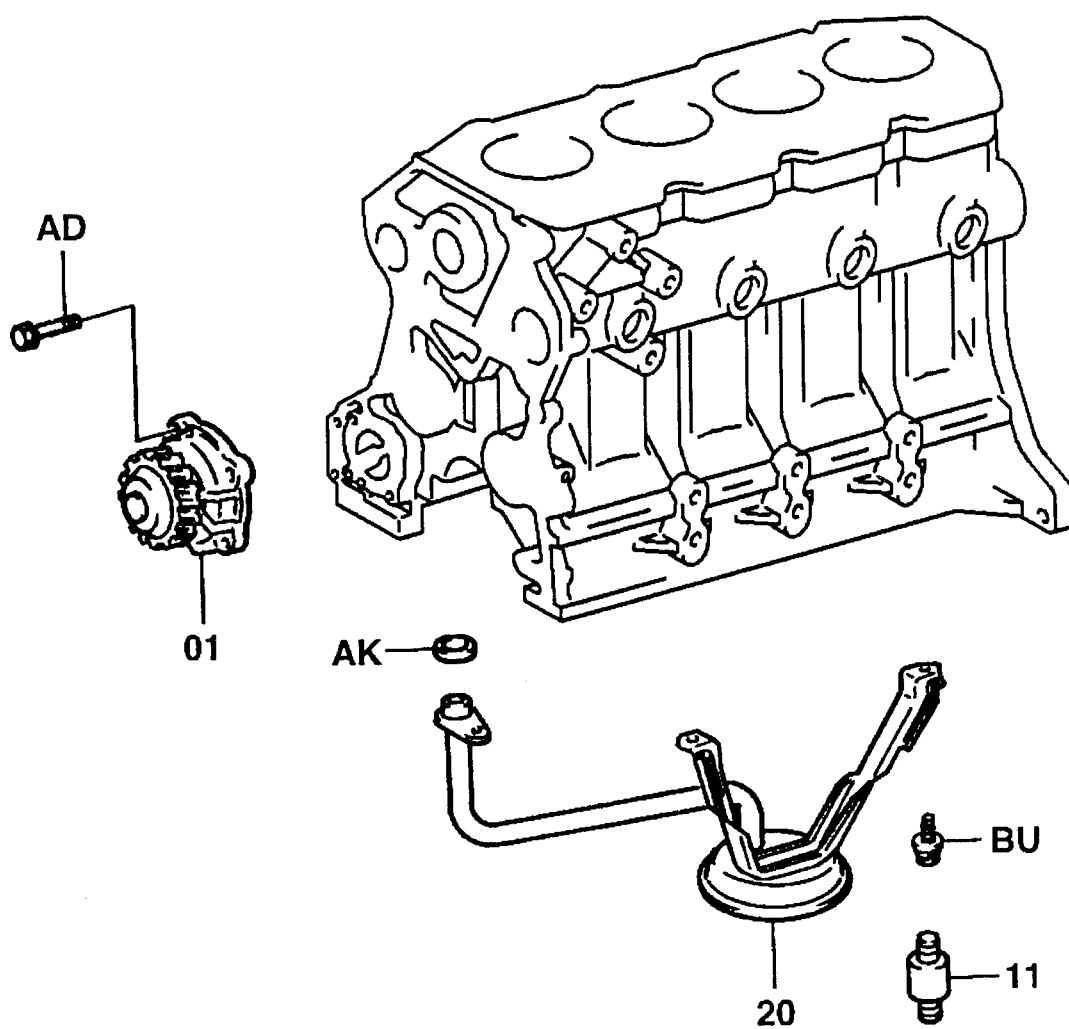
Remove the gasket very carefully to prevent gasket debris from entering the engine.

- (1) Thoroughly clean parts and mating surfaces to keep them free of moisture and dirt.
- (2) Coat FIPG on the part being installed. Coat it inside bolt holes also.
- (3) Avoid overcoating or undercoating. Always overlap the starting and ending coats.
- (4) Do not move parts after they are assembled by means of FIPG.
- (5) Assemble parts within three minutes after coating.
- (6) Allow at least 30 minutes before pouring coolant and oil and starting the engine.

LUBRICATION SYSTEM

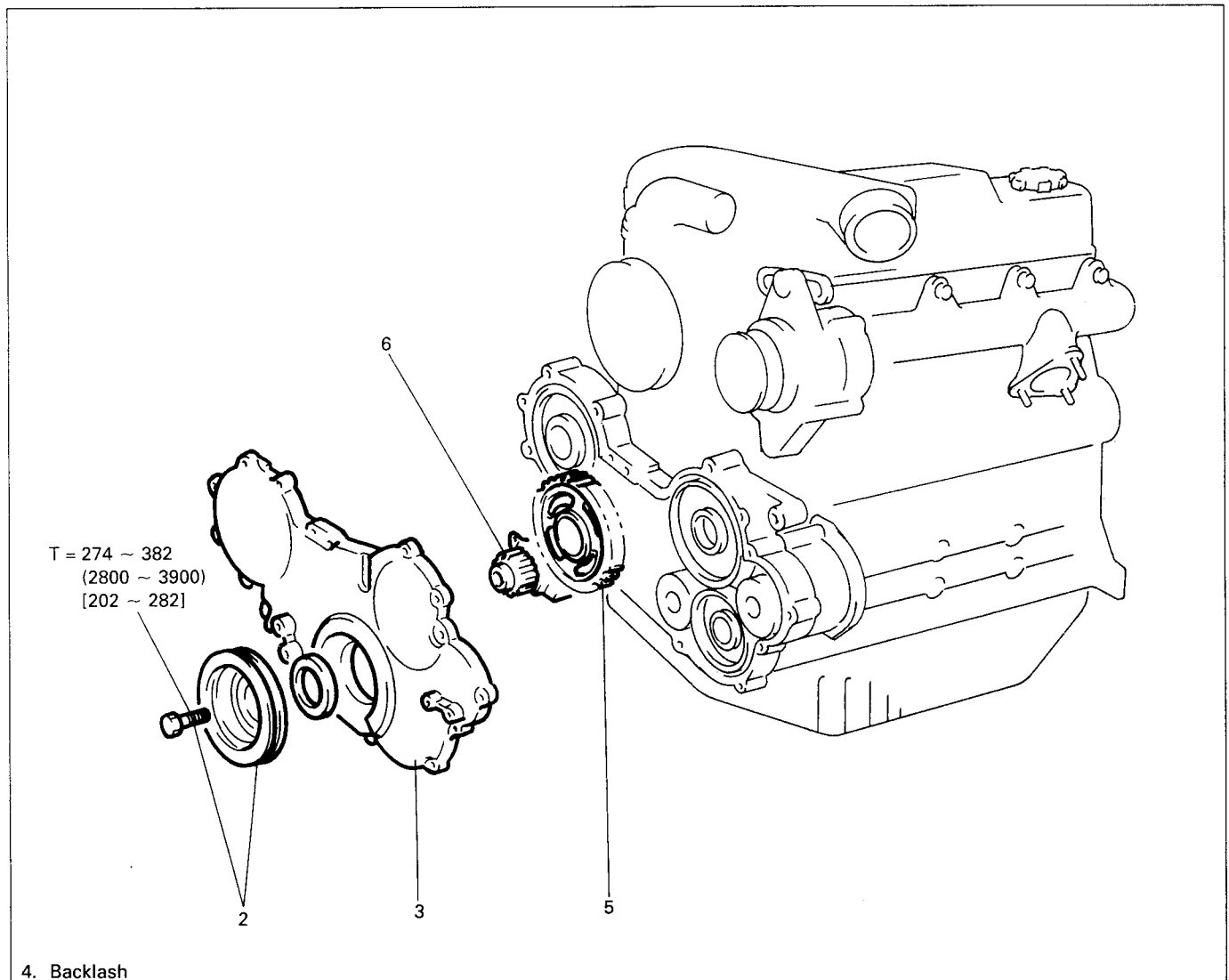
COMPONENTS

1501



1501-063

OIL PUMP REMOVAL AND INSTALLATION

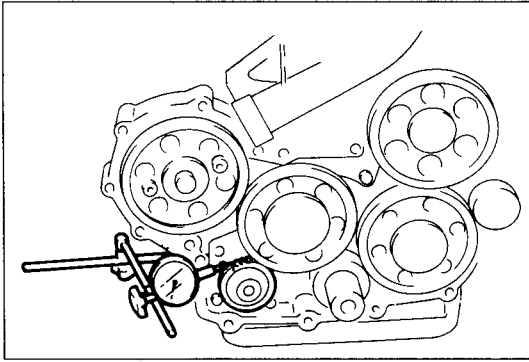


Removal Procedure

- 1 Remove the fan, fan pulley and V-belt. (See P2-2)
- 2 Remove the crank pulley with set bolt.
- 3 Remove the timing gear cover.
- 4 Measure the oil pump gear backlash. **[Point 1]**
- 5 Remove idle gear No. 1.
- 6 Remove the oil pump ASSY. **[Point 2]**

Installation Procedure

Install parts in the reverse order of removal.



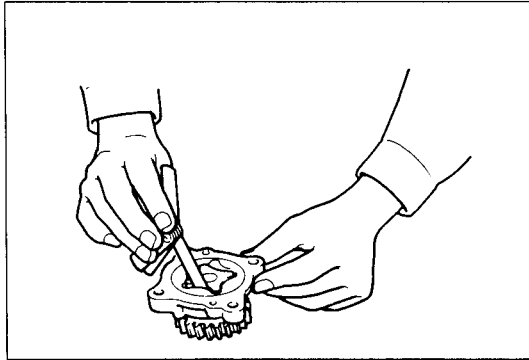
[Point Operations]

[Point 1]

Inspection: Measure the backlash between the oil pump drive gear and idle gear No. 1.

Standard: 0.05 mm (0.020 in.)

Limit: 0.3 mm (0.012 in.)



[Point 2]

Inspection:

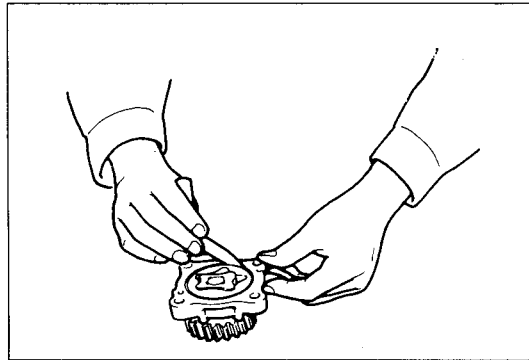
1. Check the body clearance.

(1) Check the rotor to body clearance.

Standard:

0.10 ~ 0.17 mm (0.0039 ~ 0.0067 in.)

Limit: 0.2 mm (0.008 in.)



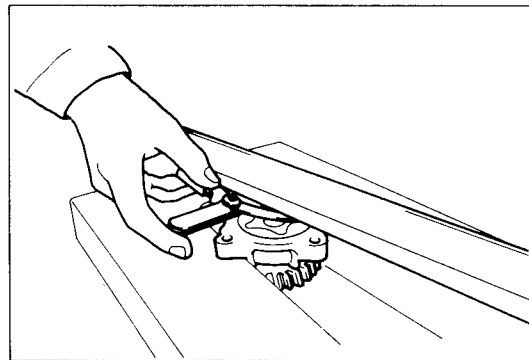
2. Check the tip clearance.

(1) Check the rotor to gear clearance.

Standard:

0.05 ~ 0.15 mm (0.0020 ~ 0.0059 in.)

Limit: 0.2 mm (0.008 in.)

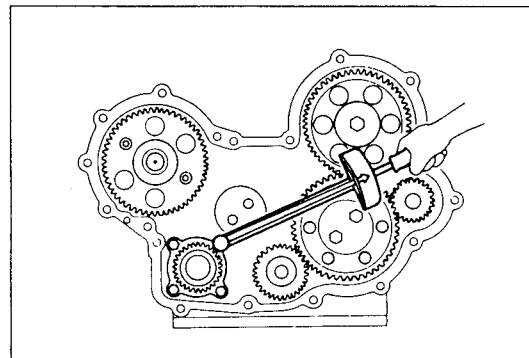


3. Check the side clearance.

Standard:

0.03 ~ 0.09 mm (0.0012 ~ 0.0035 in.)

Limit: 0.15 mm (0.0059 in.)



Installation:

1. Do not drop the rotor.

Note:

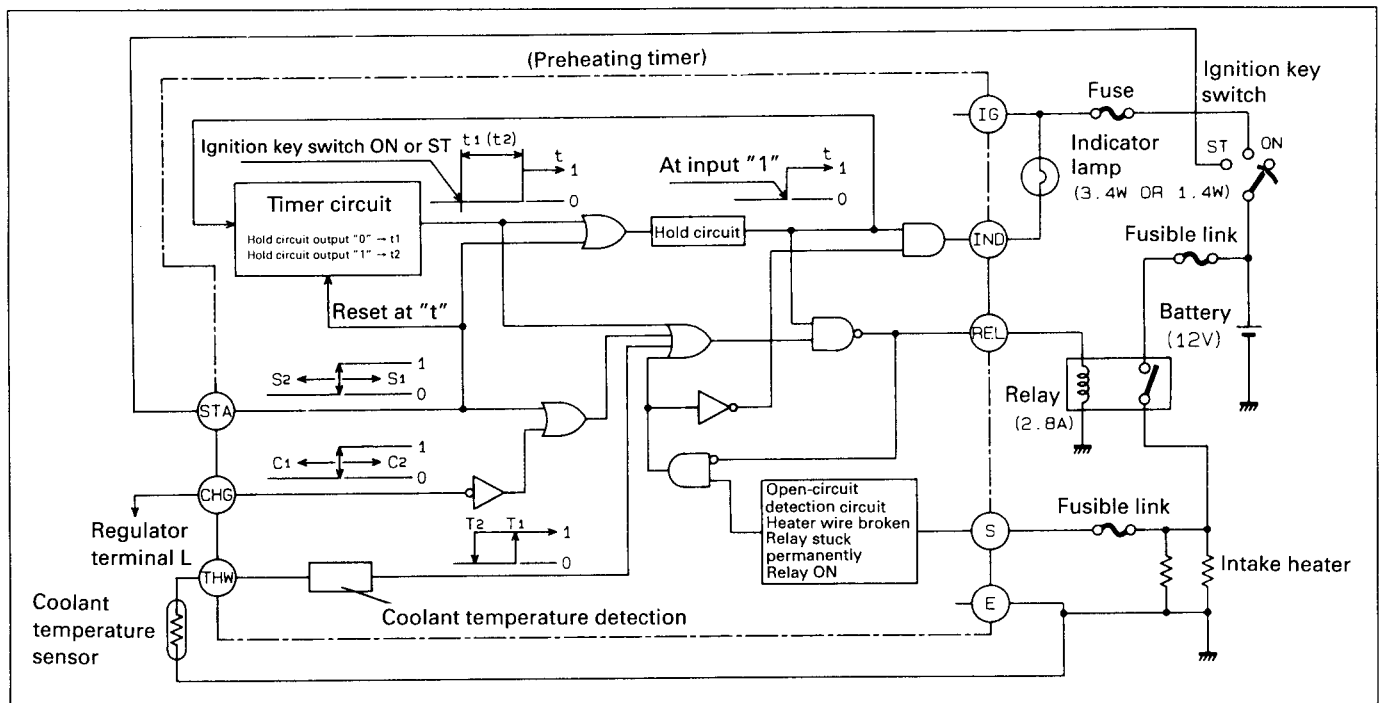
The rotor is symmetric and may be installed on either side

STARTING SYSTEM

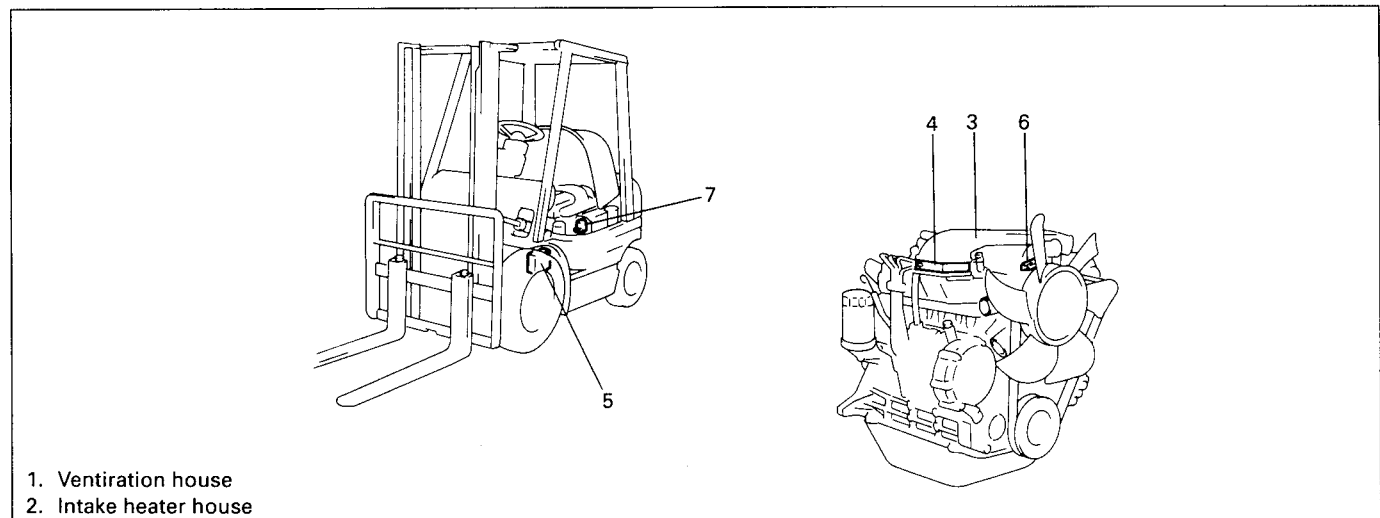
	Page
PREHEATING SYSTEM	6-2
CIRCUIT DIAGRAM	6-2
PREHEATING SYSTEM PARTS REMOVAL AND INSTALLATION	6-2
STARTER	6-5
COMPONENTS	6-5
STARTER DISASSEMBLY AND REASSEMBLY	6-6
STARTER ASSY INSPECTION	6-11
STARTER RELAY INSPECTION	6-12

PREHEATING SYSTEM

CIRCUIT DIAGRAM



PREHEATING SYSTEM PARTS REMOVAL AND INSTALLATION



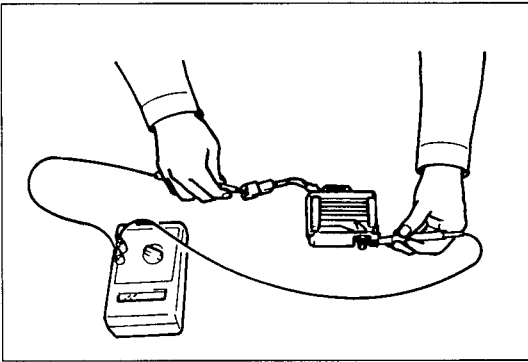
1. Ventilation house
2. Intake heater house

Removal Procedure

- 1 Disconnect the ventilation hose.
- 2 Disconnect the intake heater wiring.
- 3 Disconnect the intake pipe.
- 4 Remove the intake heater. **[Point 1]**
- 5 Remove the preheating timer. **[Point 2]**
- 6 Remove the coolant temperature sensor. **[Point 3]**
- 7 Remove the glow plug relay. **[Point 4]**

Installation Procedure

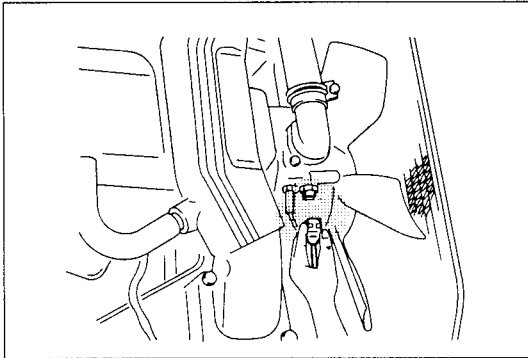
Install components in the reverse order of removal.



[Point 1]

Inspection:

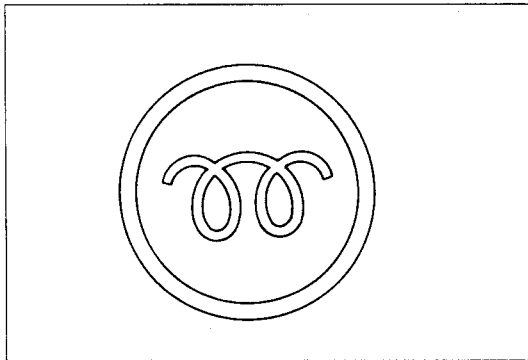
1. Check continuity of the intake heater.
 - (1) Check continuity of the intake heater.



[Point 2]

Inspection:

1. Measure the preheating indicator lamp lighting time.
 - (1) Disconnect the coolant temperature sensor connector.

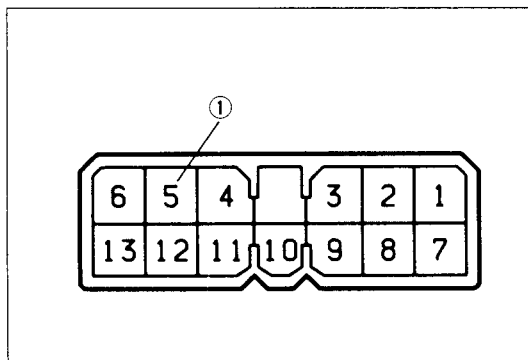


- (2) Set the ignition switch to the ON position, and measure the preheating indicator lamp lighting time.

Standard: 0 ~ 20 minuts

Note:

Do not repeat this test unnecessarily as it consumes much electricity.



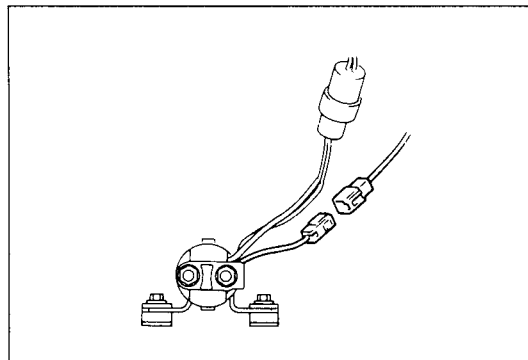
2. Check the after-heating function.

- (1) Disconnect the coolant temperature sensor connector.
- (2) Start the engine, and measure the duration of current continuity between the preheating timer terminal ① and ground.

Standard: 70 ± 10 seconds

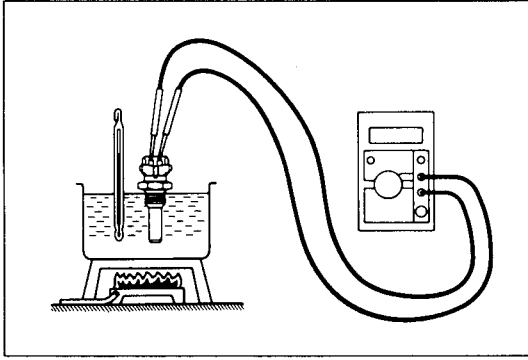
Note:

Do not repeat this test unnecessarily as it consumes much electricity.



3. Check the open-circuit detection function.

- (1) Disconnect the open-circuit detection terminal connector of the glow plug relay (for after-heating). Confirm that the preheating indicator lamp goes on and the glow plug relay (for after-heating) goes off then.

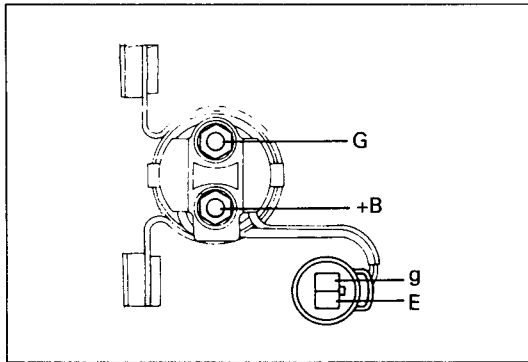
**[Point 3]**

Inspection:

1. Check the coolant temperature sensor.
 - (1) Gradually raise the coolant temperature sensor temperature, and measure the resistance between terminals.

Standard:

Coolant temperature °C (°F)	Resistance (K Ω)
-20 (-4)	17.8 ~ 14.6
+20 (+68)	2.69 ~ 2.21
+70 (+158)	0.35 ~ 0.29

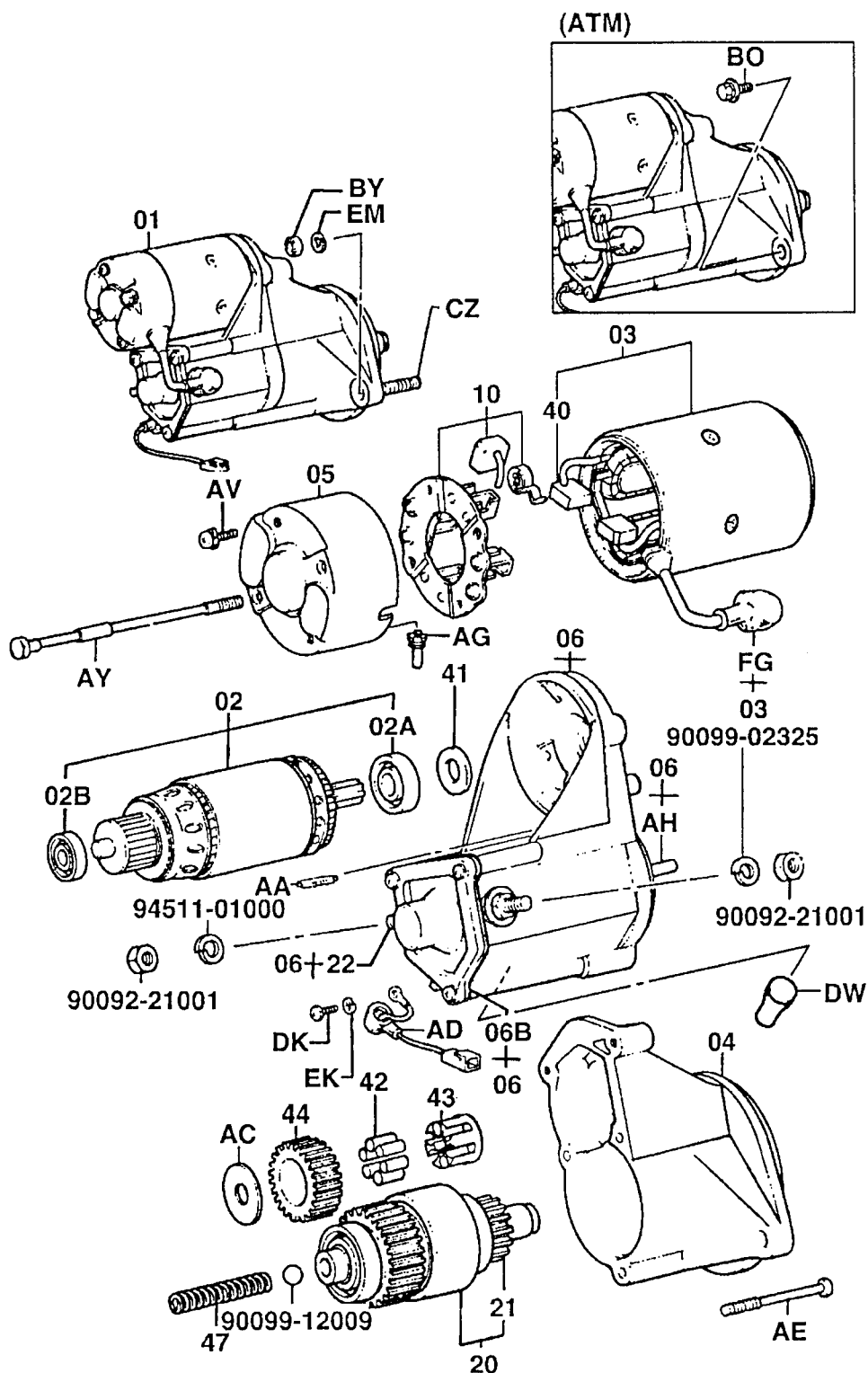
**[Point 4]**

Inspection:

1. Check continuity between connectors.
 - g $\leftrightarrow$ E Continuity
(approx. 14 Ω)
 - +B $\leftrightarrow$ G No continuity
2. Apply the battery voltage across terminals g and E and inspect the function.
 - +B $\leftrightarrow$ G Continuity

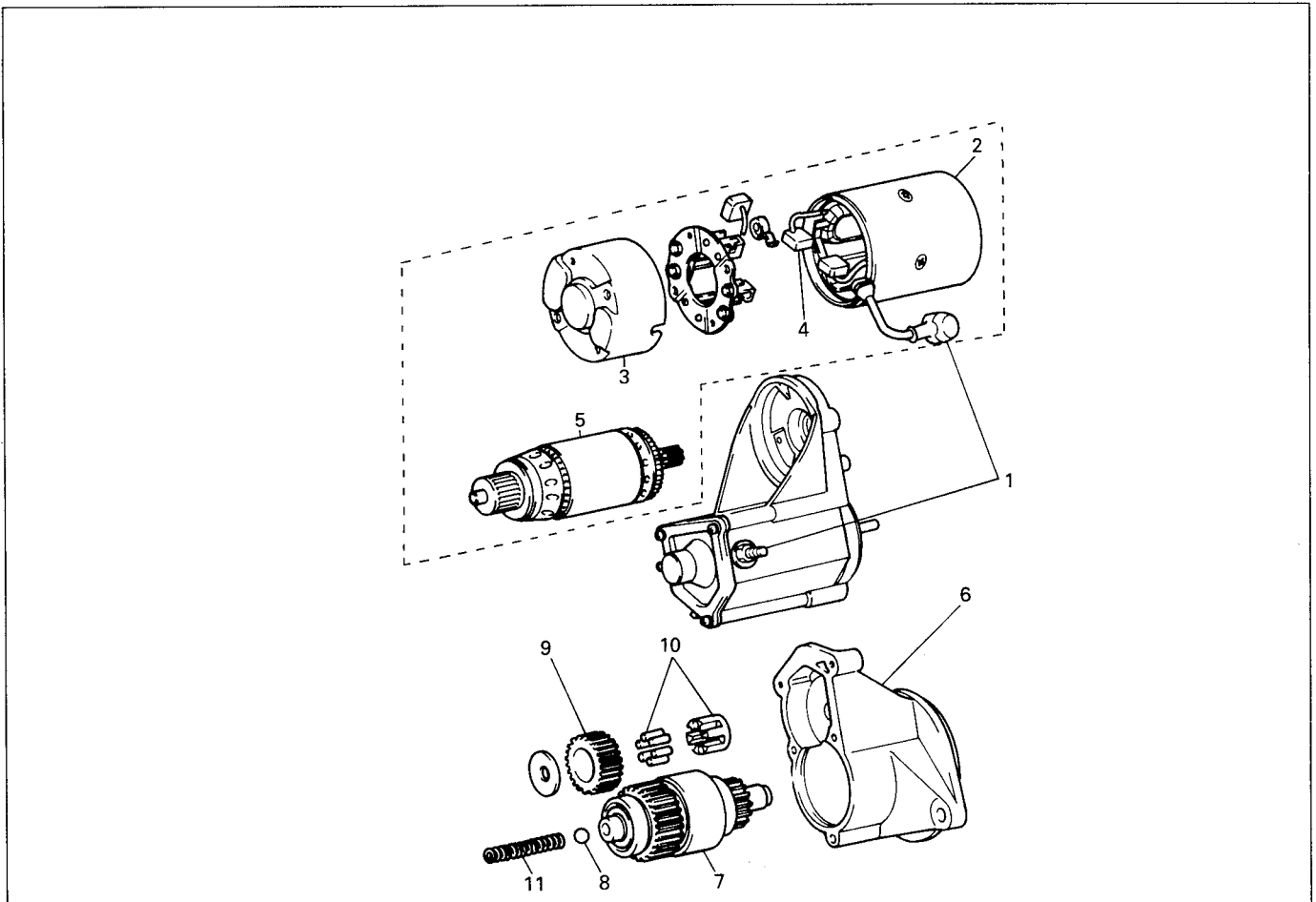
STARTER COMPONENTS

1904



1904-121A

STARTER DISASSEMBLY AND REASSEMBLY

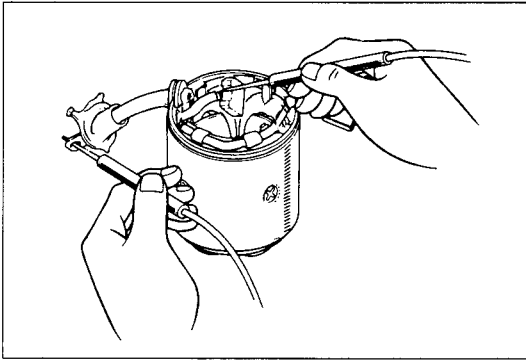


Disassembly Procedure

- 1 Disconnect the lead wires from the magnet switch.
- 2 Remove the yoke ASSY. **[Point 1]**
- 3 Remove the end frame. **[Point 2]**
- 4 Remove the brush. **[Point 3]**
- 5 Remove the armature ASSY. **[Point 4]**
- 6 Remove the housing ASSY from the magnet switch ASSY. **[Point 5]**
- 7 Remove the clutch ASSY. **[Point 6]**
- 8 Remove the steel ball.
- 9 Remove the idle gear.
- 10 Remove the retainer and roller.
- 11 Remove the coil spring.

Reassembly Procedure

Reassemble components in the reverse order of removal.



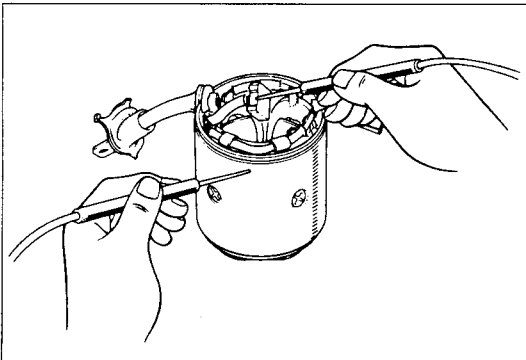
[Point operations]

[Point 1]

Inspection:

1. Check the field coil for an open circuit.
 - (1) Confirm continuity between the field coil brush and terminal C.

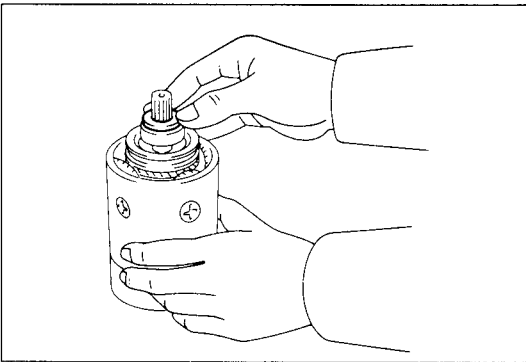
Standard: Continuity



- 2 Check the field coil grounding.

- (1) Confirm insulation between the field coil brush and the field.

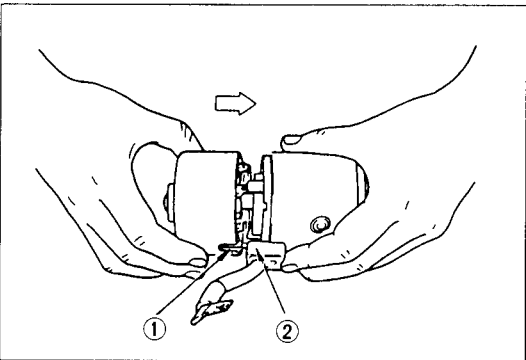
Standard: No continuity



Installation: Assemble the felt washer to the armature shaft bearing.

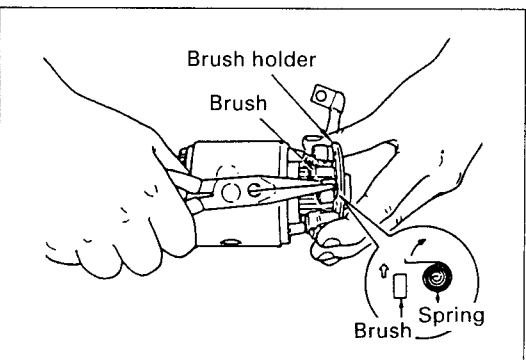
Note:

Align the notch on the yoke with the protrusion on the magnet switch.



[Point 2]

Installation: Align the notch ① on the end frame with the grommet ② on the lead wire.

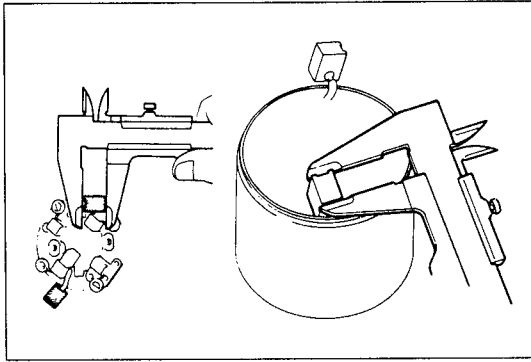


[Point 3]

Disassembly: Lift the ⊕ side brush spring using radio pliers.

Note:

Do not damage the brush and commutator.

**Inspection:**

1. Check the brush.
 - (1) Check the brush for roughened contact surfaces, and measure the brush length.

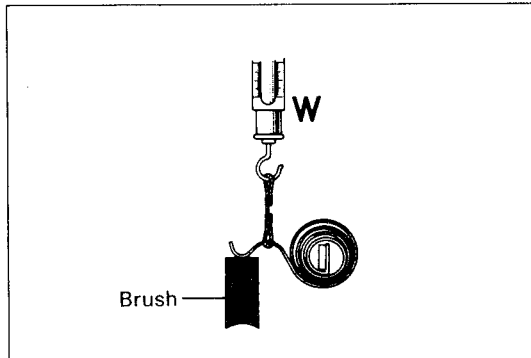
Standard: 20.5 mm (0.807 in.)

Limit: 18.5 mm (0.728 in.)

Note:

Measure the brush length at the center (recess).

- (2) When the contact surface is roughened, or at the time of brush replacement, wrap a sand paper around the commutator and correct the contact surface.



2. Check the brush spring.

- (1) Check the brush spring for smooth movement, and measure the static load.

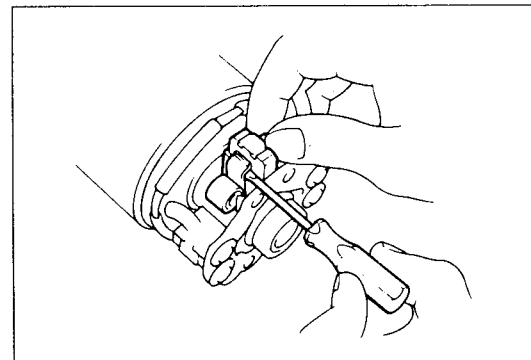
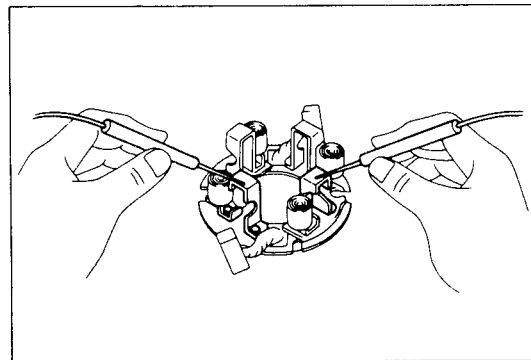
Standard:

31.4 ~ 39.2 N (3.2 ~ 4.0 Kg) [7.1 ~ 8.8 lb]

Limit: 21.6 N (2.2 Kg) [4.9 lb]

3. Check the brush holder.

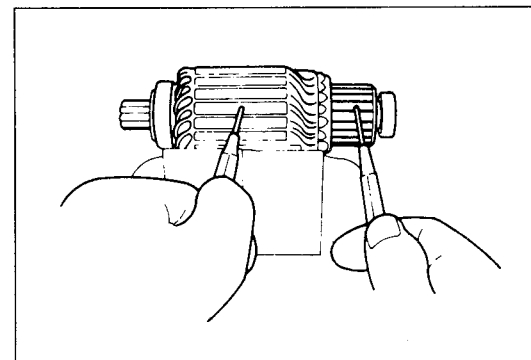
- (1) Confirm insulation between the $\oplus$ side and $\ominus$ side brush holders.

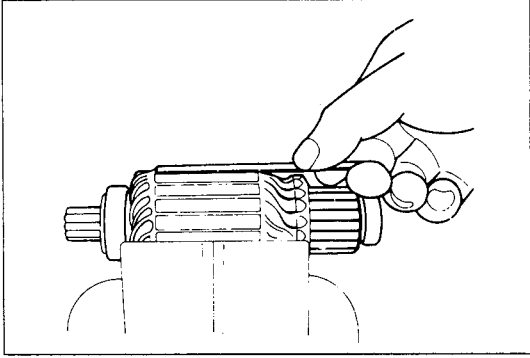
**Installation:**

1. Prying the brush spring with a screwdriver, assemble the brush holder to the starter yoke.
2. Pull up the spring and assemble the brush to the brush holder.

[Point 4]**Inspection:**

1. Check the armature coil grounding.
 - (1) Confirm insulation between the commutator and the armature coil.

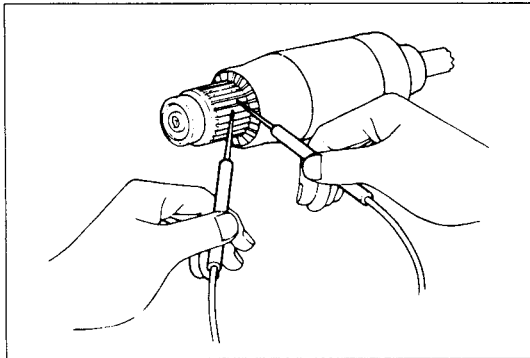




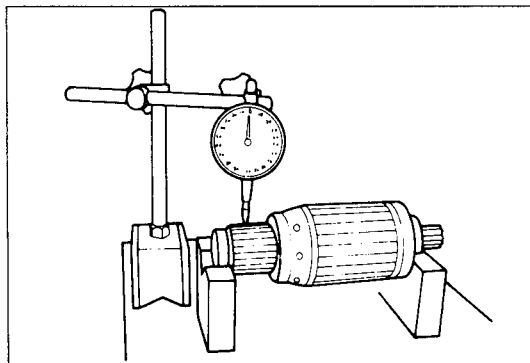
2. Perform a short-circuit test of the armature coil.
 - (1) Put an iron piece in parallel to the armature using an armature tester, and turn the armature. Confirm that the iron piece is not pulled in or that it does not vibrate.

Note:

Thoroughly clean the armature surface before the test

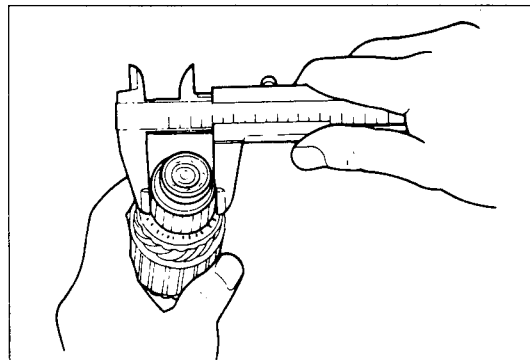


3. Check the armature coil for an open circuit.
 - (1) Check continuity between segments. Test all segments.



4. Check the commutator.
 - (1) Check radial runout.

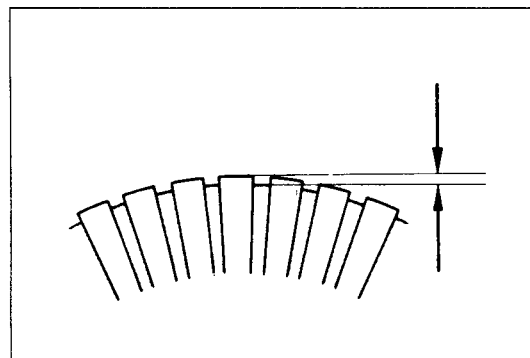
Limit: 0.05 mm (0.0020 in.) or less



- (2) Measure the outside diameter.

Standard: 36 mm (1.42 in)

Limit: 35 mm (1.38 in)

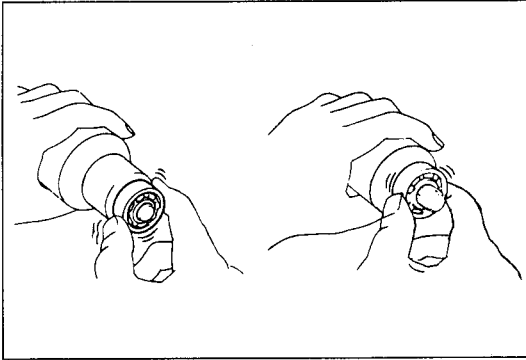


- (3) Check the undercut depth between segments.

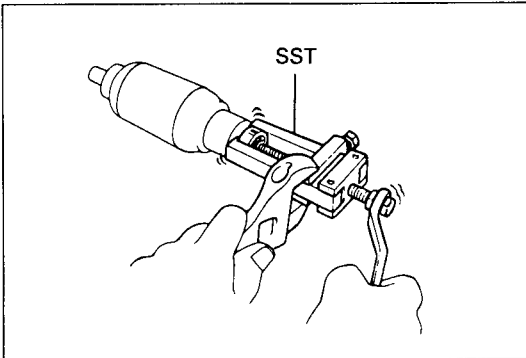
Standard:

0.7 ~ 0.9 mm (0.028 ~ 0.036 in)

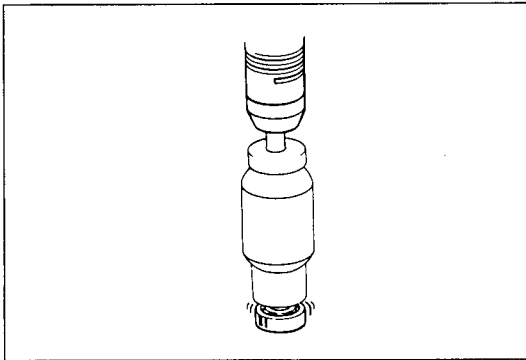
Limit: 0.2 mm (0.008 in)



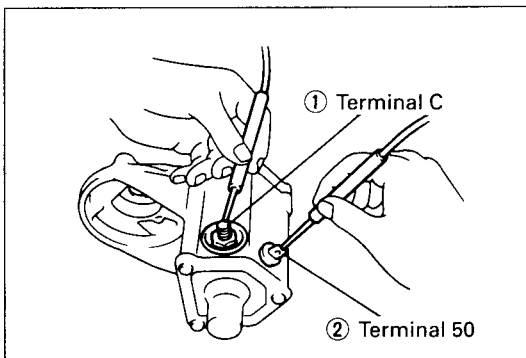
5. Check the bearing.
 - (1) Turn the bearing with a finger. Confirm that it moves smoothly.
 - (2) Confirm that unusual sound is not heard when the bearing is turned quickly.
 - (3) If necessary, replace the bearing.



- (4) Remove the bearing.
SST 09286-46011



- (5) Press-fit the bearing using a press.



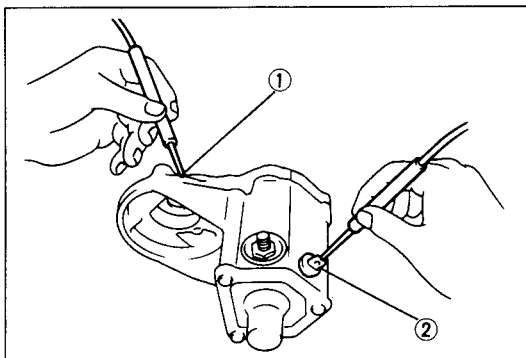
[Point 5]

Inspection:

1. Check the magnet switch ASSY.

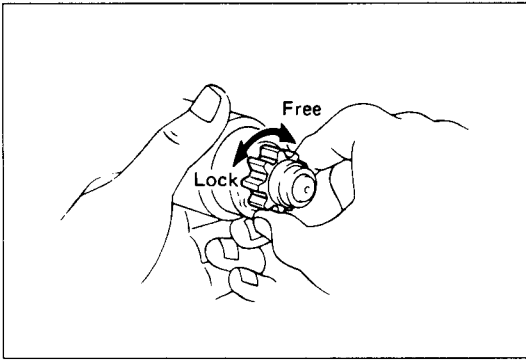
- (1) Check continuity between ② terminals 50 and ① C.

Standard: Continuity



- (2) Check continuity between ② terminal 50 and ① the magnet switch body.

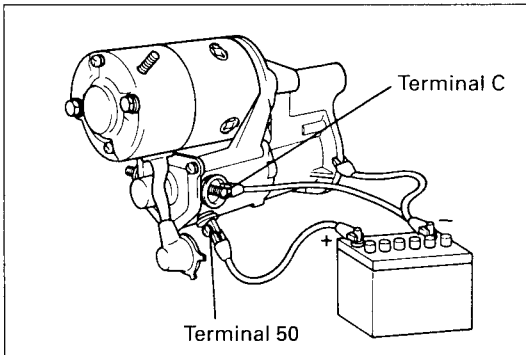
Standard: Continuity



[Point 6]

Inspection:

1. Check the clutch and gear.
 - (1) Check the gear for wear and damage.
 - (2) Confirm that the gear is locked when turned in the drive direction (counterclockwise) and that it turns smoothly when turned in the opposite direction (clockwise).



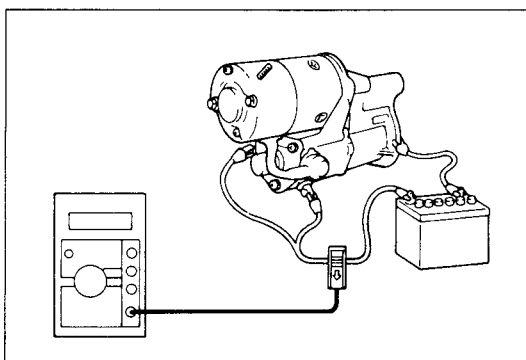
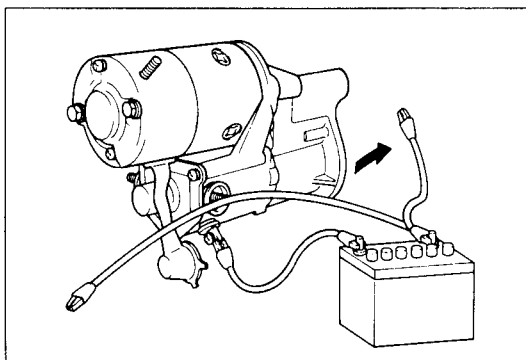
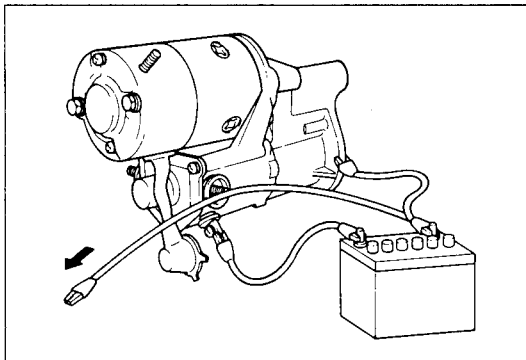
STARTER ASSY INSPECTION

Note:

Each test must be completed within a short time (3 to 5 seconds).

Inspection:

1. Pull-in test
 - (1) Check that the pinion gear comes out when wired as shown.
2. Holding coil retention test
 - (1) Disconnect the test lead wire from terminal C as shown after the pull-in test. Check that the pinion gear remains protruding.
3. Plunger return test
 - (1) Disconnect the test lead wire as shown after the holding coil retention test. Check that the pinion returns then.



4. No-load test
 - (1) Fix the starter in a vice.
 - (2) Use adequately large lead wires for a no-load test as large current is involved.
 - (3) Read the ammeter after the pointer becomes stabilized.

**Standard: 12 V 180 A or less
24 V 90 A or less**

STARTER RELAY INSPECTION

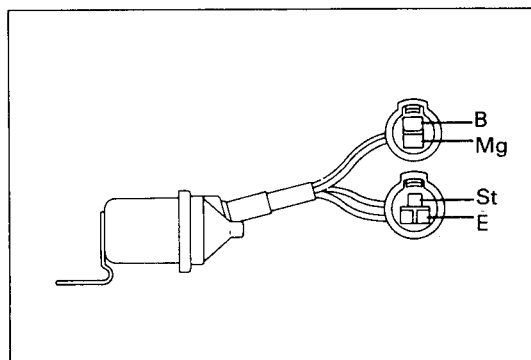
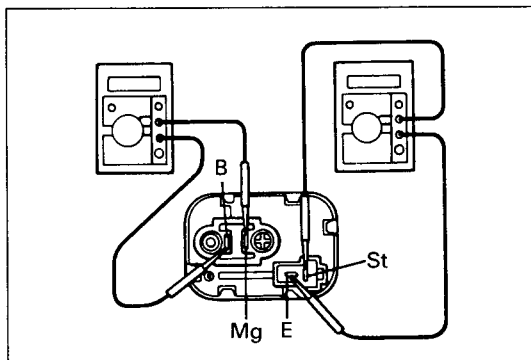
1. Check continuity between each terminal.

Measurement terminal:

St ↔ E terminals. : continuity

B ↔ Mg No continuity

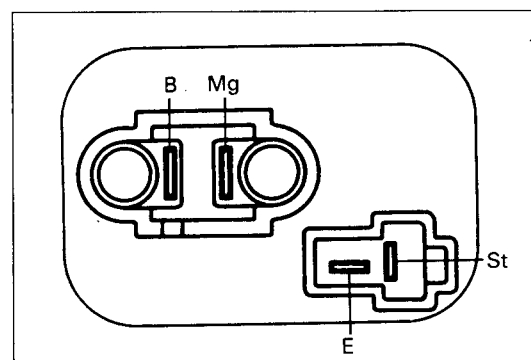
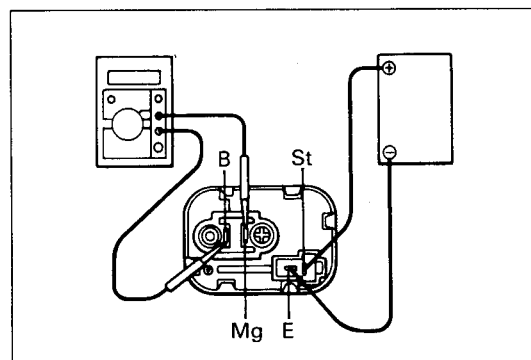
Replace the relay if necessary.



2. Check the relay operation.

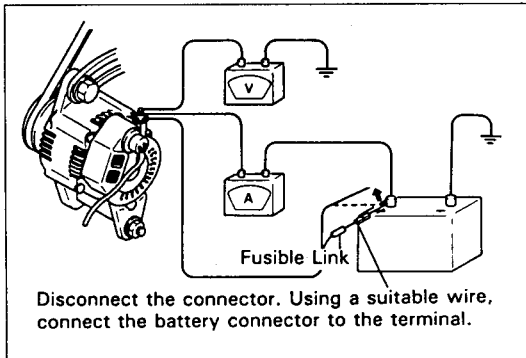
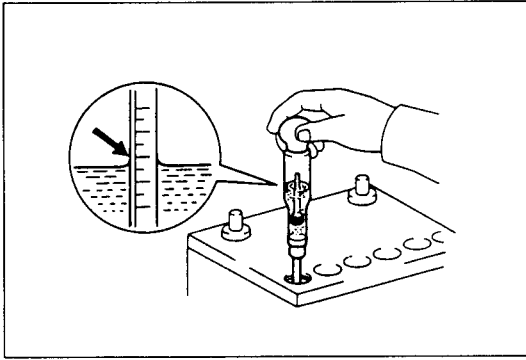
- (1) Apply the battery voltage across terminals St and E. Confirm that the circuit between terminals Mg and B is closed then.

Replace the relay if necessary.



CHARGING SYSTEM

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ON-VEHICLE INSPECTION

1. Check the specific gravity of the battery.
Standard: 1.25 ~ 1.28 (at 20°C)
2. Check the battery terminals.
3. Check the V-belt.
4. Check the fuse.
5. Check wiring.
6. Check the system for unusual sound.
 - (1) Confirm that no unusual sound is heard from the alternator when the engine is running.
7. Perform a no-load test (regulated voltage and current check).
 - (1) Connect the ammeter and voltmeter as shown.
 - (2) Gradually increase the engine speed to 1500 rpm, and measure the voltage.

Until July 1998.

Standard: 12.9 ~ 14.9 V (at 25° (77° F))

Since August 1998.

Standard: 13.5 ~ 14.3 V (at 25° (77° F))

- (3) Measure the current at engine speed of 1500 rpm.

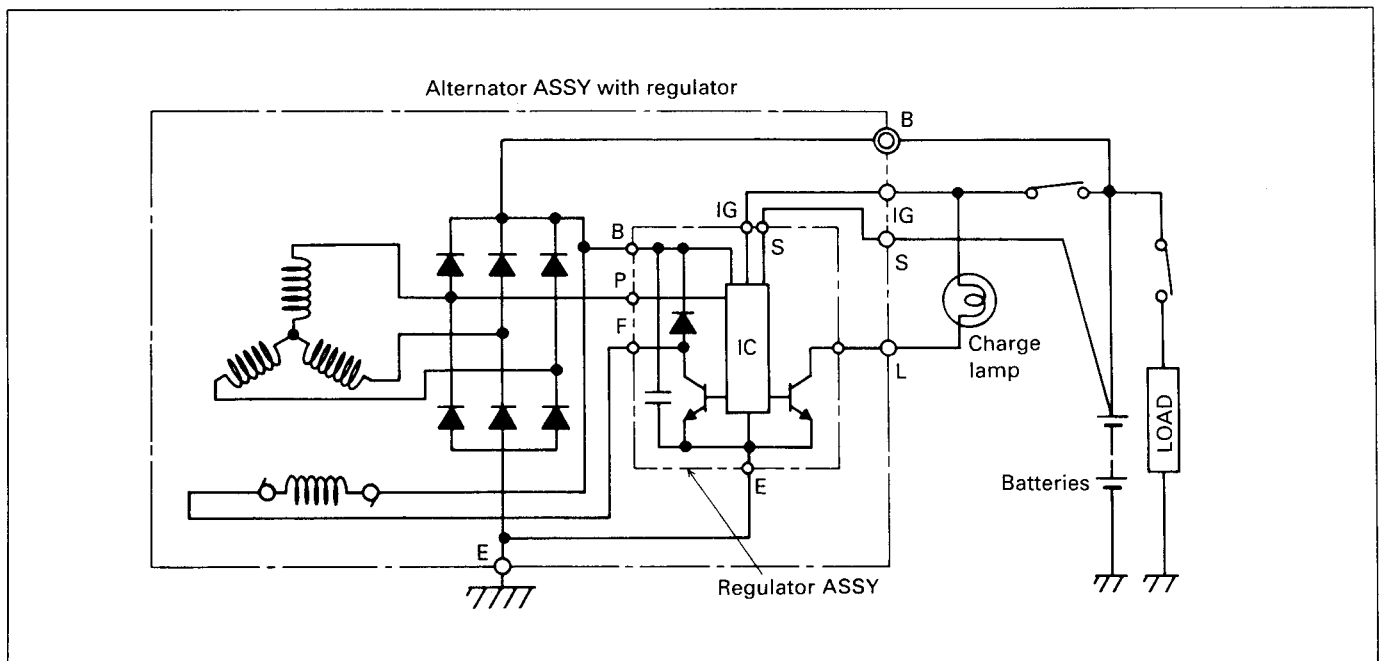
Standard: 10 A or less

Note:

The current reading instantly goes above 10A immediately after the engine starts. This does not constitute a problem.

ALTERNATOR

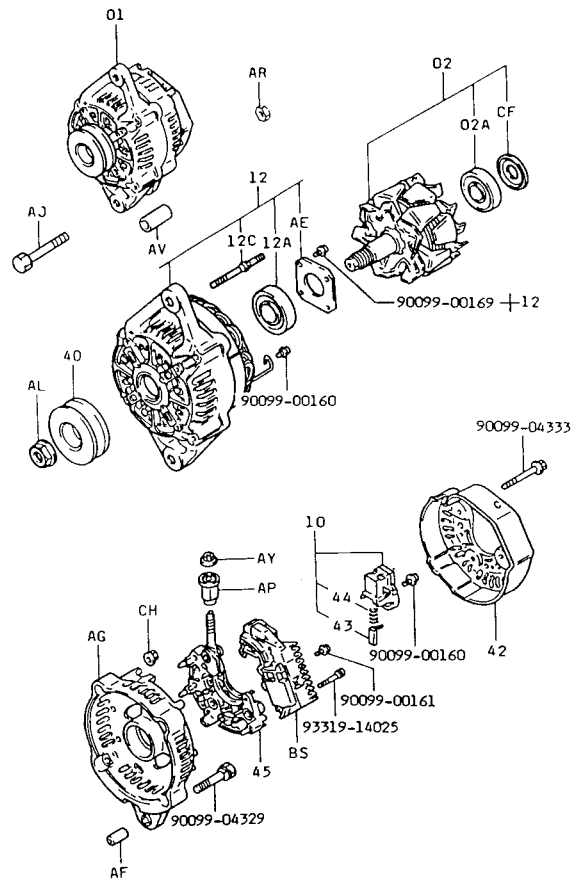
CIRCUIT DIAGRAM



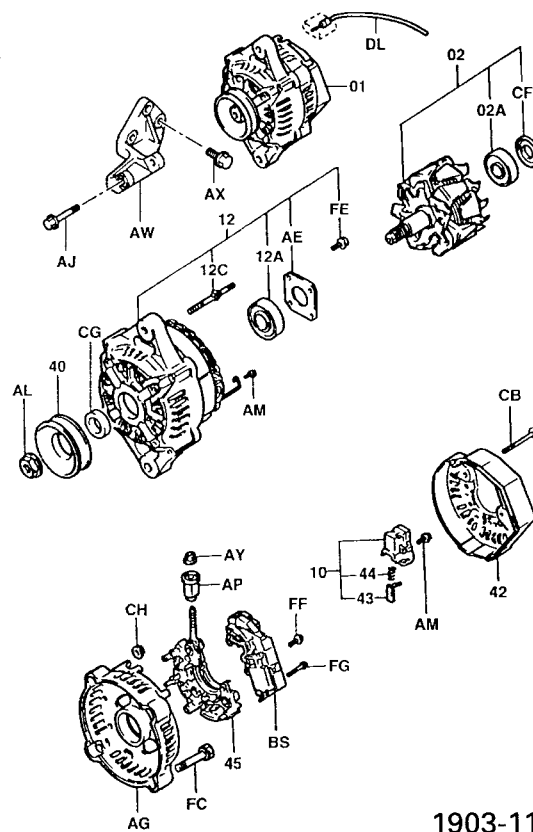
COMPONENTS

1903

~1998. 7

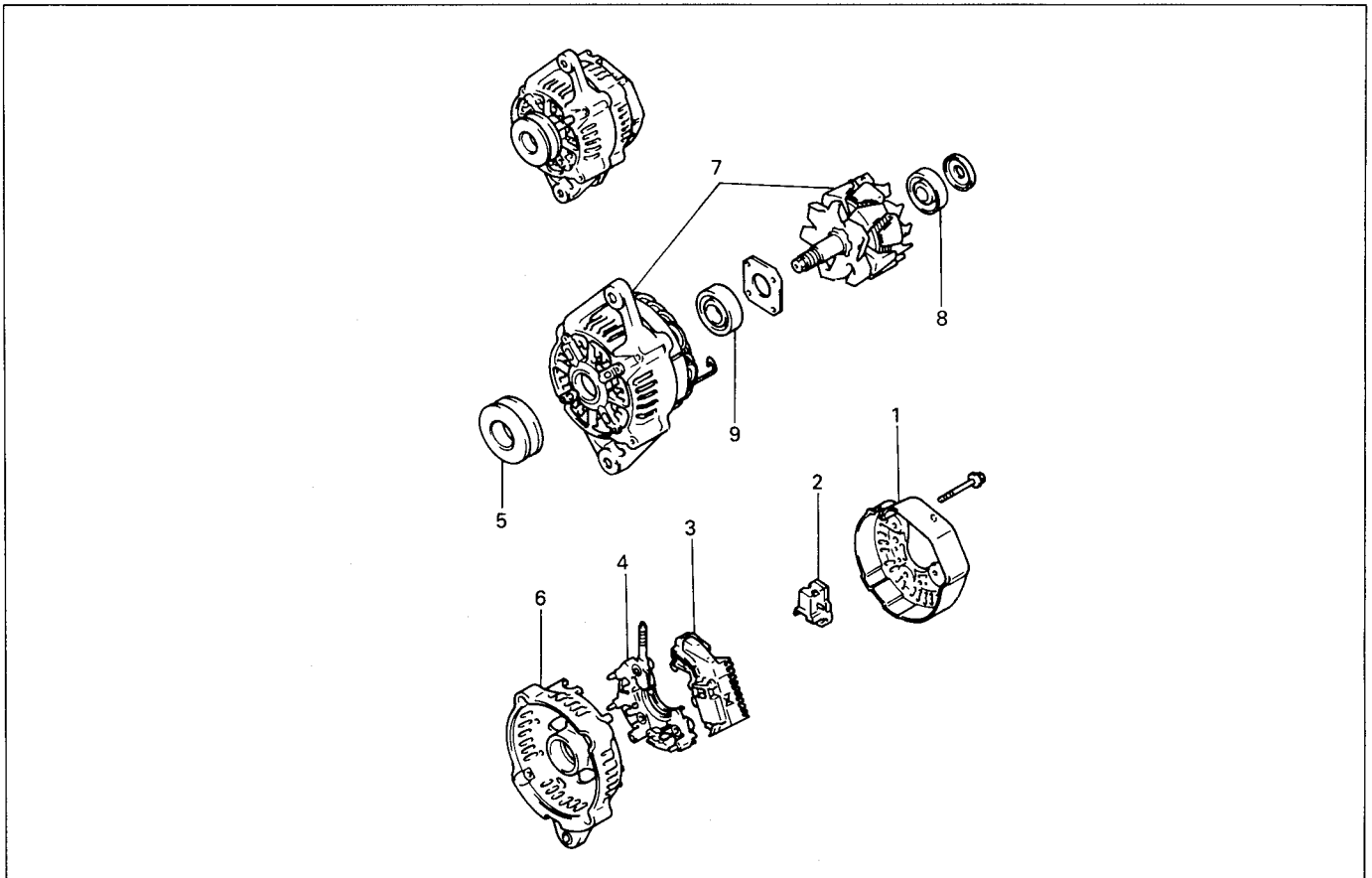


1998. 8~



1903-118A

ALTERNATOR DISASSEMBLY AND REASSEMBLY

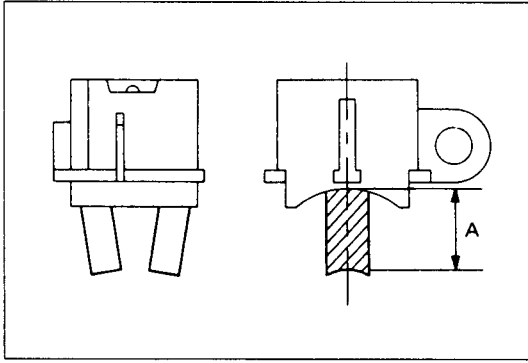


Disassembly Procedure

- 1 Remove the rear end cover.
- 2 Remove the brush holder SUB-ASSY. **[Point 1]**
- 3 Remove the IC regulator. **[Point 2]**
- 4 Remove the rectifier holder. **[Point 3]**
- 5 Remove the alternator pulley. **[Point 4]**
- 6 Remove the rectifier end frame. **[Point 5]**
- 7 Separate the drive end frame from the rotor ASSY. **[Point 6]**
- 8 Remove the rear bearing. **[Point 7]**
- 9 Remove the front bearing. **[Point 8]**

Reassembly Procedure

- 1 Install components in the reverse order of removal (steps 8 and 9)
- 2 Assemble the rectifier end frame and the rotor ASSY. **[Point 9]**
- 3 Install the drive end frame.
- 4 Install components in reverse order of removal (steps 1 to 5).



[Point 1]

Inspection:

1. Check the brush.

- (1) Measure the amount of protrusion (dimension A) of the brush.

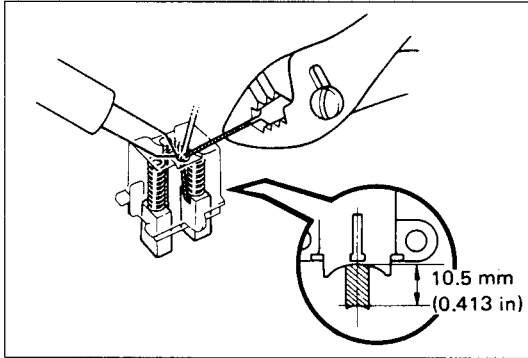
Standard: 10.5 mm (0.413 in)

Limit: 1.5 mm (0.059 in)

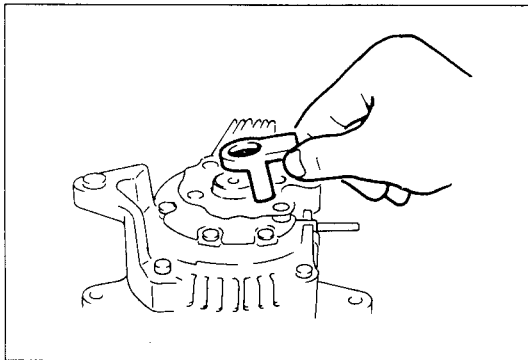
- (2) If the brush protrusion amount is below the limit, remove the brush by melting solder it at the brush holder.
- (3) Fit the spring to the brush holder. Carefully position the brush leaving a brush protrusion amount of 10.5 mm (0.413 in.) and solder it to the brush holder.
- (4) Cut off unnecessary lead wires.
- (5) Coat insulation paint to the solder.

Notes:

- Always replace both brushes as a group.
- Keep the solder thickness less than 1.0 mm (0.039 in.).



Installation: Confirm that the brush holder boot is fitted correctly.



[Point 2]

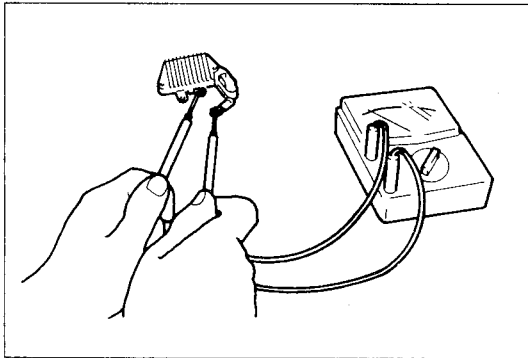
Inspection:

1. Check the IC regulator diode.

- (1) Check continuity of the diode between terminals B and F at K Ω range of the circuit tester.

Note:

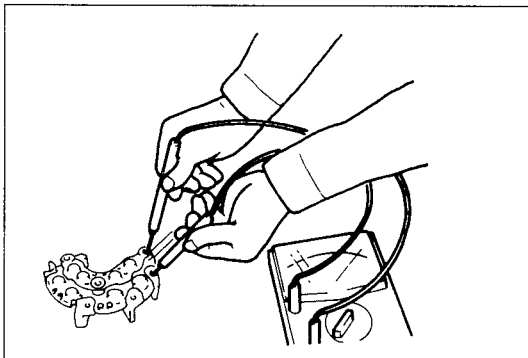
Test two times in different polarities. The diode must be continuous in one polarity and not continuous in another.

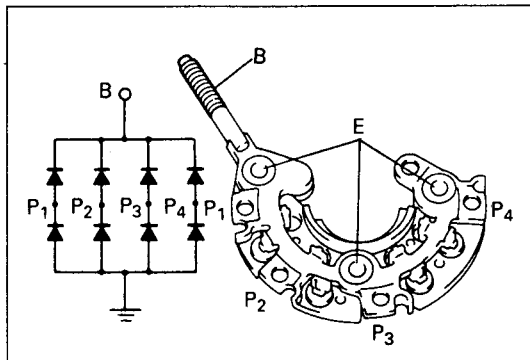


[Point 3]

Inspection:

1. Check the rectifier holder.

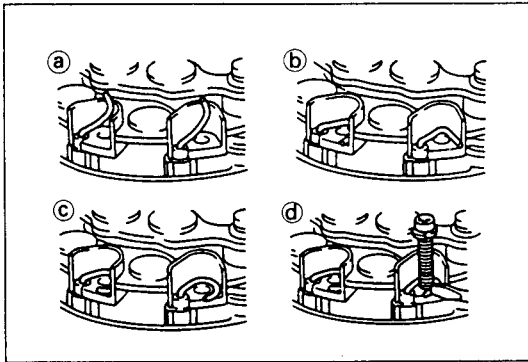




- (1) Check continuity at K Ω range of the circuit tester.

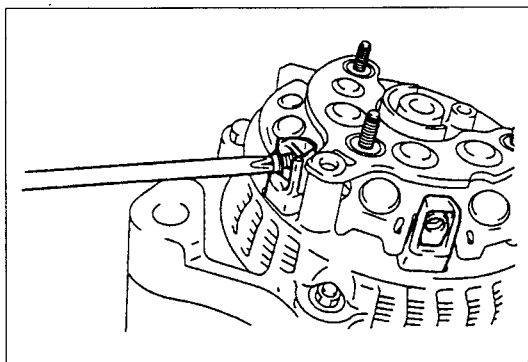
Notes:

- Test two times in different polarities. The component must be continuous in one polarity and not continuous in another.
- Refer to the rectifier circuit diagram given to the left. The rectifier quality cannot be judged on the basis of the resistance in the forward direction due to the nature of the diode. The forward current fluctuates greatly by the source voltage and the tester reading varies depending on the tester type and the resistance range used. Therefore, the rectifier may be judged acceptable on the basis of a large difference in the resistance between the forward and reverse directions.
- Never use a 500V megger as it destroys the rectifier.



Installation:
Until July 1998.

1. Assemble the rectifier holder.
 - (1) Form each wire end as shown in steps a to c to enable fixing by a screw.
 - (2) Fix the terminal with a screw as shown in step d.



Since August 1998.

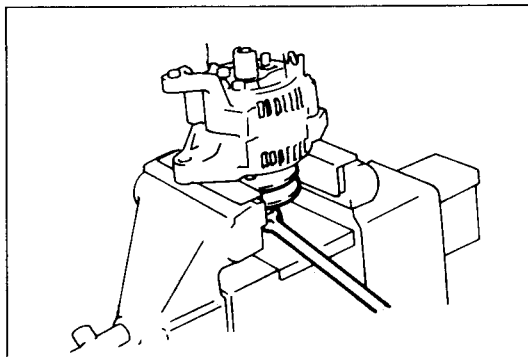
1. Check that the ends of the four stator coil terminal fit in the terminal holders at the end frame.
2. Tighten terminal mounting bolts in several sequences : first temporarily tighten all of them, then tighten them to the specified torque.
3. Mount the rectifier mounting bolts.

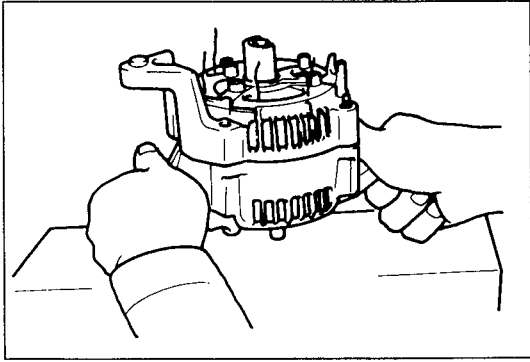
[Point 4]

Disassembly: Set the alternator pulley in a vice and remove the set bolts.

Note:

Always use pads to protect the components.



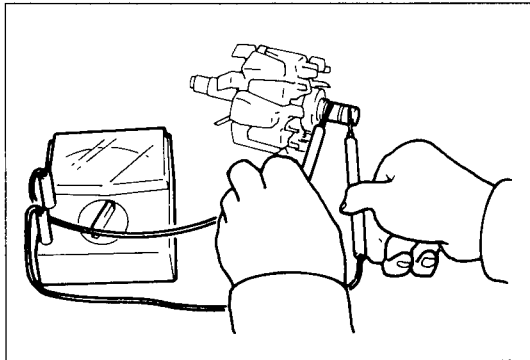


[Point 5]

Disassembly: After set nuts and set bolts are removed, hold the rectifier by the end frame and separate it by applying a shock to the rotor shaft end.

Note:

Carefully drop the rectifier holder onto a piece of wood or other appropriate material to apply a shock.

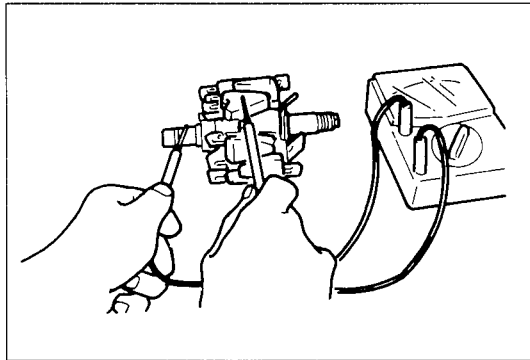


[Point 6]

Inspection:

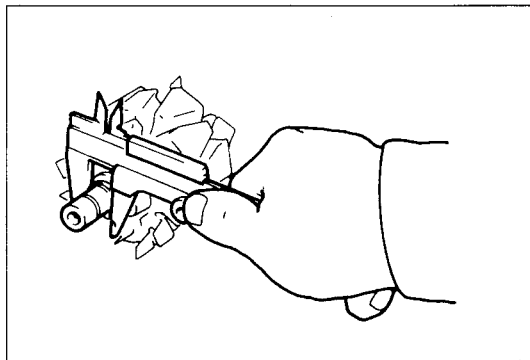
1. Check the coil for an open circuit.
 - (1) Measure the resistance between the two slip rings.

Standard: 3.0 Ω or less



2. Check the coil grounding.
 - (1) Measure the insulation resistance between slip rings and the rotor core.

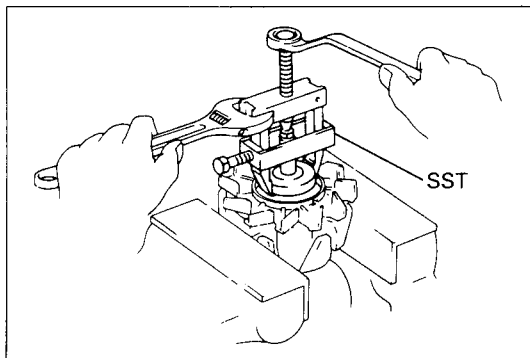
Standard: 0.1 M Ω or more



3. Check the slip rings.
 - (1) When a slip ring is damaged, repair it using an abrasive paper (#400).
 - (2) Measure the outside of the slip ring.

Standard: 14.4 mm (0.567 in)

Limit: 14.0 mm (0.552 in)

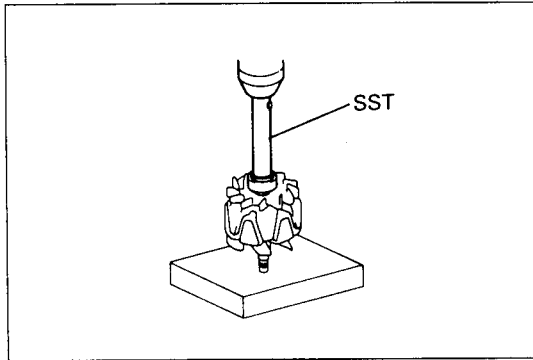


[Point 7]

Disassembly: SST 09820-76002-71
(SST 09820-00021)

Note:

Do not remove the bearing unless absolutely necessary.

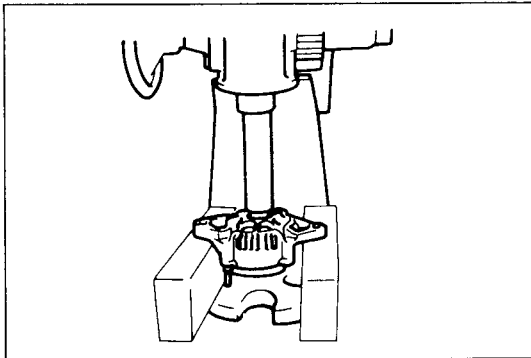


Installation: This step is necessary only when the bearing is removed.

SST 09820-76003-71
(SST 09820-00030)

Note:

Press-fit the inner race side of the bearing using a press.

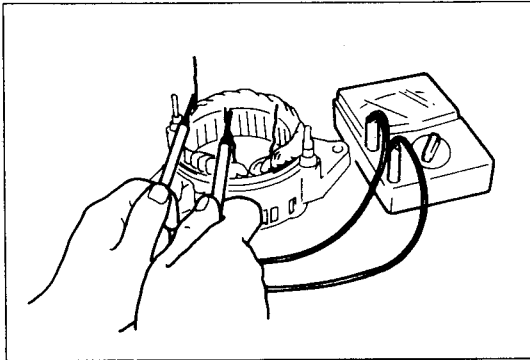


[Point 8]

Disassembly: Use an appropriate round bar (ø25 to 28 mm in diameter) and a press.

Note:

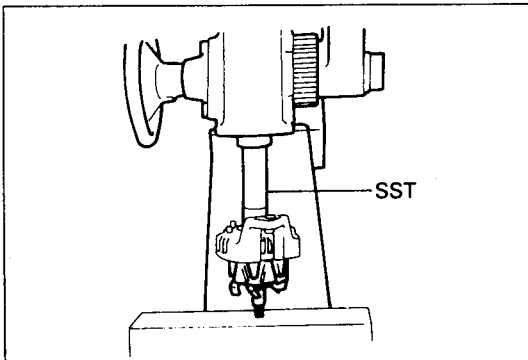
Do not remove the bearing unless absolutely necessary.



Inspection:

1. Check the stator coil in the drive end frame.
 - (1) Measure the resistance between phases.

Standard: 1 Ω



[Point 9]

Installation: SST 09381-41950-71

Note:

Put a plate washer or other appropriate material between SST and the rear end frame so that pressure applies evenly to the rear end frame.

SST LIST

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SST LIST (SPECIAL SERVICE TOOLS)

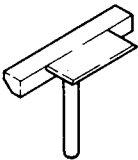
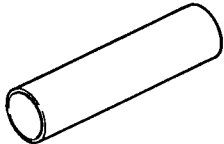
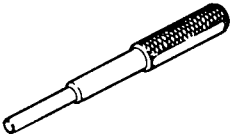
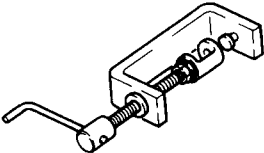
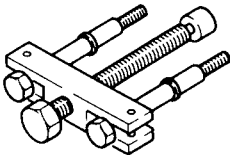
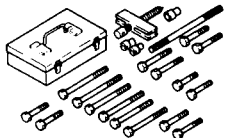
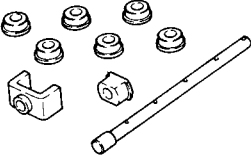
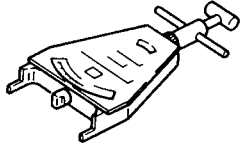
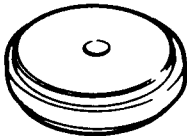
Illustration	Part No.	Part Name	Section						
			1	2	3	4	5	6	7
	09032-76001-71 (09032-00100)	Cutter, oil pan seal		○			○		
	09201-76005-71 (09201-58010)	Replacer, valve stem oil seal		○					
	09201-76006-71 (09201-60011)	Remover & replacer, valve guide bush		○					
	09202-76001-71 (09202-43013)	Compressor, valve spring		○					
	09213-76002-71 (09213-31021)	Puller, crankshaft pulley			○				
	09213-76007-71 (09213-60017)	Puller, crankshaft pulley and gear		○					
	09215-76001-71 (09215-00012)	Remover and replacer set B, camshaft bearing		○					
	09216-76002-71 (09215-0002)	Gauge, belt tension	○						
	09218-76003-71 (09218-56020)	Remover and replacer cylinder liner		○					

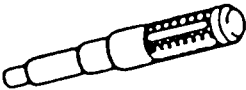
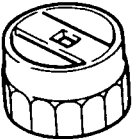
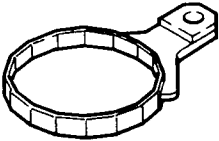
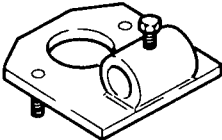
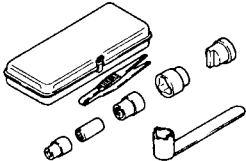
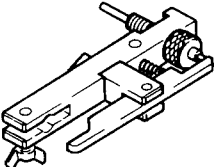
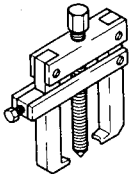
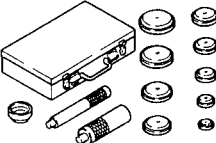
Illustration	Part No.	Part Name	Section						
			1	2	3	4	5	6	7
	09222-76003-71 (09222-66010)	Remover and replacer connecting rod bush		○					
	Until July 1988: 09228-76008-71 (09228-44011) Since August 1998: 09228-76004-71 (09228-07501)	Wrench, oil filter		○			○		
	09228-76010-71 (09228-64010)	Wrench, fuel filter			○				
	09245-76001-71 (09245-54010)	Arm, injection pump			○				
	09260-76003-71 (09260-54012)	Tool set, injection pump			○				
	09275-76002-71 (09275-54010)	Tool, plunger stroke measuring	○						
	09286-76001-71 (09286-46011)	Puller, injection pump spline shaft						○	
	09608-76008-71 (09608-30012)	Tool set, front hub and drive pinion bearing		○					
	09608-76009-71 (09608-35014)	Tool set, axle hub and drive pinion bearing		○					

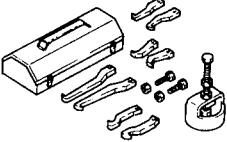
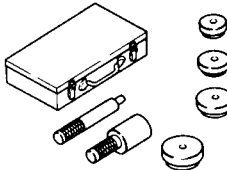
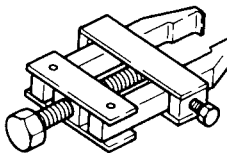
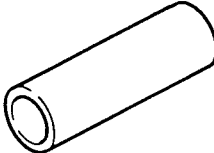
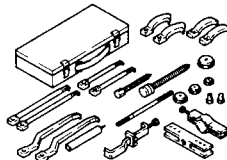
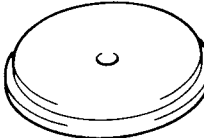
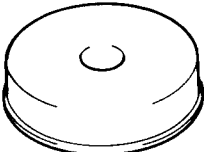
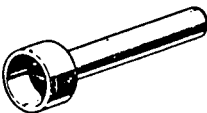
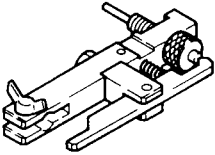
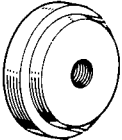
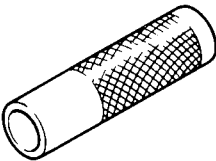
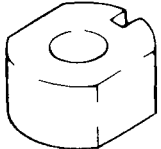
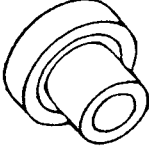
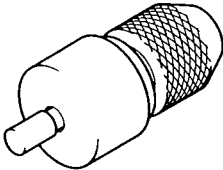
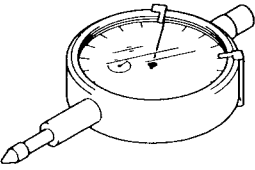
Illustration	Part No.	Part Name	Section						
			1	2	3	4	5	6	7
	09612-76006-71 (09612-65014)	Puller, steering worm bearing			○				
	09620-76001-71 (09620-30010)	Replacer set, steering gear box		○					
	09820-76002-71 (09820-00021)	Puller, alternator bearing							○
	09820-76003-71 (09820-00030)	Replacer, alternator bearing							○
	09950-76012-71 (09950-20017)	Puller, universal		○					
	09992-76001-71 (09992-00024)	Cylinder compression check gauge set	○						
	09111-23660-71	Replacer, cylinder liner		○					
	09112-23660-71	Remover and Replacer, camshaft bearing		○					
	09150-10170-71	Replacer, transmission bearing		○					

Illustration	Part No.	Part Name	Section						
			1	2	3	4	5	6	7
	09230-32880-71	Tool set, 2 spring			○				
	09240-32880-71	Tool, plunger stroke measuring	○						
	09320-10410-71	Replacer, front axle hub inner bearing		○					
	09370-20270-71	Replacer, drive pinion bearing		○					
	09381-41950-71	Replacer, HST pump bearing							○
	09231-32880-71	Base, 2-spring			○				
	09232-23320-71	Seat, master spring			○				
	09233-23320-71	Attachment, measure			○				
	09234-23320-71	Gauge, dial			○				

SERVICE STANDARDS

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Check Item	Standard	Limit
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ENGINE TUNE-UP

Coolant capacity		See the repair manual for each model	—
Lubricant oil capacity ℓ (US gal)	Total capacity	9.0 (2.38)	—
	Oil pan capacity	8.0 (2.11)	—
Electrolyte specific gravity (at 20°C)		1.25 ~ 1.28	—
V-belt deflection (at 10 kg [22 lb] force) mm (in.)	New belts	7 ~ 9 (0.28 ~ 0.35)	—
	Belts in use	8 ~ 13 (0.31 ~ 0.51)	—
V-belt tension (tension gauge) N (kg) [lb]	New belts	519 ~ 755 (53 ~ 77) [117 ~ 170]	—
	Belts in use	323 ~ 559 (33 ~ 57) [73 ~ 126]	—
Radiator cap valve opening pressure kPa (kg/cm ²) [psi]		73.5 ~ 102.9 (0.75 ~ 1.05) [10.7 ~ 149]	—
Injection timing		TDC (See page 1-6.)	—
Injection pressure kPa (kg/cm ²) [psi]		17700 ± 500 (180 ± 5) [2560 ± 71]	—
Injection order		1-3-4-2	—
Valve clearance (hot engine) mm (in.)	IN	0.20 (0.0079)	—
	EX	0.36 (0.0142)	—
Idle speed		See the repair manual for each model	—
No-load static maximum speed		See the repair manual for each model	—
Engine speed drop at tilt relief (rpm)		200	—
Compression kPa (kg/cm ²) [psi]/rpm		3230 (33) [469]/260	1960 (20) [280]/260
	Difference between cylinders	—	200 (2) [28]/260
Lubricant pressure kPa (kg/cm ²) [psi]	Idling	78.5 (0.8)	—
	2200 rpm	392 (4)	—

ENGINE

CYLINDER HEAD

Bottom surface distortion mm (in.)		—	0.15 (0.0059)
Manifold mounting surface distortion mm (in.)		—	0.20 (0.0078)
Valve seat	Contact angle		45°
	Contact width mm (in.)	IN	1.5 ~ 1.9 (0.059 ~ 0.075)
		EX	1.5 ~ 1.9 (0.059 ~ 0.075)

Check Item	Standard	Limit
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VALVE GUIDE BUSHING

Inside diameter	mm (in.)	9.01 ~ 9.03 (0.3547 ~ 0.3555)	–
Protrusion from head top surface	mm (in.)	15.5 (0.610)	–

VALVE

Overall length	mm (in.)	IN	121.94 (4.8008)	121.3 (4.7756)
		EX	121.84 (4.7969)	121.2 (4.7717)
Contact surface angle			45°	–
Stem outside diameter	mm (in.)	IN	8.97 ~ 8.99 (0.3531 ~ 0.3539)	–
		EX	8.95 ~ 8.97 (0.3523 ~ 0.3531)	–
Valve head thickness	mm (in.)	IN	–	0.9 (0.035)
		EX	–	1.0 (0.039)
Valve guide bushing oil clearance	mm (in.)	IN	0.02 ~ 0.06 (0.0008 ~ 0.0024)	0.10 (0.0039)
		EX	0.04 ~ 0.08 (0.0016 ~ 0.0031)	0.12 (0.0047)

VALVE SPRING

Free length	mm (in.)	45.1 (1.776)	44.5 (1.752)
Squareness	mm (in.)	–	2.0 (0.079)
Installed tension (at 40.0 mm)	N (kg) [lb]	212.7 (21.7) [47.9]	–

VALVE ROCKER ARM AND SHAFT

Rocker arm inside diameter	mm (in.)	18.500 ~ 18.521 (0.72835 ~ 0.72917)	18.60 (0.7323)
Rocker shaft outside diameter	mm (in.)	18.472 ~ 18.493 (0.72724 ~ 0.72807)	18.44 (0.7260)
Shaft to arm clearance	mm (in.)	0.007 ~ 0.049 (0.00028 ~ 0.00193)	0.16 (0.0063)

VALVE LIFTER AND PUSH ROD

Valve lifter outside diameter mm (in.)	STD	22.170 ~ 22.190 (0.8728 ~ 0.8736)	–
	O/S 0.05	22.220 ~ 22.235 (0.87480 ~ 0.87539)	–
Block hole oil clearance	mm (in.)	0.010 ~ 0.051 (0.00039 ~ 0.00201)	0.1 (0.004)
Block hole inside diameter (STD)	mm (in.)	22.200 ~ 22.221 (0.87401 ~ 0.87484)	–
Push rod bend	mm (in.)	–	0.25 (0.010)

MANIFOLD

Cylinder head mounting surface distortion mm (in.)	IN	–	0.4 (0.16)
	EX	–	0.4 (0.16)

Check Item	Standard	Limit
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TIMING GEAR AND IDLE GEAR

Gear Backlash, Thrust Clearance, Oil Clearance

Crankshaft timing gear x idle gear	mm (in.)	0.05 (0.020)	0.3 (0.012)
Idle gear No. 1 x camshaft timing gear	mm (in.)	0.05 (0.020)	0.3 (0.012)
Idle gear No. 1 x injection pump drive gear	mm (in.)	0.05 (0.020)	0.3 (0.012)
Idle gear No. 2 x oil pump	mm (in.)	0.05 (0.020)	0.3 (0.012)
Idle gear No. 2 x PTO pump drive gear	mm (in.)	0.05 (0.020)	0.3 (0.012)
Idle gear thrust clearance	No.1	0.030 ~ 0.090 (0.0012 ~ 0.0035)	0.3 (0.012)
	No.2	0.092 ~ 0.252 (0.00362 ~ 0.00992)	0.3 (0.012)
Idle gear to idle gear shaft thrust clearance	No.1	0.025 ~ 0.075 (0.00098 ~ 0.00295)	0.3 (0.012)
	No.2	0.040 ~ 0.080 (0.00157 ~ 0.00295)	0.3 (0.012)
Thrust washer thickness	mm (in.)	2.45 ~ 2.50 (0.0964 ~ 0.0984)	—

CAMSHAFT AND BEARING

Camshaft bend	mm (in.)	—	0.04 (0.0016)
Cam height	IN	41.912 ~ 42.012 (1.65008 ~ 1.65401)	41.45 (1.6319)
	EX	42.777 ~ 42.877 (1.68413 ~ 1.68807)	42.31 (1.6657)
Journal outside diameter (STD)	No.1	51.151 ~ 51.170 (2.01381 ~ 2.01456)	—
	No.2	50.951 ~ 50.970 (2.00594 ~ 2.00669)	—
	No.3	50.751 ~ 50.770 (1.99807 ~ 1.99881)	—
Camshaft bearing inside diameter	No.1	51.200 ~ 51.230 (2.01574 ~ 2.01693)	—
	No.2	51.000 ~ 51.030 (2.00787 ~ 2.00905)	—
	No.3	50.800 ~ 50.830 (2.00000 ~ 2.00118)	—
Camshaft oil clearance	mm (in.)	0.030 ~ 0.079 (0.00118 ~ 0.00311)	0.1 (0.004)
Camshaft bearing variation (U/S)		0.125, 0.250	—
Camshaft thrust clearance	mm (in.)	0.06 ~ 0.13 (0.0024 ~ 0.0051)	0.3 (0.012)

Check Item	Standard	Limit
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CYLINDER BLOCK

Top surface distortion	mm (in.)	—	0.1 (0.004)
Cylinder bore	mm (in.)		
	Inside diameter	98.00 ~ 98.03 (3.8583 ~ 3.8594)	—
	Taper	—	0.02 (0.0008) or less
	Ellipticity	—	0.02 (0.0008) or less
	Wear	—	0.3 (0.012)
	Honing margin	—	0.2 (0.008) or less

CYLINDER LINER OUTSIDE DIAMETER**PISTON AND PISTON RING**

Piston outside diameter	mm (in.)		
	STD	97.94 ~ 97.97 (3.85589 ~ 3.85708)	—
	O/S 0.50	98.44 ~ 98.45 (3.8756 ~ 3.8760)	—
	O/S 1.00	98.94 ~ 98.95 (3.8953 ~ 3.8957)	—
	O/S 1.50	99.44 ~ 99.45 (3.9150 ~ 3.9154)	—
Cylinder clearance	mm (in.)	0.05 ~ 0.07 (0.0020 ~ 0.0028)	0.15 (0.0059)
Piston outside diameter	mm (in.)	32.000 ~ 32.012 (1.25984 ~ 1.26013)	—
Ring to ring groove clearance	mm (in.)		
	No. 1	0.08 ~ 0.12 (0.0031 ~ 0.0047)	—
	No. 2	0.04 ~ 0.08 (0.0016 ~ 0.0031)	—
	Oil ring	0.03 ~ 0.07 (0.0012 ~ 0.0028)	—
Ring gap	mm (in.)		
	No. 1	0.30 ~ 0.45 (0.0118 ~ 0.0177)	—
	No. 2	0.43 ~ 0.55 (0.0169 ~ 0.0217)	—
	Oil ring	0.20 ~ 0.40 (0.0079 ~ 0.0157)	—
Piston fitting temperature	°C (°F)	60 (140)	—

CONNECTING ROD AND BEARING

Connecting rod bend (per 100 mm (0.04 in.))	mm (in.)	—	0.05 or less
Connecting rod torsion (per 100 mm (0.04 in.))	mm (in.)	—	0.15 or less
Big end thrust clearance	mm (in.)	0.20 ~ 0.34 (0.008 ~ 0.0134)	0.3 (0.012)
Small end bushing oil clearance	mm (in.)	0.004 ~ 0.012 (0.00016 ~ 0.00049)	0.05 (0.0020)

Check Item	Standard	Limit
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CRANKSHAFT AND BEARING

Crankshaft bend	mm (in.)	—	0.06 (0.0024)
Crank journal and crankpin taper and ellipticity	Taper	—	0.05 (0.0020)
	mm (in.)	Ellipticity	—
Crankshaft thrust clearance	mm (in.)	0.04 ~ 0.25 (0.0016 ~ 0.0100)	0.3 (0.012)
Thrust washer thickness	STD	2.43 ~ 2.48 (0.0957 ~ 0.0976)	—
	mm (in.)	O/S	0.125, 0.250 (0.00492, 0.00984)
Journal outside diameter (or finishing dimension for U/S)	STD	73.98 ~ 74.00 (2.9126 ~ 2.9134)	—
	U/S 0.25	73.74 ~ 73.75 (2.9031 ~ 2.9035)	—
	U/S 0.50	73.49 ~ 73.50 (2.8933 ~ 2.8937)	—
	U/S 0.75	73.24 ~ 73.25 (2.8835 ~ 2.8839)	—
	U/S 1.00	72.99 ~ 73.00 (2.8736 ~ 2.8740)	—
Crank journal oil clearance	mm (in.)	0.030 ~ 0.066 (0.00118 ~ 0.00260)	0.1 (0.004)
Crankpin outside diameter (or finishing dimension for U/S)	STD	54.98 ~ 55.00 (2.1646 ~ 2.1654)	—
	U/S 0.25	54.74 ~ 54.75 (2.1551 ~ 2.1555)	—
	U/S 0.50	54.49 ~ 54.50 (2.1453 ~ 2.1457)	—
	U/S 0.75	54.24 ~ 54.25 (2.1354 ~ 2.1358)	—
	U/S 1.00	53.99 ~ 54.00 (2.1256 ~ 2.1260)	—
Crankpin oil clearance	mm (in.)	0.03 ~ 0.07 (0.0012 ~ 0.0028)	0.1 (0.004)

FUEL SYSTEM

NOZZLE AND NOZZLE HOLDER

Nozzle opening pressure kPa (kg/cm ²) [psi]	First valve opening pressure	17700 ± 500 (180 ± 5) [2600 ± 70]	—
	Second valve opening pressure	Old: 9410±2.9(96.0±3.0)[1365±43] New (7FD20~J35:2002.11~, 7FDF20~JF35: 2004.1~, 4SDK10, 42-2TD20-25: 2003.9~): 26500±0.5(270±5)[3840±70]	—

INJECTION PUMP

Roller ring ASSY	Roller ring height variation mm (in.)	—	0.02 (0.0008)
Drive shaft	Wear depth limit of oil seal contact surface mm (in.)	—	0.08 (0.0031)
Cam plate	Weal limit of plunger contact surface mm (in.)	—	4.2 (0.165)
Flyweight	Stepped wear limit of washer contact surface mm (in.)	—	0.2 (0.0008)

Check Item	Standard	Limit
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INJECTION PUMP

Plunger spring	Squareness (dimension A) mm (in.)	–	2.0 (0.0008)
Pump housing	Bushing wear mm (in.)	–	0.15 (0.0059)
Cam lift during injection timing check	mm (in.)	See page 1-6.	–

INJECTION PUMP ADJUSTMENT

1. Adjustment conditions

Nozzle	Nippondenso Part No. 093400-0540
Nozzle valve opening pressure	14220 ~ 15200 kPa (145 ~ 155 kg/cm ²) [2060 ~ 2200 psi]
Test oil	JIS No. 2 light oil
Feed pressure	20 kPa (0.2 kg/cm ²) [2.8 psi]
High pressure pipe (Inside diameter x Outside diameter x length)	2.0 x 6.0 x 840 mm (0.08 x 0.24 x 33.07 in.)
Test oil temperature	40 ~ 45°C (104 ~ 113°F)
Solenoid voltage for adjustment	6V

2. Temporary adjustment (lever in FULL position) ~1998. 7

	Pump speed rpm	Injection rate cm ³ (in ³)/ 200st	Note
Full-load reference point	800	10.3 ~ 11.3 (0.628 ~ 0.689)	Adjusted at full-load set screw
High speed lever setting point	1200	3.0 ~ 5.0 (0.183 ~ 0.305)	Adjusted at maximum speed adjusting screw

7FD20~J35: 1998. 8~ 2002.10, 7FDF20~J35: 1998. 8~

Spec.	Standard point	Pump speed rpm	Injection rate cm ³ (in ³)/ 200st. 1cyl	Note
Except DPF	Full-load reference point	800	10.5 ~ 10.9 (0.641 ~ 0.665)	Adjust with the full load set screw
	High speed lever set point	1200	1.3 ~ 2.7 (0.079 ~ 0.165)	Adjust with the maximum speed adjusting screw
DPF	Full-load reference point	800	9.9 ~ 10.3 (0.604 ~ 0.629)	Adjust with the full load set screw
	High speed lever set point	1200	1.3 ~ 2.7 (0.079 ~ 0.165)	Adjust with the maximum speed adjusting screw

7FD20~J35, Others: 2002.11~

Spec.	Standard point	Pump speed rpm	Injection rate cm ³ (in ³)/ 200st. 1cyl	Note
Except DPF	Full-load reference point	800	13.1 ~ 13.5 (0.799 ~ 0.824)	Adjust with the full load set screw
	High speed lever set point	1200	2.7 ~ 4.1 (0.165 ~ 0.250)	Adjust with the maximum speed adjusting screw
DPF	Full-load reference point	800	12.2 ~ 12.6 (0.744 ~ 0.769)	Adjust with the full load set screw
	High speed lever set point	1200	2.7 ~ 4.1 (0.165 ~ 0.250)	Adjust with the maximum speed adjusting screw

3. Pump internal pressure adjustment (lever in FULL position)

Pump speed	Pump internal pressure kPa (kg/cm ²) [psi]	Note
400	284 ~ 343 (2.9 ~ 3.5) [41 ~ 50]	Adjusted at regulating valve
1100	500 ~ 559 (5.1 ~ 5.7) [73 ~ 81]	

4. Overflow rate inspection (lever in FULL position)

Pump speed	Overflow rate cm ³ (in ³)/ 1000st	Note
400	133 ~ 242 (8.11 ~ 14.76)	Measured with overflow screw fitted to the pump

5. Timer adjustment (lever in FULL position)
~1998. 7

Pump speed rpm	700	900	1100
Piston stroke mm (in.)	0.7 ~ 1.5 (0.028 ~ 0.059)	1.6 ~ 2.4 (0.063 ~ 0.094)	2.5 ~ 3.3 (0.098 ~ 0.130)

Model	Pump speed rpm	Piston stroke mm(in)
7FDF20~J35 (2001.12~)	900	0.15 ~ 0.95 (0.0059 ~ 0.037)
	1100	1.3 ~ 2.1 (0.051 ~ 0.083)
	1200	2.1 ~ 2.9 (0.083 ~ 0.114)
7FD20~J35, Others (2002.11~)	1000	0.15 ~ 0.95 (0.0059 ~ 0.0374)
	1100	0.65 ~ 1.45 (0.0256 ~ 0.0571)
	1200	1.49 ~ 2.29 (0.0587 ~ 0.0902)

<Note> Hysteresis to be 0.3 mm (0.012) or less at each speed

6. Injection rate adjustment
~1998. 7

Lever angle	Pump speed (rpm)	Injection rate cm ³ (in ³)/ 200st	Variation cm ³ (in ³)	Note
+ 12° ± 5° FULL position	800	10.3 ~ 10.7 (0.628 ~ 0.653)	0.6 (0.037)	Full-load reference injection rate setting
	1200	3.2 ~ 4.8 (0.195 ~ 0.293)	—	High speed lever setting
	1150	6.2 ~ 8.8 (0.378 ~ 0.537)	—	Confirmation
	1300	0.6 (0.037) or less	—	Confirmation
+ 12° ± 5° FULL position	100	14.2 ~ 18.6 (0.866 ~ 11.35)	1.6 (0.98)	Increase for starting
	400	9.4 ~ 11.2 (0.573 ~ 0.683)	0.76 (0.0464) or less	End of increase
	500	9.3 ~ 10.3 (0.568 ~ 0.628)		Confirmation
	600	9.5 ~ 10.7 (0.580 ~ 0.653)		Confirmation
	1000	9.8 ~ 10.6 (0.600 ~ 0.647)		Confirmation
	1100	8.2 ~ 9.6 (0.500 ~ 0.589)		Confirmation

7FD20~J35 (except DPF model): 1998.8~2002.10, 7FDF20~J35 (except DPF model): 1998.8~

Lever angle	Pump speed (rpm)	Injection rate $\text{cm}^3(\text{in}^3)/200\text{st}$	Variation $\text{cm}^3(\text{in}^3)$	Note
+ $12^\circ \pm 5^\circ$ FULL position	800	10.5 ~ 10.9 (0.641 ~ 0.665)	0.6 (0.037)	Full-load reference injection rate setting
	1200	1.3 ~ 2.7 (0.079 ~ 0.165)	—	High speed lever setting
	1150	6.5 ~ 8.7 (0.397 ~ 0.531)	—	Confirmation
	1300	0.6(0.037) or less	—	Confirmation
+ $12^\circ \pm 5^\circ$ FULL position	100	11.0 ~ 14.6 (0.671 ~ 0.891)	1.6 (0.98)	Increase for starting
	400	9.8 ~ 11.6 (0.590 ~ 0.708)	—	End of increase
	500	9.1 ~ 10.1 (0.555 ~ 0.616)	0.76 (0.0464) or less	Confirmation
	1100	9.4 ~ 10.6 (0.573 ~ 0.647)	—	Confirmation

7FD20~J35 for DPF: 1998.8~2002.10, 7FDF20~J35 for DPF: 1998.8~

Lever angle	Pump speed (rpm)	Injection rate $\text{cm}^3(\text{in}^3)/200\text{st}$	Variation $\text{cm}^3(\text{in}^3)$	Note
+ $12^\circ \pm 5^\circ$ FULL position	800	9.9 ~ 10.3 (0.604 ~ 0.629)	0.6 (0.037) or less	Full-load reference injection rate setting
	1200	1.3 ~ 2.7 (0.079 ~ 0.165)	—	High speed lever setting
	1150	6.5 ~ 8.7 (0.397 ~ 0.531)	—	Confirmation
	1300	0.6(0.037) or less	—	Confirmation
+ $12^\circ \pm 5^\circ$ FULL position	100	11.0 ~ 14.6 (0.671 ~ 0.891)	1.6 (0.98) or less	Increase for starting
	400	9.8 ~ 11.6 (0.590 ~ 0.708)	—	End of increase
	500	8.5 ~ 9.5 (0.519 ~ 0.580)	0.76 (0.0464) or less	Confirmation
	1100	8.8 ~ 10.0 (0.537 ~ 0.610)	—	Confirmation

7FD20~J35 (except DPF model), Others:2002.11~

Lever angle	Pump speed (rpm)	Injection rate cm ³ (in ³)/ 200st	Variation cm ³ (in ³)	Note
+ 12° ± 5° FULL position	800	13.1 ~ 13.5 (0.799 ~ 0.824)	0.6 (0.037) or less	Full-load reference injection rate setting
	1200	2.7 ~ 4.1 (0.165 ~ 0.250)	—	High speed lever setting
	1150	11.7 ~ 13.9 (0.714 ~ 0.848)	—	Confirmation
	1300	0.6(0.037) or less	—	Confirmation
+ 12° ± 5° FULL position	100	8.4 ~ 12.0 (0.513 ~ 0.732)	1.6 (0.98) or less	Increase for starting
	400	7.9 ~ 9.7 (0.482 ~ 0.592)	—	End of increase
	500	8.4 ~ 9.4 (0.513 ~ 0.574)	0.76 (0.0464) or less	Confirmation
	1100	12.7 ~ 13.9 (0.775 ~ 0.848)	—	Confirmation

7FD20~J35 for DPF:2002.11~

Lever angle	Pump speed (rpm)	Injection rate cm ³ (in ³)/ 200st	Variation cm ³ (in ³)	Note
+ 12° ± 5° FULL position	800	12.2 ~ 12.6 (0.744 ~ 0.769)	0.6 (0.037) or less	Full-load reference injection rate setting
	1200	2.7 ~ 4.1 (0.165 ~ 0.250)	—	High speed lever setting
	1150	11.7 ~ 13.9 (0.714 ~ 0.848)	—	Confirmation
	1300	0.6(0.037) or less	—	Confirmation
+ 12° ± 5° FULL position	100	8.4 ~ 12.0 (0.513 ~ 0.732)	1.6 (0.98) or less	Increase for starting
	400	7.9 ~ 9.7 (0.482 ~ 0.592)	—	End of increase
	500	7.7 ~ 8.7 (0.470 ~ 0.531)	0.76 (0.0464) or less	Confirmation
	1100	12.5 ~ 13.7 (0.763 ~ 0.836)	—	Confirmation

7. Load sensing timer adjustment (~1998.7)

Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/ 200st	Variation cm ³ (in ³)	Note
Start of effect	1100	(q FULL-0.8)±0.4 ((q FULL-0.049)±0.024)	-	At governor shaft
End of effect	1100	(q FULL-2.4)±0.4 ((q FULL-0.146)±0.024)	-	Confirmation

8. Low speed lever setting
~1998.7

Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/ 500st	Variation cm ³ (in ³)	Note
⊖ 18° ± 5°	380	3.00 ~ 6.00 (0.1831 ~ 0.3661)	1.5 (0.092)	Low speed lever setting
	500	2.0(0.122) or less	-	Confirmation

1998.8~2001.11

Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/ 500st	Variation cm ³ (in ³)	Note
⊖ 18° ± 5°	430	2.25 ~ 4.25 (0.1373 ~ 0.2549)	1.5 (0.092)	Low speed lever setting
	500	2.0(0.122) or less	-	Confirmation

7FD20~J35:2001.12~2002.10, 7FDF20~J35:2001.12~

Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/ 500st. 1cyl	Deviation cm ³ (in ³)	Note
- 17° ± 5°	425	4.3 ~ 6.3 (0.262 ~ 0.384)	1.5 (0.092) or less	Low speed lever setting
	545	2.0 (0.122) or less	-	Confirmation

7FD20~J35, Others:2002.11~

Lever angle	Pump speed rpm	Injection rate cm ³ (in ³)/ 500st. 1cyl	Deviation cm ³ (in ³)	Note
- 17° ± 5°	425	1.3 ~ 3.3 (0.079 ~ 0.201)	1.5 (0.092) or less	Low speed lever setting
	545	2.0 (0.122) or less	-	Confirmation

INJECTION PUMP ADJUSTMENT**7FD20~J35 (2002.11~)****INJECTION PUMP TEST SPECIFICATIONS**

196000-4650

MANUFACTURER	TOYOTA	INJECTION PUMP		196000-465#			
ENGINE TYPE	2Z			VE4/12F1100RND465			
VEHICLE MODEL	FORK LIFT	ROTATION	Clockwise viewed from drive side	GOVERNOR TYPE	All speed		
RATED VOLTAGE	12V	INJECTION ORDER	A - B - C - D	INJECTION INTERVAL	90° ± 30'		
Dimension KF (mm)		5.30 ± 0.10		Dimension MS (mm)		0.33 ± 0.05	
Dimension K (mm)		3.30 ± 0.15		Dimension PS (mm)		0.13 ± 0.02	
1. TEST CONDITIONS							
Nozzle	093400-0540 (DN12SD12A)		Feed Pressure	19.6 kPa (0.2 kgf/cm ²)			
Nozzle Opening Pressure	14.7 ± 0.5 MPa (150 ± 5 kgf/cm ²)		High Pressure Pipe	Ø2 × Ø6 × 840 mm			
Test Oil	SAE J967 (ISO4113)		Fuel Temperature	40 - 45 °C (104 - 113°F)			
NOTE : Apply 6 volts DC across the fuel cut solenoid during adjustment.							
2. PRE-ADJUSTMENT							
	Lever Position (deg)	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Max. Spread in Delivery
			(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	(mm ³) (cc)
Full Load	12 ± 5°	800	—	—	66.5 ± 0.5	13.3 ± 0.1	3.0 0.6
High Speed	(Full position)	1200	—	—	16.8 ± 2.5	3.4 ± 0.5	— —
3. ADJUSTMENT OF INTERNAL PRESSURE							
Lever Position	Pump Speed (rpm)	Boost Pressure		Internal Pressure		Remarks	
		(kPa)	(mmHg)	(kPa)	(kgf/cm ²)		
Full	400	—	—	296.0 ± 29.0	3.0 ± 0.3	By the regulating valve	
	1100	—	—	552.0 ± 29.0	5.6 ± 0.3		
4. OVERFLOW QUANTITY CHECK							
Lever Position	Pump Speed (rpm)	Boost Pressure		Overflow Quantity		Remarks	
		(kPa)	(mmHg)	(L/h)	(cc/1000st)		
Full	400	—	—	32 - 58	1330 - 2420		
NOTE : The overflow valve belonging to the pump should be used checking.							
5. ADJUSTMENT OF TIMER							
Lever Position	Pump Speed (rpm)	Boost Pressure		Piston Travel (mm)	Remarks		
		(kPa)	(mmHg)				
Full	1000	—	—	0.55 ± 0.40			
	1100	—	—	1.05 ± 0.40			
	1200	—	—	1.89 ± 0.40			
NOTE : Hysteresis at each pump speed is less than 0.3 mm.							

196000-4650

6. ADJUSTMENT OF BOOST COMPENSATOR

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Max. Spread in Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	(mm ³)	(cc)	
—	—	—	—	—	—	—	—	—

7. ADJUSTMENT OF FUEL DELIVERY

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Max. Spread in Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	(mm ³)	(cc)	
Full	800	—	—	66.5 ± 0.5	13.3 ± 0.1	3.0	0.6	By full load setting screw
	1200	—	—	16.8 ± 2.5	3.4 ± 0.5	—	—	By max. speed setting screw
	1300	—	—	Less than 1.5	Less than 0.3	—	—	
	1150	—	—	63.9 ± 4.0	12.8 ± 0.8	—	—	
	100	—	—	51.0 ± 8.0	10.2 ± 1.6	—	—	By governor sleeve plug
	400	—	—	44.0 ± 4.5	8.8 ± 0.9	—	—	End of fuel quantity increase
	500	—	—	44.5 ± 2.0	8.9 ± 0.4	3.5	0.7	
	1100	—	—	66.4 ± 2.0	13.3 ± 0.4	—	—	

8. SETTING OF LOAD SENSING TIMER

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	
Start of Load Sensing	—	—	—	—	—	—
End of Pressure Drop	—	—	—	—	—	—
Repeat Advance Angle	—	—	—	—	—	—
Check Points	1.	—	—	—	—	mm
	2.	—	—	—	—	mm
	3. Dimension of Governor Shaft : L = 1.15 ± 0.85 mm					

9. SETTING OF ADJUSTING LEVER AT LOW SPEED

Lever Position (deg)	Pump Speed (rpm)	Boost Pressure (kPa)	Fuel Delivery		Max. Spread in Delivery		Remarks
			(mm ³ /st)	(cc/500st)	(mm ³)	(cc)	
- 17 ± 5° (Idle position)	425	—	4.5 ± 1.5 = A	2.3 ± 0.8 = A	3.0	1.5	Lever setting
	525	—	Less than 3.0	Less than 1.5	—	—	
	300	—	(A + 46.1) ± 6.0	(A + 23.1) ± 3.0	—	—	

10. SETTING OF ADJUSTING LEVER AT PARTIAL RANGE

— : Not Applicable

Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Remarks
	(kPa)	(mmHg)	(mm ³ /st)	(cc/500st)	
—	—	—	—	—	—

11. CHARACTERISTIC OF A.C.S.D.

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Measuring Value	Remarks
		(kPa)	(mmHg)		
—	—	—	—	—	—

Fuel temperature : 39 - 41°C

12. ADJUSTMENT OF T.C.V.

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Piston Travel (mm)	Remarks
		(kPa)	(mmHg)		
—	—	—	—	—	—

13. SETTING OF DIAPHRAGM FOR HEATER & POWER STEERING

— : Not Applicable

Pump Speed (rpm)	Vacuum Pressure		Fuel Delivery		Remarks
	(kPa)	(mmHg)	(mm ³ /st)	(cc/500st)	
—	—	—	—	—	—

14. ADJUSTMENT OF POWER CONTROL

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	
—	—	—	—	—	—	—

196000-4650

15. ADJUSTMENT OF THROTTLE POSITION SENSOR							— : Not Applicable
Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Sensor Output Voltage (V)	Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/500st)		
—	—	—	—	—	—	—	—

16. FINAL CHECK AFTER ADJUSTMENT

- Lever position at idle is $-17 \pm 5^\circ$ and $12 \pm 5^\circ$ at full.
- After adjustment has been completed, delivery quantity must be 4.5 mm³/st (0.9 cc/200st) when voltage at fuel cut solenoid is reduced to zero. (Pump Speed Np = 200 rpm)

7FD20~J35 DPF spec. (2002.11~)

INJECTION PUMP TEST SPECIFICATIONS

196000-4730

MANUFACTURER	TOYOTA	INJECTION PUMP		196000-473#	
ENGINE TYPE	2Z			VE4/12F1100RND473	
VEHICLE MODEL	FORK LIFT	ROTATION	Clockwise viewed from drive side	GOVERNOR TYPE	All speed
RATED VOLTAGE	12V	INJECTION ORDER	A - B - C - D	INJECTION INTERVAL	90° ± 30'
Dimension KF (mm)	5.30 ± 0.10		Dimension MS (mm)	0.33 ± 0.05	
Dimension K (mm)	3.30 ± 0.15		Dimension PS (mm)	0.10 ± 0.02	

1. TEST CONDITIONS

Nozzle	093400-0540 (DN12SD12A)	Feed Pressure	19.6 kPa (0.2 kgf/cm ²)
Nozzle Opening Pressure	14.7 ± 0.5 MPa (150 ± 5 kgf/cm ²)	High Pressure Pipe	Ø2 × Ø6 × 840 mm
Test Oil	SAE J967 (ISO4113)	Fuel Temperature	40 - 45 °C (104 - 113°F)

NOTE : Apply 6 volts DC across the fuel cut solenoid during adjustment.

2. PRE-ADJUSTMENT

	Lever Position (deg)	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Max. Spread in Delivery	
			(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	(mm ³)	(cc)
Full Load	12 ± 5°	800	—	—	61.8 ± 0.5	12.4 ± 0.1	3.0	0.6
High Speed	(Full position)	1200	—	—	16.8 ± 2.5	3.4 ± 0.5	—	—

3. ADJUSTMENT OF INTERNAL PRESSURE

Lever Position	Pump Speed (rpm)	Boost Pressure		Internal Pressure		Remarks
		(kPa)	(mmHg)	(kPa)	(kgf/cm ²)	
Full	400	—	—	296.0 ± 29.0	3.0 ± 0.3	By the regulating valve
	1100	—	—	552.0 ± 29.0	5.6 ± 0.3	

4. OVERFLOW QUANTITY CHECK

Lever Position	Pump Speed (rpm)	Boost Pressure		Overflow Quantity		Remarks
		(kPa)	(mmHg)	(L/h)	(cc/1000st)	
Full	400	—	—	32 - 58	1330 - 2420	

NOTE : The overflow valve belonging to the pump should be used checking.

5. ADJUSTMENT OF TIMER

Lever Position	Pump Speed (rpm)	Boost Pressure		Piston Travel (mm)	Remarks
		(kPa)	(mmHg)		
Full	1000	—	—	0.55 ± 0.40	
	1100	—	—	1.05 ± 0.40	
	1200	—	—	1.89 ± 0.40	

NOTE : Hysteresis at each pump speed is less than 0.3 mm.

196000-4730

6. ADJUSTMENT OF BOOST COMPENSATOR

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Max. Spread in Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	(mm ³)	(cc)	
—	—	—	—	—	—	—	—	—

7. ADJUSTMENT OF FUEL DELIVERY

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Max. Spread in Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	(mm ³)	(cc)	
Full	800	—	—	61.8 ± 0.5	12.4 ± 0.1	3.0	0.6	By full load setting screw
	1200	—	—	16.8 ± 2.5	3.4 ± 0.5	—	—	By max. speed setting screw
	1300	—	—	Less than 1.5	Less than 0.3	—	—	
	1150	—	—	63.9 ± 4.0	12.8 ± 0.8	—	—	
	100	—	—	51.0 ± 8.0	10.2 ± 1.6	—	—	By governor sleeve plug
	400	—	—	44.0 ± 4.5	8.8 ± 0.9	—	—	End of fuel quantity increase
	500	—	—	41.1 ± 2.0	8.2 ± 0.4	3.5	0.7	
	1100	—	—	65.6 ± 2.0	13.1 ± 0.4	—	—	

8. SETTING OF LOAD SENSING TIMER

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	
Start of Load Sensing	—	—	—	—	—	—
End of Pressure Drop	—	—	—	—	—	—
Repeat Advance Angle	—	—	—	—	—	—
Check Points	1.	—	—	—	mm	
	2.	—	—	—	mm	
	3. Dimension of Governor Shaft	: L = 1.15 ± 0.85 mm				

9. SETTING OF ADJUSTING LEVER AT LOW SPEED

Lever Position (deg)	Pump Speed (rpm)	Boost Pressure (kPa)	Fuel Delivery		Max. Spread in Delivery		Remarks
			(mm ³ /st)	(cc/500st)	(mm ³)	(cc)	
- 17 ± 5° (Idle position)	425	—	4.5 ± 1.5 = A	2.3 ± 0.8 = A	3.0	1.5	Lever setting
	545	—	Less than 3.0	Less than 1.5	—	—	
	300	—	(A + 46.1) ± 6.0	(A + 23.1) ± 3.0	—	—	

10. SETTING OF ADJUSTING LEVER AT PARTIAL RANGE

— : Not Applicable

Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Remarks
	(kPa)	(mmHg)	(mm ³ /st)	(cc/500st)	
—	—	—	—	—	—

11. CHARACTERISTIC OF A.C.S.D.

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Measuring Value	Remarks
		(kPa)	(mmHg)		
—	—	—	—	—	—

Fuel temperature : 39 - 41°C

12. ADJUSTMENT OF T.C.V.

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Piston Travel (mm)	Remarks
		(kPa)	(mmHg)		
—	—	—	—	—	—

13. SETTING OF DIAPHRAGM FOR HEATER & POWER STEERING

— : Not Applicable

Pump Speed (rpm)	Vacuum Pressure		Fuel Delivery		Remarks
	(kPa)	(mmHg)	(mm ³ /st)	(cc/500st)	
—	—	—	—	—	—

14. ADJUSTMENT OF POWER CONTROL

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	
—	—	—	—	—	—	—

196000-4730

15. ADJUSTMENT OF THROTTLE POSITION SENSOR

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Sensor Output Voltage (V)	Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/500st)		
—	—	—	—	—	—	—	—

16. FINAL CHECK AFTER ADJUSTMENT

1. Lever position at idle is $-17 \pm 5^\circ$ and $12 \pm 5^\circ$ at full.
2. After adjustment has been completed, delivery quantity must be 4.5 mm³/st (0.9 cc/200st) when voltage at fuel cut solenoid is reduced to zero. (Pump Speed Np = 200 rpm)

7FDF20~JF35 (2004.1~)

INJECTION PUMP TEST SPECIFICATIONS

196000-4890

MANUFACTURER	TOYOTA	INJECTION PUMP		196000-489#	
ENGINE TYPE	2Z			VE4/12F1100RND489	
VEHICLE MODEL	FORK LIFT	ROTATION	Clockwise viewed from drive side	GOVERNOR TYPE	All speed
RATED VOLTAGE	12V	INJECTION ORDER	A - B - C - D	INJECTION INTERVAL	90° ± 30'
Dimension KF (mm)	5.30 ± 0.10		Dimension MS (mm)	0.37 ± 0.05	
Dimension K (mm)	3.00 ± 0.15		Dimension PS (mm)	0.13 ± 0.05	

1. TEST CONDITIONS

Nozzle	093400-0540 (DN12SD12)	Feed Pressure	19.6 kPa (0.2 kgf/cm ²)
Nozzle Opening Pressure	14.7 ± 0.5 MPa (150 ± 5 kgf/cm ²)	High Pressure Pipe	Ø2 × Ø6 × 840 mm
Test Oil	SAE J967 (ISO4113)	Fuel Temperature	40 - 45 °C (104 - 113°F)

NOTE : Apply 6 volts DC across the fuel cut solenoid during adjustment.

2. PRE-ADJUSTMENT

Applying 6 V to T.C.V.

	Lever Position (deg)	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Max. Spread in Delivery	
			(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	(mm ³)	(cc)
Full Load	12 ± 5°	800	—	—	70.7 ± 0.5	14.1 ± 0.1	3.0	0.6
High Speed	(Full position)	1190	—	—	22.0 ± 3.0	4.4 ± 0.6	—	—

3. ADJUSTMENT OF INTERNAL PRESSURE

Applying 0 V to T.C.V.

Lever Position	Pump Speed (rpm)	Boost Pressure		Internal Pressure		Remarks
		(kPa)	(mmHg)	(kPa)	(kgf/cm ²)	
Full	500	—	—	196.0 ± 29.0	2.0 ± 0.3	
	1100	—	—	461.0 ± 49.0	4.7 ± 0.5	

4. OVERFLOW QUANTITY CHECK

Applying 6 V to T.C.V.

Lever Position	Pump Speed (rpm)	Boost Pressure		Overflow Quantity		Remarks
		(kPa)	(mmHg)	(L/h)	(cc/1000st)	
Full	400	—	—	32 - 58	1330 - 2420	

NOTE : The overflow valve belonging to the pump should be used checking.

5. ADJUSTMENT OF TIMER

Applying 0 V to T.C.V.

Lever Position	Pump Speed (rpm)	Boost Pressure		Piston Travel (mm)	Remarks
		(kPa)	(mmHg)		
Full	1000	—	—	0.59 ± 0.40	
	1100	—	—	0.97 ± 0.40	
	1200	—	—	1.74 ± 0.40	

NOTE : Hysteresis at each pump speed is less than 0.3 mm.

196000-4890

6. ADJUSTMENT OF BOOST COMPENSATOR

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Max. Spread in Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	(mm ³)	(cc)	
—	—	—	—	—	—	—	—	—

7. ADJUSTMENT OF FUEL DELIVERY

Applying 6 V to T.C.V.

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Max. Spread in Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	(mm ³)	(cc)	
Full	800	—	—	70.7 ± 0.5	14.1 ± 0.1	3.0	0.6	By full load setting screw
	1190	—	—	22.0 ± 3.0	4.4 ± 0.6	—	—	By max. speed setting screw
	1150	—	—	64.8 ± 5.0	13.0 ± 1.0	—	—	
	1300	—	—	Less than 1.5	Less than 0.3	—	—	
	100	—	—	51.0 ± 8.5	10.2 ± 1.7	—	—	By governor sleeve plug
	400	—	—	51.5 ± 4.0	10.3 ± 0.8	—	—	End of fuel quantity increase
	500	—	—	47.8 ± 2.0	9.6 ± 0.4	3.5	0.7	
	1100	—	—	71.6 ± 2.5	14.3 ± 0.5	6.5	1.3	

8. SETTING OF LOAD SENSING TIMER

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	
Start of Load Sensing	—	—	—	—	—	—
End of Pressure Drop	—	—	—	—	—	—
Repeat Advance Angle	—	—	—	—	—	—
Check Points	1.	—	—	—	—	mm
	2.	—	—	—	—	mm
	3. Dimension of Governor Shaft	: L = 1.15 ± 0.85 mm				

9. SETTING OF ADJUSTING LEVER AT LOW SPEED							Applying 6 V to T.C.V.
Lever Position (deg)	Pump Speed (rpm)	Boost Pressure (kPa)	Fuel Delivery		Max. Spread in Delivery		Remarks
			(mm ³ /st)	(cc/500st)	(mm ³)	(cc)	
- 17 ± 5° (Idle position)	450	—	5.1 ± 1.5 = A	2.6 ± 0.8 = A	3.0	1.5	Lever setting
	545	—	Less than 3.0	Less than 1.5	—	—	
	300	—	(A + 40.6) ± 6.0	(A + 20.3) ± 3.0	—	—	

10. SETTING OF ADJUSTING LEVER AT PARTIAL RANGE					— : Not Applicable
Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Remarks
	(kPa)	(mmHg)	(mm ³ /st)	(cc/500st)	
—	—	—	—	—	—

11. CHARACTERISTIC OF A.C.S.D.					— : Not Applicable
Lever Position	Pump Speed (rpm)	Boost Pressure		Measuring Value	Remarks
		(kPa)	(mmHg)		
—	—	—	—	—	—

Fuel temperature : 39 - 41°C

12. ADJUSTMENT OF T.C.V.					
Lever Position	Pump Speed (rpm)	Boost Pressure		Piston Travel (mm)	Remarks
		(kPa)	(mmHg)		
Full	1200	—	—	3.57 ± 0.60	With applying 6 (V)

13. SETTING OF DIAPHRAGM FOR HEATER & POWER STEERING					— : Not Applicable
Pump Speed (rpm)	Vacuum Pressure		Fuel Delivery		Remarks
	(kPa)	(mmHg)	(mm ³ /st)	(cc/500st)	
—	—	—	—	—	—

14. ADJUSTMENT OF POWER CONTROL						— : Not Applicable
Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	
—	—	—	—	—	—	—

196000-4890

15. ADJUSTMENT OF THROTTLE POSITION SENSOR

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Sensor Output Voltage (V)	Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/500st)		
—	—	—	—	—	—	—	—

16. FINAL CHECK AFTER ADJUSTMENT

1. Lever position at idle is $-17 \pm 5^\circ$ and $12 \pm 5^\circ$ at full.
2. After adjustment has been completed, delivery quantity must be 4.5 mm³/st (0.9 cc/200st) when voltage at fuel cut solenoid is reduced to zero. (Pump Speed Np = 200 rpm)

7FDF20~JF35 DPF spec. (2004.1~)

INJECTION PUMP TEST SPECIFICATIONS

196000-4900

MANUFACTURER	TOYOTA	INJECTION PUMP		196000-490# VE4/12F1100RND490	
ENGINE TYPE	2Z				
VEHICLE MODEL	FORK LIFT	ROTATION	Clockwise viewed from drive side	GOVERNOR TYPE	All speed
RATED VOLTAGE	12V	INJECTION ORDER	A - B - C - D	INJECTION INTERVAL	90° ± 30'
Dimension KF (mm)	5.30 ± 0.10		Dimension MS (mm)	0.37 ± 0.05	
Dimension K (mm)	3.00 ± 0.15		Dimension PS (mm)	0.13 ± 0.05	

1. TEST CONDITIONS

Nozzle	093400-0540 (DN12SD12)	Feed Pressure	19.6 kPa (0.2 kgf/cm ²)
Nozzle Opening Pressure	14.7 ± 0.5 MPa (150 ± 5 kgf/cm ²)	High Pressure Pipe	Ø2 × Ø6 × 840 mm
Test Oil	SAE J967 (ISO4113)	Fuel Temperature	40 - 45 °C (104 - 113°F)

NOTE : Apply 6 volts DC across the fuel cut solenoid during adjustment.

2. PRE-ADJUSTMENT

Applying 6 V to T.C.V.

	Lever Position (deg)	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Max. Spread in Delivery	
			(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	(mm ³)	(cc)
Full Load	12 ± 5°	800	—	—	67.7 ± 0.5	13.5 ± 0.1	3.0	0.6
High Speed	(Full position)	1190	—	—	22.0 ± 3.0	4.4 ± 0.6	—	—

3. ADJUSTMENT OF INTERNAL PRESSURE

Applying 0 V to T.C.V.

Lever Position	Pump Speed (rpm)	Boost Pressure		Internal Pressure		Remarks
		(kPa)	(mmHg)	(kPa)	(kgf/cm ²)	
Full	500	—	—	196.0 ± 29.0	2.0 ± 0.3	By the regulating valve
	1100	—	—	461.0 ± 49.0	4.7 ± 0.5	

4. OVERFLOW QUANTITY CHECK

Applying 6 V to T.C.V.

Lever Position	Pump Speed (rpm)	Boost Pressure		Overflow Quantity		Remarks
		(kPa)	(mmHg)	(L/h)	(cc/1000st)	
Full	400	—	—	32 - 58	1330 - 2420	

NOTE : The overflow valve belonging to the pump should be used checking.

5. ADJUSTMENT OF TIMER

Applying 0 V to T.C.V.

Lever Position	Pump Speed (rpm)	Boost Pressure		Piston Travel (mm)	Remarks
		(kPa)	(mmHg)		
Full	1000	—	—	0.59 ± 0.40	
	1100	—	—	0.97 ± 0.40	
	1200	—	—	1.74 ± 0.40	

NOTE : Hysteresis at each pump speed is less than 0.3 mm.

196000-4900

6. ADJUSTMENT OF BOOST COMPENSATOR								— : Not Applicable
Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Max. Spread in Delivery		Remarks
		(kPa)	(mmHg)	(mm³/st)	(cc/200st)	(mm³)	(cc)	
—	—	—	—	—	—	—	—	—

7. ADJUSTMENT OF FUEL DELIVERY								Applying 6 V to T.C.V.
Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Max. Spread in Delivery		Remarks
		(kPa)	(mmHg)	(mm³/st)	(cc/200st)	(mm³)	(cc)	
Full	800	—	—	67.7 ± 0.5	13.5 ± 0.1	3.0	0.6	By full load setting screw
	1190	—	—	22.0 ± 3.0	4.4 ± 0.6	—	—	By max. speed setting screw
	1150	—	—	60.6 ± 5.0	12.1 ± 1.0	—	—	
	1300	—	—	Less than 1.5	Less than 0.3	—	—	
	100	—	—	51.0 ± 8.5	10.2 ± 1.7	—	—	By governor sleeve plug
	400	—	—	47.3 ± 4.0	9.5 ± 0.8	—	—	End of fuel quantity increase
	500	—	—	45.1 ± 2.0	9.0 ± 0.4	3.5	0.7	
	1100	—	—	68.6 ± 2.5	13.7 ± 0.5	6.5	1.3	

8. SETTING OF LOAD SENSING TIMER								— : Not Applicable
Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Remarks		
		(kPa)	(mmHg)	(mm³/st)	(cc/200st)			
Start of Load Sensing	—	—	—	—	—	—		
End of Pressure Drop	—	—	—	—	—	—		
Repeat Advance Angle	—	—	—	—	—	—		
Check Points	1. — : — mm							
	2. — : — mm							
	3. Dimension of Governor Shaft : L = 1.15 ± 0.85 mm							

9. SETTING OF ADJUSTING LEVER AT LOW SPEED							Applying 6 V to T.C.V.
Lever Position (deg)	Pump Speed (rpm)	Boost Pressure (kPa)	Fuel Delivery		Max. Spread in Delivery		Remarks
			(mm ³ /st)	(cc/500st)	(mm ³)	(cc)	
- 17 ± 5° (Idle position)	450	—	5.1 ± 1.5 = A	2.6 ± 0.8 = A	3.0	1.5	Lever setting
	545	—	Less than 3.0	Less than 1.5	—	—	
	300	—	(A + 40.6) ± 6.0	(A + 20.3) ± 3.0	—	—	

10. SETTING OF ADJUSTING LEVER AT PARTIAL RANGE					— : Not Applicable
Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Remarks
	(kPa)	(mmHg)	(mm ³ /st)	(cc/500st)	
—	—	—	—	—	—

11. CHARACTERISTIC OF A.C.S.D.					— : Not Applicable
Lever Position	Pump Speed (rpm)	Boost Pressure		Measuring Value	Remarks
		(kPa)	(mmHg)		
—	—	—	—	—	—

Fuel temperature : 39 - 41°C

12. ADJUSTMENT OF T.C.V.					
Lever Position	Pump Speed (rpm)	Boost Pressure		Piston Travel (mm)	Remarks
		(kPa)	(mmHg)		
Full	1200	—	—	3.57 ± 0.60	With applying 6 (V)

13. SETTING OF DIAPHRAGM FOR HEATER & POWER STEERING					— : Not Applicable
Pump Speed (rpm)	Vacuum Pressure		Fuel Delivery		Remarks
	(kPa)	(mmHg)	(mm ³ /st)	(cc/500st)	
—	—	—	—	—	—

14. ADJUSTMENT OF POWER CONTROL						— : Not Applicable
Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	
—	—	—	—	—	—	—

196000-4900

15. ADJUSTMENT OF THROTTLE POSITION SENSOR

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Sensor Output Voltage (V)	Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/500st)		
—	—	—	—	—	—	—	—

16. FINAL CHECK AFTER ADJUSTMENT

- Lever position at idle is $-17 \pm 5^\circ$ and $12 \pm 5^\circ$ at full.
- After adjustment has been completed, delivery quantity must be 4.5 mm³/st (0.9 cc/200st) when voltage at fuel cut solenoid is reduced to zero. (Pump Speed Np = 200 rpm)

4SDK10, 42-2TD20-25 (2003.9 ~)**INJECTION PUMP TEST SPECIFICATIONS**

196000-4910

MANUFACTURER	TOYOTA	INJECTION PUMP		196000-491#	
ENGINE TYPE	2Z			VE4/12F1150RND491	
VEHICLE MODEL	FORK LIFT	ROTATION	Clockwise viewed from drive side	GOVERNOR TYPE	All speed
RATED VOLTAGE	12V	INJECTION ORDER	A - B - C - D	INJECTION INTERVAL	90° ± 30'
Dimension KF (mm)	5.30 ± 0.10		Dimension MS (mm)	0.37 ± 0.05	
Dimension K (mm)	3.00 ± 0.15		Dimension PS (mm)	0.13 ± 0.05	

1. TEST CONDITIONS

Nozzle	093400-0540 (DN12SD12)	Feed Pressure	19.6 kPa (0.2 kgf/cm ²)
Nozzle Opening Pressure	14.7 ± 0.5 MPa (150 ± 5 kgf/cm ²)	High Pressure Pipe	Ø2 × Ø6 × 840 mm
Test Oil	SAE J967 (ISO4113)	Fuel Temperature	40 - 45 °C (104 - 113°F)

NOTE : Apply 6 volts DC across the fuel cut solenoid during adjustment.

2. PRE-ADJUSTMENT

Applying 6 V to T.C.V.

	Lever Position (deg)	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Max. Spread in Delivery	
			(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	(mm ³)	(cc)
Full Load	16 ± 5°	800	—	—	69.0 ± 0.5	13.8 ± 0.1	3.0	0.6
High Speed	(Full position)	1290	—	—	15.7 ± 3.0	3.1 ± 0.6	—	—

3. ADJUSTMENT OF INTERNAL PRESSURE

Applying 0 V to T.C.V.

Lever Position	Pump Speed (rpm)	Boost Pressure		Internal Pressure		Remarks
		(kPa)	(mmHg)	(kPa)	(kgf/cm ²)	
Full	500	—	—	196.0 ± 29.0	2.0 ± 0.3	By the regulating valve
	1150	—	—	473.0 ± 49.0	4.8 ± 0.5	

4. OVERFLOW QUANTITY CHECK

Applying 6 V to T.C.V.

Lever Position	Pump Speed (rpm)	Boost Pressure		Overflow Quantity		Remarks
		(kPa)	(mmHg)	(L/h)	(cc/1000st)	
Full	400	—	—	32 - 58	1330 - 2420	

NOTE : The overflow valve belonging to the pump should be used checking.

5. ADJUSTMENT OF TIMER

Applying 0 V to T.C.V.

Lever Position	Pump Speed (rpm)	Boost Pressure		Piston Travel (mm)	Remarks
		(kPa)	(mmHg)		
Full	1000	—	—	0.49 ± 0.40	
	1150	—	—	1.23 ± 0.40	
	1300	—	—	2.41 ± 0.40	

NOTE : Hysteresis at each pump speed is less than 0.3 mm.

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6. ADJUSTMENT OF BOOST COMPENSATOR

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Max. Spread in Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	(mm ³)	(cc)	
—	—	—	—	—	—	—	—	—

7. ADJUSTMENT OF FUEL DELIVERY

Applying 6 V to T.C.V.

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Max. Spread in Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	(mm ³)	(cc)	
Full	800	—	—	69.0 ± 0.5	13.8 ± 0.1	3.0	0.6	By full load setting screw
	1290	—	—	15.7 ± 3.0	3.1 ± 0.6	—	—	By max. speed setting screw
	1275	—	—	26.6 ± 5.0	5.3 ± 1.0	—	—	
	1400	—	—	Less than 1.5	Less than 0.3	—	—	
	100	—	—	51.0 ± 8.5	10.2 ± 1.7	—	—	By governor sleeve plug
	400	—	—	44.0 ± 4.0	8.8 ± 0.8	—	—	End of fuel quantity increase
	500	—	—	45.5 ± 2.0	9.1 ± 0.4	3.5	0.7	
	1150	—	—	69.9 ± 2.5	14.0 ± 0.5	6.5	1.3	

8. SETTING OF LOAD SENSING TIMER

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	
Start of Load Sensing	—	—	—	—	—	—
End of Pressure Drop	—	—	—	—	—	—
Repeat Advance Angle	—	—	—	—	—	—
Check Points	1.	—	—	—	—	mm
	2.	—	—	—	—	mm
	3. Dimension of Governor Shaft	: L = 1.15 ± 0.85 mm				

9. SETTING OF ADJUSTING LEVER AT LOW SPEED

Applying 6 V to T.C.V.

Lever Position (deg)	Pump Speed (rpm)	Boost Pressure (kPa)	Fuel Delivery		Max. Spread in Delivery		Remarks
			(mm ³ /st)	(cc/500st)	(mm ³)	(cc)	
- 18 ± 5° (Idle position)	400	—	5.6 ± 1.5 = A	2.8 ± 0.8 = A	3.0	1.5	Lever setting
	545	—	Less than 3.0	Less than 1.5	—	—	
	300	—	(A + 32.7) ± 6.0	(A + 16.4) ± 3.0	—	—	

10. SETTING OF ADJUSTING LEVER AT PARTIAL RANGE

— : Not Applicable

Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Remarks
	(kPa)	(mmHg)	(mm ³ /st)	(cc/500st)	
—	—	—	—	—	—

11. CHARACTERISTIC OF A.C.S.D.

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Measuring Value	Remarks
		(kPa)	(mmHg)		
—	—	—	—	—	—

Fuel temperature : 39 - 41°C

12. ADJUSTMENT OF T.C.V.

Lever Position	Pump Speed (rpm)	Boost Pressure		Piston Travel (mm)	Remarks
		(kPa)	(mmHg)		
Full	1300	—	—	4.53 ± 0.60	With applying 6 (V)

13. SETTING OF DIAPHRAGM FOR HEATER & POWER STEERING

— : Not Applicable

Pump Speed (rpm)	Vacuum Pressure		Fuel Delivery		Remarks
	(kPa)	(mmHg)	(mm ³ /st)	(cc/500st)	
—	—	—	—	—	—

14. ADJUSTMENT OF POWER CONTROL

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/200st)	
—	—	—	—	—	—	—

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15. ADJUSTMENT OF THROTTLE POSITION SENSOR

— : Not Applicable

Lever Position	Pump Speed (rpm)	Boost Pressure		Fuel Delivery		Sensor Output Voltage (V)	Remarks
		(kPa)	(mmHg)	(mm ³ /st)	(cc/500st)		
—	—	—	—	—	—	—	—

16. FINAL CHECK AFTER ADJUSTMENT

1. Lever position at idle is $-18 \pm 5^\circ$ and $16 \pm 5^\circ$ at full.
2. After adjustment has been completed, delivery quantity must be 4.5 mm³/st (0.9 cc/200st) when voltage at fuel cut solenoid is reduced to zero. (Pump Speed Np = 200 rpm)

Check Item	Standard	Limit
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COOLING SYSTEM

RADIATOR

Radiator cap valve opening pressure kPa (kg/cm ²) [psi]	73.5 ~ 102.9 (0.75 ~ 1.05) [10.7 ~ 14.9]	58.8 (0.6) [8.5]
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THERMOSTAT

Threshold temperature	°C (°F)	80 ~ 84 (176 ~ 183)	–
Fully-opened temperature	°C (°F)	95 (203)	–

LUBRICATION SYSTEM

OIL PUMP

Body clearance	mm (in.)	0.10 ~ 0.17 (0.0039 ~ 0.0067)	0.2 (0.008)
Chip clearance	mm (in.)	0.05 ~ 0.15 (0.0020 ~ 0.0059)	0.2 (0.008)
Side clearance	mm (in.)	0.03 ~ 0.09 (0.0012 ~ 0.0035)	0.15 (0.0059)
Oil regulator valve opening pressure kPa (kg/cm ²) [psi]		490 (5) [70]	–

STARTING SYSTEM

Note

The 2Z engine is available in 24V and 12V types. The 24V type requires 24V supply for starting only. Standards for the two types are given separately under the starter and starting relay.

Intake heater (12V)

Check Item		Standard	
		Preheater	After-heater
Rated voltage	V	10.5	11
Rated current	A	101	104
Maximum allowable voltage	V	14	14
Heater temperature	°C (°F)	–	800 (1500)

Intake heater relay (12V)

Rated voltage	V	12
Rated current	A	100
Minimum operated voltage	V	8

Check Item	Standard
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STARTER (DC series wound reduction type)

Check item			12V type	24V type	
Nominal voltage			V	12	24
Nominal output			kw	2.7	4.5
No-load characteristics	Voltage		V	11.0	23.0
	Current		A	180 or less	90 or less
	Speed		rpm	3500 or above	3500 or above
Commutator mm (in.)	Ellipticity	Standard	0.02 (0.0008)	0.02 (0.0008)	
		Limit	0.05 (0.0020)	0.05 (0.0020)	
	Outside diameter	Standard	36 (1.42)	36 (1.42)	
		Limit	35 (1.38)	35 (1.38)	
	Mica depth	Standard	0.7 ~ 0.9 (0.028 ~ 0.035)	0.7 ~ 0.9 (0.028 ~ 0.035)	
		Limit	0.2 (0.008)	0.2 (0.008)	
Brush length mm (in.)	Standard		20.5 (0.807)	20.5 (0.807)	
	Limit		18.5 (0.728)	18.5 (0.728)	
Brush spring installed load N (kg) [lb]	Standard		31.4 ~ 39.2 (3.2 ~ 4.0) [7.1 ~ 8.8]	31.4 ~ 39.2 (3.2 ~ 4.0) [7.1 ~ 8.8]	
	Limit		21.6 (2.2) [4.9]	21.6 (2.2) [4.9]	
Bound characteristics	Voltage		V	3.0	6.0
	Current		A	1200 or less	900 or less
	Torque N·m (kg·cm) [ft·lb]		39.2 (400) [28] or above	49 (500) [36] or above	

Check Item	Standard
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STARTER RELAY

		12V type	24V type
Rated voltage	V	12	24
Rated coil current	A	1.2 ± 0.3	0.37 ± 0.09
Rated contact current	A	25	14
Instantaneous max. contact current capacity	A	95	50
Minimum operating voltage	V	6 (at 20°C)	12 (at 20°C)
Working voltage range	V	9 ~ 16	18 ~ 32
Grounding method		Grounded by lead wires	

CHARGING SYSTEM

ALTERNATOR

Check Item		Standard	Limit
Nominal voltage	V	12	—
Maximum output	A	Until July 1998 : 40 Since August 1998 : 60	—
No-load characteristics	Regulating voltage V	Until July 1998 : 13.8 ~ 14.4 Since August 1998 : 13.5 ~ 14.3	—
	Regulating current A	10 or less	—
Spring protrusion length	mm (in.)	10.5 (0.413)	1.5 (0.059)
Slip ring outside diameter	mm (in.)	14.4 (0.567)	14.0 (0.552)
Rotor coil check		3 or less	—
Resistance between slip ring and rotor core	M Ω	0.1 or less	—
Rotor coil resistance between phases	Ω	1	—

Until July 1998.

Place	Tightening torque N·m (kg·cm) [ft·lb]
Cylinder block x cylinder head	107.9 ~ 117.7 (1100 ~ 1200) [80 ~ 87]
x crankshaft bearing cap	122.6 ~ 147.1 (1250 ~ 1500) [90.4 ~ 108.5]
x timing gear cover	29.4 ~ 44.1 (300 ~ 450) [21.7 ~ 32.6]
x idle gear thrust plate	58.8 ~ 74.5 (600 ~ 760) [43.4 ~ 55.0]
x camshaft thrust plate	29.4 ~ 44.1 (300 ~ 450) [43.4 ~ 55.0]
x oil pan	14.5 ~ 21.8 (148 ~ 222) [10.71 ~ 16.06]
x oil pump	14.5 ~ 21.8 (148 ~ 222) [10.71 ~ 16.06]
x timing gear case 1 pc.	14.5 ~ 21.8 (148 ~ 222) [10.71 ~ 16.06]
4 pcs.	29.4 ~ 44.1 (300 ~ 450) [43.4 ~ 55.0]
x rear oil seal retainer	14.5 ~ 21.8 (148 ~ 222) [10.71 ~ 16.06]
x engine mounting bracket	29.4 ~ 44.1 (300 ~ 450) [43.4 ~ 55.0]
x alternator bracket	29.4 ~ 44.1 (300 ~ 450) [43.4 ~ 55.0]
x oil strainer	14.5 ~ 21.8 (148 ~ 222) [10.71 ~ 16.06]
x oil regulator	23.5 ~ 35.3 (240 ~ 360) [17.4 ~ 26.0]
Cylinder head x cylinder head cover	4.9 ~ 8.8 (50 ~ 90) [36 ~ 65]
x intake manifold	14.5 ~ 21.8 (148 ~ 222) [10.71 ~ 16.06]
x exhaust manifold	37.3 ~ 55.9 (380 ~ 570) [27.5 ~ 41.2]
x valve rocker support	14.5 ~ 21.8 (148 ~ 222) [10.71 ~ 16.06]
x injection nozzle	14.5 ~ 21.8 (224 ~ 336) [16.21 ~ 24.31]
x water pump	29.4 ~ 44.1 (300 ~ 450) [43.4 ~ 55.0]
Crankshaft x crankshaft pulley	274 ~ 382 (2800 ~ 3900) [20.3 ~ 28.2]
Camshaft x camshaft timing gear	35.3 ~ 53.0 (360 ~ 540) [26.0 ~ 39.1]
Connecting rod x connecting rod cap	92.2 ~ 104.0 (940 ~ 1060) [68.0 ~ 76.7]
Injection pump x timing gear case	29.4 ~ 44.1 (300 ~ 450) [43.4 ~ 55.0]
x pump drive gear	59.8 ~ 67.7 (610 ~ 690) [44.1 ~ 49.9]
x injection pipe	24.5 ~ 34.3 (250 ~ 350) [18.1 ~ 25.3]
Timing gear case x timing gear cover	29.4 ~ 44.1 (300 ~ 450) [43.4 ~ 55.0]
x PTO pump flange	
Alternator bracket x alternator	29.4 ~ 44.1 (300 ~ 450) [43.4 ~ 55.0]
Water pump x fan, fan pulley	14.5 ~ 21.8 (148 ~ 222) [10.71 ~ 16.06]
Valve rocker arm x adjusting screw	19.6 ~ 29.4 (200 ~ 300) [14 ~ 22]
Valve rocker support x rocker shaft	10.8 ~ 15.7 (110 ~ 160) [8.0 ~ 11.6]
Water outlet x outlet housing	14.5 ~ 21.8 (148 ~ 222) [10.71 ~ 16.06]
Nozzle holder x nozzle leakage lock nut	11.6 ~ 13.0 (118 ~ 133) [8.54 ~ 9.62]
Intake pipe x intake heater	14.5 ~ 21.8 (148 ~ 222) [10.71 ~ 16.06]
Oil pipe No. 2 x cylinder block	
x PTO pump flange	14.5 ~ 21.8 (148 ~ 222) [10.71 ~ 16.06]

Since August 1998.

Place	Tightening torque N·m(kgf·cm)[ft·lbf]
Cylinder block × cylinder head × crankshaft bearing cap × timing gear cover × idle gear thrust plate × camshaft thrust plate × oil pan × oil pump × timing gear case × rear oil seal retainer × engine mounting bracket × alternator bracket × oil strainer × oil regulator × oil cooler (7FDF20 ~ JF35only : 2004.1 ~)	108 ~ 118 (1100 ~ 1200) [79.6 ~ 86.8] 123 ~ 147 (1250 ~ 1500) [90.4 ~ 108.5] 35 ~ 53 (360 ~ 540) [26.0 ~ 39.1] 58 ~ 76 (590 ~ 770) [42.7 ~ 55.7] 35 ~ 53 (360 ~ 540) [26.0 ~ 39.1] 11 ~ 16 (110 ~ 160) [8.0 ~ 11.6] 17 ~ 25 (170 ~ 250) [12.3 ~ 18.1] 17 ~ 25 (170 ~ 250) [12.3 ~ 18.1] 17 ~ 25 (170 ~ 250) [12.3 ~ 18.1] 29 ~ 44 (300 ~ 450) [21.7 ~ 32.6] 35 ~ 53 (360 ~ 540) [26.0 ~ 39.1] 15 ~ 22 (150 ~ 220) [10.9 ~ 15.9] 20 ~ 30 (200 ~ 300) [14.5 ~ 21.7] 68 ~ 88 (690 ~ 890) [49.9 ~ 64.4]
Cylinder head × cylinder head cover × intake manifold × exhaust × valve rocker support × injection nozzle × water pump	5 ~ 9 (50 ~ 90) [3.6 ~ 6.5] 17 ~ 25 (170 ~ 250) [12.3 ~ 18.1] 37 ~ 55 (370 ~ 560) [26.8 ~ 40.5] 35 ~ 53 (360 ~ 540) [26.0 ~ 39.1] 16 ~ 20 (160 ~ 200) [11.6 ~ 14.5] 17 ~ 25 (170 ~ 250) [12.3 ~ 18.1]
Crank shaft × crank shaft pulley	274 ~ 382 (2800 ~ 3900) [202.6 ~ 282.2]
Camshaft × camshaft timing gear	36 ~ 54 (370 ~ 550) [26.8 ~ 39.8]
Connecting rod × connecting rod cap	92 ~ 104 (940 ~ 1060) [68.0 ~ 76.7]
Injection pump × timing gear case × pump drive gear × injection pipe × pump retainer	35 ~ 53 (360 ~ 540) [26.0 ~ 39.1] 56 ~ 72 (570 ~ 730) [41.2 ~ 52.8] 25 ~ 35 (260 ~ 360) [18.8 ~ 26.0] 15 ~ 22 (150 ~ 220) [10.9 ~ 15.9]
Timing gear case × timing gear cover	35 ~ 53 (360 ~ 540) [26.0 ~ 39.1]
Alternator × alternator bracket	46 ~ 70 (470 ~ 710) [34.0 ~ 51.4]
Water pump × Fan·Fan pulley	15 ~ 22 (150 ~ 220) [10.9 ~ 15.9]
Valve rocker arm × adjusting screw	15 ~ 22 (150 ~ 220) [10.9 ~ 15.9]
Valve rocker support × rocker shaft	10 ~ 15 (100 ~ 150) [7.2 ~ 10.9]
Water outlet × water pump	17 ~ 25 (170 ~ 250) [12.3 ~ 18.1]
Nozzle holder × nozzle leakage lock nut	22 ~ 28 (220 ~ 290) [15.9 ~ 21.0]
Injection nozzle holder × injection pipe	24 ~ 36 (240 ~ 370) [17.4 ~ 26.8]
Intake pipe × intake heater	17 ~ 25 (170 ~ 250) [12.3 ~ 18.1]