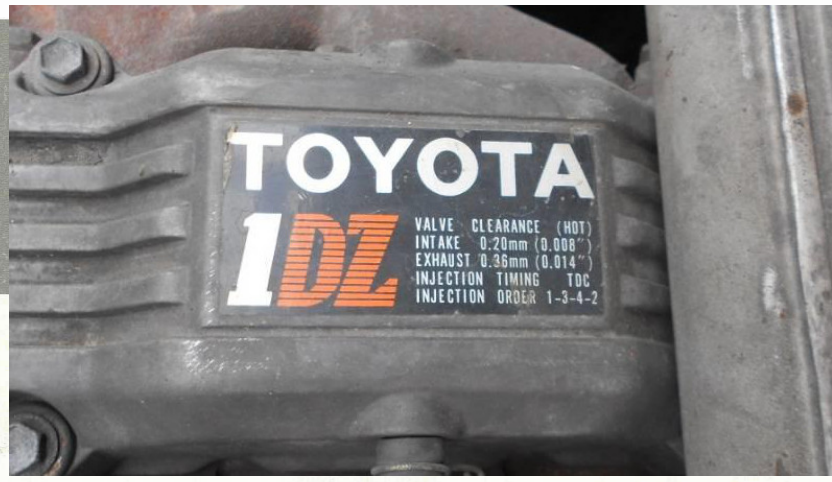


REPAIR MANUAL

1DZ-II ENGINE

Pub. No. CE618-1

FOREWORD

This repair manual explains the repair points of the 1DZ-II 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 August 1998. 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 MOTOR CORPORATION

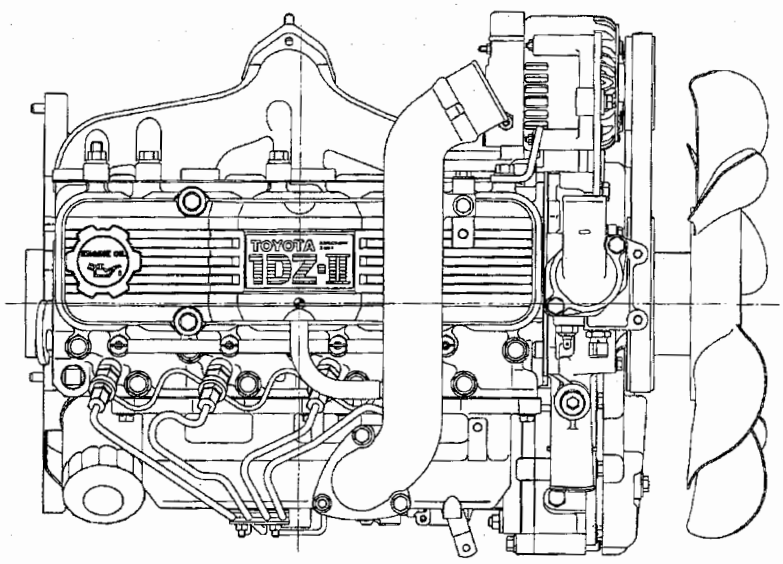
SECTION INDEX

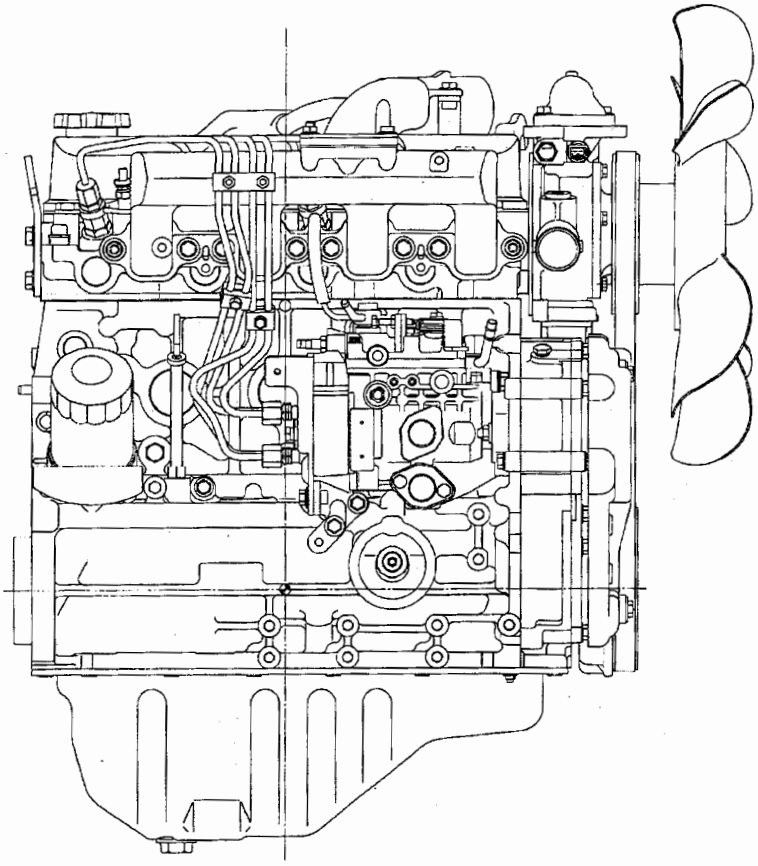
GENERAL

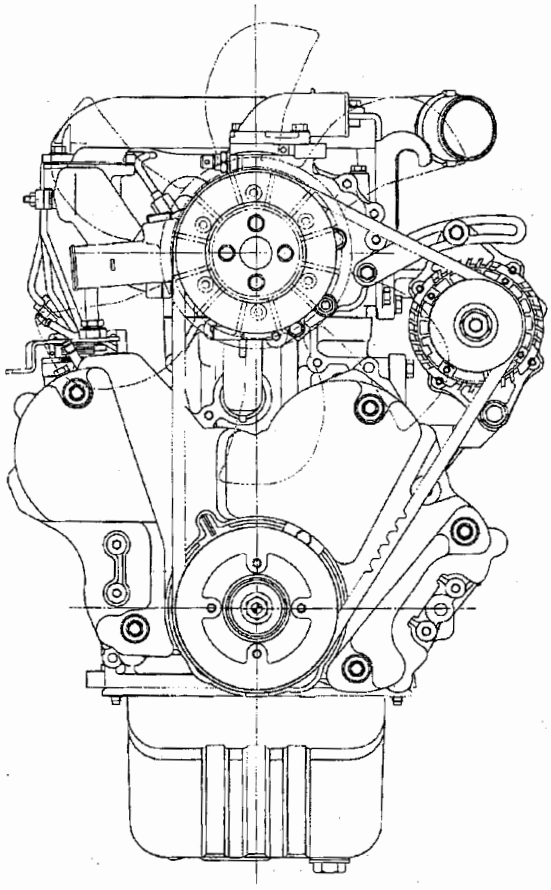
SPECIFICATIONS

Engine model			1DZ-II
Type			Diesel
Cycle			4
Number of cylinders and arrangement			In-line 4 cylinders, vertical
Injection order			1-3-4-2
Starting method			Pinion shift or self starter
Combustion chamber type			Vortex type
Valve mechanism			Gear drive, OHV
Bore × stroke	mm (in.)		86 × 107 (3.39 × 4.53)
Piston displacement	cc (cu·in)		2486 (151.65)
Compression ratio			21.5
Compression pressure	kPa (kgf/cm²) [psi]/rpm		2840 (29) [412]/260
Rated output	PS/rpm		66/2400
Maximum torque	N·m (kgf-m) [ft-lbf]/rpm		167 (17) [123]/1600
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
Cylinder liner type			Dry
Intake valve opening & closing timing		Open	BTDC 16°
		Close	ABDC 44°
Exhaust valve opening and closing timing		Open	BBDC 52°
		Close	ATDC 14°
Ignition system			Compression ignition
Injection timing			0/static (BTDC)
Oil pump type			Trochoid pump
Oil filter type			Paper filter
Engine oil amount	ℓ	Oil pan capacity	7.0 (1.85)
	(US gal)	Total capacity	7.5 (1.98)

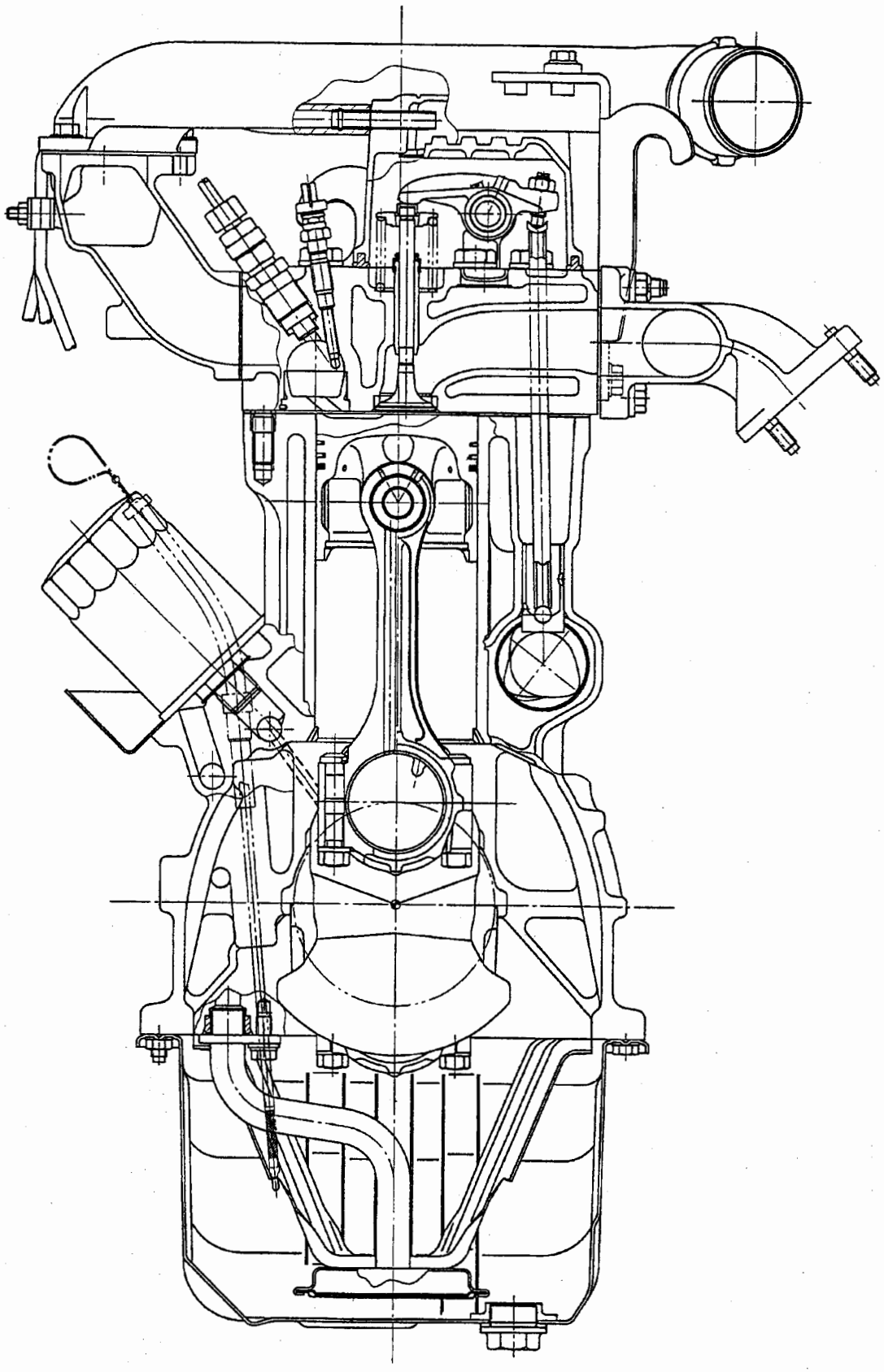
ENGINE EXTERIOR VIEWS

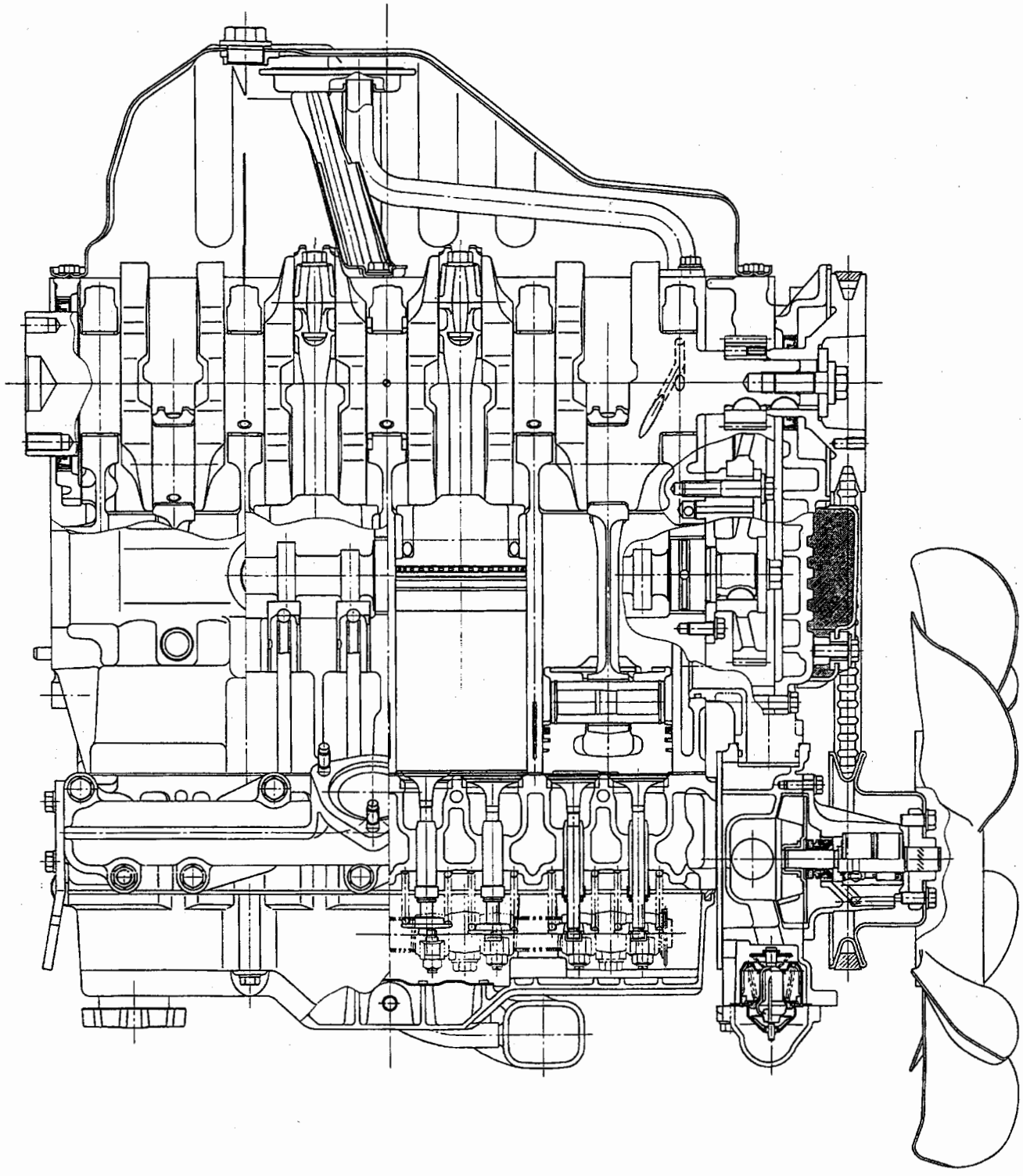






ENGINE SECTIONAL VIEWS





HOW TO READ THIS MANUAL

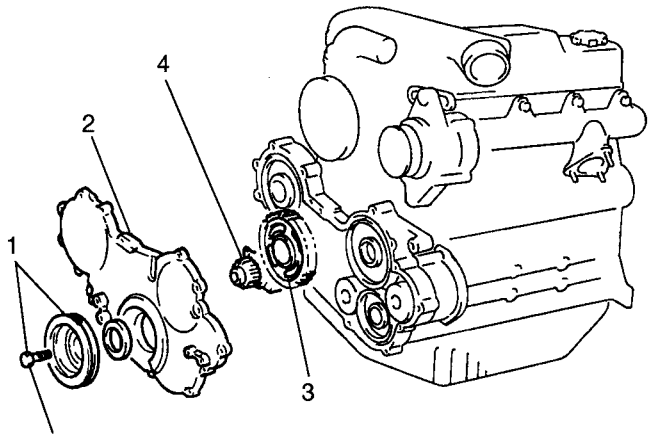
EXPLANATION METHOD

1. Operation procedure
   (1) The operation procedure is described in either pattern A or pattern B below.
   Pattern A: Explanation of each operation step with an illustration.
   Pattern B: Explanation of operation procedure by indicating step numbers in one illustration, followed by explanation of cautions and notes summarized as point operations.

Example of Description in Pattern B

REMOVAL · INSTALLATION Tightening torque unit T=N·m (kgf-cm)[ft-lbt]

- Step Nos. are partially sometimes omitted in illustrations.
- When a part requiring tightening torque instruction is not indicated in the illustration, the part name is described in the illustration frame.



T=274.59 ~ 370.69 (2800 ~ 3780) [202.58 ~ 273.48]

Removal Procedure

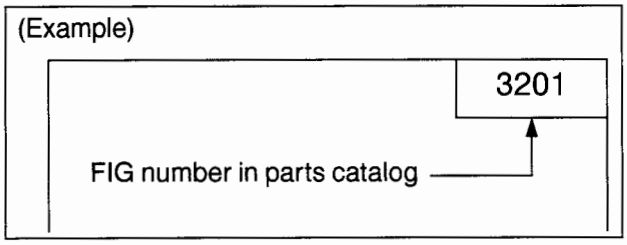
1 Remove the crank pulley W/set bolts.
2 Remove the timing gear cover. ← Operation covered on the following page.
3 Remove the idle gear No.1. **[Point 1]**
4 Remove the oil pump ASSY. **[Point 2]**

Point Operation

[Point 1]
Inspection: ← Explanation of key point for operation with an illustration.
Measure the backlash.
Standard: 0.05mm (0.0020in)

[Point 2]
Installation:
Install the rotor as a illustration.

2. How to read components figures
   (1) The components figure uses the illustration in the parts catalog for the vehicle model. Please refer to the catalog for checking the part name.
   The number at the right shoulder of each components figure indicates the Fig. number in the parts catalog.



3. Matters omitted in this manual
   (1) This manual omits description of the following jobs, but perform them in actual operation:
   ① Cleaning and washing of removed parts as required
   ② Visual inspection (partially described)

TERMINOLOGY

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	O/S	Over size
ABDC	After bottom dead center	OPT	Option
ATDC	After top dead center	RH	Right hand
BBDC	Before bottom dead center	rpm	Revolution per minute
BTDC	Before top dead center	SST	Special service tool
EX	Exhaust	STD	Standard
IN	Intake	T=	Tightening torque
LH	Left hand	TDC	Top dead center
LLC	Long life coolant	U/S	Under size
L/	Less	W/	With

OPERATIONAL TIPS

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 stand, 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. Disposal of waste fluid, etc.
   When draining waste fluid from the vehicle, receive it in a container.
   If any oil, fuel, coolant, oil filter, battery or other harmful substance is directly discharged or scrapped without permission, it will either adversely affect human health or destroy the environment. Always sort waste fluids, etc. and treat them properly by requesting disposal by specialized companies.

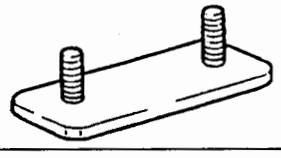
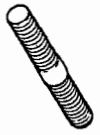
STANDARD BOLT & NUT TIGHTENING TORQUE

Standard bolt and tightening torques are not indicated.
Judge the standard tightening torque as shown below.

1. Find out the type of the bolt from the list below and then find the bolt tightening torque from the table.
2. The nut tightening torque can be judged from the mating bolt type.

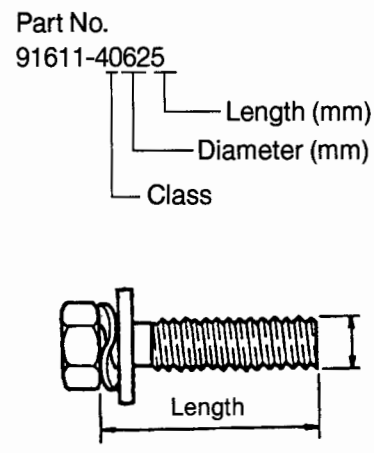
BOLT STRENGTH TYPE IDENTIFICATION METHOD

Identification by bolt shape

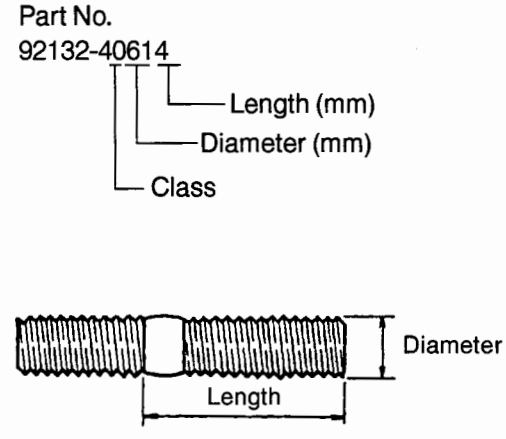
	Shape and class	Class
Hexagon head bolt	 Bolt head No.	4=4T 5=5T 6=6T 7=7T 8=8T
	 No mark	4T
Hexagon flange bolt	 No mark	4T
Hexagon head bolt	 Two protruding lines	5T
Hexagon flange bolt	 Two protruding lines	6T
Hexagon head bolt	 Three protruding lines	7T
Hexagon head bolt	 Four protruding lines	8T
Welded bolt		4T
Stud bolt	 No mark	4T
	 Grooved	6T

Identification by part No.

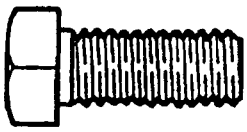
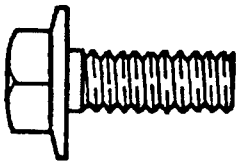
Hexagon head bolt



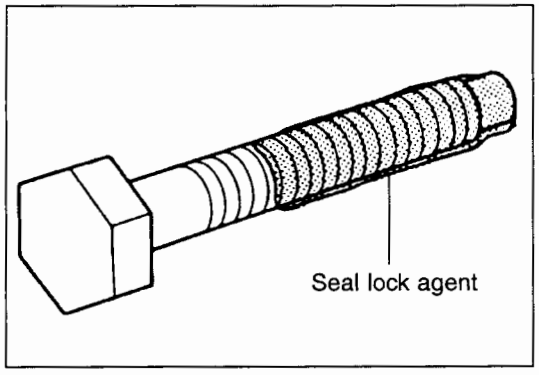
Stud bolt



TIGHTENING TORQUE TABLE

Class	Diameter mm	Pitch mm	Specified torque					
			Hexagon head bolt 			Hexagon flange bolt 		
			N·m	kgf-cm	ft-lbf	N·m	kgf-cm	ft-lbf
4T	6	1.0	5.4	55	48 in-lbf	5.9	60	52 in-lbf
	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	127	1300	94
5T	6	1.0	6.4	65	56 in-lbf	7.5	75	65 in-lbf
	8	1.25	16	160	12	18	175	13
	10	1.25	32	330	24	36	360	26
	12	1.25	59	600	43	65	670	48
	14	1.5	91	930	67	100	1050	76
	16	1.5	137	1400	101	157	1600	116
6T	6	1.0	7.8	80	69 in-lbf	8.8	90	78 in-lbf
	8	1.25	19	195	14	21	215	16
	10	1.25	38	400	29	43	440	32
	12	1.25	72	730	53	79	810	59
	14	1.5	110	1100	80	123	1250	90
	16	1.5	170	1750	127	191	1950	141
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	255	2600	188
8T	6	1.0	12	125	9	14	145	9
	8	1.25	29	300	22	32	330	24
	10	1.25	61	620	45	68	690	50
	12	1.25	108	1100	80	123	1250	90
	14	1.5	172	1750	127	196	2000	145
	16	1.5	265	2700	195	299	3050	221

PRECOAT BOLTS (Bolts with seal lock agent coating on treads)

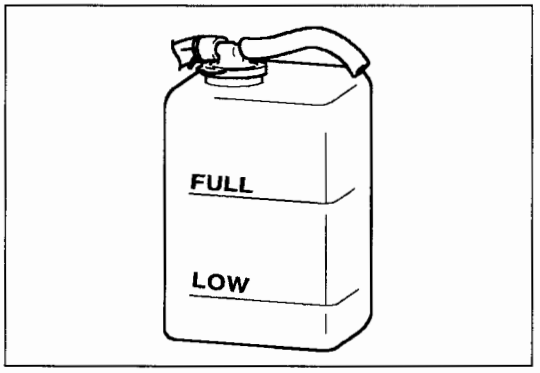


1. Do not use precoated part in any of the following cases:
   (1) When a precoated part is removed.
   (2) When a precoated part is removed as a result of tightening torque check, etc.

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.

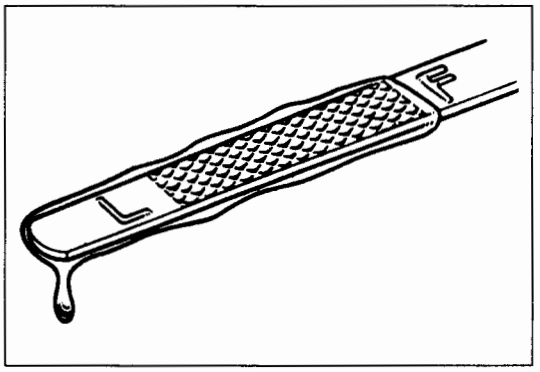
ENGINE TUNE-UP



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.

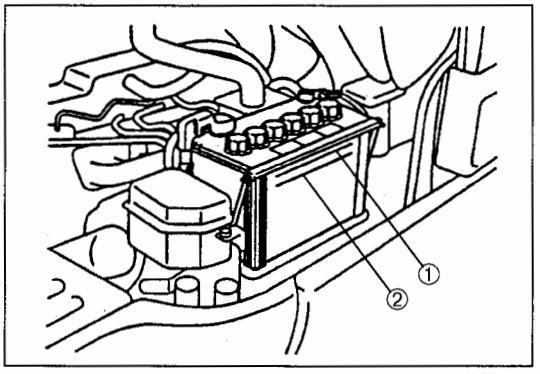
Reference:
See the section on COOLING SYSTEM.



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.

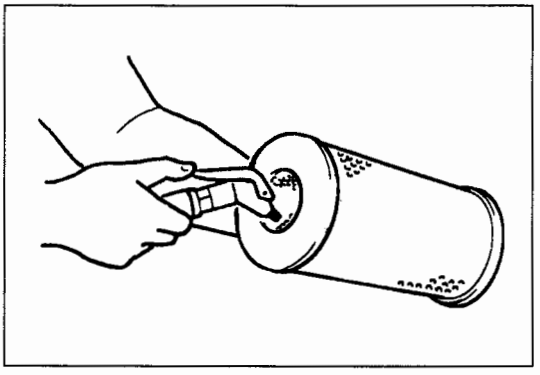
Oil amount: 7.5 ℓ (1.98 US gal.)
Oil pan: 7.0 ℓ (1.85 US gal.)



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 · CLEANING

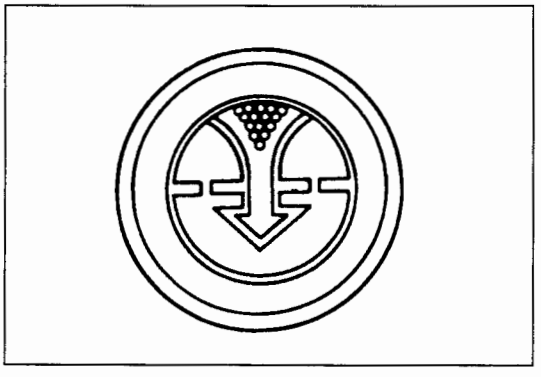
Air Cleaner Element Inspection and Cleaning

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 kgf/cm²) [99 psi] or lower.

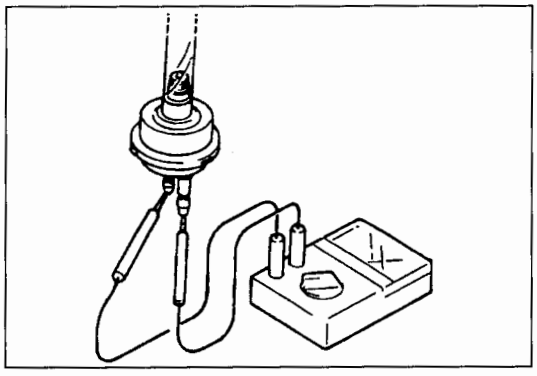
Air Cleaner Case Cleaning

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



CLOGGING WARNING SYSTEM INSPECTION

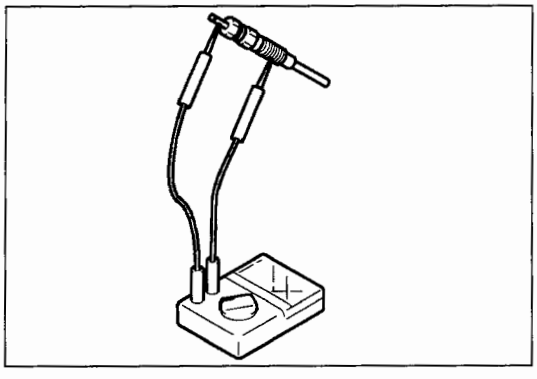
1. Inspection on the vehicle
   Check that the air cleaner warning lamp on the combination meter comes on when the ignition key switch is set to the ON position, and goes off when the engine is started.



2. Individual inspection
   Check the vacuum switch for continuity when negative pressure is applied.

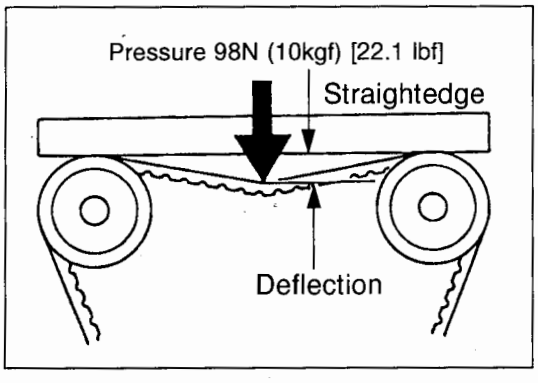
   Standard: Approx. 7473 ± 569 Pa (762 ± 58 mmAq, 56.0 ± 4.3 mmHg) or above - Continuity

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



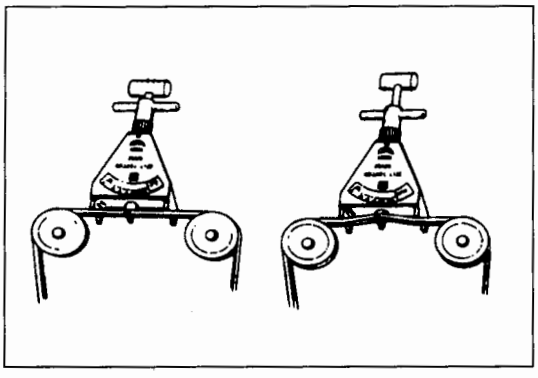
GLOW PLUG INSPECTION

1. Disconnect wires to glow plug.
2. Remove the glow plug, and check the glow plug for continuity.
   Confirm continuity between the glow plug body and terminals.

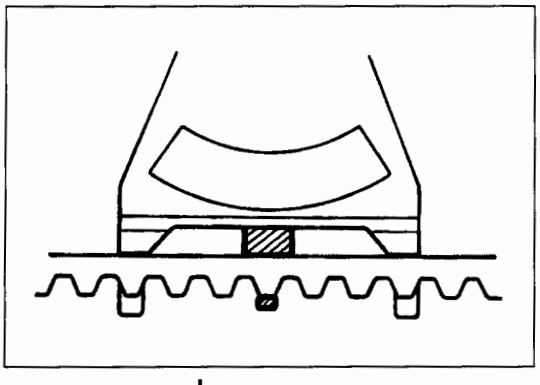


V BELT TENSION INSPECTION · ADJUSTMENT

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 (10kgf) [22.05 lbf], 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.)



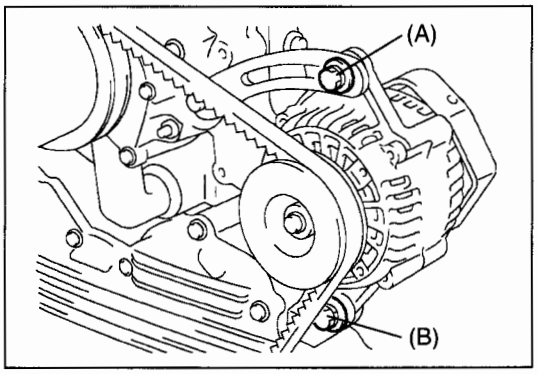
Notes:
- **Measure the amount of deflection between the specified pulleys.**
- **When a new belt is fitted, adjust tension to the median of the standard for new belts.**
- **The standard for belts in use applies to belts that have been used for 5 minutes or longer.**
- **When refitting a belt that has 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
SST 09216-00021

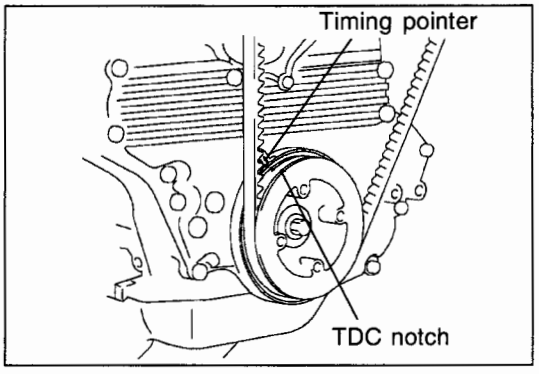
New belts: 520 ~ 755 N (53 ~ 77kgf) [116.9 ~ 169.8 lbf]
Belts in use: 324 ~ 559 N (33 ~ 57kgf) [72.8 ~ 125.7 lbf]

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



VALVE CLEARANCE INSPECTION · ADJUSTMENT

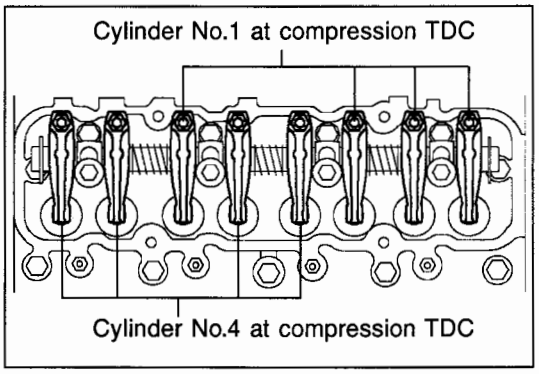
1. Warm up the engine.

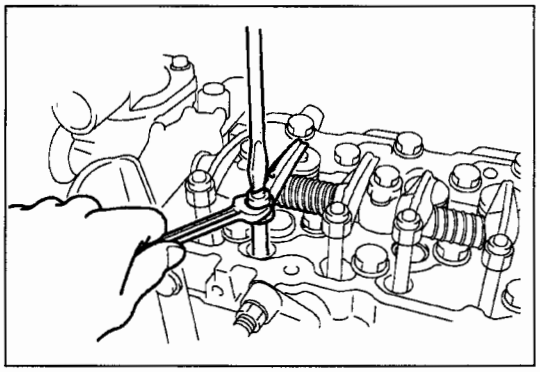
   Standard: Coolant temperature 75 ~ 85°C (167 ~ 185°F)

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

   Standard:
   IN: 0.18 ~ 0.22 mm (0.0071 ~ 0.0087 in.) (hot engine)
   EX: 0.33 ~ 0.37 mm (0.0130 ~ 0.0146 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.

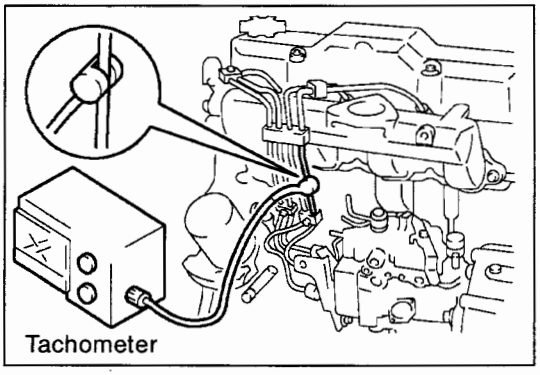




3. Adjust valves clearance as needed.
   (1) Loosen the lock nut and turn the adjusting screw as needed for adjustment.

   Standard:
   IN: 0.20 mm (0.0079 in.) (hot engine)
   EX: 0.35 mm (0.0138 in.) (hot engine)

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

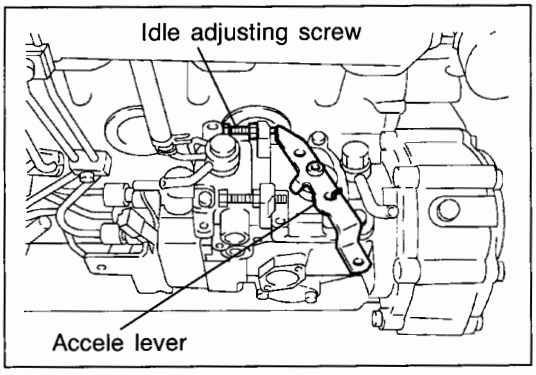


IDLE SPEED INSPECTION · ADJUSTMENT

1. Warm up the engine.

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

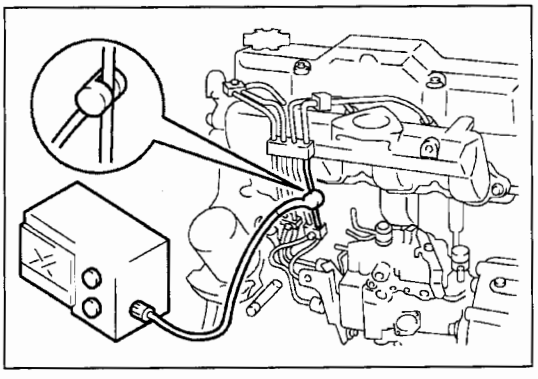
2. Attach the tachometer.
3. Check the idle speed.
   (1) Check that the accelerator wire returns, and confirm that the adjusting screw of the injection pump is touching the adjusting lever.



(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 · ADJUSTMENT

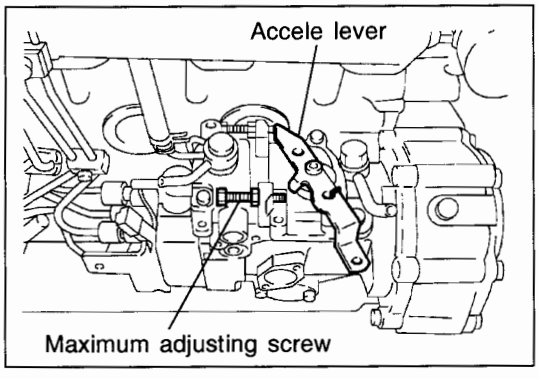
1. Warm up the engine.

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

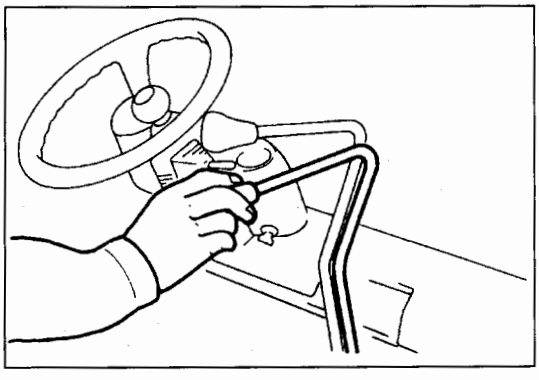
2. Attach the tachometer.

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

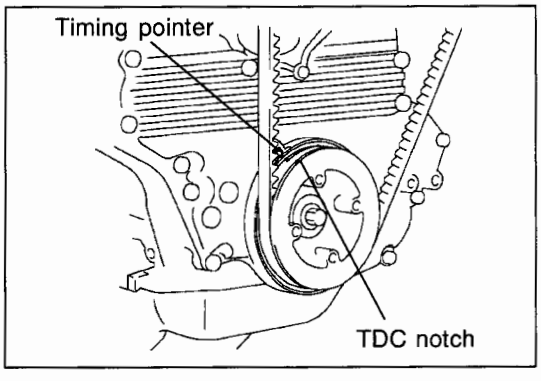
Standard: Refer to the appropriate repair manuals.



4. Adjust the no-load static maximum engine speed. Unseal the adjusting screw and turn it as needed for adjustment.

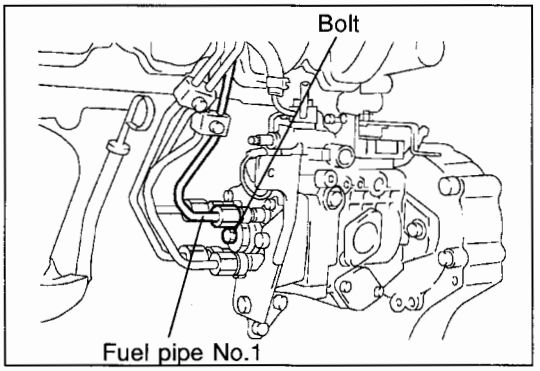


5. Check the no-load maximum engine speed.
   (1) With the engine running at the maximum speed, operate the material handing levers and check the engine speed drop (relief down) at full relief.
   Relief down at full relief:
   Refer to the appropriate repair manuals.
   (2) Seal the set screw.



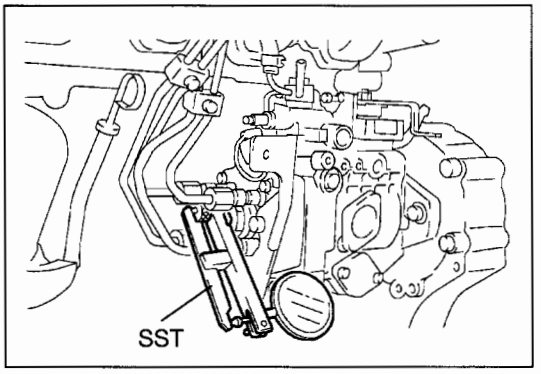
INJECTION TIMING INSPECTION · ADJUSTMENT

1. Set cylinder No. 1 to the TDC. Align the TDC notch mark of the crank pulley with the timing pointer.
2. Disconnect the fuel pipe No. 1 at the pump side.



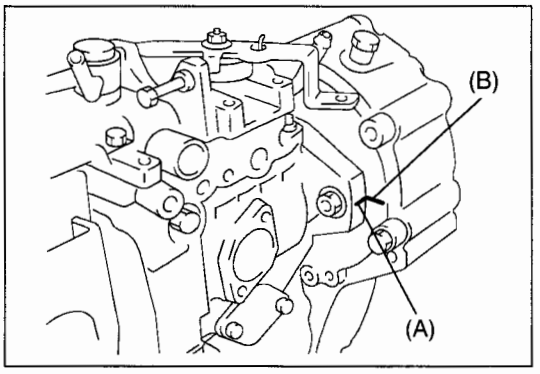
3. Remove the bolt at the rear end of the injection pump.
4. Set the SST and the dial gauge in the bolt hole.
   SST 09240-32880-71 or 09275-54010

Note:
Prevent foreign matter or dust entrance during work.

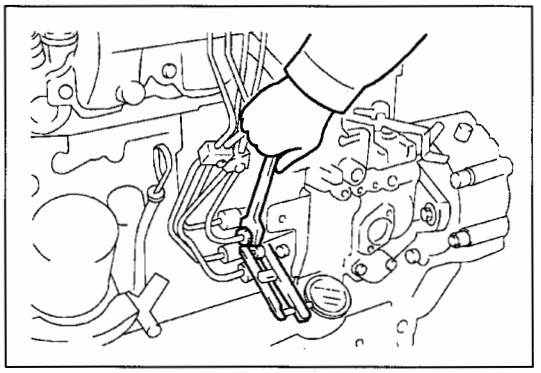


5. While observing the dial gauge reading, rotate the crankshaft in the reverse direction by a crank angle over 25° from the TDC of cylinder No. 1. When the dial gauge pointer deflection stops, set the dial gauge to 0.
6. Slowly rotate the crankshaft in the forward direction until cylinder No. 1 comes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

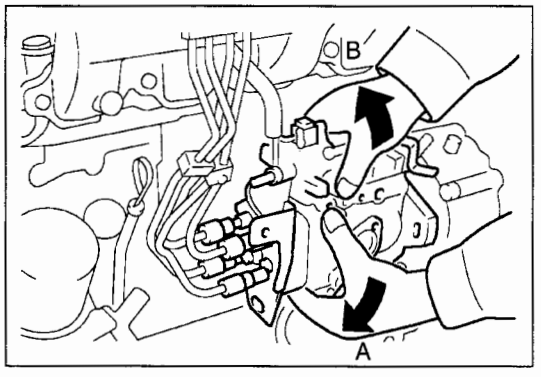
   Standard: 0.90 ± 0.03 mm (0.0354 ± 0.0012 in.)



8. Adjust the injection timing as needed.
   (1) Check if the marks on the timing gear case (B) and the injection pump body (A) 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 and overflow pipe.
   (3) Loosen the injection pump set nut and the lower bracket.

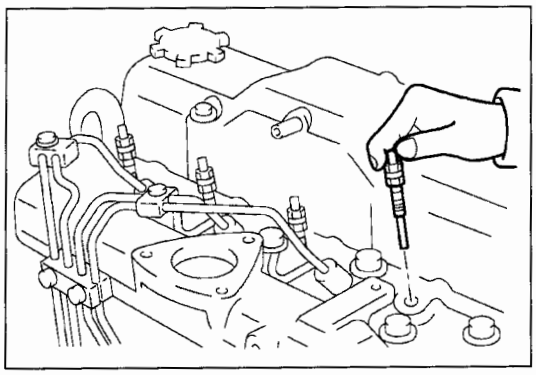


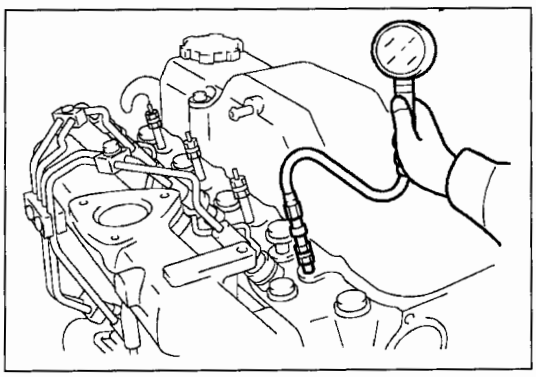
   (4) Move the pump body as needed to adjust the injection timing.
      ① Move the pump body in direction (A) when the measured value in step 7 above was smaller than the standard.
      ② Move the pump body in direction (B) when the measured value in step 7 above was larger than the standard.
   (5) Tighten the injection pump set nut and the lower bracket, and check the injection timing again.
   (6) Tighten the loosened pipe joints.



9. After the injection timing inspection and adjustment, remove the SST and the dial gauge, and fit the bolt at the rear end the pump.
   T=13.7 ~ 19.6 N·m (140 ~ 200 kgf-cm) [10.1 ~ 14.5 ft-lbf]

Note:
- **Always use a new copper washer**
- **Carefully prevent dust an foreign matters from entering the circuit.**





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 glow plug wiring, and remove the glow plugs.
4. Disconnect the wiring for fuel cut solenoid.
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.

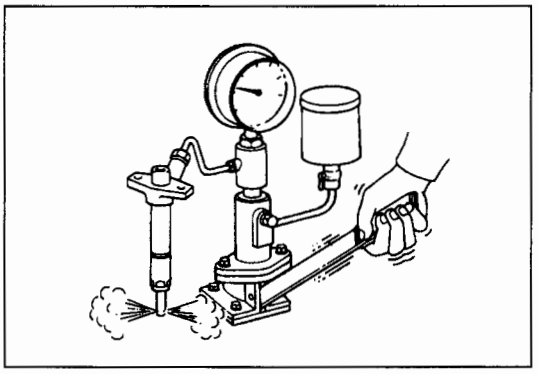
Standard: 2850 kPa (29.0 kgf/cm²) [412 psi] at 260 rpm
Limit: 2000 kPa (20.0 kgf/cm²) [284 psi] at 260 rpm

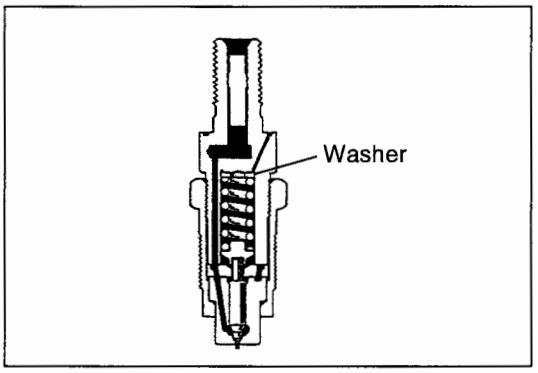
Note:
- **Use a fully charged battery to maintain the specified engine speed.**
- **Use the same number of compression strokes for each cylinder. For example, if ten compression strokes are necessary to obtain the maximum pressure for No.1 cylinder, use ten strokes also for other cylinders.**

(3) Repeat steps (1) and (2) for each cylinders.

Limit of difference between cylinders:
196 kPa (2 kgf/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

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: 11800 ± 500 kPa (120 ± 5 kgf/cm²)
   [1700 ± 70 psi]

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

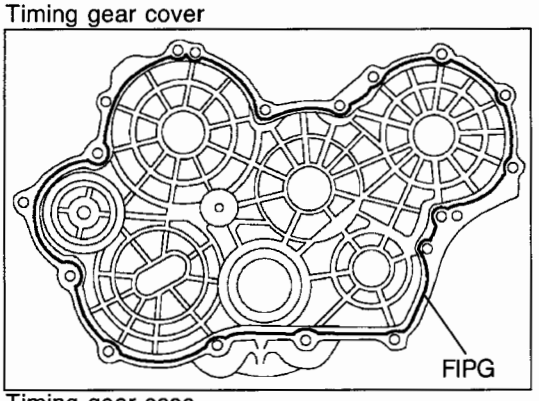
ENGINE OVERHAUL

FIPG (LIQUID GASKET) GUIDANCE

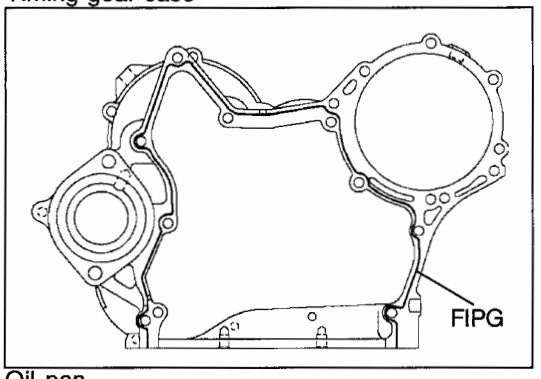
1. FIPG Part No. 08826-00080
2. FIPG using parts and applying positions.

Using parts	Oil pan, Timing gear cover and case

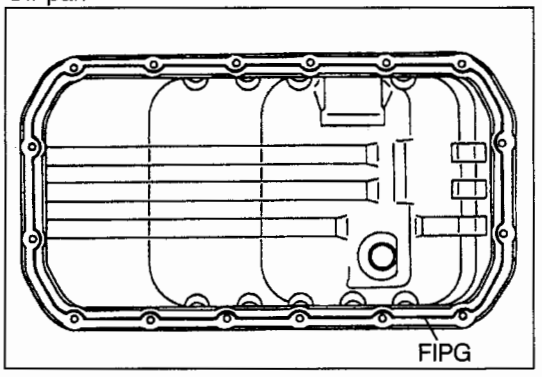
Timing gear cover



Timing gear case



Oil pan



3. FIPG coating and parts assembly procedure

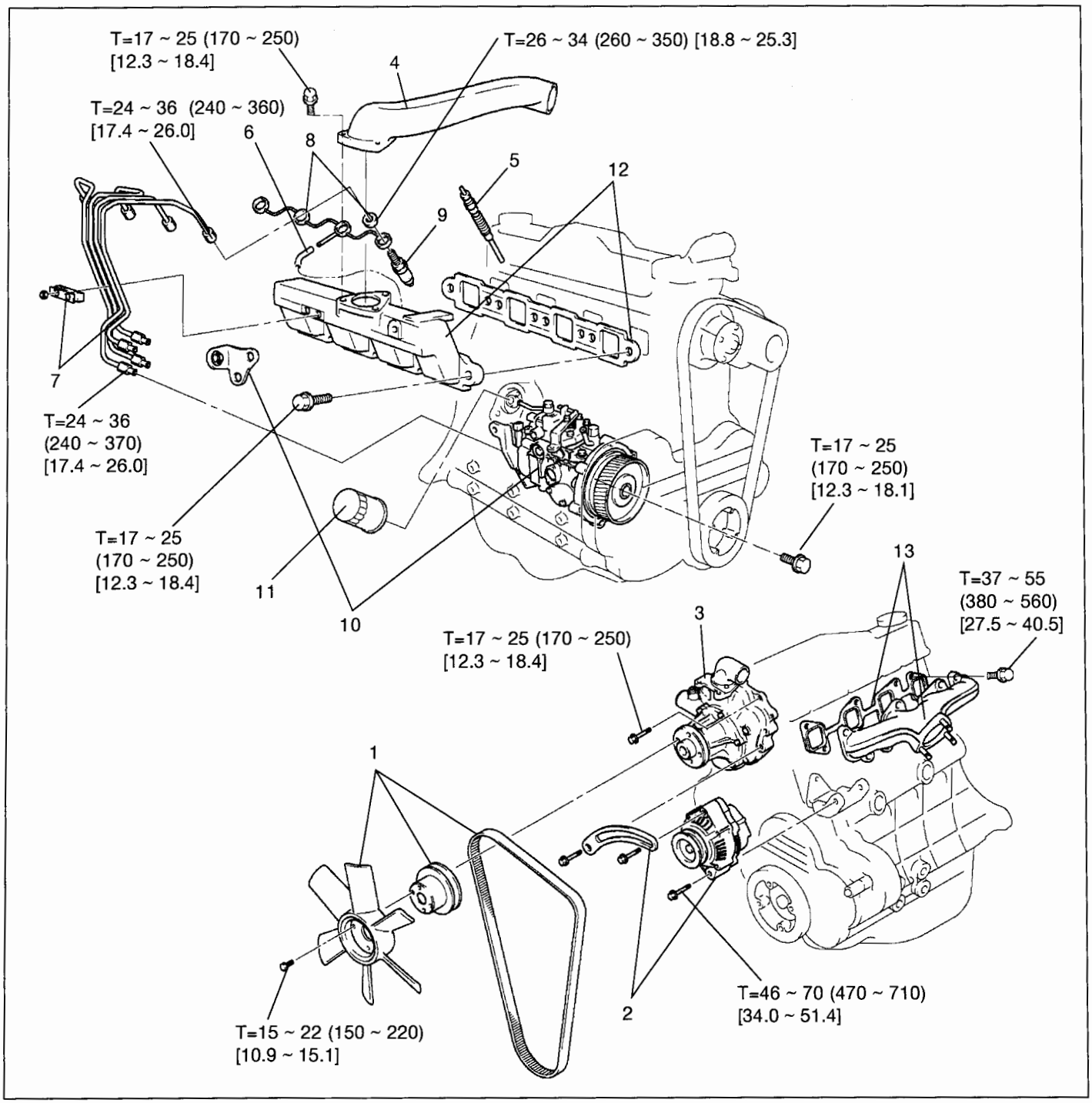
Note:
When removing the gasket, carefully prevent gasket fragments from falling into the engine.

(1) Clean each part and mating surfaces with dry cloth to eliminate oil, moisture, dirt, etc.
(2) Coat FIPG on the parts to be installed.
(3) Avoid excessive or insufficient coating. The start and end of coating shall be overlaid.
(4) After assembly, carefully prevent parts movement.
(5) Always assemble within 3 minutes after coating.
(6) Avoid cooling water supply, oil filling and engine starting within 30 minutes after assembly.

ENGINE ACCESSORIES

REMOVAL · INSTALLATION

T=N·m (kgf-cm) [ft-lbf]



Removal Procedure

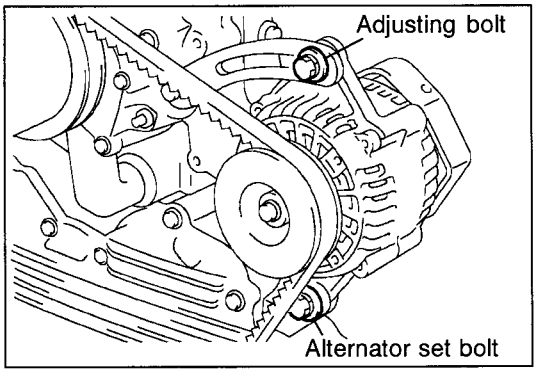
1 Remove the fan, fan pulley, and V belt. **[Point 1]**
2 Remove the alternator.
3 Remove the water pump.
4 Remove the intake pipe.
5 Remove the glow plug.
6 Remove the fuel hose.
7 Remove the injection pipe.
8 Remove the nozzle leakage pipe.
9 Remove the injection nozzle. **[Point 2]**

10 Remove the injection pump with drive gear. **[Point 3]**
11 Remove the oil filter. **[Point 4]**
12 Remove the intake manifold. **[Point 5]**
13 Remove the exhaust manifold. **[Point 6]**

Installation Procedure

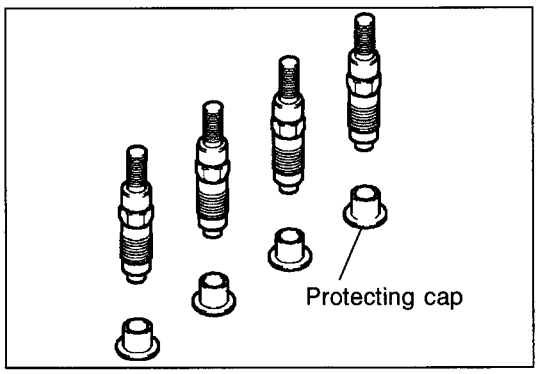
Installation procedure is the reverse of the removal procedure.

Note:
If remove the injection pump, adjust the injection timing after install it.

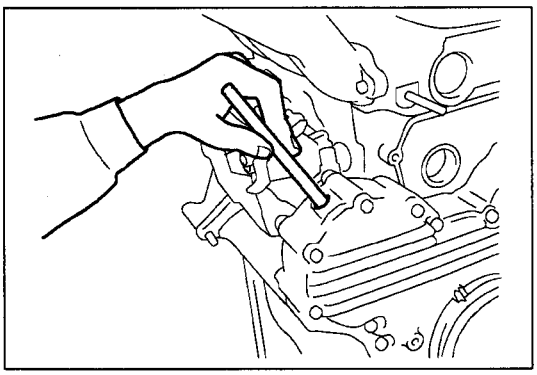


Point operations

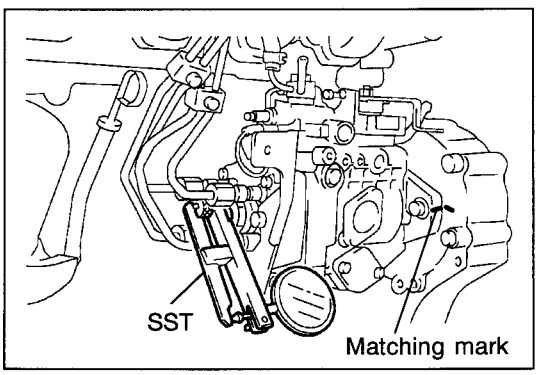
[Point 1]
Installation:
Adjust the V belt tension.
See page on 1-3 about V belt adjustment.



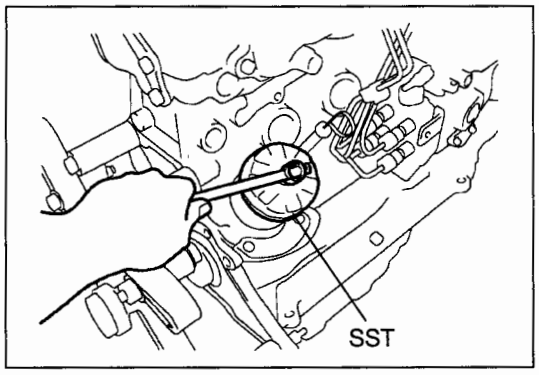
[Point 2]
Removal:
Protect the disassembled nozzles and keep them in the order of cylinders to ensure correct installation.
Installation:
Always renew the nozzle gasket. The nozzle seat may be reused after thoroughly removing the carbon deposits.



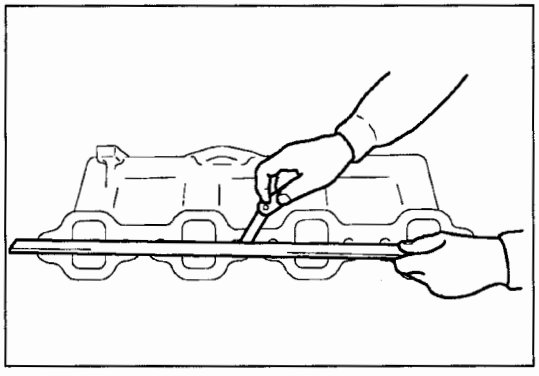
[Point 3]
Removal:
1. Bring cylinder No.1 to the TDC and then return it a little for ease of work. If it is set at the TDC, the injection pump cam is lifted and makes work difficult.
2. Unbolt the timing gear cover and put matching marks using white paint, etc.



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.
SST 09240-32880-71
See page on 1-5 about injection timing adjustment.

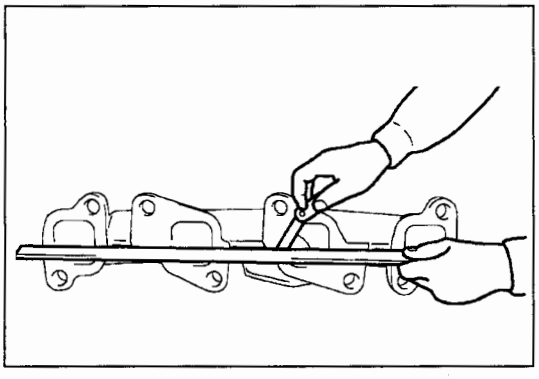


[Point 4]
Removal:
SST 09228-07501
Installation:
Apply a thin coat of engine oil to the O ring and install the oil filter by turning it by hand. Then, retighten the oil filter by 3/4 of a turn using SST.
SST 09228-07501



[Point 5]
Inspection:
Check the intake manifold for distortion.

Limit: 0.4 mm (0.016 in)



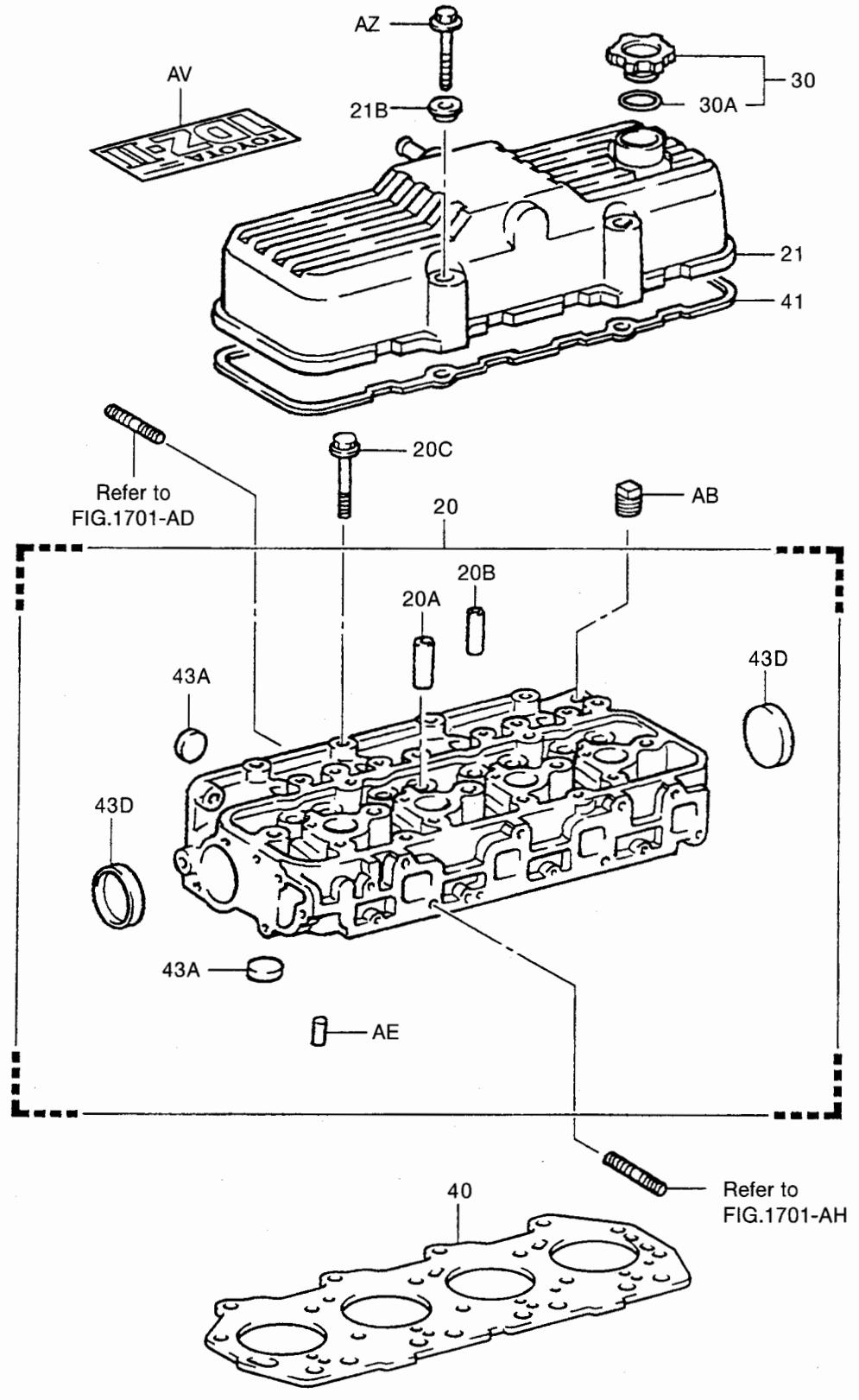
[Point 6]
Inspection:
Check the exhaust manifold for distortion.

Limit: 0.4 mm (0.016 in)

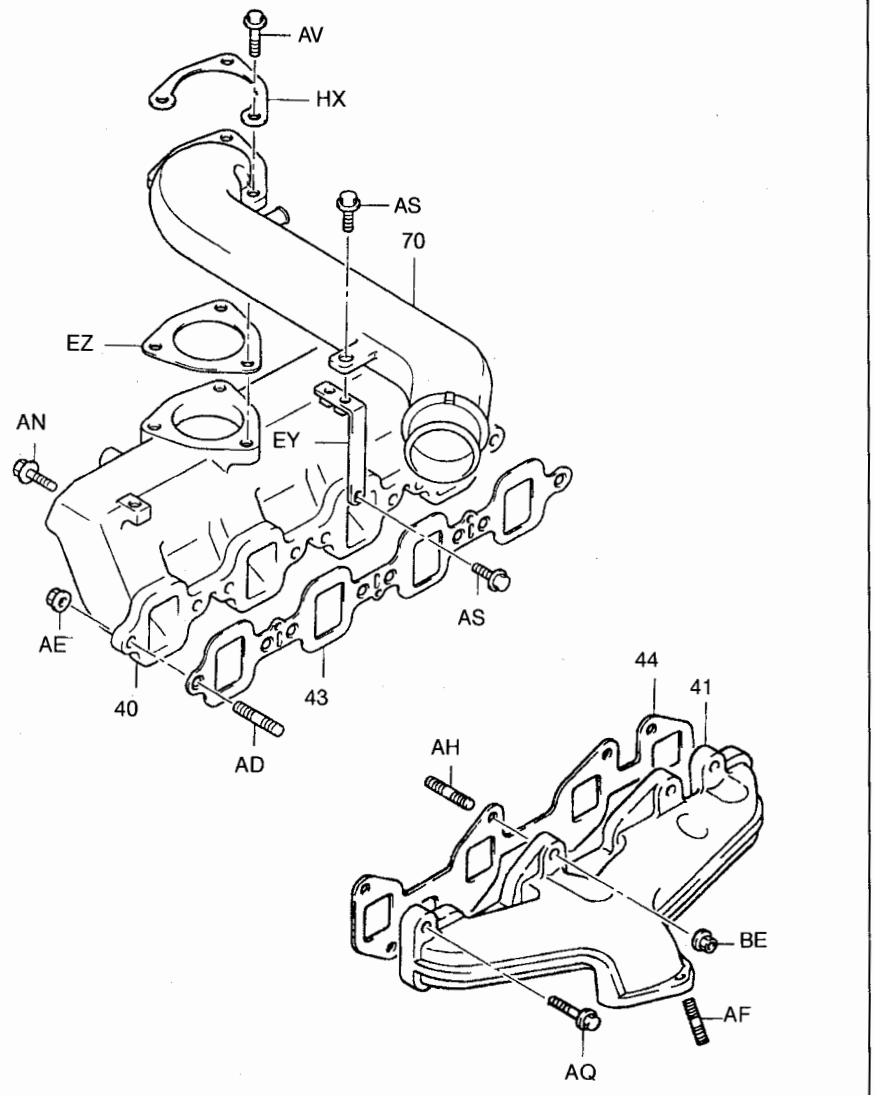
CYLINDER HEAD

COMPONENTS

1104

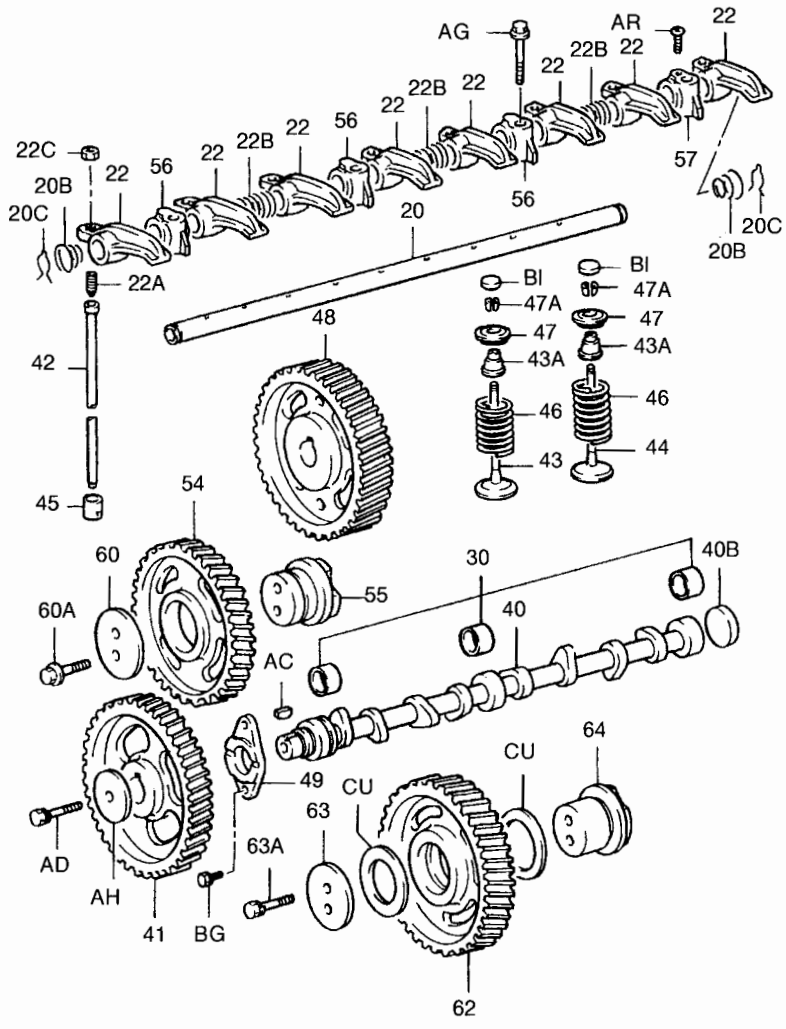


1104-098



1701-114

1701

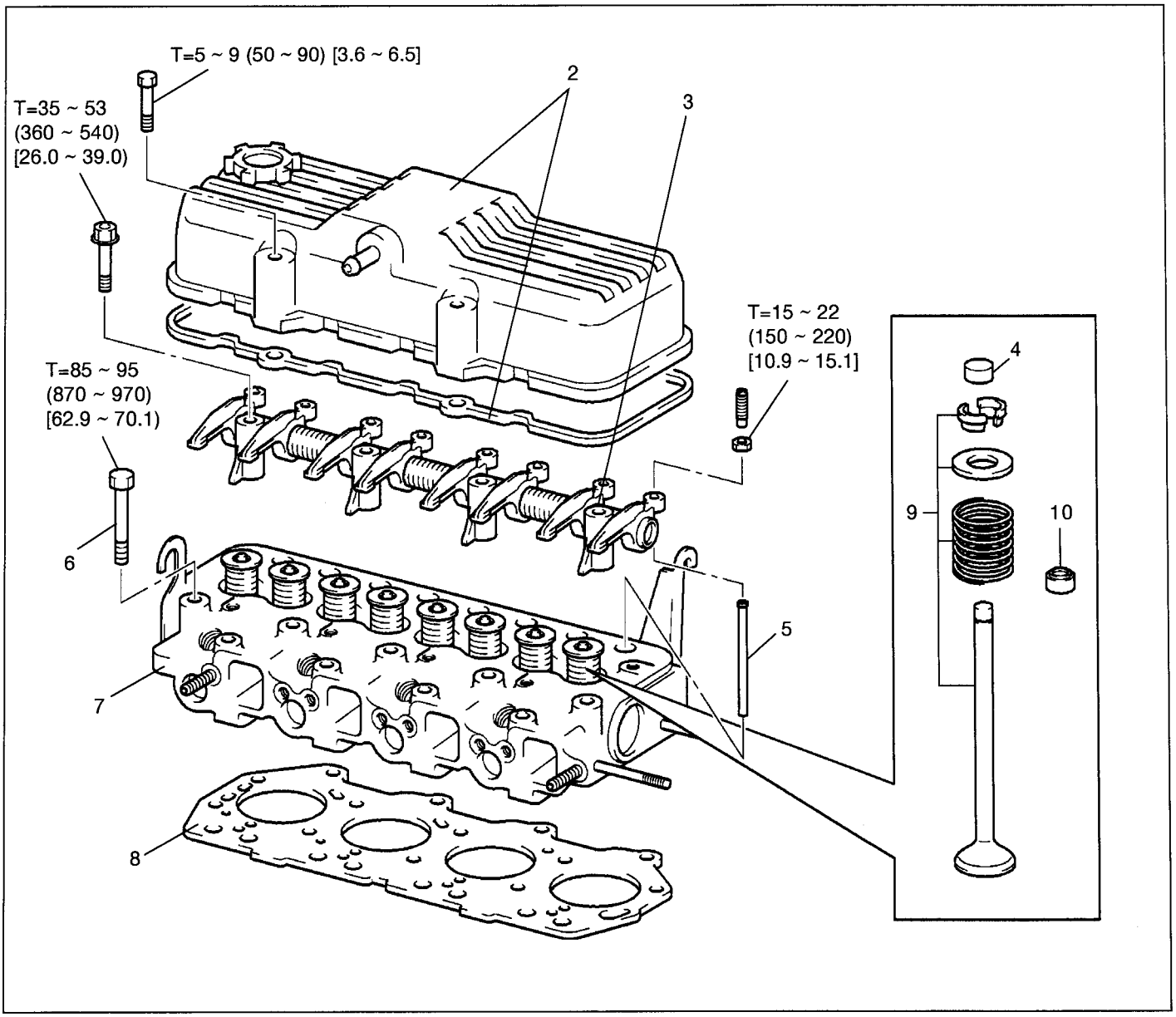


1302-060A

1302

REMOVAL · INSTALLATION

T=N·m (kgf-cm) [ft-lbf]

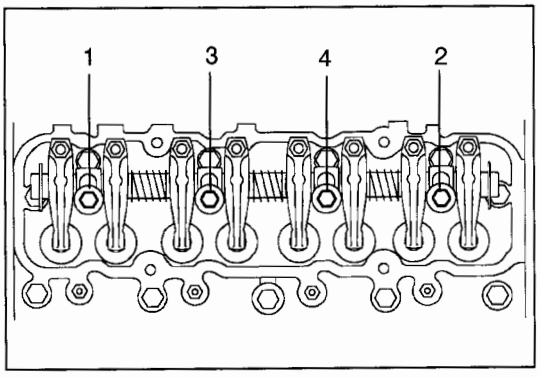


Removal Procedure

1 Remove items 1 to 9, 12 and 13 shown under ENGINE ACCESSORIES REMOVAL · INSTALLATION.
2 Remove the cylinder head cover.
3 Remove the rocker shaft ASSY. **[Point 1]**
4 Remove the valve stem cap. **[Point 2]**
5 Remove the valve push rods. **[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

Installation procedure is the reverse of the removal procedure.



Point operations

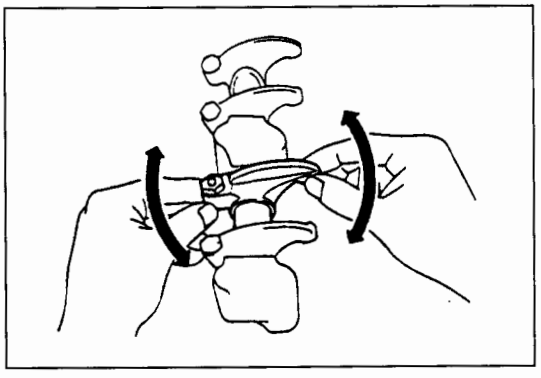
[Point 1]

Removal:

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.



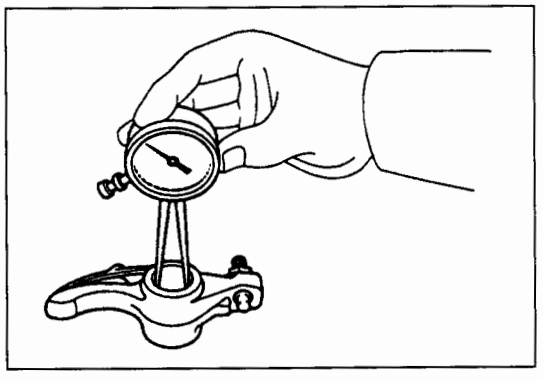
Inspection:

Check the valve rocker arm for wear and damage on the contact area with the valve stem cap.

Repair minor scratches by polishing with an oil stone. Replace if worn or damaged beyond repair.

Inspection:

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.

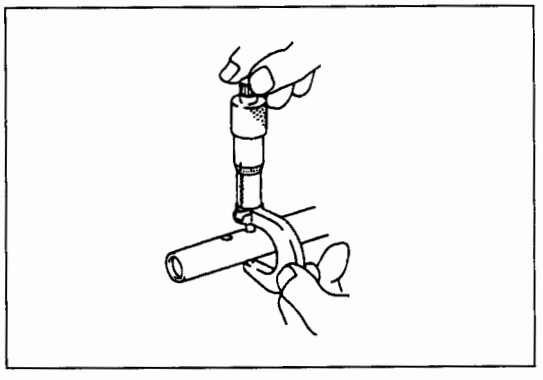


Inspection:

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

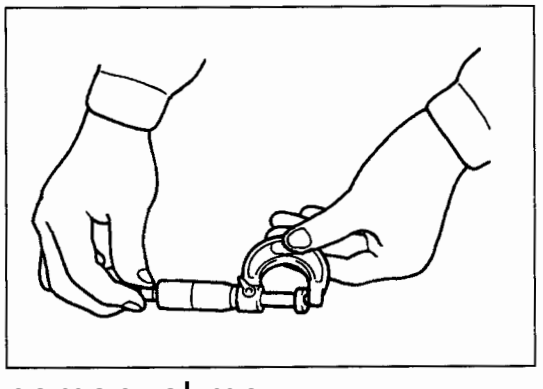
1. Measure the inside diameter of the rocker arm.
   Standard: 18.500 ~ 18.520 mm (0.72835 ~ 0.72913 in.)
   Limit: 18.60 mm (0.7323 in.)

2. Measure the outside diameter of the rocker shaft.
   Standard: 18.470 ~ 18.490 mm (0.72716 ~ 0.72825 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.



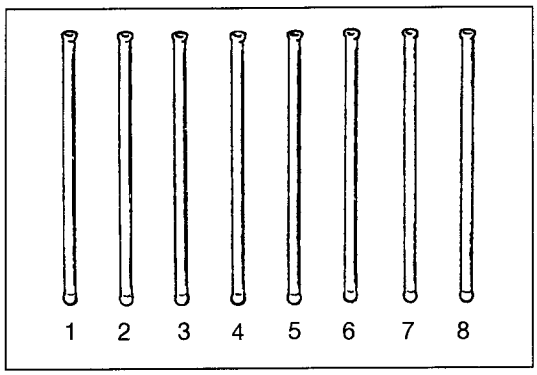
[Point 2]

Inspection:

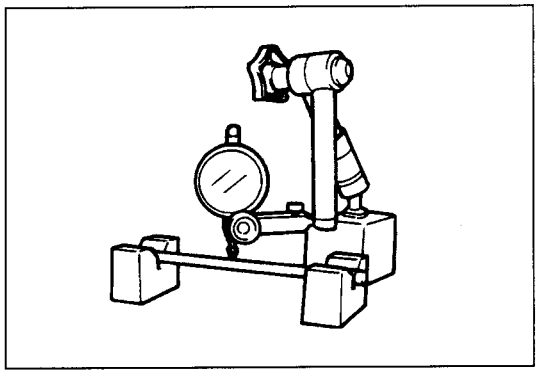
Check the valve stem cap.

1. Measure the thickness of the valve stem cap.
   Standard: 1.31 ~ 1.49 mm (0.0547 ~ 0.587 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.



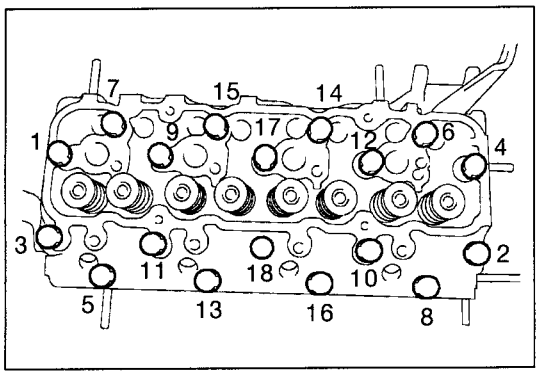
[Point 3]
Removal:
Keep the removed push rods carefully so they can be installed in a correct order.



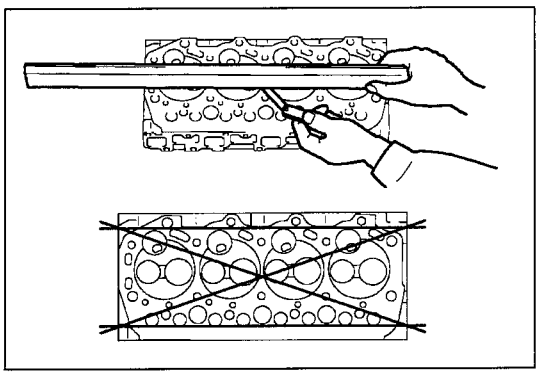
Inspection:
Check the push rods for bend. Measure the amount of bend per a full turn.

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

Limit: 0.25 mm (0.010 in.)

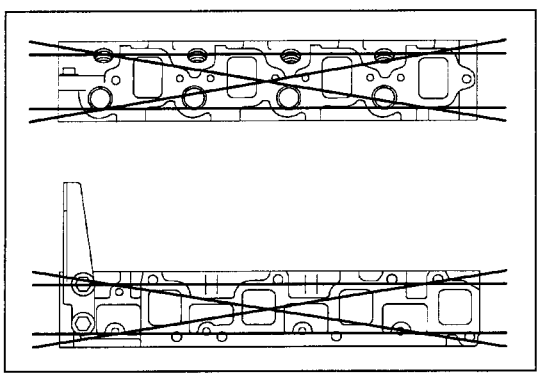


[Point 4]
Removal:
Loosen the cylinder head bolts evenly in 2 to 3 steps in the order shown to the left.
Installation:
Tighten the cylinder head bolts evenly in 2 to 3 steps in the reverse order shown to the left.



[Point 5]
Inspection:
1. Check distortion along the four edges and along the diagonal lines at the bottom of the cylinder head.

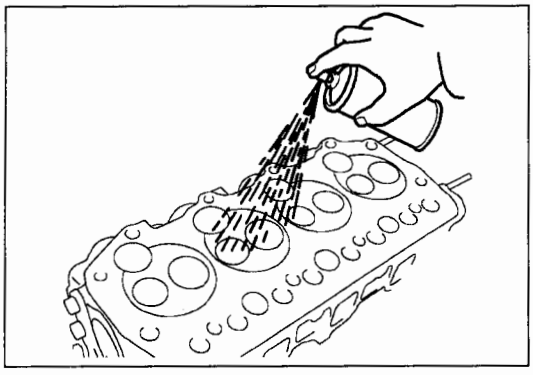
Limit: 0.15 mm (0.0059 in.)



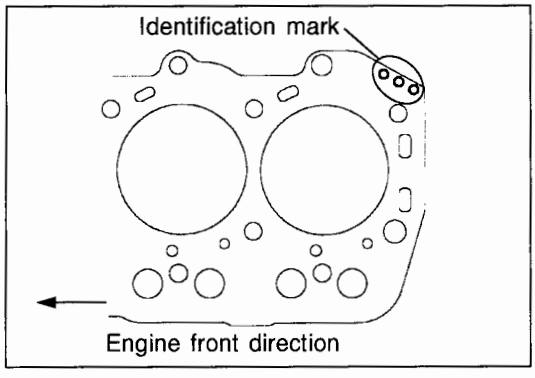
2. Check distortion in the manifold fitting surface.

Limit: IN·EX 0.20 mm (0.008 in)

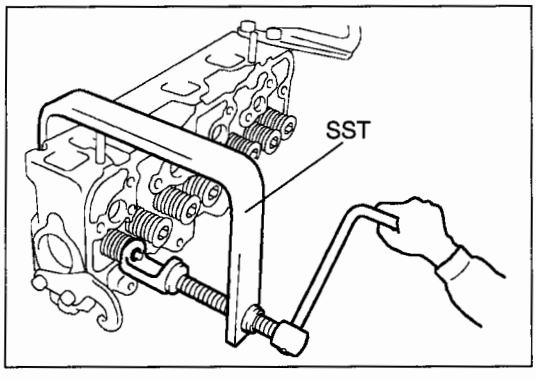
If the limit is exceeded, repair or replace.



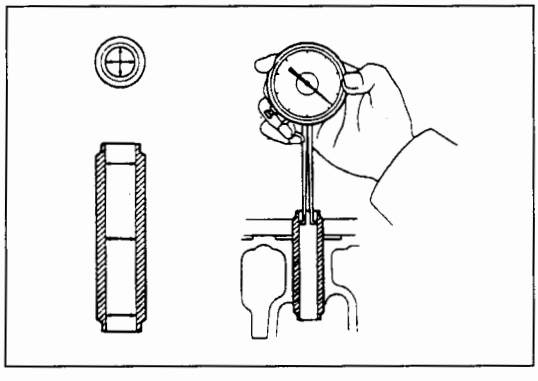
Inspections:
Check the cylinder head for cracks. Using the color check method (dye detection method), look for cracks in the combustion chamber, intake port, exhaust port, and the lower and upper cylinder head surfaces.

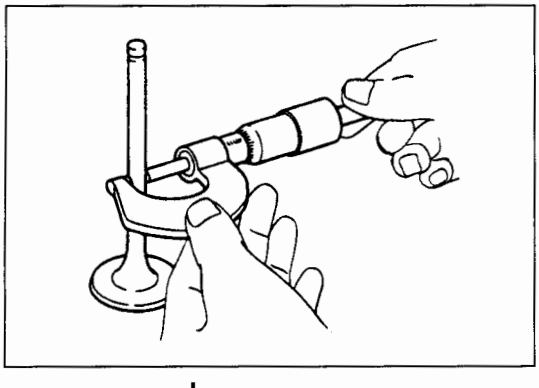


[Point 6]
Installation:
1. Put the new gasket with the identification mark facing backward and upside.

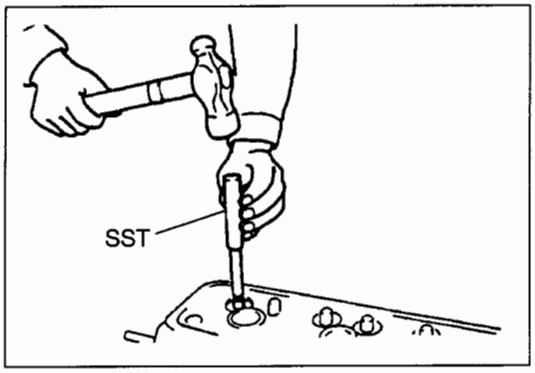


[Point 7]
Removal · installation:
SST 09202-70020
Removal:
Keep the removed parts in cylinder groups.

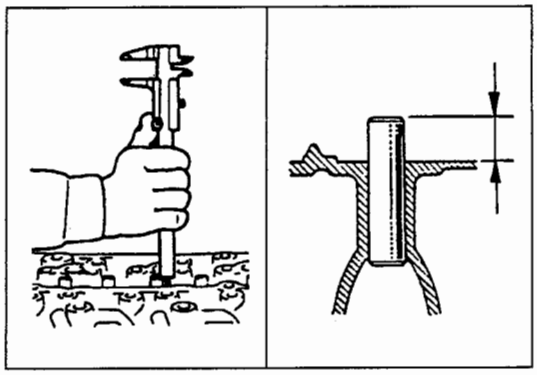




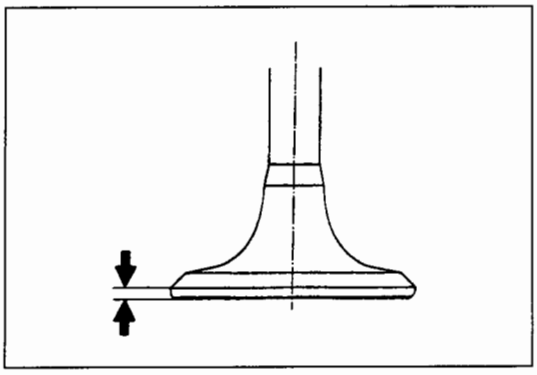
Inspection:
Check the oil clearance between the valve guide bushing and the valve stem.
1. Measure the inside diameter of the valve guide bushing.
   Standard:
   IN: 8.01 ~ 8.03 mm (0.3154 ~ 0.3161 in.)
   EX: 8.01 ~ 8.03 mm (0.3154 ~ 0.3161 in.)
2. Measure the outside diameter of the valve stem.
   Standard:
   IN: 7.97 ~ 7.99 mm (0.3138 ~ 0.3146 in.)
   EX: 7.96 ~ 7.97 mm (0.3134 ~ 0.3138 in.)
3. Calculate the oil clearance.
   Standard:
   IN: 0.02 ~ 0.06 mm (0.0008 ~ 0.0024 in.)
   EX: 0.04 ~ 0.07 mm (0.0016 ~ 0.0028 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.



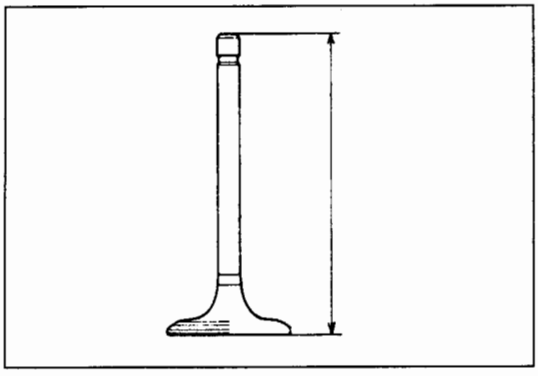
4. Valve guide bushing replacement
   SST 09201-60011



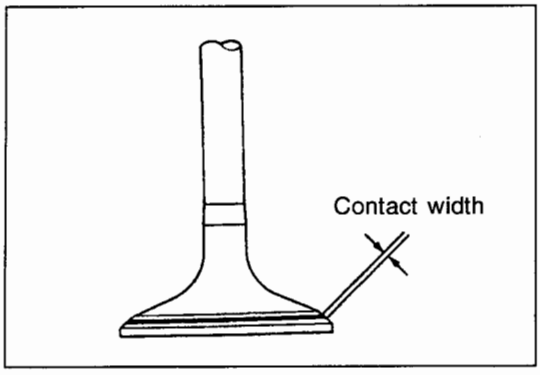
5. Measure the amount of protrusion of the valve guide bushing.
   Standard: 16.6 ± 0.4 mm (0.6535 ± 0.0157 in.)



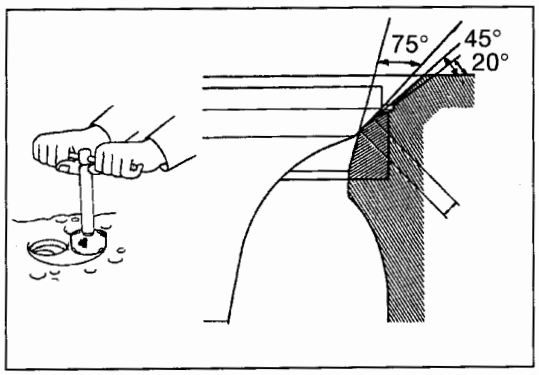
Inspection:
Inspect the valve.
1. Measure the thickness of the valve head.
   Limit:
   IN: 0.9 mm (0.035 in.)
   EX: 1.0 mm (0.039 in.)



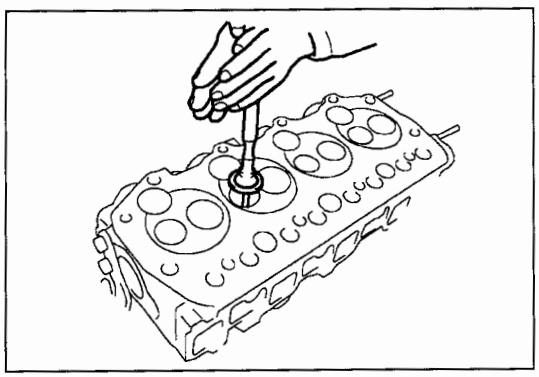
2. Measure the overall length of the valve.
   Standard:
   IN: 108.54 mm (4.2732 in.)
   EX: 108.24 mm (4.2614 in.)
   Limit:
   IN: 107.90 mm (4.2480 in.)
   EX: 107.60 mm (4.2362 in.)



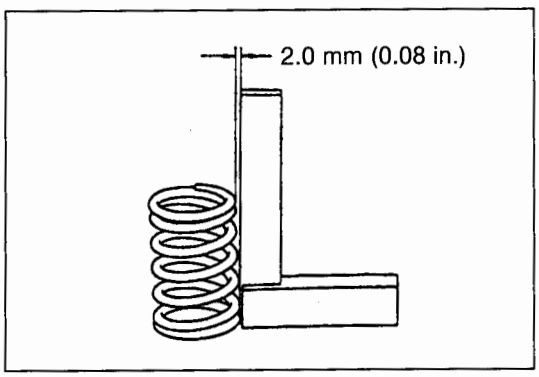
Inspection:
Inspect the valve seat.
1. Apply a thin coat of red lead on the valve face.
2. Insert the valve into the valve guide bushing, and push the valve against the valve seat.
   Do not rotate the valve while it is being pushed.
3. Check that the standard contact is met along the entire circumference.
   Standard:
   IN: 1.2 ~ 1.6 mm (0.0472 ~ 0.0630 in.)
   EX: 1.6 ~ 2.0 mm (0.0630 ~ 0.0787 in.)
   If the standard is not satisfy, replace valve or correct the valve seat.



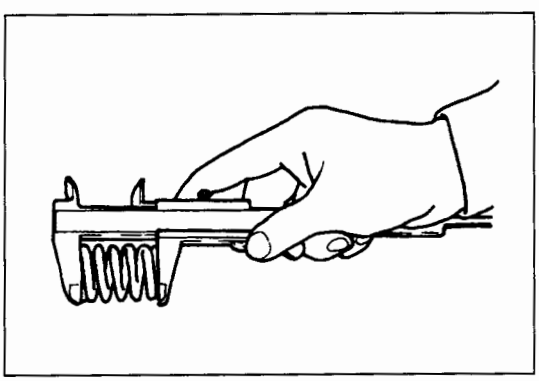
4. Valve seat correction
   (1) Use a 45° valve seat cutter for refacing.
   (2) If the contact position is deviated inside, use a 75° cutter for refacing. If the contact position is deviated outside, use a 20° cutter.
   Use a cutter with a cemented carbide tip on the EX side.
   Proceed carefully while 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.



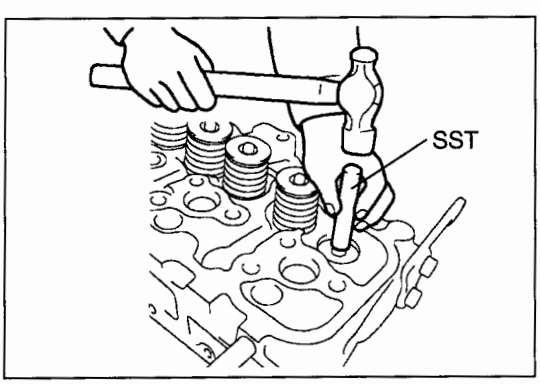
   (3) Use a compound for lapping. Use red lead for checking uniform contact with the valve along the entire circumference.
   After lapping the valve, thoroughly wipe off the compound.



Inspection:
Inspect the compression spring.
1. Check squareness at the upper end of the spring.
   Limit: IN · EX 2.0 mm (0.08 in.)



2. Measure the free length.
   Standard: IN · EX 46.0 mm (1.811 in.)
   Limit: IN · EX 45.5 mm (1.791 in.)

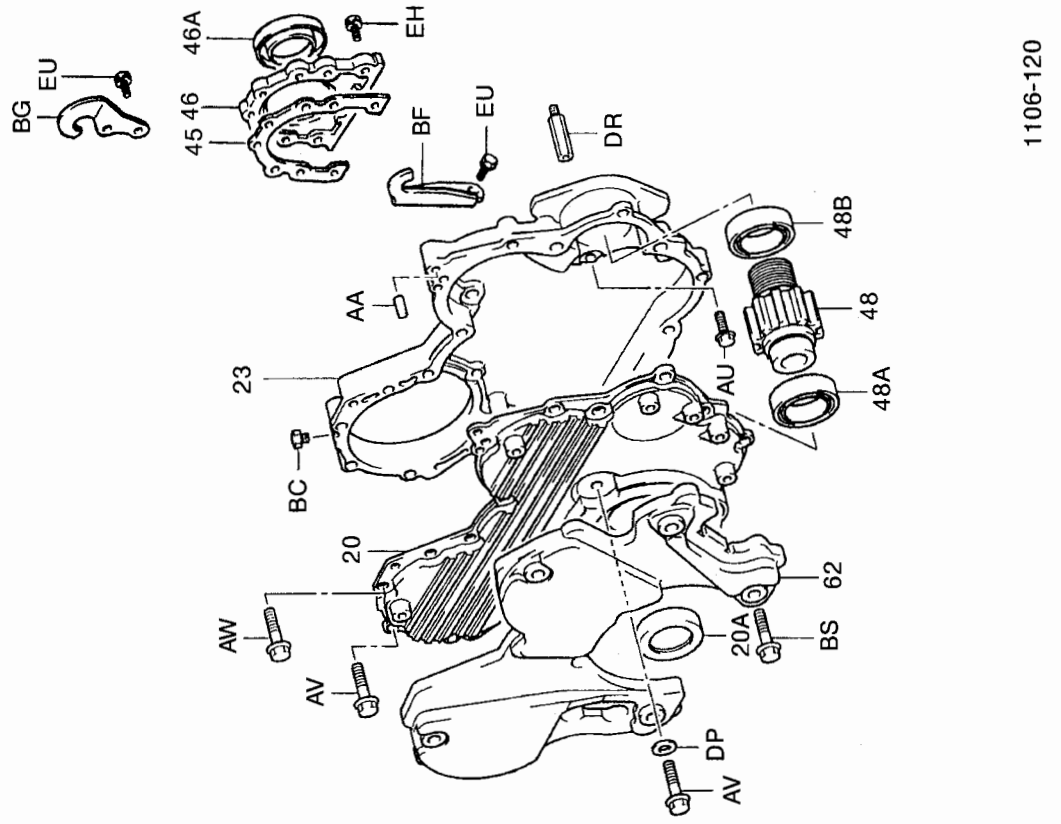


[Point 8]
Removal:
Pry oil seals off with a slight force using a flat blade screwdriver.
Installation:
Coat engine oil on the lips of the new valve stem oil seal and the valve stem.
SST 09201-58011

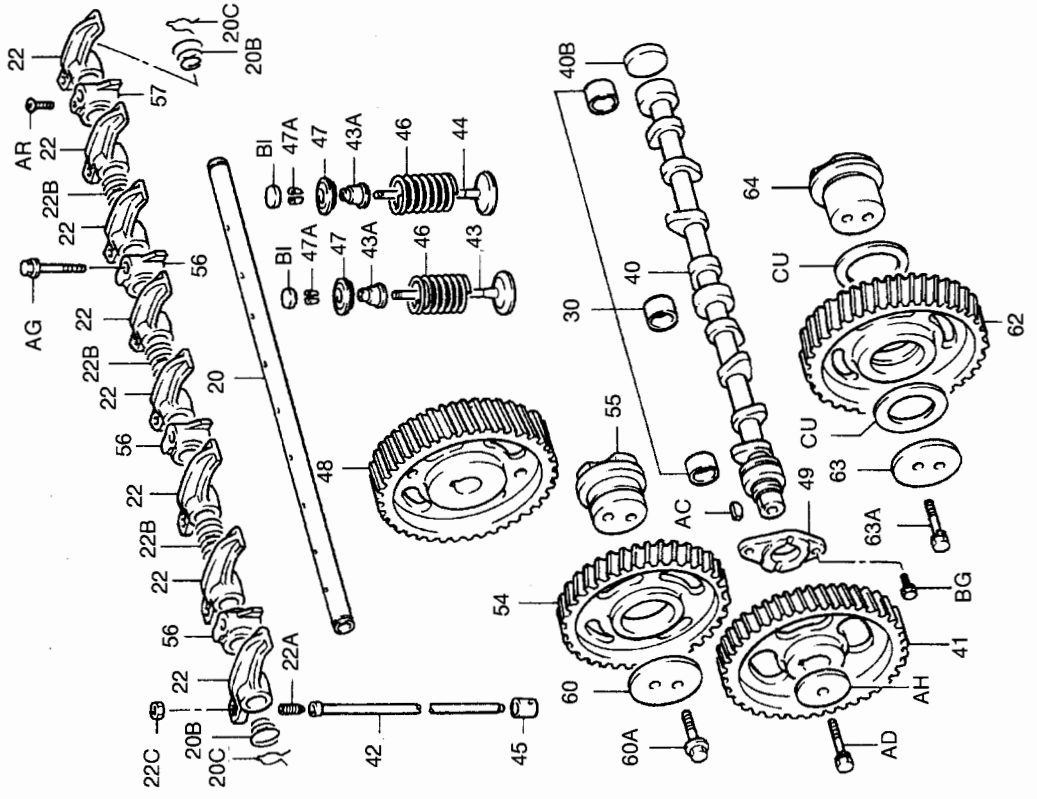
TIMING GEAR

COMPONENTS

1106

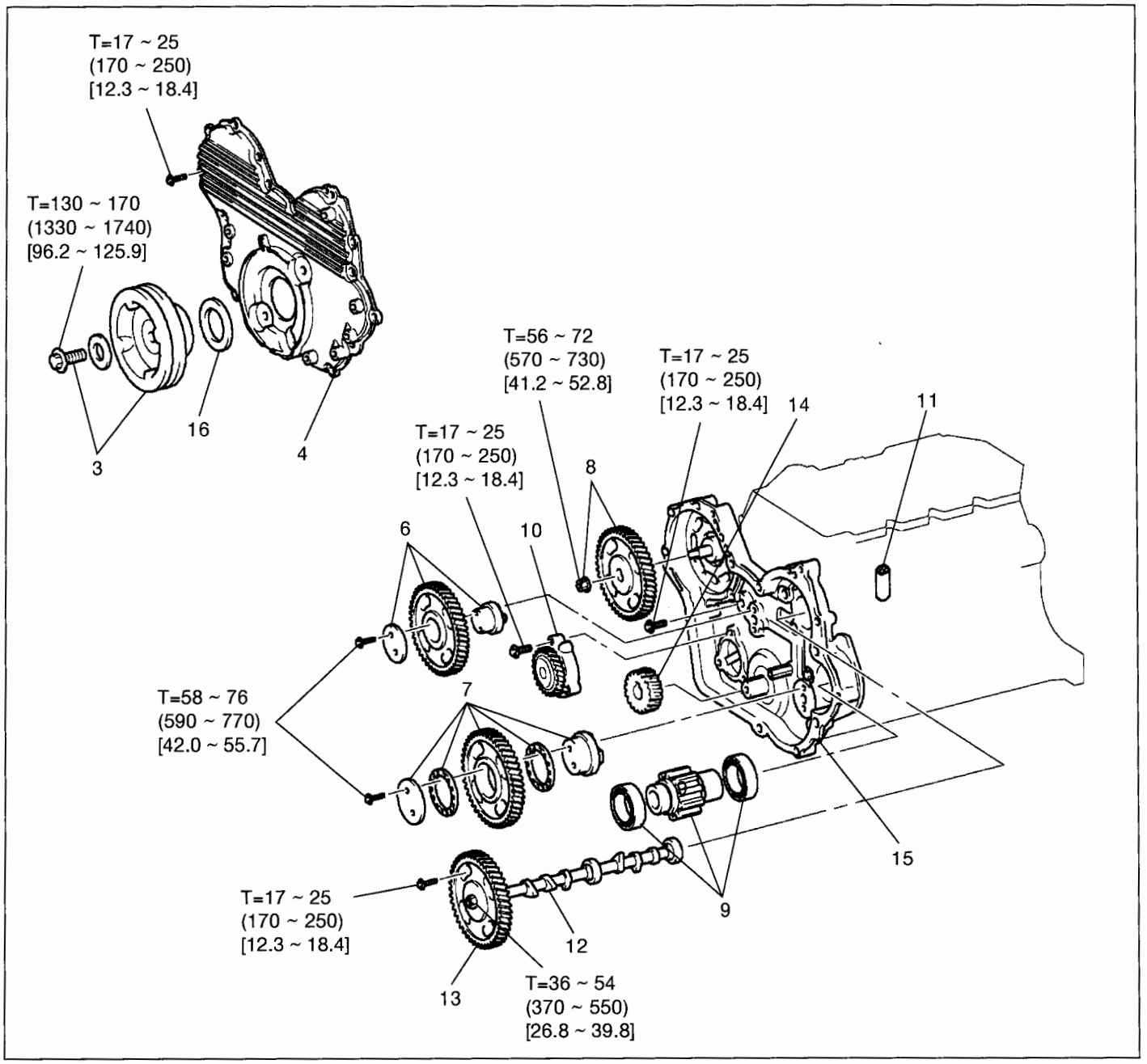


1302



REMOVAL · INSTALLATION

T=N·m (kgf-cm) [ft-lbf]



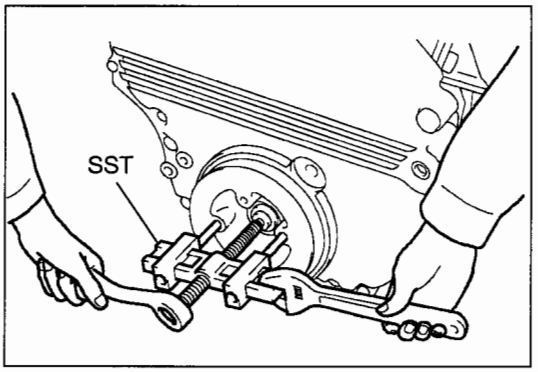
Removal Procedure

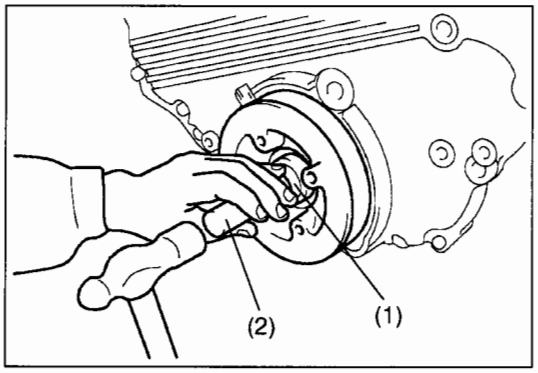
1 Remove the fan pulley, V belt and alternator. (See page on 2-2.)
2 Remove the cylinder head ASSY. (See page on 2-2.)
(Cylinder head removal is unnecessary for other than the camshaft timing gear removal.)
3 Remove the crankshaft pulley and set bolt. **[Point 1]**
4 Remove the timing gear cover. **[Point 2]**
5 Measure the backlash and idle gear thrust clearance. **[Point 3]**
6 Remove idle gear No.1, thrust washer and shaft. **[Point 4]**
7 Remove idle gear No.2, thrust washer and shaft. **[Point 4]**
8 Remove the injection pump drive gear. **[Point 5]**
9 Remove the PTO pump drive gear W/bearing. **[Point 6]**
10 Remove the oil pump ASSY. (See page on 5-5.)
11 Remove the valve lifter. **[Point 7]**
12 Remove the camshaft W/timing gear. **[Point 8]**

13 Remove the camshaft timing gear. **[Point 9]**
14 Remove the crankshaft timing gear. **[Point 10]**
15 Remove the timing gear case.
16 Remove the front oil seal. **[Point 11]**

Installation Procedure

Installation procedure is the reverse of the removal procedure.
Note:
Apply a thin coat of MP grease on the oil seal lips.

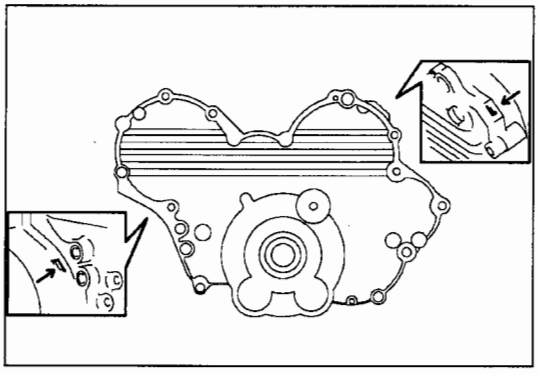




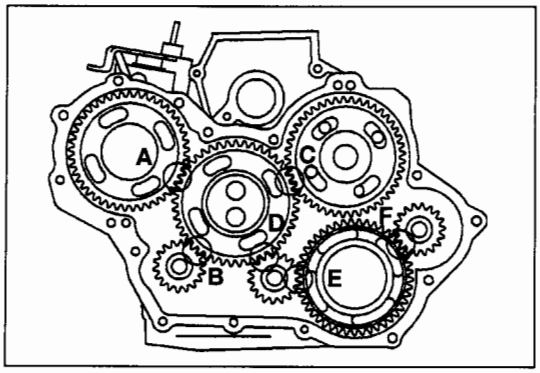
Point Operations

[Point 1]
Removal:
SST 09950-50012

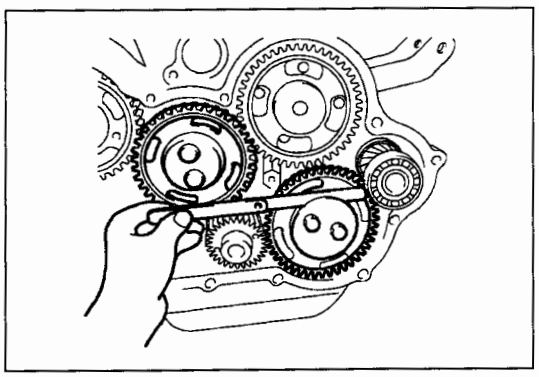
Installation:
SST 09950-60010 ..... (1)
09950-70010 ..... (2)



[Point 2]
Removal:
If the cover is hard to remove, apply a screwdriver to the slit in the cover and pry off the cover.
At this time, use care not to damage surfaces of the cover other than the slit.
Installation:
When reinstalling the cover, completely remove old sealant from the cover and case and apply fresh sealant by following the correct application procedure. (See page on 2-2.)
FIPG: 08826-00080



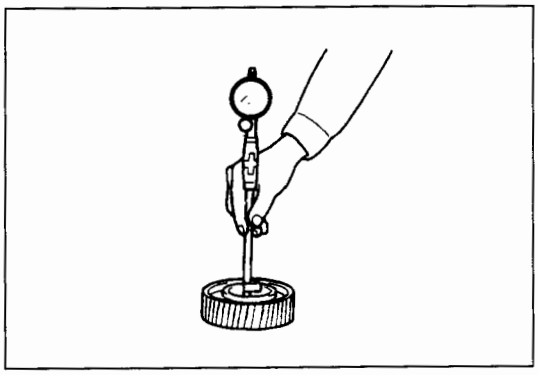
[Point 3]
Inspection:
1. Measure gear backlash before removal and after installation at A to F portion.
Standard: 0.05 mm (0.0020 in)
Limit: 0.30 mm (0.0118 in)



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

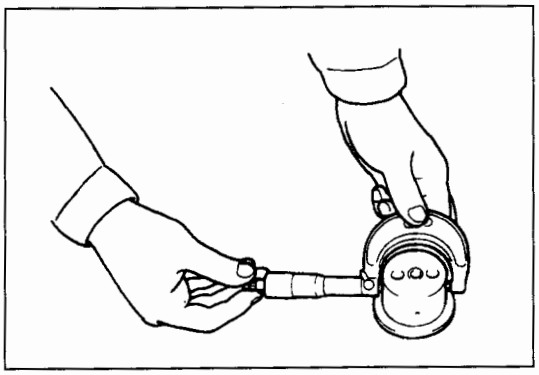
Standard:
No.1 0.03 ~ 0.11 mm (0.0012 ~ 0.0043 in.)
No.2 0.10 ~ 0.26 mm (0.0039 ~ 0.0102 in.)

Limit:
No.1: 0.3 mm (0.012 in.)
No.2: 0.5 mm (0.020 in.)



[Point 4]
Inspection:
Check the idle gear oil clearance.
1. Measure the inside diameter of the idle gear.

Standard:
No.1: 45.000 ~ 45.025 mm (1.77165 ~ 1.77263 in.)
No.2: 50.000 ~ 50.025 mm (1.96700 ~ 1.96948 in.)

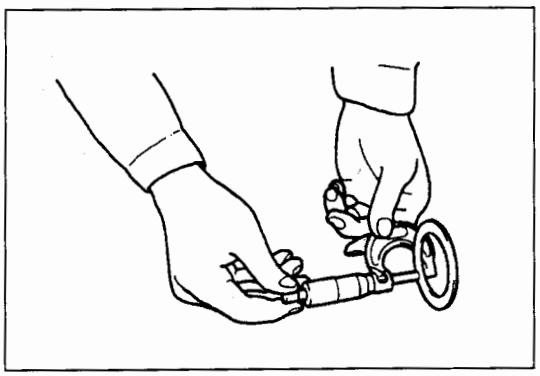


2. Measure the outside diameter of the idle gear shaft.

Standard:
No.1: 49.950 ~ 44.975 mm (1.76968 ~ 1.77067 in.)
No.2: 49.930 ~ 49.945 mm (1.96574 ~ 1.96633 in.)

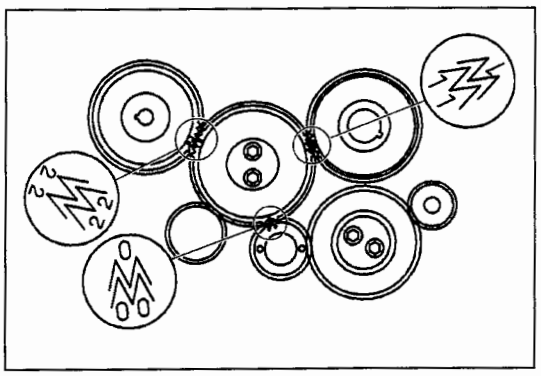
3. Calculate the oil clearance.

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.)

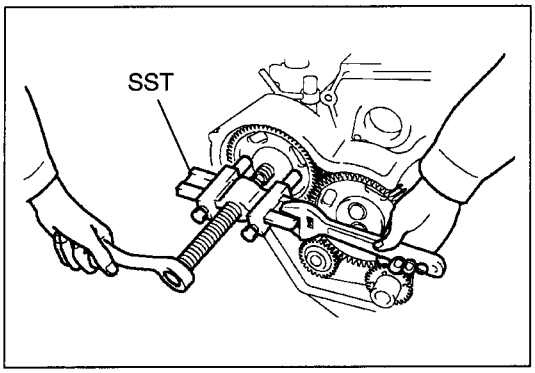


Inspection:
Measure the plate washer thickness.

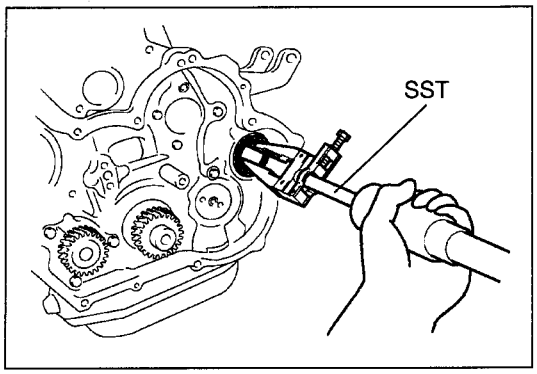
Standard: 2.45 ~ 2.50 mm (0.0964 ~ 0.0984 in.)



Installation:
Check to see that No.1 cylinder is TDC.
Install the idle gears. When doing so, align the punched matching marks with the marks on the other gears.

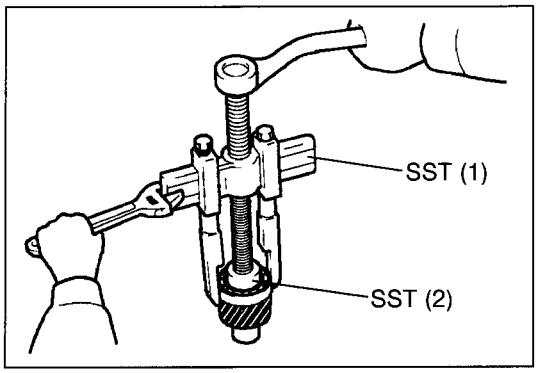


[Point 5]
Removal:
Remove the injection pump drive gear.
SST 09950-50012

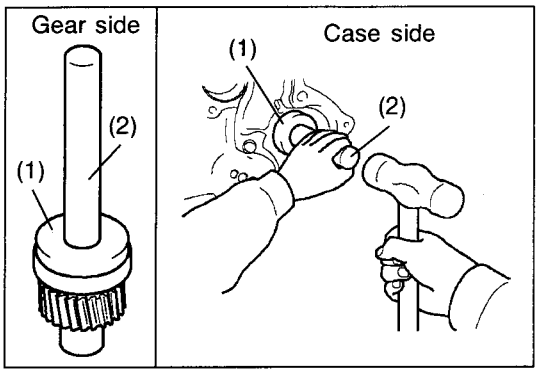


[Point 6]
Removal:
Remove the bearing.

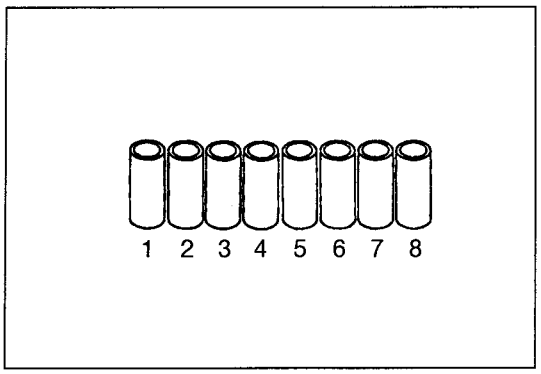
Case side:
SST 09320-23000-71



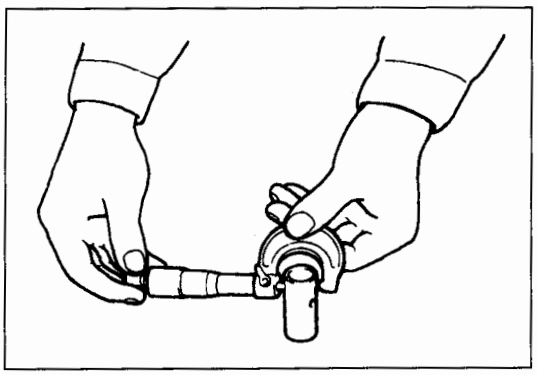
Gear side:
SST 09950-40011 ..... (1)
09950-60010 ..... (2)



Installation:
Case and gear side:
SST 09950-60010 ..... (1)
09950-70010 ..... (2)



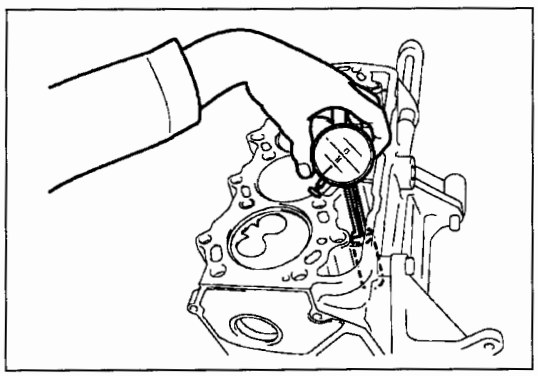
[Point 7]
Removal:
Keep the removed valve lifters carefully so they can be installed in a correct order.



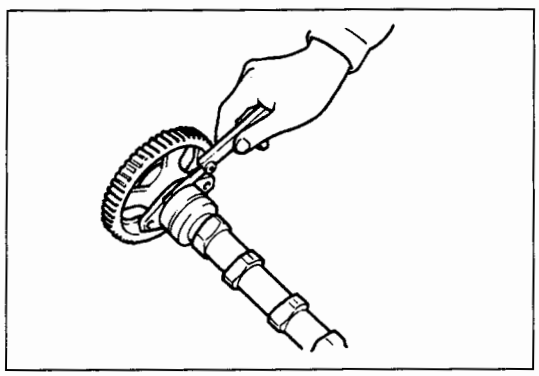
Inspection:
Check the valve lifter oil clearance.
1. Measure the outside diameter of the valve lifter.

Standard: 22.170 ~ 22.190 mm (0.8728 ~ 0.8736 in.)

O/S 0.05 mm (0.0020 in.) lifter standard:
22.220 ~ 22.240 mm (0.8748 ~ 0.8755 in.)

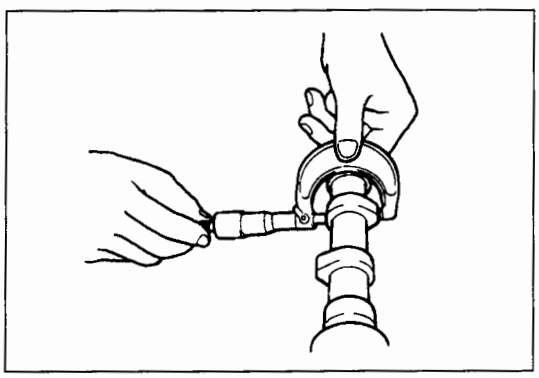


2. Measure the inside diameter of the cylinder block valve lifter hole.
Standard: 22.200 ~ 22.221 mm (0.87401 ~ 0.87484 in.)
3. Calculate the valve lifter oil clearance.
Standard: 0.010 ~ 0.051 mm (0.00039 ~ 0.00201 in.)
Limit: 0.1 mm (0.004 in.)
If the limit is exceeded, replace with STD or O/S valve lifter. If an O/S valve lifter is to be used, correct the inside diameter of the valve lifter hole to specifications.
O/S valve lifter hole inside diameter standard:
22.245 ~ 22.271 mm (0.87579 ~ 0.87681 in.)



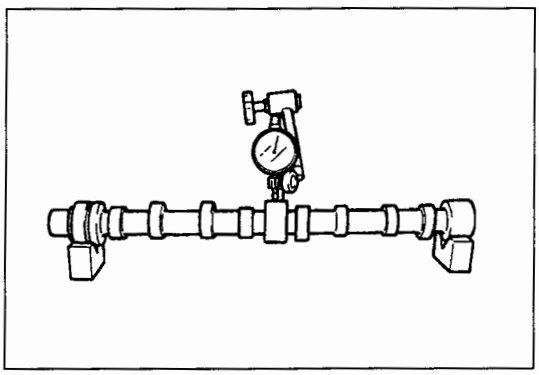
[Point 8]
Inspection:
Check the camshaft thrust clearance.

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



Inspection:
Measure the cam height.
Standard:
IN: 39.928 ~ 40.028 mm (1.57197 ~ 1.57590 in.)
EX: 40.312 ~ 40.412 mm (1.58708 ~ 1.59102 in.)

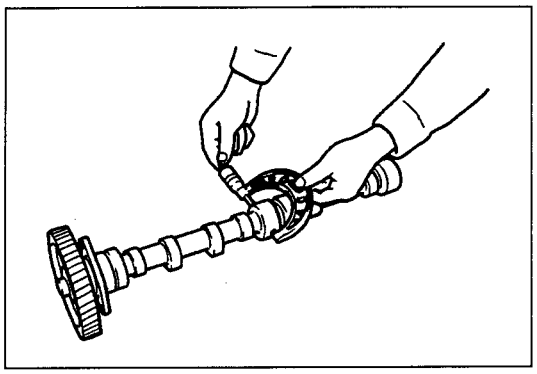
Limit:
IN: 39.47 mm (1.5539 in.)
EX: 39.85 mm (1.5689 in.)

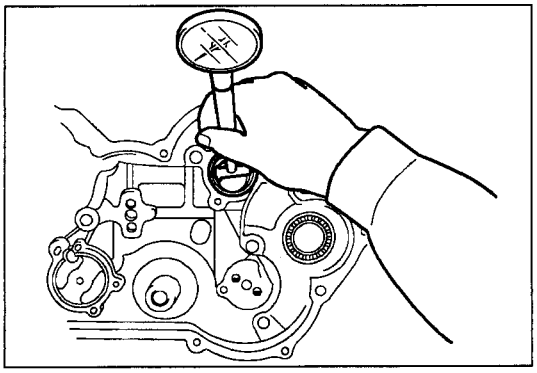


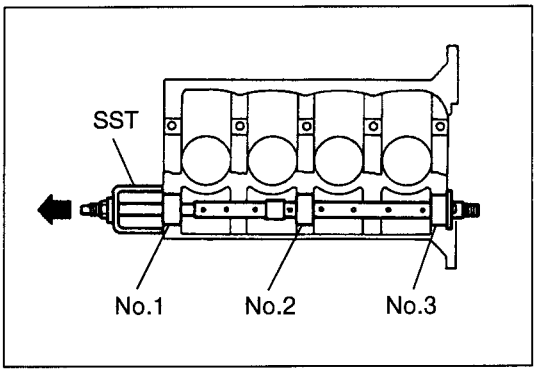
Inspection:
Check the camshaft for bend.

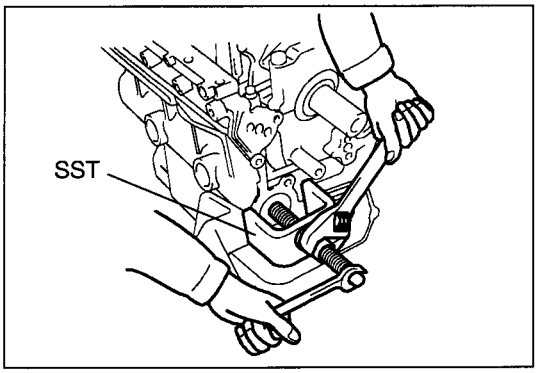
$$\text{Bend} = \frac{\text{Dial gauge deflection}}{2}$$

Limit: 0.04 mm (0.0016 in.)









Inspection:

Check the camshaft bearing oil clearance.

1. Measure the outside diameter of the camshaft journal.

Standard:

No.1 (front)	**47.159 ~ 47.175 mm (1.85665 ~ 1.85728 in.)**
No.2 (center)	**46.959 ~ 46.975 (1.84878 ~ 1.84870 in.)**
No.3 (rear)	**46.759 ~ 46.775 mm (1.84090 ~ 1.84153 in.)**

2. Measure the inside diameter of the camshaft bearing.

Standard:

No.1 (front)	**47.200 ~ 47.225 mm (1.85826 ~ 1.85925 in.)**
No.2 (center)	**47.000 ~ 47.025 mm (1.85039 ~ 1.85137 in.)**
No.3 (rear)	**46.800 ~ 46.825 mm (1.84252 ~ 1.84350 in.)**

3. Calculate the oil clearance.

Standard: 0.025 ~ 0.066 mm (0.00098 ~ 0.00260 in.)

Limit: 0.1 mm (0.0039 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.

Removal:

Remove the camshaft bearing.

1. Remove the oil pan.
   SST 09032-00100
2. Remove the oil strainer.
3. Remove the camshaft expansion plug.
   SST 09215-00101
4. Remove the camshaft bearing No.1 and No.3.
   SST 09215-00101
5. Remove the camshaft bearing No.2.
   SST 09215-00101

Installation:

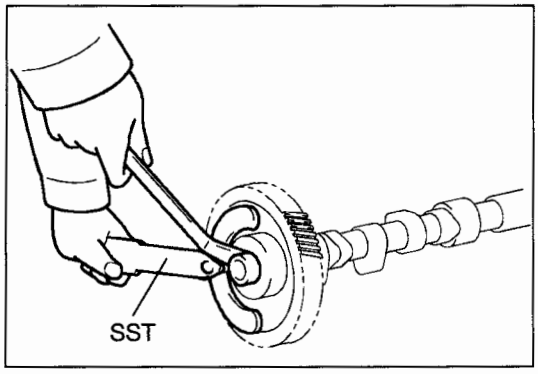
Install the camshaft bearing.

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

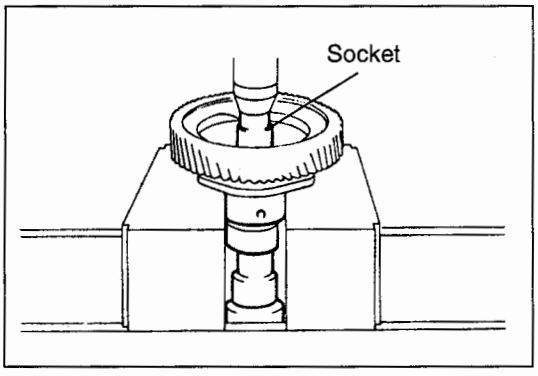
1. Install the camshaft bearing No.2.
   SST 09215-00101
2. Install the camshaft bearing No.1 and No.3.
   SST 09215-00101
3. Use a new tight plug, apply THREEBOND 1386 to the outer periphery, and drive the bearings until they are flush with the cylinder block.
   SST 09215-00101
4. Install the oil pan.

Camshaft bearing size

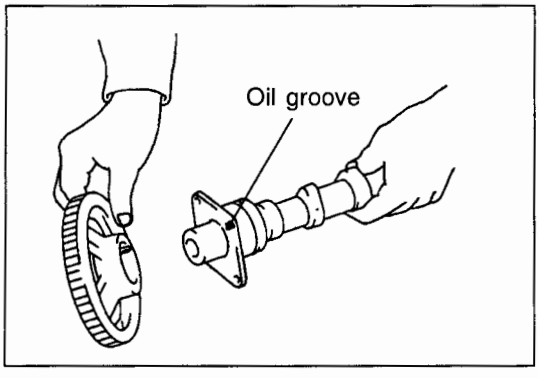
Bearing type	Standard outside diameter of camshaft journals mm (in.)		
	No.1	No.2	No.3
STD	47.159~47.175(1.85665~1.85728)	46.959~46.975(1.84878~1.84941)	46.759~46.775(1.84090~1.84153)
U/S 0.125	47.034~47.050(1.85173~1.85236)	46.834~46.850(1.84385~1.84448)	46.634~46.650(1.83598~1.83661)
U/S 0.250	46.909~46.925(1.84680~1.84744)	46.709~46.725(1.83893~1.83956)	46.509~46.525(1.83106~1.83169)



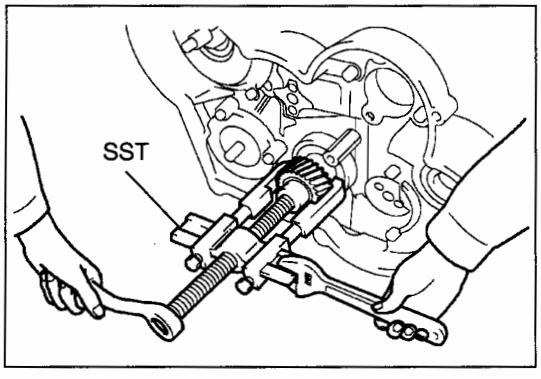
[Point 9]
Removal · installation:
Remove the camshaft timing gear set bolt.
SST 09960-10010



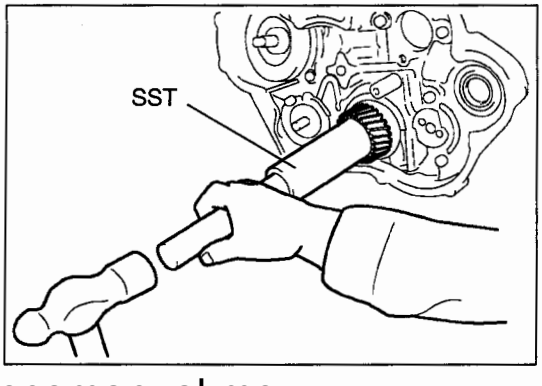
Removal:
Remove the camshaft timing gear using a press.



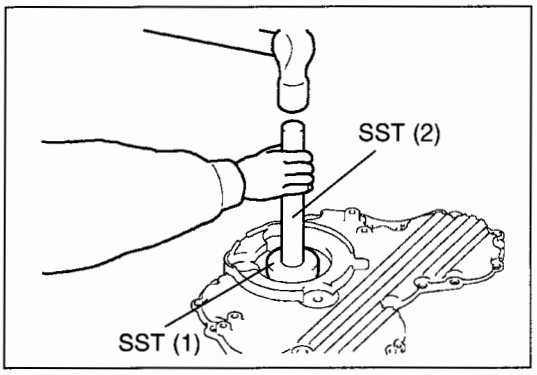
Installation:
Install the thrust plate with the oil groove facing the gear.



[Point 10]
Removal:
SST 09950-40011



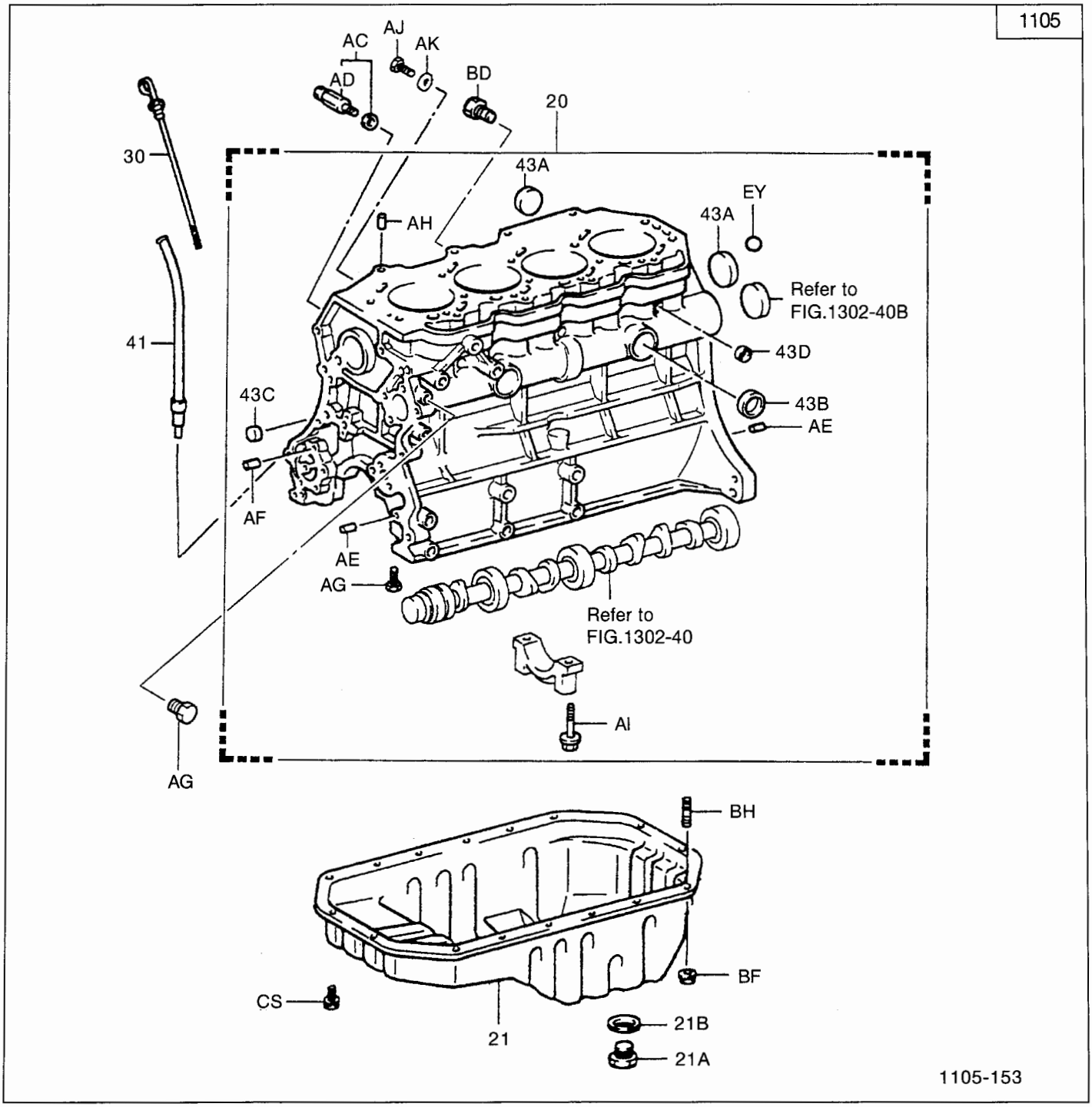
Installation:
SST 09370-20270-71



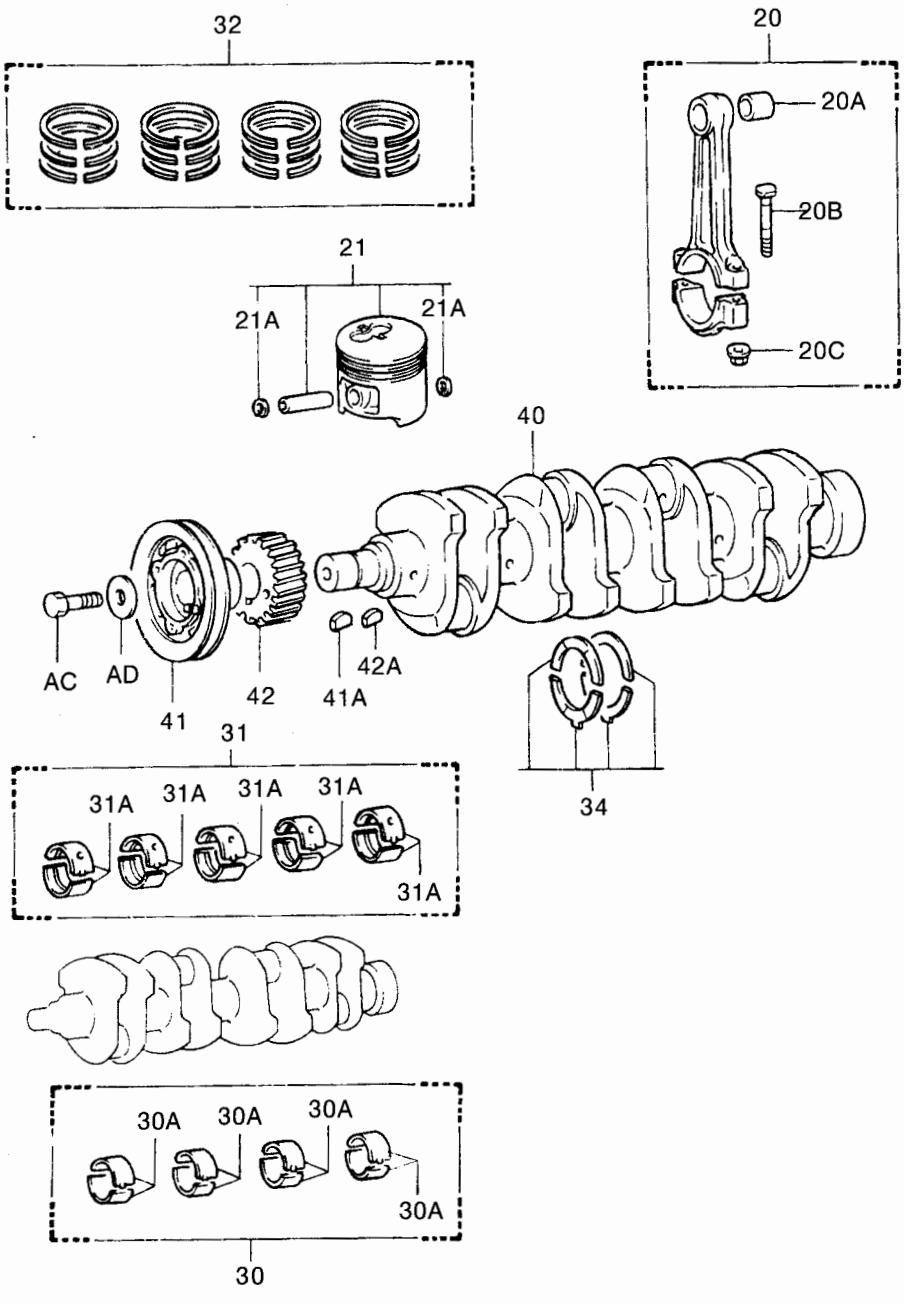
[Point 11]
Installation:
Drive in the oil seal until it becomes flush with the timing gear cover surface.
SST 09950-60020 ..... (1)
09950-70010 ..... (2)

CYLINDER BLOCK

COMPONENTS



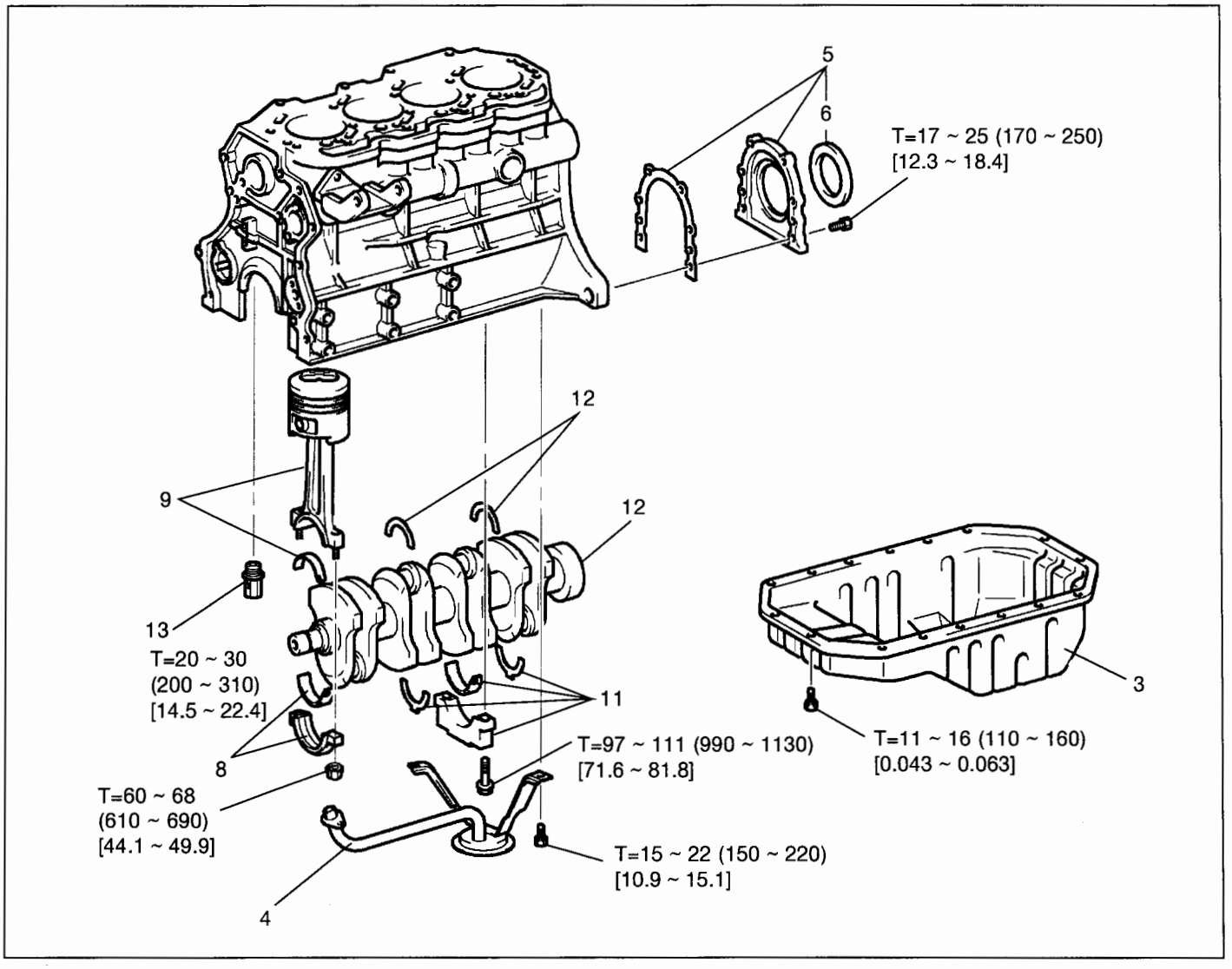
1301



1301-089

REMOVAL · INSTALLATION

T=N·m (kgf-cm) [ft-lbf]



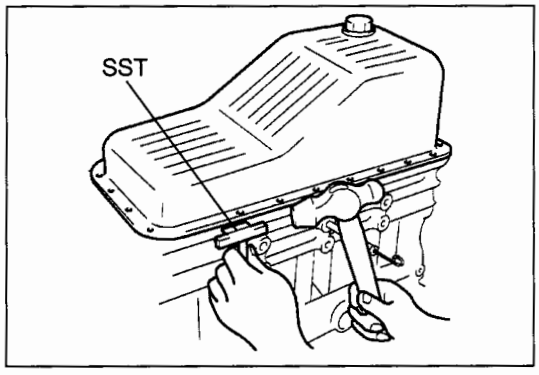
Removal Procedure

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

Installation Procedure

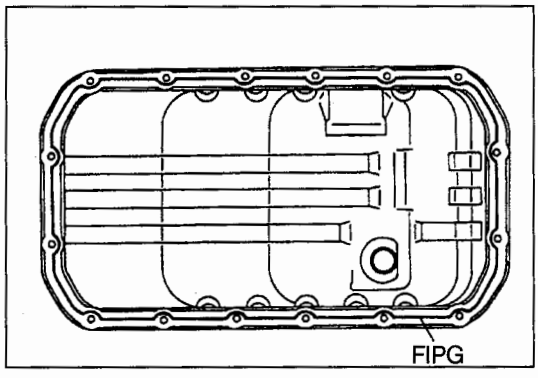
Installation procedure is the reverse of the removal procedure.

Note:
Keep the removed parts in order to prevent installation in incorrect positions.

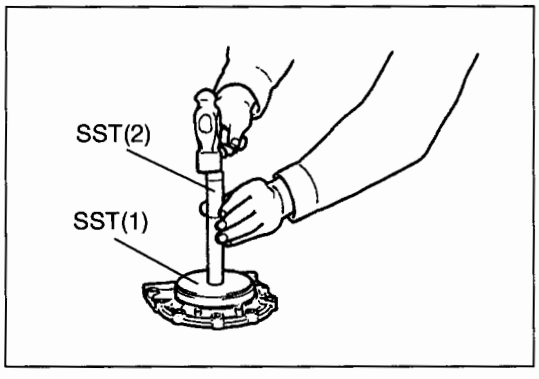


Point Operations

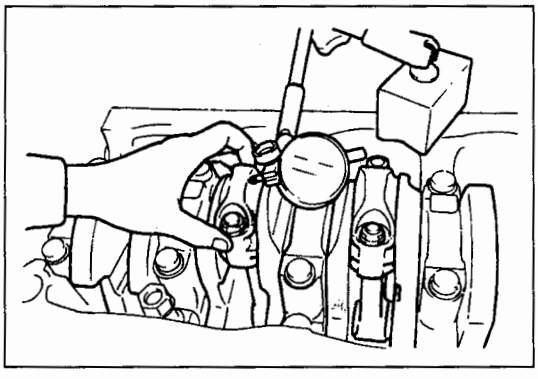
[Point 1]
Removal:
Work carefully without deforming the oil pan flange.
Do not attempt prying with a screwdriver, etc.
SST 09032-00100



Installation:
Apply FIPG to the oil pan seal.
FIPG: 08826-00080
(See page on 2-2 to dealing with FIPG)

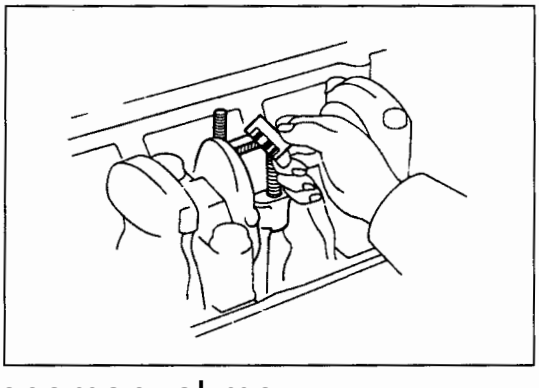


[Point 2]
Installation:
SST 09320-10410-71 ..... (1)
SST 09160-10710-71 ..... (2)

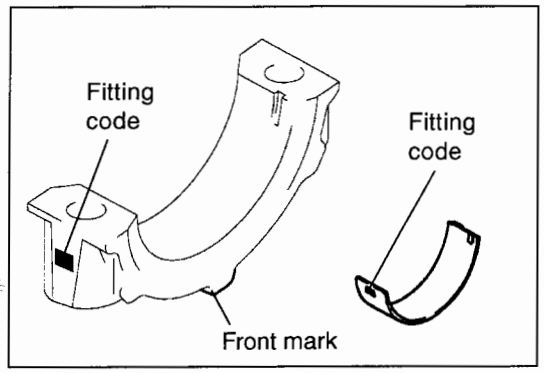


[Point 3]
Inspection:
Measure thrust clearance of the connecting rod before removal.

Standard: 0.08 ~ 0.30 mm (0.0031 ~ 0.0118 in.)
Limit: 0.40 mm (0.0157 in.)



[Point 4]
Inspection:
Measure oil clearance of the connecting rod bearing. Measure by plastigage, and tight the connecting rod set nut to specified torque.
Do not rotate the crankshaft during measurement.
Standard: 0.044 ~ 0.080 mm (0.00173 ~ 0.00315 in.)
0.11 mm (0.0043 in.)
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.

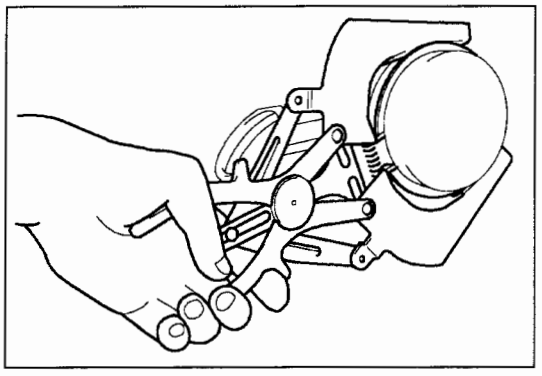


Bearing cap fitting code	Bearing fitting code	Standard crankpin outside diameter mm (in.)
1 2 3	1 2 3	50.48 ~ 50.50 (1.9874 ~ 1.9882)
U/S 0.25		50.23 ~ 50.25 (1.9776 ~ 1.9783)
U/S 0.50		49.98 ~ 50.00 (1.9677 ~ 1.9685)
U/S 0.75		49.73 ~ 49.75 (1.9579 ~ 1.9587)
U/S 1.00		49.48 ~ 49.50 (1.9480 ~ 1.9488)

Installation:

Install the connecting rod caps.

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.

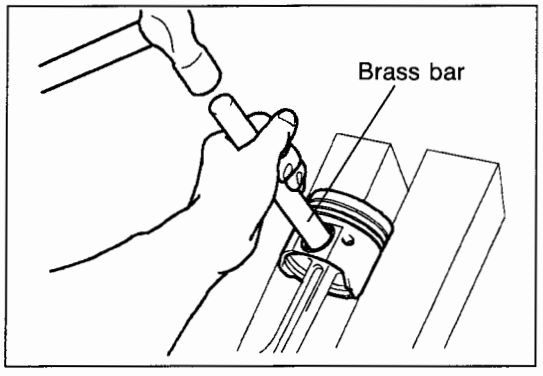


[Point 5]

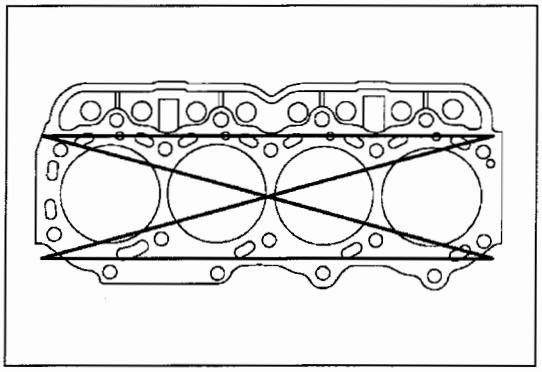
Removal:

Disassemble the piston and connecting rod.

1. Remove the piston rings and oil ring.



2. Remove the snap ring, and warm the piston to about 60°C (140°F), and remove the piston pin from piston by using brass bar.
   Keep the pistons, piston pins and connecting rods in cylinder group.



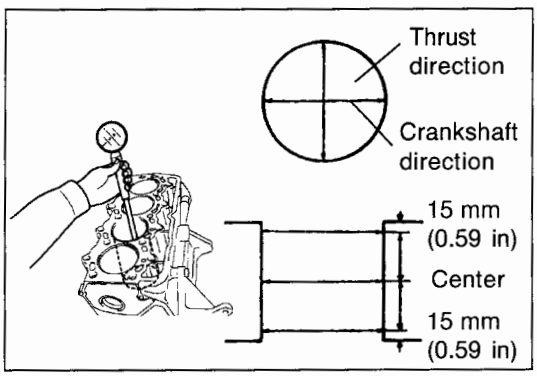
Inspection:

Inspect the cylinder block.

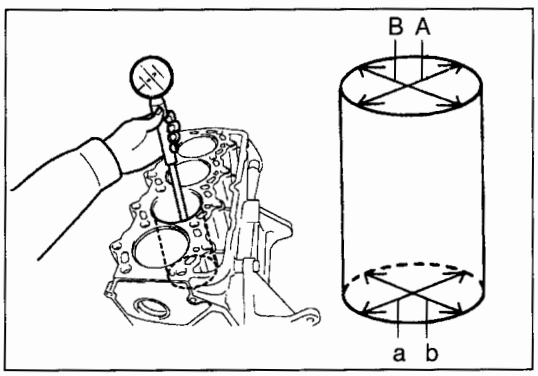
1. Check the cylinder block for distortion in the upper surface.

   Limit: 0.1 mm (0.004 in.)

   Confirm that the cylinder wall is free of serious scratches.



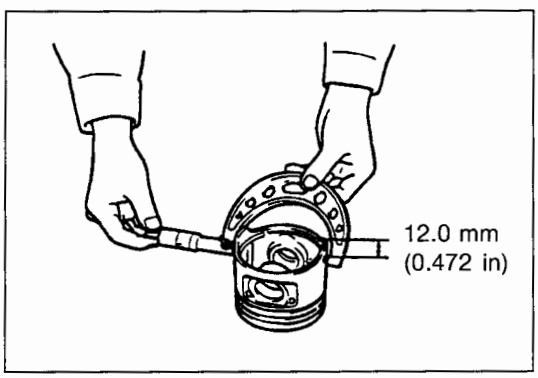
2. Measure the six dimensions as shown, and determine the difference between the maximum and minimum dimensions.
Limit: 0.2 mm (0.008 in.)



3. Check ellipticity and taper.

Ellipticity: A-B or a-b
Taper: A-a or B-b

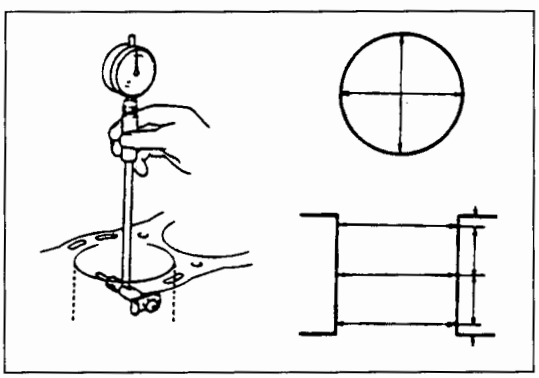
Limit:
Ellipticity: 0.02 mm (0.0008 in.)
Taper: 0.02 mm (0.0008 in.)



4. Measure the piston clearance.
(1) Measure the outside diameter of the piston.

Measuring position:
Measure at a location vertical to the piston pin and 12.0 mm (0.472 in.) away from the piston bottom (skirt).

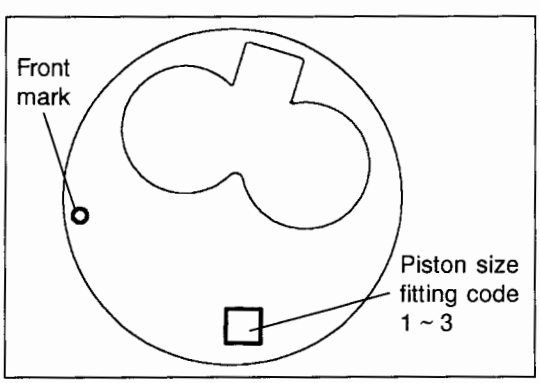
Standard: 85.950 ~ 85.980 mm (3.3839 ~ 3.3850 in.)



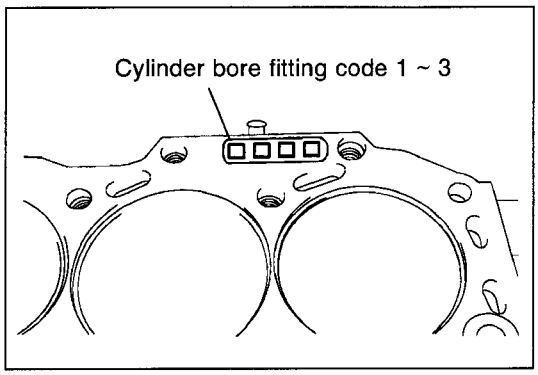
(2) Measure the minimum inside diameter in the thrust direction of the cylinder, and measure the piston clearance.

Standard: 0.040 ~ 0.060 mm (0.00157 ~ 0.00236 in.)
Limit: 0.15 mm (0.0059 in.)

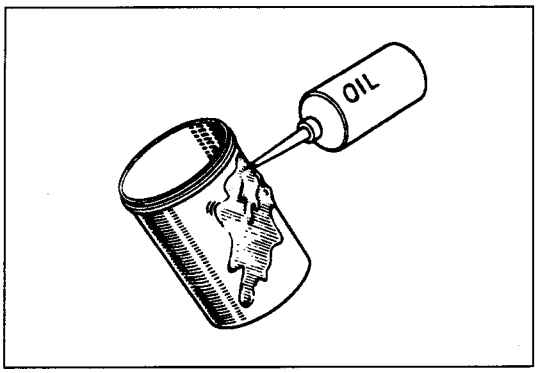
5. If the limit is exceeded in Inspection 2, 3, or 4, replace the piston, or bore the cylinder and install an O/S piston. If there is a wear larger than the limit for O/S piston, use a repair liner (exclusive part).
(1) Piston replacement or cylinder boring



Piston type	Cylinder inside diameter mm (in.)	Piston outside diameter mm (in.)
STD1	86.00 ~ 86.01 (3.3859 ~ 3.3862)	85.95 ~ 85.96 (3.3839 ~ 3.3843)
STD2	86.01 ~ 86.02 (3.3862 ~ 3.3866)	85.96 ~ 85.97 (3.3843 ~ 3.3846)
STD3	86.02 ~ 86.03 (3.3866 ~ 3.3870)	85.97 ~ 85.98 (3.3846 ~ 3.3850)
O/S0.50	86.50 ~ 86.51 (3.4055 ~ 3.4059)	86.45 ~ 86.46 (3.4035 ~ 3.4039)
O/S1.00	87.00 ~ 87.01 (3.4252 ~ 3.4256)	86.95 ~ 86.96 (3.4232 ~ 3.4236)

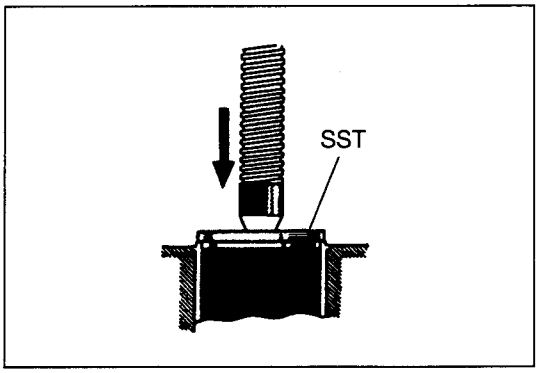


When boring the cylinder, select an appropriate O/S piston on the basis of the minimum inside diameter among all cylinders.
Bored dimension=
(O/S piston outside diameter) + (Oil clearance) – (Boring margin)
Oil clearance: 0.040 ~ 0.060 mm (0.00157 ~ 0.00236)
Boring margin: 0.02 mm (0.008 in.)
When cylinder boring is chosen, measure ellipticity, taper, difference in inside diameter, and piston clearance afterwards.

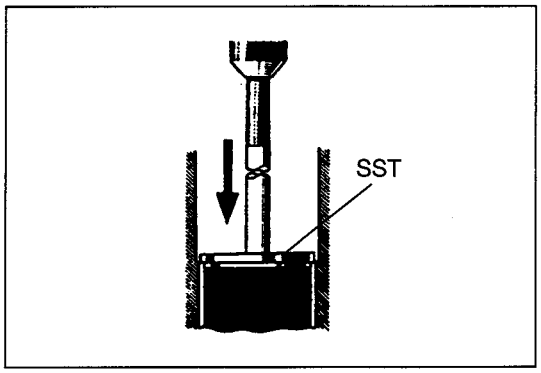


(2) Using the repair liner

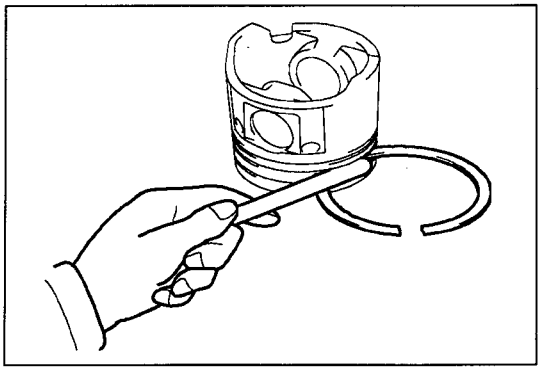
Liner fitting code	Cylinder hole before liner mm (in.)	Cylinder liner outside diameter mm (in.)
A	89.000 ~ 89.015 (3.50393 ~ 3.50452)	89.030 ~ 89.045 (3.50511 ~ 3.50570)
B	89.015 ~ 89.030 (3.50452 ~ 3.50511)	89.045 ~ 89.060 (3.50452 ~ 3.50629)



① Prepare the cylinder block upper surface and the cylinder bottom hole by machining for press-fitting liner.
Refer to 2-34 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 09950-60020

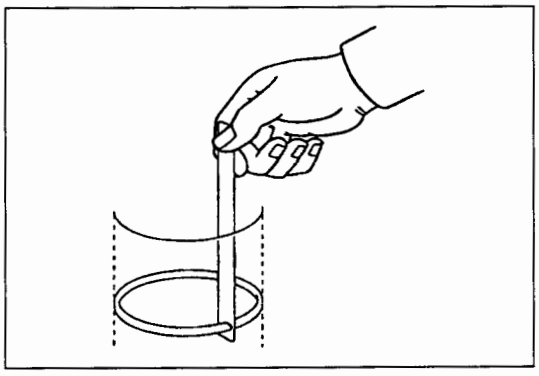


④ When replacing the cylinder liner, remove liner using SST and a press and follow steps ① to ③ above.
SST 09950-60020-71



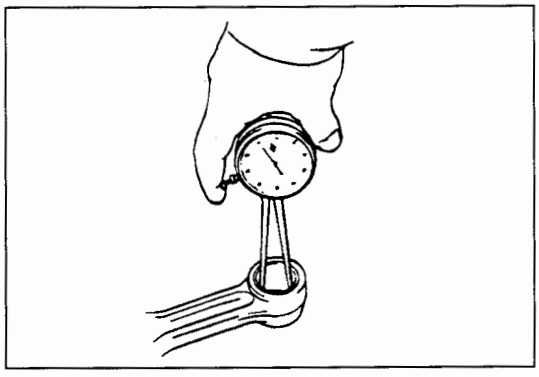
Inspection:
Inspect the piston and connecting rod.
1. Measure the gap between the piston ring and the ring groove along the entire circumference of the piston.

Standard:
No.1: 0.06 ~ 0.09 mm (0.0024 ~ 0.0035 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.)



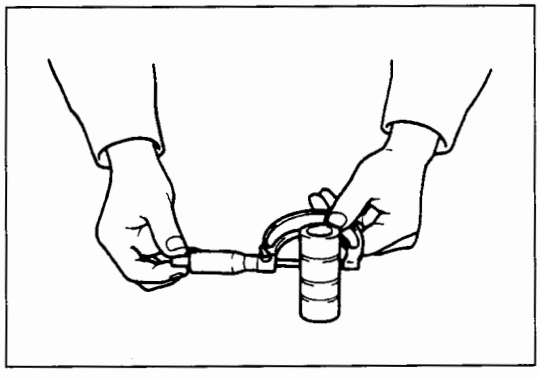
2. Measure the piston ring gap.

Standard:
No.1: 0.27 ~ 0.39 mm (0.0106 ~ 0.0154 in.)
No.2: 0.45 ~ 0.60 mm (0.0177 ~ 0.0236 in.)
Oil ring: 0.20 ~ 0.40 mm (0.0079 ~ 0.0157 in.)



3. Measure the oil clearance of the connecting rod bushing.
(1) Measure the inside diameter of the bushing.

Standard: 27.011 ~ 27.023 mm (1.06342 ~ 1.63896 in.)



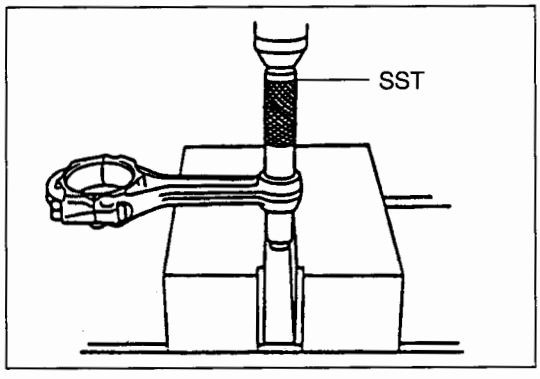
(2) Measure the outside of the piston pin.

Standard: 27.000 ~ 27.012 mm (1.06299 ~ 1.06346 in.)

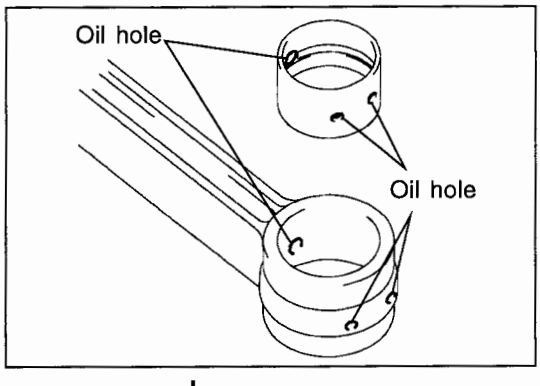
(3) Calculate the oil clearance.

Standard: 0.007 ~ 0.015 mm (0.00028 ~ 0.00059 in.)
Limit: 0.05 mm (0.0020 in.)

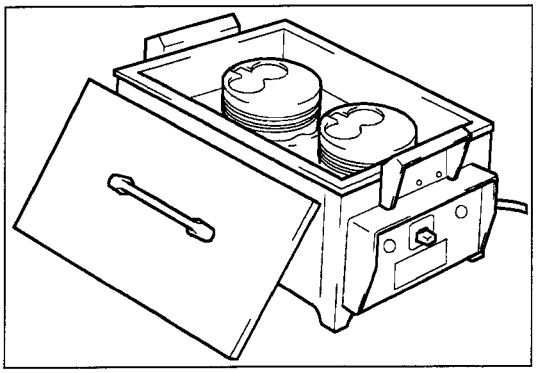
If the limit is exceeded, replace the connecting rod bushing.



4. Replace the connecting rod bushing.
(1) Remove the bushing using SST and a press.
SST 09222-66010



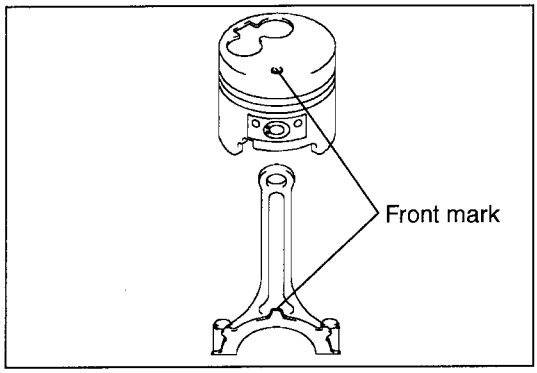
(2) Install the bushing using SST and a press.
Confirm that the oil holes of the connecting rod and of the bushing are aligned correctly.
SST 09222-66010



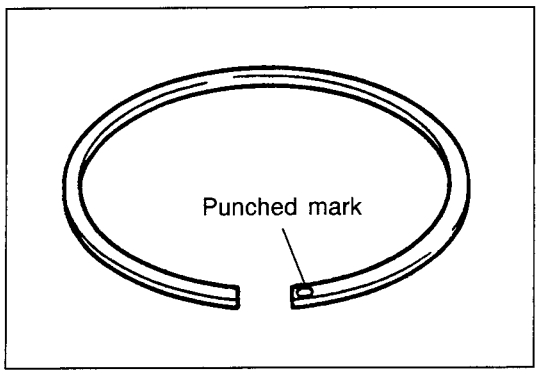
Installation:

Assemble the connecting rod.

1. Fit the snap ring on one side.
2. Warm the piston to about 60°C (140°F).



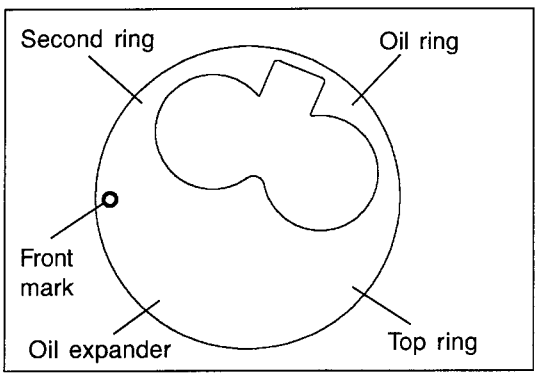
3. Align the front marks on the piston and the connecting rod.
4. Install the piston pin.
5. Fit the snap ring on another side.



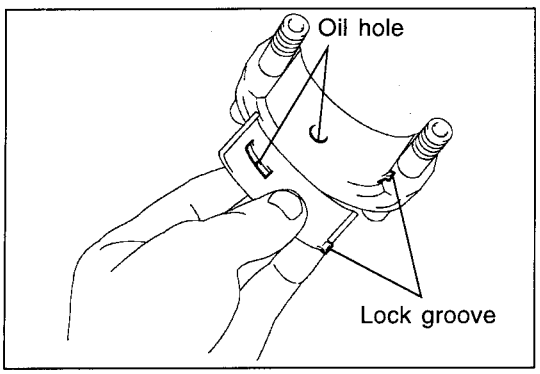
Installation:

Install the piston rings.

1. Install the oil ring expander.
2. Use a piston ring tool, install the oil ring side rail. Oil rings may be installed with either side facing up ward.
3. Install the piston rings with the punched marks facing upward.
   Punched marks
   Top ring..... 1T
   Second ring... 2T
   Oil ring ..... None



4. Position the ring joints as shown.



Installation:

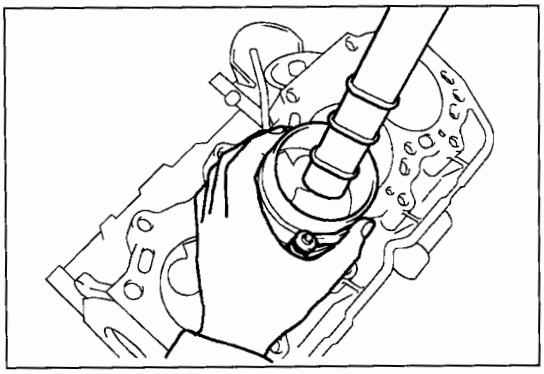
Install the bearing.

Assemble the upper bearing by matching the connecting rod lock groove.

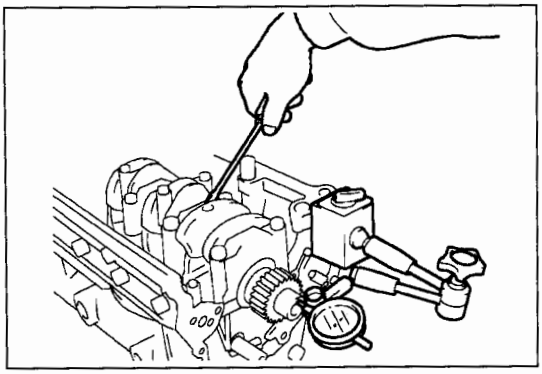
Install the lower bearing by matching the bearing cap lock groove.

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.

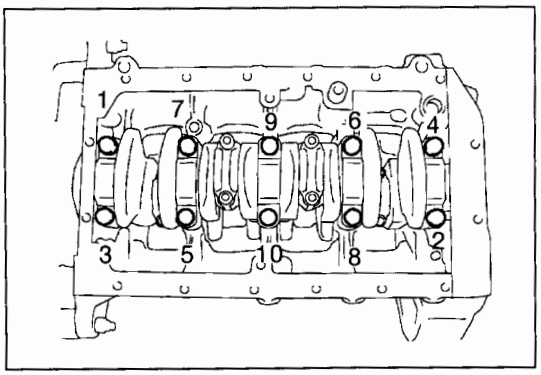


Installation:
Install the piston in the same cylinder it was removed from.
Fit a vinyl tube to the connecting rod bolt to protect it from damage.
Install the piston with the front mark facing front.
Coat engine oil on the bearing bore and crank pin.

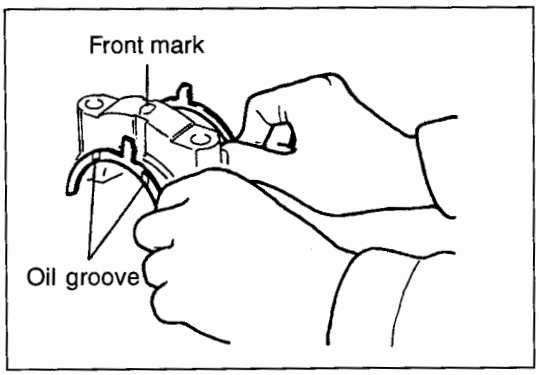


[Point 6]
Inspection:
Measure the crankshaft thrust clearance.
Standard: 0.04 ~ 0.24 mm (0.0016 ~ 0.0094 in.)
Limit: 0.3 mm (0.012 in.)

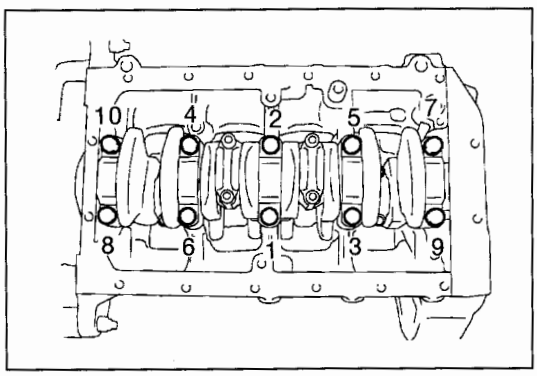
If the limit is exceeded, replace the thrust washer or crankshaft.
Thrust washer thickness:
STD: 1.93 ~ 1.98 mm (0.0760 ~ 0.0780 in.)
O/S: 0.125, 0.250 mm (0.00492, 0.00984 in.)



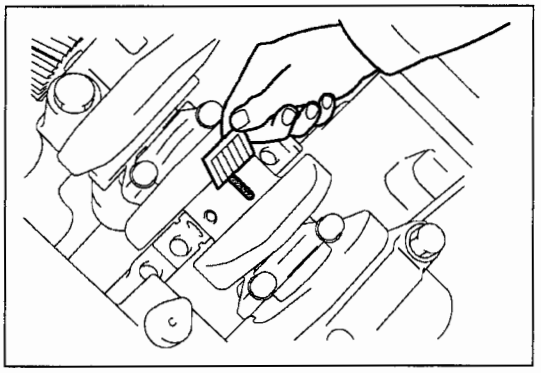
[Point 7]
Removal:
Loosen the cap set bolts in the order shown to the left.
Keep the removed parts carefully so they can be installed in correct positions.

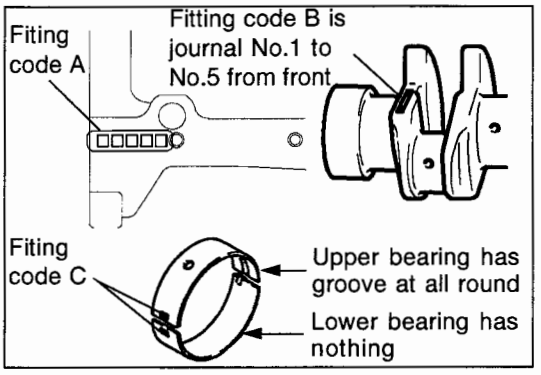


Installation:
Install the crankshaft bearing cap.
1. Install the thrust washer with the oil groove facing the crankshaft.
2. Install in the same place as before disassembly in reference to the front mark.



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





[Point 8]

Inspection:

Inspect the crankshaft.

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

Standard: 0.028 ~ 0.048 mm (0.00110 ~ 0.00189 in.)
Limit: 0.1 mm (0.004 in.)

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.

Selecting the bearing:

Based on the appropriate fit code given in the table below, select the bearing to be used.
C (code of bearing to be selected) = A (bearing hole code) + B (journal outside diameter code)

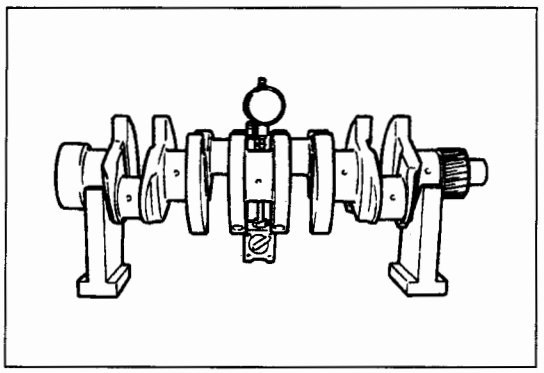
Unit: mm (in)

A		B		C	
Code	Bearing hole	Code	Journal outside diameter	Code	Bearing thickness
1	69.000 ~ 69.006 (2.71653 ~ 2.71677)	0	64.994 ~ 65.000 (2.55881 ~ 2.55905)	1	1.983 ~ 1.986 (0.07807 ~ 0.07819)
2	69.006 ~ 69.012 (2.71677 ~ 2.71700)	1	64.987 ~ 64.994 (2.55854 ~ 2.55881)	2	1.986 ~ 1.989 (0.07819 ~ 0.07831)
3	69.012 ~ 69.018 (2.71700 ~ 2.71724)	2	64.980 ~ 64.987 (2.55826 ~ 2.55854)	3	1.989 ~ 1.992 (0.07831 ~ 0.07843)
4	69.018 ~ 69.024 (2.71724 ~ 2.71747)			4	1.992 ~ 1.995 (0.07843 ~ 0.07854)
				5	1.995 ~ 1.998 (0.07854 ~ 0.07866)
				6	1.998 ~ 2.001 (0.07866 ~ 0.07878)

U/S bearing

Unit: mm (in.)

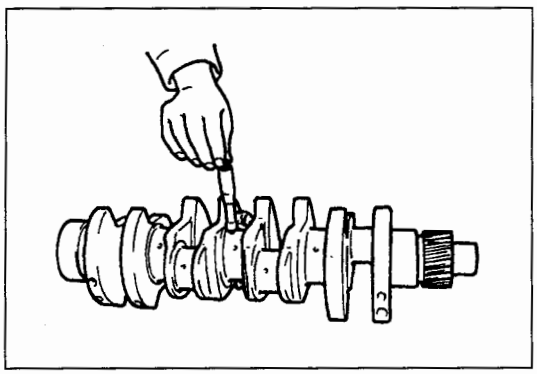
Size	Journal outside diameter	Bearing thickness
U/S 0.25	64.730 ~ 64.750 (2.54842 ~ 2.54921)	2.104 ~ 2.110 (0.08283 ~ 0.08307)
U/S 0.50	64.480 ~ 64.500 (2.53858 ~ 2.53937)	2.229 ~ 2.235 (0.08776 ~ 0.08799)
U/S 0.75	64.230 ~ 64.250 (2.52874 ~ 2.52952)	2.354 ~ 2.360 (0.09232 ~ 0.09291)
U/S 1.00	63.980 ~ 64.000 (2.51889 ~ 2.51968)	2.479 ~ 2.485 (0.09760 ~ 0.09783)

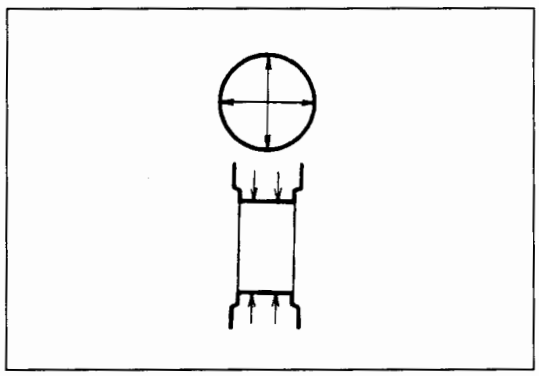


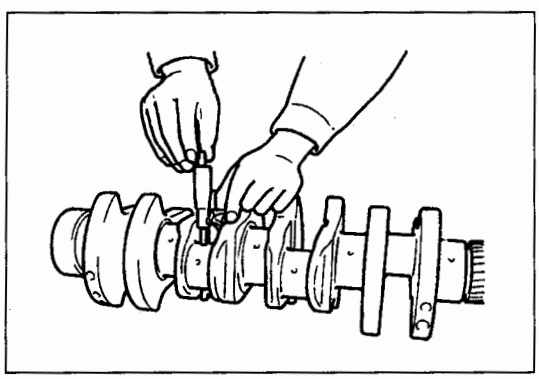
2. Crankshaft bend inspection Measure the amount of bend per a full turn of the crankshaft.

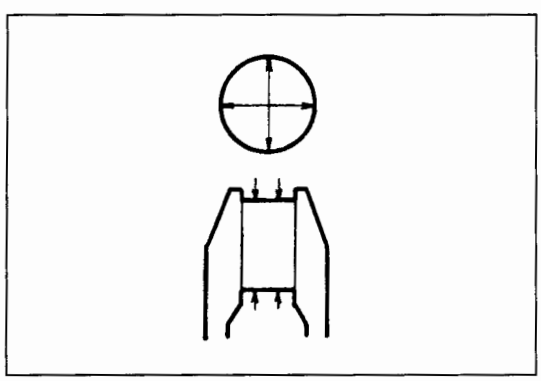
$$\text{Bend} = \frac{\text{Dial gauge deflection}}{2}$$

Limit: 0.05 mm (0.0020 in.)









3. Crankshaft wear inspection
   (1) Measure the dimensions of the crankshaft journal as shown.

   Standard: 64.98 ~ 65.00 mm (2.5583 ~ 2.5591 in.)

   (2) Calculate the eclipticity and taper.

   Limit:
   Ellipticity: 0.02 mm (0.0008 in.)
   Taper: 0.05 mm (0.0020 in.)

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.

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

   Standard: 50.48 ~ 50.50 mm (1.9874 ~ 1.9882 in.)

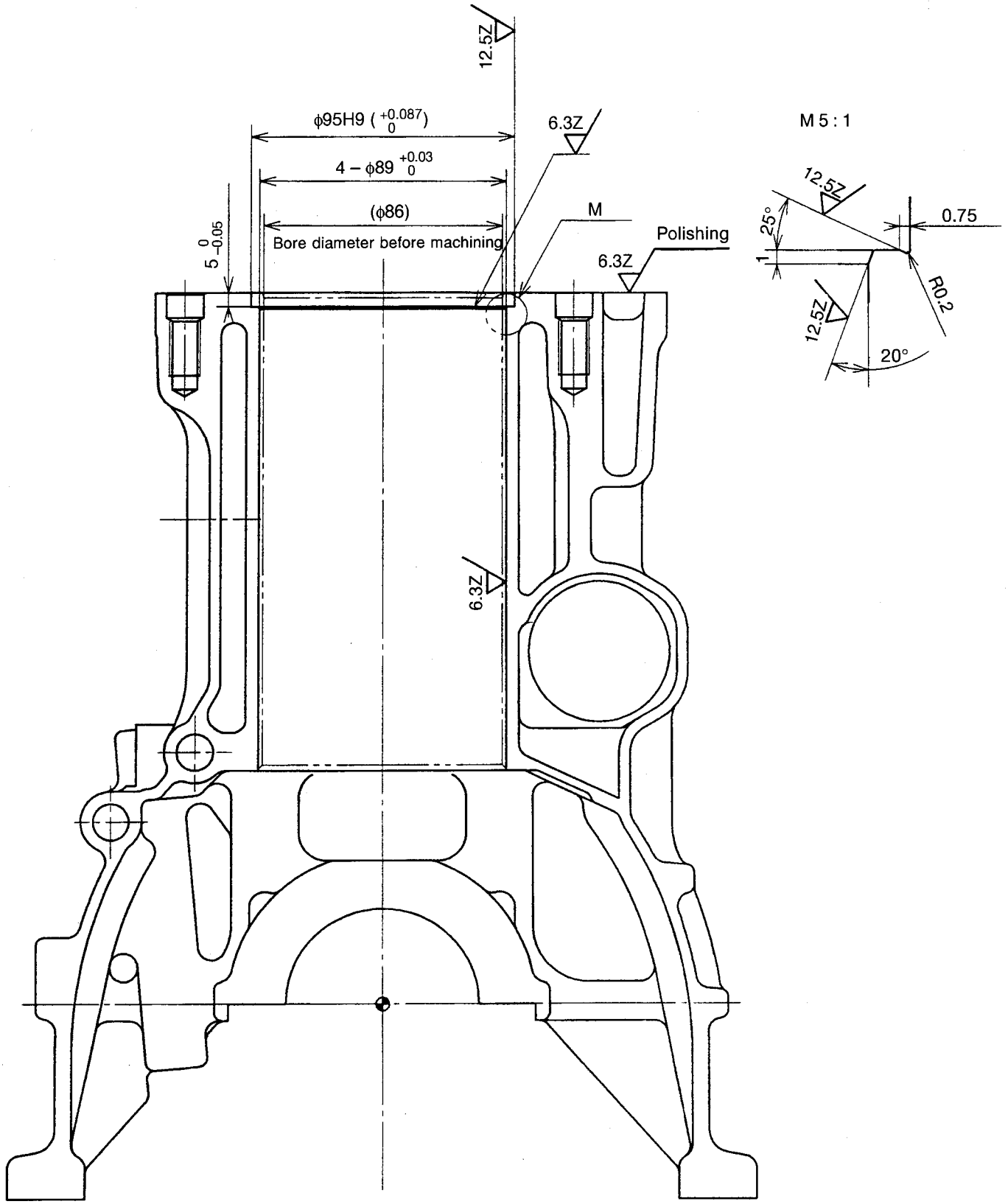
   (4) Calculate the ellipticity and taper.

   Limit:
   Ellipticity: 0.02 mm (0.0008 in.)
   Taper: 0.05 mm (0.0020 in.)

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 pin mm(in)
U/S 0.25	50.24 ~ 50.25 (1.9779 ~ 1.9783)
U/S 0.50	49.99 ~ 50.00 (1.9681 ~ 1.9685)
U/S 0.75	49.74 ~ 49.75 (1.9583 ~ 1.9566)
U/S 1.00	49.49 ~ 49.50 (1.9484 ~ 1.9488)

CYLINDER BLOCK BORE DIMENSIONS



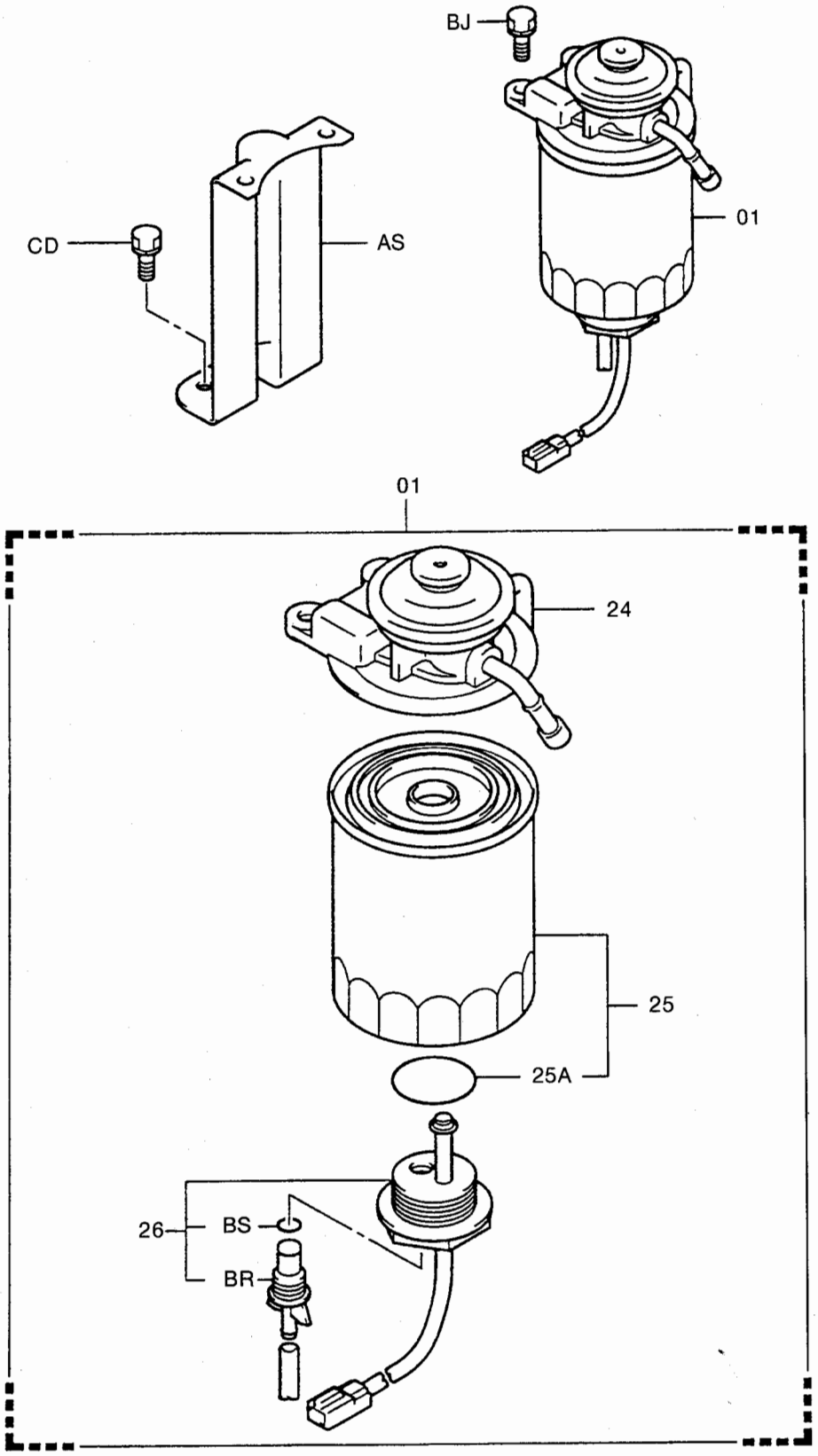
NOTE:
Upon press fitting the cylinder liner, grind the cylinder liner so that the liner will be flush with the upper surface of the cylinder block. At the time, maximum limit for the cylinder block must be less than 0.1mm (0.039in).

FUEL SYSTEM

FUEL FILTER

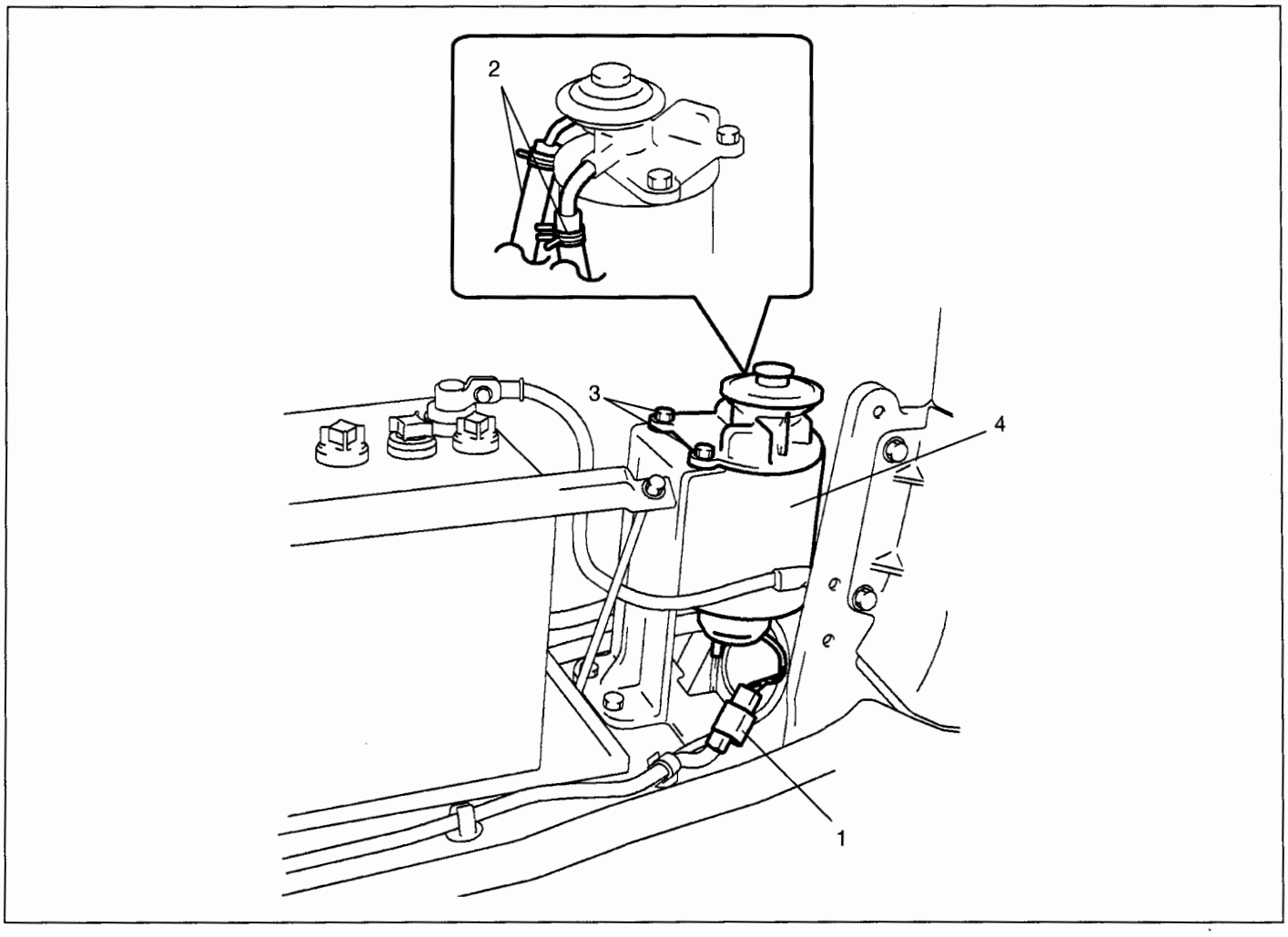
COMPONENTS

2302



2302-090

REMOVAL · INSTALLATION



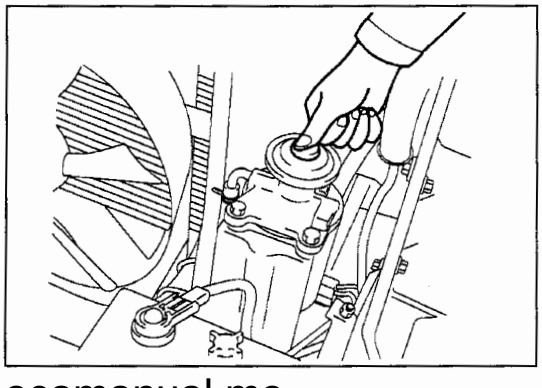
Removal Procedure

1 Disconnect wiring.
2 Remove hose clamp and disconnect fuel hose.
3 Remove the fuel filter set bolts.
4 Remove the fuel filter.

Installation Procedure

Installation procedure is the reverse of the removal procedure.

Note:
Bleed air from the fuel system after install the fuel pump.

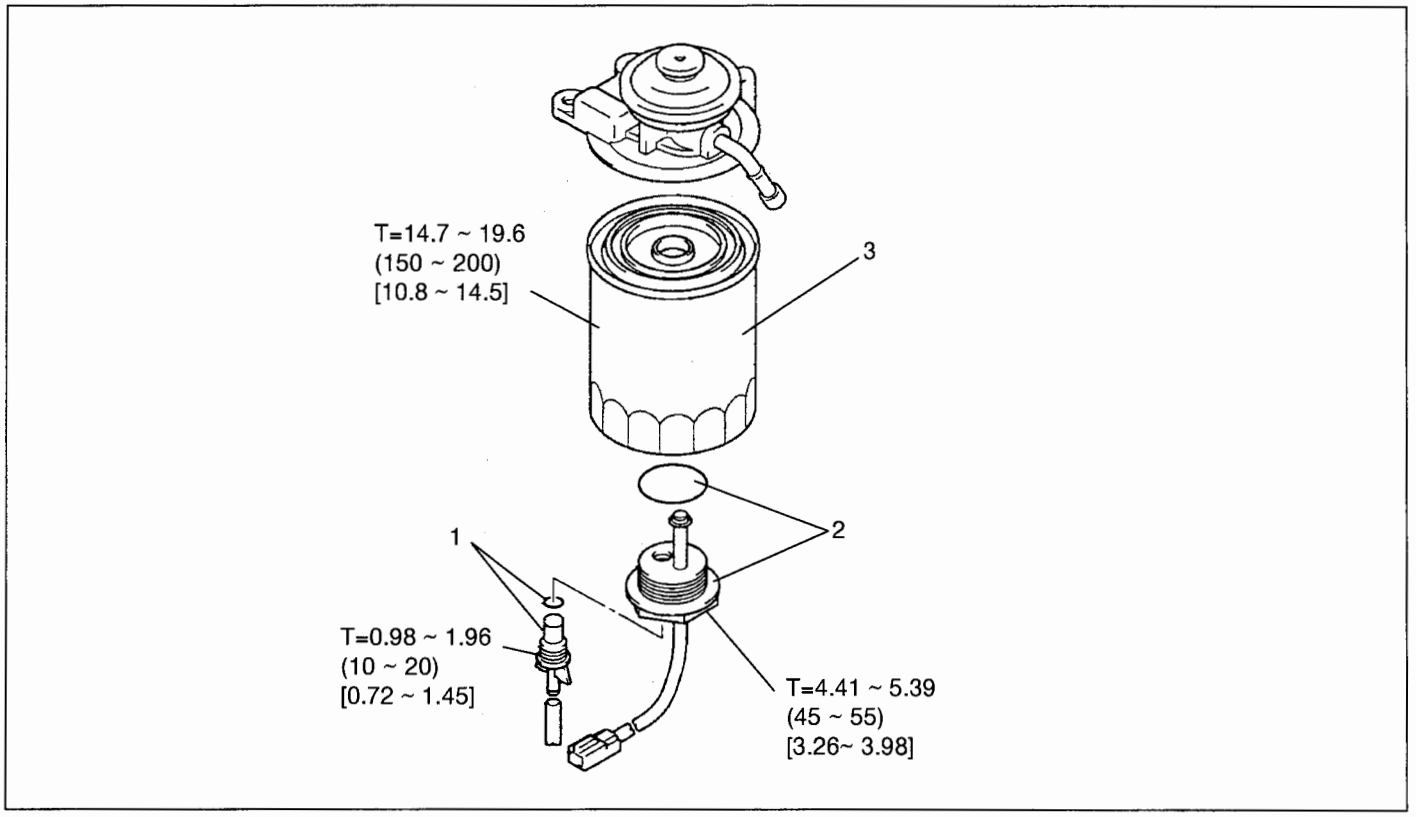


BLEEDING AIR FROM FUEL SYSTEM

1. Operate the priming pump knob up and down to bleeding air. Bleeding air is the end when the knob movement becomes hard.

DISASSEMBLY · INSPECTION · REASSEMBLY

T=N·m (kgf-cm) [ft-lbf]

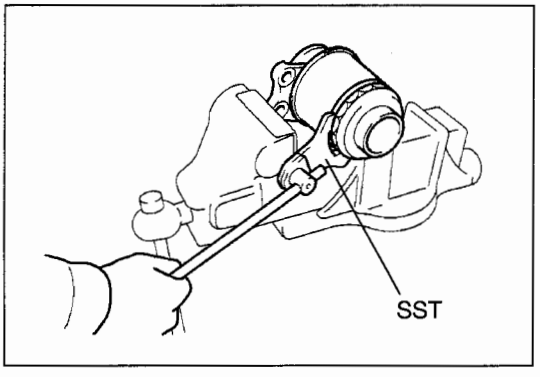


Disassembly Procedure

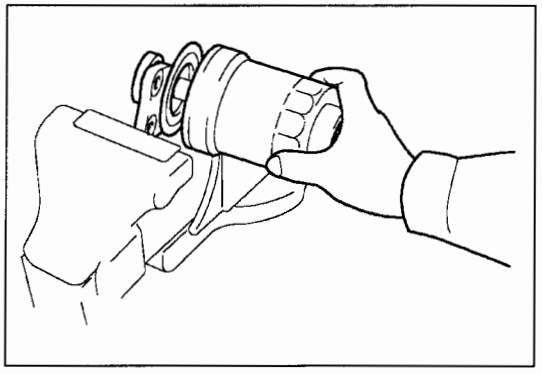
1 Remove the drain bolt and O ring.
2 Remove the sedimenter and O ring.
3 Remove the fuel filter element. **[Point 1]**

Reassembly Procedure

Reassembly procedure is the reverse of the disassembly procedure.



[Point 1]
Disassembly · reassembly:
SST 09228-64010

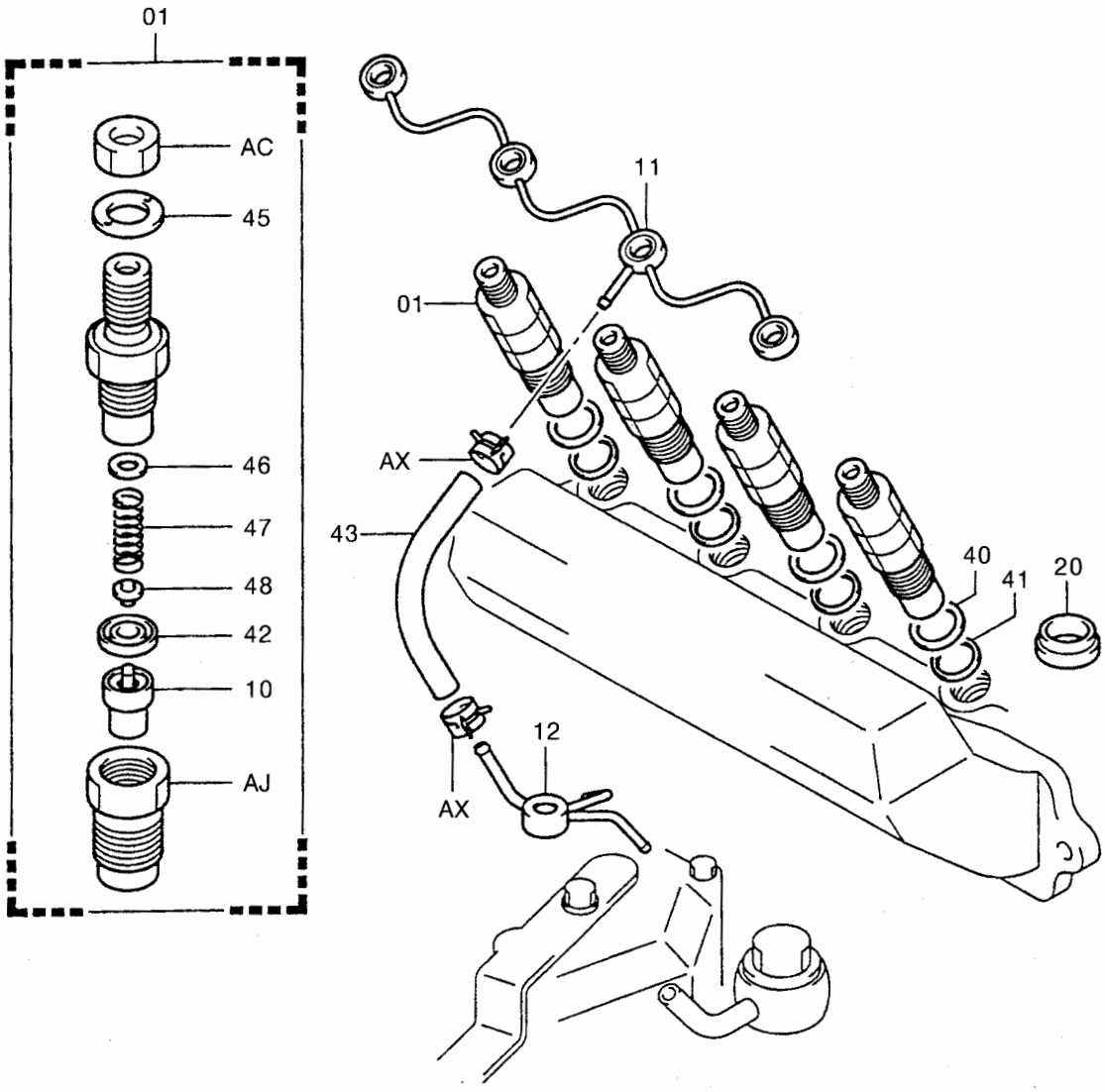


Reassembly:
Apply a thin coat of light oil on the O ring of the fuel filter element.

INJECTION NOZZLE

COMPONENTS

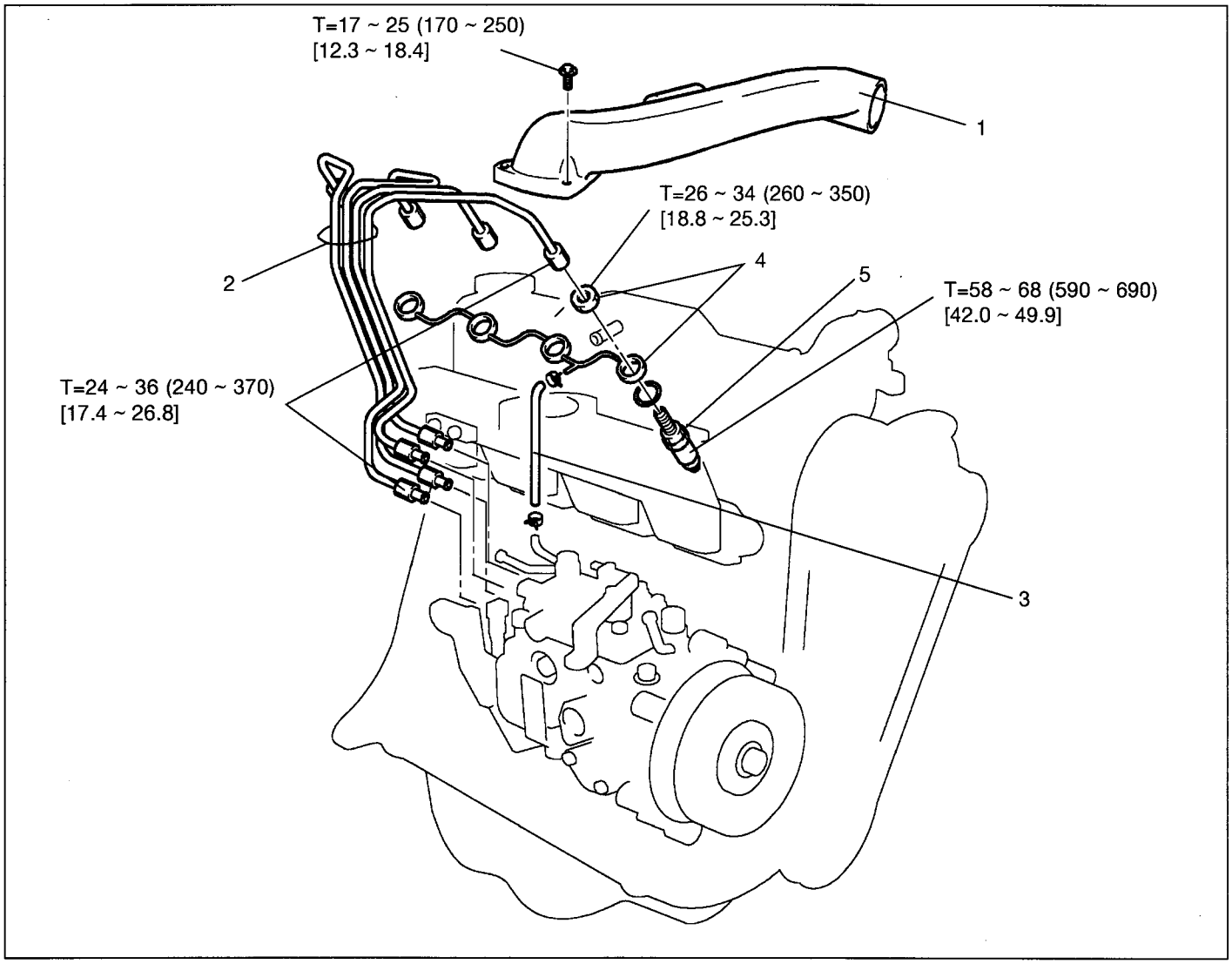
2201



2201-066

REMOVAL · INSTALLATION

T=N·m (kg-cm) [ft-lbf]



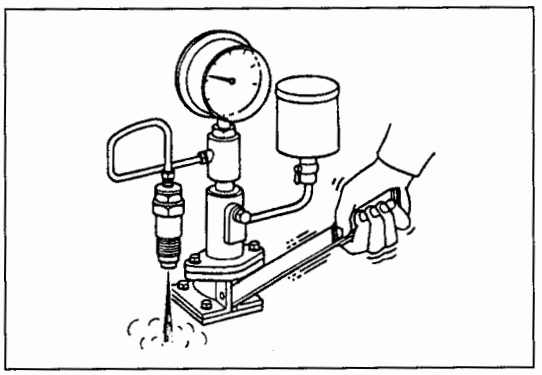
Removal Procedure

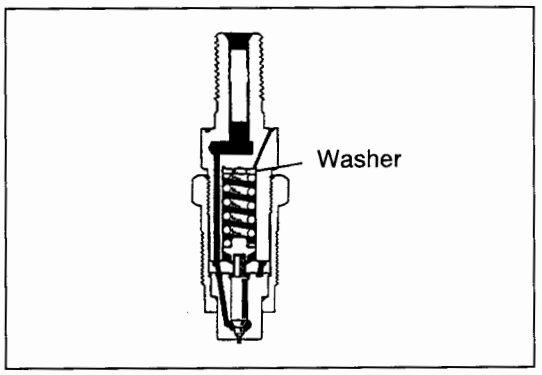
1 Disconnect the intake pipe.
2 Disconnect the injection pipe.
3 Disconnect the fuel hose between the injection pump and nozzle leakage pipe.
4 Disconnect the nozzle linkage pipe.
5 Remove the injection nozzle ASSY. **[Point 1]**

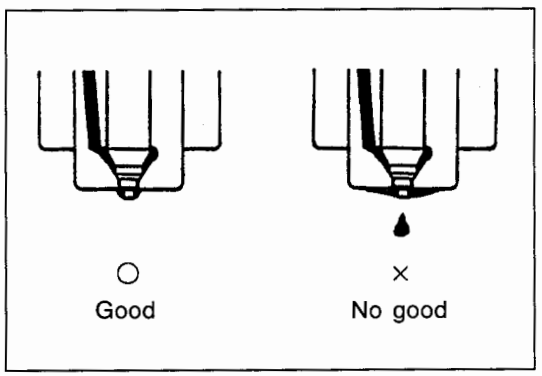
Installation Procedure

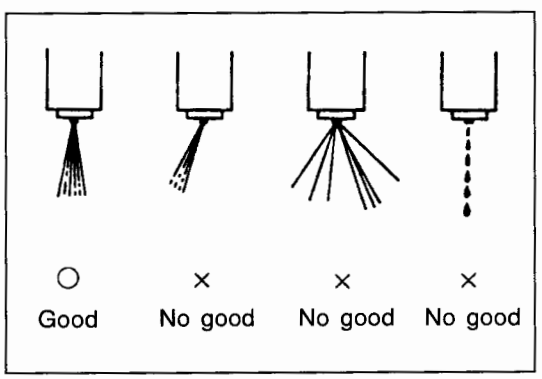
Installation procedure is the reverse of the removal procedure.

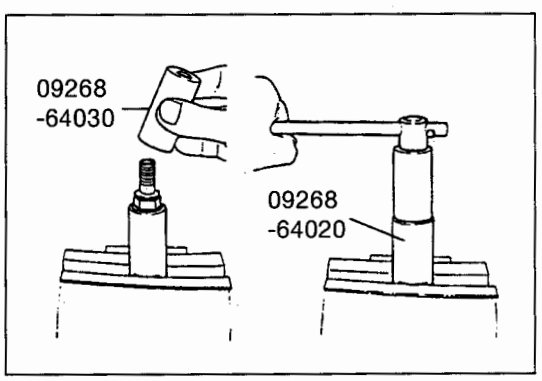
Note:
Always renew the nozzle gasket.











Point Operation

[Point 1]

Inspection:

Inspect the injection nozzle ASSY.

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: 11770 ± 490 kPa (120 ± 5 kgf/cm²) [1710 ± 71 psi]

   (5) If the standard is not met, disassemble the nozzle and adjust by replacing a shim.
   If the pressure is outside the standard range, adjust the pressure by selecting a proper washer for setting on top of the pressure spring.
   The injection pressure changes by about 490 kPa (5 kgf/cm²) [71 psi] as the washer thickness changes by 0.05 mm (0.00197 in.).
   43 types of washers are provided in 0.025 mm (0.00098 in.) steps in a range of 0.900 to 1.950 mm (0.0354 to 0.0768 in.).

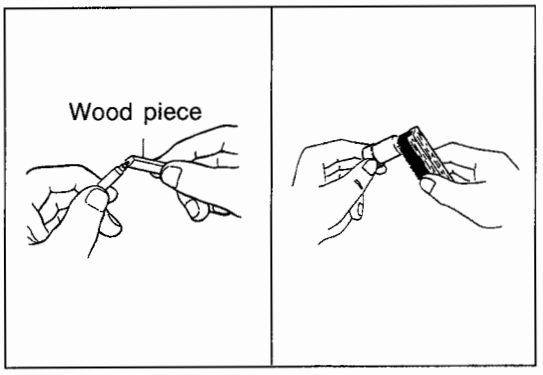
2. Check oil seal at the valve seat.
   (1) Slowly push the tester lever until the pressure rises to approximately 10 ~ 11 MPa (100 ~ 110 kgf/cm²) [1400 ~ 1500 psi]. Maintain the pressure for about 10 seconds, and confirm that the fuel is not leaking form the nozzle outlet or the retaining nut.
   (2) If leaking, disassemble and clean the nozzle or replace it. Check again after replacement.

3. Check the spray pattern.

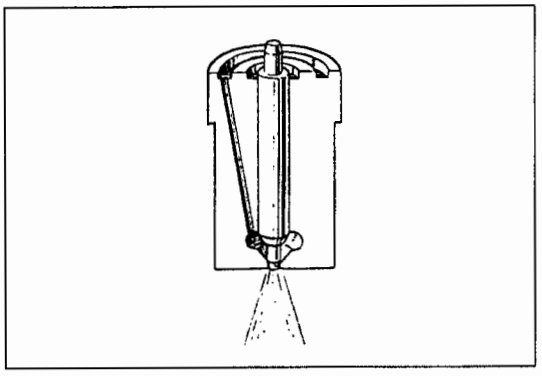
Inspection:

Disassemble, clean, and check the injection nozzle ASSY.

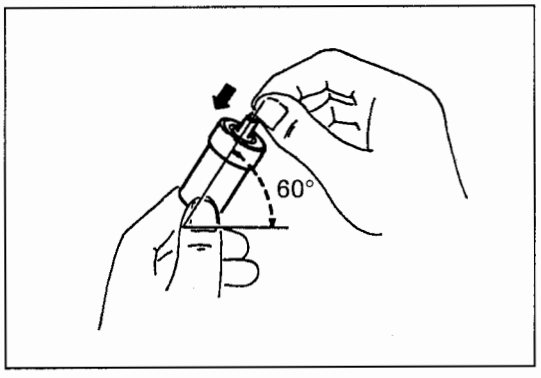
1. Secure the nozzle holder by way of a cushioning metal in a vise and remove the retaining nut.
   Be careful at this time that the spring inside is active. Note also that the removal of the retaining nut will allow all other parts to be taken apart.
   SST 09268-64010



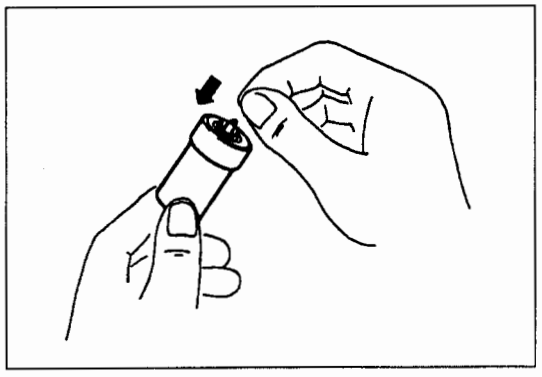
2. Clean the nozzle.
   (1) Use a small piece of hard wood and brass brush. Clean the nozzle with clean light oil.
   (2) Clean the carbon deposit at the nozzle needle tip using a small piece of hard wood.
   (3) Clean the carbon deposit on the outside of the nozzle body using a brass brush.



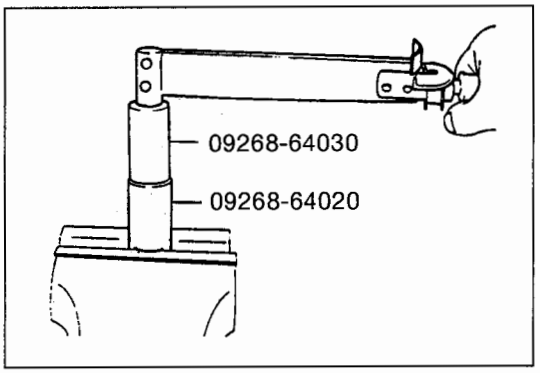
3. Check the nozzle appearance.
   (1) Check the nozzle body for cracks and corrosion.
   (2) Check the nozzle needle for damage and corrosion. If necessary, replace the nozzle ASSY.



4. 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.



5. The installation procedure is the reverse of the removal procedure.
   SST 09268-64010
   Retaining nut tightening torque
   T=58.8 ~ 78.5 N·m (600 ~ 800 kgf-cm) [43.4 ~ 57.9 ft-lbf]

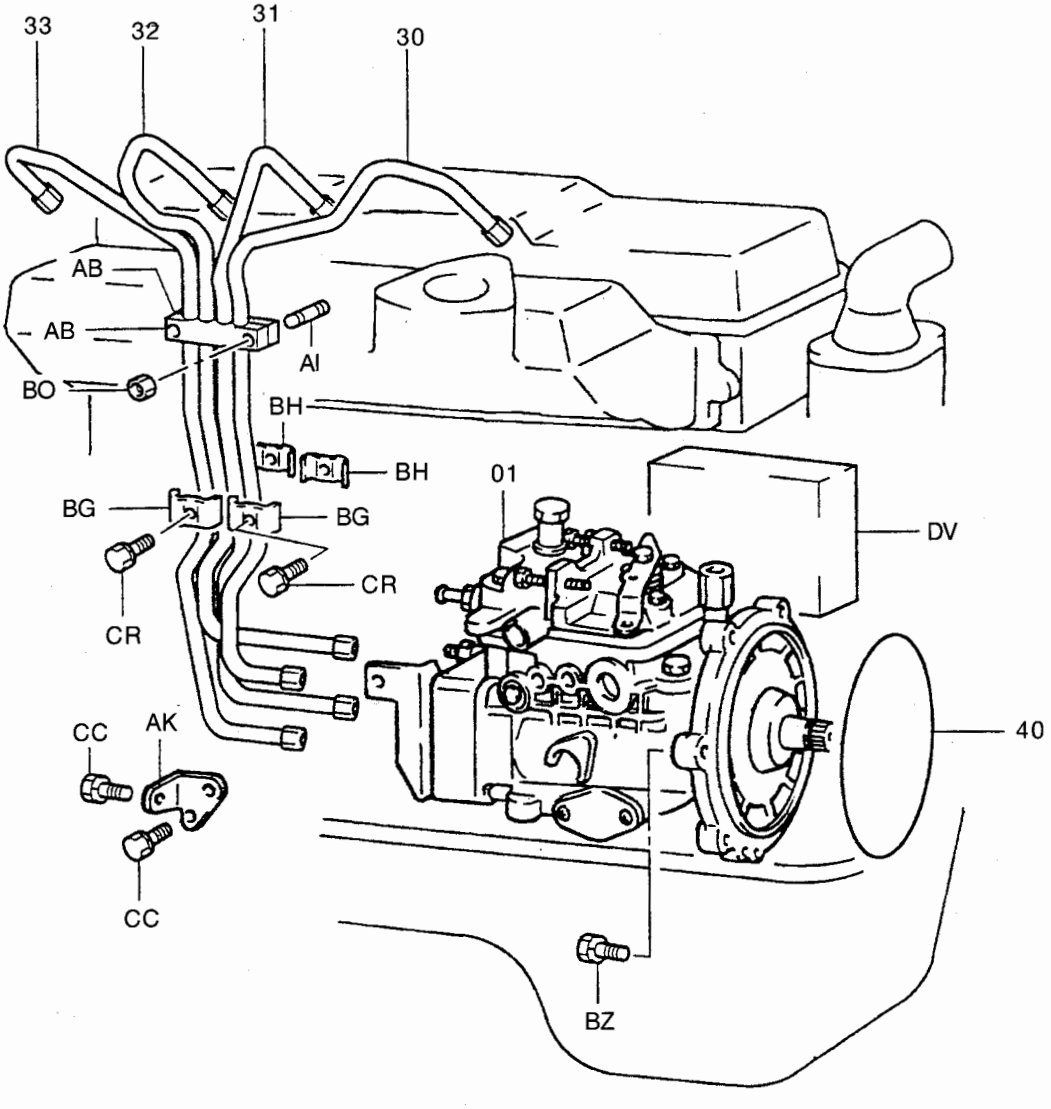
INJECTION PUMP

SPECIFICATIONS

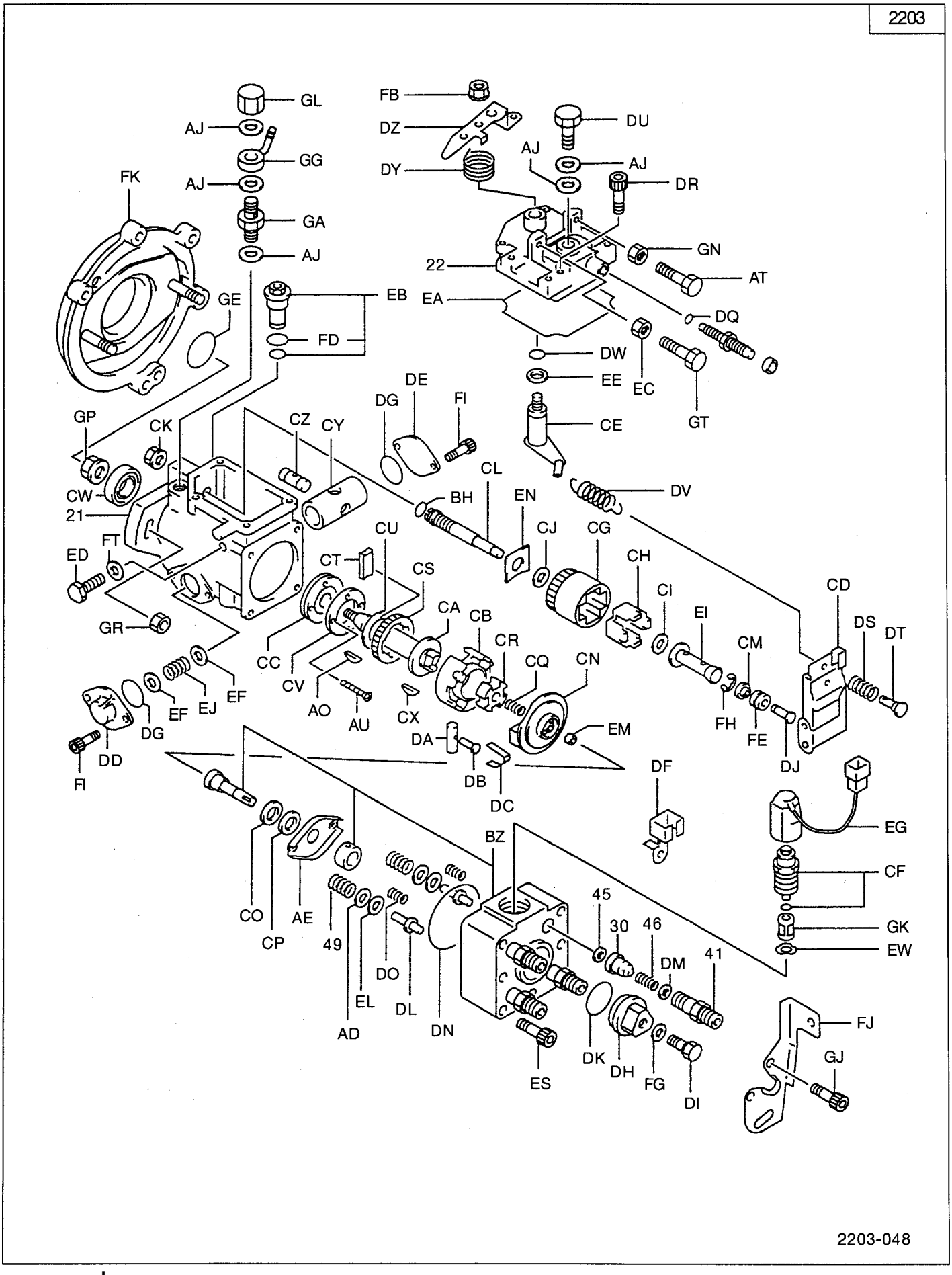
Direction of rotation	Clockwise as viewed from the drive side
Order of injection	A-B-C-D
Injection interval	90° ± 30'
Plunger diameter	10 mm (0.39 in.)
Cam lift	2.2mm (0.087 in.)
Governor type	Mechanical (all speed)
Timer	Hydraulic (with a load sensing timer)
Feed pump	Vane type (built-in type)
Lubrication method	Fuel lubrication
Fuel cut	Fuel cut by a solenoid

COMPONENTS

2202

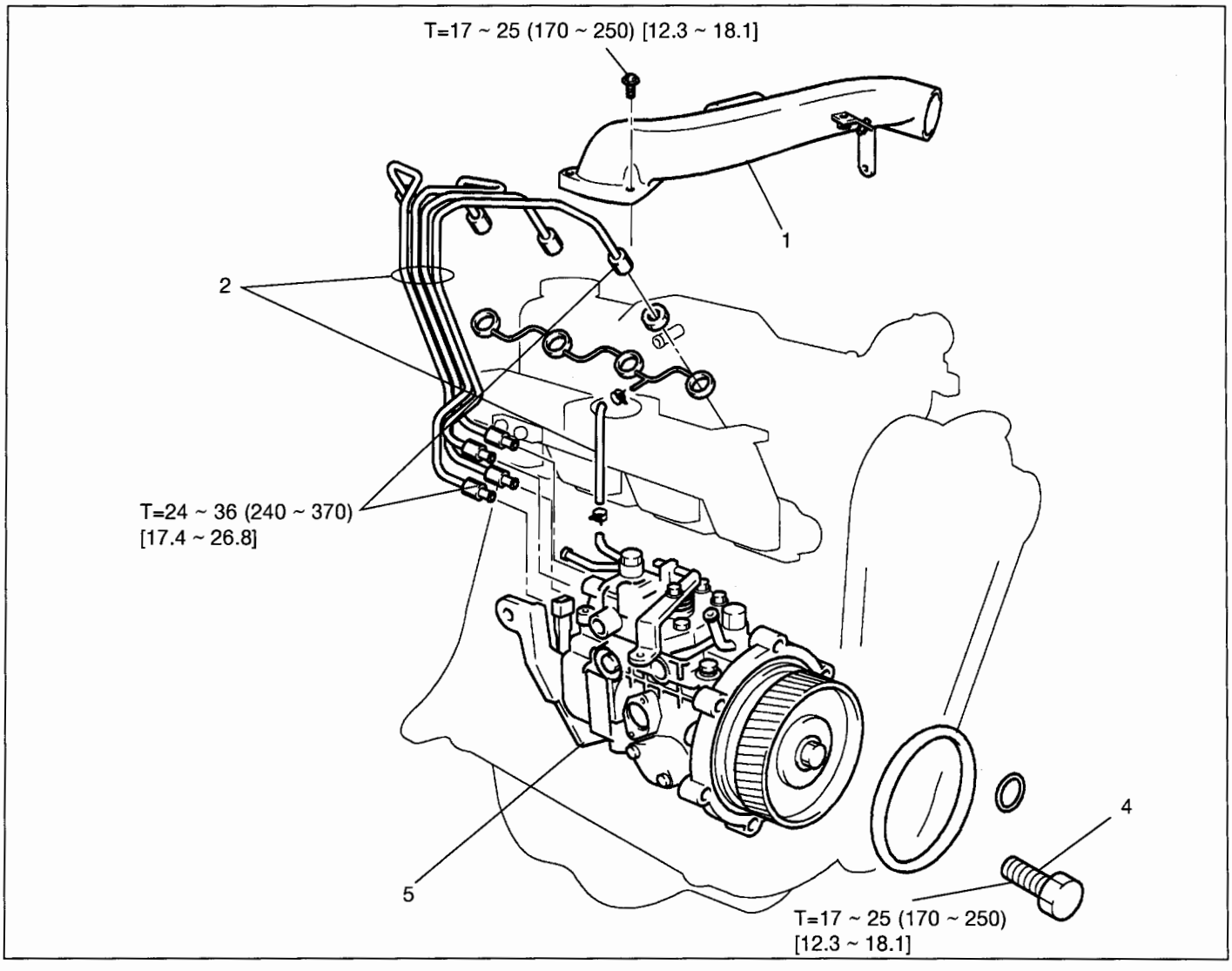


2202-068



REMOVAL · INSTALLATION

T=N·m (kgf-cm) [ft-lbf]

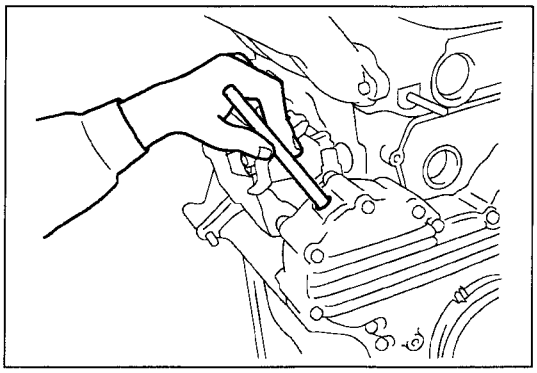


Removal Procedure

1 Remove the intake pipe.
2 Remove the injection pipe and hose.
3 Put the match mark on the injection pump drive gear. **[Point 1]**
4 Remove the injection pump set bolt.
5 Remove the injection pump ASSY W/ drive gear. **[Point 2]**

Installation Procedure

Installation procedure is the reverse of the removal procedure.



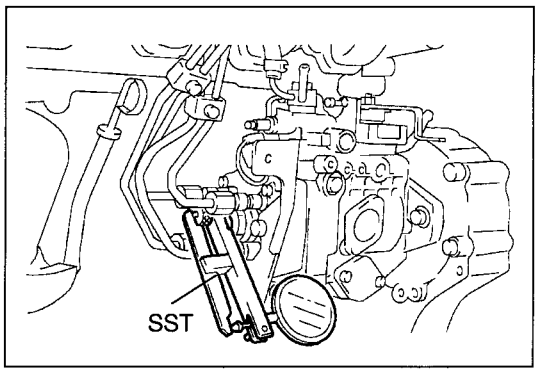
Point Operations

[Point 1]

Removal:

When no. 1 cylinder is at TDC, the injection pump cam is in the lifted position, which makes the job hard. To make the job easier, return the cylinder slightly back (about 30°) from TDC.

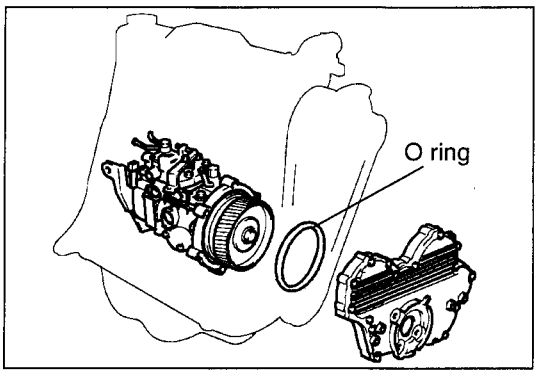
Remove the timing gear cover bolt and put a matching mark using a white paint or similar device.



Installation:

After the injection pump has been reinstalled, check and adjust the injection timing. (See page on 1-5.)

SST 09240-32880-71



[Point 2]

Installation:

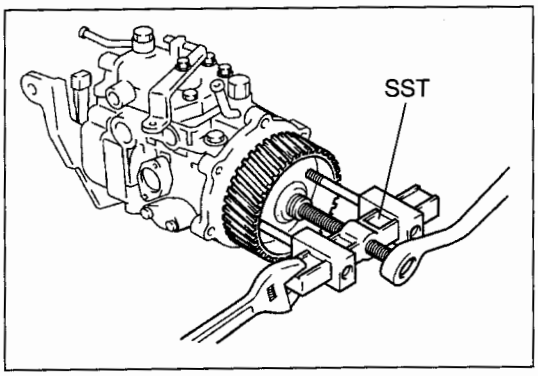
Apply a thin coat of MP grease to the O ring.

Installation:

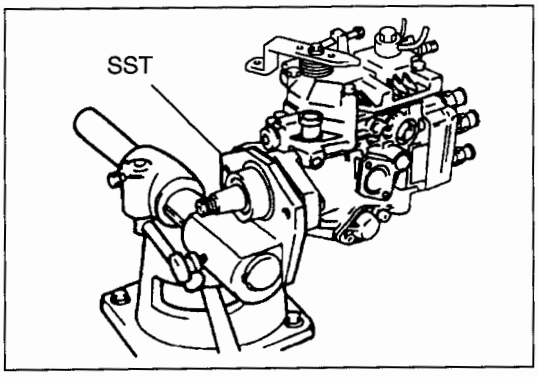
At installation, ensure that the matching mark put during removal is visible through the hole in the timing gear case.

DISASSEMBLY

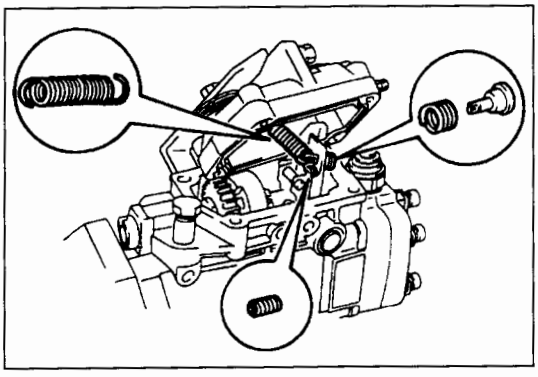
Notes:
- **Wash outside of the injection pump. Clean the work bench and workshop for operation.**
- **Always measure and record the pump injection volume characteristics before disassembly. This information gives a clue as to the cause of any adjustment error or defective parts.**
- **While disassembling 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.**



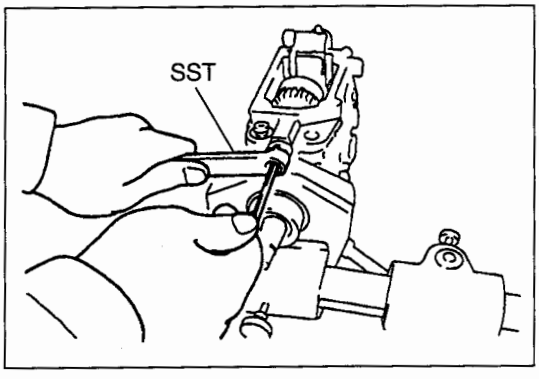
1. Remove the injection pump drive gear.
   (1) Self locking nut
   (2) Injection pump drive gear
   SST 09950-50012
   (3) Injection pump cover
2. Remove the overflow screw and drain fuel.



3. Attach the pump using the pump mounting bench.
   SST 09245-54010

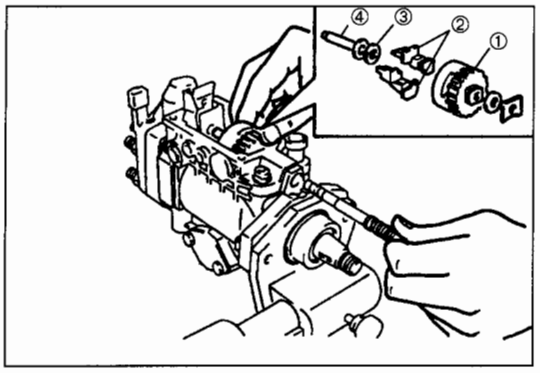


4. Remove the governor cover.
   (1) Socket bolt
   (2) Lift the governor cover, and disconnect the control spring from the governor spring seat.
   (3) Damper spring
   (4) Governor spring seat
   (5) Control spring
   (6) Governor cover

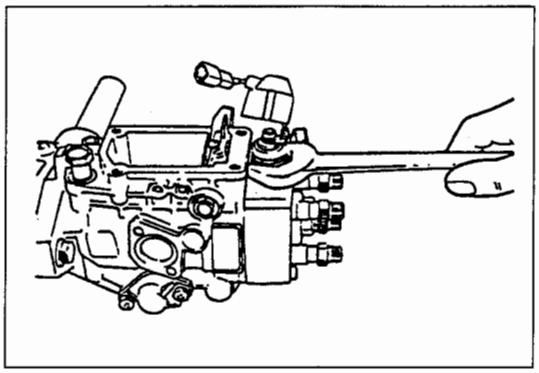


5. Remove the fuel inlet union.
6. Remove the governor shaft parts.
   (1) Loosen the governor shaft lock nut.
   SST 09260-54012
   (2) Loosen the governor shaft using a hexagon wrench.

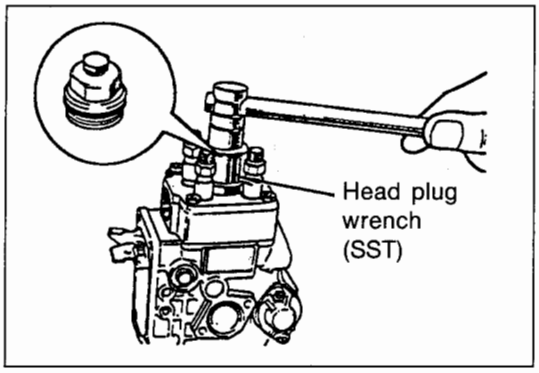
Note:
Note that the lock nut and the governor shaft have left-handed threads.



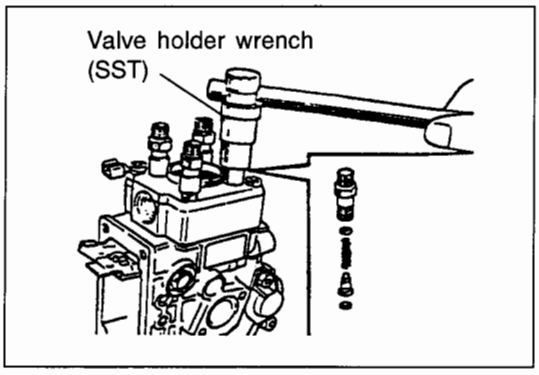
(3) While extracting the governor shaft, remove the following parts as an ASSY:
① Flyweight holder
② Flyweight
③ Flyweight washer
④ Governor sleeve
(4) Washer
(5) Adjusting washer



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

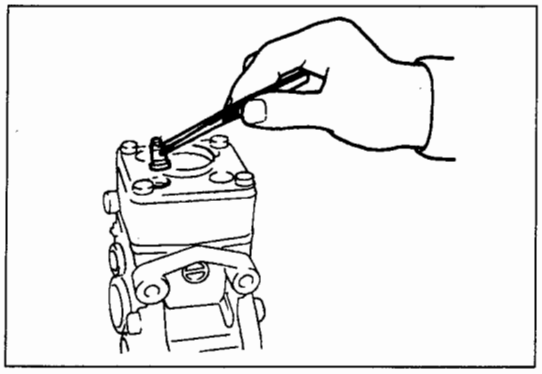


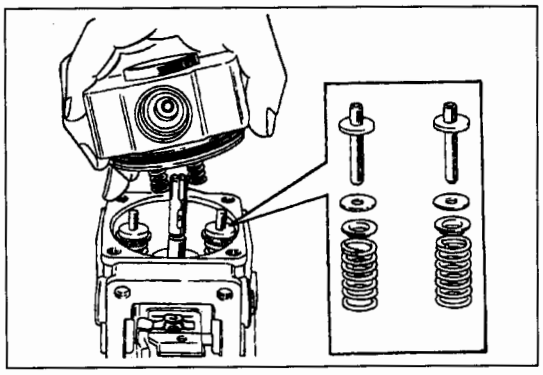
8. Remove the distributor head plug.
(1) Head plug
SST 09260-54012
(2) O ring



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

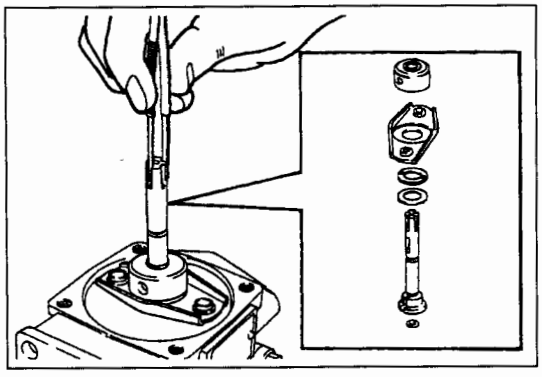
Notes:
- **Keep removed valves and valve seats in pairs per cylinder.**
- **Cylinder marks (A, B, C, D) are punched on the distributor heads.**
- **Keep delivery valves, delivery holders and other parts in groups for reinstallation in the same cylinders.**





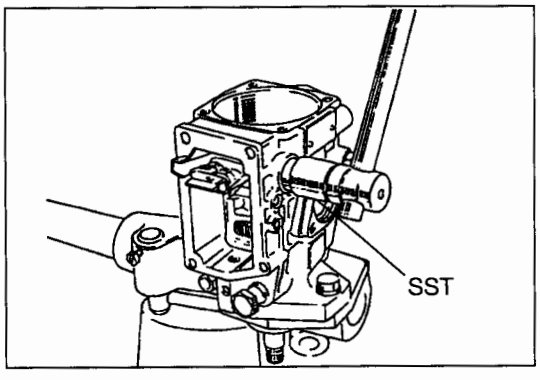
10. Remove the distributor head.
    (1) Distributor head
    (2) Lever support spring

Note:
When removing the distributor head, do that carefully while holding the plunger end with a pair of tweezers or similar tool.

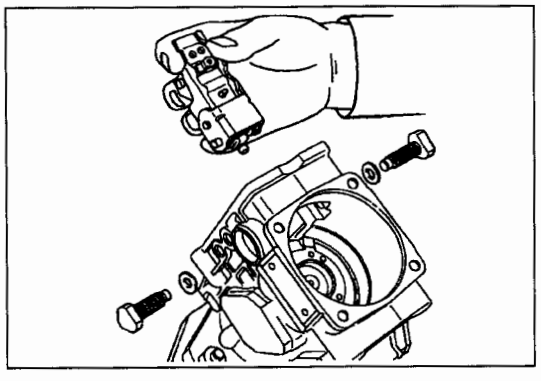


11. Remove the plunger.
    (1) Plunger spring guide
    (2) Plunger spring shim
    (3) Plunger spring upper seat
    (4) Plunger spring
    (5) Spill ring
    (6) Plunger spring lower seat
    (7) Plunger upper plate
    (8) Plunger lower plate
    (9) Plunger

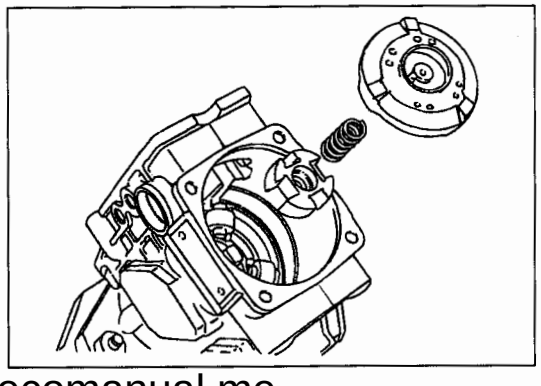
Note:
Do not lose adjusting shims under the plunger.



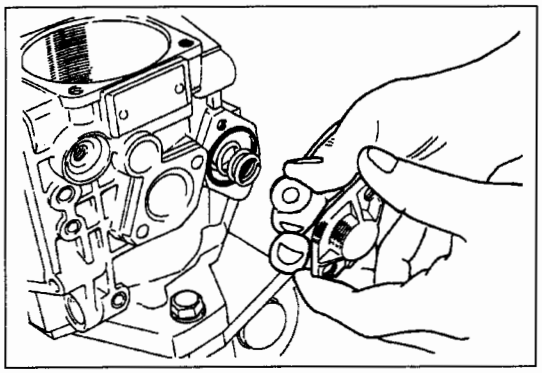
12. Remove the governor lever.
    (1) Supporter bolt
        SST 09260-54012



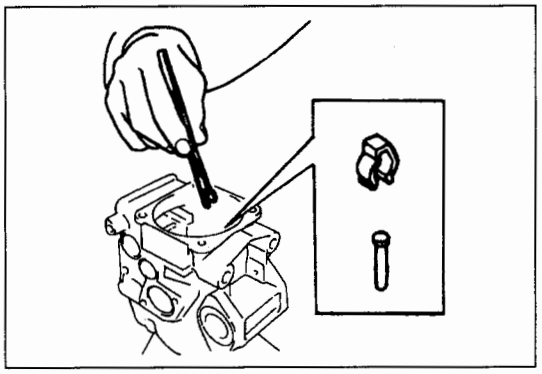
    (2) Governor lever



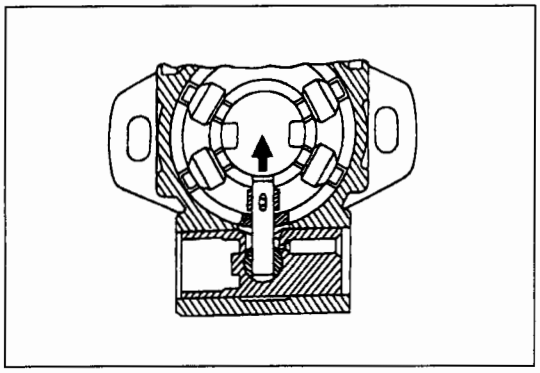
13. Remove the cam plate and coupling.
    (1) Cam plate
    (2) Plunger adjusting shim
    (3) Coupling spring
    (4) Coupling



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

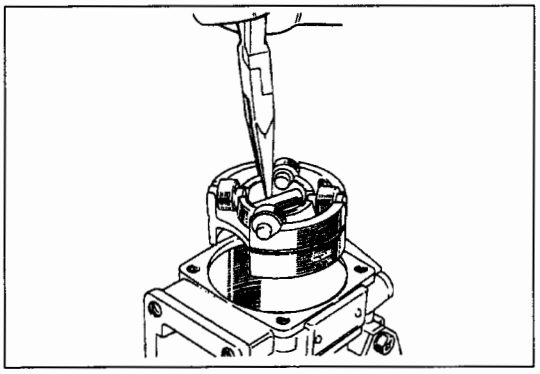


15. Remove the roller ring and timer piston.
    (1) Timer clip
    (2) Stopper pin



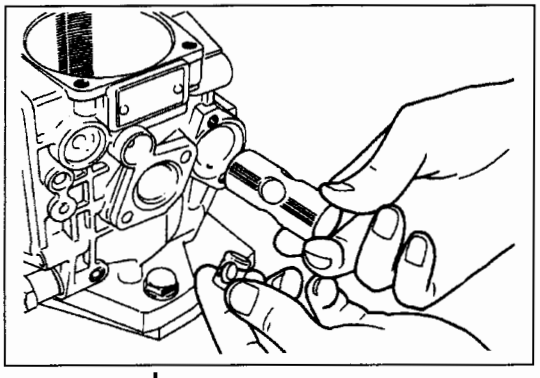
(3) Push the timer slide pin to the center of the roller ring.

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



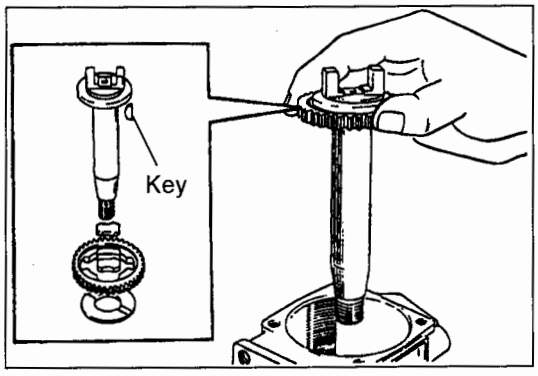
(4) Roller ring

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

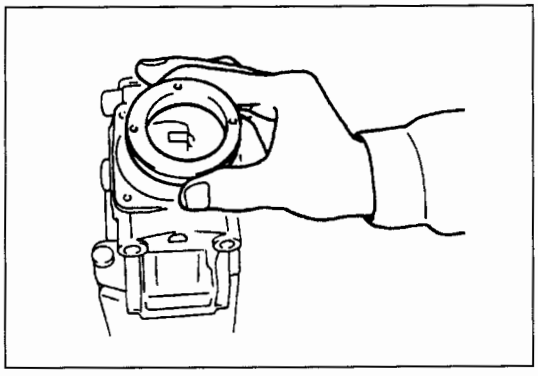
Note:
Do not drop the timer sub-piston.



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

Note:
Do not lose the feed pump drive key.

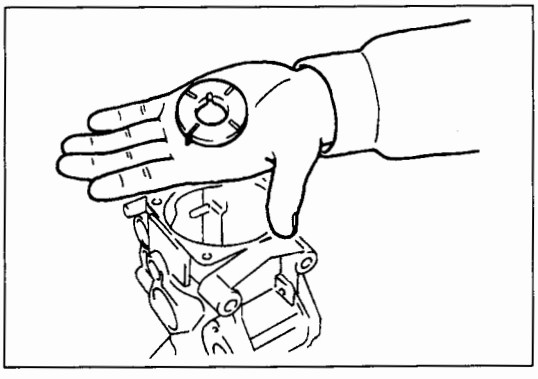
    (2) Disassemble the drive shaft (with gear).
        ① Drive shaft
        ② Drive gear
        ③ Rubber joints (2 pieces)
        ④ Drive shaft washer
        ⑤ Drive shaft



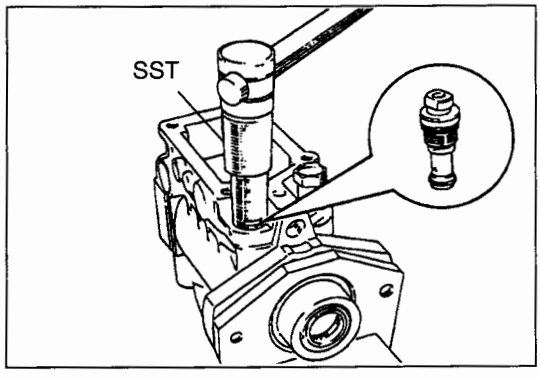
17. Remove the feed pump parts.
    (1) Feed pump cover set screw
    (2) Feed pump cover · liner

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

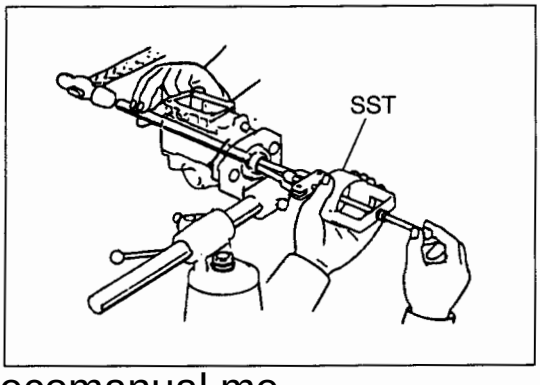
    (3) Rotor · blade



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.**

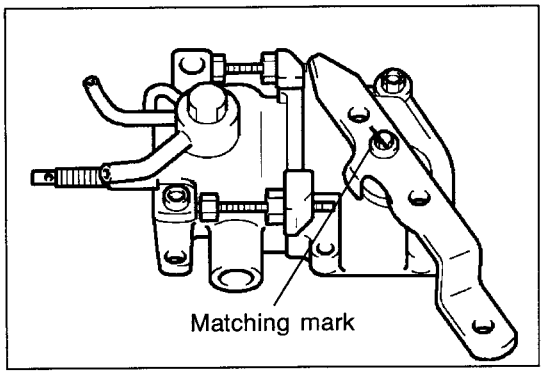


18. Remove the regulating valve.
    (1) Regulating valve
        SST 09260-54012
    (2) O ring

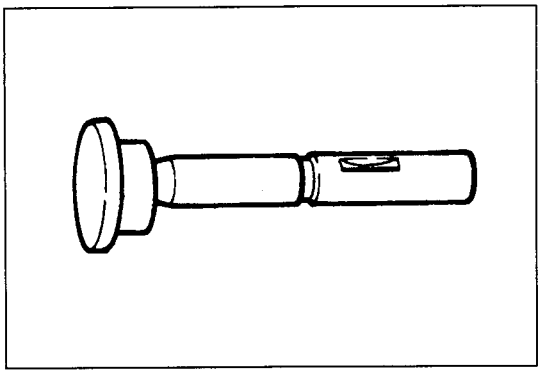


19. Remove the oil seal.
    SST 09612-65014

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

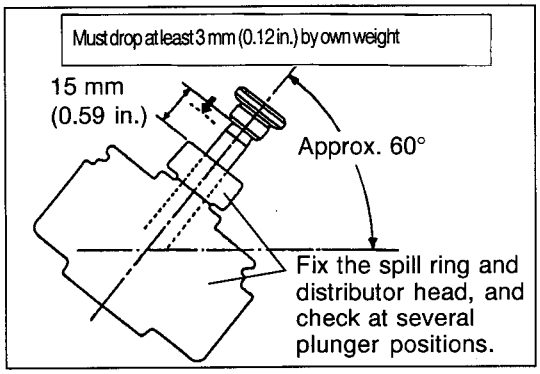


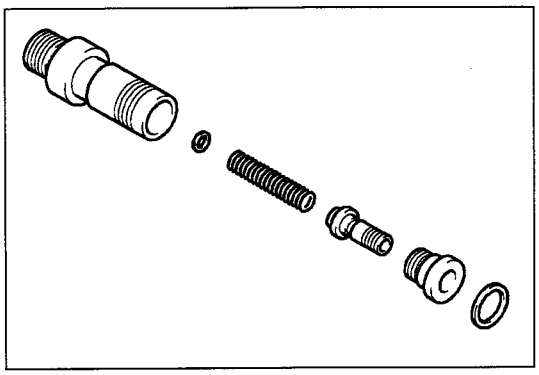
20. Remove the governor cover parts.
    (1) Align the lever shaft with the lever, and put matching marks.
    (2) Nut
    (3) Adjusting lever
    (4) Return spring
    (5) Extract the lever shaft to the inside.



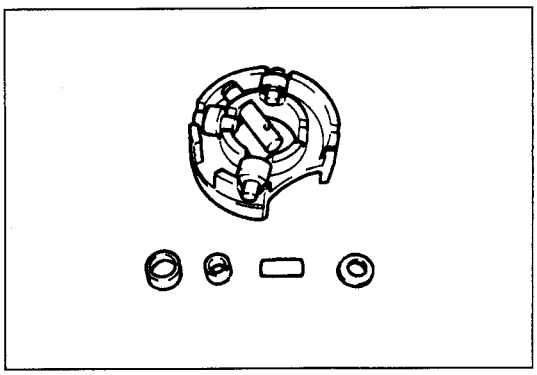
INSPECTION

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.

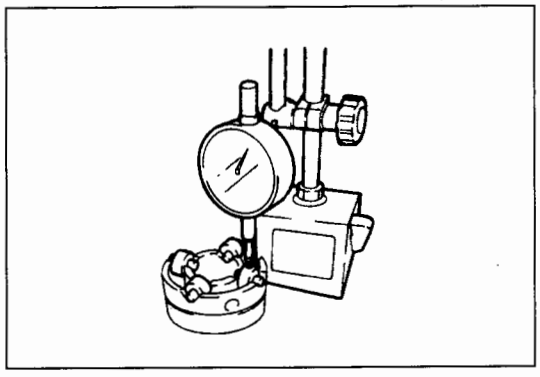




2. Inspect the delivery valve and holder.
    (1) Check the valve seat surface and piston for scratch, dent and wear.
    (2) Check the delivery valve and holder for scratch in contact surfaces with injection pipe.
    (3) Check the suck-back action.
        ① Thoroughly wash the parts in light oil and 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.



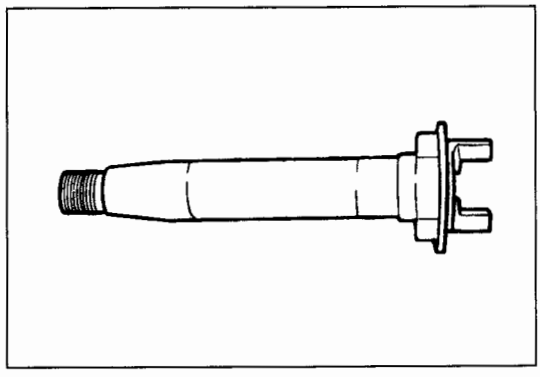
3. Inspect the roller ring.
    (1) If flaking, local wear or other flaw prohibiting reuse is found on the roller and roller and roller pin, replace the roller ring ASSY.



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

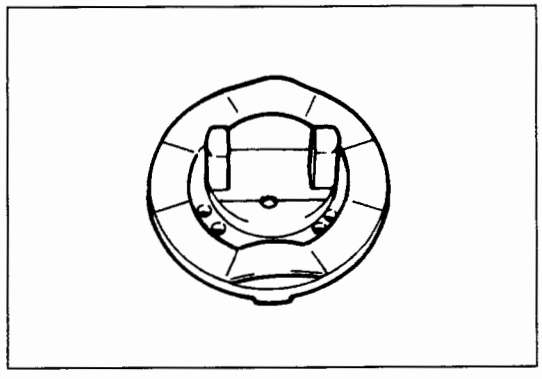
Limit: 0.02 mm (0.0008 in.)

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

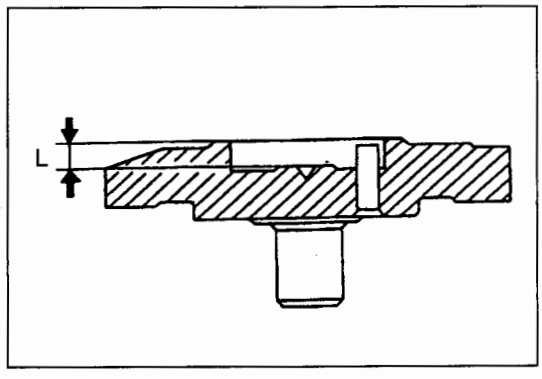


4. Inspect the drive shaft.
   (1) A free play is provided between the key and the key groove. Replace the drive shaft if the taper is damaged.
   (2) Measure the amount of wear in the oil seal contact surface.

Limit: 0.08 mm (0.0031 in.)

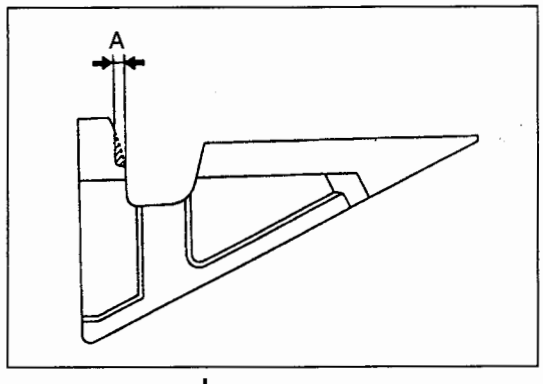


5. Inspect the cam plate.
   (1) Check the cam surface for flaking, local wear or damage.



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

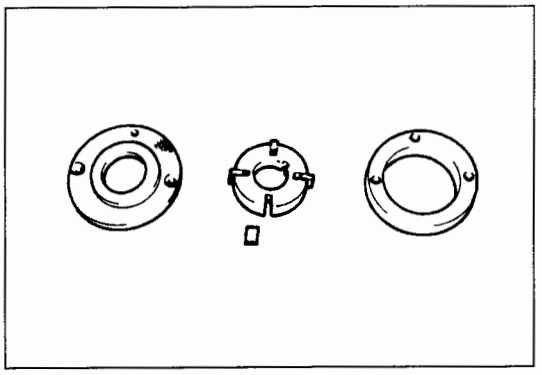
Limit: L=4.2 mm (0.165 in.)



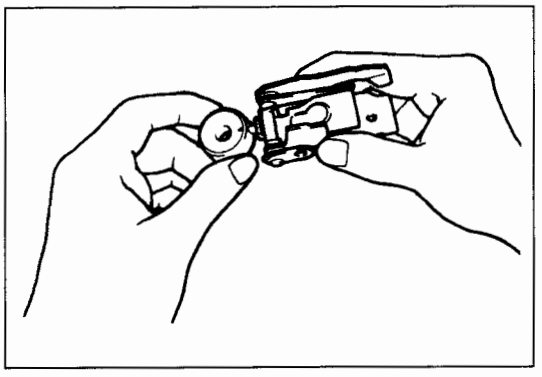
6. Inspect the flyweights.
   (1) Measure the amount of stepped wear at the flyweight surface coming contact with the washer.

Limit: A=0.2 mm (0.008 in.)

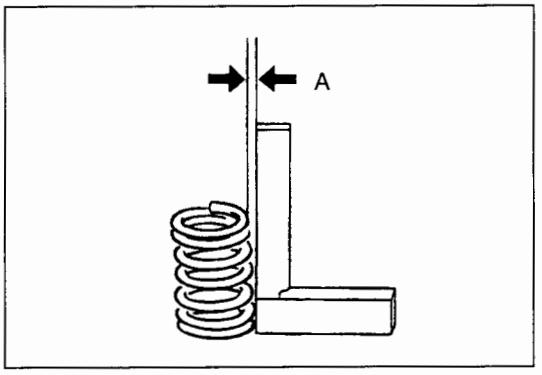
If the limit is exceeded, replace all four parts as a group.



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.

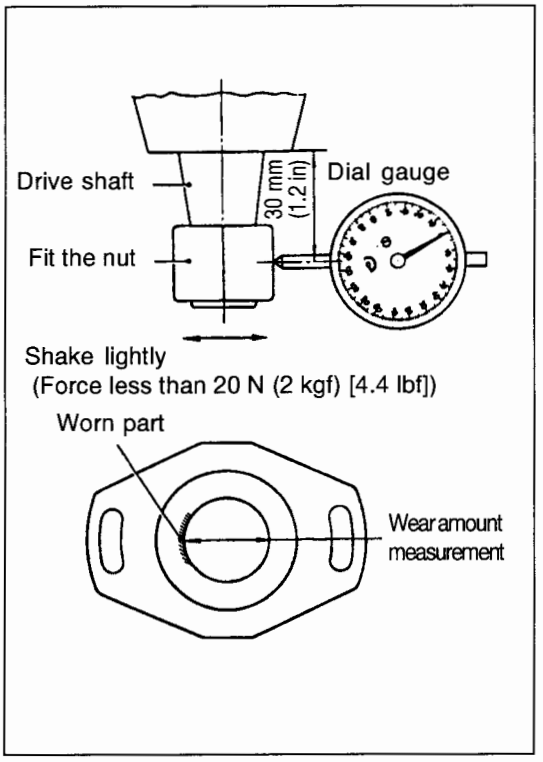


9. Inspect the plunger springs.
   (1) Replace if the surface is damaged.

Note:
Replace both springs simultaneously.

   (2) Squareness of the spring

   Limit: A=2.0 mm (0.08 in.)



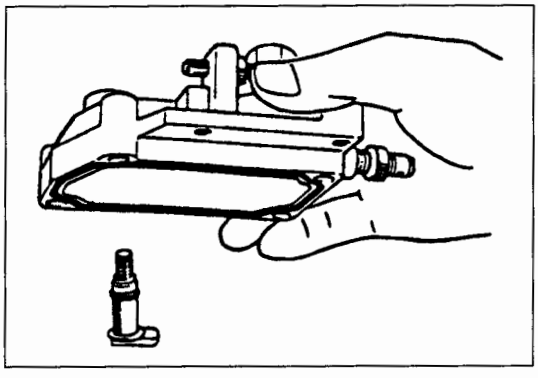
10. Inspect the pump housing.
   (1) Check the feed pump for wear or scratch in the sliding surface.
   (2) check the threads for damage.
   (3) Wear of the housing bushing
      ① Fit the nut on the drive shaft as illustrated. Lightly shake the drive shaft in the direction of wear (by a light push with 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: 0.1 mm (0.0039 in.)

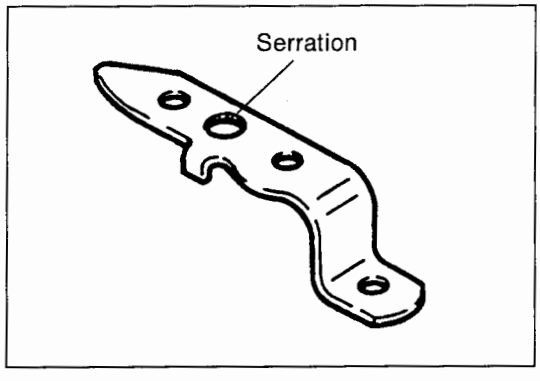
REASSEMBLY

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.**



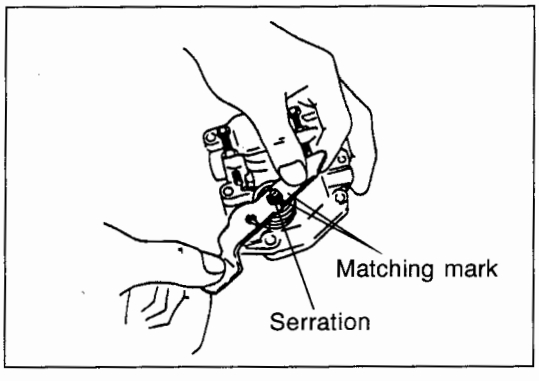
1. Assemble the adjusting lever parts.
   (1) Assemble O rings and washers to the lever shaft.
   (2) Assemble parts in the lever shaft cover first.
   (3) Return spring



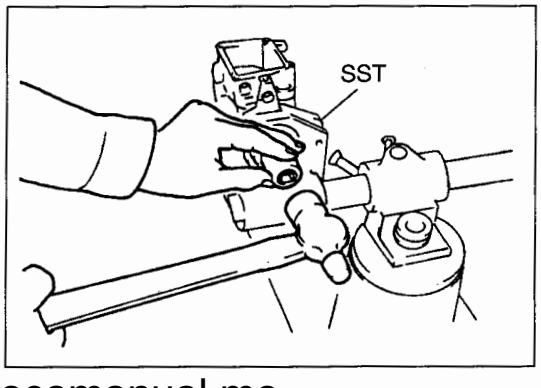
(4) Adjusting lever

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.**

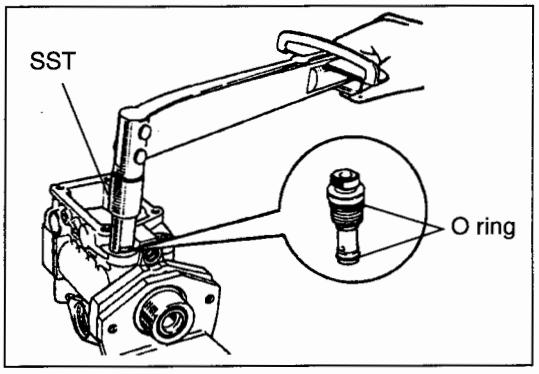


(5) Spring guide
(6) Nut
T=4.90 ~ 9.81 N·m (50 ~ 100 kgf-cm)
[3.62 ~ 7.27 ft-lbf]

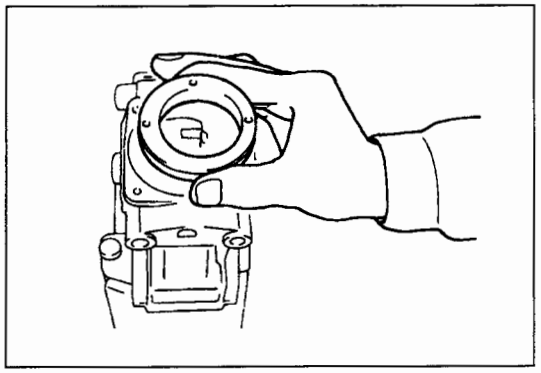


2. Install the pump housing in the pump stand.
   SST 09245-54010
3. Assemble the oil seal.

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

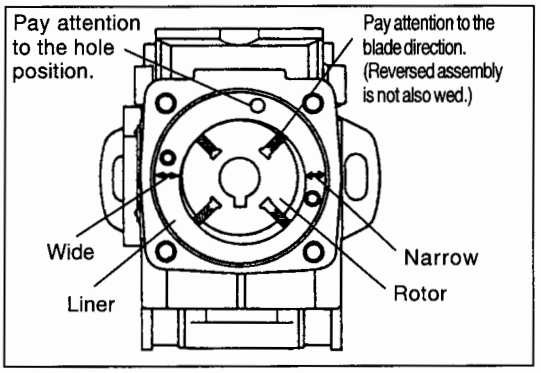


4. Assemble the regulating valve.
   (1) Assemble O ring to the regulating valve.
   (2) Regulating valve
   SST 09260-54012
   T=7.85 ~ 9.81 N·m (80 ~ 100 kgf-cm)
   [5.79 ~ 7.27 ft-lbf]



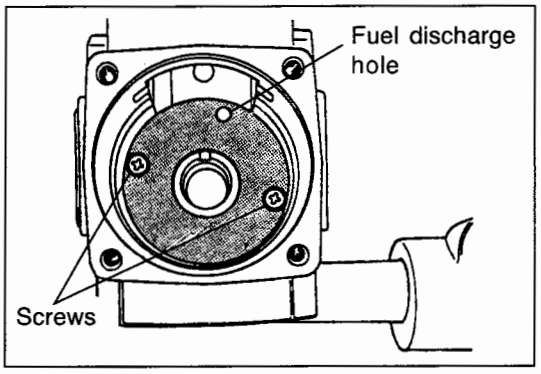
5. Assemble the feed pump parts.
   (1) Liner

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.)



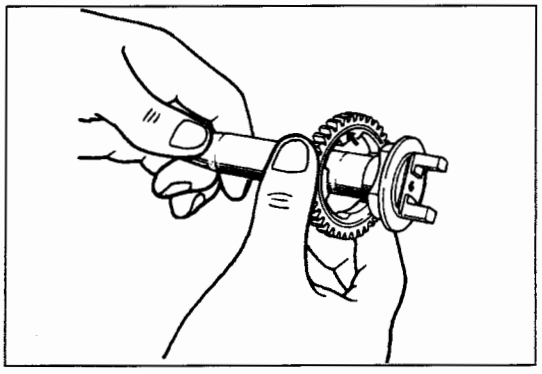
   (2) Rotor · blades

Note:
- **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).**



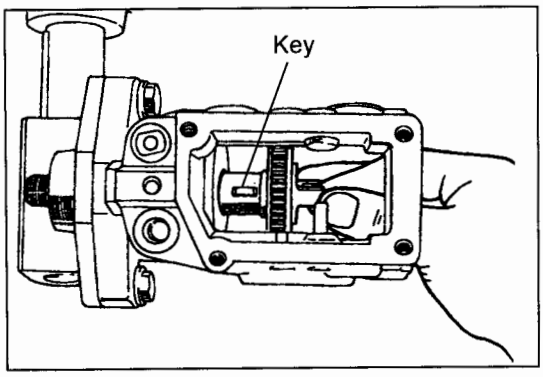
   (3) Feed pump cover

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 your directions (vertical and horizontal directions).**



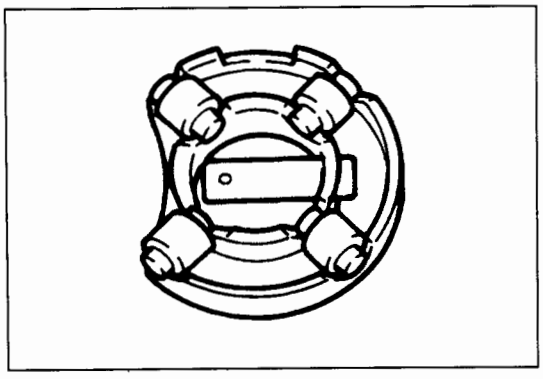
6. Assemble the drive shaft.
   (1) Assemble the governor drive gear to the drive shaft. Then insert a rubber joint into the gap between the drive shaft and the driver gear.

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



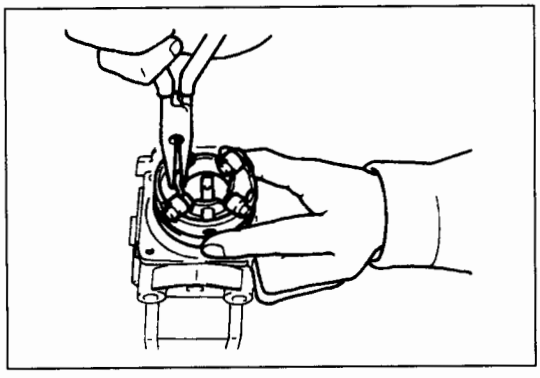
(2) Drive shaft washer · drive shaft ASSY · key

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.**



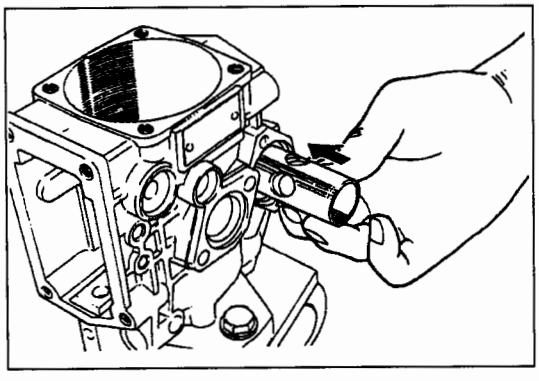
7. Assemble the roller ring.
   (1) Insert the timer slide pin into the roller ring ASSY.

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.**



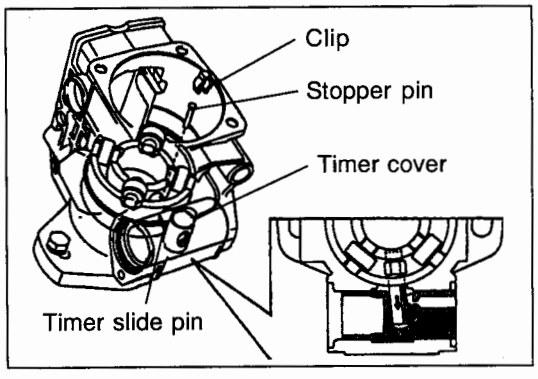
(2) Hold the pump vertically and assemble the roller ring ASSY as shown.

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



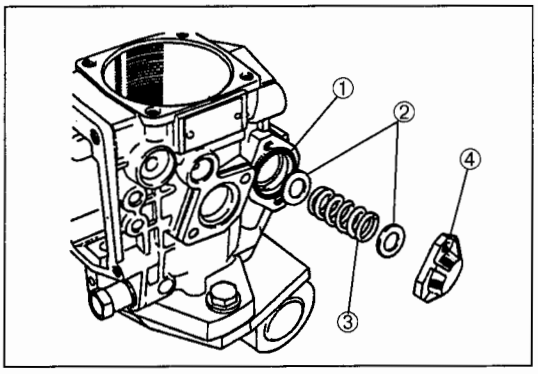
8. Assemble the timer.
   (1) Assemble the sub-piston to the timer piston. Coat grease (Timer Grease), and insert the parts into the pump housing.

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.**



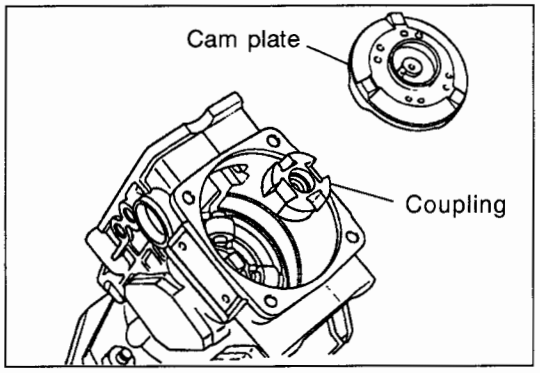
(2) Insert the timer slide pin into the timer sub-piston. Assemble the stopper pin, and fit the clip.

Note:
Confirm that the timer piston slides smoothly.



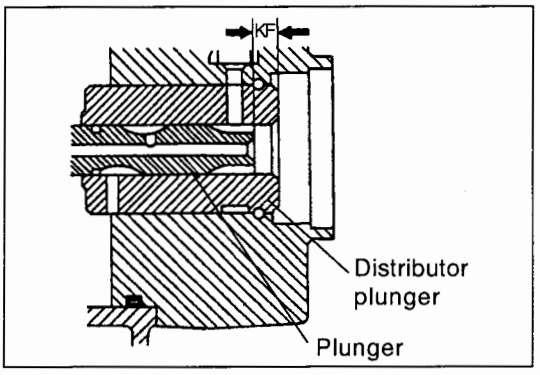
(3) Assemble the following parts:
① O ring
② Washers
③ Timer spring
④ Timer cover

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

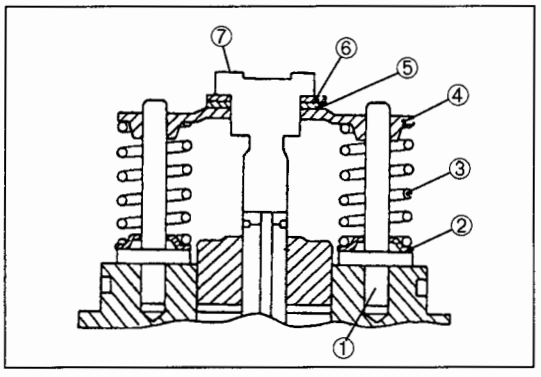


9. Assemble the coupling and cam plate.
(1) Coupling
(2) Assemble the cam plate with the pin in the same direction as the key groove in the drive shaft.

Notes:
- **Install the coupling so that its end with a larger center hole diameter is on the upper side.**
- **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.**

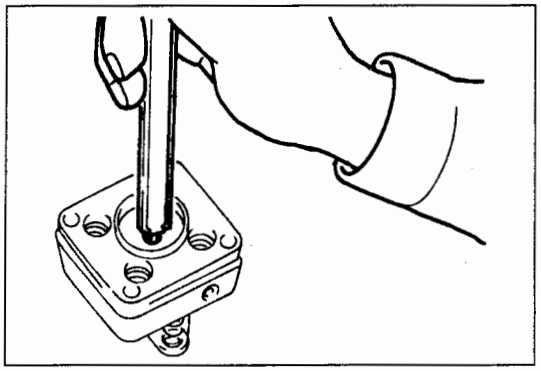


10. Adjust the plunger spring shim (measuring dimension KF).
(1) Dimension KF is the distance from the end surface of the distributor cylinder ① to the end surface of the plunger ② head. The set length of the plunger spring can be altered by selective use of the plunger spring shim.



(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.**



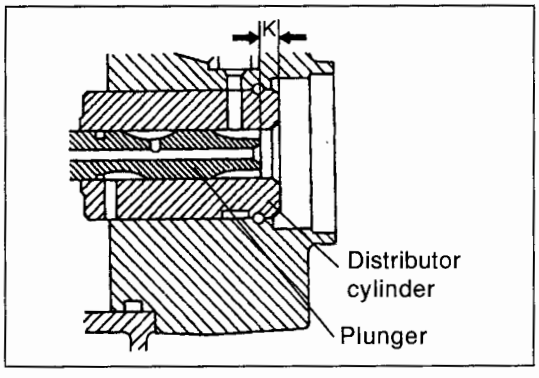
(3) Selective use of the plunger spring shim
Measure dimension KF when the plunger spring is released, and calculate the necessary shim thickness from the following equation:

Shim thickness=5.9 mm (0.232 in.) – dimension KF

Size variation of plunger spring shims

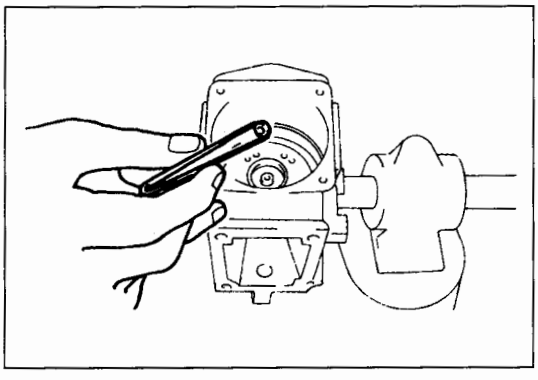
Part No.	Thickness mm (in.)
22182-54010	0.5 (0.020)
22183-54010	0.8 (0.031)
22184-54010	1.0 (0.039)
22185-54010	1.2 (0.047)
22186-54010	1.5 (0.059)
22187-54010	1.8 (0.071)
22188-54010	2.0 (0.079)

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.**

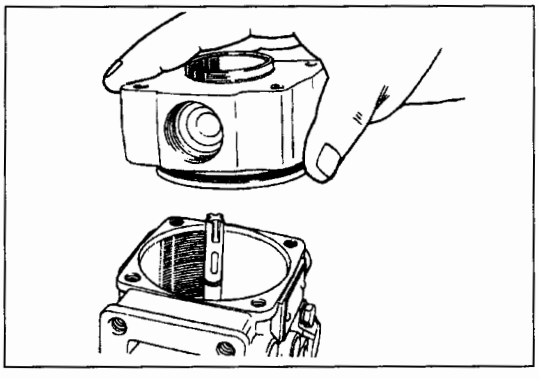


11. Adjust the plunger spring shim (measuring dimension K.)
    (1) Dimension K is the distance from the end surface of the distributor cylinder as assembled to the end surface of the plunger head at the BDC of the plunger.
    Dimension K can be altered by selective use of the plunger adjusting shim.

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

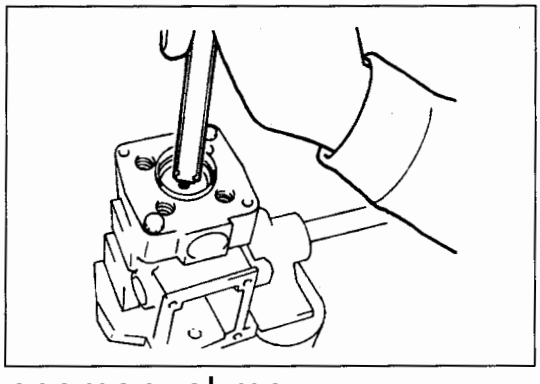


Note:
Do not coat grease on the plunger shim.



(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 ± 0.1 mm (0.130 ± 0.004 in.)

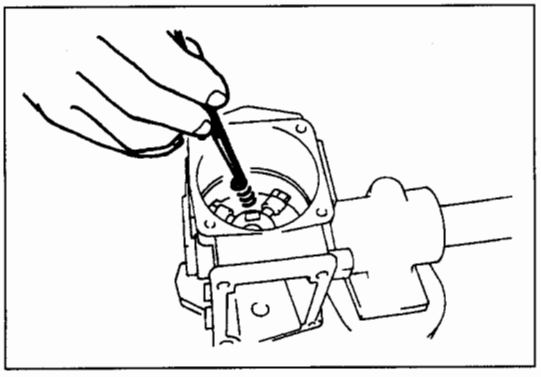
Note:
Make sure the plunger is not raised during measurement.

Size variation of plunger shims

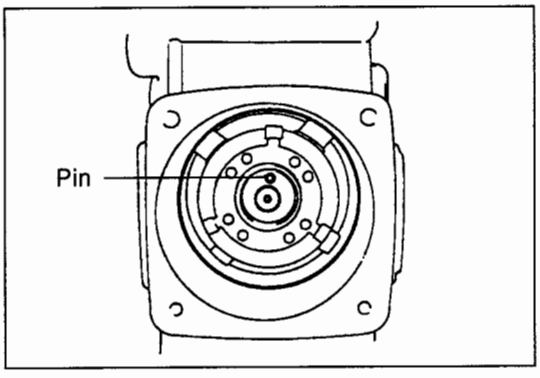
Part No.	Thickness mm (in.)
22179-54010	1.9 (0.074)
22179-54011	2.0 (0.079)
22179-54012	2.1 (0.083)
22179-54013	2.2 (0.087)
22179-54014	2.3 (0.091)
22179-54015	2.4 (0.094)
22179-54016	2.5 (0.098)
22179-54017	2.6 (0.102)
22179-54018	2.7 (0.106)
22179-54019	2.8 (0.110)
22179-54020	2.9 (0.114)

(5) Plunger shim selection
Compare the measured value with the standard, and select the appropriate shim thickness accordingly.
Shim thickness (mm) = t_1 + (t_2 – 3.3)
(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.

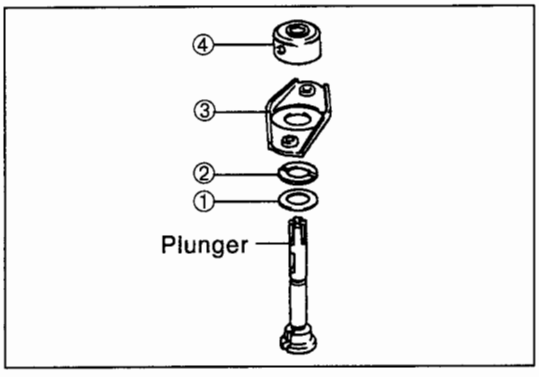


12. Assemble the coupling spring.



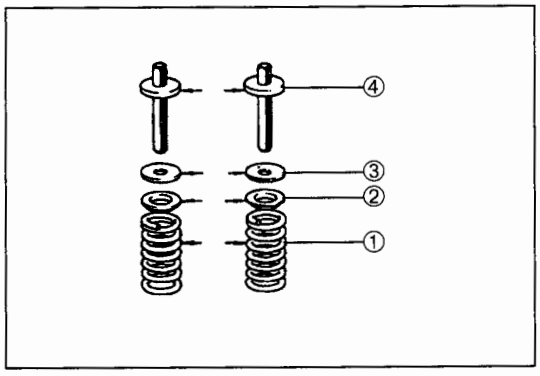
13. Assemble the cam plate.

Note:
Install the cam plate so that its drive pin is aligned with the drive shaft key groove.
Carefully prevent misalignment because it will cause incorrect injection sequence.



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

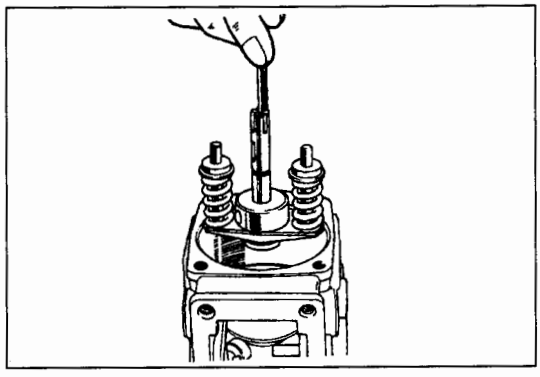
Note:
Install the spill ring in such a way the end surface with a hole faces the cam plate.



(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

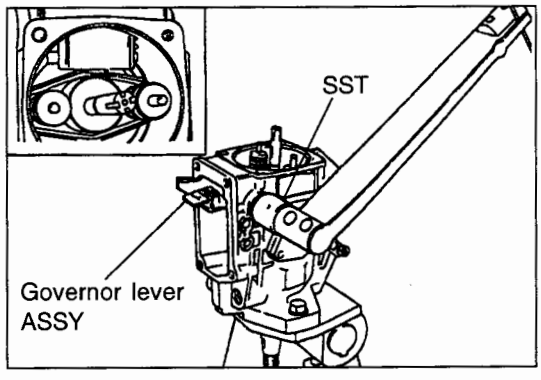
(3) Plunger shim (selective use)

Note:
Do not coat grease on the plunger shim.



(4) Assemble the plunger parts as shown.

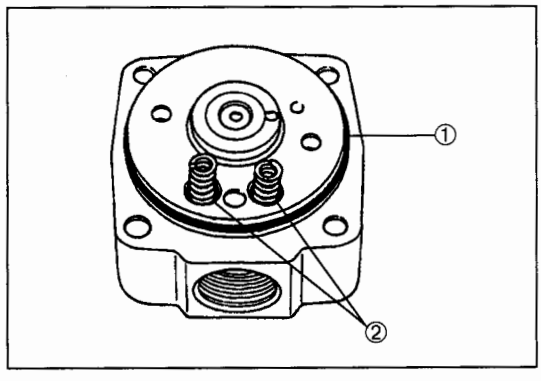
Note:
The drive pin of the cam plate must fit in the groove at the plunger leg.



15. Assemble the governor lever.
(1) Governor lever

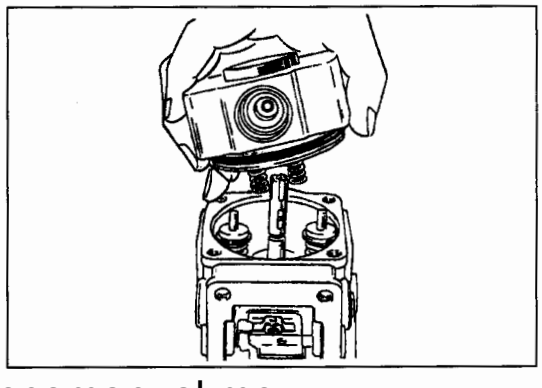
Note:
The ball pin of the governor lever must fit in the spill ring.

(2) Support bolt
SST 09260-54012
T=9.8 N ~ 12.7 N·m (100 ~ 130 kgf-cm)
[7.3 ~ 9.3 ft-lbf]



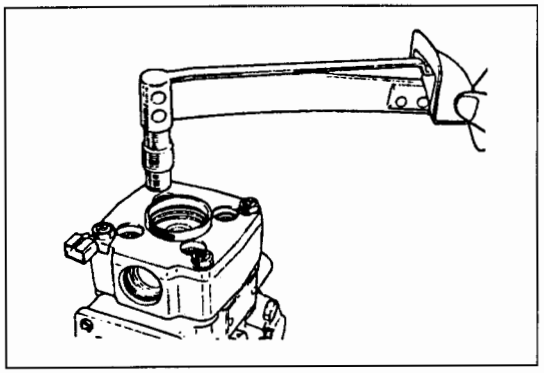
16. Assemble the distributor head.
(1) Assemble the following parts to the distributor head:
① O ring
② Lever support spring

Note:
Apply grease (Timer Grease) to the spring to adhere it to the distributor head.



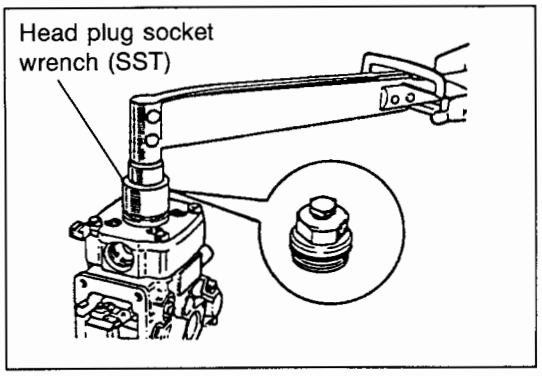
(2) Assemble the distributor head.

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



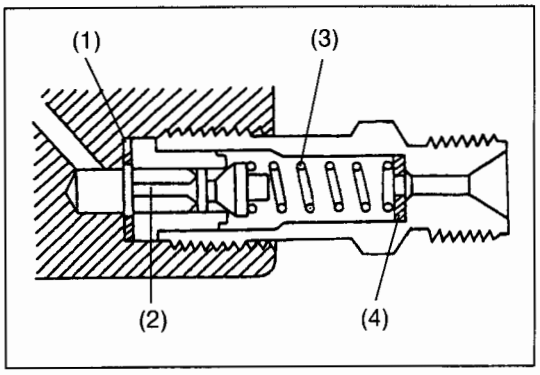
(3) Distributor head set bolts
T=10.8 ~ 12.7 N·m (110 ~ 130 kgf-cm)
[8.0 ~ 9.3 ft-lbf]

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



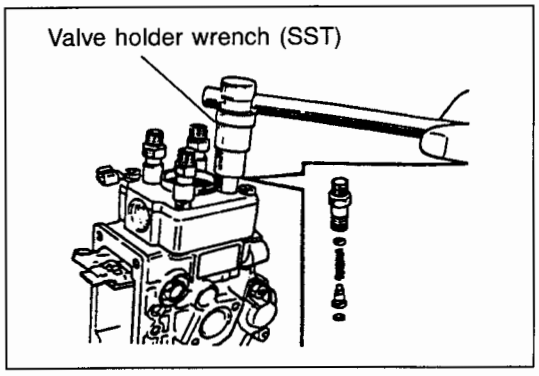
17. Assemble the head plug.
(1) Assemble O ring to the head plug.
(2) Head plug
SST 09260-540120
T=58.8 ~ 78.4 N·m (600 ~ 800 kgf-cm)
[43.4 ~ 57.6 ft-lbf]

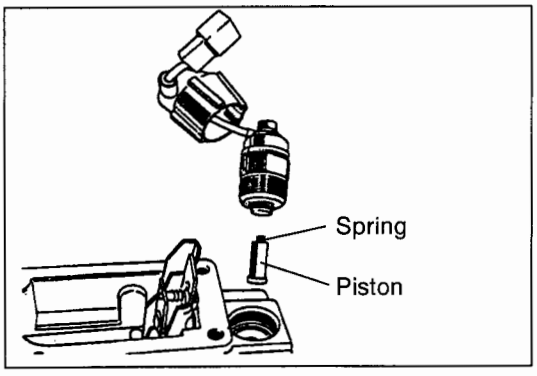
Note:
Always use new head plugs.



18. Assemble the delivery valve.
(1) Gasket
(2) Delivery valve
(3) Valve spring
(4) Spring seat
(5) Valve holder
SST 09260-54012
T=53.9 ~ 63.7 N·m (550 ~ 650 kgf-cm)
[32.5 ~ 47.0 ft-lbf]

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

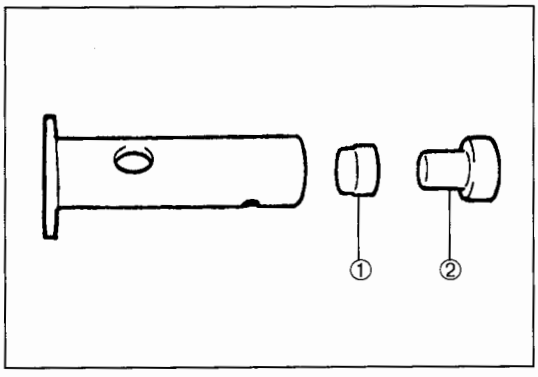




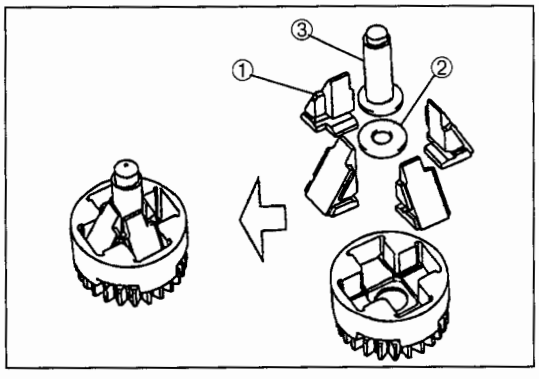
19. Assemble the solenoid.
(1) Assemble O ring to the solenoid.
(2) Solenoid
T=19.6 ~ 24.5 N·m (200 ~ 250 kgf-cm)
[14.5 ~ 18.0 ft-lbf]

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

(3) Boot

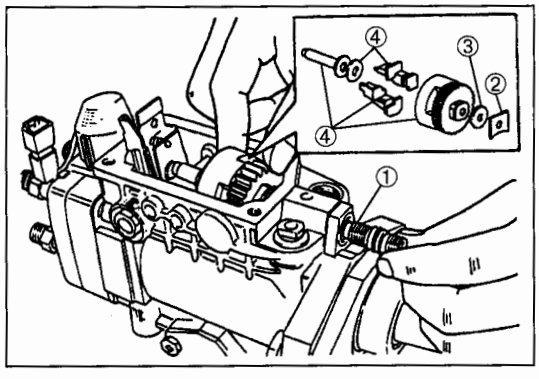


20. Assemble the governor shaft parts
(1) Assemble the following parts to the governor sleeve:
① Stop ring
② Sleeve plug



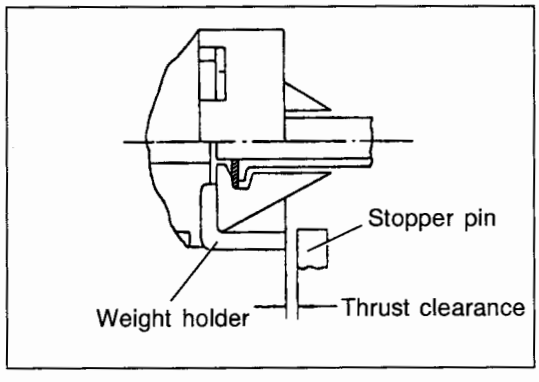
(2) Assemble the following parts to the weight holder:
① Flyweight
② Flyweight washer
③ Governor sleeve

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

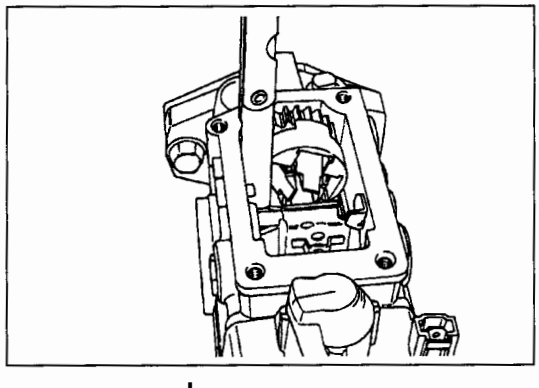


(3) Assemble O ring to the governor shaft.
(4) Assemble the following parts:
① Governor shaft
② Adjusting washer
③ Washer
④ Governor flyweight ASSY

Note:
The governor shaft has left-hand threads.

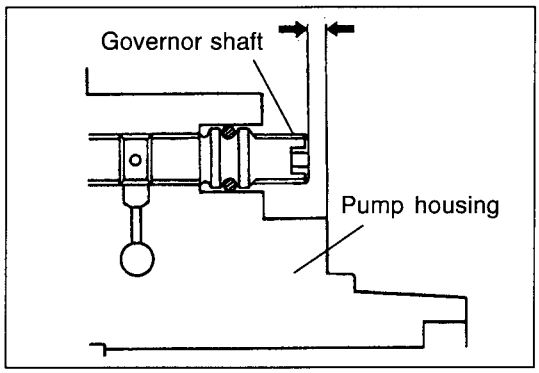


(5) Using a thickness gauge, measure the thrust clearance of the flyweight holder.
If the standard is not met, change the thickness of the adjusting washer as needed.
Thrust clearance (over the entire circumference)
0.15 ~ 0.35 mm (0.0059 ~ 0.0138 in.)



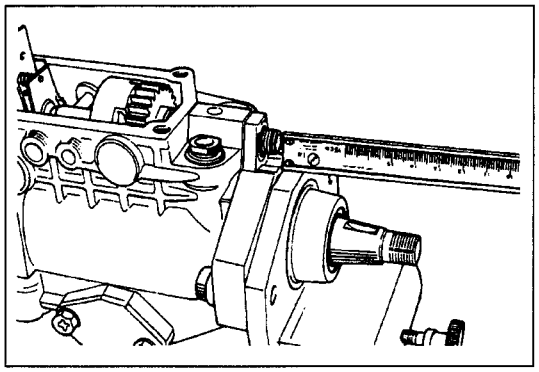
Size variation of adjusting washers

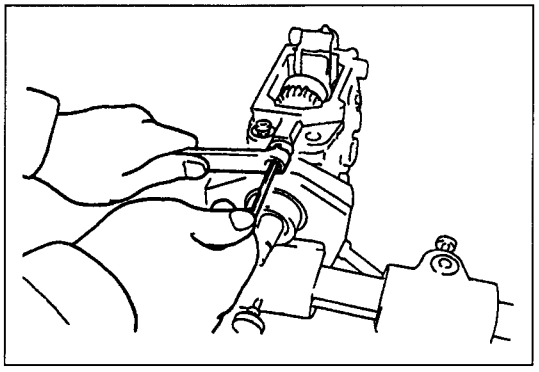
Part No.	Thickness mm (in.)
22713-54010	1.05 (0.0413)
22714-54010	1.25 (0.0492)
22715-54010	1.45 (0.0571)
22716-54010	1.65 (0.0650)
22717-54010	1.85 (0.0728)



(6) Adjust dimension L from the governor shaft tip to the end surface of the pump housing.
Standard: 1.5 ~ 2.5 mm (0.059 ~ 0.098 in.)

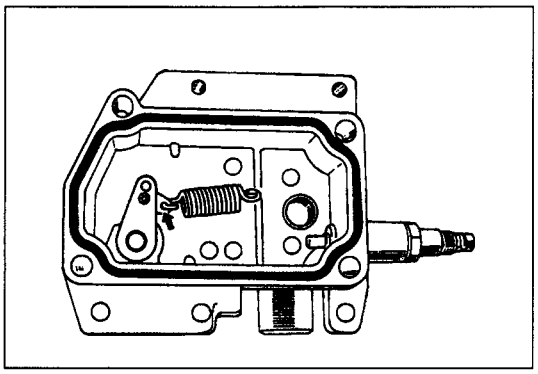
Note:
The governor shaft has left-hand threads.





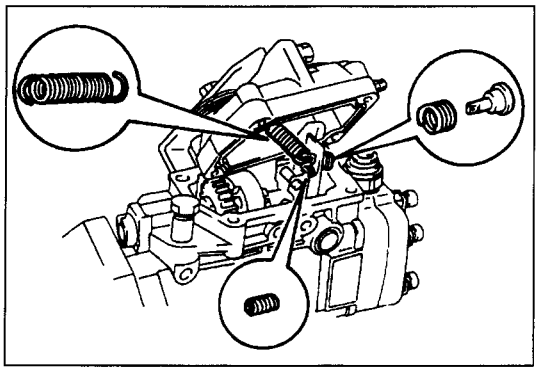
(7) Governor shaft lock nut
SST 09260-54012
T=24.5 ~ 29.4 N·m (250 ~ 300 kgf-cm)
[18.1 ~ 21.6 ft-lbf]

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.

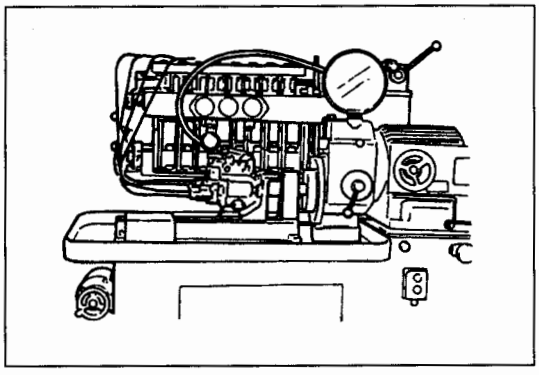
Notes:
- **Assemble the governor spring seat in the correct position.**
- **Always use new governor cover gaskets.**

(3) Socket bolts

AIRTIGHTNESS TEST

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

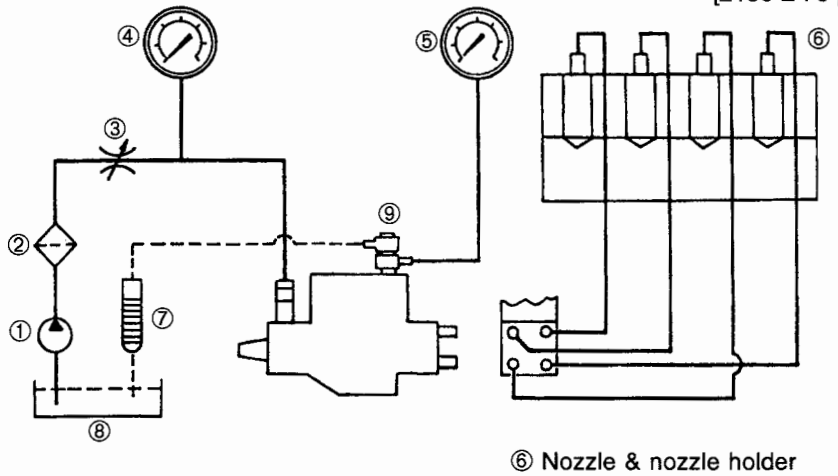
1. Install a blind plug to the overflow screw opening. Apply air pressure of about 147 kPa (1.5 kgf/cm²) [21.33 psi] from the fuel inlet hole. Put the pump in oil until the overflow screw is in the oil, and check that air does not leak from any part of the pump.
2. Then, apply higher air pressure of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



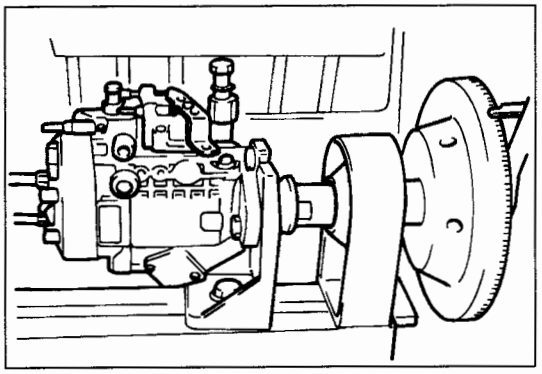
ADJUSTMENT

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
12. Low speed lever setting



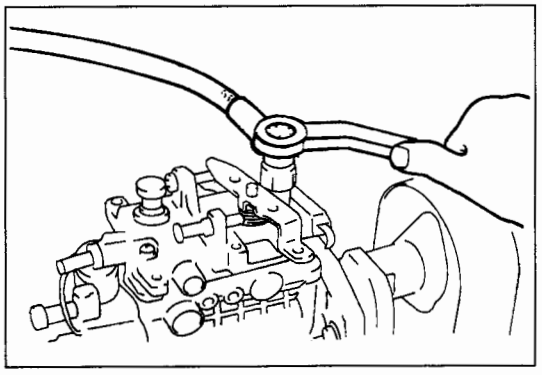
① Feed pump
② Fuel filter
③ Adjusting valve
④ Pressure gauge (for feed pressure measurement)
⑤ Pressure gauge (for internal pressure measurement)
⑥ Nozzle & nozzle holder
⑦ Measuring cylinder
⑧ Fuel tank
⑨ Overflow screw



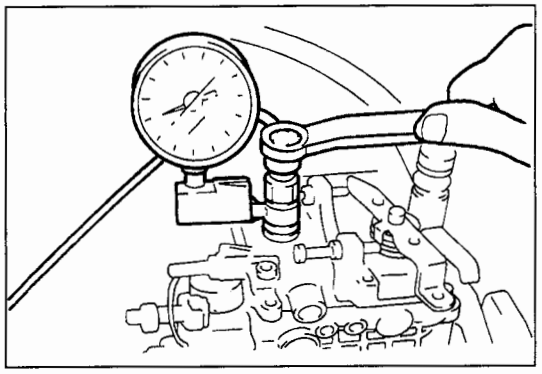
Pre-test inspection and preparation

1. Measure the valve opening pressure of the test nozzle holder.
   Valve opening pressure: 14.71 ± 0.49 MPa (150 ± 5 kgf/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

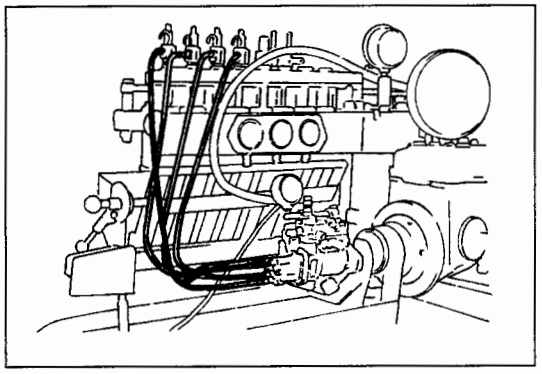


(2) Pressure gauge and overflow hose

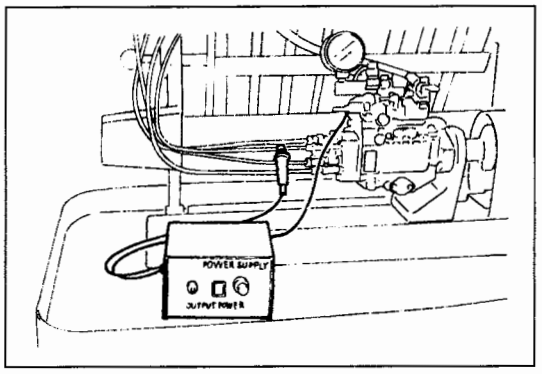
Note:
Do not confuse the overflow screw with the inlet screw. The overflow screw has "OUT" stamped on it.

(3) Pressure gauge

Note:
The type of pressure gauge used comes with a timer measuring device as an integral part. The piping test point may be sourced from the overflow hose connection.



(4) High pressure pipe
Use high pressure hose of the following specifications (Inside diameter × Outside diameter × length):
2.0 × 6.0 × 840 mm (0.079 × 0.236 × 33.071 in.)

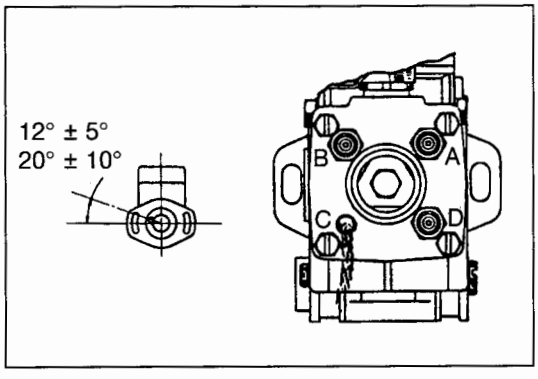


(5) Apply voltage (6V) to the fuel cut solenoid.

Run-in operation

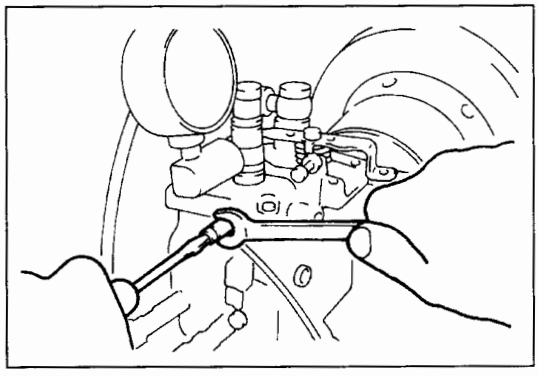
1. Maintain fuel temperature at 40 to 45°C (104 to 113°F).
2. Adjust the feed pressure of the pump tester to 19.6 kPa (0.2 kgf/cm²) [2.8 psi].
3. Operate the pump at low speed (300 rpm) until air inside the pump chamber is bled from the overflow pipe.
4. Maintain the adjusting lever at the FULL position using a spring or other appropriate tool. Raise the pump speed gradually an 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.



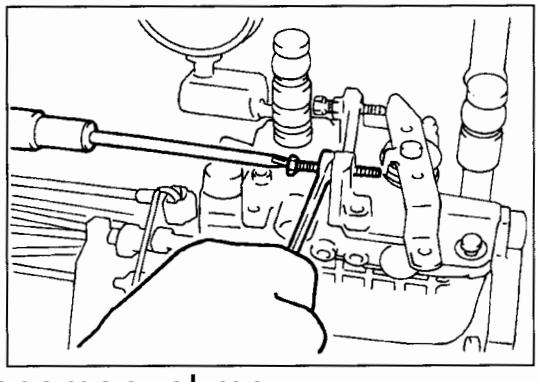
6. Set the key groove of the drive shaft at the angle shown. Remove the delivery valve from cylinder C, apply a feed pressure of 19.6 kPa (0.2 kgf/cm²) [2.8 psi], and confirm that fuel starts coming out.

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

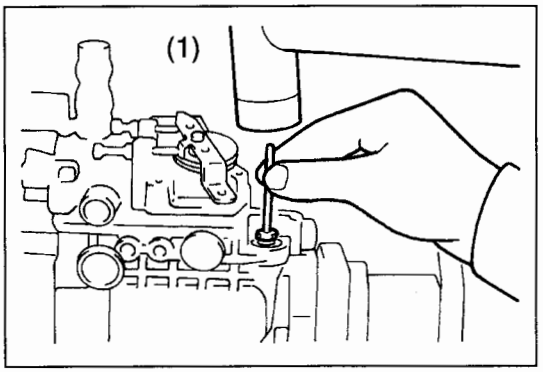


Temporary adjustment (lever at FULL position)

1. Temporary adjustment of the full-load standard injection rate.
   Measure the injection rate at pump speed 900 rpm.
   When the standard is not met, turn the full-load set screw as necessary.
   Standard: 8.3 ~ 8.7 cm³/200st. 1cyl
   (0.506 ~ 0.531 cu-in. /200st. /cyl)



2. Temporary adjustment of the high speed lever setting.
   Measure the injection rate at pump speed 1310 rpm.
   When the standard is not met, turn the maximum speed set screw as necessary.
   Standard: 3.3 ~ 4.9 cm³/200st. 1cyl
   (0.201 ~ 0.299 cu-in. /200st. 1cyl)



Pump internal pressure adjustment (lever at FULL position)

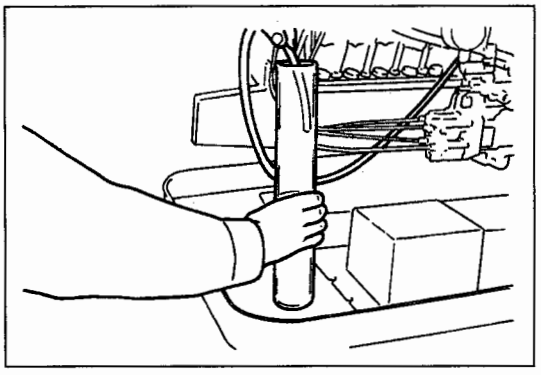
1. Measure the pressure at specified pump speeds.
   Standard:

Pump speed	Pump internal pressure		
rpm	kPa	kgf/cm²	psi
400	412 ~ 471	4.2 ~ 4.8	59.7 ~ 68.3
1200	608 ~ 667	6.2 ~ 6.8	88.2 ~ 96.7

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.

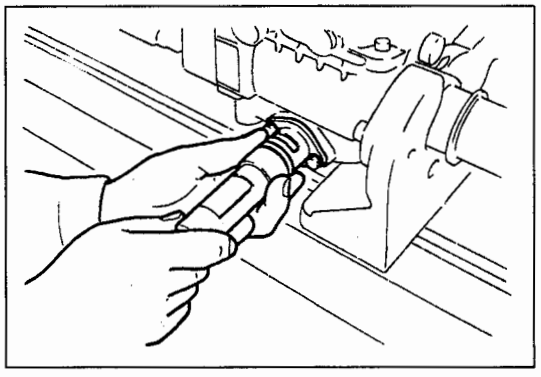
When the pressure is higher than the standard, replace the regulating valve.



Overflow rater inspection (lever at FULL position)

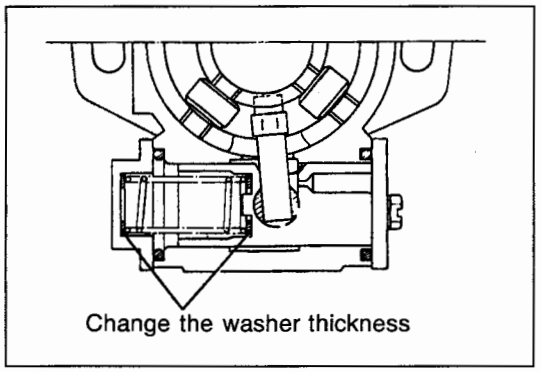
1. Measure the overflow rate at pump speed 1200 rpm.
   Standard: 283 ~ 533 cm³/100 st (17.27 ~ 32.52 cu-in / 100 st)

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 (DENSO Part No. 95905-10110) and set the zero point.



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

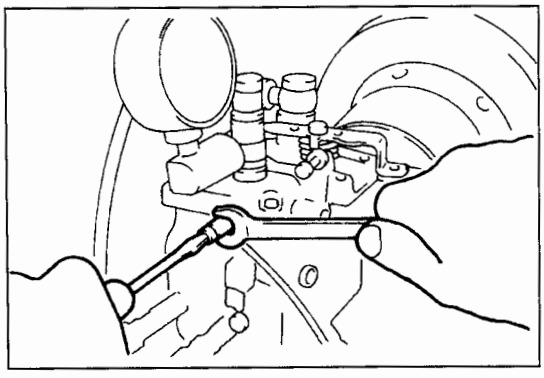
Pump speed rpm	Piston stroke mm (in.)
700	0.45 ~ 1.25 (0.0177 ~ 0.0492)
1200	2.35 ~ 3.15 (0.0925 ~ 0.1240)

(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.

Size variation of timer adjusting washers

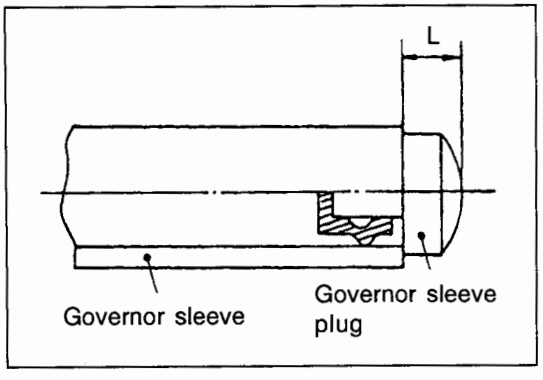
Washer Part No.	Thickness mm (in.)
22624-54010	0.2 (0.008)
22621-54010	0.5 (0.020)
22622-54010	1.0 (0.039)

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 900 rpm. If the standard is not met, adjust the rate by turning the full-load set screw as needed.
   Standard: 8.3 ~ 8.7 cm³/200 st. /cyl.
   (0.506 ~ 0.531 cu-in. /200 st. /cyl.)
   [Deviation 0.6 cm³ (0.037 cu-in.) or less]



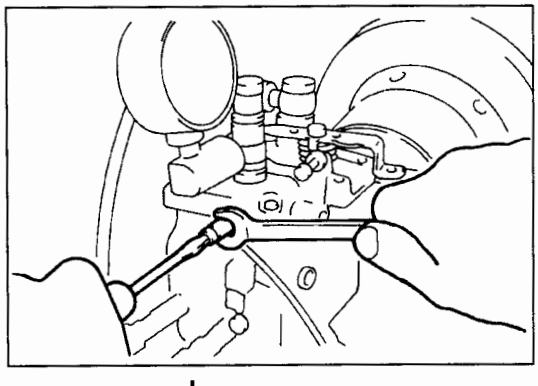
Starting injection rate adjustment (lever at FULL position)

1. Measure the injection rate at pump speed 100 rpm.
   Standard: 9.7 ~ 12.9 cm³ /200 st. 1cyl.
   (0.592 ~ 0.787 cu-in. /200 st. 1cyl.)
   [Deviation 1.2 cm³ (0.073 cu-in.)]
2. 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 n.) results in a decrease of the injection rate by 1.6 cm³ (0.098 cu-in.) /200 st.

Size variation of governor sleeve plugs

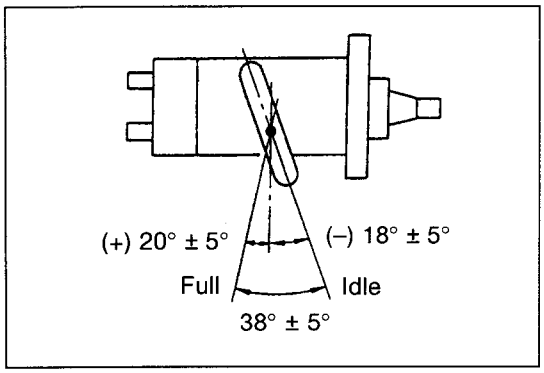
Part No.	Dimension L mm (in.)	Part No.	Dimension L mm (in.)
22787-54018	4.3 (0.169)	22787-54022	5.1 (0.201)
22787-54019	4.5 (0.177)	22787-54023	5.3 (0.209)
22787-54020	4.7 (0.185)	22787-54024	5.5 (0.217)
22787-54021	4.9 (0.193)	22787-54025	5.7 (0.224)

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



Full-load injection rate confirmation

1. 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:

Lever angle	Pump speed rpm	Injection rate cm³/200st. 1cyl (cu-in./200st. 1cyl)	Deviation cm³ (cu-in.)
20° ± 5° (at FULL position)	1200	9.24 ~ 10.36 (0.564 ~ 0.632)	0.5 (0.031)
	500	6.94 ~ 8.06 (0.423 ~ 0.492)	0.5 (0.031)
	400	7.20 ~ 9.80 (0.439 ~ 0.598)	—

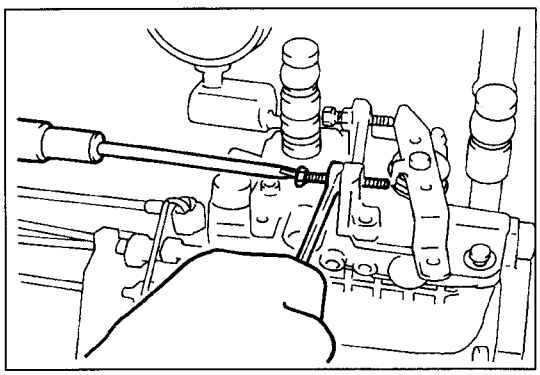
2. If the deviation limit is exceeded, replace the delivery valve, delivery valve spring, etc., or check if the delivery valve gasket is fitted correctly.

High speed lever setting

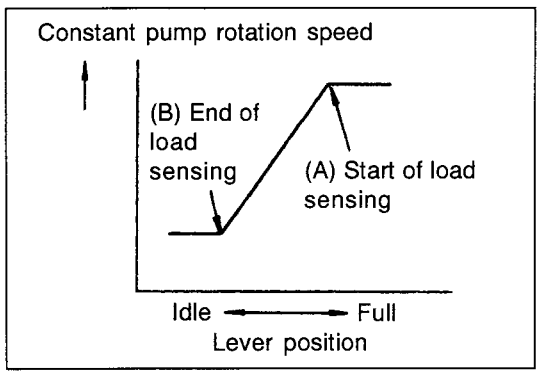
1. Turn the maximum speed set screw as necessary so that the standard injection rate is met at the conditions shown below.

Standard:

Lever angle	Pump speed rpm	Injection rate cm³/200 st. 1cyl (cu-in. /200 st. 1cyl)	Note
20° ± 5° (at FULL position)	1310	3.3 ~ 4.9 (0.201 ~ 0.299)	High speed lever setting
	1275	7.2 ~ 10.0 (0.0439 ~ 0.0610)	Confirmation
	1400	0.9 (0.055) or less	Confirmation

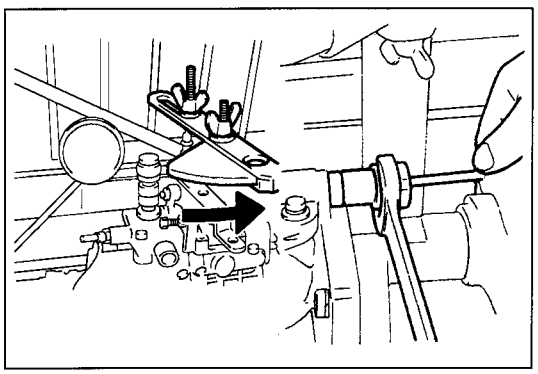


Note:
Tightening the screw decreases the injection rate.

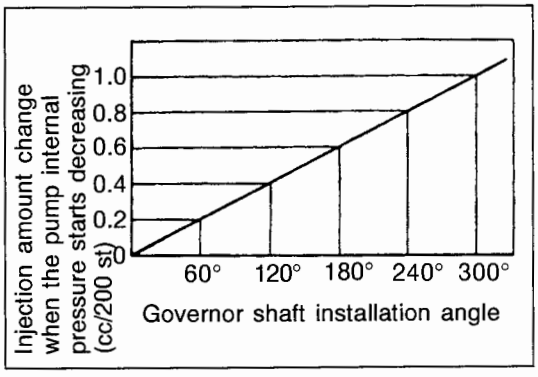


Load sensing timer adjustment

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.

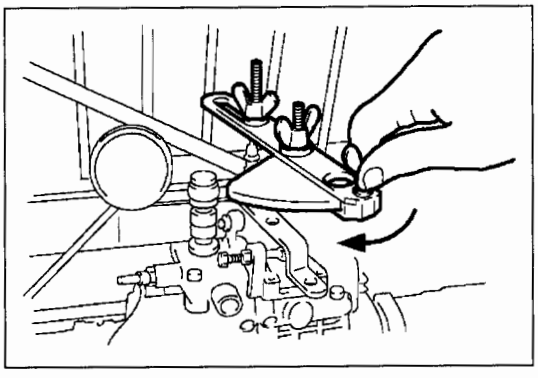


   (2) If the standard is not met, adjust the rate by turning the governor shaft. Set the lever again as in step 1 above, and check the injection rate.
   Method of adjustment:
   - When the injection rate is low
     Turn the governor shaft clockwise.
   - When the injection rate is high
     Turn the governor shaft counterclockwise.



Lever angle	Pump speed rpm	Injection rate cm³/200st. (cu-in./200st.)	Note
Threshold	1200	q FULL – 0.8 ± 0.4 (qFULL–0.049±0.024)	By governor shaft
End of sensing	1200	q FULL -2.4 ± 0.4 (qFULL–0.146±0.024)	Confirmation

q FULL: Injection rate (measured value) at pump speed 1200 rpm with the lever at FULL position
(Reference value) 9 ~ 10 cm³
(0.55 ~ 0.61 cu-in.)

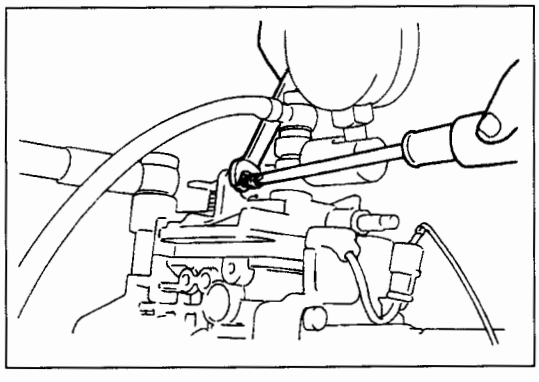


2. Setting the end of sensing
Operate the pump at a specified speed. Slowly switch the adjusting lever from IDLE to FULL position, and maintain the adjusting lever at position (B) where the pump internal pressure begins to rise (see the relative positions of the lever position and pump internal pressure). 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:

Lever angle	Pump speed rpm	Injection rate cm³ / 500st. 1cyl (cu-in. /500st. 1cyl)	Deviation cm³ (cu-in.)	Note
(–) 18° ± 5° (at IDLE position)	390	2.5 ~ 5.5 (0.153 ~ 0.336)	1.5 (0.0092)	Low speed lever setting
	490	0.75 (0.046) or less	—	Confirmation

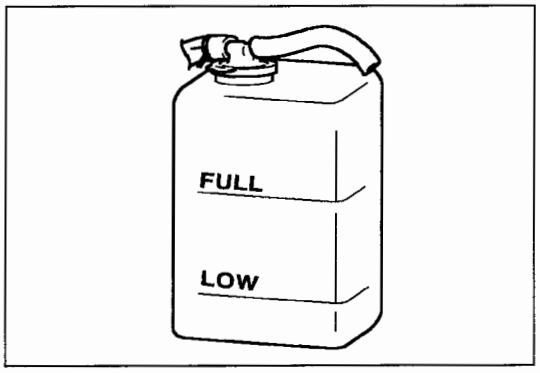


Note:
Tightening the screw increases the injection rate.

Confirmation after adjustment

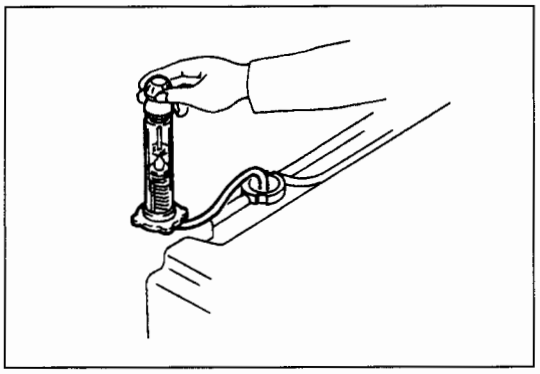
1. After completion of adjustment, reduce the fuel cut solenoid voltage to 0V and confirm that the injection rate is zero at that voltage (at pump speed 100 rpm).
2. Check that the lever angle is 38° ± 15° between the IDLE and FULL positions.
3. Seal the full-load set screw and the maximum speed set screw.

COOLING SYSTEM



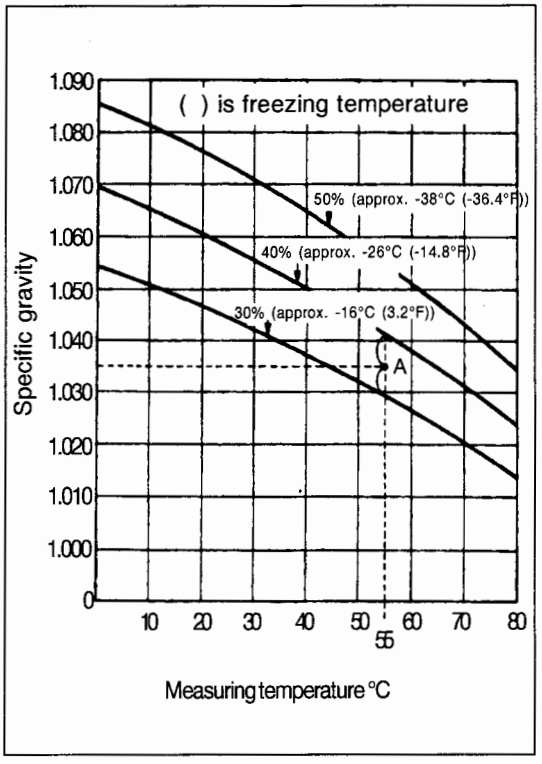
COOLANT INSPECTION

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.

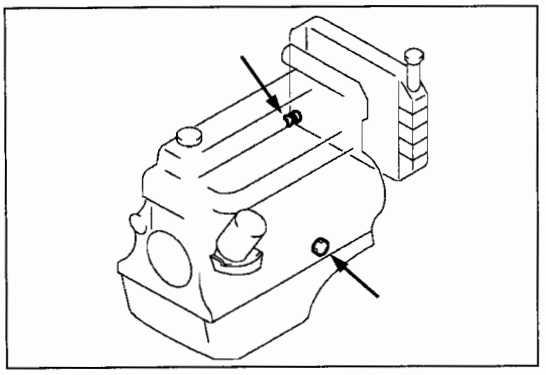
Note:
The coolant concentration must be at least 30% (50% in cold areas).



(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 clocks, and pour coolant (LLC).

   Coolant capacity: See the repair manual for each model

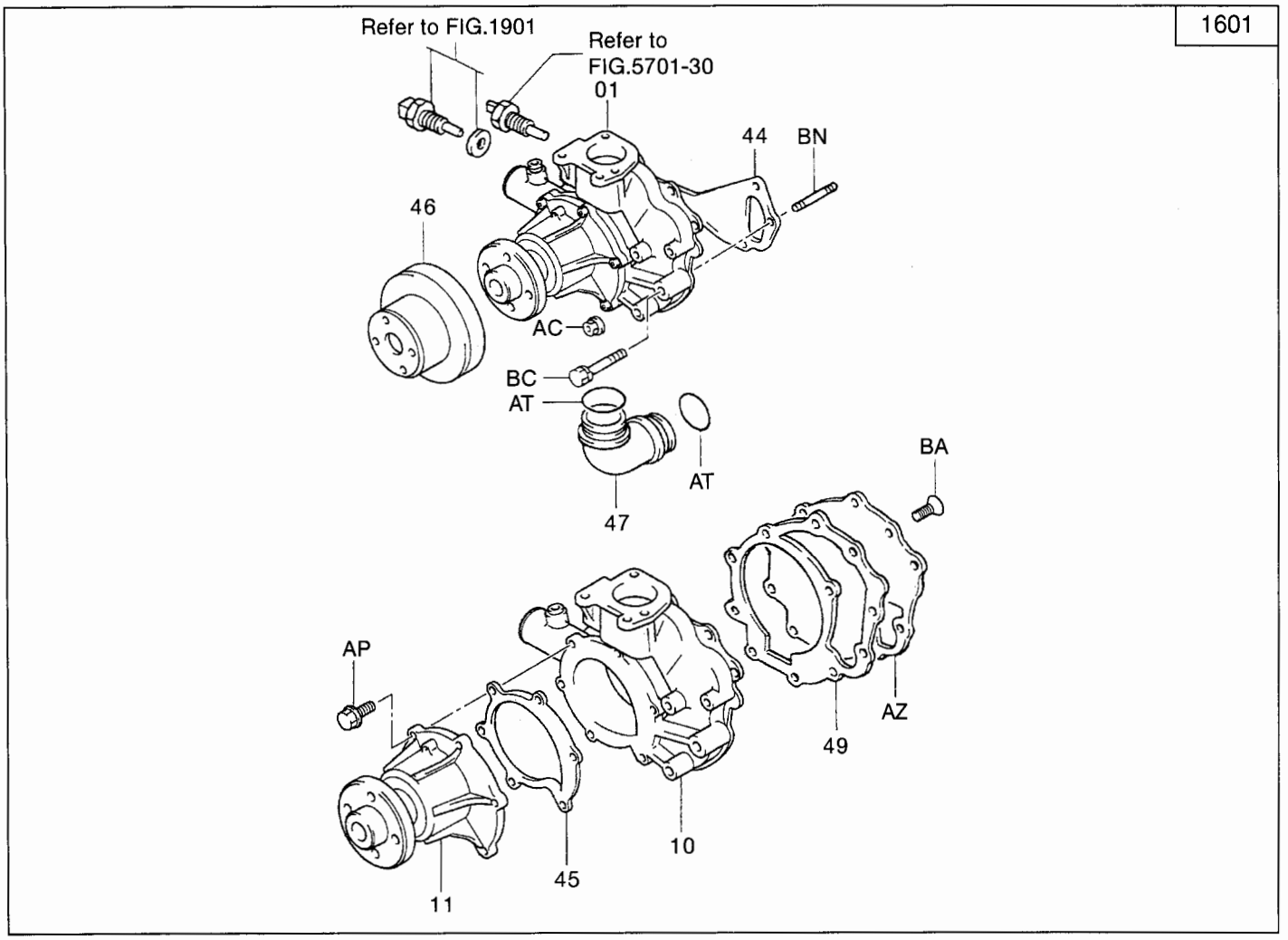
   (2) Warm up the engine, and check the coolant level.

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

   (3) Add coolant as necessary.

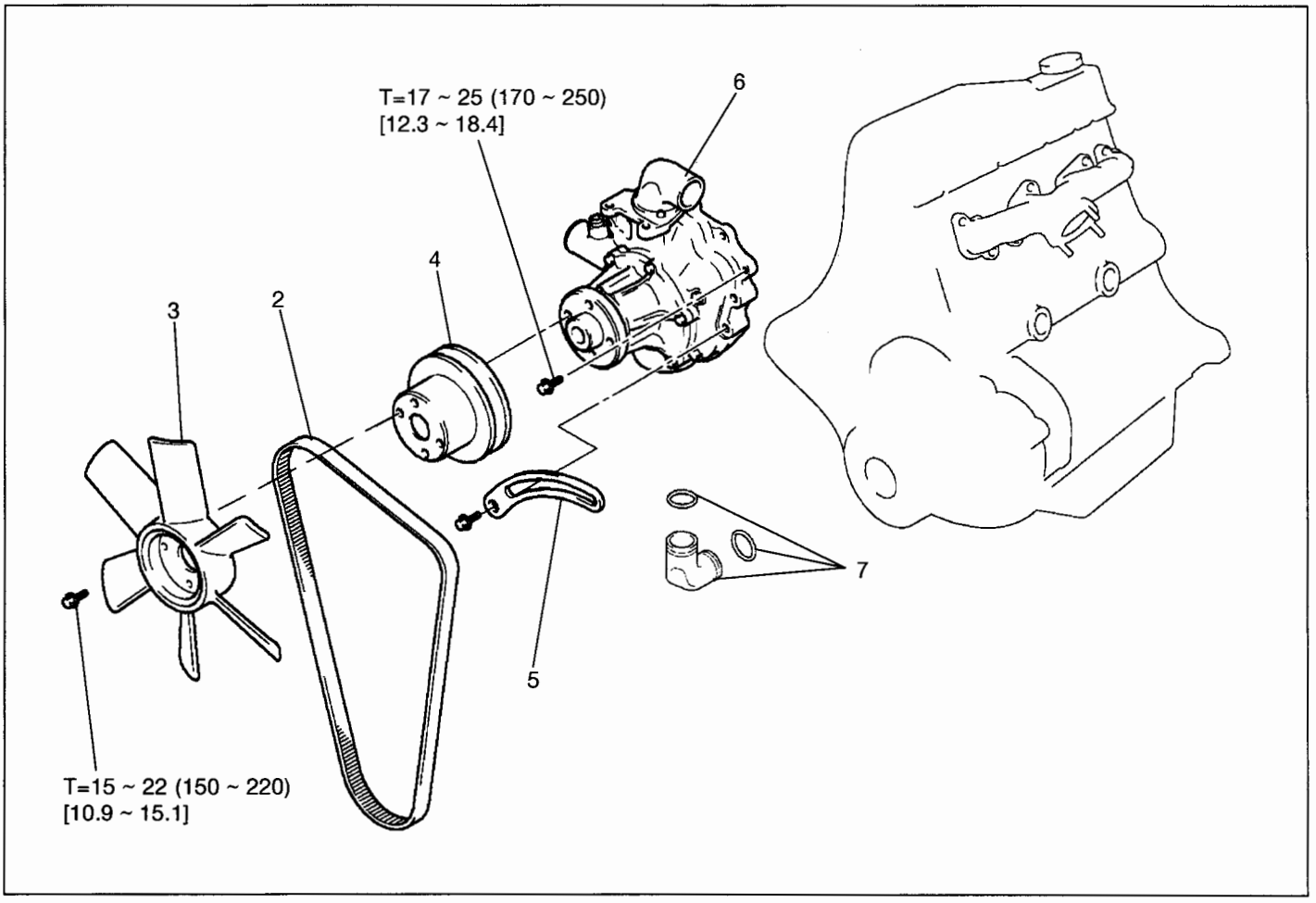
WATER PUMP

COMPONENTS



REMOVAL · INSTALLATION

T=N·m (kgf-cm) [ft-lbf]

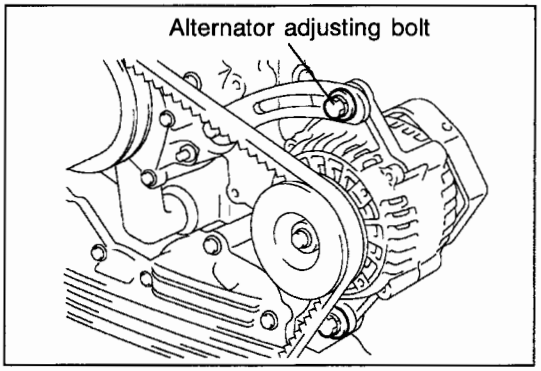


Removal Procedure

1 Drain the coolant. (See page on 4-3.)
2 Remove the V belt. **[Point 1]**
3 Remove the fan.
4 Remove the fan pulley.
5 Remove the alternator adjusting bar.
6 Remove the water pump.
7 Remove the water pump inlet.

Installation Procedure

Installation procedure is the reverse of the removal procedure.



Point Operation

[Point 1]

Removal:

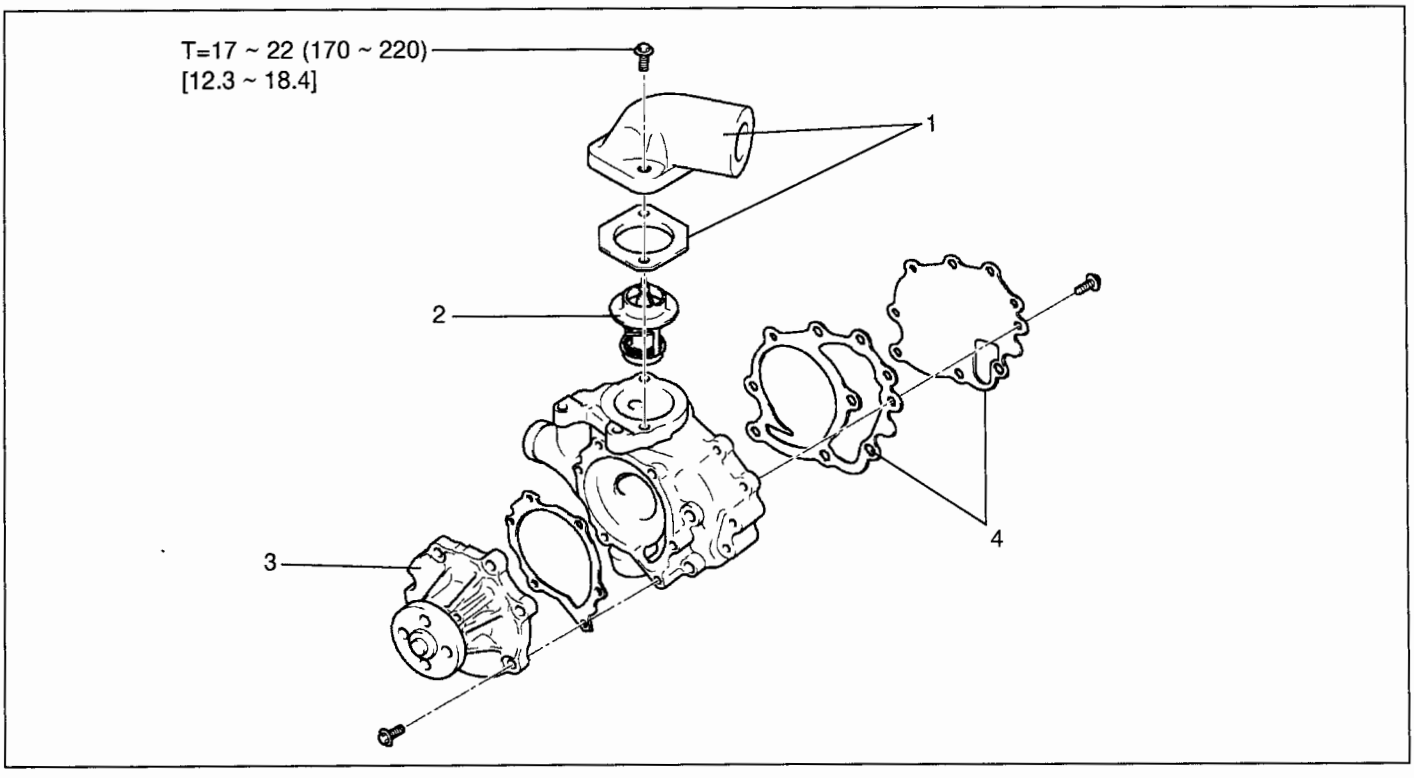
Loosen the alternator adjusting bolt and loosen the belt tension.

Installation:

Adjust the V belt tension. (See page on 1-3 about V belt tension adjustment.)

DISASSEMBLY · INSPECTION · REASSEMBLY

T=N·m (kgf-cm) [ft-lbf]

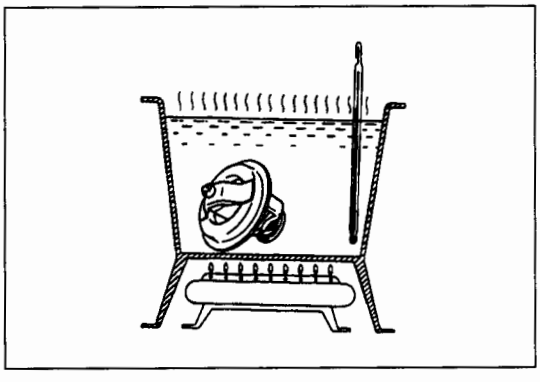


Disassembly Procedure

1 Remove the water outlet.
2 Remove the thermostat. **[Point 1]**
3 Remove the water pump rotor. **[Point 2]**
4 Remove the water pump cover.

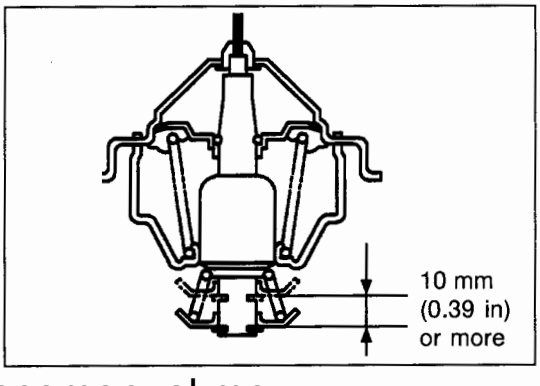
Reassembly Procedure

Reassembly procedure is the reverse of the disassembly procedure.



Point Operations

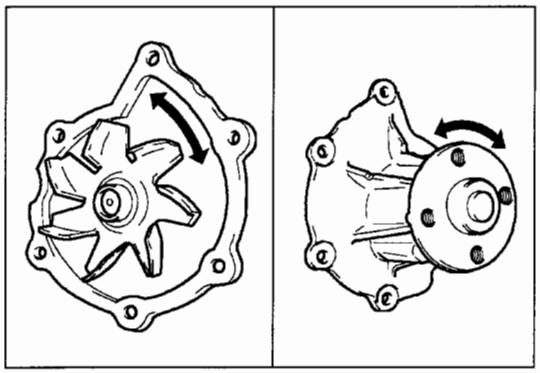
[Point 1]
Inspection:
Check the valve opening temperature and the fully opened temperature.
1. Put the thermostat in water and increase the water temperature while agitating.



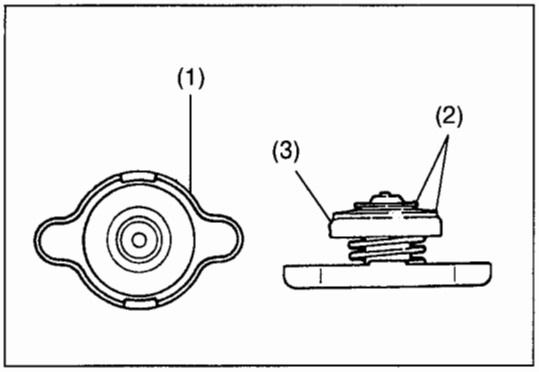
2. Measure the temperature at which the valve begins to open and at which it is fully opened.
Standard:

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**

Inspection:
If the valve is open at normal temperature or if the valve tightness is impaired, replace the valve.

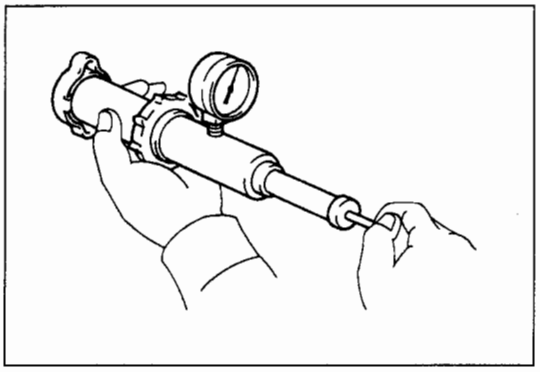


[Point 2]
Inspection:
Inspect the water pump.
1. Check the water pump rotors for cracks, damage and excessive rust.
2. Check the water pump bearing for unusual sound and resistance of revolution.



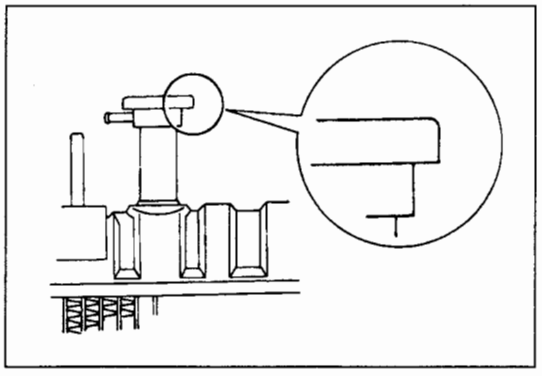
ON-VEHICLE INSPECTION OF THE RADIATOR

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.

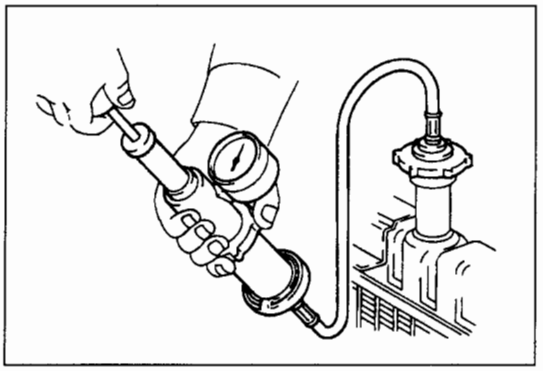


2. Measure the valve opening pressure of the radiator cap.
   Fit a cap tester to the radiator cap, and measure the valve opening pressure.

   Standard: 73.5 ~ 102.9 kPa (0.75 ~ 1.05 kgf/cm²) [10.7 ~ 14.9 psi]
   Limit: 59 kPa (0.6 kgf/cm²) [8.5 psi]



3. Check the neck filler (inlet port).
   (1) Check the seal for deformation or dent.
   (2) Check the radiator cap end portion for deformation or dents.
   (3) Remove the radiator cap and apply the coolant fully, and attach the tester.
   (4) Warm up the engine.
   (5) Stop the engine, apply pressure of 176 kPa (1.8 kgf/cm²) [25.6 psi], and check the parts for leakage.

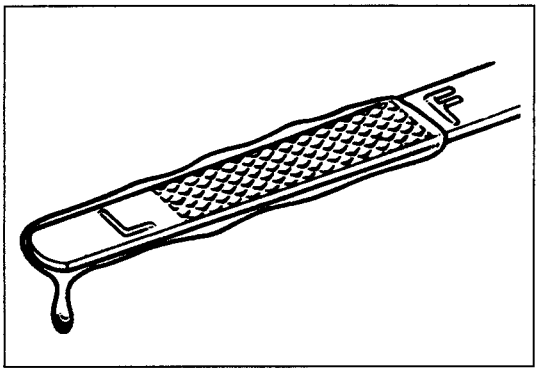


Notes:
- **Always top up the radiator.**
- **Wipe off water from checking areas before inspection.**
- **Attach and detach the tester and operate the pump carefully to protect the radiator neck filler from deformation.**

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

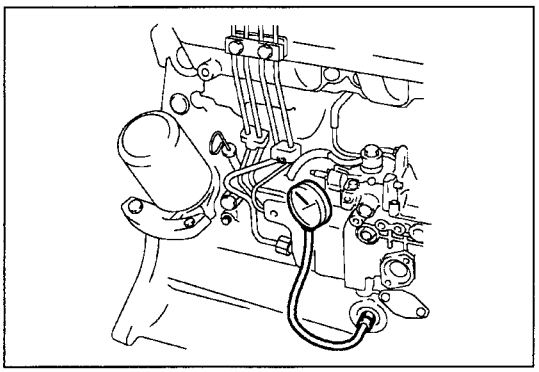
LUBRICATION SYSTEM

5



OIL PRESSURE INSPECTION

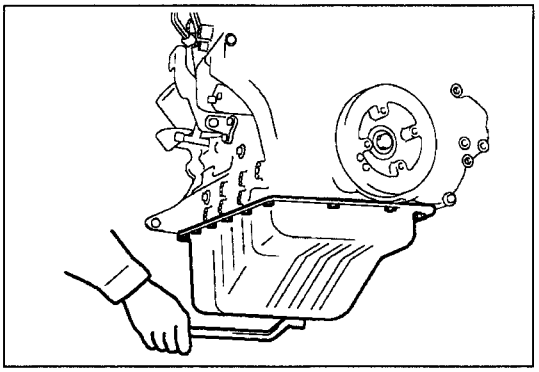
1. Check the oil.
   Standard:
   The oil level must be somewhere between the F and L marks on the level gauge. It must be free of excessive contamination, and have appropriate viscosity. It must not contain coolant, light oil or other foreign matter.



2. Check the oil pressure.
   (1) Remove the bolt.
   (2) Attach the oil pressure gauge.
   (3) Warm up the engine, and measure the oil pressure.

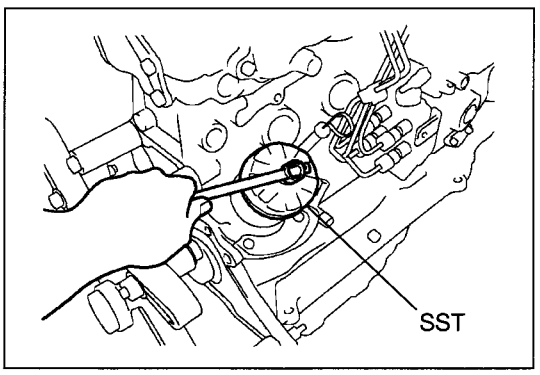
   Condition: Coolant temperature 75 ~ 85°C (167 ~ 185°F)

   Standard:
   At idle speed
   78.4 kPa (0.8 kgf/cm²) [11.4 psi] or more
   At 1600 rpm
   343 kPa (3.5 kgf/cm²) [49.8 psi] or more



ENGINE OIL AND OIL FILTER REPLACEMENT

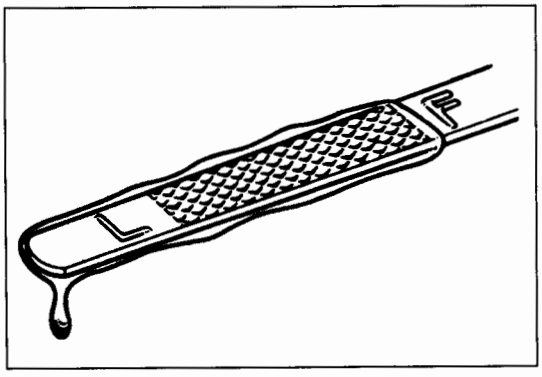
1. Drain the oil
   (1) Remove the oil filler cap.
   (2) Remove the oil drain plug and drain the oil.



2. Remove the oil filter.
   (1) SST 09228-07501

3. Install the oil filter.
   (1) Fit O ring to the oil filter, and attach the oil filter by turning it by hand.
   (2) Using SST, retighten the oil filter by 3/4 of a turn.
   SST 09228-07501

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



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

Total capacity (F level)	**7.5 ℓ (1.98 US gal)**
Oil pan capacity	**7.0 ℓ (1.85 US gal)**

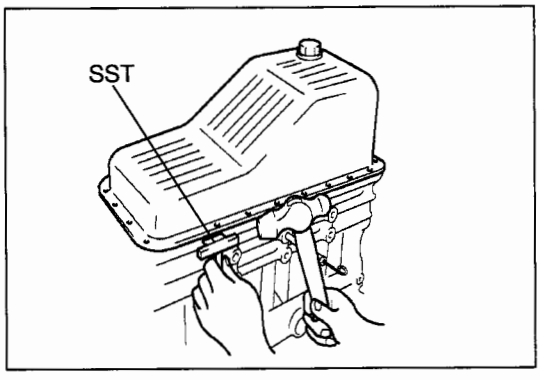
   (3) Fit the oil filler cap.

5. Check the oil amount.
   (1) Check the amount by the oil level gauge.

6. Check oil leakage.
   (1) Start the engine and check the system for oil leakage.

7. 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.

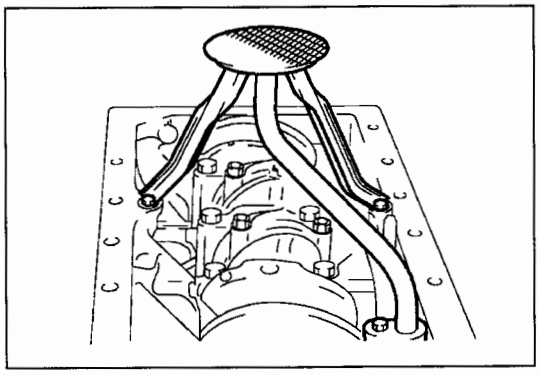


OIL STRAINER

REMOVAL · 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.**

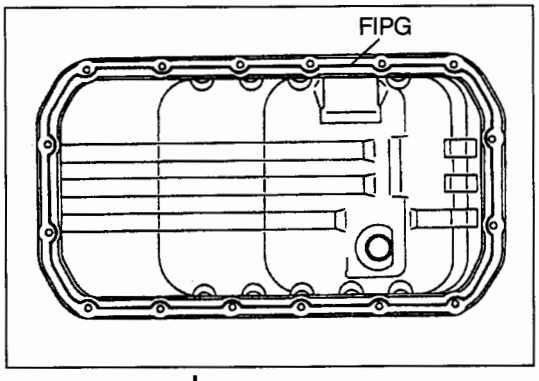


2. Remove the oil strainer.

3. Install the oil strainer.
   T=14.7 ~ 21.6N·m (150 ~ 220 kgf-cm) [10.9 ~ 15.9 ft-lbf]

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. 08826-00080

Note:
See page on 2-2 to during with FIPG.

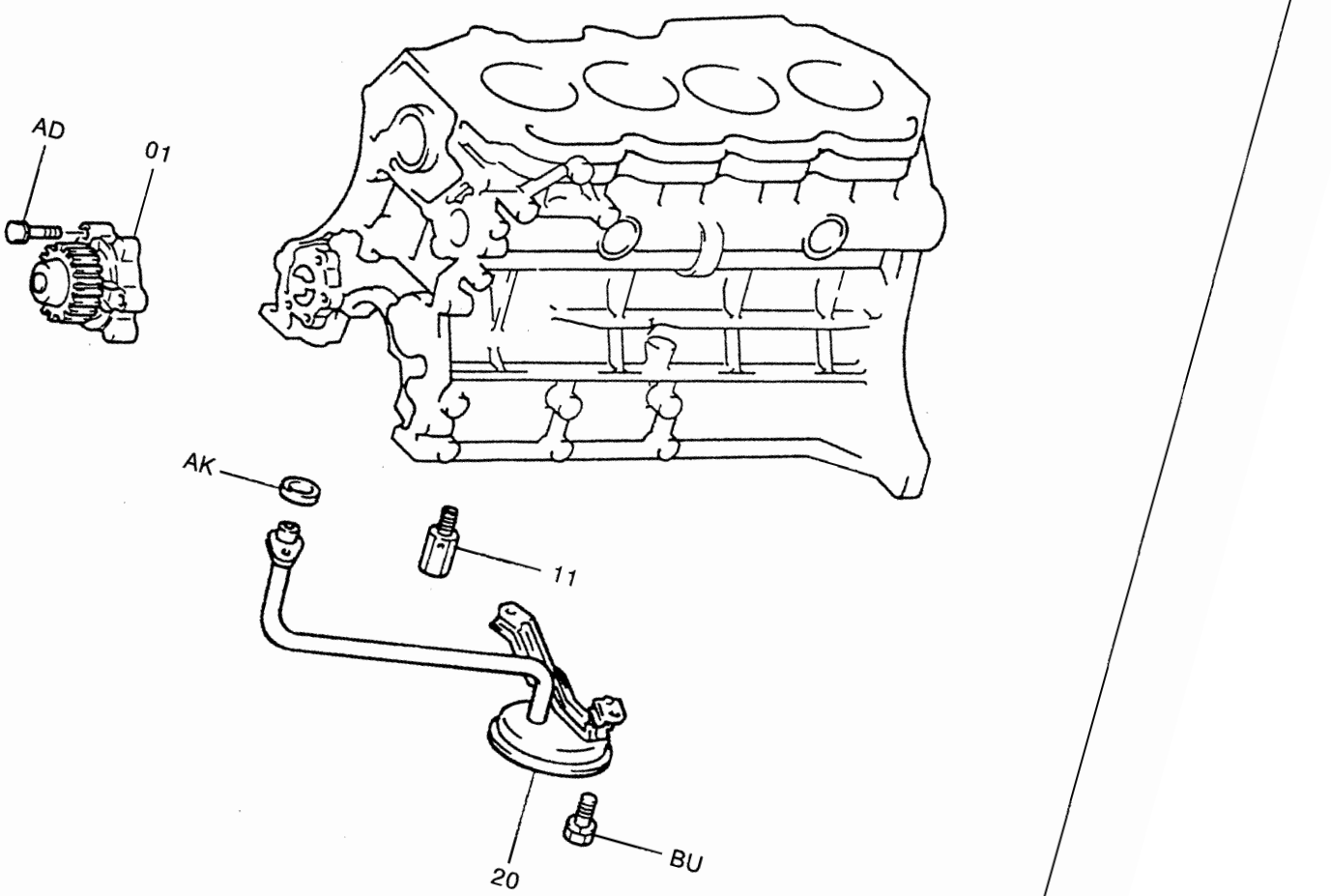


   (3) Install the oil pan set bolt
   T=10.8 ~ 15.7 N·m (110 ~ 160 kgf-cm) [8.0 ~ 11.6 ft-lbf]

OIL PUMP

COMPONENTS

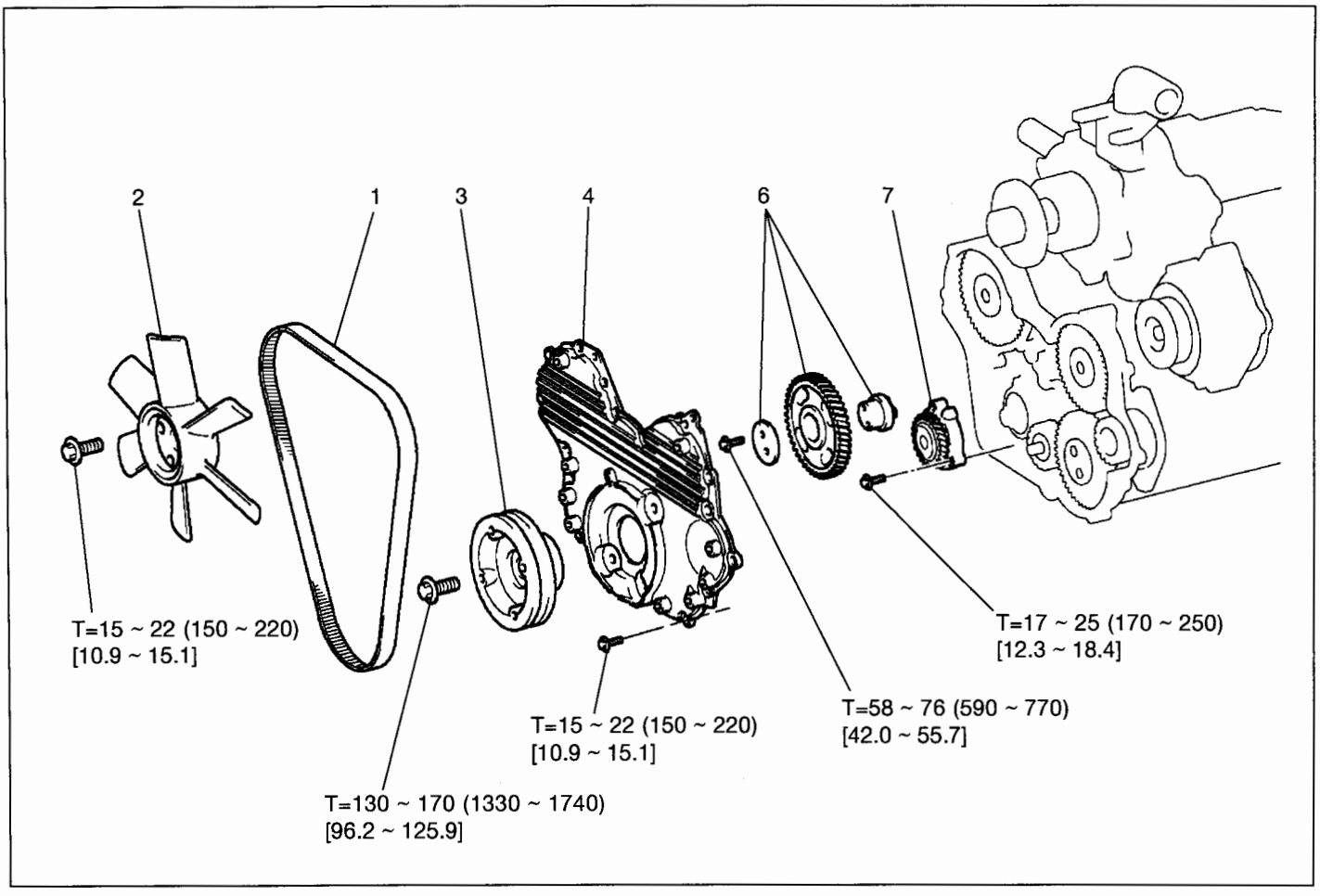
1501



1501-061

REMOVAL · INSTALLATION

T=N·m (kgf-cm) [ft-lbf]

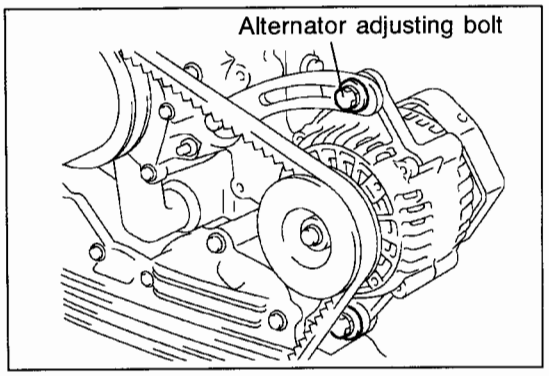


Removal Procedure

1 Remove the V belt. **[Point 1]**
2 Remove the fan.
3 Remove the crank pulley. **[Point 2]**
4 Remove the timing gear cover. **[Point 3]**
5 Measure the oil pump gear backlash. **[Point 4]**
6 Remove idle gear No.1. **[Point 5]**
7 Remove the oil pump ASSY. **[Point 6]**

Installation Procedure

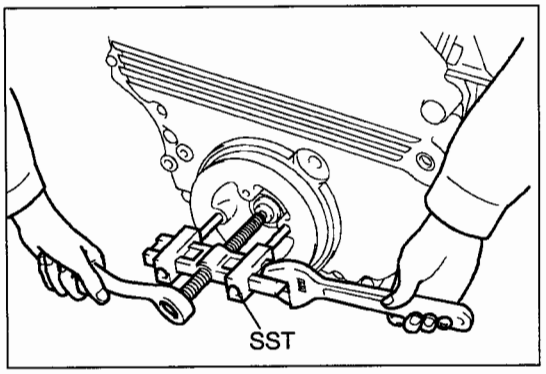
Installation procedure is the reverse of the removal procedure.



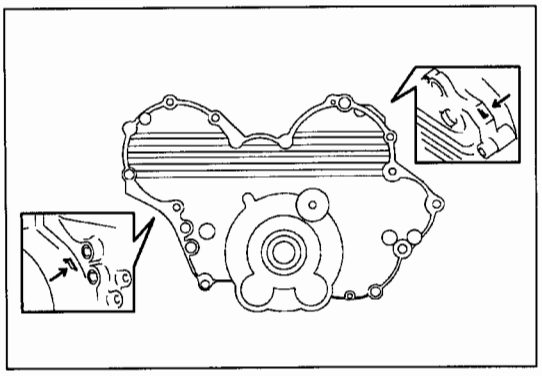
Point Operations

[Point 1]
Removal:
Loosen the alternator adjust bolt, and loosen the belt tension.

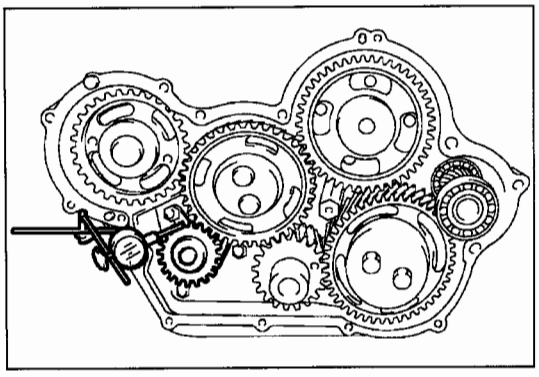
Installation:
Adjust the V belt tension. (See page on 1-3 about V belt tension adjustment.)



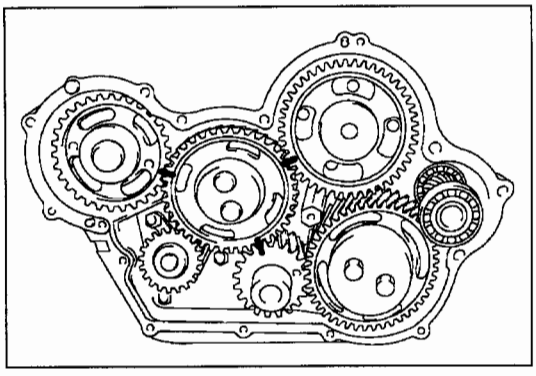
[Point 2]
Removal:
SST 09950-50012



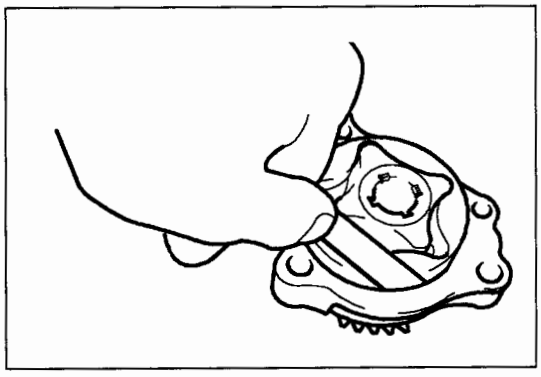
[Point 3]
Removal:
If the cover is hard to remove, apply a screwdriver to the slit in the cover and pry off the cover.
At this time, use care not to damage surfaces of the cover other than the slit.
Installation:
When reinstalling the cover, scrape old sealant off the cover and case with a scraper and apply fresh sealant before installation. (See page on 2-2.)



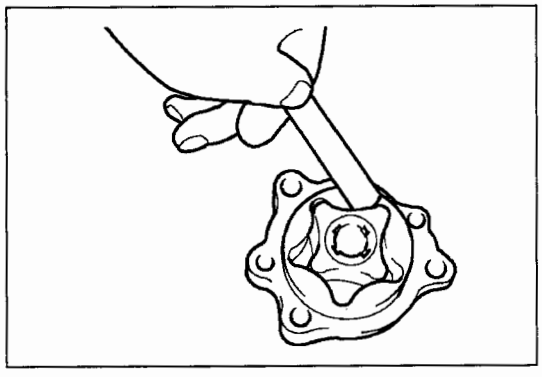
[Point 4]
Inspection:
Measure the backlash between the oil pump drive gear and idle gear No.1.
Standard: 0.050 mm (0.00197 in)
Limit: 0.30 mm (0.0118 in)
If the limit is exceeded, replace the idle gear No.1 and oil pump ASSY as a set.



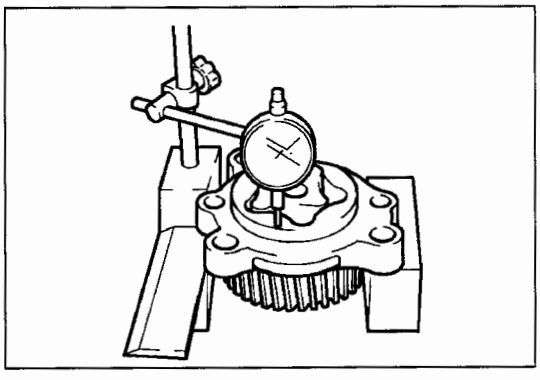
[Point 5]
Removal:
Put matching marks at the point of engagement between the idle gear and each gear.



[Point 6]
Inspection:
Check the body clearance.
Measurement portion: Clearance between the rotor and body.
Standard: 0.10 ~ 0.17 mm (0.0039 ~ 0.0067 in)
Limit: 0.20 mm (0.0079 in)



Inspection:
Check the tip clearance.
Measurement portion: Clearance between the rotor and gear.
Standard: 0.05 ~ 0.15 mm (0.0020 ~ 0.0059 in)
Limit: 0.20 mm (0.0079 in)



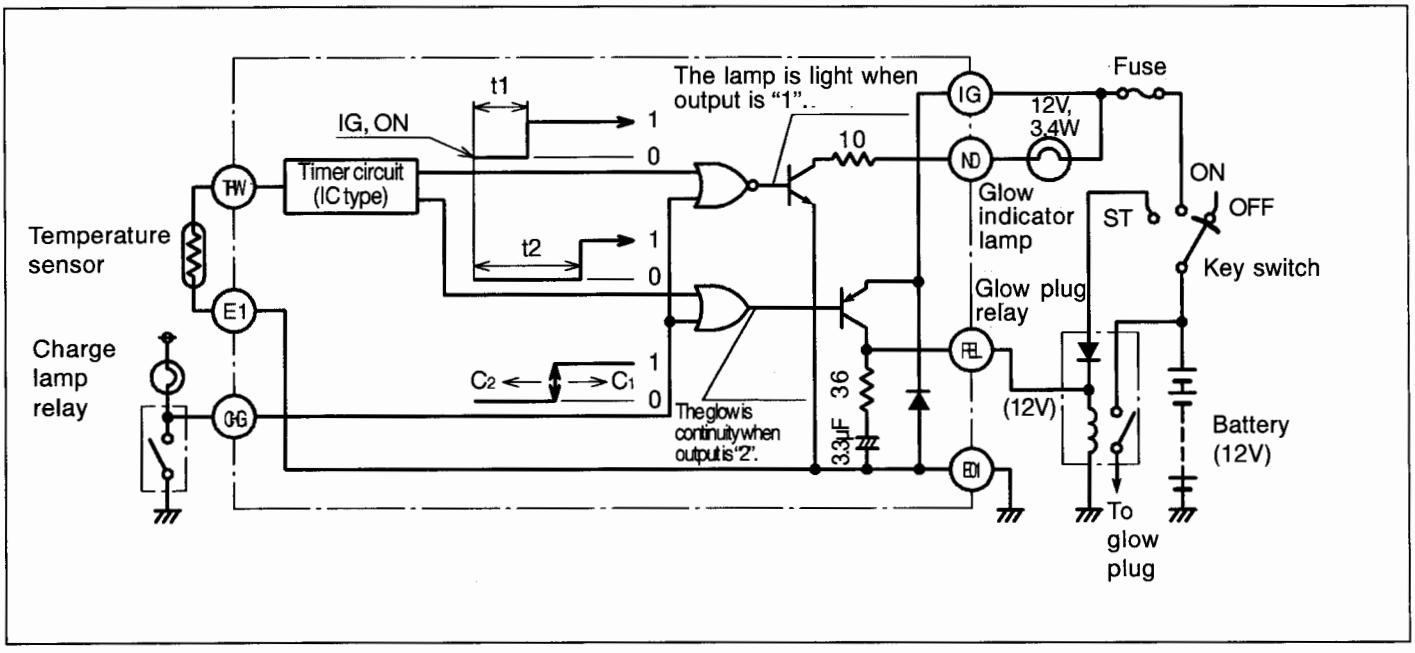
Inspection:
Check the rotor protrusion.
Measure the rotor protrusion from the body using the straightedge and dial gage.
Reference valve: 3.91 ~ 3.97 mm (0.1539 ~ 0.1563 in)

Installation:
Do not drop the rotor.
The rotor is symmetric and may be installed on either side.

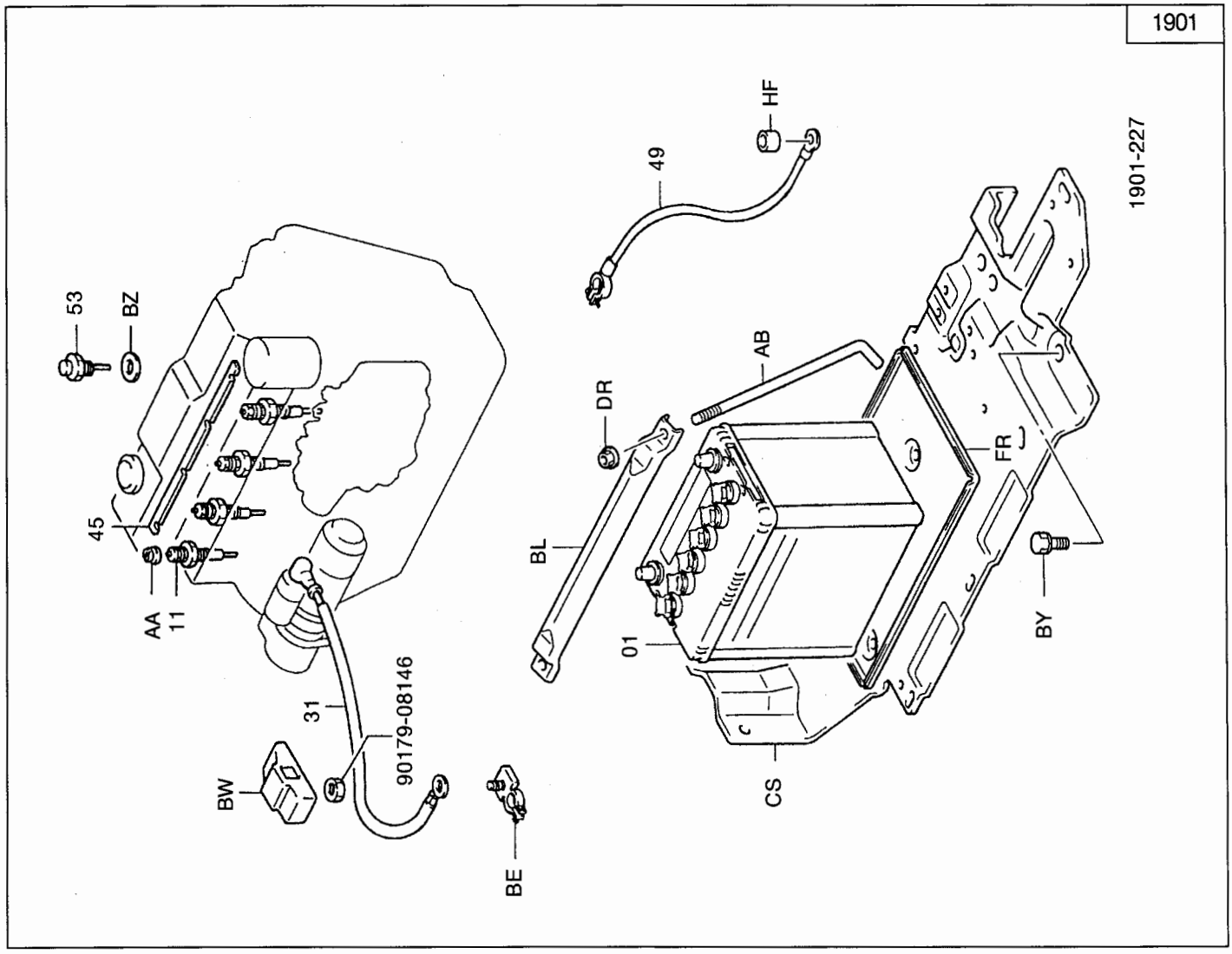
STARTING SYSTEM

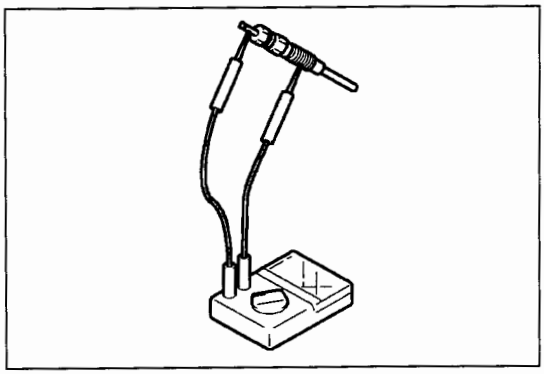
PREHEATING SYSTEM

ELECTRIC CIRCUIT DIAGRAM



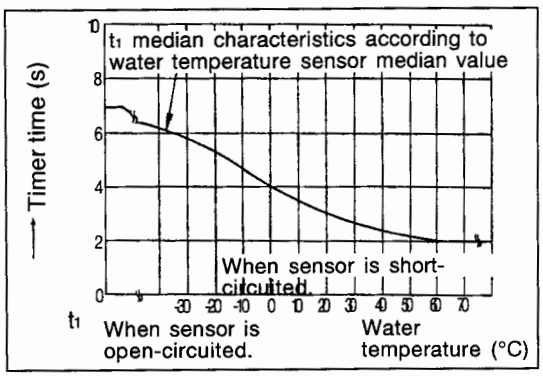
COMPONENTS





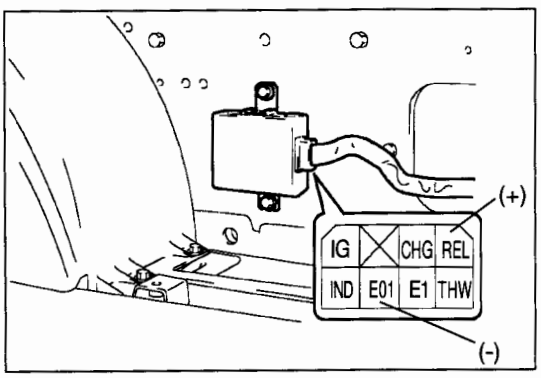
INSPECTION OF GLOW PLUG

1. Remove the glow plug.
2. Check that the circuit across the glow plug terminal and body is continuity.



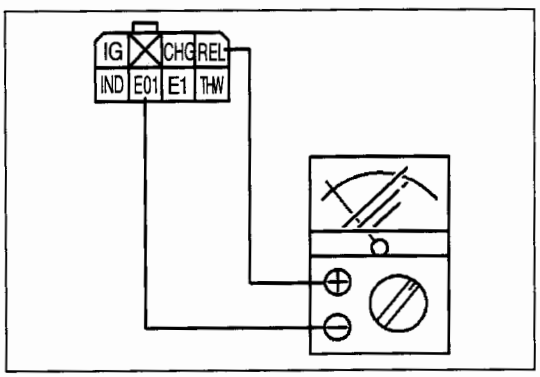
INSPECTION OF PREHEATING TIMER

1. Measure the period of time during which the glow indicator lamp remains lit when the key switch is placed in the ON position.
   Standard: See the chart on the right.

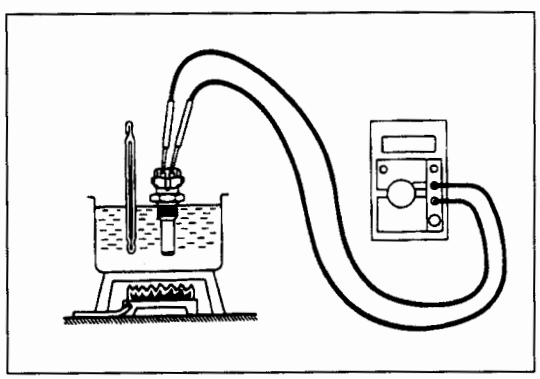


2. Measure the voltage of the preheating timer when the ignition switch is turned to ON.
   Measurement terminals: REL(+) - E01(-)
   Standard: The battery voltage (approx. 12 V) should be indicated immediately after the switch is turned ON and soon go away.

3. Start the engine while the battery voltage is being applied across REL(+) and E01(-) during step 2 and read the voltage at that time.
   Standard: The voltage should read 0 V immediately after the engine has been started.



Note
Make this check with the timer connector connected.



INSPECTION OF WATER TEMPERATURE SENSOR

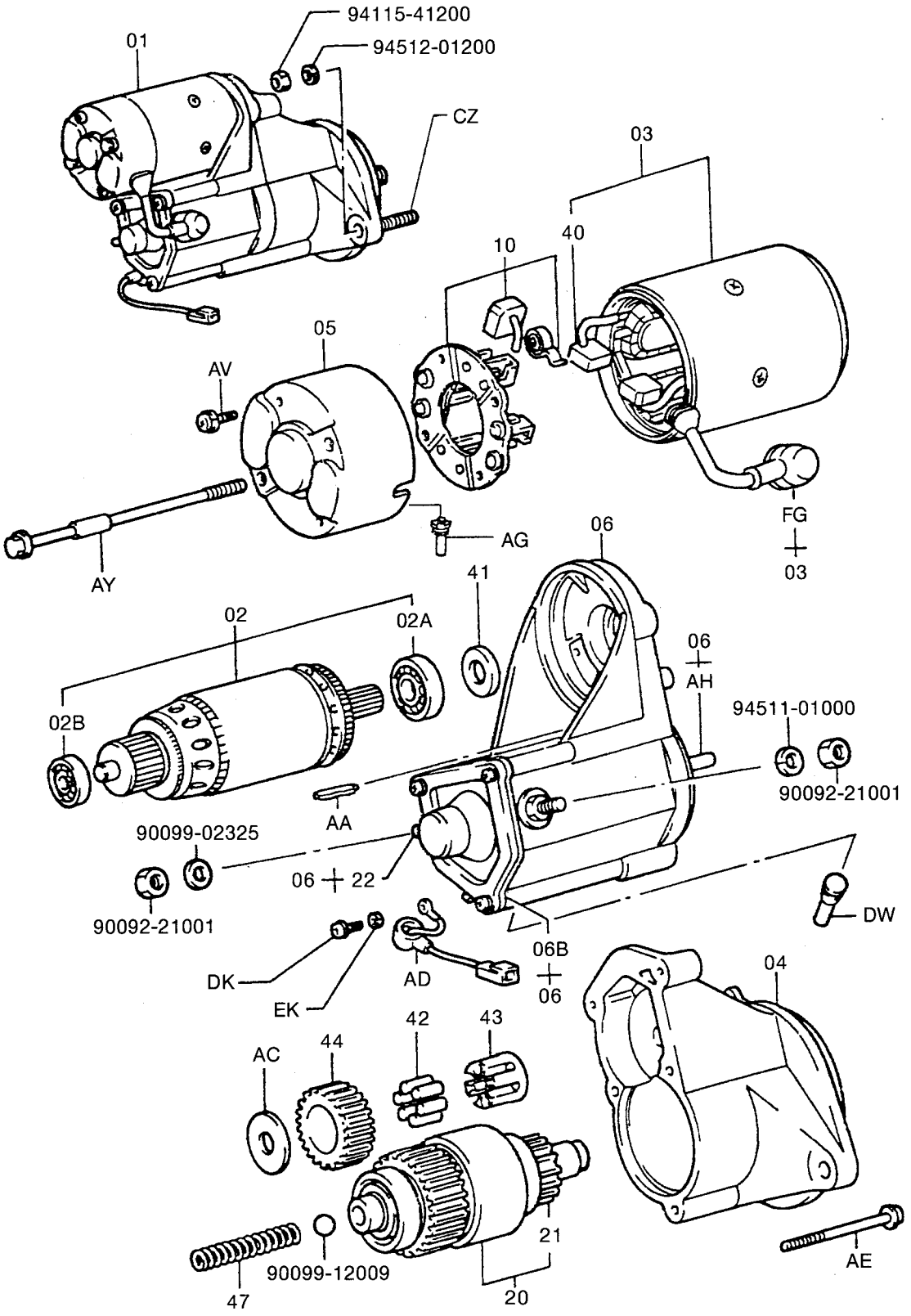
1. Measure the resistance across both terminals of the water temperature sensor.
   Standard:

-15°C (5°F):	**11.16 to 13.62 kΩ**
20°C (68°F):	**2.21 to 2.69 kW**
50°C (122°F):	**Approx. 0.43 kΩ**

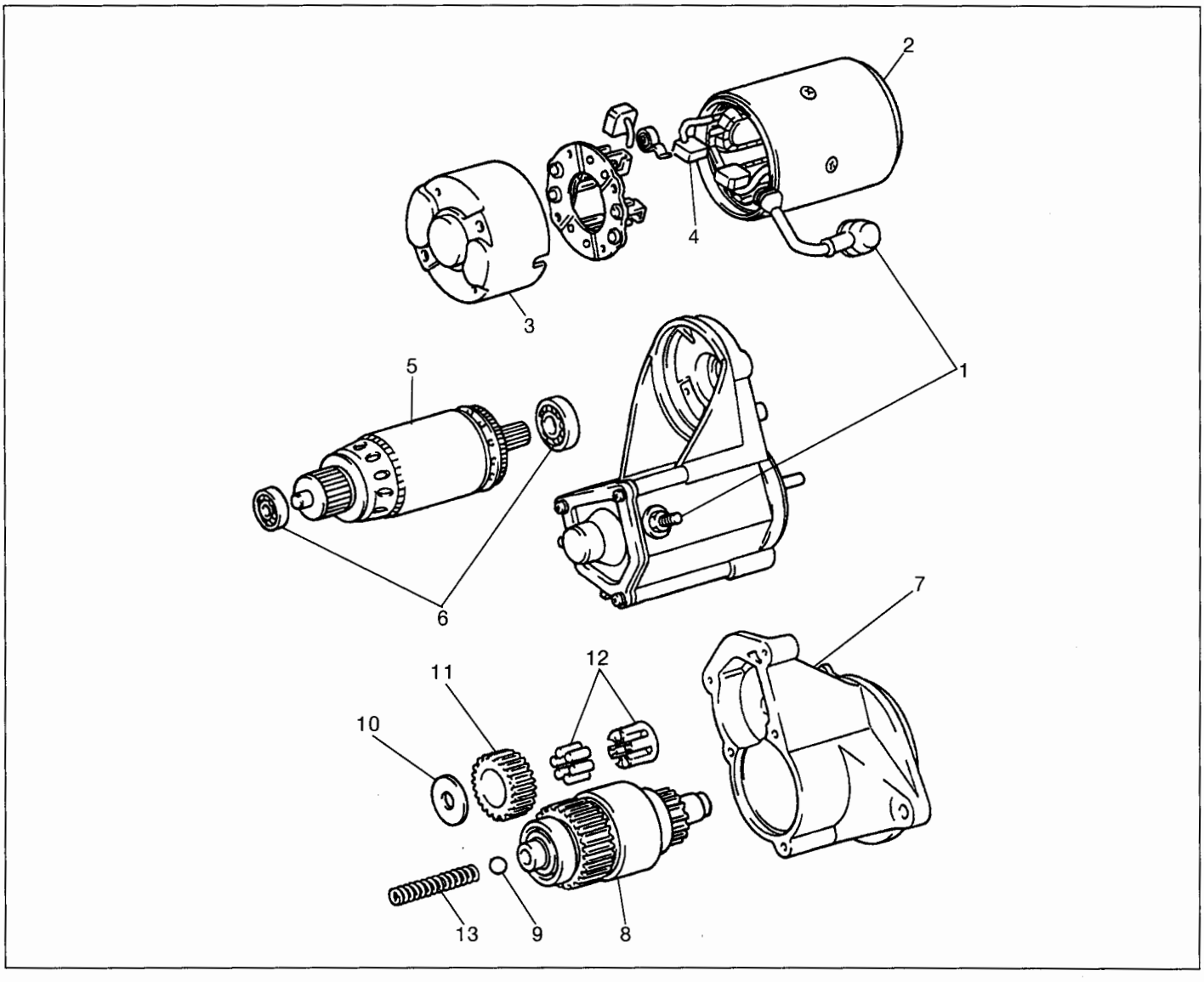
STARTER

COMPONENTS

1904



DISASSEMBLY · INSPECTION · REASSEMBLY



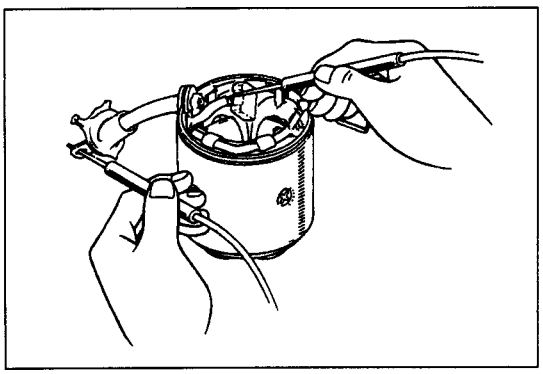
Disassembly Procedure

1 Disconnect the lead wire 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 bearings from the armature ASSY. **[Point 5]**
7 Remove the housing ASSY from the magnet switch ASSY. **[Point 6]**
8 Remove the clutch ASSY. **[Point 7]**
9 Remove the steel ball.
10 Remove the snap retainer.
11 Remove the idle gear.
12 Remove the retainer and roller.
13 Remove the coil spring.

Reassembly Procedure

Reassembly procedure is the reverse of the disassembly procedure.

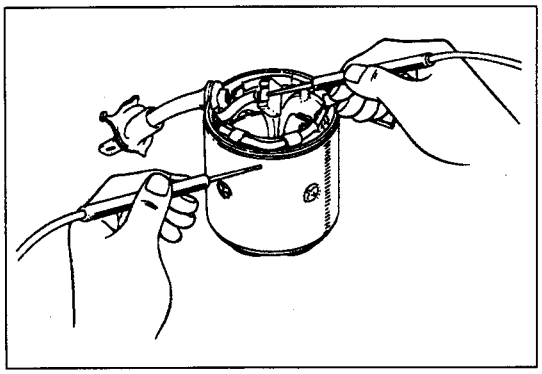
Note:
At reassembly, apply grease to steel ball, idler gear, starter clutch, and return spring.



Point operations

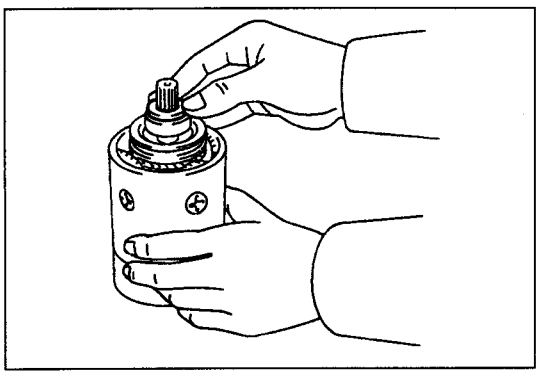
[Point 1]
Inspection:
Confirm continuity between the field coil brush and terminal C.

Standard: Continuity

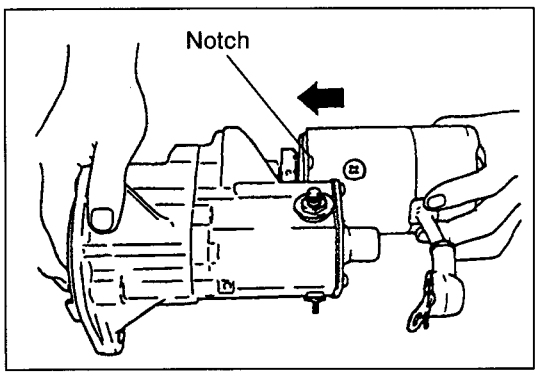


Inspection:
Confirm insulation between the field coil brush and the field.

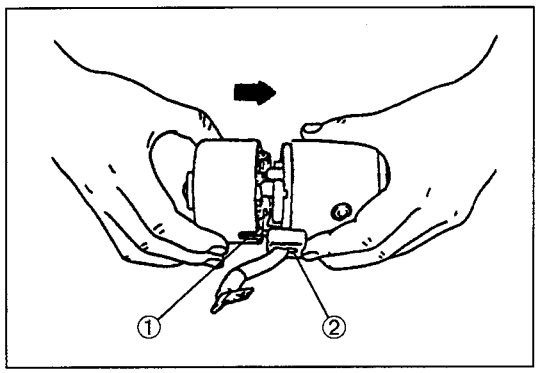
Standard: No continuity



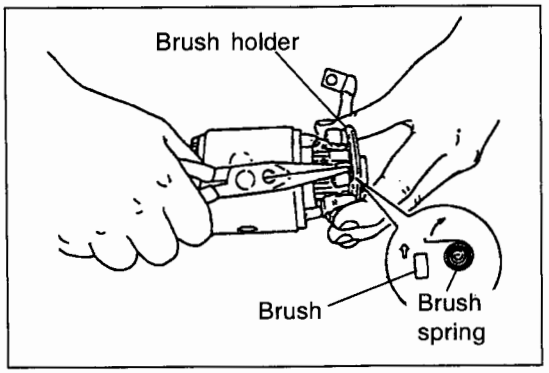
Reassembly:
Assemble the felt washer to the armature shaft bearing



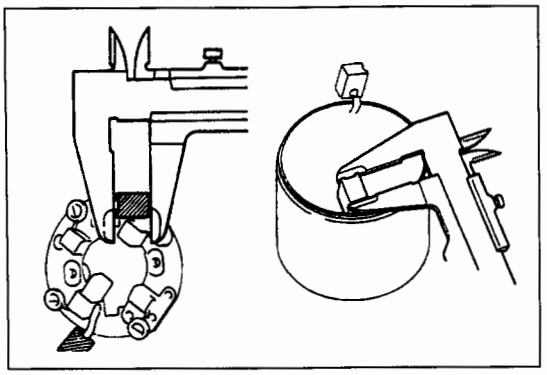
Reassembly:
Align the notch on the yoke with the protrusion on the magnet switch.



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

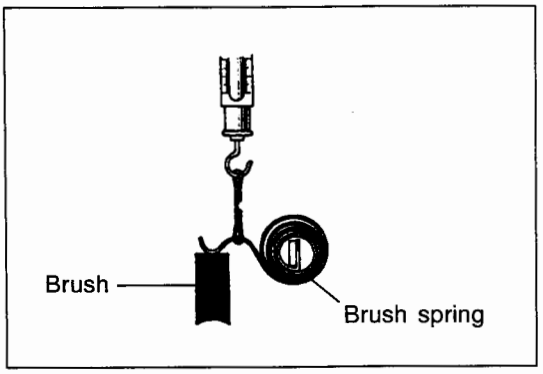


[Point 3]
Disassembly:
Lift the (+) side brush spring using radio pliers.
Do not damage the brush and commutator.



Inspection:
Check the brush.
1. Check the brush for roughened contact surfaces, and measure the brush length.
Measure the brush length at the center (recess).

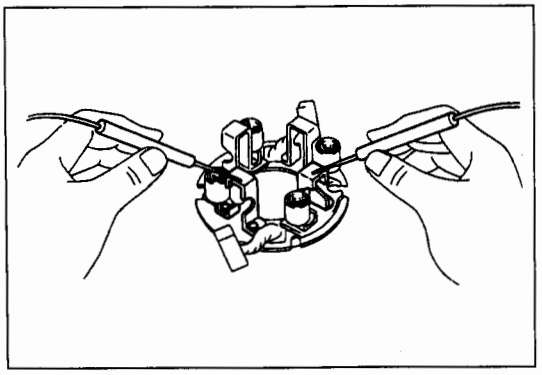
Standard: 20.5 mm (0.807 in.)
Limit: 13.0 mm (0.512 in.)



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.

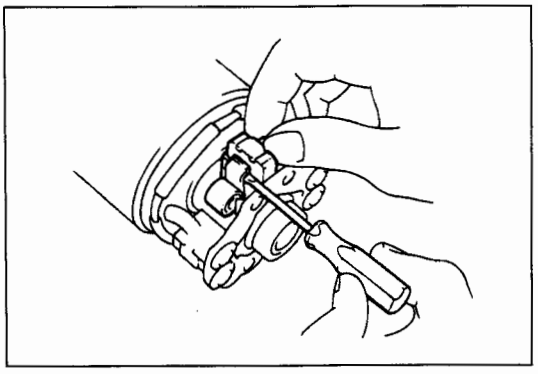
Inspection:
Check the brush spring for smooth movement, and measure the static load.

Standard: 31.4 ~ 39.2 N (3.2 ~ 4.0 kgf) [7.1 ~ 8.8 lbf]
Limit: 21.6 N (2.2 kgf) [4.9 lbf]



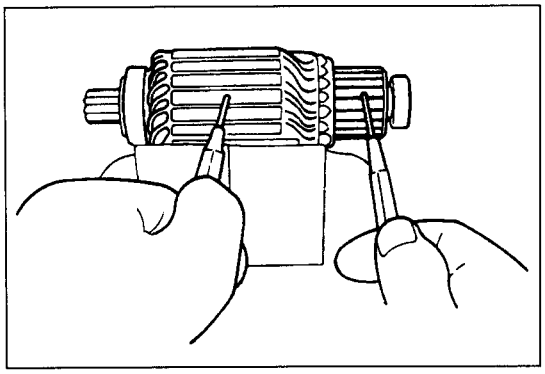
Inspection:
Confirm insulation between the (+) side and (-) side brush holders.

Standard: No continuity



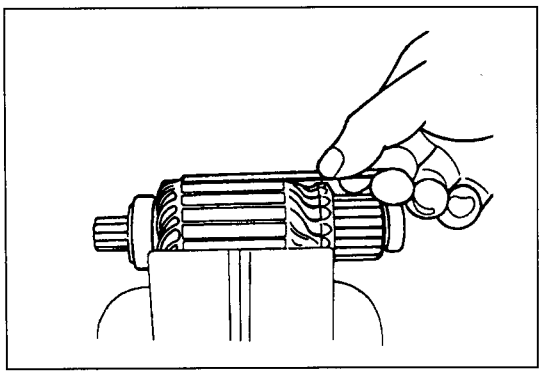
Reassembly:
Assemble the brush.
1. Prying the brush spring with a screwdriver, assemble the brush holder to the starter yoke.

2. Pull up the spring and assemble the brush to the brush holder.

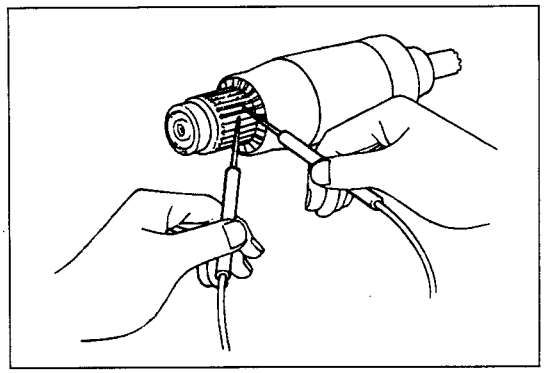


[Point 4]
Inspection:
Confirm insulation between the commutator and the armature coil.

Standard: No continuity

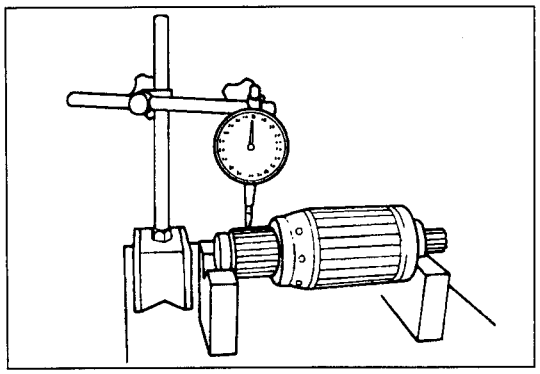


Inspection:
Perform a short-circuit test of the armature coil.
1. Thoroughly clean the armature surface before the test.
2. Put an iron piece in parallel to the armature using an armature tester, and turn the armature. Confirm that the iron piece is not pulled in or that it does not vibrate.



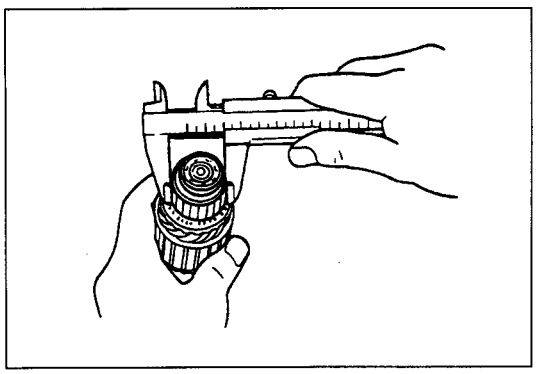
Inspection:
Check continuity between segments.

Standard: Continuity between all segments;



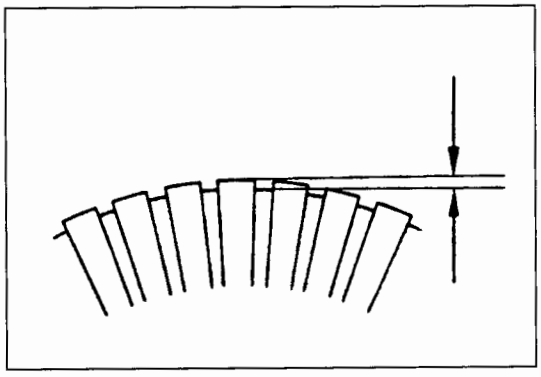
Inspection:
Check the commutator.
1. Check radial runout.

Limit: 0.05 mm (0.0020 in.) or less



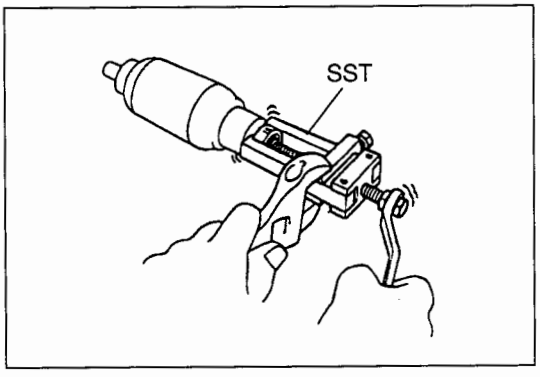
2. Measure the outside diameter.

Standard: 36 mm (1.42 in)
Limit: 35 mm (1.38 in)

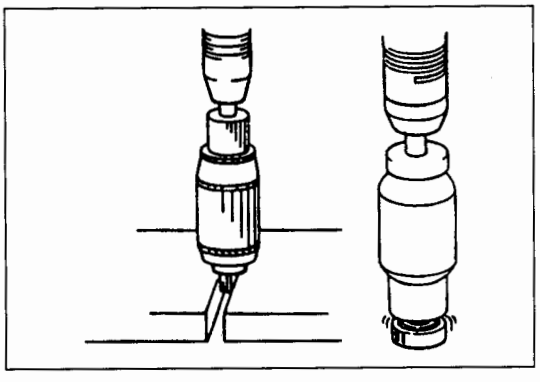


3. Check the undercut depth between segments.

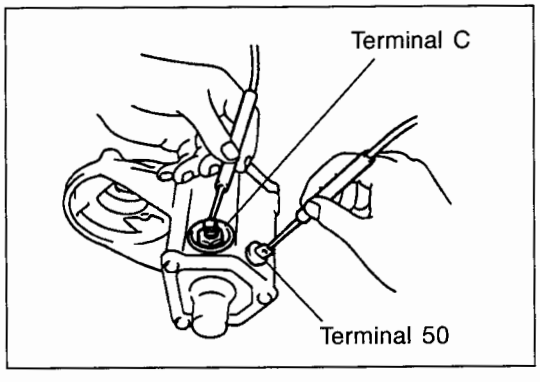
Standard: 0.7 mm (0.028 in)
Limit: 0.2 mm (0.008 in)



[Point 5]
Disassembly:
SST 09286-46011

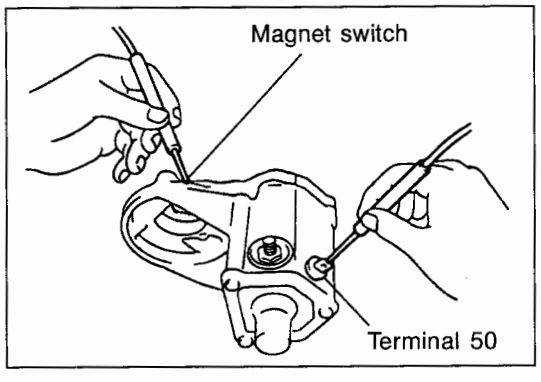


Reassembly:
Press-fit the bearing using a press.



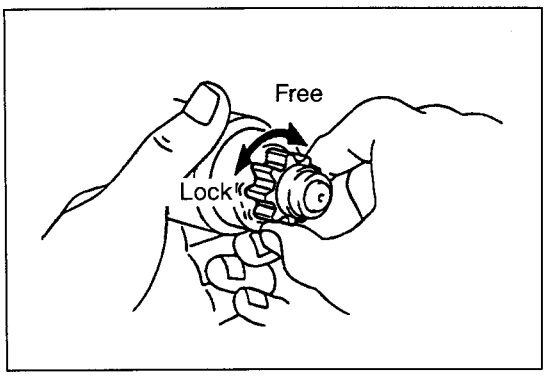
[Point 6]
Inspection:
Check the magnet switch ASSY.
1. Check continuity between terminals 50 and C.

Standard: Continuity

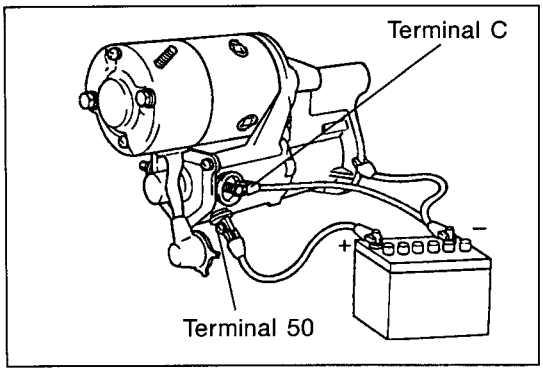


2. Check continuity between terminal 50 and the magnet switch body.

Standard: Continuity



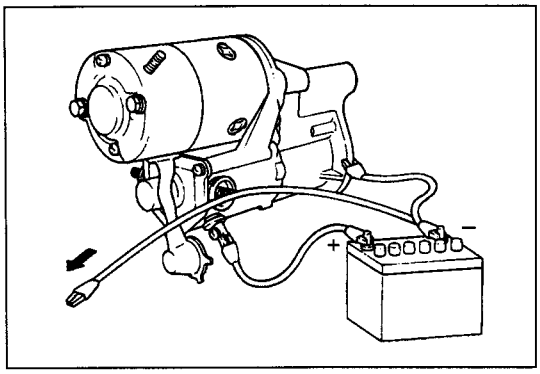
[Point 7]
Inspection:
Check the clutch and gear.
1. Check the gear for wear and damage.
2. Confirm that the gear is locked when turned in the drive direction (counterclockwise) and that it turns smoothly when turned in the opposite direction (clockwise).



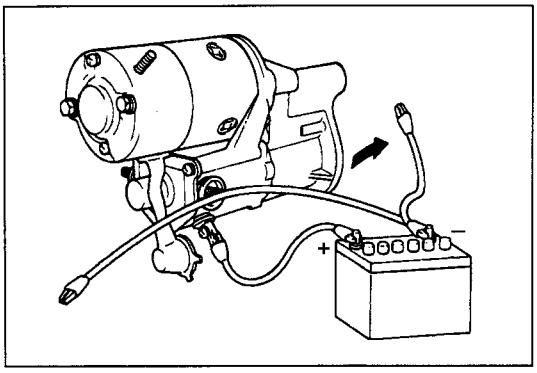
STARTER MOTOR ASSY INDIVIDUAL INSPECTION

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

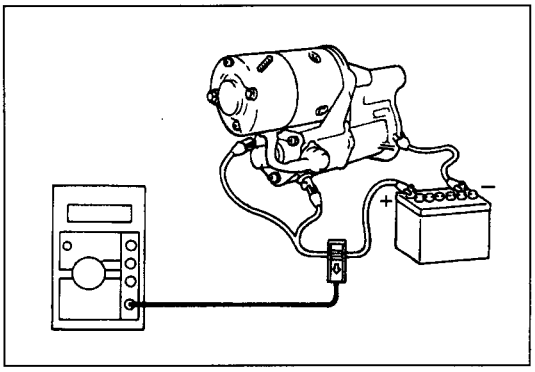
1. Pull-in test
   (1) Check that the pinion gear comes out when wired as shown.



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.



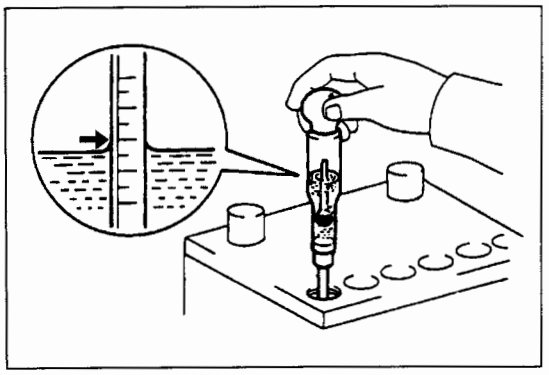
3. Plunger return test
   (1) Disconnect the test lead wire as shown after the holding coil retention test. Check that the pinion returns then.

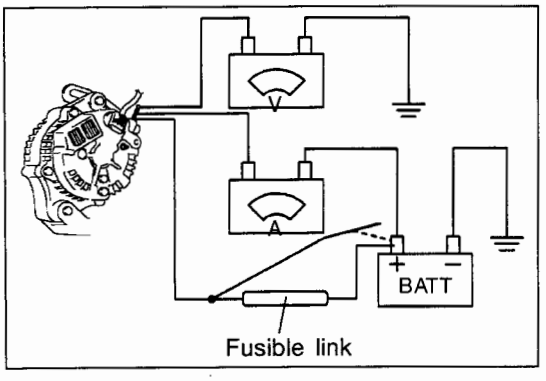


4. No-load test.
   (1) Fix the starter in a vice.
   (2) Use adequately large lead wires for a no-load test as large current is involved.
   (3) Read the ammeter after pointer becomes stabilized.

   Standard: 90 A or less

CHARGING SYSTEM





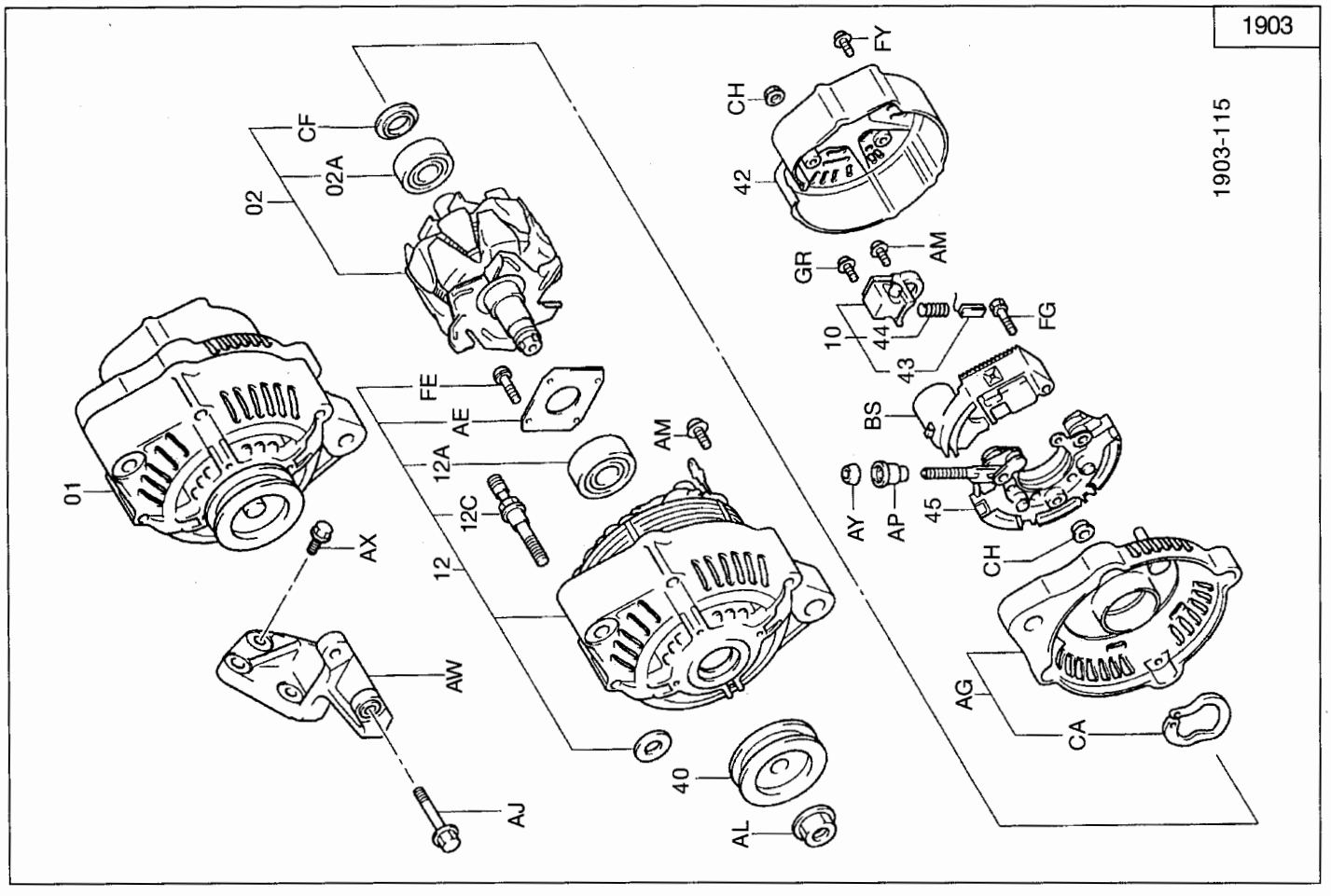
ON-VEHICLE INSPECTION

1. Check the specific gravity of the battery.
   Standard: 1.25 ~ 1.28 (at 20°C (68°F))
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.
   Standard: 12.9 ~ 14.3V (At the engine warmed up)
   (3) Measure the current at engine speed of 1500 rpm.
   Standard: 10 A or less

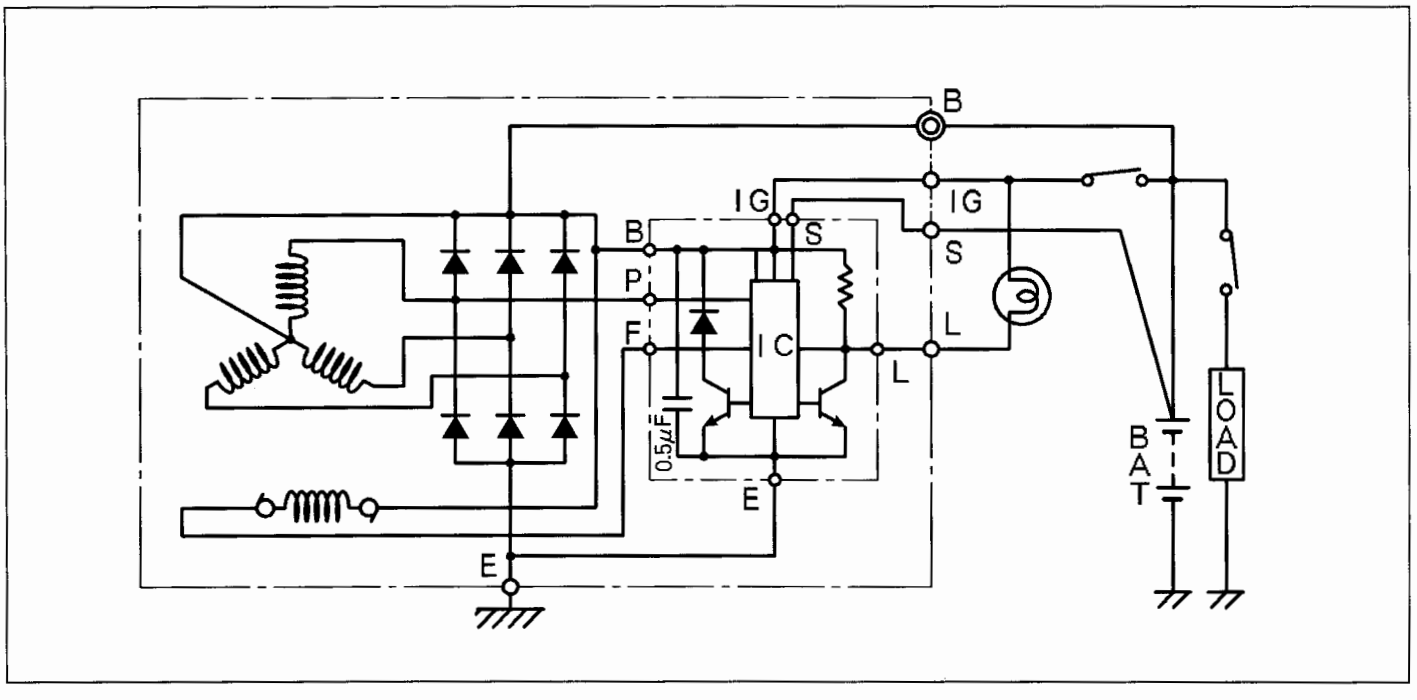
Note:
The current reading instantly goes above 10A immediately after the engine starts. This does not constitute a problem.

ALTERNATOR

COMPONENTS

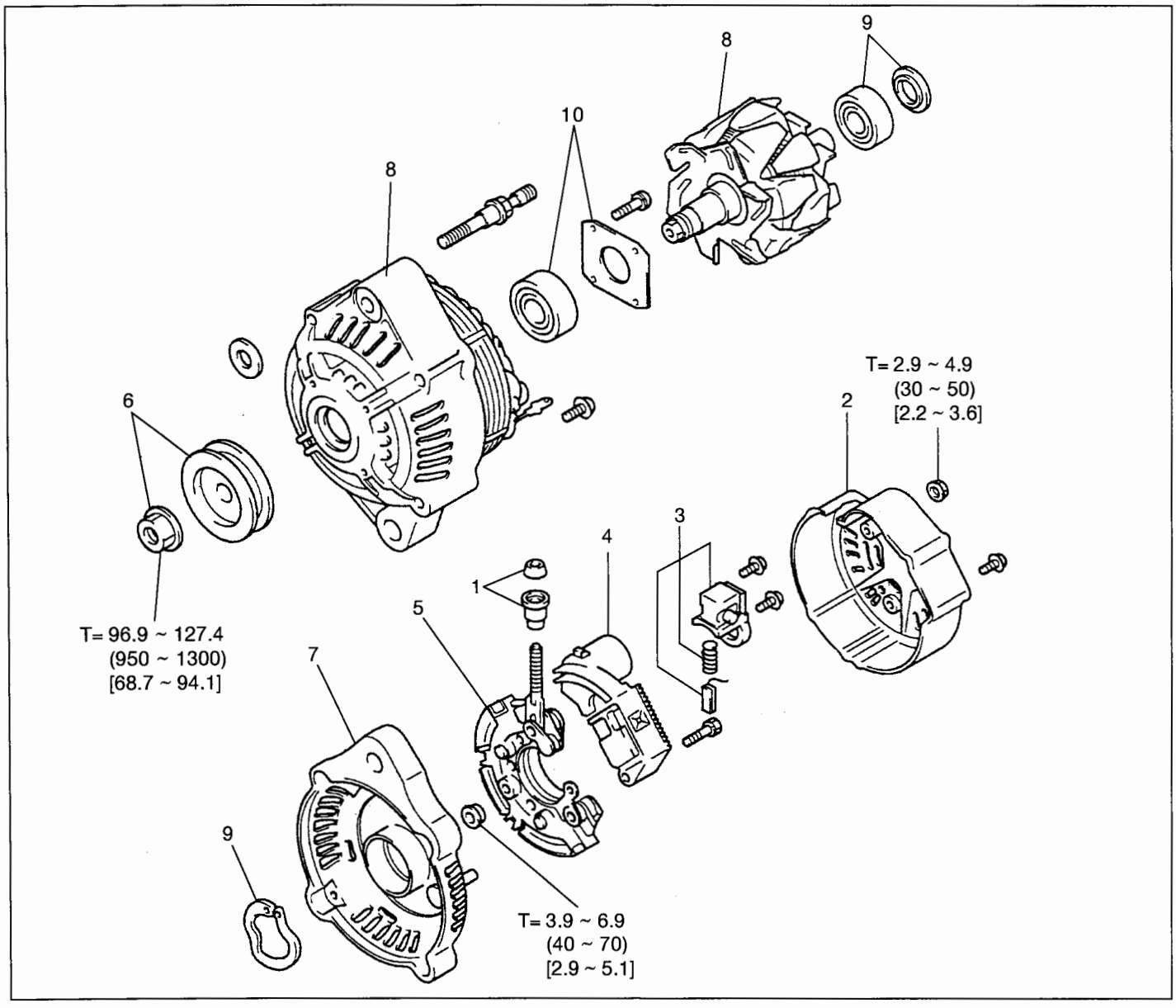


CIRCUIT DIAGRAM



DISASSEMBLY · INSPECTION · REASSEMBLY

T=N·m (kgf-cm) [ft-lbf]

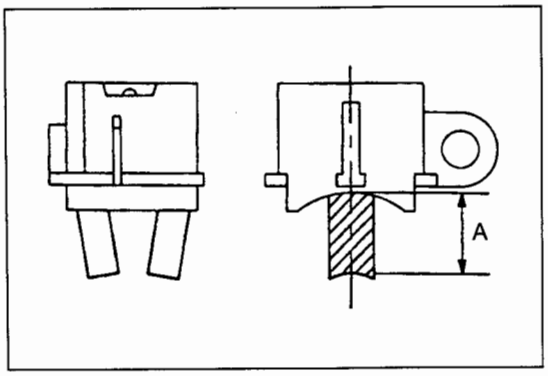


Disassembly Procedure

1 Remove the terminal insulator.
2 Remove the rear end cover.
3 Remove the brush holder W/brush. **[Point 1]**
4 Remove the IC regulator. **[Point 2]**
5 Remove the rectifier holder. **[Point 3]**
6 Remove the alternator pulley. **[Point 4]**
7 Remove the rectifier end frame. **[Point 5]**
8 Separate the drive end frame from the rotor ASSY. **[Point 6]**
9 Remove the rear bearing and spring washer. **[Point 7]**
10 Remove the bearing cover, and remove the front bearing. **[Point 8]**

Reassembly Procedure

1 Install components in the reverse order of removal (steps 9 and 10).
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 6).



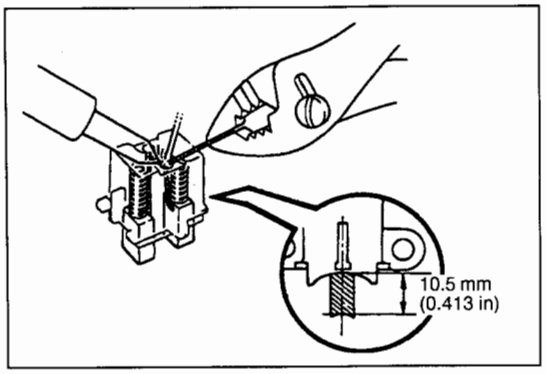
Point Operations

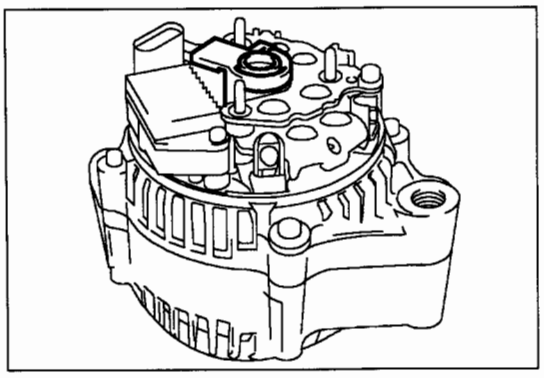
[Point 1]

Inspection:

Check the brush.

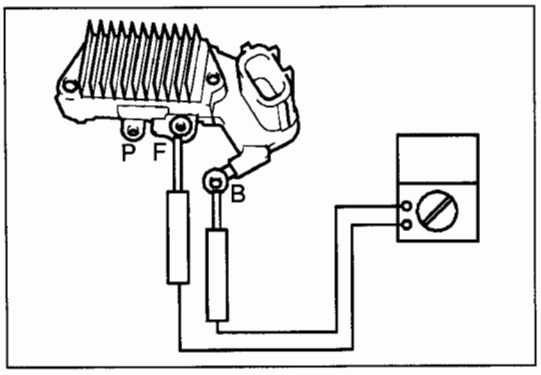
1. Measure the amount of protrusion (dimension A) of the brush.
   Standard: 10.5 mm (0.413 in)
   Limit: 1.5mm (0.059 in)
2. If the brush protrusion amount is below the limit, remove the brush by melting solder it at the brush holder.
3. Fit the spring to the brush holder. Carefully position the brush leaving a brush protrusion amount of 10.5 mm (0.413 in.) and solder it to the brush holder.
   Keep the solder thickness less than 1.0 mm (0.039 in.).
4. Cut off unnecessary lead wires.
5. Coat insulation paint to the solder.
6. Always replace both brushes as a group.





Reassembly:

Confirm that the blush holder boot is fitted correctly.

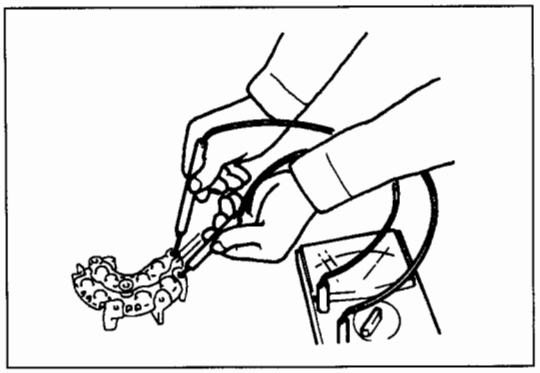


[Point 2]

Inspection:

Check the IC regulator diode.

1. Check continuity of the diode between terminals B and F at k Ω range of the circuit tester.
   Standard:
   Test two times in different polarities. The diode must be continuous in one polarity and not continuous in another.

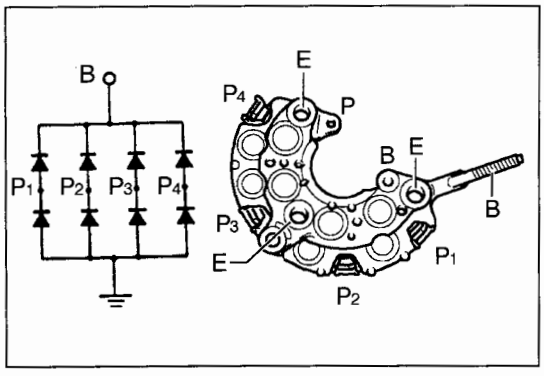


[Point 3]

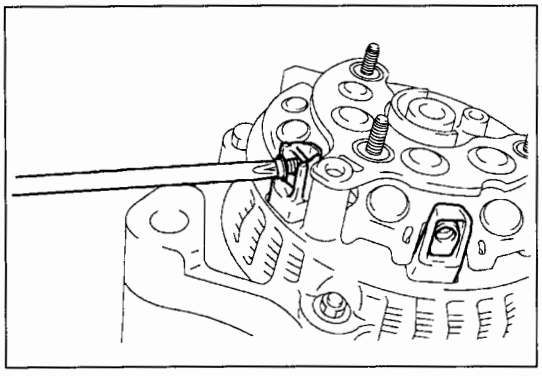
Inspection:

Check the rectifier holder.

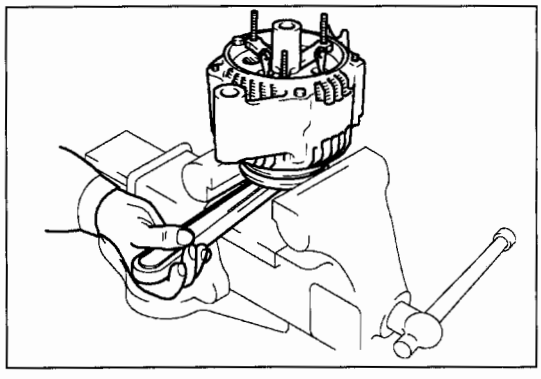
1. Check continuity of the rectifier between terminals B and E at k Ω range of the circuit tester.
   Standard:
   Test two times in different polarities. The diode must be continuous in one polarity and not continuous in another.



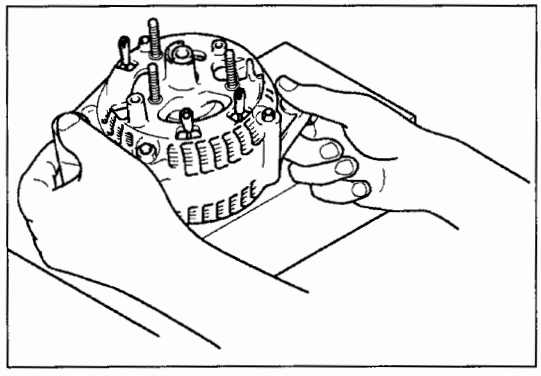
2. See the figure at right for the rectifier circuit.
   The rectifier quality cannot be judged on the basis of the resistance in the forward direction. Because of the diode characteristic, the forward current varies greatly with the source voltage. As a result, the multimeter indication depend on the multimeter type and resistance range. Therefore, the rectifier is judged normal if the difference between the resistances in the forward and reverse directions is great. Do not use a 500 V meger since it will damage the rectifier.



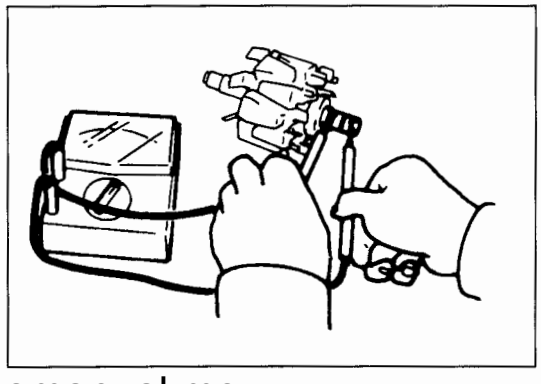
Reassembly:
Install the rectifier holder.
1. Check that the ends of the four stator coil terminal fit in position in the terminal holders of the end frame.
2. Tighten terminal mounting bolts in several sequences: first temporarily tighten all of them, then tighten them to the specified torque.
3. Mount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



[Point 4]
Disassembly:
Set the alternator puller in a vice and remove the set bolts.
Always use pads to protect the components.

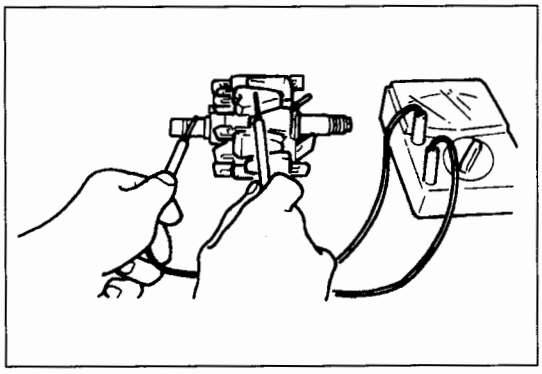


[Point 5]
Disassembly:
After set nuts and set bolts are removed, hold the rectifier by the end frame and separate it by applying a shock to the rotor shaft end.



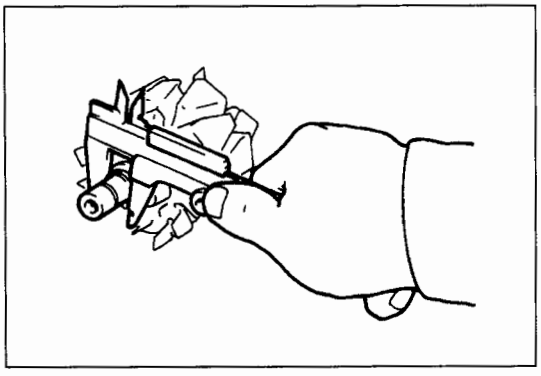
[Point 6]
Inspection:
Measure the resistance between the two slip rings.

Standard: 3.0Ω or less



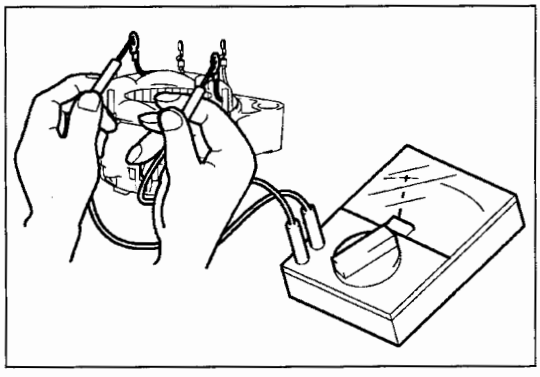
Inspection:
Measure the insulation resistance between slip rings and the rotor core.

Standard: ∞Ω



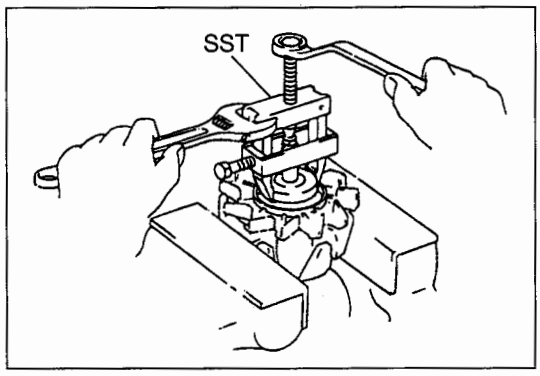
Inspection:
Check the slip rings.
1. When a slip ring is damaged, repair it using an abrasive paper (#400).
2. Measure the outside of the slip ring.

Standard: 14.4 mm (0.567 in)
Limit: 14.0 mm (0.552 in)

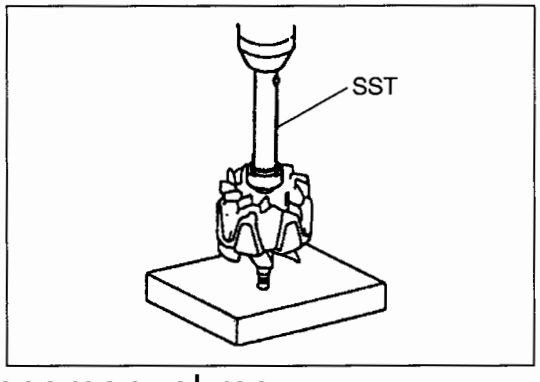


Inspection:
Check the stator coil in the drive end frame.
Measure the resistance between phases.

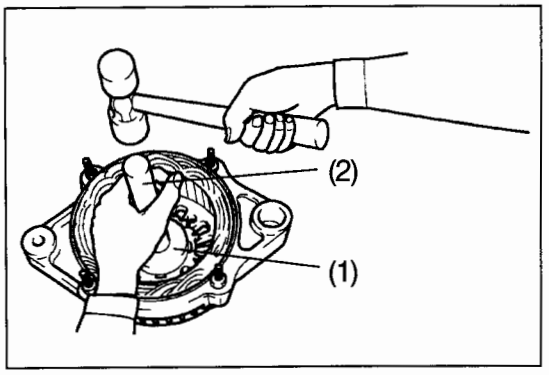
Standard: Approx. 1.0Ω



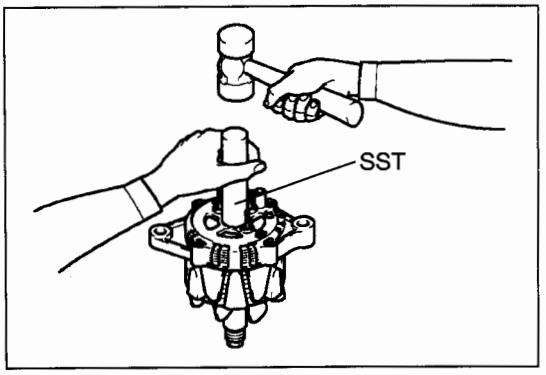
[Point 7]
Disassembly:
SST 09820-00021



Installation:
SST 09820-00030



[Point 8]
Disassembly · Reassembly:
SST 09950-60010 ..... (1)
SST 09950-70010 ..... (2)



[Point 9]
Installation:
SST 09381-41950-71
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.

APPENDIX

SST LISTS

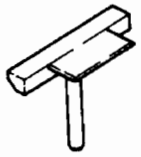
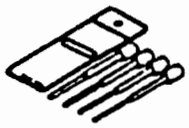
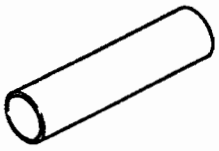
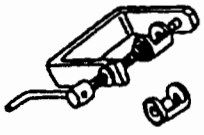
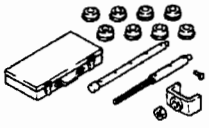
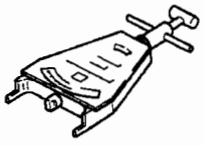
Illustration	Part No.	Part Name	Section					
			1	2	3	5	6	7
	09032-00100	Oil pan seal cutter		○		○		
	09201-10000	Valve guide bush remover & replacer		○				
	09201-56010	Valve stem oil seal replacer		○				
	09202-70020	Valve spring compressor		○				
	09215-00101	Camshaft bearing remover & replacer		○				
	09216-00021	Belt tension gauge	○					
	09222-66010	Connecting rod bush remover & replacer		○				
	09228-07501	Oil filter wrench		○		○		

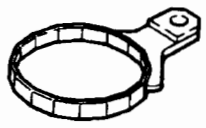
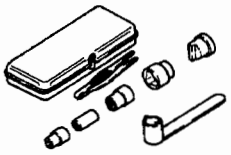
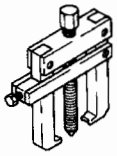
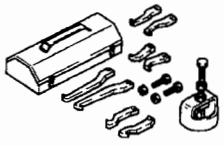
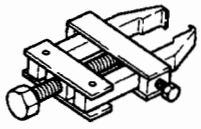
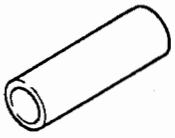
Illustration	Part No.	Part Name	Section					
			1	2	3	5	6	7
	09228-64010	Fuel filter wrench			○			
	09245-54010	Injection pump arm			○			
	09260-54012	Injection pump tool set			○			
	09268-64010	Nozzle holder wrench set			○			
	09286-46011	Injection pump spline shaft puller					○	
	09612-65014	Steering worm bearing puller			○			
	09820-00021	Alternator rear bearing puller						○
	09820-00030	Alternator rear bearing replacer						○

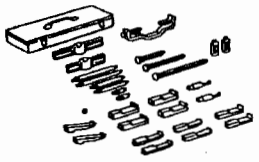
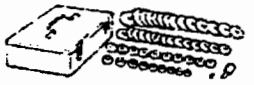
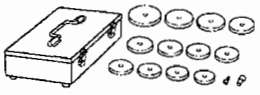
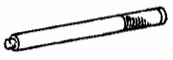
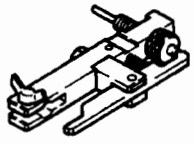
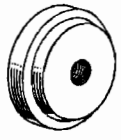
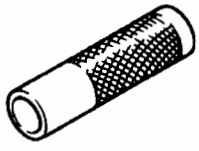
Illustration	Part No.	Part Name	Section					
			1	2	3	5	6	7
	09950-40011	Puller B set		○				
	09950-50012	Puller C set		○	○			
	09950-60010	Replacer set		○				
	09950-60020	Replacer B set		○				
	09950-70010	Handle set		○				
	09960-10010	Variable pin wrench set		○				
	09160-10710-71	Remover & replacer		○				
	09220-32880-71	Inlet adaptor			○			

Illustration	Part No.	Part Name	Section					
			1	2	3	5	6	7
	09240-32880-71	Plunger shaft tool	❍	❍				
	09320-10410-71	Front axle hub inner bearing replacer		❍				
	09370-20270-71	Drive pinion bearing replacer		❍				
	09381-41950-71	HST pump bearing replacer						❍

SERVICE STANDARDS

ENGINE TUNE-UP

V belt tension (Tension gauge) N(kgf) [lbf]	New belt	520 ~ 755 (53 ~ 77) [117 ~ 170]
	Belts in use	324 ~ 559 (33 ~ 57) [73 ~ 126]
V belt deflection [at 98.1N(10kgf) [22lbf] force] mm(in)	New belt	7 ~ 9 (0.28 ~ 0.35)
	Belts in use	8 ~ 13 (0.31 ~ 0.51)
Electrolyte specific gravity (At 20°C 68°F)		1.25 ~ 1.28
Coolant capacity		See the repair manual for each model
Radiator cap valve opening pressure kPa(kgf/cm²) [psi]		73.5 ~ 103.0 (0.75 ~ 1.05) [10.7 ~ 14.9]
Lubricant oil capacity ℓ (US gal)	Total capacity	7.5 (1.98)
	Oil pan capacity	7.0 (1.85)
Injection timing [BTDC]		0°
Injection pressure kPa(kgf/cm²) [psi]		11800 ± 500 (120 ± 5) [1700 ± 70]
Valve clearance [Warm engine] mm (in)	IN	0.18 ~ 0.22 (0.0071 ~ 0.0087)
	EX	0.33 ~ 0.37 (0.0130 ~ 0.0147)
Compression kPa(kgf/cm²) [psi]/rpm	Standard	2850 (29.0) [412]/260
	Limit	1960 (20) [284]/260
	Difference between cylinder	200 (2) [28]/260
Idle speed		See the repair manual for each model
No-load maximum speed		See the repair manual for each model

MANIFOLD

Cylinder head installing surface distortion limit mm (in)	IN	0.4 (0.016)
	EX	0.4 (0.016)

ENGINE

CYLINDER HEAD

Bottom surface distortion limit mm (in)			0.15 (0.0059)
IN manifold mounting surface distortion limit mm (in)			0.20 (0.0078)
EX manifold mounting surface distortion limit mm (in)			0.20 (0.0078)
Valve seat	Contact width mm (in)	IN	1.2 ~ 1.6 (0.047 ~ 0.063)
		EX	1.6 ~ 2.0 (0.063 ~ 0.079)
	Contact angle		45°

VALVE GUIDE BUSHING

Inside diameter mm (in)		8.01 ~ 8.03 (0.3154 ~ 0.3161)
Protrusion from head top surface mm (in)		16.6 ± 0.4 (0.654 ± 0.016)

VALVE SPRING

Free length mm (in)	Standard	46.0 (1.811)
	Limit	45.5 (1.791)
Installed tension N(kgf) [lbf]		124.0 (12.6) [27.8]
Squareness mm (in)		2.0 (0.079)

VALVE

Overall length mm (in)	Standard	IN	108.54 (4.2732)
		EX	108.24 (4.2614)
	Limit	IN	107.90 (4.2480)
		EX	107.60 (4.2362)
Stem outside diameter mm (in)		IN	7.97 ~ 7.99 (0.3138 ~ 0.3146)
		EX	7.96 ~ 7.97 (0.3134 ~ 0.3138)
Valve guide bushing oil clearance mm (in)	Standard	IN	0.02 ~ 0.06 (0.0008 ~ 0.0024)
		EX	0.04 ~0.07 (0.0016 ~ 0.0028)
	Limit	IN	0.10 (0.0039)
		EX	0.12 (0.0047)
Valve head width Limit mm (in)		IN	0.9 (0.0354)
		EX	1.0 (0.039)
Contact face angle			45°
Valve stem cap width mm (in)		Standard	1.31 ~ 1.49 (0.0516 ~ 0.0587)

VALVE ROCKER SHAFT & ROCKER SHAFT

Rocker shaft outside diameter mm (in)	Standard	18.470 ~18.490 (0.72716 ~ 0.72795)
	Limit	18.44 (0.7260)
Rocker arm inside diameter mm (in)	Standard	18.500 ~ 18.520 (0.72835 ~ 0.72913)
	Limit	18.60 (0.7322)
Oil clearance between shaft and arm mm (in)	Standard	0.007 ~ 0.049 (0.00028 ~ 0.00193)
	Limit	0.16 (0.0063)

VALVE LIFTER & PUSH ROD

Valve lifter outside diameter mm (in)	STD	22.170 ~ 22.190 (0.87283 ~ 0.87362)
	O/S 0.05	22.220 ~ 22.240 (0.87480 ~ 0.87559)
Oil clearance between valve lifter and cylinder block mm (in)	Standard	0.010 ~ 0.051 (0.00039 ~ 0.00201)
	Limit	0.1 (0.004)
Push rod bend limit mm (in)		0.25 (0.0098)

TIMING GEAR & IDLE GEAR

Gear backlash mm (in)	Crank gear × Idle gear No.1 · No.2	Standard	0.05 (0.0020)
		Limit	0.3 (0.012)
	Idle gear No.2 × Camshaft gear	Standard	0.05 (0.0020)
		Limit	0.3 (0.012)
	Idle gear No.1 × Injection pump gear	Standard	0.05 (0.0020)
		Limit	0.3 (0.012)
	Idle gear No.1 × Oil pump gear	Standard	0.05 (0.0020)
		Limit	0.3 (0.012)
Idle gear thrust clearance mm (in)		Standard	No.1 0.030 ~ 0.110 (0.00118 ~ 0.00433) No.2 0.100 ~ 0.260 (0.00394 ~ 0.01024)
		Limit	No.1 0.3 (0.012), No.2 0.5 (0.020)
Idle gear inside diameter mm (in)		Standard	No.1 45.000 ~ 45.025 (1.77165 ~ 1.77263) No.2 50.000 ~ 50.025 (1.96850 ~ 1.96948)
Idle gear shaft outside diameter mm (in)		Limit	No.1 44.950 ~ 44.975 (1.76968 ~ 1.77067) No.2 49.930 ~ 49.945 (1.96574 ~ 1.96633)
Oil clearances between idle gear shaft No.1 · No.2 and Idle gear No.1 · No.2. mm (in)		Standard	No.1 0.025 ~ 0.075 (0.00098 ~ 0.00295) No.2 0.055 ~ 0.095 (0.00217 ~ 0.00374)
		Limit	0.3 (0.012)
Idle gear No.2 plate washer thickness mm (in)		Standard	2.45 ~ 2.50 (0.0965 ~ 0.0984)

CAMSHAFT & BEARING

Bend limit		mm (in)	0.04 (0.0016)
Thrust clearance mm (in)		Standard	0.06 ~ 0.13 (0.0024 ~ 0.0051)
		Limit	0.3 (0.012)
Cam height mm (in)	Standard	IN	39.928 ~ 40.028 (1.57197 ~ 1.57590)
		EX	40.312 ~ 40.412 (1.58708 ~ 1.59102)
	Limit	IN	39.47 (1.5539)
		EX	39.85 (1.5689)
Journal outside diameter mm (in)	Standard	No.1	47.159 ~ 47.175 (1.85665 ~ 1.85728)
		No.2	46.959 ~ 46.975 (1.84878 ~ 1.84941)
		No.3	46.759 ~ 46.775 (1.84090 ~ 1.84153)
Camshaft bearing inside diameter mm (in)	Standard	No.1	47.200 ~ 47.225 (1.85826 ~ 1.85925)
		No.2	47.000 ~ 47.025 (1.85039 ~ 1.85137)
		No.3	46.800 ~ 46.825 (1.84252 ~ 1.84350)
Bearing O/S valve		mm (in)	0.125, 0.250 (0.00492, 0.00984)
Oil clearance mm (in)		Standard	0.025 ~ 0.066 (0.00098 ~ 0.00260)
		Limit	0.1 (0.004)

CYLINDER BLOCK

Top surface distortion limit mm (in)		0.1 (0.004)
Cylinder bore mm (in)	Standard	86.00 ~ 86.03 (3.3858 ~ 3.3870)
	Difference between maximum and minimum	0.2 (0.008)
	Taper · Ellipticity	0.02 (0.0008) or less
	Honing margin	0.02 (0.0008) or less
Cylinder liner outside diameter mm (in)	A	89.030 ~ 89.045 (3.50511 ~ 3.50570)
	B	89.045 ~ 89.060 (3.50570 ~ 3.50629)
Cylinder liner hole inside diameter mm (in)	A	89.000 ~ 89.015 (3.50393 ~ 3.50452)
	B	89.015 ~ 89.030 (3.50452 ~ 3.50511)
Cylinder liner protrusion mm (in)	Standard	0.1 (0.004) or less
Valve lifter hole inside diameter mm (in)		22.200 ~ 22.221 (0.87401 ~ 0.87484)
	O/S 0.05	22.245 ~ 22.271 (0.87579 ~ 0.87681)

PISTON & PISTON RING

Piston outside diameter mm (in)		Standard		85.950 ~ 85.980 (3.38385 ~ 3.38530)
		O/S 0.50		86.450 ~ 86.460 (3.40354 ~ 3.40393)
		O/S 1.00		86.950 ~ 86.960 (3.42322 ~ 3.42362)
Piston pin	Pin outside diameter mm (in)			27.000 ~ 27.012 (1.062990 ~ 1.063462)
	Piston fitting temperature °C (°F)			60 (140)
Piston ring	Piston ring end gap mm (in)	Compression ring	No.1	0.27 ~ 0.39 (0.0106 ~ 0.0154)
			No.2	0.45 ~ 0.60 (0.0177 ~ 0.0236)
		Oil ring		0.20 ~ 0.40 (0.0079 ~ 0.0157)
	Ring to ring groove clearance mm (in)	Compression ring	No.1	0.06 ~ 0.09 (0.0024 ~ 0.0035)
			No.2	0.04 ~ 0.08 (0.0016 ~ 0.0031)
		Oil ring		0.03 ~ 0.07 (0.0012 ~ 0.0028)
Piston clearance mm (in)		Standard		0.040 ~ 0.060 (0.0016 ~ 0.0023)
		Limit		0.15 (0.0059)

CONNECTING ROD & BUSHING

Connecting rod thrust clearance mm (in)	Standard	0.08 ~ 0.30 (0.0031 ~ 0.0118)
	Limit	0.40 (0.0157)
Bushing inside diameter standard mm (in)		27.011 ~ 27.023 (1.06342 ~ 1.06390)
Bushing oil clearance mm (in)	Standard	0.007 ~ 0.015 (0.00028 ~ 0.00059)
	Limit	0.05 (0.0020)
Connecting rod bearing oil clearance mm (in)	Standard	0.044 ~ 0.080 (0.00173 ~ 0.00315)
	Limit	0.110 (0.00433)

CRANKSHAFT

Crankshaft bend limit		mm (in)	0.05 (0.0020)
Thrust clearance	mm (in)	Standard	0.04 ~ 0.24 (0.0016 ~ 0.0094)
		Limit	0.3 (0.012)
Thrust washer thickness	mm (in)	Standard	1.93 ~ 1.98 (0.0760 ~ 0.0780)
		O/S Value	0.125, 0.250 (0.00492, 0.00984)
Journal outside diameter (For finishing dimension for U/S)	mm (in)	STD	64.98 ~ 65.00 (2.5583 ~ 2.5591)
		U/S 0.25	64.74 ~ 64.75 (2.5488 ~ 2.5492)
		U/S 0.50	64.49 ~ 64.50 (2.5390 ~ 2.5394)
		U/S 0.75	64.24 ~ 64.25 (2.5291 ~ 2.5230)
		U/S 1.00	63.99 ~ 64.00 (2.5193 ~ 2.5197)
Crank journal oil clearance	mm (in)	Standard	0.028 ~ 0.048 (0.00110 ~ 0.00189)
		Limit	0.1 (0.0039)
Crankpin outside diameter (For finishing dimension for U/S)	mm (in)	STD	50.48 ~ 50.50 (1.9874 ~ 1.9882)
		U/S 0.25	50.24 ~ 50.25 (1.9779 ~ 1.9783)
		U/S 0.50	49.99 ~ 50.00 (1.9681 ~ 1.9685)
		U/S 0.75	49.74 ~ 49.75 (1.9583 ~ 1.9587)
		U/S 1.00	49.49 ~ 49.50 (1.9484 ~ 1.9488)
Crank journal and crankpin	mm (in)	Ellipticity limit	0.02 (0.0008)
		Taper limit	0.05 (0.0020)

FUEL SYSTEM

NOZZLE & NOZZLE HOLDER

NOZZLE	Nozzle Opening pressure MPa(kgf/cm²) [psi]	11.8 ± 0.5 (120 ± 5) [1706 ± 71]
Adjusting washer thickness (For adjusting nozzle opening pressure)	mm (in)	1.00 ~ 1.95 (0.0394 ~ 0.0768) (43 types every 0.025 mm (0.0010 in))

INJECTION PUMP

Roller ring ASSY	Roller ring height variation limit	mm (in)	0.02 (0.0008)
Drive shaft	Wear depth limit of oil seal contact surface	mm (in)	0.08 (0.0031)
Cam plate	Wear limit of plunger contact surface (dimension L)	mm (in)	4.2 (0.165)
Flyweight	Stepped wear limit of washer contact surface (dimension A)	mm (in)	0.2 (0.008)
Plunger Spring	Squareness (dimension A) limit	mm (in)	2.0 (0.079)
Pump housing	Bushing wear limit	mm (in)	0.1 (0.004)
Cam lift amount during injection timing check		mm (in)	0.90 ± 0.03 (0.035 ± 0.001)

INJECTION PUMP ADJUSTMENT

1. Adjustment condition

Nozzle	DN12SD12
Nozzle valve opening pressure MPa(kgf/cm²) [psi]	14.71 ± 0.49 (150 ± 5) [2133 ± 71]
Test oil	JIS No.2 light oil
Feed oil pressure kPa(kgf/cm²) [psi]	20 (0.2) [2.8]
High pressure hose (Inside diameter × Outside diameter × length) mm (in)	φ 2 × φ 6 × 840 (φ 0.08 × φ 0.24 × 33.07)
Test oil temperature °C (°F)	40 ~ 45 (104 ~ 113)
Solenoid voltage for adjustment V	6

2. Temporary adjustment (Lever in FULL position)

	Pump speed rpm	Injection rate cm³(cu-in)/200st	Note
Full-load reference point	900	8.3 ~ 8.7 (0.506 ~ 0.531)	Adjust with full load set screw
High speed lever set point	1310	3.3 ~ 4.9 (0.201 ~ 0.299)	Adjust with maximum speed adjusting screw

3. Pump internal pressure adjustment (Lever FULL position)

Pump speed rpm	Pump internal pressure kPa(kgf/cm²) [psi]	Note
400	412 ~ 471 (4.2 ~ 4.8) [59.7 ~ 68.3]	Adjust with regulating valve
1200	608 ~ 667 (6.2 ~ 6.8) [88.2 ~ 96.7]	

4. Over flow rate inspection (Lever FULL position)

Pump speed rpm	Over flow rate cm³ (cu-in)/minute	Note
1200	283 ~ 533 (17.27 ~ 32.52)	Use overflow screw on each pump

5. Timer adjustment (Lever FULL position)

Pump speed rpm	700	1100
Piston stroke mm (in)	0.45 ~ 1.25 (0.0177 ~ 0.0492)	2.35 ~ 3.15 (0.0925 ~ 0.1240)

6. Injection rate adjustment

Lever angle	Pump speed rpm	Injection rate cm³(cu-in)/200st	Variation cm³(cu-in)	Note
(+)20° ±5° (FULL position)	900	8.3 ~ 8.7 (0.506 ~ 0.531)	0.6 (0.037)	Full-load reference injection rate setting
	1310	3.3 ~ 4.9 (0.201 ~ 0.299)	–	High speed lever setting
	1275	7.2 ~ 10.0 (0.439 ~ 0.610)	–	Confirm
	1400	0.9 (0.055) or less	–	Confirm
	100	9.7 ~ 12.9 (0.592 ~ 0.787)	1.2 (0.073)	Increase for starting
	400	7.20 ~ 9.80 (0.439 ~ 0.598)	–	End of increase
	500	6.94 ~ 8.06 (0.424 ~ 0.492)	–	Confirm
	1200	9.24 ~ 10.36 (0.5639 ~ 0.6322)	–	Confirm

7. Low speed lever setting

Lever angle	Pump speed rpm	Injection rate cm^3(cu-in)/500st	Variation cm^3(cu-in)	Note
(–)18° ±5° (Idle position)	390	2.5 ~ 5.5 (0.153 ~ 0.336)	1.5 (0.092)	Low speed lever setting
	490	0.75 (0.0458) or less	–	Confirm

8. Load sensing timer adjustment

Lever angle	Pump speed rpm	Injection rate cm^3(cu-in)/500st	Variation cm^3(cu-in)	Note
Start of effect	1200	(q Full-0.8)±0.4 ((qFull-0.049) ± 0.024)	–	At governor shaft
End of effect	1200	(q Full-2.4)±0.4 ((qFull-0.146) ± 0.024)	–	Confirm

COOLING SYSTEM

RADIATOR

Radiator cap valve opening pressure kPa(kgf/cm^2) [psi]	Standard	73.5 ~ 103.0 (0.75 ~ 1.05) [10.7 ~ 14.9]
	Limit	59 (0.6) [8.5]

THERMOSTAT

Threshold temperature	°C (°F)	80 ~ 84 (176 ~ 153)
Full-open temperature	°C (°F)	95 (203)
Full-open valve lift amount	mm (in)	10 (0.39)

LUBLICATION SYSTEM

OIL PUMP

Oil pump type			Trochoid pump
Body clearance	mm (in)	Standard	0.10 ~ 0.17 (0.0039 ~ 0.0067)
		Limit	0.2 (0.008)
Tip clearance	mm (in)	Standard	0.05 ~ 0.15 (0.0020 ~ 0.0059)
		Limit	0.2 (0.008)
Rotor protrusion	mm (in)	Standard	3.91 ~ 3.97 (0.1539 ~ 0.1563) (Reference)

STARTING SYSTEM

STARTER MOTOR

Motor type			DC series-wound reduction type
Rated voltage		V	12
Rated output		kW	2.5
No-load characteristics	Voltage	V	11
	Current	A	90 or less
	Speed	rpm	3500 or more
Commutator	Ellipticity mm (in)	Standard	0.02 (0.0008)
		Limit	0.05 (0.0020)
	Outside diameter mm (in)	Standard	36 (1.42)
		Limit	35 (1.38)
	Mica depth mm (in)	Standard	0.7 (0.028)
		Limit	0.2 (0.008)
Brush	Length mm (in)	Standard	20.5 (0.807)
		Limit	13 (0.51)
	Spring installed load N(gf) [lbf]	Standard	31.4 ~ 39.2 (3200 ~ 4000) [7.1 ~ 8.8]
		Limit	21.6 (2200) [4.9]

CHARGING SYSTEM

ALTERNATOR

Rated voltage	V	12
Maximum output	A	60
Output speed	rpm	1500
Blush length mm (in)	Standard	10.5 (0.413)
	Limit	1.5 (0.059)
Slip ring outside diameter mm (in)	Standard	14.4 (0.567)
	Limit	14.0 (0.551)

TIGHTENING TORQUES

Tightening Point	Tightening Torque N·m(kgf-cm)[ft-lbf]
Cylinder block × Cylinder head	85 ~ 95 (870 ~ 970) [62.9 ~ 70.1]
Cylinder block × Crankshaft bearing cap	97 ~ 111 (990 ~ 1130) [71.6 ~ 81.8]
Cylinder block × Timing gear cover	17 ~ 25 (170 ~ 250) [12.3 ~ 18.4]
Cylinder block × Idle gear thrust plate	58 ~ 76 (590 ~ 770) [42.0 ~ 55.7]
Cylinder block × Camshaft thrust plate	17 ~ 25 (170 ~ 250) [12.3 ~ 18.4]
Cylinder block × Oil pan	11 ~ 16 (110 ~ 160) [8.0 ~ 11.6]
Cylinder block × Oil pump	17 ~ 25 (170 ~ 250) [12.3 ~ 18.4]
Cylinder block × Timing gear case	17 ~ 25 (170 ~ 250) [12.3 ~ 18.4]
Cylinder block × Rear oil seal retainer	17 ~ 25 (170 ~ 250) [12.3 ~ 18.4]
Cylinder block × Engine mounting bracket	29 ~ 44 (300 ~ 450) [21.7 ~ 32.5]
Cylinder block × Alternator bracket	35 ~ 53 (360 ~ 540) [26.0 ~ 39.0]
Cylinder block × Oil strainer	15 ~ 22 (150 ~ 220) [10.9 ~ 15.1]
Cylinder block × Oil regulator	20 ~ 30 (200 ~ 310) [14.5 ~ 22.4]
Cylinder head × Cylinder head cover	5 ~ 9 (50 ~ 90) [3.6 ~ 6.5]
Cylinder head × Intake manifold	17 ~ 25 (170 ~ 250) [12.3 ~ 18.4]
Cylinder head × Exhaust manifold	37 ~ 55 (380 ~ 560) [27.5 ~ 40.5]
Cylinder head × Valve rocker support	35 ~ 53 (360 ~ 540) [26.0 ~ 39.0]
Cylinder head × Nozzle holder	58 ~ 68 (590 ~ 690) [42.0 ~ 49.9]
Cylinder head × Water pump	17 ~ 25 (170 ~ 250) [12.3 ~ 18.4]
Crankshaft × Crankshaft pulley	130 ~ 170 (1330 ~ 1740) [96.2 ~ 125.9]
Camshaft × Camshaft timing gear	36 ~ 54 (370 ~ 550) [26.8 ~ 39.8]
Connecting rod × Connecting rod cap	60 ~ 68 (610 ~ 680) [44.1 ~ 49.2]
Injection pump × Timing gear case	17 ~ 25 (170 ~ 250) [12.3 ~ 18.4]
Injection pump × Pump drive gear	56 ~ 72 (570 ~ 730) [41.2 ~ 52.8]
Injection pump × Injection pipe	24 ~ 36 (240 ~ 370) [17.4 ~ 26.8]
Timing gear case × Timing gear cover	17 ~ 25 (170 ~ 250) [12.3 ~ 18.4]
Timing gear cover × Timing gear cover No.2	15 ~ 22 (150 ~ 220) [10.9 ~ 15.1]
Alternator bracket × Alternator	46 ~ 70 (470 ~ 710) [34.0 ~ 51.4]
Water pump × Fan and fan pulley	15 ~ 22 (150 ~ 220) [10.9 ~ 15.1]
Valve rocker arm × Adjust screw	15 ~ 22 (150 ~ 220) [10.9 ~ 15.1]
Valve rocker support × Rocker shaft	10 ~ 15 (100 ~ 150) [7.2 ~ 10.9]
Water outlet × Water pump	17 ~ 22 (170 ~ 220) [12.3 ~ 15.1]
Nozzle holder × Nozzle leakage locknut	26 ~ 34 (260 ~ 350) [18.8 ~ 25.3]
Injection nozzle holder × Injection pipe	24 ~ 36 (240 ~ 370) [17.4 ~ 26.8]
Intake pipe × Intake manifold	17 ~ 25 (170 ~ 250) [12.3 ~ 18.4]