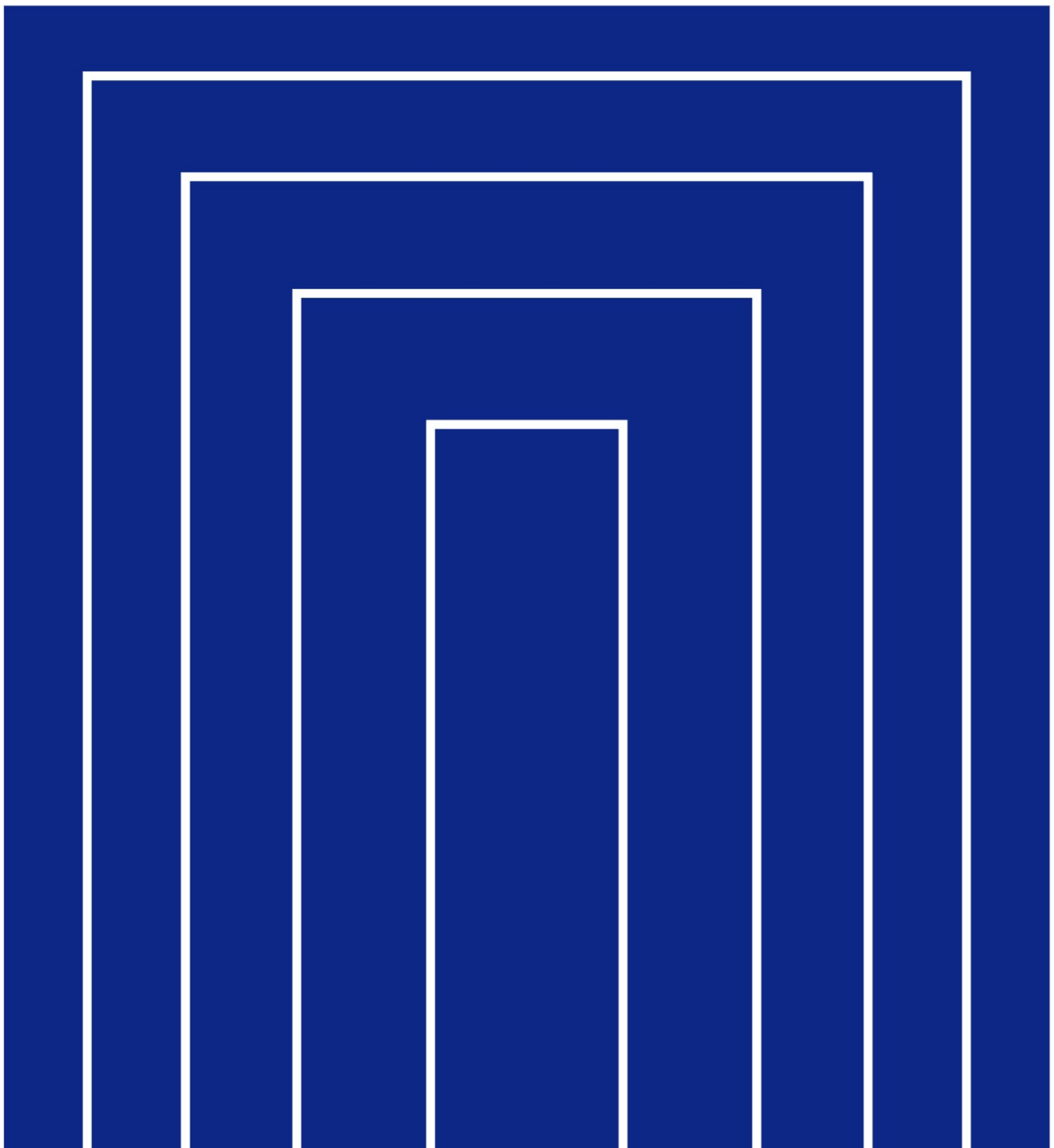
TOYOTA

1HD-FT ENGINE

REPAIR MANUAL

Jan., 1995



Pub. No. RM437E

FOREWORD

This repair manual has been prepared to provide information covering general service repairs for the 1HD-FT engine equipped in the TOYOTA LAND CRUISER.

Applicable models: HDJ80 series

Please note that the publications below have also been prepared as relevant service manuals for the components and system in this engine.

Manual Name	Pub. No.
• 1HD-FT Engine Emission Control Repair Manual	ERM111E

All information in this manual is based on the latest product information at the time of publication. However, specifications and procedures are subject to change without notice.

TOYOTA MOTOR CORPORATION

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INTRODUCTION IN
ENGINE EG
STARTING SYSTEM ST
CHARGING SYSTEM CH

INTRODUCTION

HOW TO USE THIS MANUAL ..... IN– 2
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HOW TO USE THIS MANUAL

IN002-11

INDEX

An INDEX is provided on the first page of each section to guide you to the item to be repaired. To assist you in finding your way through the manual, the Section Title and major heading are given at the top of every page.

IN

GENERAL DESCRIPTION

At the beginning of each section, a General Description is given that pertains to all repair operations contained in that section.
Read these precautions before starting any repair task.

TROUBLESHOOTING

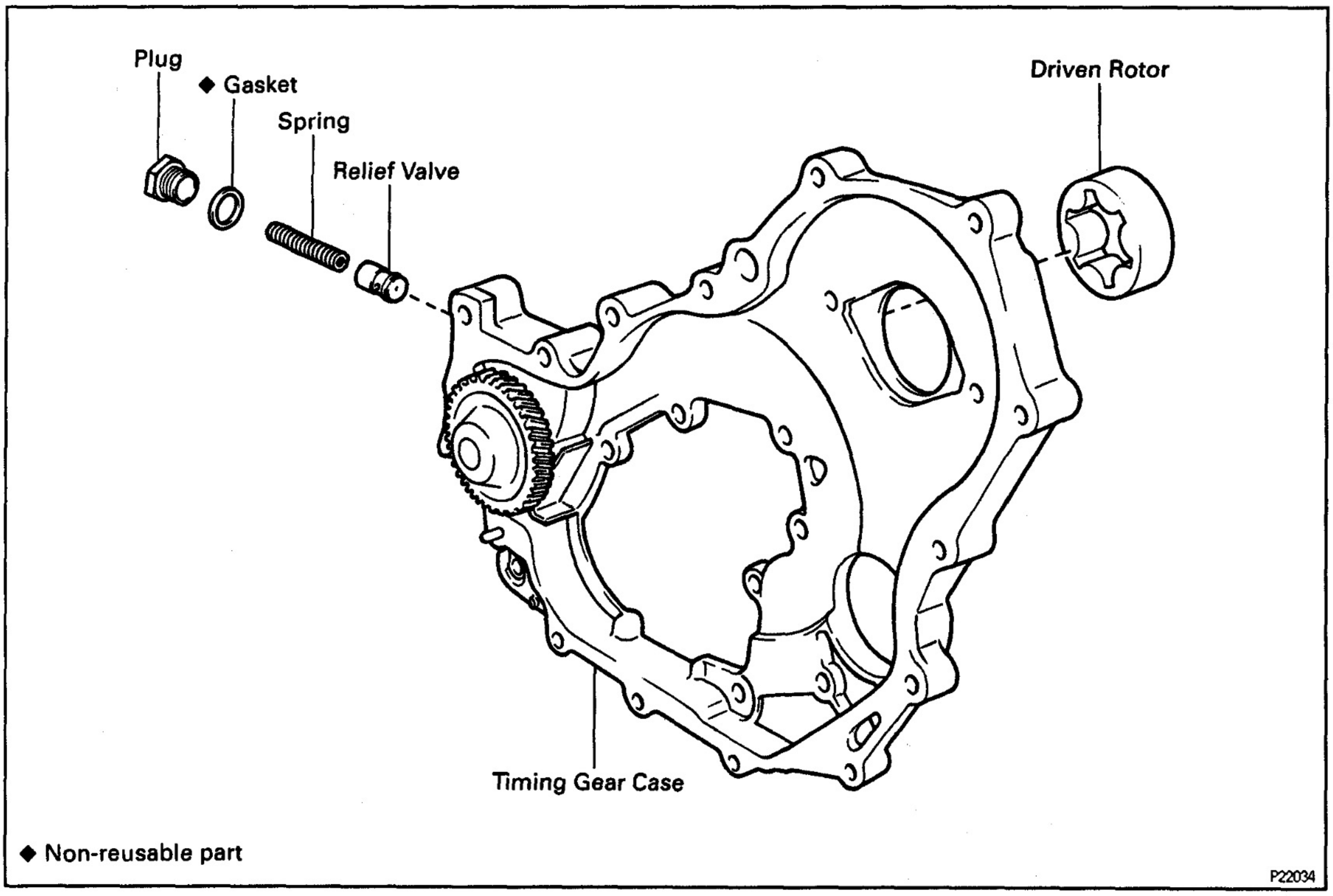
TROUBLESHOOTING tables are included for each system to help you diagnose the problem and find the cause.

PREPARATION

Preparation lists the SST (Special Service Tools), recommended tools, equipment, lubricant and SSM (Special Service Materials) which should be prepared before beginning the operation and explains the purpose of each one.

REPAIR PROCEDURES

Most repair operations begin with an overview illustration. It identifies the components and shows how the parts fit together.
Example:



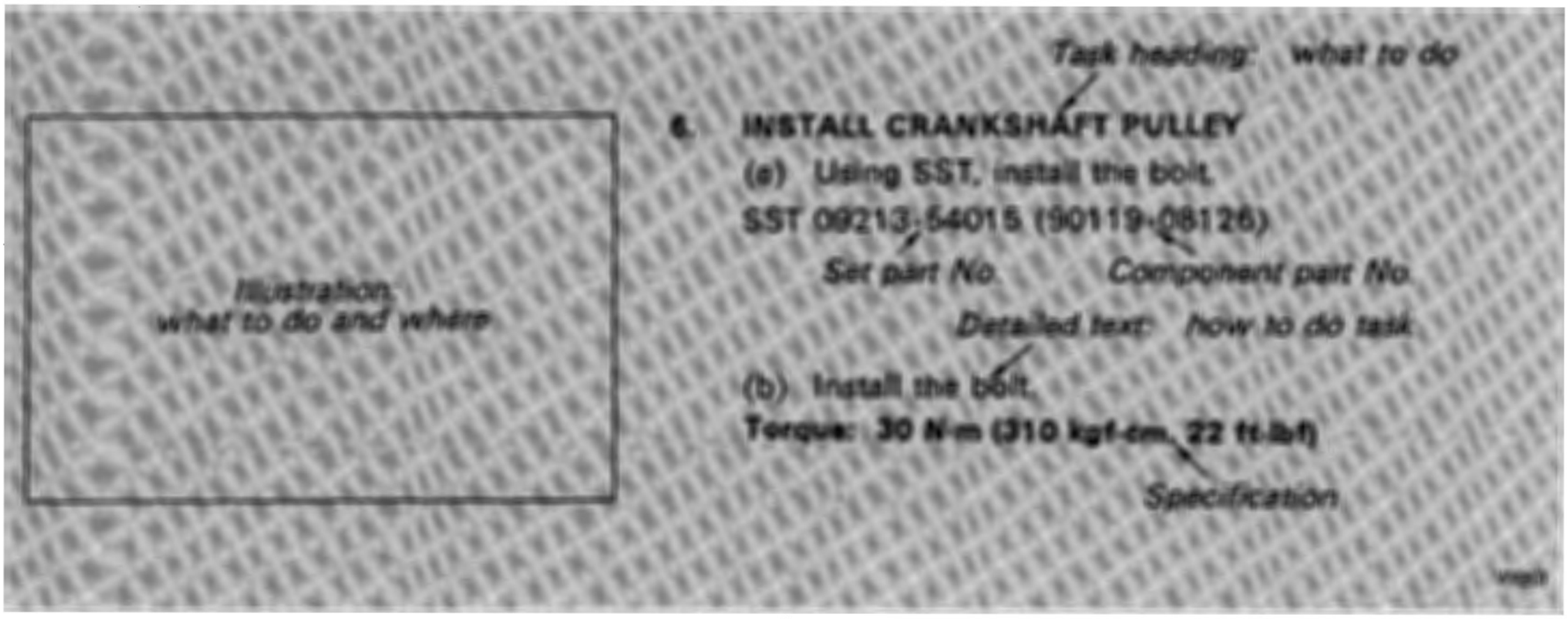
◆ Non-reusable part

P22034

The procedures are presented in a step–by–step format:

- The illustration shows what to do and where to do it.
- The task heading tells what to do.
- The detailed text tells how to perform the task and gives other information such as specifications and warnings.

Example:



This format provides the experienced technician with a FAST TRACK to the information needed. The upper case task heading can be read at a glance when necessary, and the text below it provides detailed information. Important specifications and warnings always stand out in bold type.

REFERENCES

References have been kept to a minimum. However, when they are required you are given the page to refer to.

SPECIFICATIONS

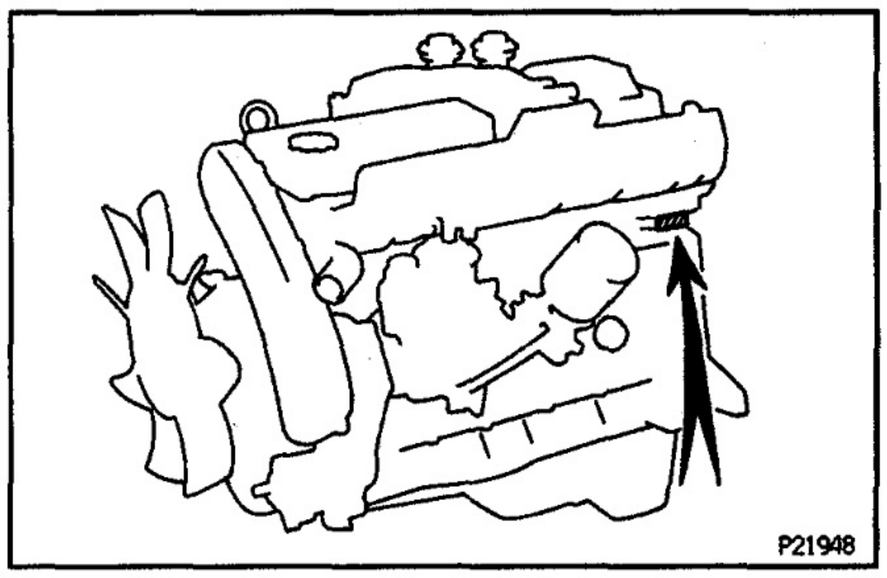
Specifications are presented in bold type throughout the text where needed. You never have to leave the procedure to look up your specifications. They are also found at the end of each section, for quick reference.

CAUTIONS, NOTICES, HINTS:

- CAUTIONS are presented in bold type, and indicate there is a possibility of injury to you or other people.
- NOTICES are also presented in bold type, and indicate the possibility of damage to the components being repaired.
- HINTS are separated from the text but do not appear in bold. They provide additional information to help you perform the repair efficiently.

SI UNIT

The UNITS given in this manual are primarily expressed according to the SI UNIT(International System of Unit), and alternately expressed in the metric system and in the English System.
Example:
Torque: 30 N·m (310 kgf·cm, 22 ft·lbf)



IDENTIFICATION INFORMATION

I0001A-06

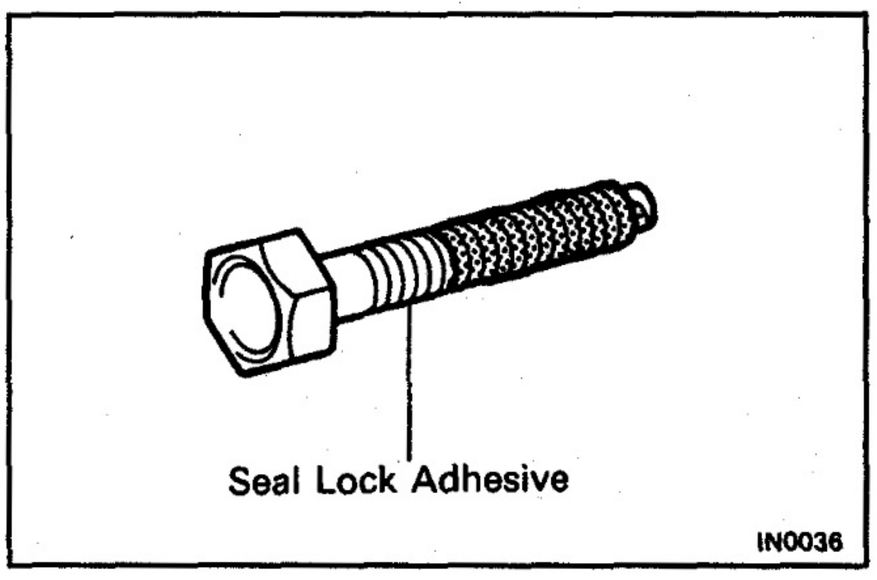
ENGINE SERIAL NUMBER

The engine serial number is stamped on the engine block as shown.

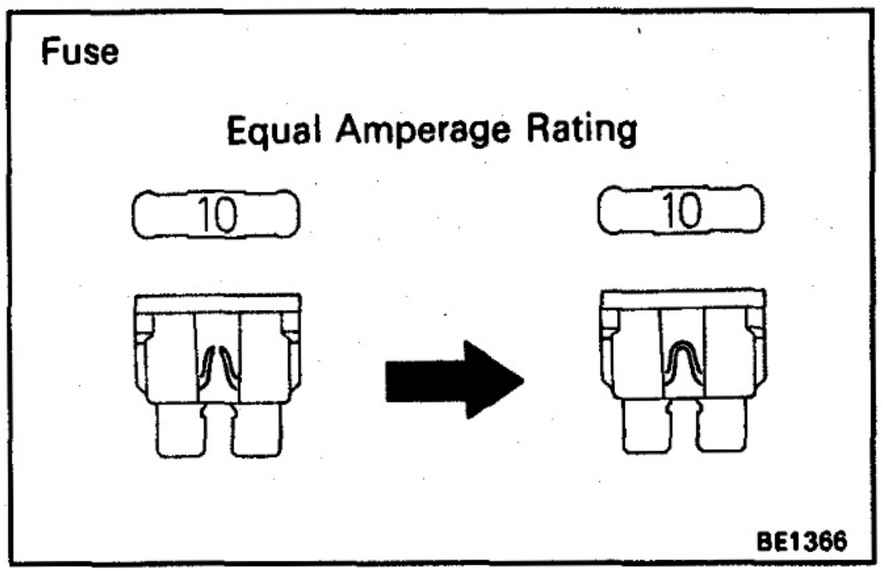
GENERAL REPAIR INSTRUCTIONS

IN05H-01

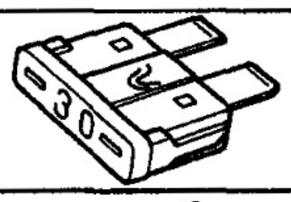
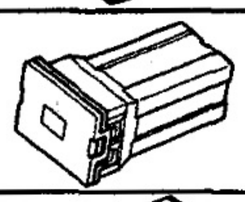
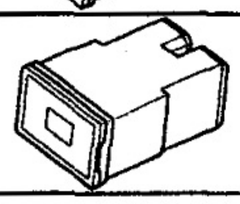
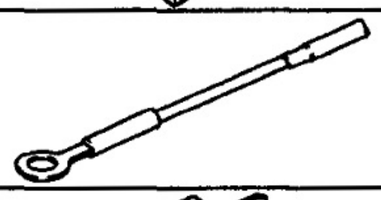
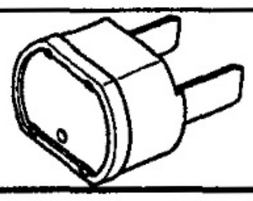
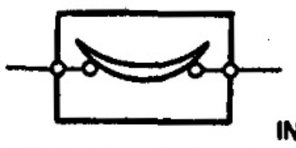
1. Use fender, seat and floor covers to keep the vehicle clean and prevent damage.
2. During disassembly, keep parts in the appropriate order to facilitate reassembly.
3. Observe the following:
   (a) Before performing electrical work, disconnect the negative cable from the battery terminal.
   (b) If it is necessary to disconnect the battery for inspection or repair, always disconnect the cable from the negative (−) terminal which is grounded to the vehicle body.
   (c) To prevent damage to the battery terminal post, loosen the terminal nut and raise the cable straight up without twisting or prying it.
   (d) Clean the battery terminal posts and cable terminals with a clean shop rag. Do not scrape them with a file or other abrasive objects.
   (e) Install the cable terminal to the battery post with the nut loose, and tighten the nut after installation. Do not use a hammer to tap the terminal onto the post.
   (f) Be sure the cover for the positive (+) terminal is properly in place.
4. Check hose and wiring connectors to make sure that they are secure and correct.
5. Non−reusable parts
   (a) Always replace cotter pins, gaskets, O−rings and oil seals etc. with new ones.
   (b) Non−reusable parts are indicated in the component illustrations by the "◆" symbol.
6. Precoated parts
   Precoated parts are bolts and nuts, etc. that are coated with a seal lock adhesive at the factory.
   (a) If a precoated part is retightened, loosened or caused to move in any way, it must be recoated with the specified adhesive.
   (b) When reusing precoated parts, clean off the old adhesive and dry with compressed air. Then apply the specified seal lock adhesive to the bolt, nut or threads.
   (c) Precoated parts are indicated in the component illustrations by the "★" symbol.
7. When necessary, use a sealer on gaskets to prevent leaks.
8. Carefully observe all specifications for bolt tightening torques. Always use a torque wrench.



9. Use of special service tools (SST) and special service materials (SSM) may be required, depending on the nature of the repair. Be sure to use SST and SSM where specified and follow the proper work procedure. A list of SST and SSM can be found in the preparation part at the front of each section in this manual.

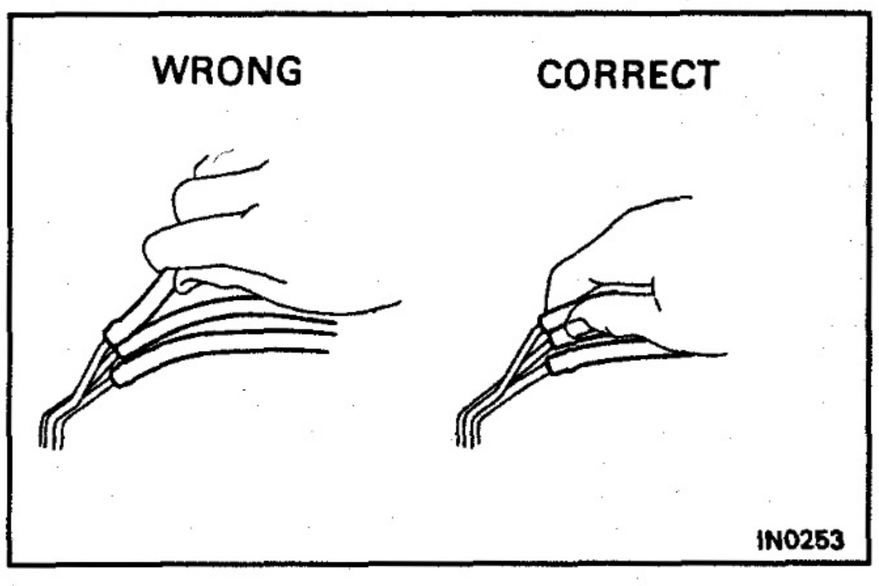


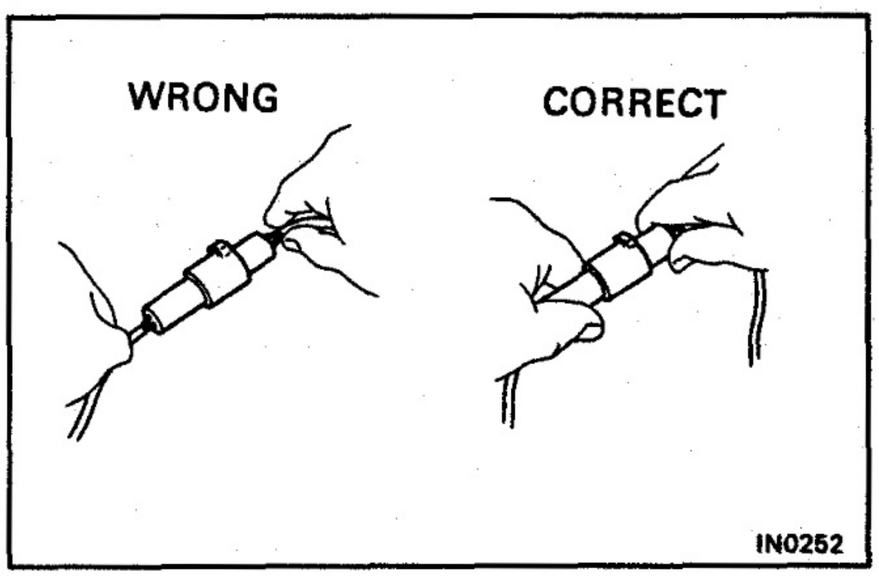
10. When replacing fuses, be sure the new fuse has the correct amperage rating. DO NOT exceed the rating or use one with a lower rating.

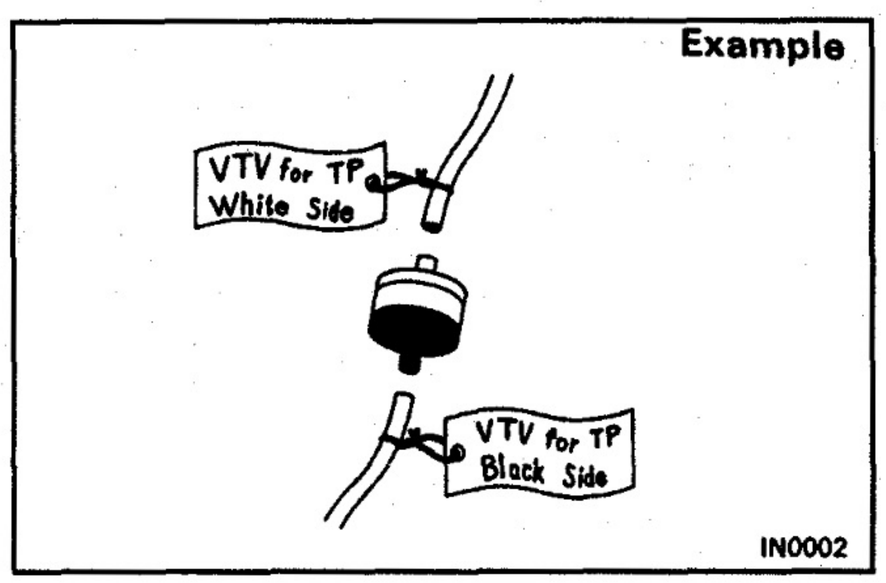
Illustration	Symbol	Part Name	Abbreviation
 BE5594	IN0365	FUSE	FUSE
 BE5595	IN0366	MEDIUM CURRENT FUSE	M-FUSE
 BE5596	IN0367	HIGH CURRENT FUSE	H-FUSE
 BE5597	IN0367	FUSIBLE LINK	FL
 BE5598	 IN0368	CIRCUIT BREAKER	CB

V00076

11. Care must be taken when jacking up and supporting the vehicle. Be sure to lift and support the vehicle at the proper locations.
    (a) If the vehicle is to be jacked up only at the front or rear end, be sure to block the wheels at the opposite end in order to ensure safety.







(b) After the vehicle is jacked up, be sure to support it on stands. It is extremely dangerous to do any work on a vehicle raised on a jack alone, even for a small job that can be finished quickly.

12. Observe the following precautions to avoid damage to the parts:
    (a) Do not open the cover or case of the ECU unless absolutely necessary. (If the IC terminals are touched, the IC may be destroyed by static electricity.)
    (b) To disconnect vacuum hoses, pull on the end, not the middle of the hose.
    (c) To pull apart electrical connectors, pull on the connector itself, not the wires.
    (d) Be careful not to drop electrical components, such as sensors or relays. If they are dropped on a hard floor, they should be replaced and not reused.
    (e) When steam cleaning an engine, protect the distributor, air filter, and VCV from water.
    (f) Never use an impact wrench to remove or install temperature switches or temperature sensors.
    (g) When checking continuity at the wire connector, insert the tester probe carefully to prevent terminals from bending.
    (h) When using a vacuum gauge, never force the hose onto a connector that is too large. Use a step—down adapter instead. Once the hose has been stretched, it may leak.

13. Tag hoses before disconnecting them:
    (a) When disconnecting vacuum hoses, use tags to identify how they should be reconnected.
    (b) After completing a job, double check that the vacuum hoses are properly connected. A label under the hood shows the proper layout.

14. Unless otherwise stated, all resistance is measured at an ambient temperature of 20°C (68°F). Because the resistance may be outside specifications if measured at high temperatures immediately after the vehicle has been running, measurements should be made when the engine has cooled down.

ABBREVIATIONS USED IN THIS MANUAL

IN05G–01

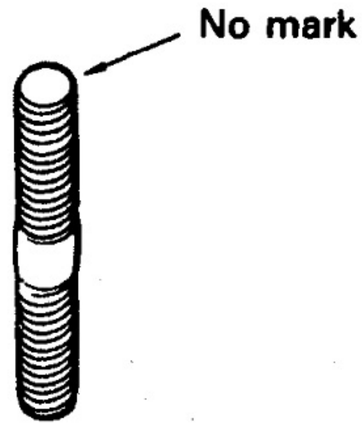
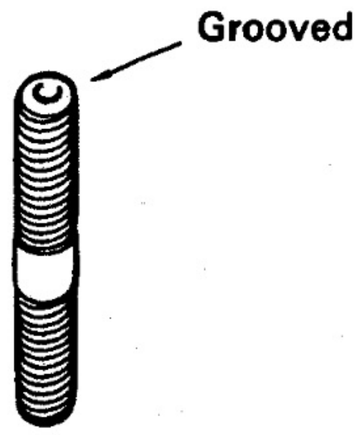
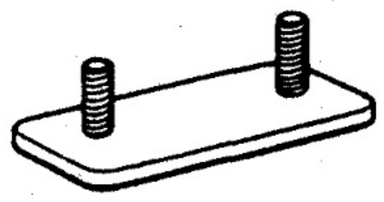
A/C	Air Conditioner
ACV	Air Control Valve
ACSD	Automatic Cold Start Device
Approx.	Approximately
A/T	Automatic Transmission
BACS	Boost and Altiude Compensation Stopper
BDC	Bottom Dead Center
ECU	Engine Control Unit
EGR	Exhaust Gas Recirculation
FIPG	Formed in Place Gasket
LHD	Left–Hand Drive
LST	Load Sensing Timer
MP	Multipurpose
M/T	Manual Transmission
OHC	Over Head Camshaft
O/S	Oversized
PCS	Power Control System
PCV	Positive Crankcase Ventilation
PS	Power Steering
RHD	Right–Hand Drive
SICS	Starting Injection Control System
SSM	Special Service Materials
SST	Special Service Tools
STD	Standard
SW	Switch
TDC	Top Dead Center
TEMP.	Temperature
U/S	Undersize
VSV	Vacuum Switching Valve
w/	With
w/o	Without

STANDARD BOLT TORQUE SPECIFICATIONS

IN008-08

IN

HOW TO DETERMINE BOLT STRENGTH

	Mark	Class		Mark	Class
Hexagon head bolt		4T 5T 6T 7T 8T 9T 10T 11T	Stud bolt		4T
	No mark	4T			6T
Hexagon flange bolt w/ washer hexagon bolt	No mark	4T			
Hexagon head bolt	2 protruding lines	5T			
Hexagon flange bolt w/ washer hexagon bolt	2 protruding lines	6T	Welded bolt		4T
Hexagon head bolt	3 protruding lines	7T			
Hexagon head bolt	4 protruding lines	8T			

V00078

SPECIFIED TORQUE FOR STANDARD BOLTS

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	5	55	48 in.·lbf	6	60	52 in.·lbf
	8	1.25	12.5	130	9	14	145	10
	10	1.25	26	260	19	29	290	21
	12	1.25	47	480	35	53	540	39
	14	1.5	74	760	55	84	850	61
	16	1.5	115	1,150	83	–	–	–
5T	6	1	6.5	65	56 in.·lbf	7.5	75	65 in.·lbf
	8	1.25	15.5	160	12	17.5	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	1,050	76
	16	1.5	140	1,400	101	–	–	–
6T	6	1	8	80	69 in.·lbf	9	90	78 in.·lbf
	8	1.25	19	195	14	21	210	15
	10	1.25	39	400	29	44	440	32
	12	1.25	71	730	53	80	810	59
	14	1.5	110	1,100	80	125	1,250	90
	16	1.5	170	1,750	127	–	–	–
7T	6	1	10.5	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	105	1,050	76
	14	1.5	145	1,500	108	165	1,700	123
	16	1.5	230	2,300	166	–	–	–
8T	8	1.25	29	300	22	33	330	24
	10	1.25	61	620	45	68	690	50
	12	1.25	110	1,100	80	120	1,250	90
9T	8	1.25	34	340	25	37	380	27
	10	1.25	70	710	51	78	790	57
	12	1.25	125	1,300	94	140	1,450	105
10T	8	1.25	38	390	28	42	430	31
	10	1.25	78	800	58	88	890	64
	12	1.25	140	1,450	105	155	1,600	116
11T	8	1.25	42	430	31	47	480	35
	10	1.25	87	890	64	97	990	72
	12	1.25	155	1,600	116	175	1,800	130

ENGINE

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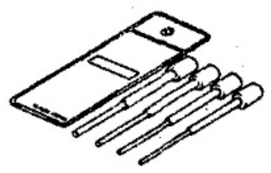
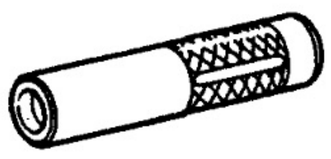
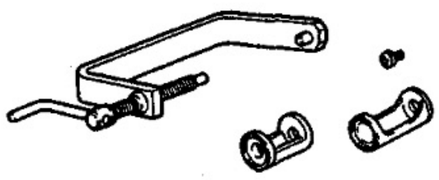
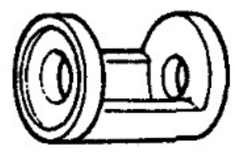
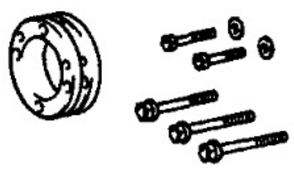
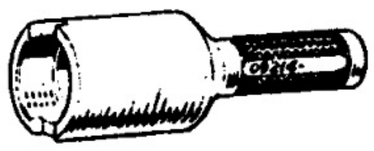
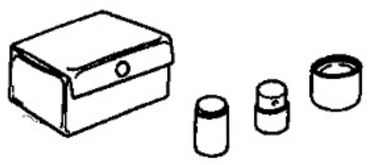
ENGINE MECHANICAL

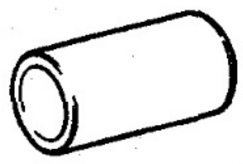
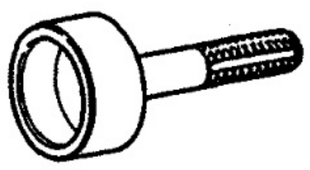
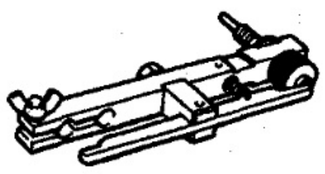
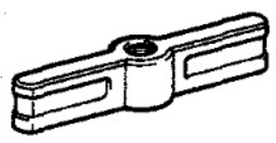
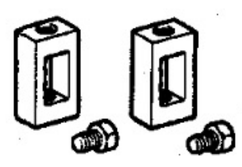
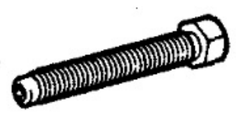
PREPARATION

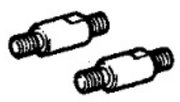
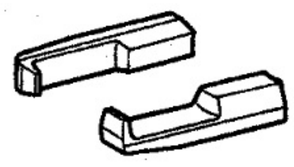
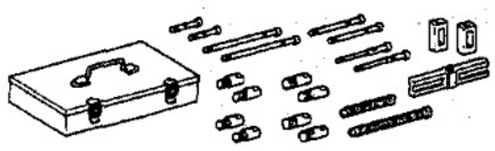
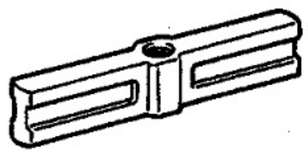
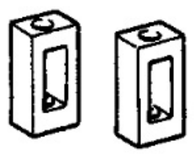
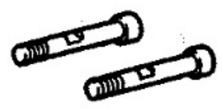
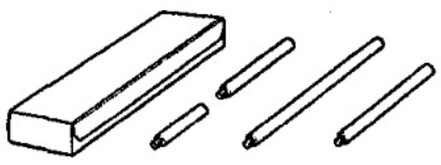
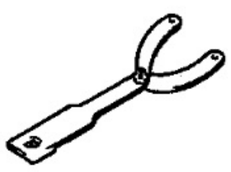
SST (SPECIAL SERVICE TOOLS)

EG0AY-1N

EG

	09201-10000	Valve Guide Bushing Remover & Replacer Set	
	(09201-01070)	Valve Guide Bushing Remover & Replacer 7	
	09201-41020	Valve Stem Oil Seal Replacer	
	09202-70020	Valve Spring Compressor	
	(09202-00010)	Attachment	
	09213-58012	Crankshaft Pulley Holding Tool	
	(90201-08131)	Washer	
	(91111-50845)	Bolt	
	09214-60010	Crankshaft Pulley & Gear Replacer	Crankshaft pulley
	09214-76011	Crankshaft Pulley Replacer	Injection pump drive gear bearing Injection pump drive gear oil seal
	09222-17010	Connecting Rod Bushing Remover & Replacer	
	(09222-05020)	Remover & Replacer	

	(09222−05030) Guide	
	(09222−05040) Base	
	09223−00010 Cover & Seal Replacer	Crankshaft timing gear Oil pump drive shaft gear
	09223−46011 Crankshaft Front Oil Seal Replacer	Camshaft oil seal
	09223−56010 Crankshaft Rear Oil Seal Replacer	
	09223−78010 Crankshaft Oil Seal Replacer	Crankshaft front oil seal
	09275−54011 Plunger Stroke Measuring Tool	
	09308−10010 Oil Seal Puller	Crankshaft front oil seal
	09330−00021 Companion Flange Holding Tool	Crankshaft pulley
	09950−40010 Puller B Set	
	(09951−04010) Hanger 150	No.1 camshaft timing pulley Oil pump drive shaft gear Crankshaft timing gear Injection pump drive gear bearing
	(09952−04010) Slide Arm	No.1 camshaft timing pulley Oil pump drive shaft gear Crankshaft timing gear Injection pump drive gear bearing
	(09953−04010) Center Bolt 100	Oil pump drive shaft gear Crankshaft timing gear
	(09953−04020) Center Bolt 150	No.1 camshaft timing pulley Oil pump drive shaft gear Crankshaft timing gear Injection pump drive gear bearing

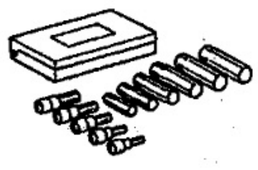
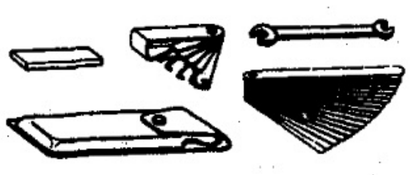
	(09954–04010) Arm 25	No.1 camshaft timing pulley Oil pump drive shaft gear Crankshaft timing gear Injection pump drive gear bearing
	(09955–04060) Claw No.6	No.1 camshaft timing pulley Oil pump drive shaft gear Crankshaft timing gear Injection pump drive gear bearing
	09950–50010 Puller C Set	
	(09951–05010) Hanger 150	Crankshaft pulley Injection pump drive gear
	(09952–05010) Slide Arm	Crankshaft pulley Injection pump drive gear
	(09953–05010) Center Bolt 100	Crankshaft pulley Injection pump drive gear
	(09953–05020) Center Bolt 150	Crankshaft pulley
	(09954–05020) Claw No.2	Crankshaft pulley Injection pump drive gear
	09950–70010 Handle Set	
	(09951–07100) Handle 100	Valve guide bushing
	09960–10010 Variable Pin Wrench Set	
	(09962–01000) Variable Pin Wrench Arm Assy	Injection pump drive gear
	(09963–00700) Pin 7	Injection pump drive gear
	09992–00024 Cylinder Compression Check Gauge Set	

	(09992–00211) Gauge Assy	
	09992–00400 Attachment No.7	Cylinder compression check

EG0AZ–1A

EG

RECOMMENDED TOOLS

	09040–00010 Hexagon Wrench Set .	
	09200–00010 Engine Adjust Kit .	
	09904–00010 Expander Set .	

EG080–13

EQUIPMENT

Caliper gauge	
Connecting rod aligner	
Cylinder gauge	
Dial indicator	
Dye penetrant	
Engine tune–up tester	
Heater	
Micrometer	
Piston ring compressor	
Piston ring expander	
Plastigage	
Precision straight edge	
Soft brush	
Spring tester	Valve spring
Steel square	Valve spring

Thermometer	
Torque wrench	
Valve seat cutter	
V—block	
Vernier calipers	

EG

EG081–29

SSM (SERVICE SPECIAL MATERIALS)

08826–00080	Seal Packing Black or equivalent (FIPG)	Timing belt cover Timing gear cover Camshaft oil seal retainer Cylinder head semi—circular plug
08826–00080	Seal Packing Black or equivalent (FIPG)	Cylinder head cover Main bearing cover Rear oil seal retainer
08826–00100	Seal Packing 1282B, THREE BOND 1282B or equivalent (FIPG)	Water temperature sender gauge

TROUBLESHOOTING

Diesel Engine Diagnosis

EG59H–01

GENERAL

1. Diesel engine problems are usually caused by the engine or fuel system. The injection pump is very rarely the cause of fuel system problems.
2. Before beginning fuel system tests, first check that the engine compression, valve timing and other major systems are within specifications.

PRELIMINARY CHECKS

1. Before performing fuel system checks, ensure that the engine is in good running condition. If necessary, first check the compression, timing and major components or systems.
2. Check the air filter, and clean or replace it if necessary.
3. Check that there is sufficient fuel in the tank.
4. Check if the fuel is contaminated with gasoline or other foreign elements. Only good—quality diesel fuel should be used.
5. Bleed air from the system by pumping the priming.
6. Check for water in the fuel filter and fuel tank, and drain as necessary.
7. If the engine will not crank or if it cranks slowly, first troubleshoot the electrical system.

PRECAUTION:

1. **The basic troubleshooting procedures for the diesel engine (valve clearance, compression, bearings, valves, pistons, etc.) are the same checks you would make for gasoline engine.**
2. **Repair of the injection pump requires considerable skill and use of a special test bench.**

	Suspect area / Symptom	Battery	Battery Terminal	Fusible Link	Starter	Starter Relay	Pre-Heating System	Intake Heater	Injection Nozzle	Fuel Filter	Delivery Valve	Feul Line	Fuel Cut Solenoid	ACSD	Fuel Quality	No Fuel	Fuel Leakage	Ignition Timing	Air Cleaner	Accelerator Cable	Timing Belt	Ignition Switch
	See page	CH-3	CH-3	CH-3	ST-10	ST-18	ST-3	ST-7	EG-112	EG-107	EG-138	–	EG-11	–	–	–	–	EG-15	EG-11	–	EG-23	–
Does not start	Engine does not crank	2	1	3	6	4																5
	Engine cranks normally								5			2	1	6				4				
Difficult to start	Engine cranks slowly	2	1		3																	
	Engine cranks normally						1	2														
Poor idling	High engine idle speed													3						1		
	Rough idle with warm engine								6		7						2	5				
Others	Lack of power								9	6					12		5	8	1	2		
	Engine suddenly stops												2		4	1					3	
	Engine does not shut off with key												1									2
	Excessive exhaust smoke								4	3								2	1			
	Excessive fuel consumption								8						10		5	7	1			
	Engine overheat																	7				
	Low oil pressure																					
	High oil pressure																					
	Engine noise when warm								2									1				

HINT: When inspecting a wire harness or circuit the Electrical Wiring Diagram repair manual should be referred to and the circuits of related systems also should be checked.

V06661

EG

	See page	EG-17	EG-17	EG-27	EG-12	EG-185	CH-3	EG-182	EG-182	EG-186	EG-186	EG-199	EG-199	–	–	–	EG-67	EG-69	EG-46	EG-72	–	
	Suspect area / Symptom	Idle Speed	Maximum Speed	Valve Timing	Compression	Thermostat	Fan Belt	Fluid Coupling	Water Pump	Radiator and Radiator Cap	Coolant Leakage	Oil Pump	Relief Valve	Oil Pressure Sender Gauge	Clutch Slipping	Brake Grabbing	Connecting Rod Bearing	Crankshaft Bearing	Cylinder Head	Cylinder Block	Flywheel	
Does not start	Engine does not crank			8																	7	
	Engine cranks normally			3																		
Difficult to start	Engine cranks slowly																4	5				
	Engine cranks normally																					
Poor idling	High engine speed					2																
	Rough idle with warm engine	1		4	3																	
Others	Lack of power		7	11	10										3	4						
	Engine suddenly stops																					
	Engine does not shut off with key																					
	Excessive exhaust smoke																					
	Excessive fuel consumption	4	6		9										2	3						
	Engine overheat					5	2	3	6	4	1								8	9		
	Low oil pressure											3	2	1			4	5				
	High oil pressure												1									
	Engine noise when warm																					

V06662

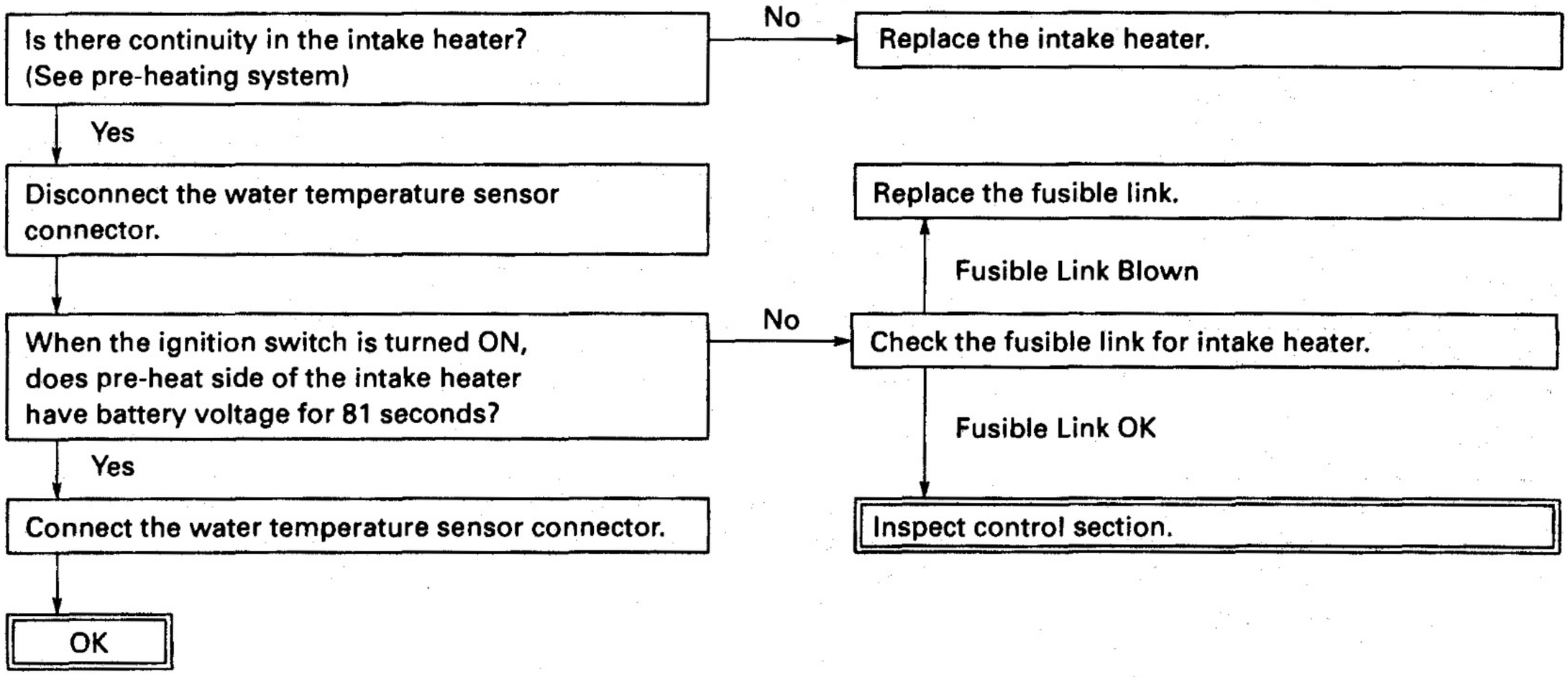
Diesel Electrical System Diagnosis (Engine does not start cold)

HINT:

- Battery voltage at 12 V — Ignition switch OFF.
- Engine cranks normally.
- Fusible link okay.

PRE—HEATING SYSTEM

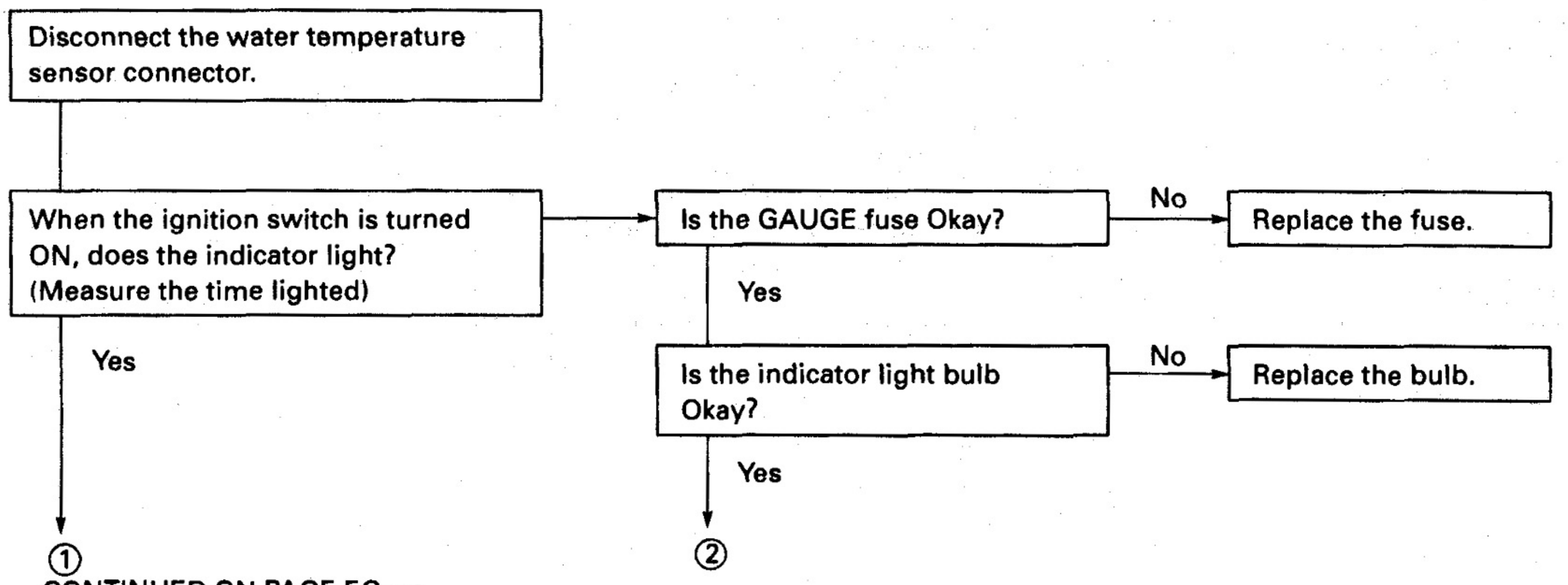
1. Inspect power supply section



V06664

2. Inspect control section

HINT: Perform this inspection with the intake heater lead wire properly connected.



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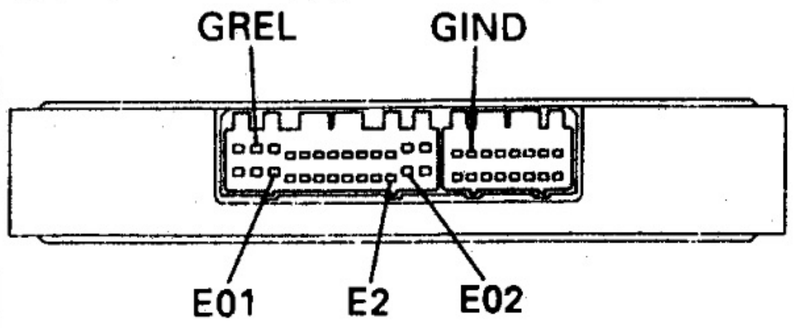
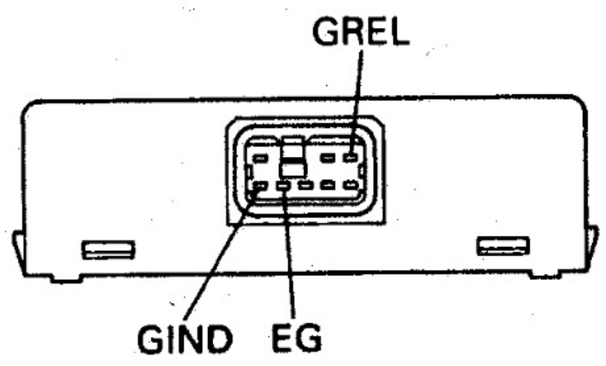
CONTINUED FROM PAGE EG-9

①

Emission ECU (w/ EGR System)



Pre-Heating Timer (w/o EGR System)



Is the lighting time correct?
6.5 seconds

No → Replace the ECU or timer.

Yes

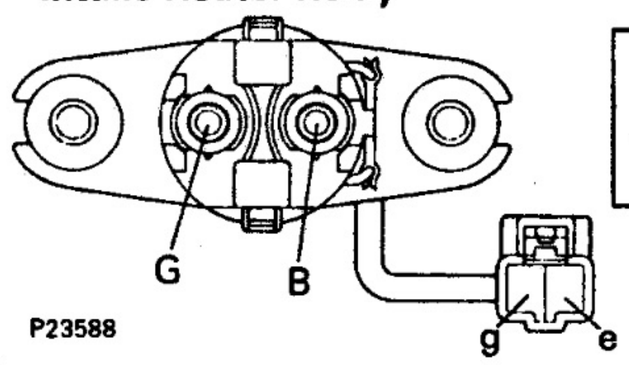
Is there battery voltage between terminal G of the intake heater relay and body ground for 81 seconds with the ignition switch ON?

No → Is intake heater relay Okay? (See pre-heating system in Starting System)

No → Replace the intake heater relay.

Yes

Intake Heater Relay



Connect the water temperature sensor connector.

Inspect power supply section.

Yes

When the ignition switch is turned ON, does terminal GREL of the ECU or timer have battery voltage for 81 seconds?

No → Replace the ECU or timer.

Yes

- Open circuit in wire harness between terminal GREL of the ECU or timer and terminal g of the intake heater relay.
- Open circuit or ground faulty in wire harness between terminal e of the intake heater relay and body ground.

②

Is there grounding of terminal E1, E01 or E02 of emission ECU or terminal EG of the pre-heating timer?

No → Open circuit or ground faulty in wire harness between terminal E1, E01 or E02 of the ECU or terminal EG of the timer and body ground.

Yes

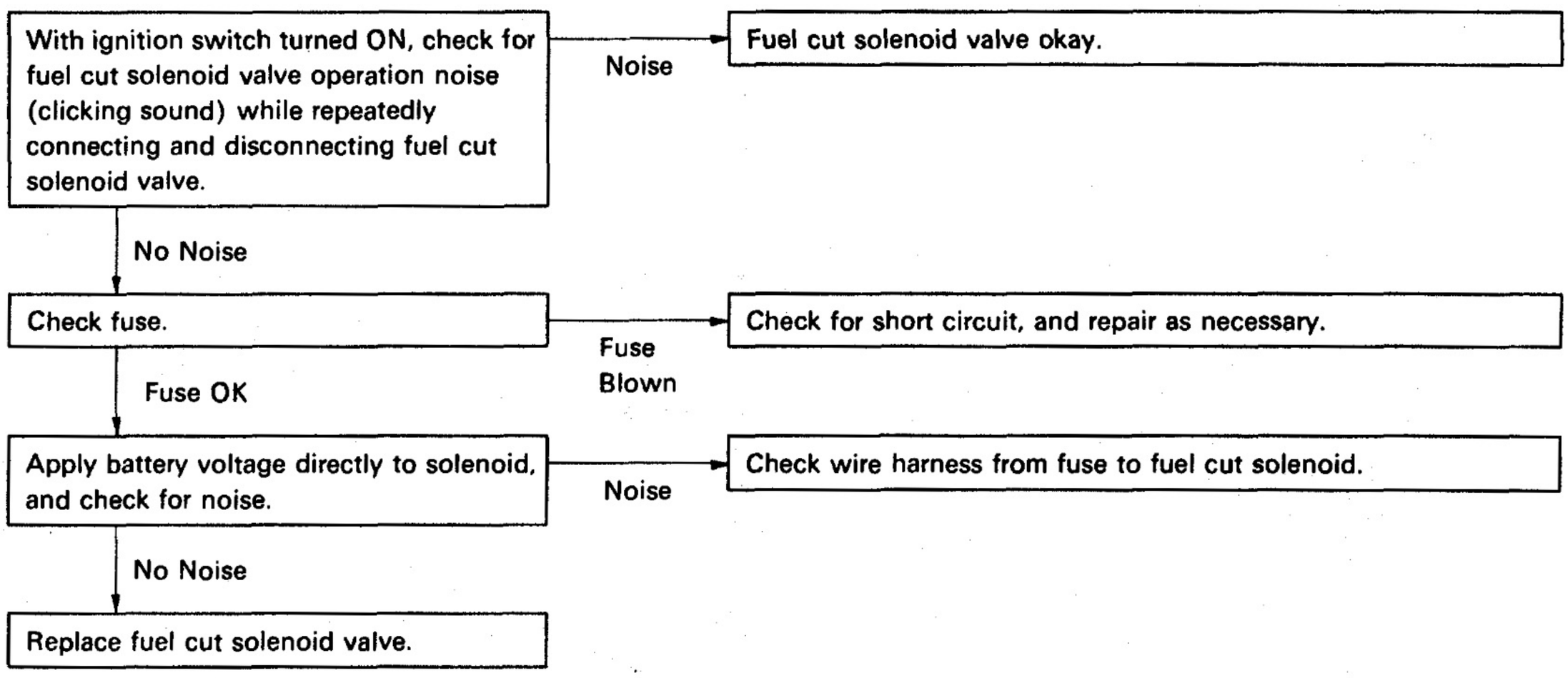
Is there battery voltage to terminal GIND of the ECU or timer (on wire harness side)?

Yes → Replace the ECU or timer.

No → Open circuit in wire harness between terminal GIND of the ECU or timer and indicator light.

V06666

FUEL CUT SOLENOID VALVE



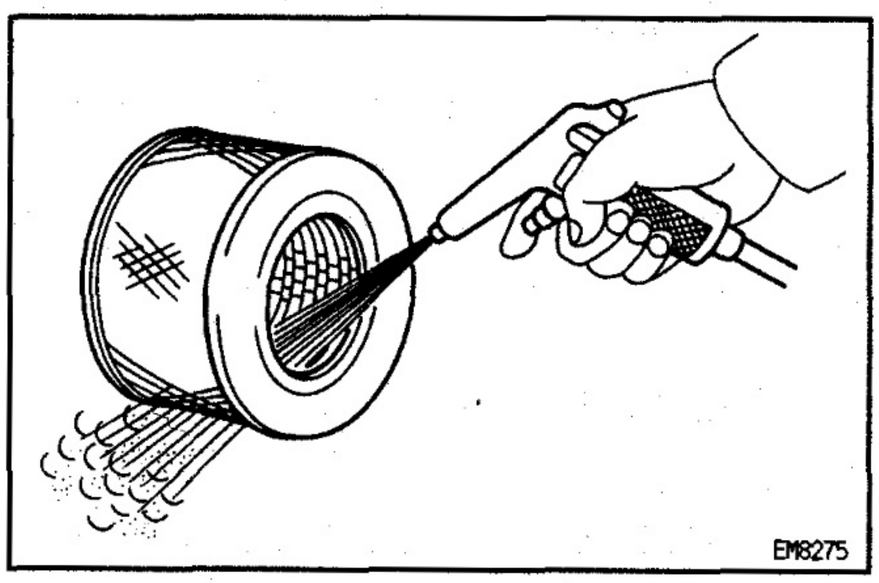
V06663

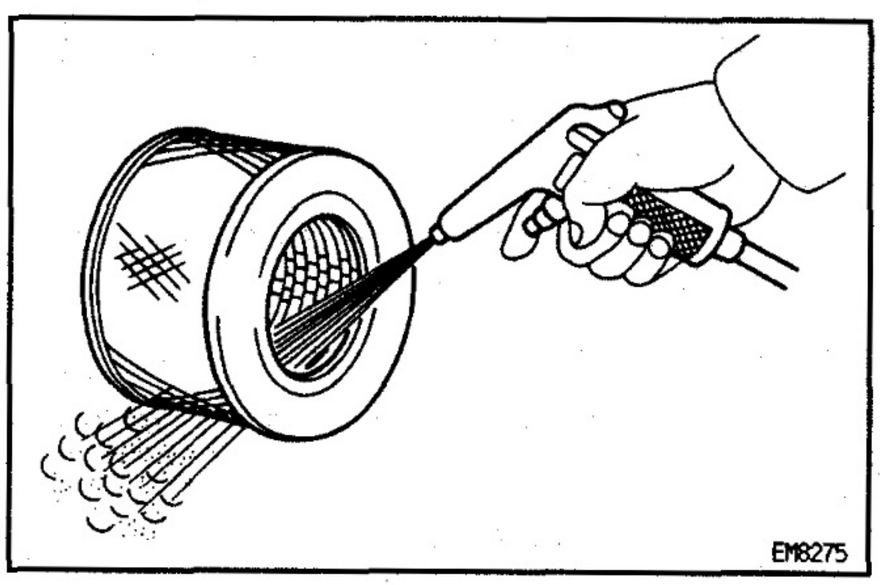
AIR FILTER INSPECTION AND CLEANING

EG34H-02

Paper Filter Type:

1. **REMOVE AIR FILTER**
2. **INSPECT AIR FILTER**
   Visually check that the filter element is not excessively dirty, damaged or oily.
3. **CLEAN AIR FILTER**
   Clean the filter element with compressed air.
   First blow from the inside thoroughly. Then blow off the outside of the filter element.
4. **REINSTALL AIR FILTER**

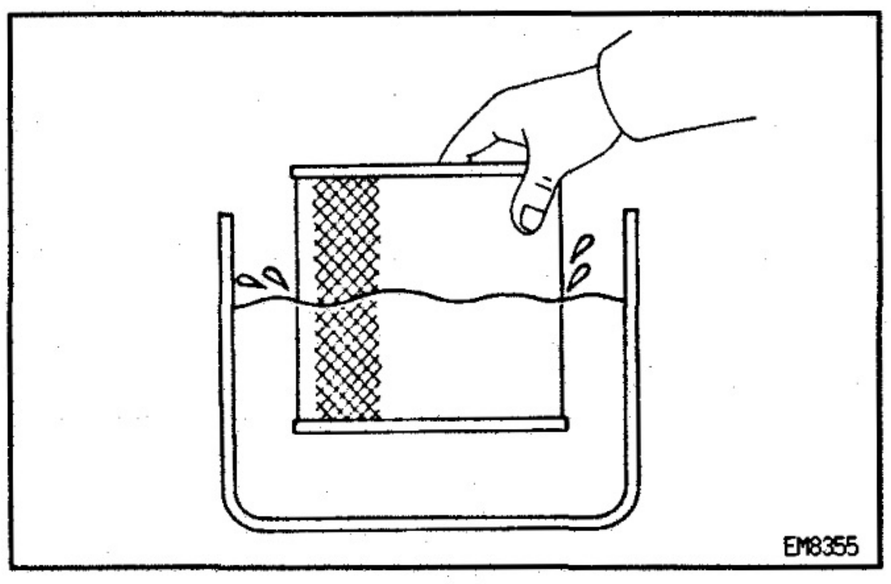




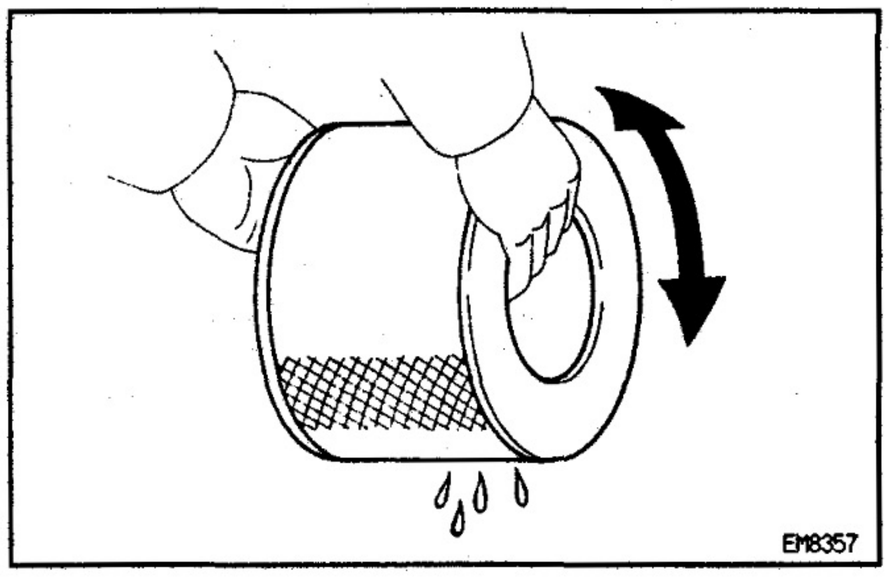
Washable Type:

1. **REMOVE AIR FILTER**
2. **INSPECT AIR FILTER**
   Visually check that the filter element is not excessively dirty, damaged or oily.
3. **CLEAN AIR FILTER**

(a) Blow dirt off in the filter element with compressed air.



(b) Submerge the filter element in the water and agitate it up and down more than 10 times.
(c) Repeat rinsing in clean water until rinsing water is clear.



(d) Remove excess water by shaking the filter element or blowing with compressed air.
NOTICE: Do not beat or drop filter element.
(e) Wipe off dust on the air cleaner case interior.

4. REINSTALL AIR FILTER

COMPRESSION CHECK

EG58J-01

HINT: If there is lack of power, excessive oil consumption or poor fuel economy, measure the compression pressure.

1. WARM UP AND STOP ENGINE
Allow the engine to warm up to normal operating temperature.

2. REMOVE CYLINDER HEAD COVER
(See steps 2 or 3 and 11 in cylinder head removal)

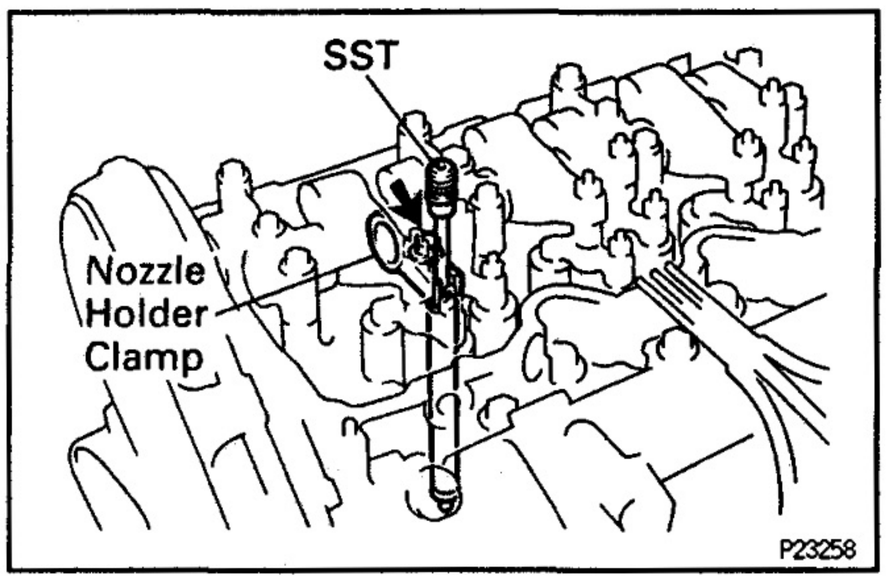
3. REMOVE INJECTION PIPES
(See steps 3 and 5 in injection nozzles removal in Fuel System)

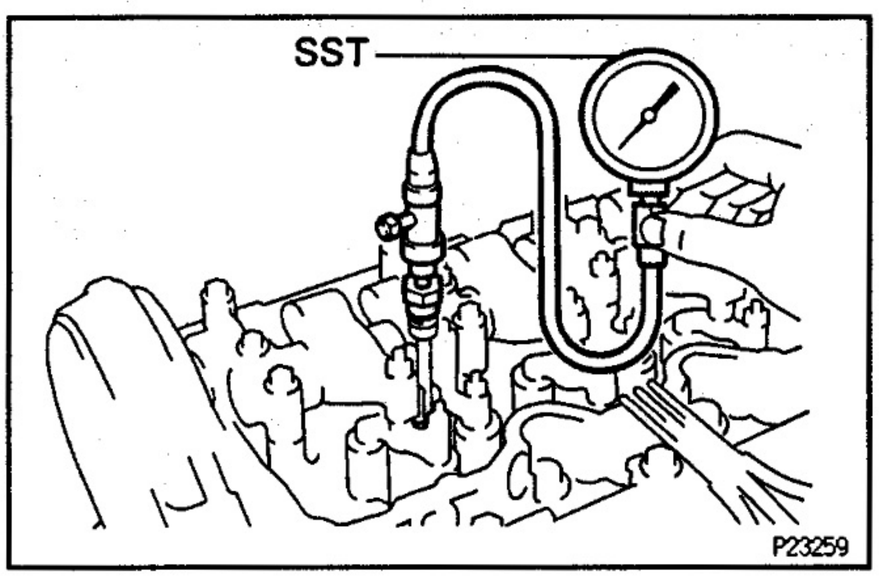
4. REMOVE NO.1 NOZZLE LEAKAGE PIPE
(See step 4 in injection nozzles removal in Fuel System)

5. DISCONNECT INJECTION PUMP (FUEL CUT SOLENOID) CONNECTOR

6. CHECK CYLINDER COMPRESSION PRESSURE
NOTICE: When measuring the compression pressure of each, the other 5 injection nozzles must be installed in the cylinder head.

(a) Remove the injection nozzle.
(See steps 6 and 7 in injection nozzles removal in Fuel System)
(b) Install the gasket and SST (attachment) to the injection nozzle hole with the nozzle holder clamp and bolt.
SST 09992–00400
Torque: 25 N·m (255 kgf·cm, 18 ft·lbf)





(c) Connect SST (compression gauge) to the SST (attachment).
SST 09992–00024 (09992–00160)

(d) While cranking the engine, measure the compression pressure.
HINT: Always use a fully charged battery to obtain engine revolution of 250 rpm or more.

(e) Repeat steps (b) through (d) for each cylinder.
NOTICE: This measurement must be done in as short a time as possible.
Compression pressure:
3,432 kPa (35.0 kgf/cm², 498 psi) or more
Minimum pressure:
2,452 kPa (25.0 kgf/cm², 356 psi)
Difference between each cylinder:
490 kPa (5.0 kgf/cm², 71 psi) or less

(f) If the cylinder compression in one or more cylinders is low, pour a small amount of engine oil into the cylinder through the injection nozzle hole and repeat steps (b) through (d) for the cylinder with low compression.
- If adding oil helps the compression, chances are that the piston rings and/or cylinder bore are worn or damaged.
- If pressure stays low, a valve may be sticking or seating improperly, or there may be leakage past the gasket.

(g) Remove the SST.
SST 09992–00400, 09992–00024 (09992–00160)

(h) Reinstall the injection nozzle.
(See steps 1 and 2 in injection nozzles installation in Fuel System)

7. RECONNECT INJECTION PUMP (FUEL CUT SOLENOID) CONNECTOR

8. REINSTALL NO.1 NOZZLE LEAKAGE PIPE
(See step 4 in injection nozzle installation in Fuel System)

9. REINSTALL INJECTION PIPES
(See steps 3 and 5 in injection nozzles installation in Fuel System)

10. REINSTALL CYLINDER HEAD COVER
(See steps 10 and 18 or 19 in cylinder head installation)

11. START ENGINE AND CHECK FOR LEAKS

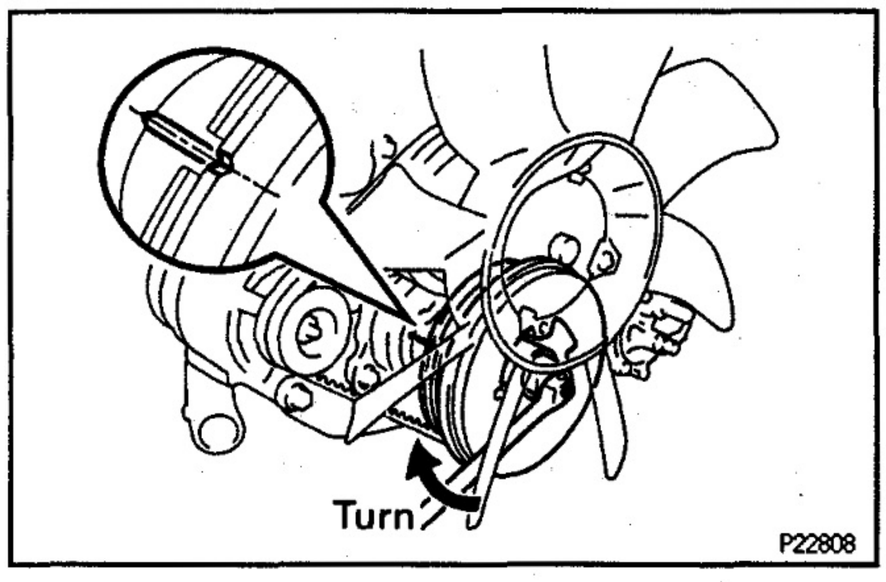
EG

VALVE CLEARANCE INSPECTION AND ADJUSTMENT

EG58K-01

HINT: Inspect and adjust the valve clearance when the engine is cold.

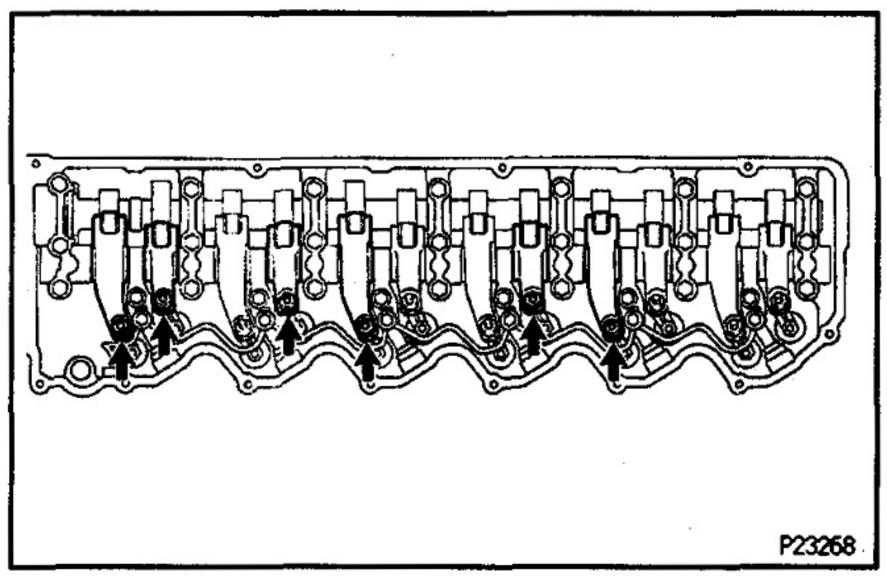
1. REMOVE CYLINDER HEAD COVER
(See steps 2 or 3 and 11 in cylinder head removal)



2. SET NO.1 CYLINDER TO TDC/COMPRESSION

(a) Turn the crankshaft pulley clockwise, and align its groove with the groove of the timing gear cover.

(b) Check that the valve rocker arm on the No.1 cylinder are loose and valve rocker arm on the No.6 cylinder are tight.
If not, turn the crankshaft 1 revolution (360°) and align the mark as above.



3. INSPECT VALVE CLEARANCE

(a) Check only the valves indicated in the illustration.
- Using a feeler gauge, measure the clearance between the adjusting screw on the valve rocker arm and the valve bridge.
- Record the out — of — specification valve clearance measurements.

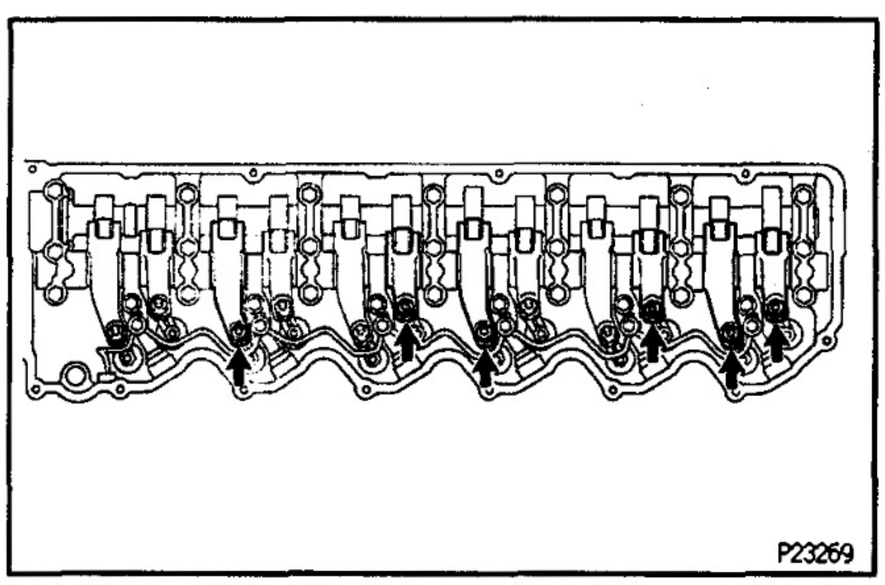
Valve clearance (Cold):

Intake

0.17 — 0.23 mm (0.007 — 0.009 in.)

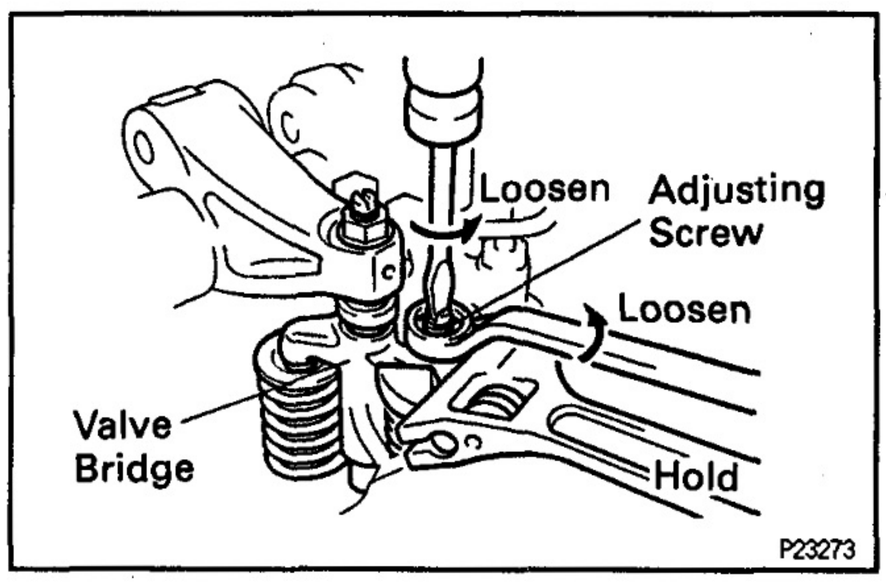
Exhaust

0.47 — 0.53 mm (0.019 — 0.021 in.)



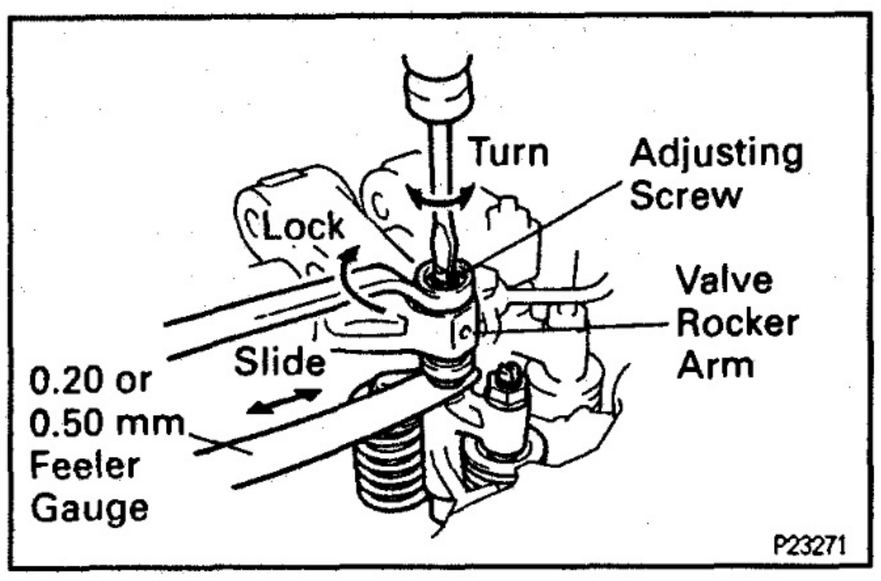
(b) Turn the crankshaft pulley 1 revolution (360°) and align the mark as above. (See procedure step 2)

(c) Check only the valves indicated as shown. Measure the valve clearance. (See procedure in step (a))

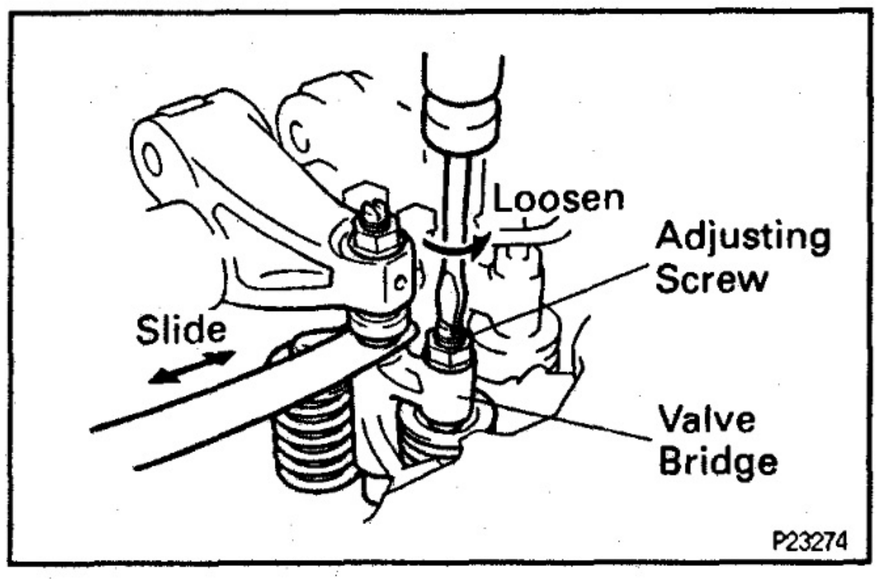


4. ADJUST VALVE CLEARANCE

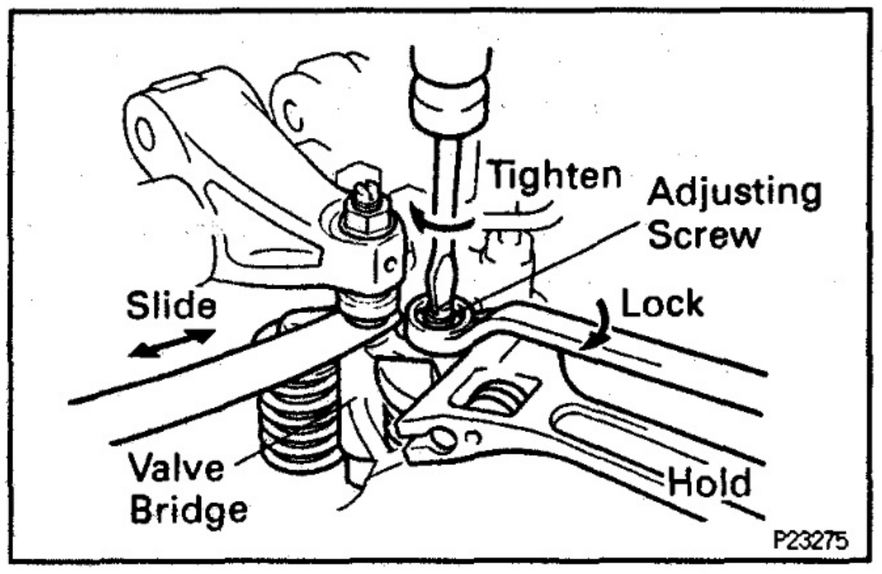
(a) Loosen the lock nut on the valve bridge, and loosen the adjusting screw until the adjusting screw and valve stem are completely separated.
NOTICE: Hold the valve bridge with a wrench, and loosen the lock nut. Do not apply torque to the valve bridge.



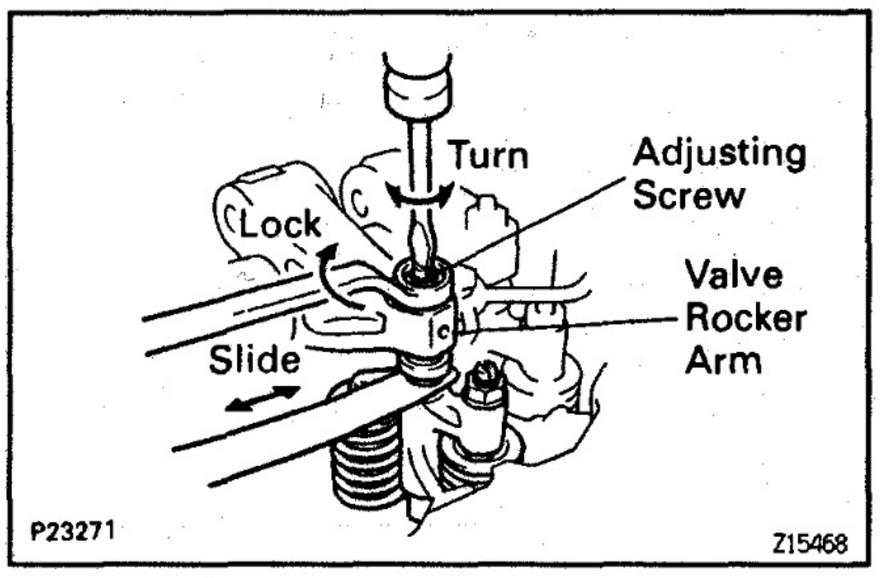
(b) Loosen the lock nut on the valve rocker arm, and loosen the adjusting screw.
(c) Insert a 0.20 mm (0.008 in.) feeler gage for intake or 0.50 mm (0.020 in.) feeler gage for exhaust between the adjusting screw on the valve rocker arm and the valve bridge.
(d) Turn the adjusting screw on the valve rocker arm until the feeler gauge slides with a very slight drag, and lock the adjusting screw with the lock nut.



(e) With the feeler gauge inserted, check that the resistance of the feeler gauge remains the same when the adjusting screw on the valve bridge is loosened.
If the resistance of the feeler gauge changes, repeat from step (b).

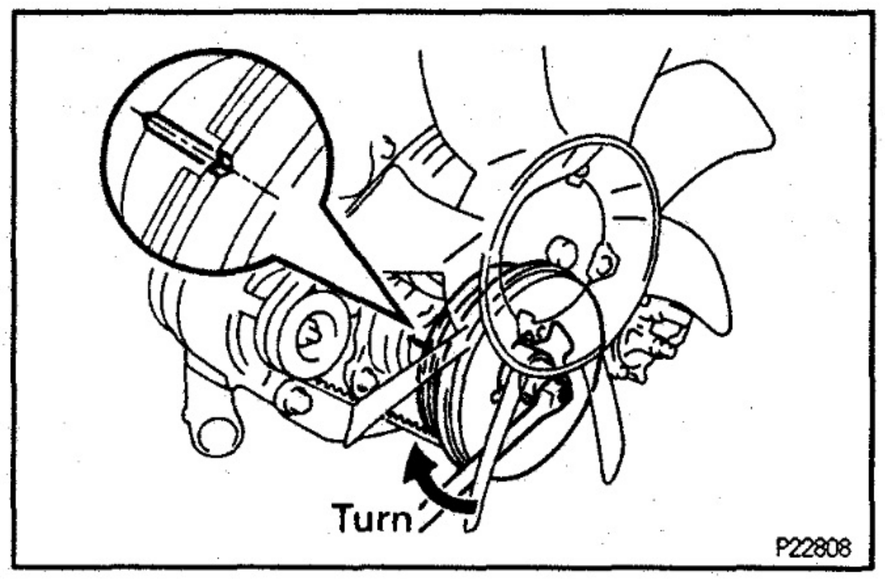


(f) Tighten the adjusting screw on the valve bridge, and lock the adjusting screw with the lock nut when the resistance of the feeler gauge begins to get stronger.
NOTICE: Hold the valve bridge with a wrench, and lock the adjusting screw with the lock nut. Do not apply torque to the valve bridge.



(g) Loosen the lock nut on the valve rocker arm.
(h) Turn the adjusting screw on the valve rocker arm until the feeler gauge slides with a very slight drag, and lock the adjusting screw with the lock nut.

5. REINSTALL CYLINDER HEAD COVER
(See steps 10 and 18 or 19 in cylinder head installation)

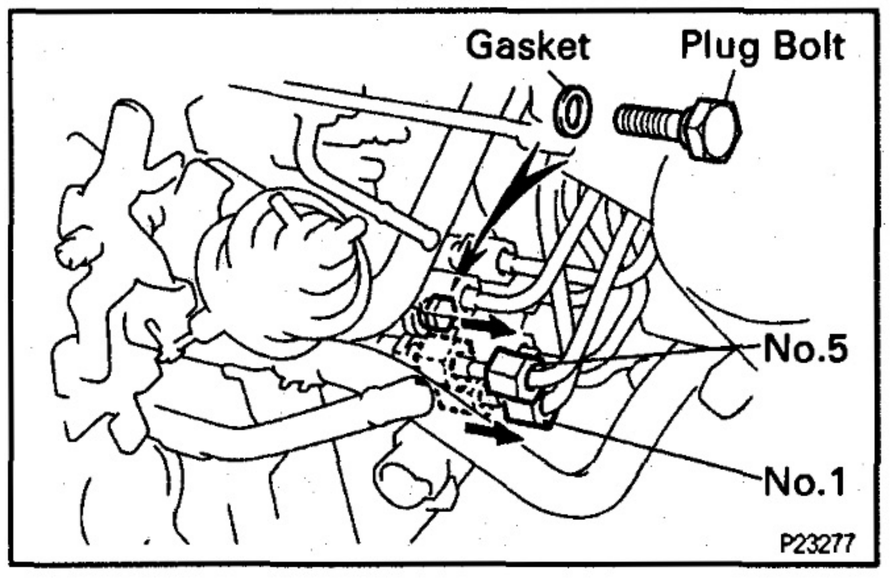


INJECTION TIMING INSPECTION AND ADJUSTMENT

EG6EL-01

1. SET NO.1 OR NO.6 CYLINDER TO TDC/COMPRESSION

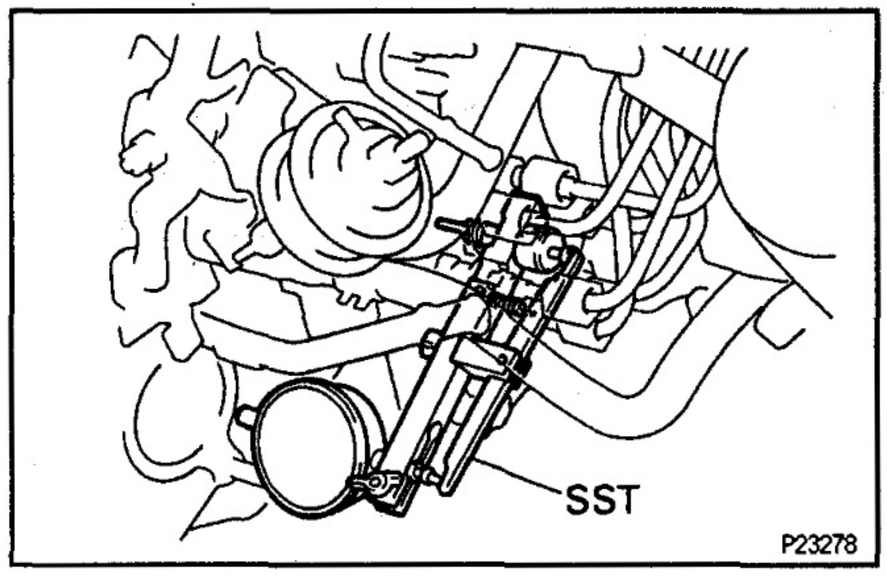
Turn the crankshaft pulley clockwise, and align its groove with the groove of the timing gear cover.



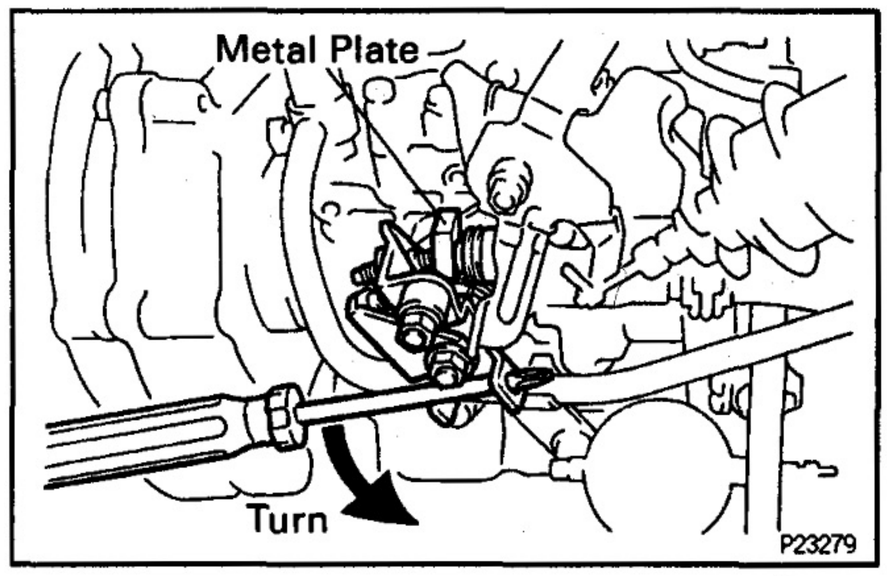
2. INSTALL SST AND DIAL INDICATOR

(a) Remove the plug bolt and gasket from the distributive head plug of the injection pump.

(b) Loosen the 2 union nuts holding the injection pump to the No.1 and No.5 injection pipes, and slide the 2 union nuts rearward.



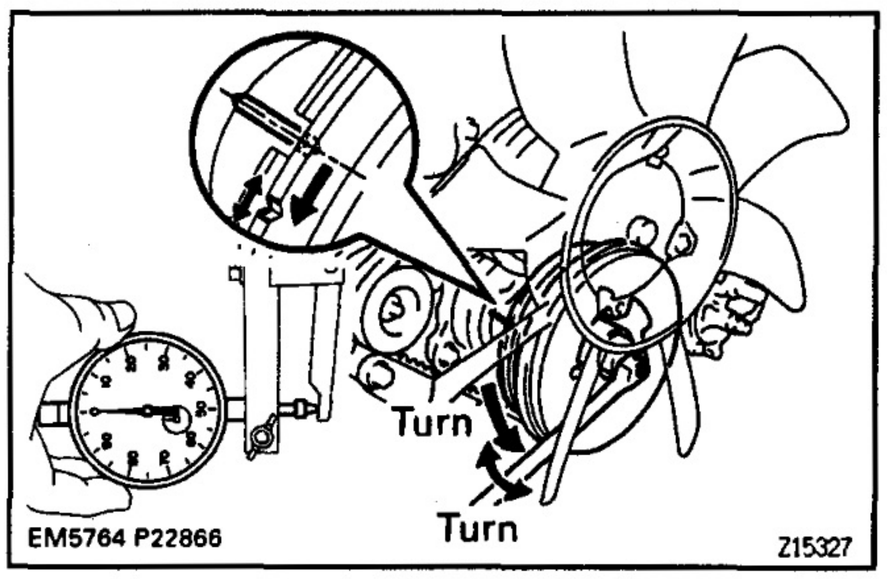
(c) Install SST (plunger stroke measuring tool) and a dial indicator to the plug bolt hole of distributive head plug.
SST 09275–54011



3. RELEASE ACSD ADVANCE

(a) Using a screwdriver, turn the cold starting lever counterclockwise approx. 20°.

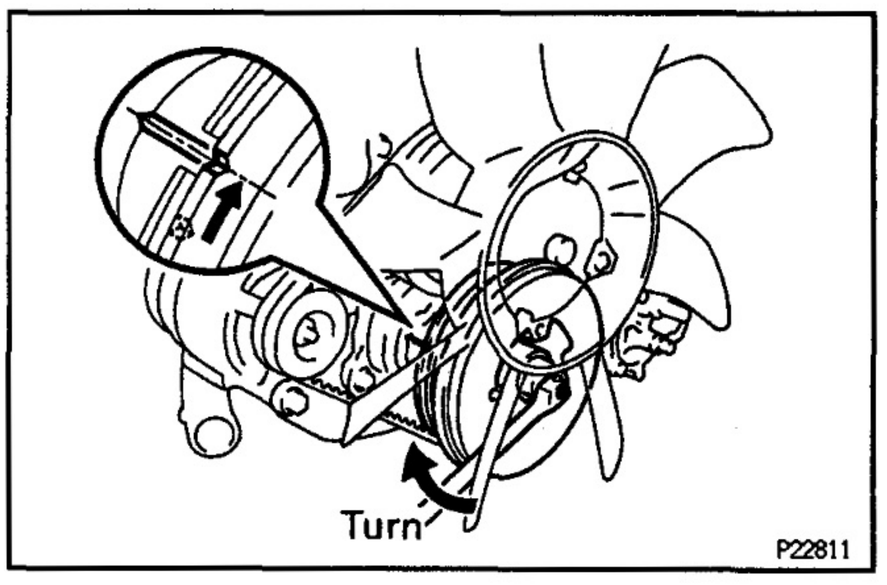
(b) Put a metal plate (thickness of 9.0 – 10.0 mm (0.354 – 0.394 in.)) between the cold starting lever and thermo wax plunger.



4. INSPECT AND ADJUST INJECTION TIMING

(a) Slowly rotate the crankshaft pulley counterclockwise and set the dial indicator at 0 mm (0 in.) when the dial indicator reaches the minimum value.

(b) Turn the crankshaft to the left and right and check that the dial indicator shows the minimum value.
NOTICE: Check that the minimum value is set at 0 mm (0 in.)



(c) Slowly rotate the crankshaft pulley clockwise until its groove is aligned with the groove of the timing gear cover.

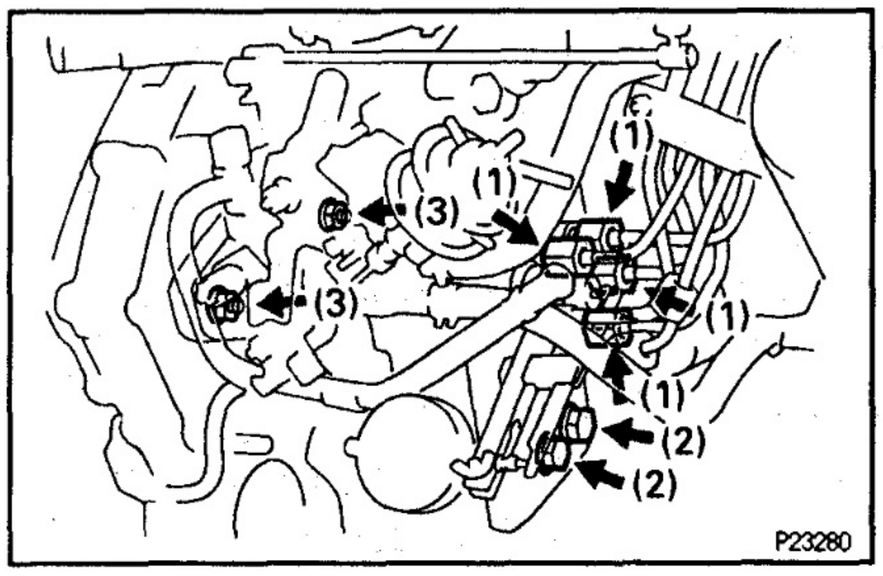
(d) Measure the plunger stroke.
Plunger stroke:

Europe

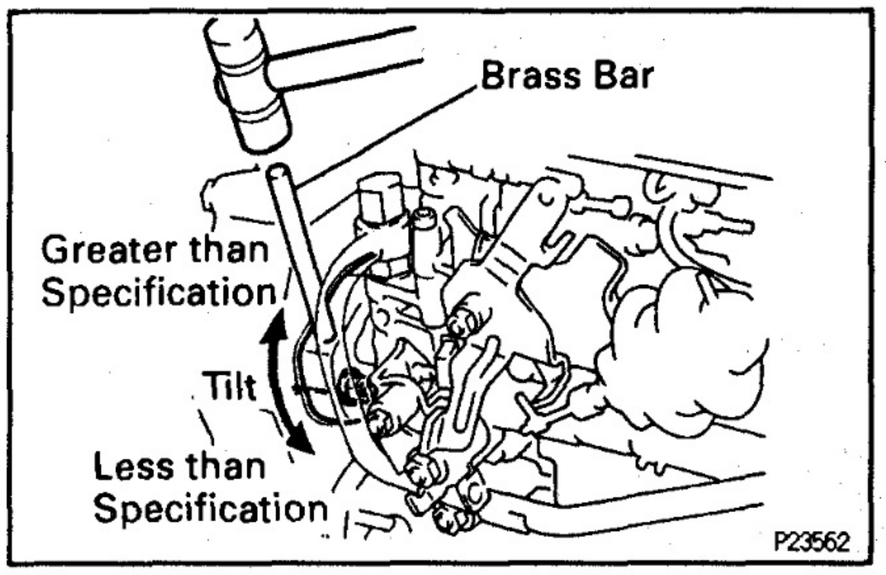
1.52 – 1.58 mm (0.0598 – 0.0622 in.)

Australia

1.37 – 1.43 mm (0.0539 – 0.0563 in.)



(e) Loosen these nuts and bolts:
(1) 4 remaining union nuts holding injection pipes to injection pump
(2) 2 bolts holding injection pump to injection pump stay
(3) 2 nuts holding injection pump to timing gear case
NOTICE: Do not turn the nuts more than 90°.



(f) Adjust plunger stroke by slightly tilting the injection pump body.
If the stroke is less than specification, tilt the pump toward the engine.
If the stroke is greater than specification, tilt the pump away from the engine.
HINT:
- If the stroke is less than specification, move the injection pump toward the engine.
- Using a brass bar and plastic–faced hammer, gradually tap the pump flange away from the engine.

(g) Tighten these nuts and bolts:
- 2 nuts holding injection pump to timing gear case

Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)
- 2 bolts holding injection pump to injection pump stay

Torque: 69 N·m (700 kgf·cm, 51 ft·lbf)

(h) Recheck the plunger stroke.

5. REMOVE METAL PLATE

6. REMOVE SST AND DIAL INDICATOR

(a) Remove the SST and dial indicator.
SST 09275–54011

(b) Install a new gasket and the plug bolt of the distributive head plug.
Torque: 25.5 N·m (260 kgf·cm, 19 ft·lbf)

7. TIGHTEN INJECTION PIPE UNION NUTS
Torque: 24.5 N·m (250 kgf·cm, 18 ft·lbf)

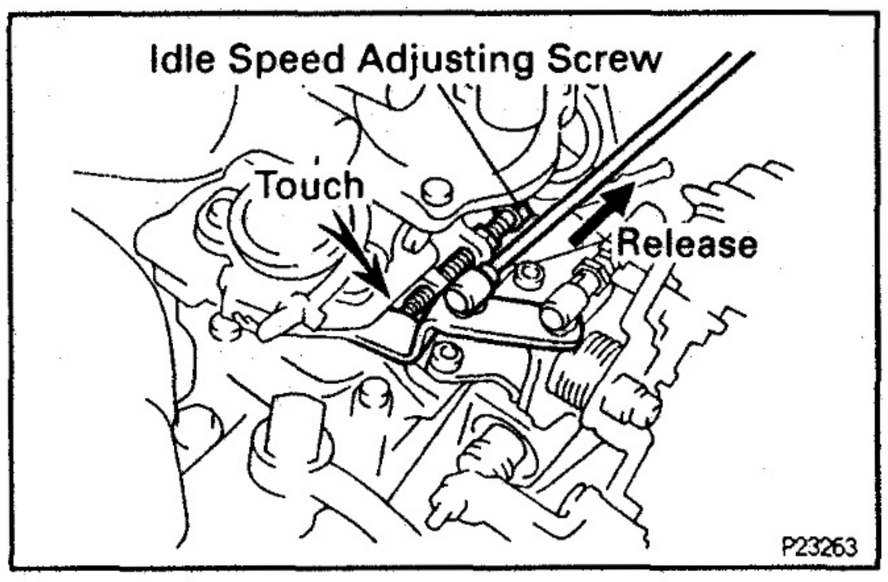
8. START ENGINE AND CHECK FOR FUEL LEAKS

IDLE SPEED AND MAXIMUM SPEED INSPECTION AND ADJUSTMENT

S08TH–01

1. INITIAL CONDITIONS

(a) Engine at normal operating temperature
(b) Air cleaner installed
(c) All accessories switched OFF
(d) All vacuum lines properly connected
(e) Valve clearance set correctly



(f) Injection timing set correctly

(g) A/T:
Transmission in neutral position

(h) M/T:
Steering wheel at straight—ahead position

2. CONNECT TACHOMETER

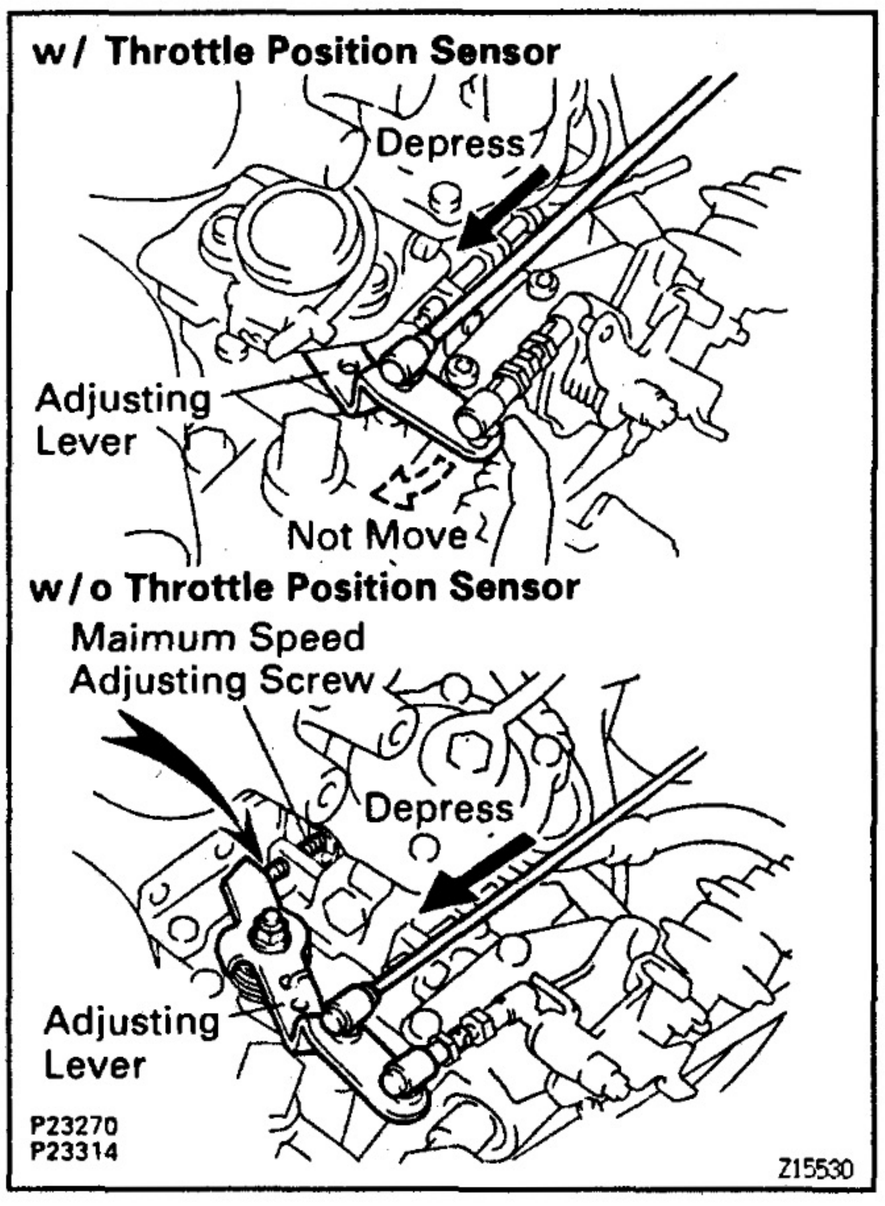
3. CHECK AND ADJUST IDLE SPEED

(a) Check that the adjusting lever touches the idle speed adjusting screw when the accelerator pedal is released.
If not, adjust the accelerator linkage.

(b) Start the engine.

(c) Check the idle speed.
Idle speed:
M/T
700 ± 50 rpm
A/T
800 ± 50 rpm

(d) Adjust the idle speed.
- Disconnect the accelerator linkage.
- Loosen the lock nut of the idle speed adjusting screw.
- Adjust the idle speed by turning the idle speed adjusting screw.
- Securely tighten the lock nut, and recheck the idle speed.
- Reconnect the accelerator linkage.
- After adjustment, adjust the accelerator linkage.



4. CHECK AND ADJUST MAXIMUM SPEED

(a) w/ Throttle Position Sensor:
Depress the accelerator pedal all the way. Then check that the adjusting lever does not move when you try to push it to the maximum speed side.
If not, adjust the accelerator linkage.

(b) w/o Throttle Position Sensor:
Ckeck that the adjusting lever touches the maximum speed adjusting screw when the accelerator pedal is depressed all the way.
If not, adjust the accelerator linkage.

(c) Start the engine.

(d) Depress the accelerator pedal all the way.

(e) Check the maximum speed.
Maximum speed:
4,400 ± 100 rpm
If the maximum speed is not as specified, remove the injection pump and adjust the maximum speed.
(See injection pump adjustment in Fuel System)

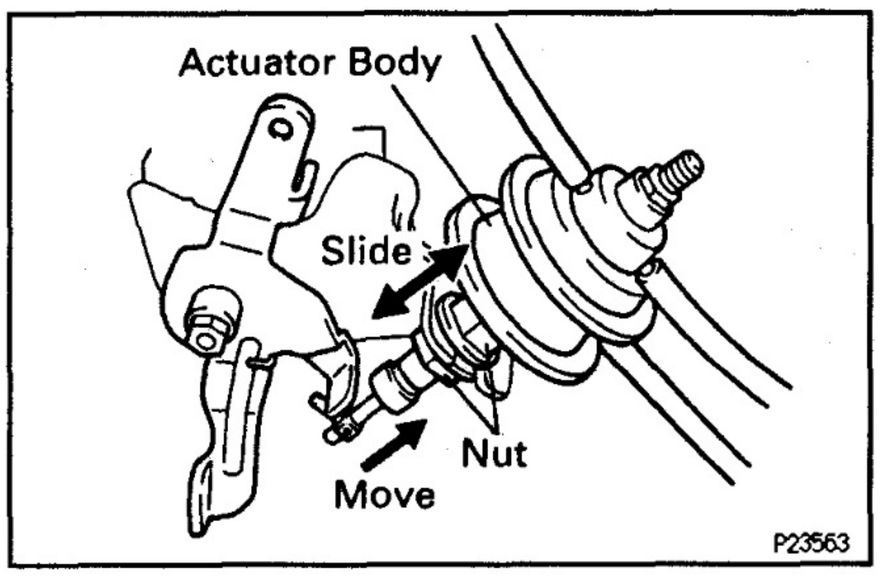
PS IDLE—UP SPEED INSPECTION AND ADJUSTMENT (M/T)

EGSTK—01

1. INITIAL CONDITIONS

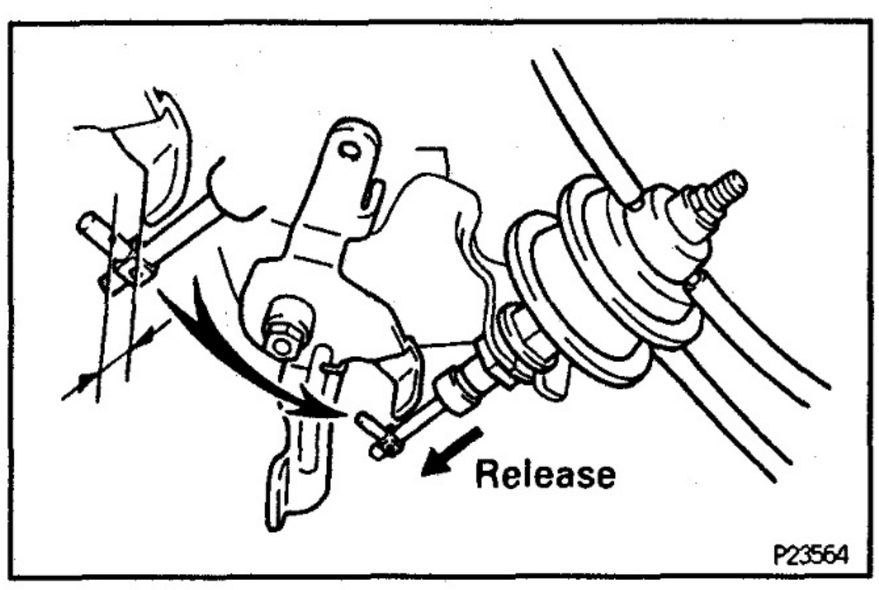
(a) Engine at normal operating temperature
(b) Air cleaner installed
(c) All accessories switched OFF
(d) All vacuum lines properly connected
(e) Valve clearance set correctly
(f) Injection timing set correctly
(g) A/T:
Transmission in neutral position
(h) Idle speed set correctly

2. CONNECT TACHOMETER



3. ADJUST PS IDLE—UP SPEED

(a) Start the engine.
(b) Turn the steering wheel from the straight—ahead position to full left or full right position.
(c) Check the idle—up speed.
PS idle—up speed:
650 — 750 rpm
(d) Loosen the 2 nuts, and adjust the idle—up setting speed by sliding the idle—up actuator body. Lock the idle—up actuator with the 2 nuts.
(e) Return the steering wheel to the straight—ahead position. Then turn the steering wheel from the straight—ahead position to full left or full right position, and recheck the idle—up speed.



(f) Return the steering wheel to the straight—ahead position, and check that the rod end of the idle—up actuator is not touching the idle—up lever.
(g) Check and adjust the A/C idle—up speed.
(See step 3 in A/C idle—up speed inspection and adjustment)
NOTICE: After adjusting the PS idle—up speed, always check the A/C idle—up speed.

EG

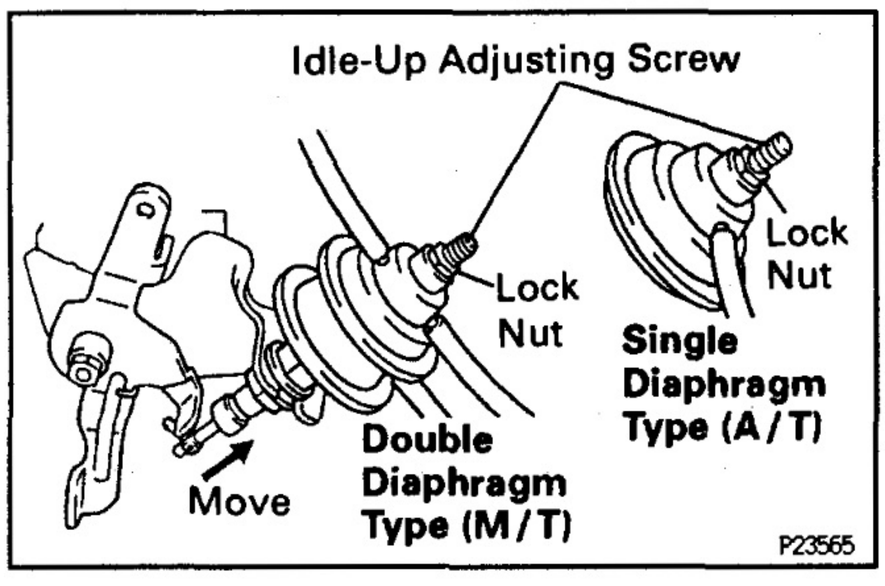
A/C IDLE—UP SPEED INSPECTION AND ADJUSTMENT

EG8TJ—01

1. INITIAL CONDITIONS

(a) Engine at normal operating temperature
(b) Air cleaner installed
(c) All accessories switched OFF
(d) All vacuum lines properly connected
(e) Valve clearance set correctly
(f) Injection timing set correctly
(g) A/T:
Transmission in neutral position
(h) M/T:
Steering wheel at straight—ahead position
(i) Idle speed set correctly
(j) M/T:
PS idle—up speed correctly

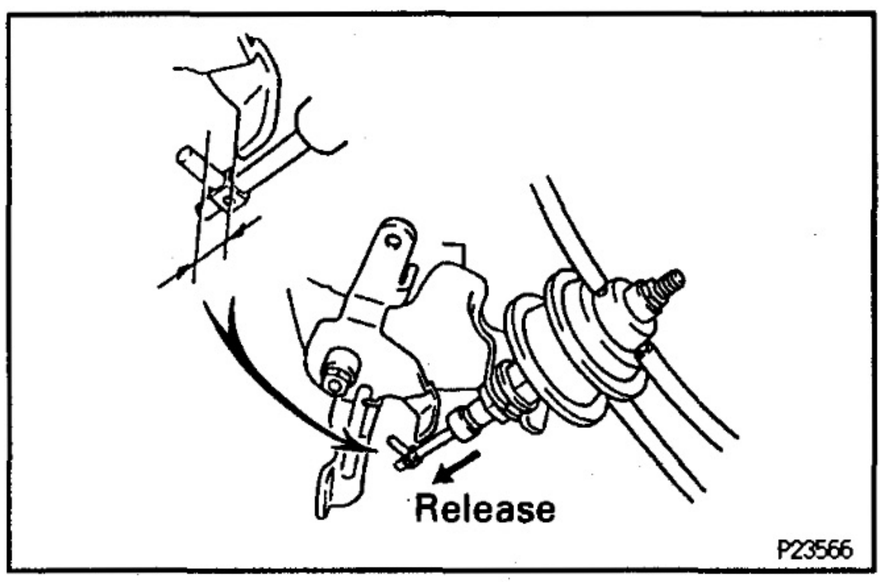
2. CONNECT TACHOMETER



3. ADJUST A/C IDLE—UP SPEED

(a) Start the engine.
(b) Turn the A/C switch ON, and set these position:
- Blower switch to HI
- Air intake control lever to RECIRCULATED AIR
- Air flow control lever to FACE
- Temperature control lever to COOL

(c) Check the idle—up speed.
A/C idle—up speed:
775 — 850 rpm
(d) Loosen the lock nut, and adjust the idle—up setting speed by turning the idle—up speed adjusting screw. Lock the adjusting screw with the lock nut.
(e) Turn the A/C switch OFF, then ON again, and recheck the idle—up speed.

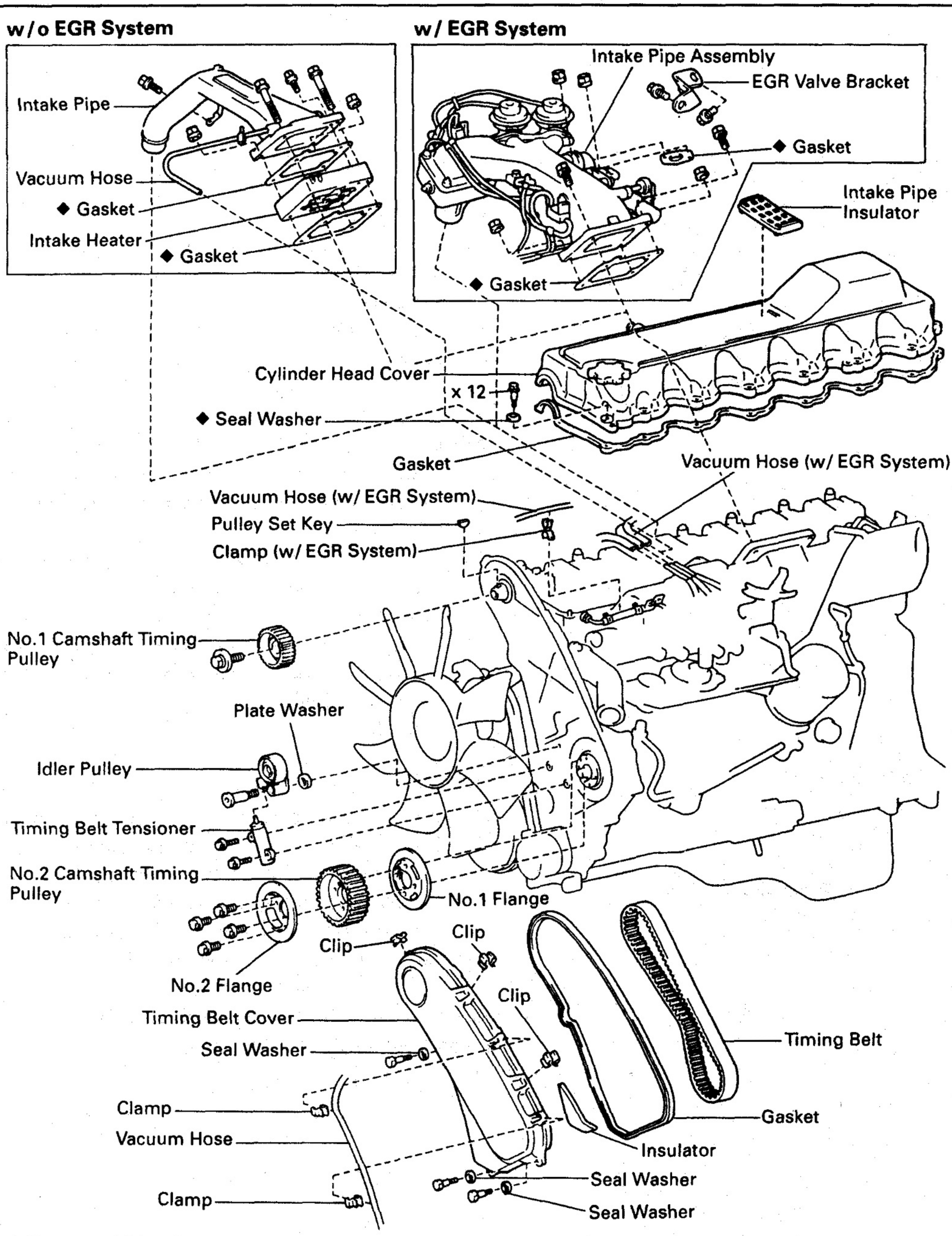


(f) Turn the A/C switch OFF, and check that the rod end of the idle—up actuator is not touching the idle—up lever.

TIMING BELT

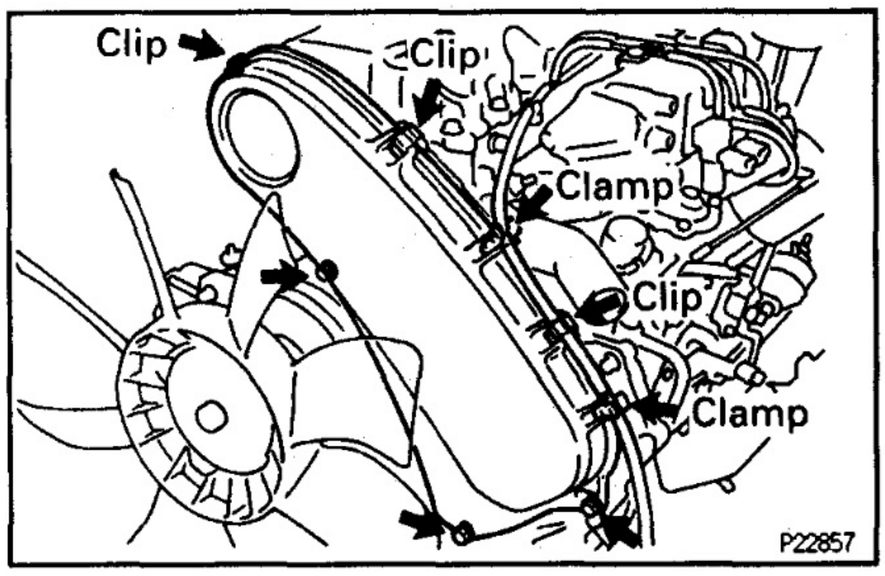
COMPONENTS FOR REMOVAL AND INSTALLATION

EG17P-04



EG5R9-01

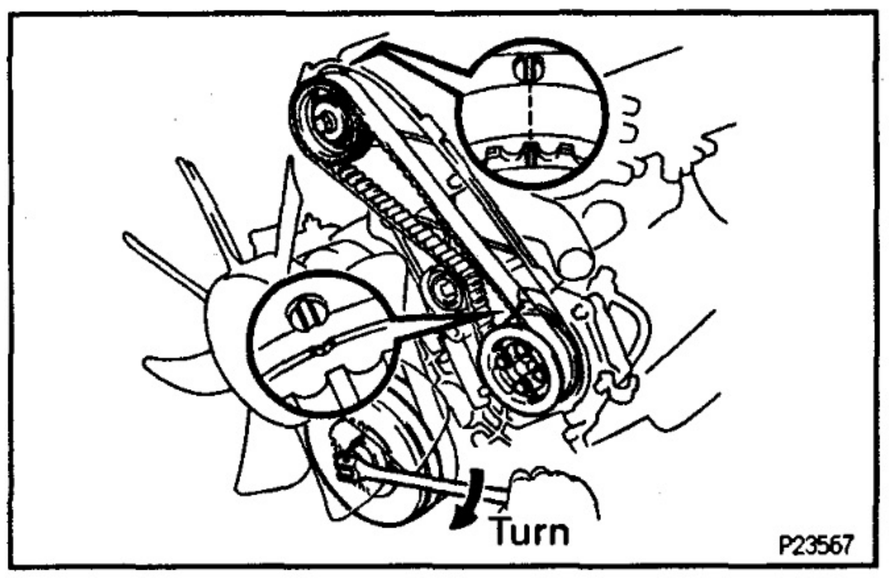
HINT: If replacing the timing belt before the timing belt warning light comes on, (light comes on after 100,000 km (60,000 miles) of driving), be sure to reset the timing belt counter of the speedometer to zero.



TIMING BELT REMOVAL

1. REMOVE TIMING BELT COVER

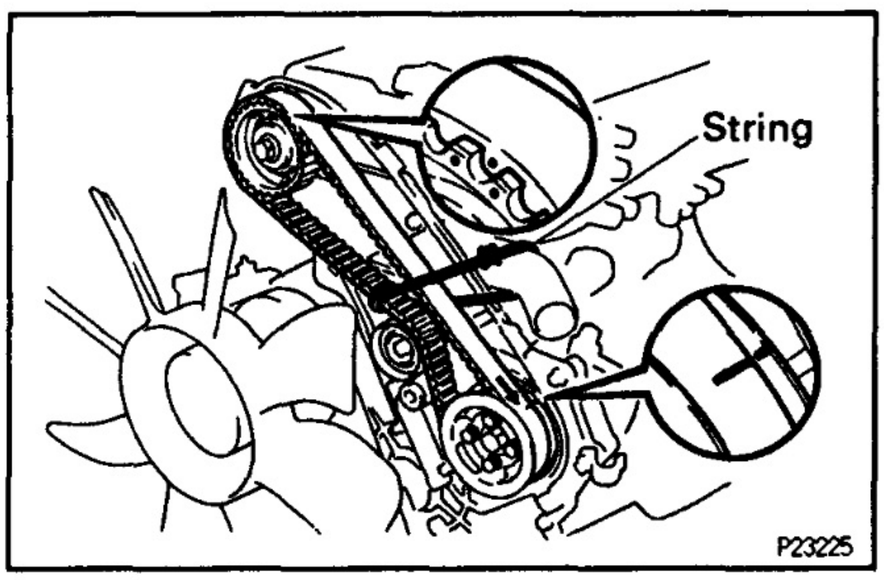
(a) Disconnect the vacuum hose from the 2 clamps on the timing belt cover.
(b) Remove the 3 clips.
(c) Remove the 3 bolts, 3 seal washers and timing belt cover, gasket and insulator.



2. SET NO.1 CYLINDER TO BDC/COMPRESSION

Turn the crankshaft pulley clockwise, align the timing marks of the No.1 and No.2 camshaft timing pulleys with the BDC marks.

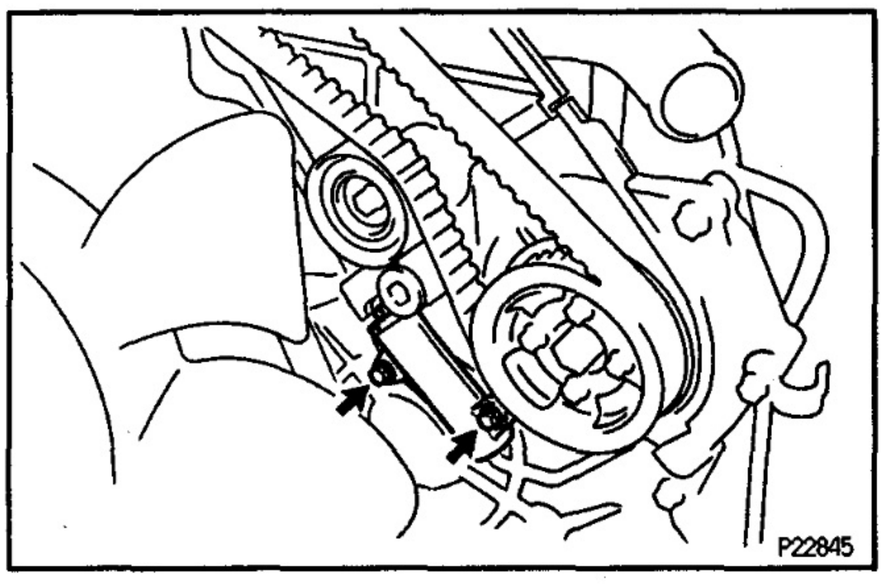
NOTICE: If the timing belt is disengaged, having the crankshaft pulley at the wrong angle can cause the piston head and valve head to come into contact with each other when you remove the camshaft timing pulley (step 8), causing damage. So always set the crankshaft pulley at the correct angle.



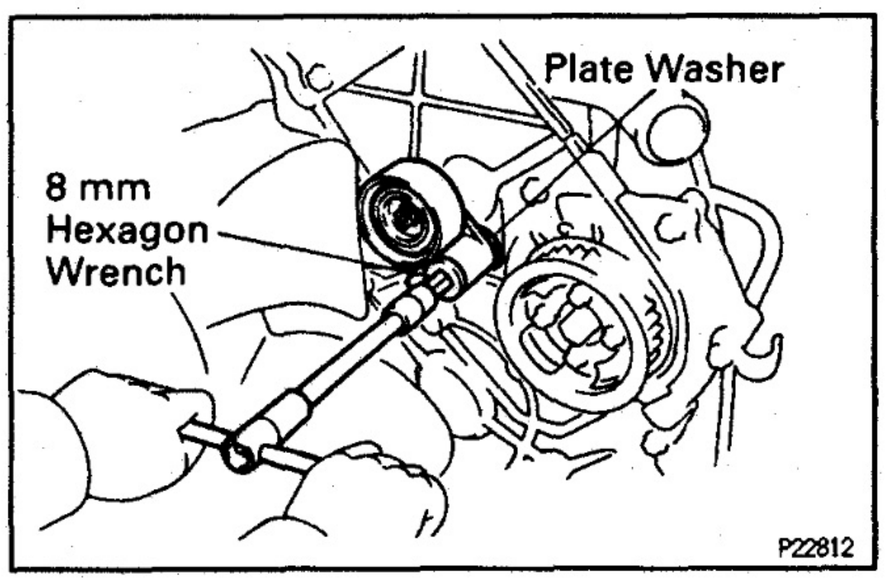
3. REMOVE TIMING BELT

HINT:

- When re—using timing belt:
  Draw a direction arrow on the timing belt (in the direction of engine revolution), and place match-marks on the timing pulleys and timing belt.
- When replacing timing belt tensioner only:
  To avoid meshing of the timing pulley and timing belt, secure one of them with string.

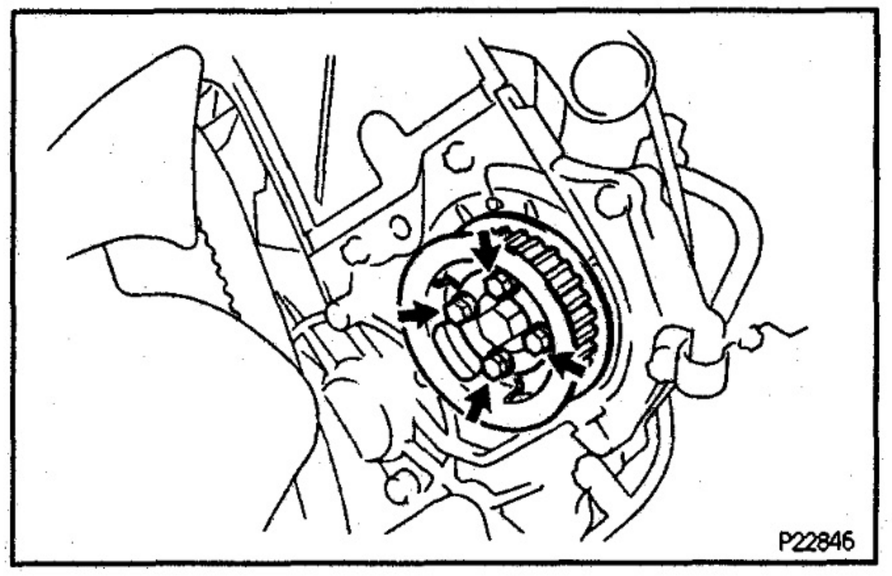


(a) Alternately loosen the 2 bolts, and remove them and the timing belt tensioner.
(b) Remove the timing belt.



4. REMOVE IDLER PULLEY

Using an 8 mm hexagon wrench, remove the pivot bolt, idler pulley and plate washer.

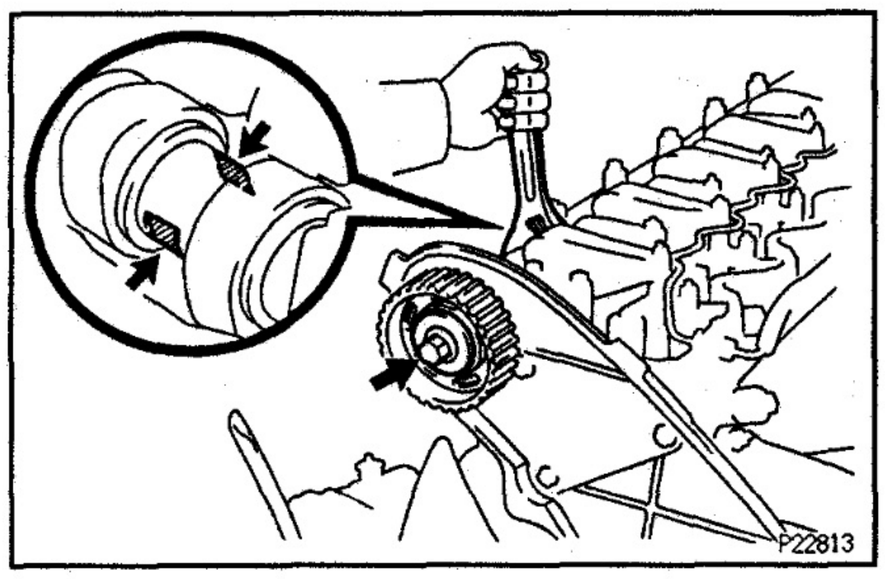


5. REMOVE NO.2 CAMSHAFT TIMING PULLEY

Remove the 4 bolts, No.2 flange, timing pulley and No.1 flange.

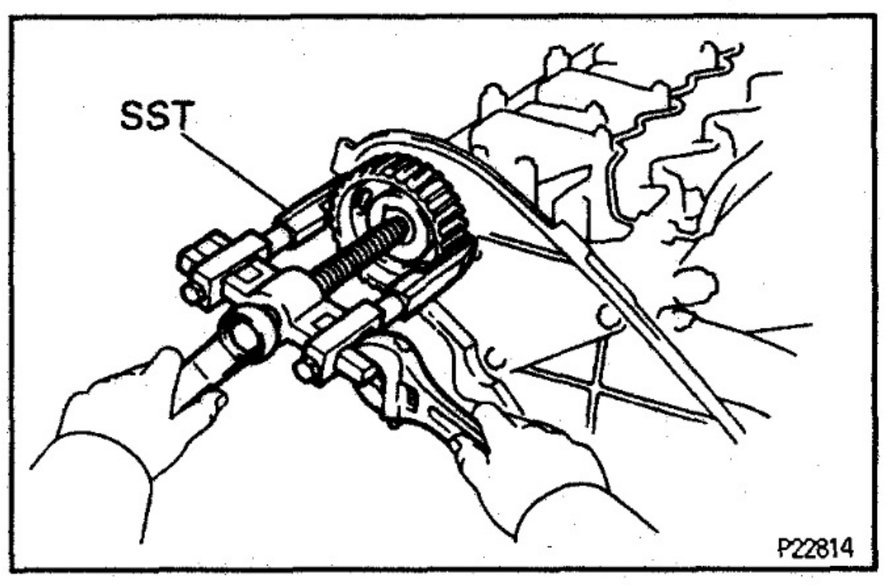
6. REMOVE CYLINDER HEAD COVER

(See steps 2 or 3 and 11 in cylinder head removal)



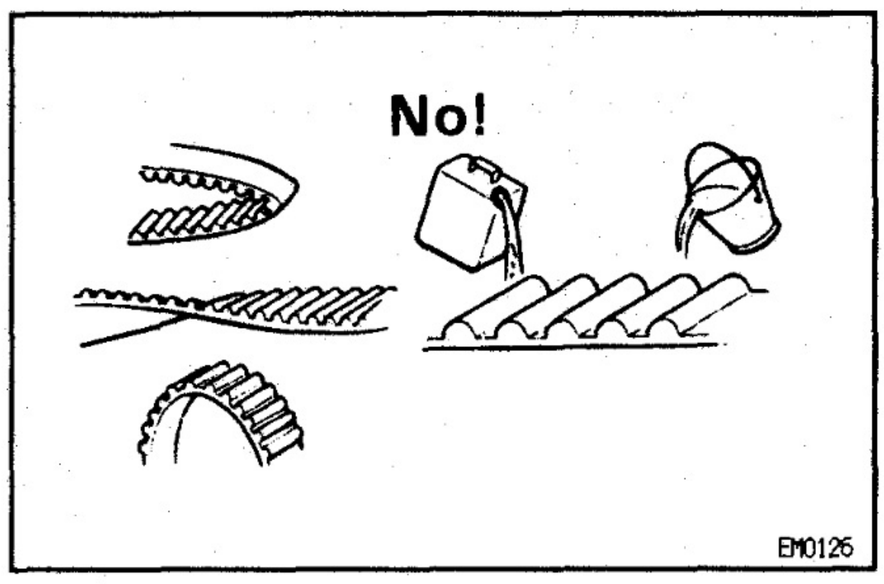
7. REMOVE NO.1 CAMSHAFT TIMING PULLEY

(a) Slightly turn the camshaft timing pulley counterclockwise and hold the hexagon wrench head portion of the camshaft with a wrench, and remove the bolt and timing pulley.



(b) Using SST, remove the timing pulley.
SST 09950–40010 (09951–04010, 09952–04010, 09953–04020, 09954–04010, 09955–04060)

(c) Remove the set key.



TIMING BELT COMPONENTS INSPECTION EGBRA–01

1. INSPECT TIMING BELT

NOTICE:

- **Do not bend, twist or turn the timing belt inside out.**
- **Do not allow the timing belt to come into contact with oil, water or steam.**

- **Do not utilize timing belt tension when installing or removing the mount bolt of the camshaft timing pulley.**

If there are any defects, as shown in the illustrations, check these points:

(a) Premature parting
- Check for proper installation.
- Check the timing cover gasket for damage and proper installation.

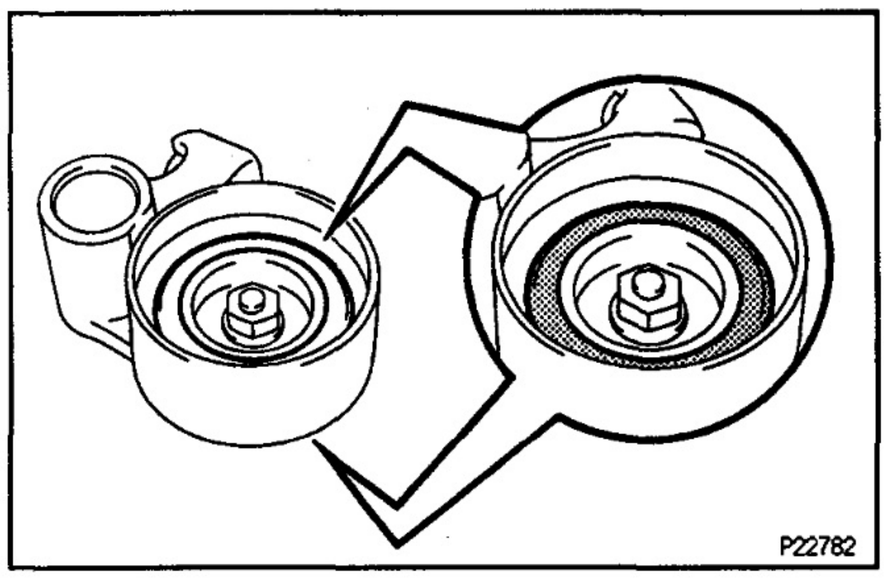
(b) If the belt teeth are cracked or damaged, check to see if either camshaft is locked.

(c) If there is noticeable wear or cracks on the belt face, check to see if there are nicks on the side of the idler pulley lock.

(d) If there is wear or damage on only one side of the belt, check the belt guide and the alignment of each pulley.

(e) If there is noticeable wear on the belt teeth, check timing cover for damage and check gasket has been installed correctly and for foreign material on the pulley teeth.

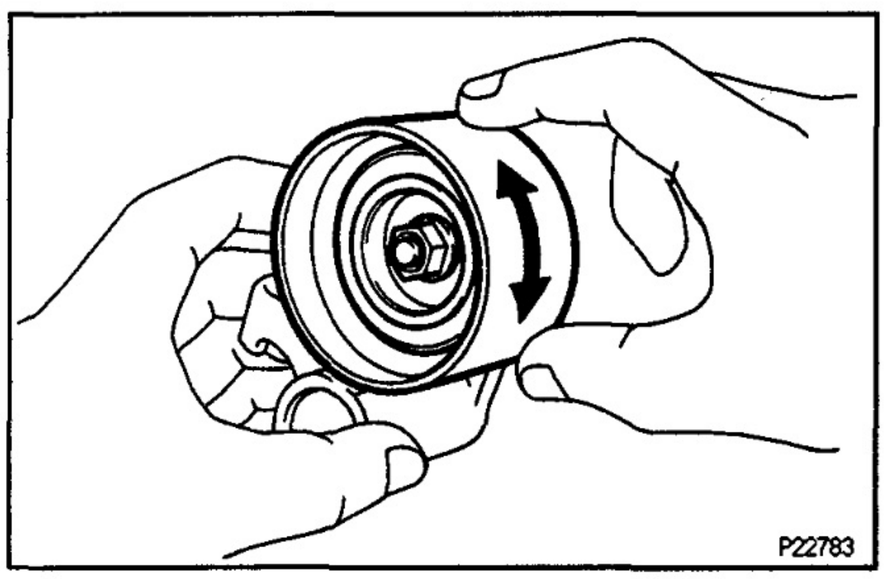
If necessary, replace the timing belt.


P22782

2. INSPECT IDLER PULLEY

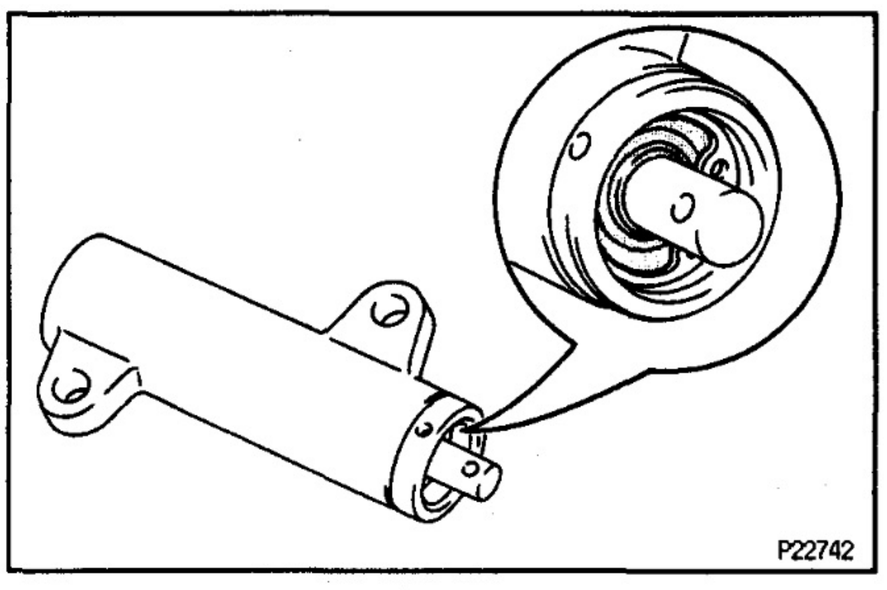
(a) Visually check the seal portion of the idler pulley for oil leakage.

If leakage is found, replace the idler pulley.


P22783

(b) Check that the idler pulley turns smoothly.

If necessary, replace the idler pulley.

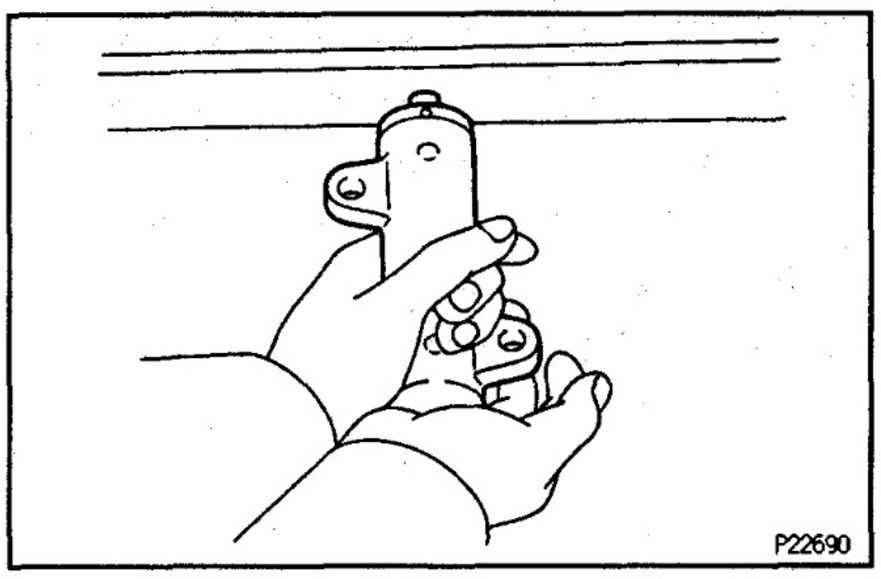

P22742

3. INSPECT TIMING BELT TENSIONER

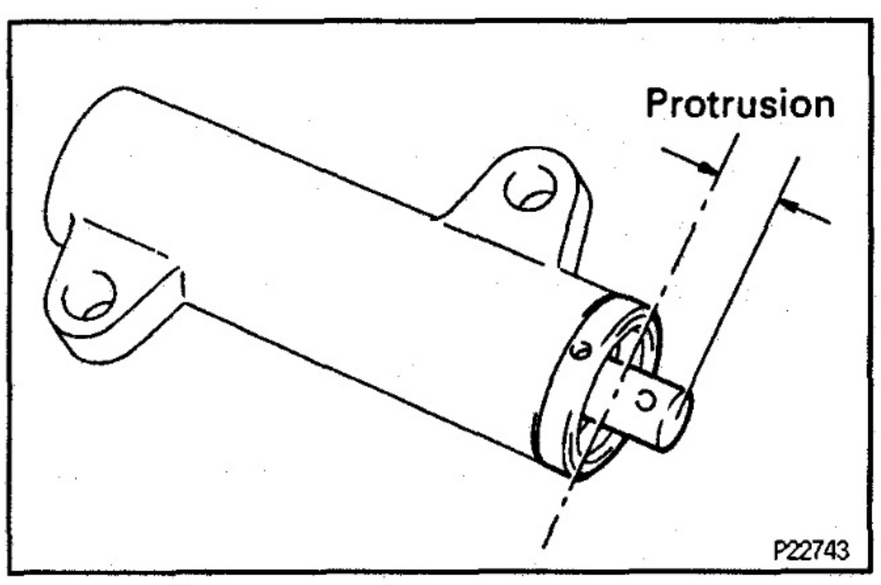
(a) Visually check the seal portion of the tensioner for oil leakage.

HINT: If there is only the faintest trace of oil on the seal on the push rod side, the tensioner is all right.

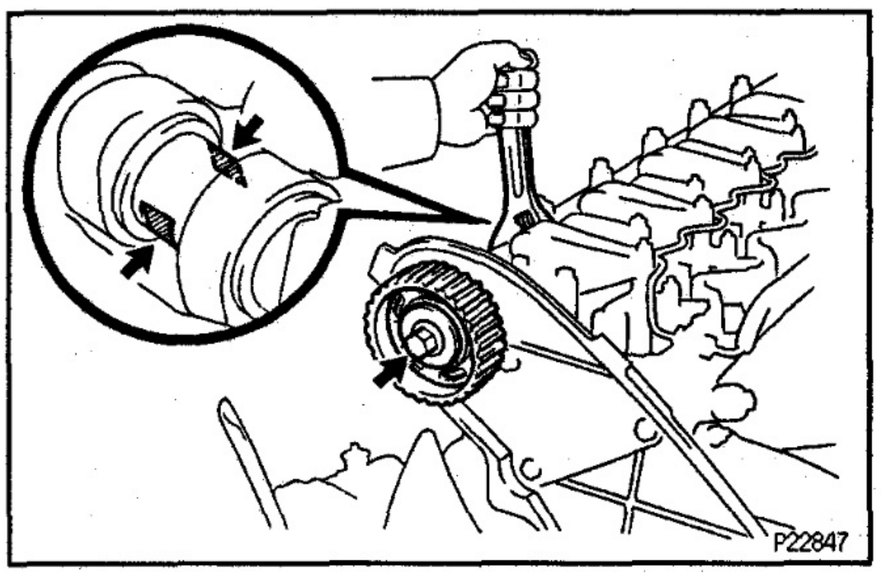
If leakage is found, replace the tensioner.

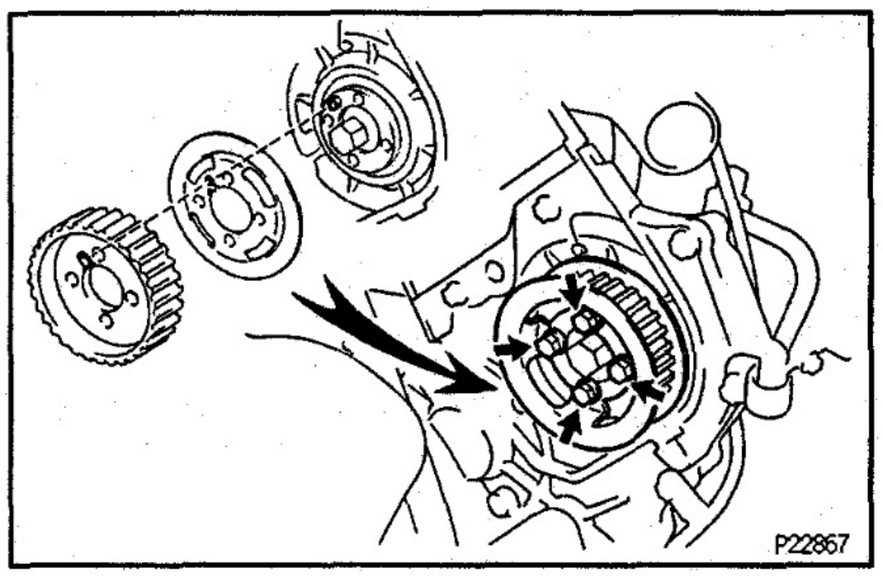


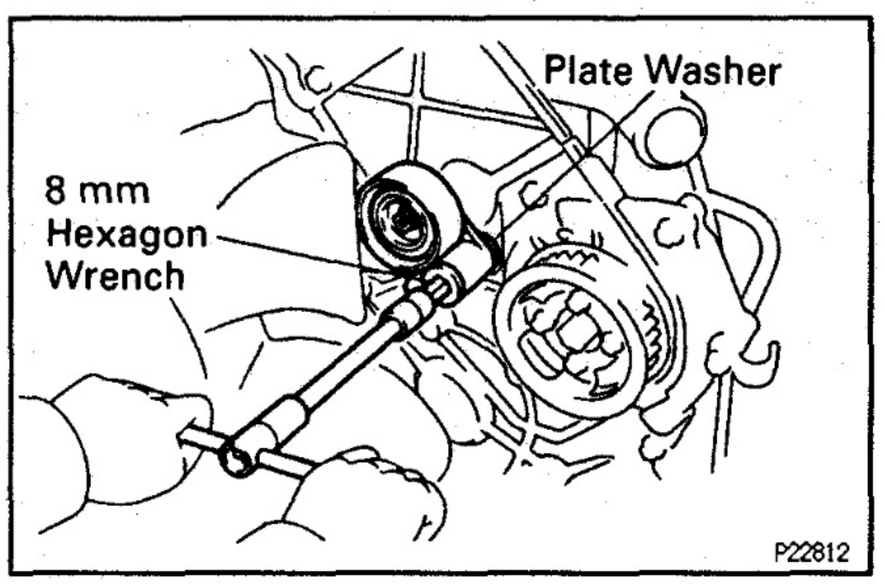
(b) Hold the tensioner with both hands and push the push rod strongly as shown to check that it doesn't move. If the push rod moves, replace the tensioner.
NOTICE: Never hold the tensioner push rod facing downward.



(c) Measure the protrusion of the push rod from the housing end.
Protrusion:
9.0 – 9.8 mm (0.354 – 0.386 in.)
If the protrusion is not as specified, replace the tensioner.







TIMING BELT INSTALLATION

EGBR8-01

1. INSTALL NO.1 CAMSHAFT TIMING PULLEY

(a) Install the set key to the key groove of the camshaft.

(b) Align the pulley set key with the key groove of the timing pulley, and slide the timing pulley.

(c) Temporarily install the pulley bolt.

(d) Hold the hexagon wrench head portion of the camshaft with a wrench, and tighten the pulley bolt.
Torque: 98 N·m (1,000 kgf·cm, 72 ft·lbf)

2. INSTALL CYLINDER HEAD COVER
(See steps 10 and 18 or 19 in cylinder head installation)

3. INSTALL NO.2 CAMSHAFT TIMING PULLEY

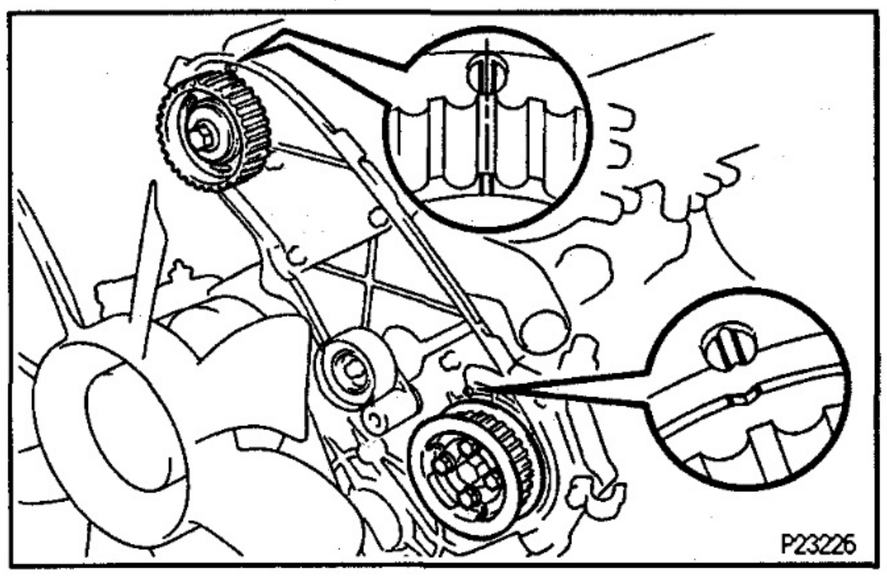
(a) Align the knock pin on the injection pump drive gear with the knock pin hole of the No.1 flange and the knock pin groove of the timing pulley.

(b) Install the No.1 flange, timing pulley and No.2 flange with the 4 bolts.
Torque: 31 N·m (315 kgf·cm, 23 ft·lbf)

4. INSTALL IDLER PULLEY

(a) Using an 8 mm hexagon wrench, install the plate washer and idler pulley with the pivot bolt.
Torque: 34.5 N·m (350 kgf·cm, 25 ft·lbf)

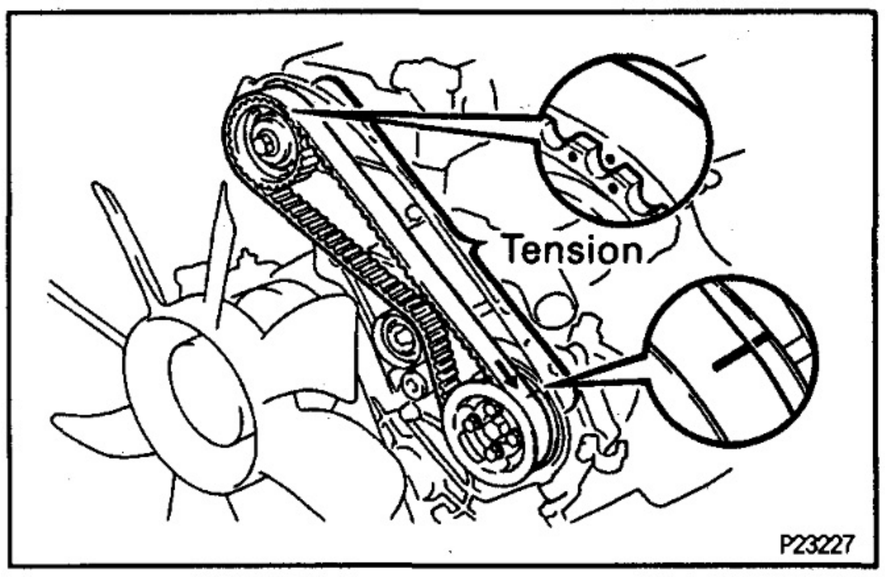
(b) Check that the pulley bracket moves smoothly.



5. SET NO.1 CYLINDER TO BDC/COMPRESSION

(a) Check that the timing mark of the No.2 camshaft timing pulley is aligned with the BDC mark.
NOTICE: Do not turn the crankshaft pulley. The valve heads will hit against the piston top.

(b) Align the timing mark of the No.1 camshaft timing pulley with the BDC mark.



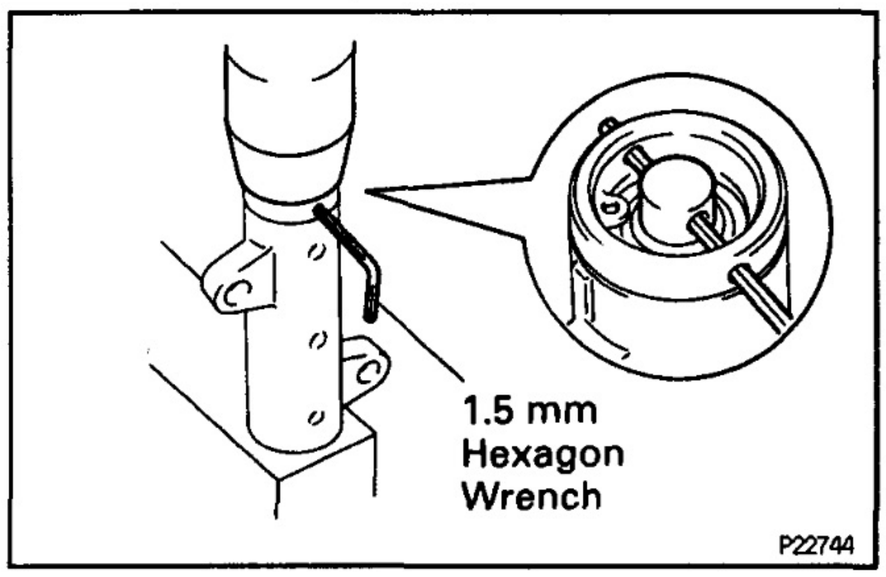
6. INSTALL TIMING BELT

NOTICE: The engine should be cold.

HINT (When re—using timing belt): Align the points marked during removal, and install the belt with the arrow pointing in the direction of engine revolution.

(a) Remove any oil or water on the pulleys, and keep them clean.
NOTICE: Only wipe the pulleys; do not use any cleansing agent.

(b) Install the timing belt under tension between the No.1 and No.2 camshaft timing pulleys.

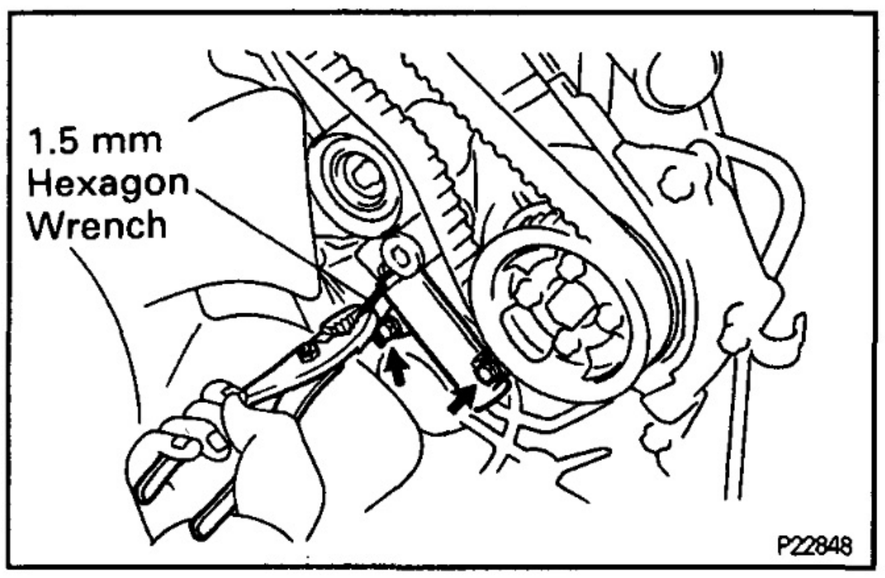


7. SET TIMING BELT TENSIONER

(a) Using a press, slowly press in the push rod using 981 — 9,807 N (100 — 1,000 kgf, 220 — 2,205 lbf) of force.

(b) Align the holes of the push rod and housing, pass a 1.5 mm hexagon wrench through the holes to keep the setting position of the push rod.

(c) Release the press.

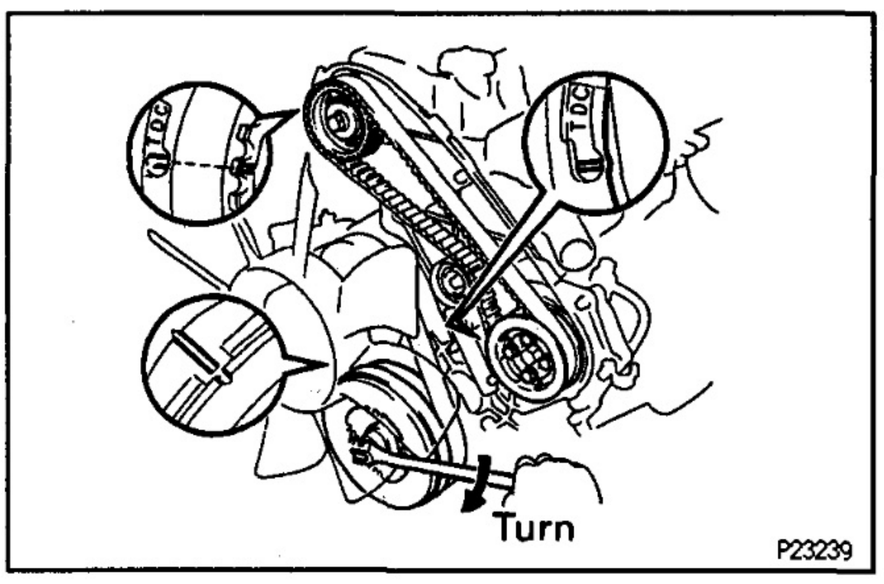


8. INSTALL TIMING BELT TENSIONER

(a) Temporarily install the timing belt tensioner with the 2 bolts while pushing the idler pulley toward the timing belt.

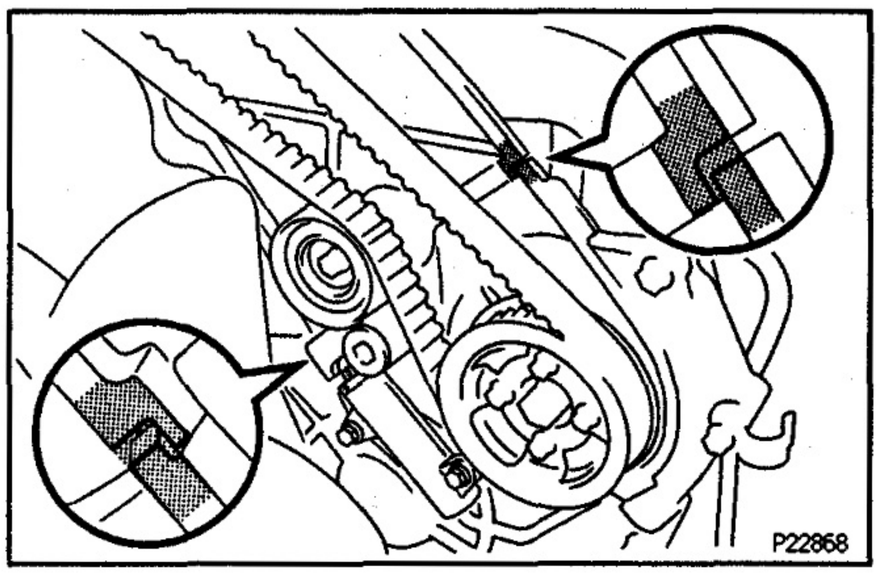
(b) Alternately tighten the 2 bolts.
Torque: 13 N·m (130 kgf·cm, 10 ft·lbf)

(c) Remove the 1.5 mm hexagon wrench from the tensioner.



9. CHECK VALVE TIMING

Turn the crankshaft pulley clockwise and check that each pulley timing mark aligns with the TDC marks.
If the marks do not align, remove the timing belt and reinstall it.



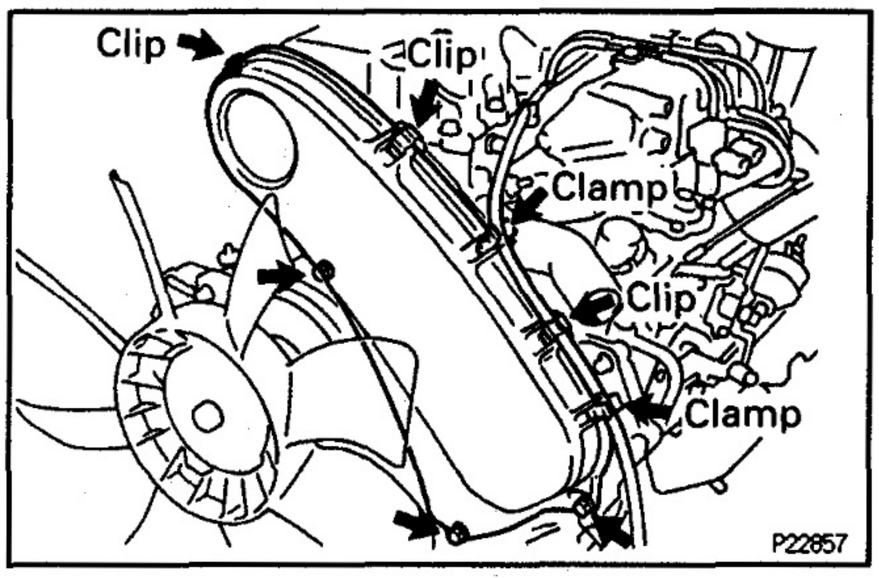
10. INSTALL TIMING BELT COVER

(a) Remove any old packing (FIPG) material.

(b) Apply seal packing to the camshaft oil seal retainer and timing gear cover as shown in the illustration.

Seal packing:

Part No. 08826—00080 or equivalent



(c) Install the insulator to the timing gear cover.

(d) Install the gasket to the timing belt cover.

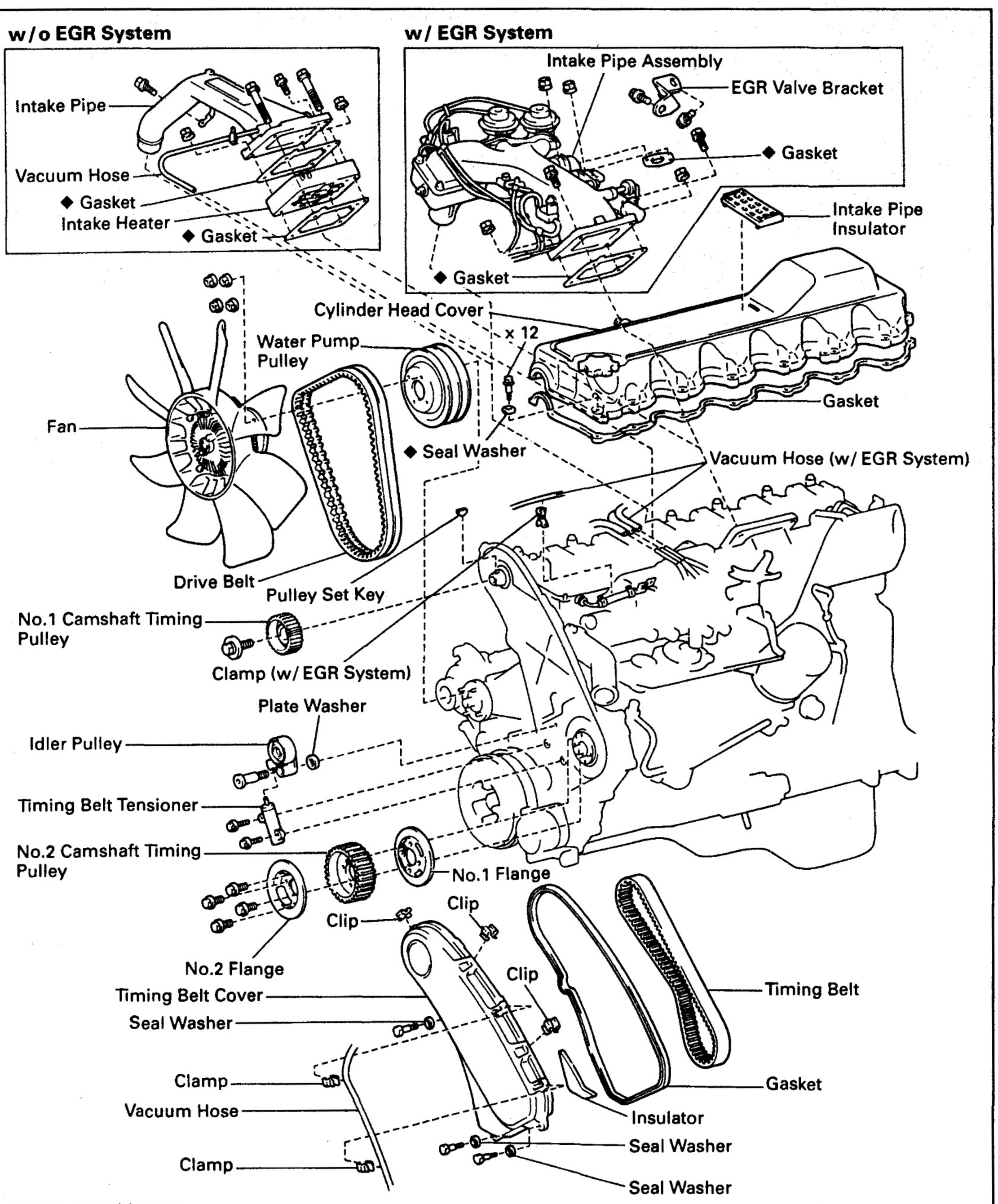
(e) Install the timing belt cover with the 3 seal washers, 3 bolts and 3 clips.

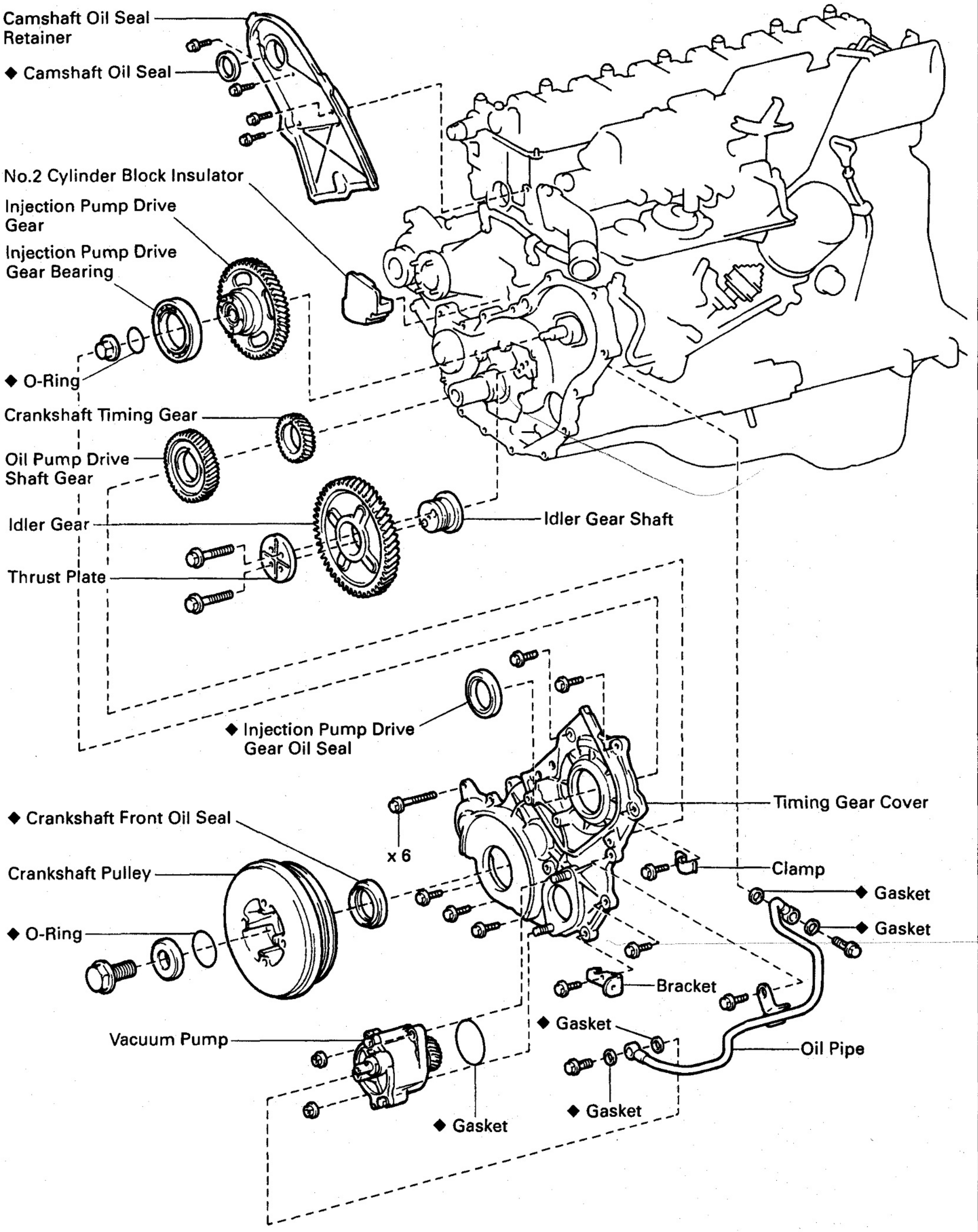
(f) Install the vacuum hose to the 2 clamps on the timing belt cover.

EG

TIMING GEAR
COMPONENTS FOR REMOVAL AND INSTALLATION

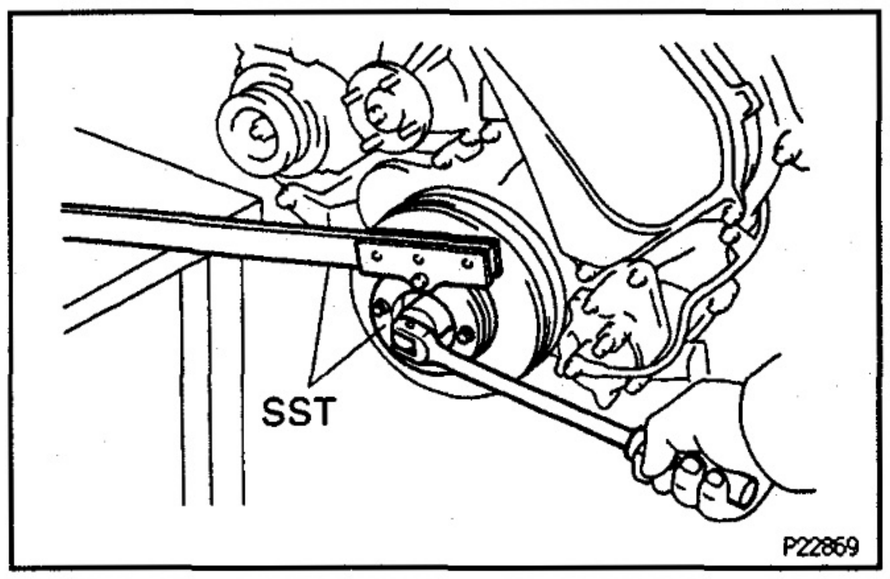
EGENE-01





◆ Non-reusable part

P22039



EG

B3RF–01

TIMING GEARS REMOVAL

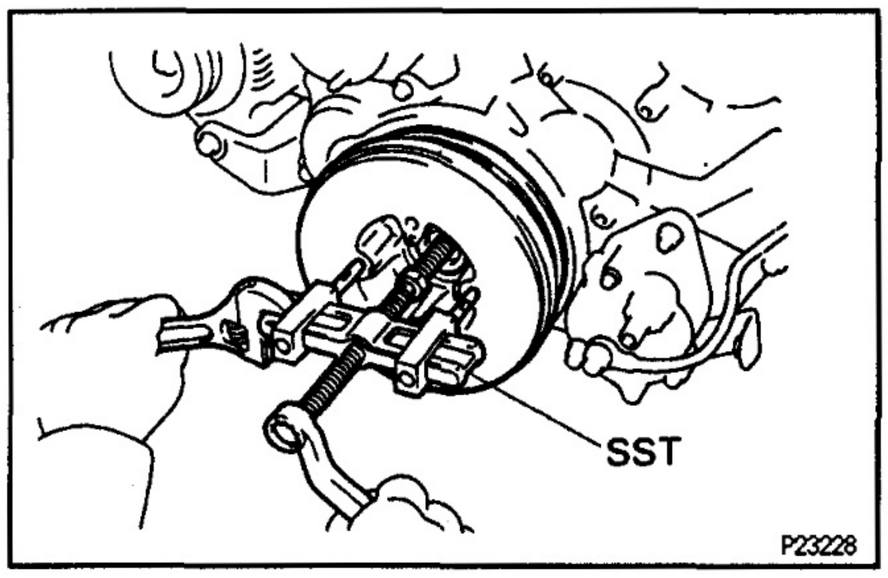
1. REMOVE DRIVE BELTS, FAN, FLUID COUPLING AND WATER PUMP PULLEY
(See step 2 in water pump removal in Cooling System)

2. LOOSEN CRANKSHAFT PULLEY
Using SST, loosen the pulley bolt.
SST 09213–58012 (90201–08131, 91111–50845), 09330–00021

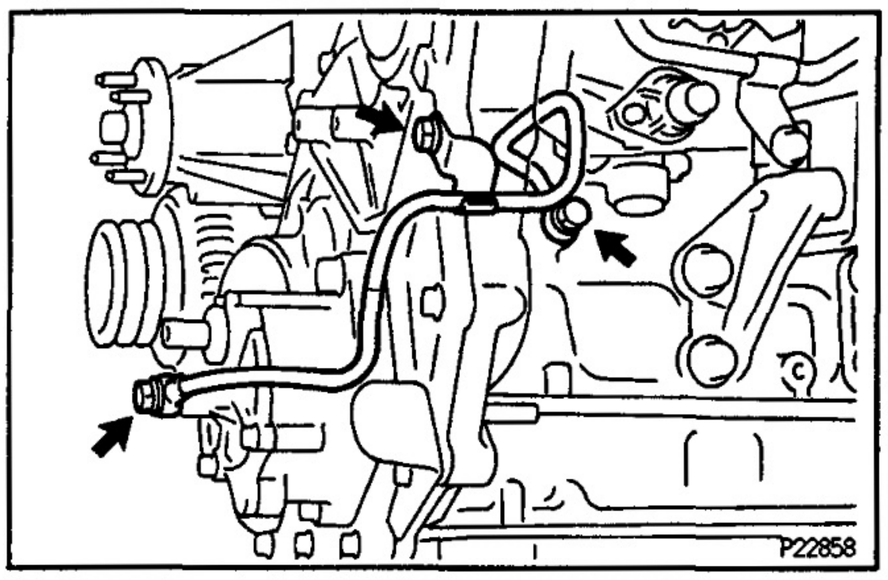
NOTICE: If the timing belt is disengaged, having the crankshaft pulley at the wrong angle can cause the piston head and valve head to come into contact with each other when you remove the camshaft timing pulley (step 8 in timing belt removal), causing damage.

3. REMOVE TIMING BELT AND PULLEYS
(See steps 1 to 7 timing belt removal)

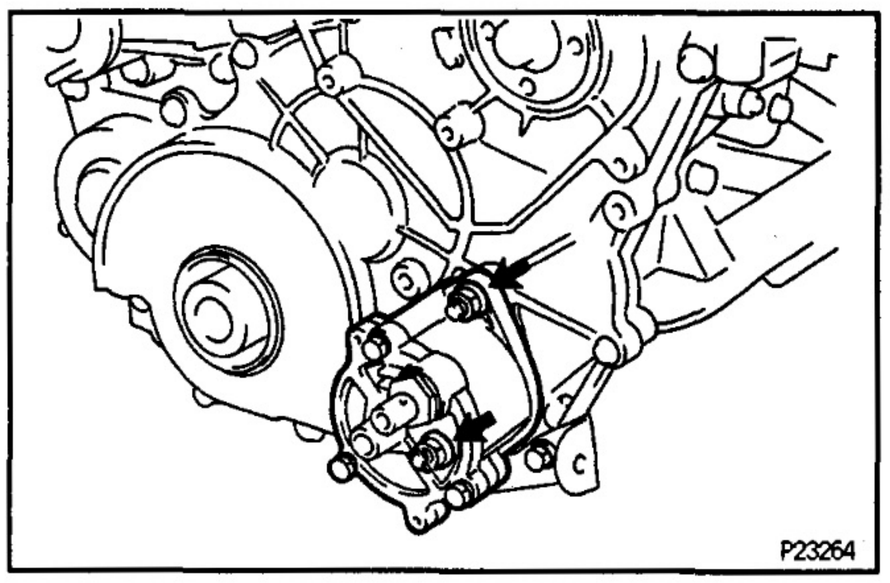
4. REMOVE CAMSHAFT OIL SEAL RETAINER
(See step 14 in cylinder head removal)



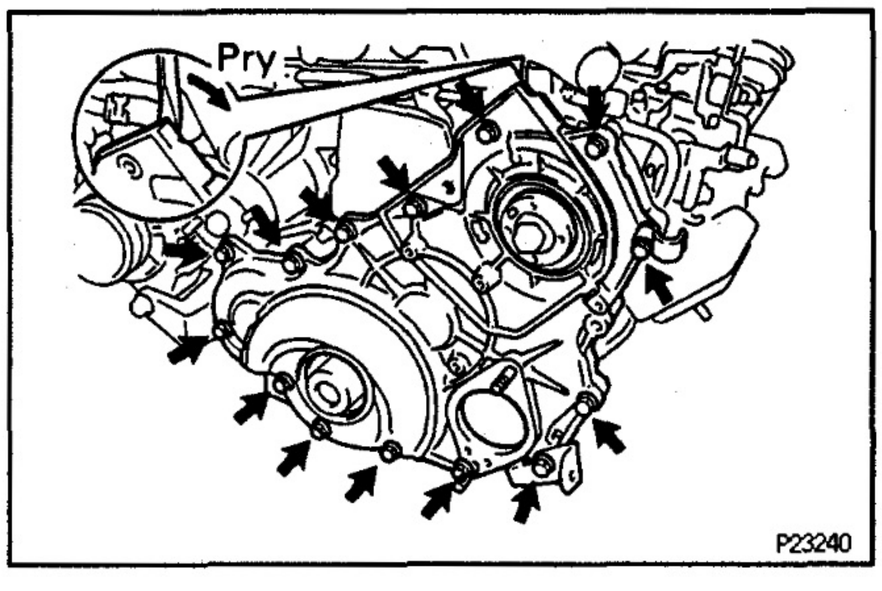
5. REMOVE CRANKSHAFT PULLEY
(a) Remove the pulley bolt and plate washer.
NOTICE: Do not turn the crankshaft pulley. The valve heads will hit against the piston top.
(b) Using SST, remove the crankshaft pulley.
SST 09950–50010 (09951–05010, 09952–05010, 09953–05010, 09953–05020, 09954–05020)
(c) Remove the O–ring from the crankshaft pulley.



6. REMOVE OIL PIPE
(a) Remove the 2 union bolts and 4 gaskets.
(b) Remove the bolt and oil pipe.



7. REMOVE VACUUM PUMP
(a) Remove the 2 nuts and vacuum pump.
(b) Remove the O–ring.

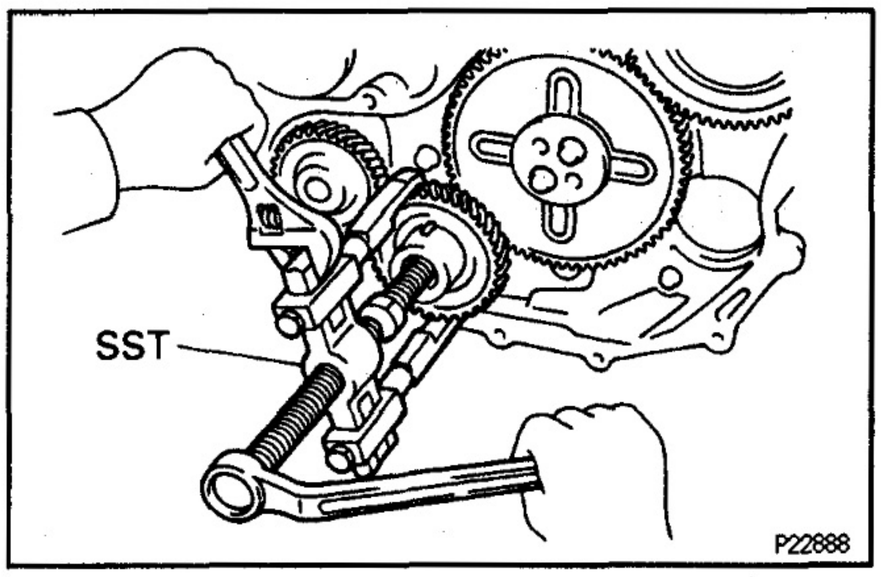


8. REMOVE TIMING GEAR COVER

(a) Remove the 14 bolts, clamp and bracket.

(b) Pry out the timing gear cover.

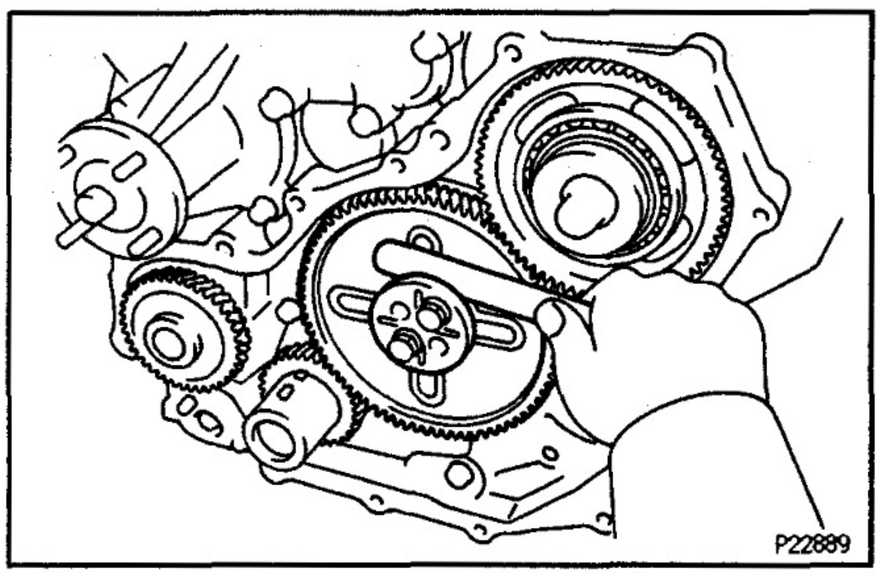
9. REMOVE NO.2 CYLINDER BLOCK INSULATOR



10. REMOVE OIL PUMP DRIVE SHAFT GEAR

Using SST, remove the drive shaft gear.

SST 09950—40010 (09951—04010, 09952—04010, 09953—04010, 09953—04020, 09954—04010, 09955—04060)



11. CHECK THRUST CLEARANCE OF IDLER GEAR

Using a feeler gauge, measure the thrust clearance.

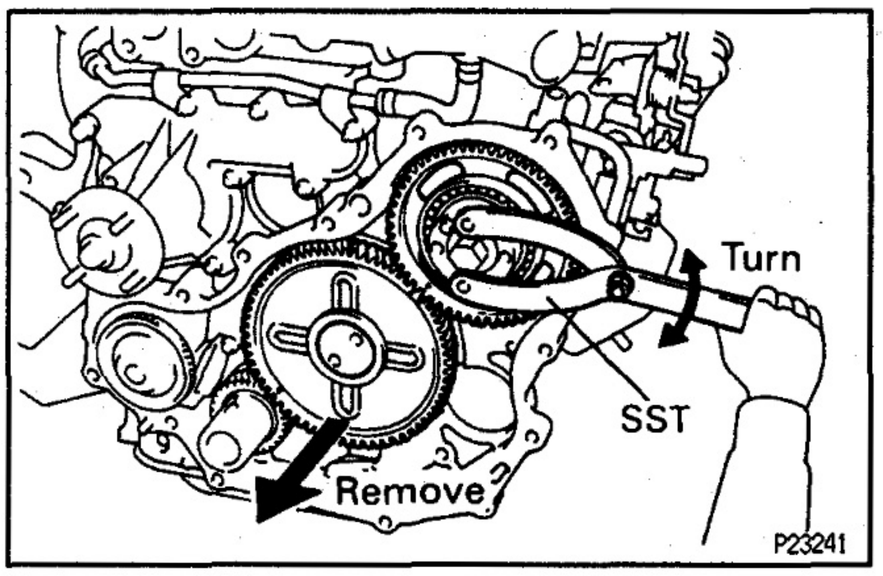
Standard thrust clearance:

0.05 — 0.15 mm (0.0020 — 0.0059 in.)

Maximum thrust clearance:

0.30 mm (0.0118 in.)

If the thrust clearance is greater than maximum, replace the thrust plate. If necessary, replace the idler gear and/or idler gear shaft.

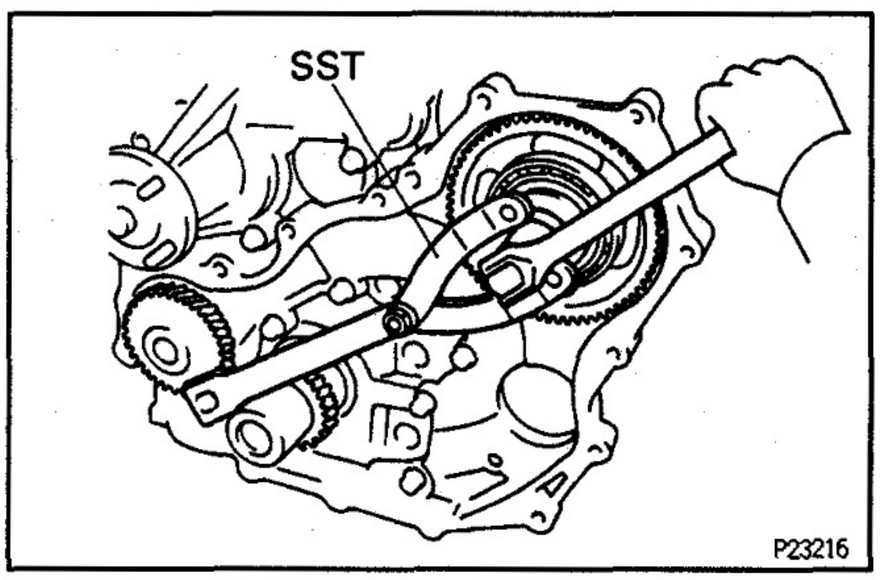


12. REMOVE IDLER GEAR

(a) Remove the 2 bolts and thrust plate.

(b) Using SST, turn the injection pump drive gear clockwise or counterclockwise and remove the idler gear.
SST 09960—10010 (09962—01000, 09963—00700)

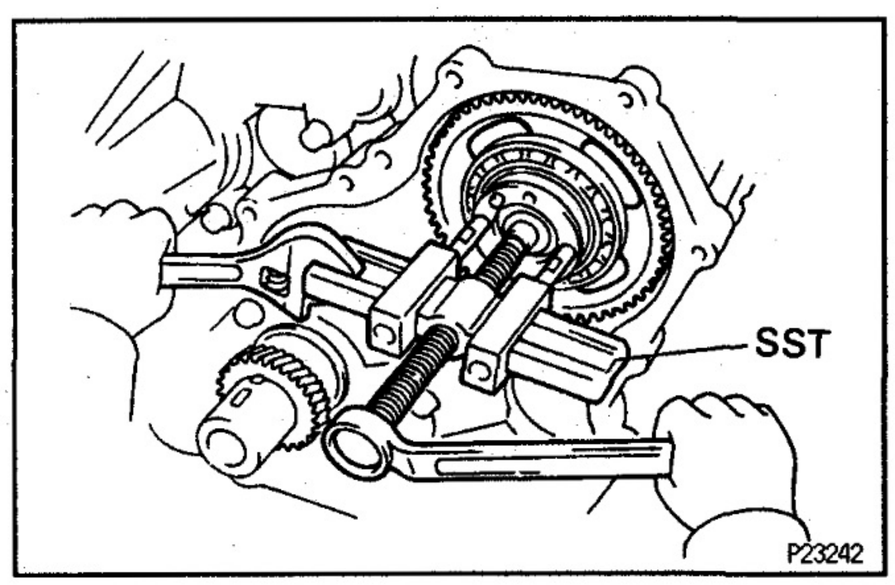
(c) Remove the idler gear shaft.



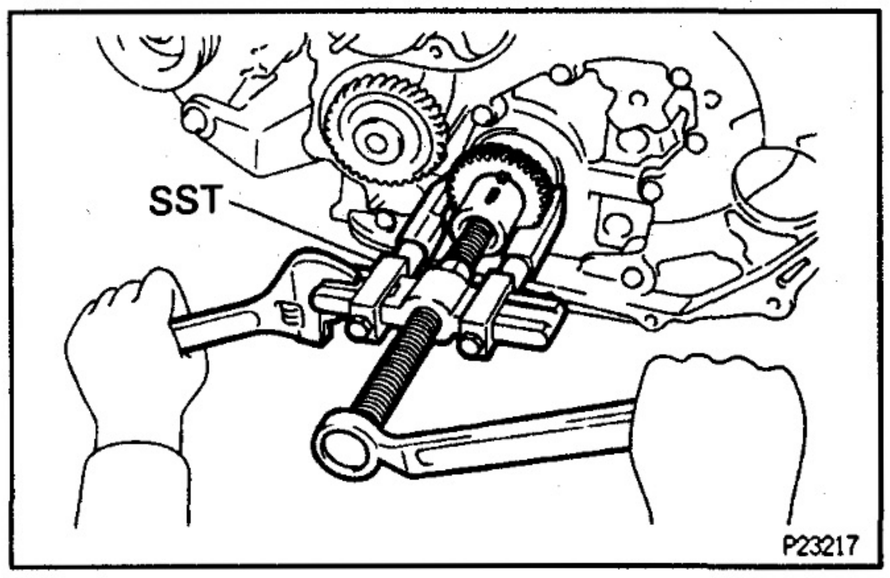
13. REMOVE INJECTION PUMP DRIVE GEAR

(a) Using SST, loosen the gear nut.
SST 09960—10010 (09962—01000, 09963—00700)

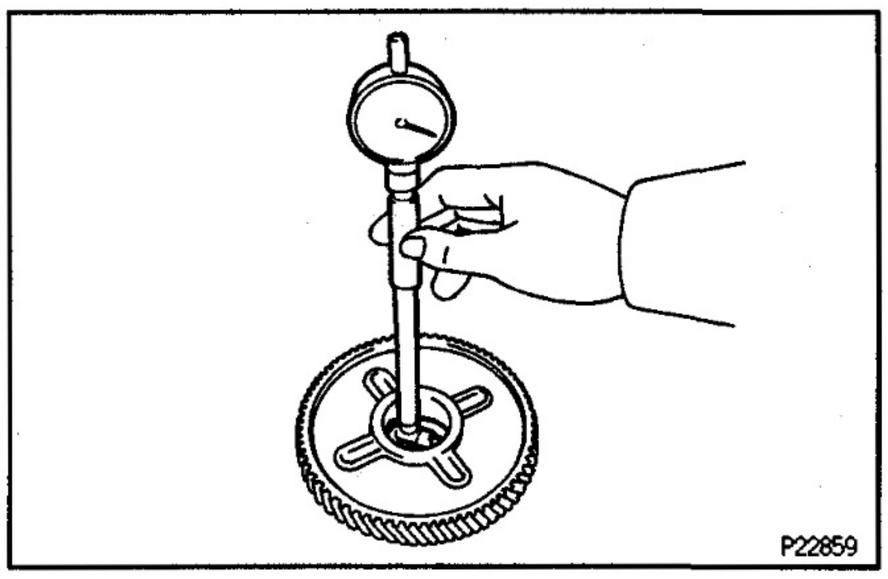
(b) Remove the gear nut and O—ring.



(c) Using SST, remove the drive gear.
SST 09950–50010 (09951–05010, 09952–05010, 09953–05010, 09954–05020)



14. REMOVE CRANKSHAFT TIMING GEAR
Using SST, remove the timing gear.
SST 09950–40010 (09951–04010, 09952–04010, 09953–04010, 09953–04020, 09954–04010, 09955–04060)

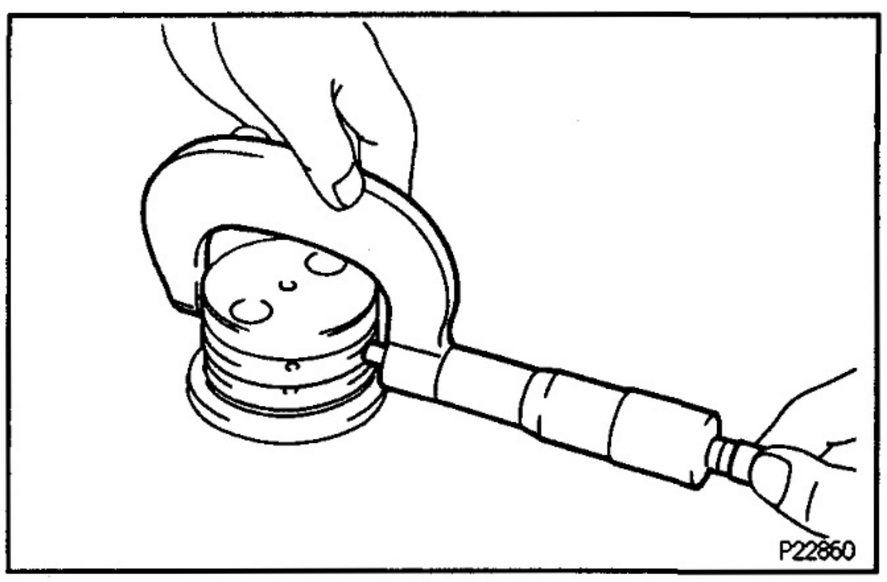


TIMING GEARS INSPECTION

EQ5RG–01

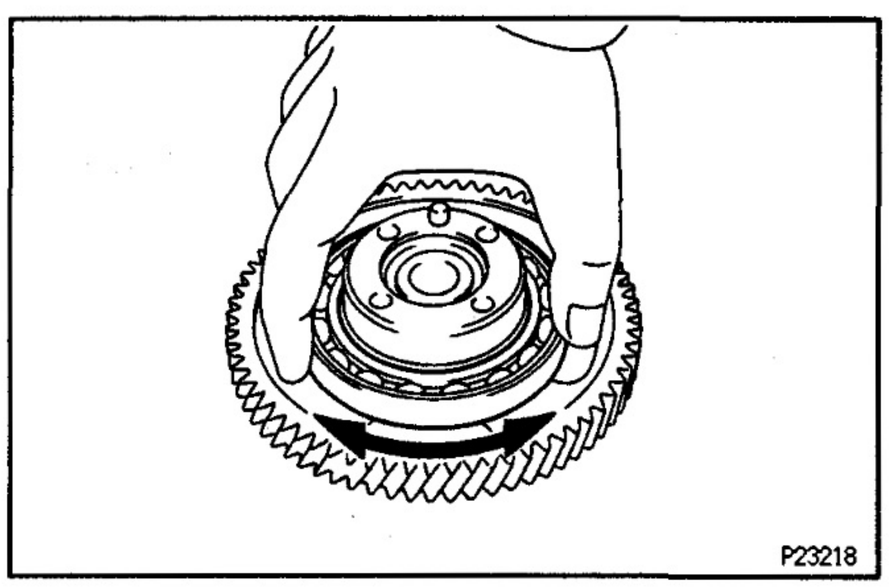
1. INSPECT IDLER GEAR

(a) Using a cylinder gauge, measure the inside diameter of the idler gear.
Idler gear inside diameter:
45.000 – 45.025 mm (1.7717 – 1.7726 in.)

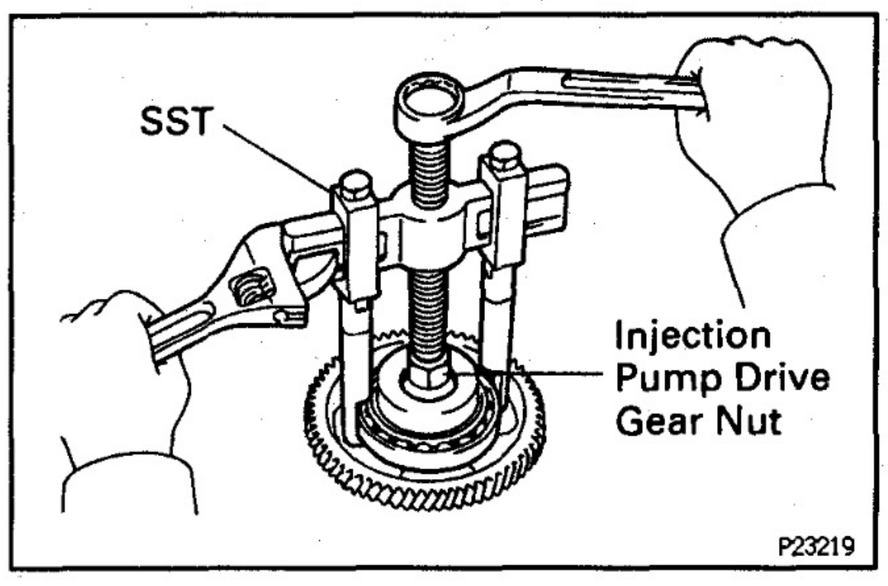


(b) Using a micrometer, measure the diameter of the idler gear shaft.
Idler gear shaft diameter:
44.950 – 44.975 mm (1.7697 – 1.7707 in.)

(c) Subtract the idler gear shaft diameter measurement from the idler gear inside diameter measurement.
Standard oil clearance:
0.025 – 0.075 mm (0.0010 – 0.0030 in.)
Maximum oil clearance:
0.20 mm (0.0079 in.)
If the clearance is greater than maximum, replace the gear and shaft.



2. INSPECT INJECTION PUMP DRIVE GEAR BEARING
Check that bearing is not rough or worn.

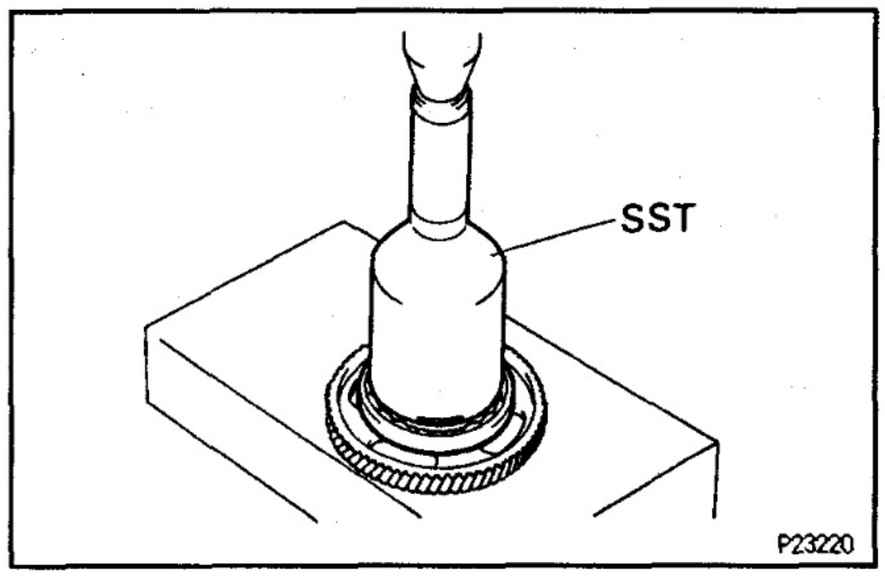


3. IF NECESSARY, REPLACE INJECTION PUMP DRIVE GEAR BEARING

A. Remove bearing

Using SST, remove the bearing.

SST 09950−40010 (09951−04010, 09952−04010, 09953−04020, 09954−04010, 09955−04040)

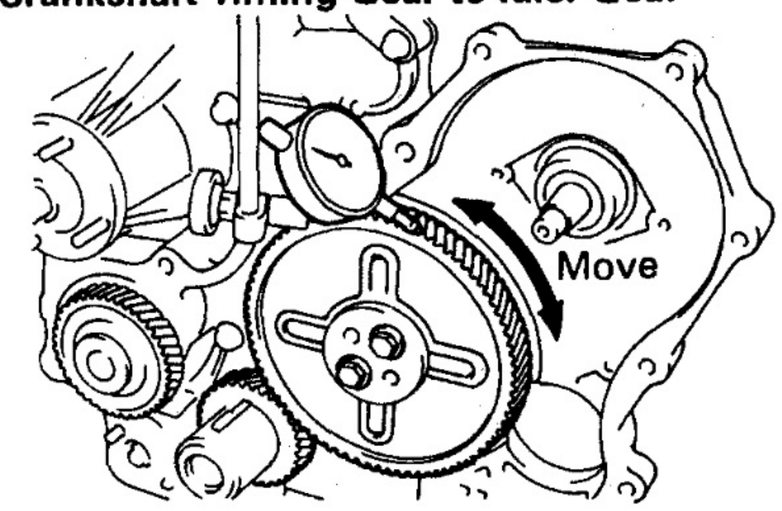


B. Install bearing

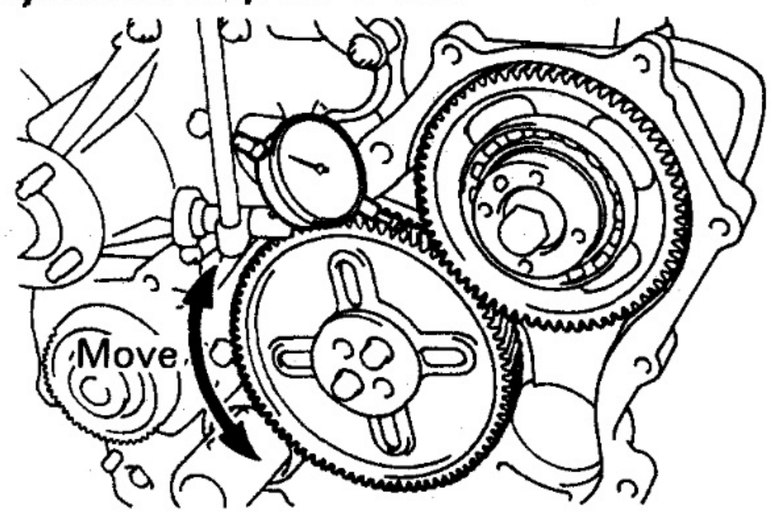
Using SST and a press, press in a new bearing.

SST 09214−76011

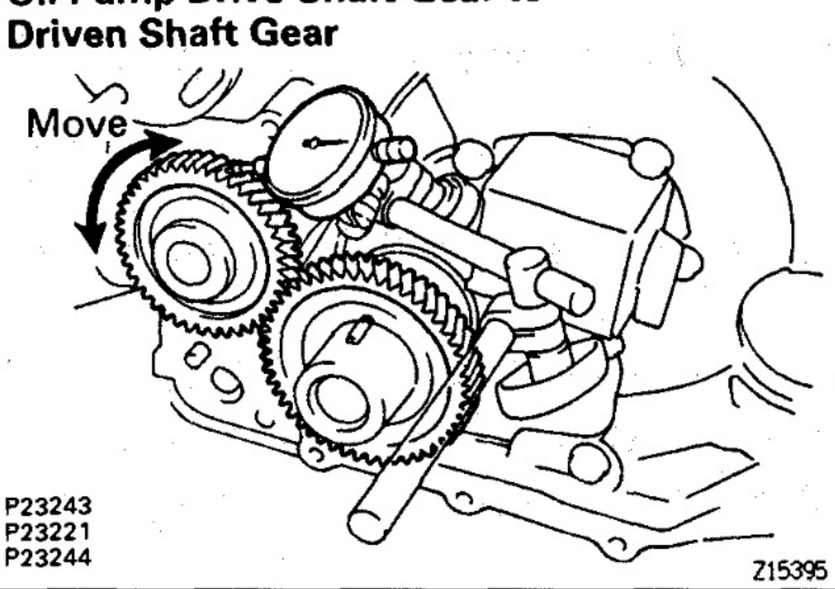
Crankshaft Timing Gear to Idler Gear



Injection Pump Drive Gear to Idler Gear



Oil Pump Drive Shaft Gear to Driven Shaft Gear



4. CHECK BACKLASH OF TIMING GEARS

(a) Install the gears.

(b) Using a dial indicator, measure the backlash.

Standard gear backlash:

0.05 − 0.15 mm (0.0020 − 0.0059 in.)

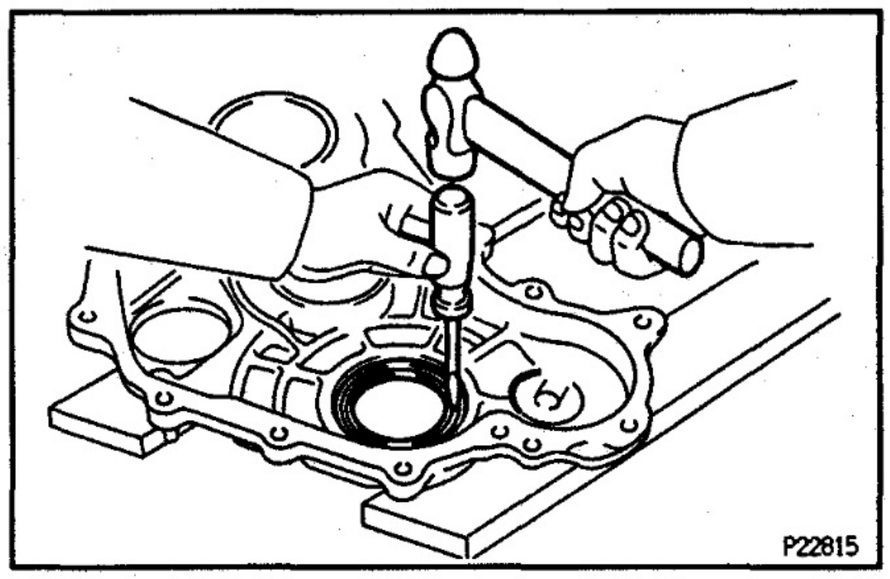
Maximum gear backlash:

0.30 mm (0.0118 in.)

If the gear backlash is greater than maximum, replace the gears as a set.

(c) Remove the gears.

EG



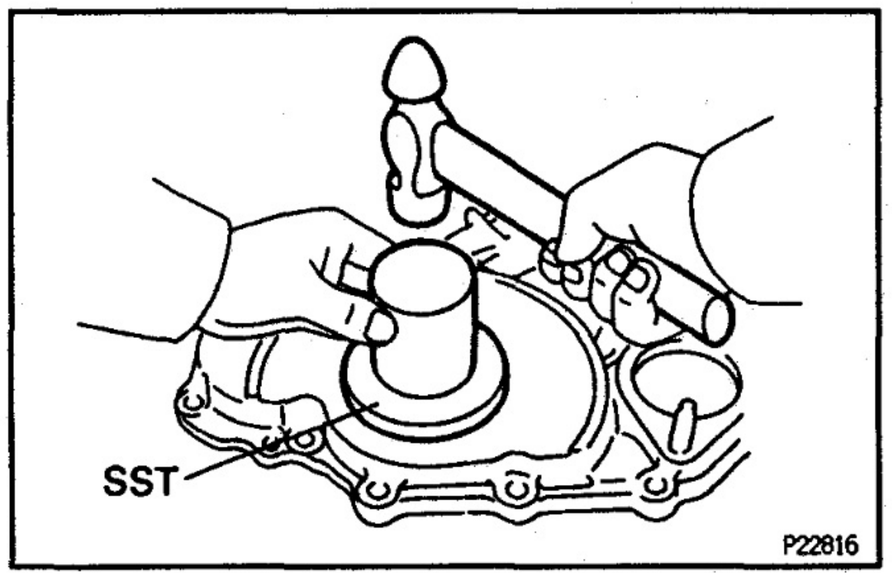
CRANKSHAFT FRONT OIL SEAL REPLACEMENT

HINT: There are 2 methods (A and B) to replace the oil seal as follows:

REPLACE CRANKSHAFT FRONT OIL SEAL

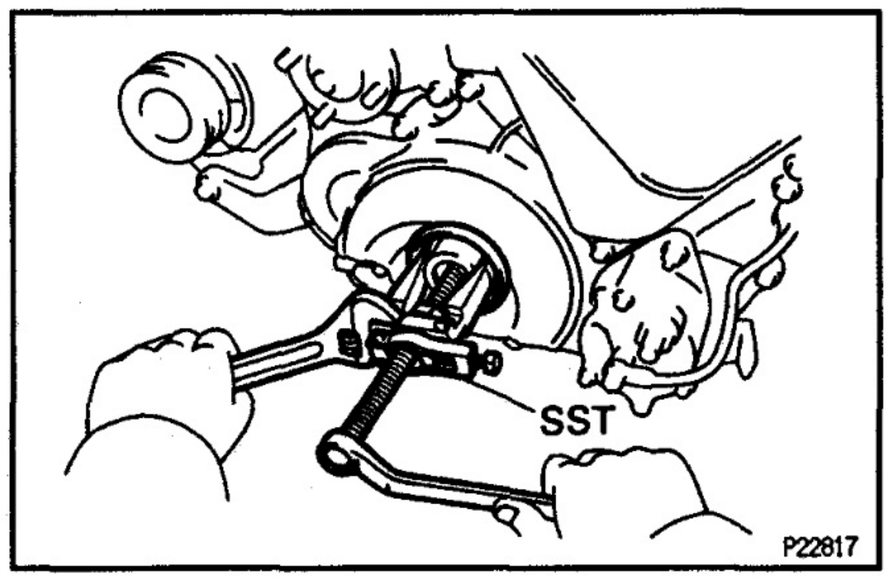
A. If timing gear cover is removed from cylinder block:

(a) Using a screwdriver and hammer, tap out the oil seal.



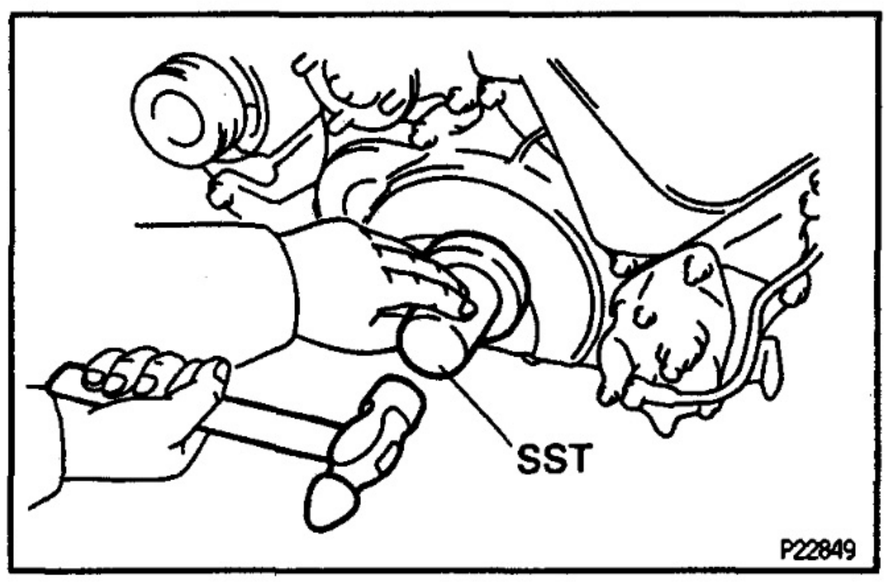
(b) Using SST and a hammer, tap in a new oil seal until its surface is flush with the timing gear cover edge.
SST 09223−78010

(c) Apply MP grease to the oil seal lip.



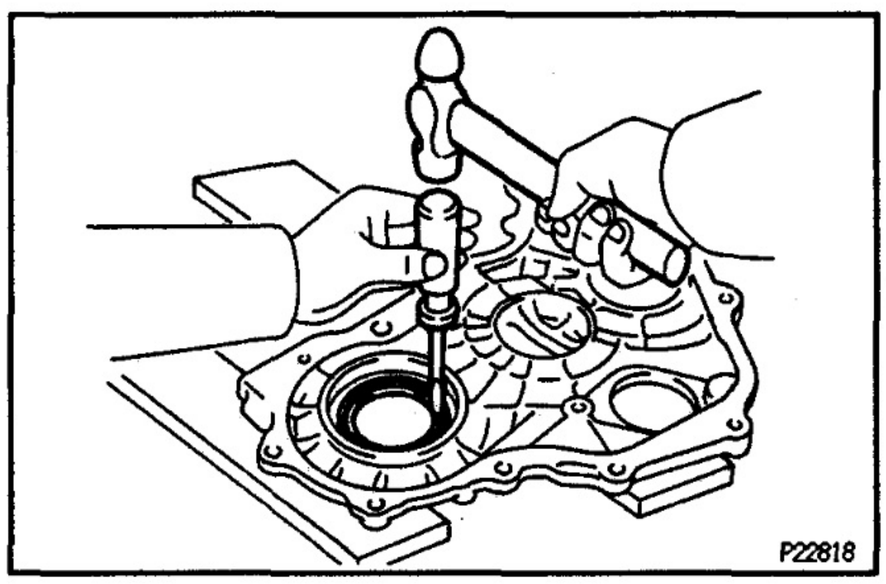
B. If timing gear cover is installed to the cylinder block:

(a) Using SST, remove the oil seal.
SST 09308−10010, 09950−50010 (09953−05010)



(b) Apply MP grease to a new oil seal lip.

(c) Using SST and a hammer, tap in the oil seal until its surface is flush with the timing gear cover edge.
SST 09223−78010



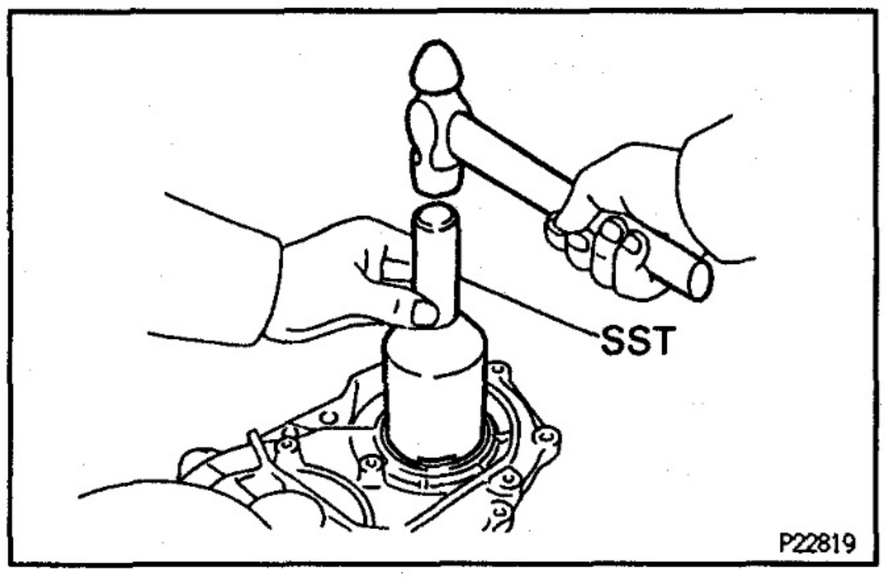
INJECTION PUMP DRIVE GEAR OIL SEAL REPLACEMENT

HINT: There are 2 methods (A and B) to replace the oil seal as follows:

REPLACE INJECTION PUMP DRIVE GEAR OIL SEAL

A. If timing gear cover is removed from cylinder block:

(a) Using a screwdriver and hammer, tap out the oil seal.



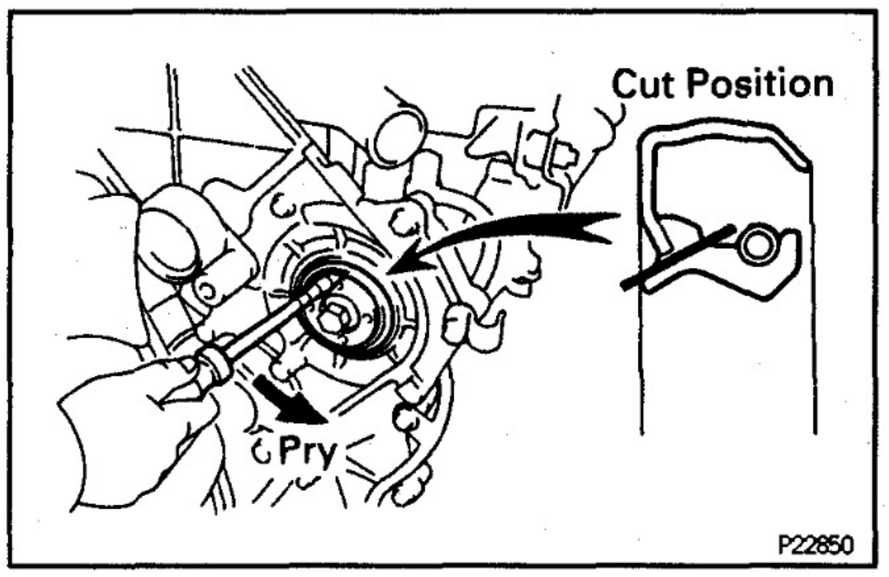
(b) Using SST and a hammer, tap in a new oil seal until its surface is flush with the timing gear cover edge.
SST 09214–76011

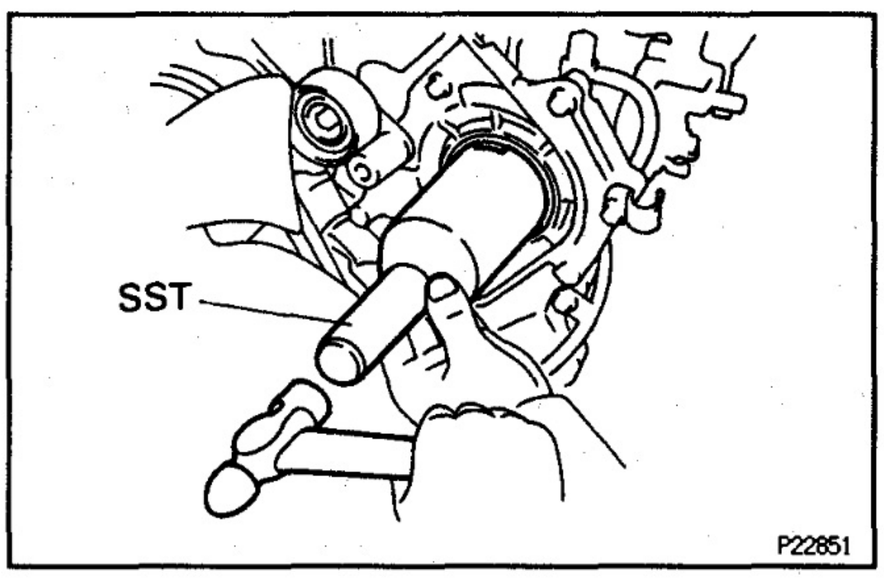
(c) Apply MP grease to the oil seal lip.

B. If timing gear cover is installed to the cylinder block:

(a) Using a knife, cut off the oil seal lip.

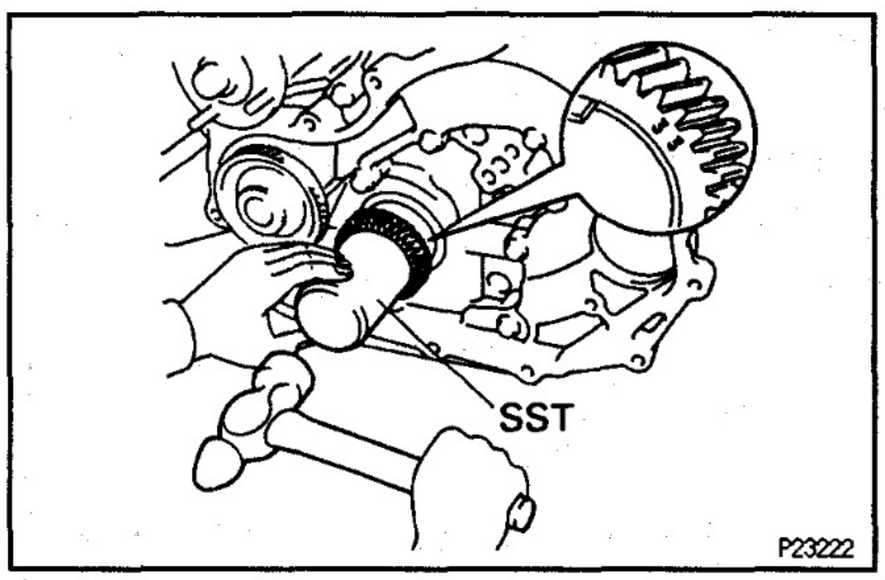
(b) Using a screwdriver, pry out the oil seal.
NOTICE: Be careful not to damage the injection pump drive gear. Tape the screwdriver tip.





(c) Apply MP grease to the oil seal lip.

(d) Using SST and a hammer, tap in a new oil seal until its surface is flush with the timing gear cover edge.
SST 09214–76011



TIMING GEARS INSTALLATION

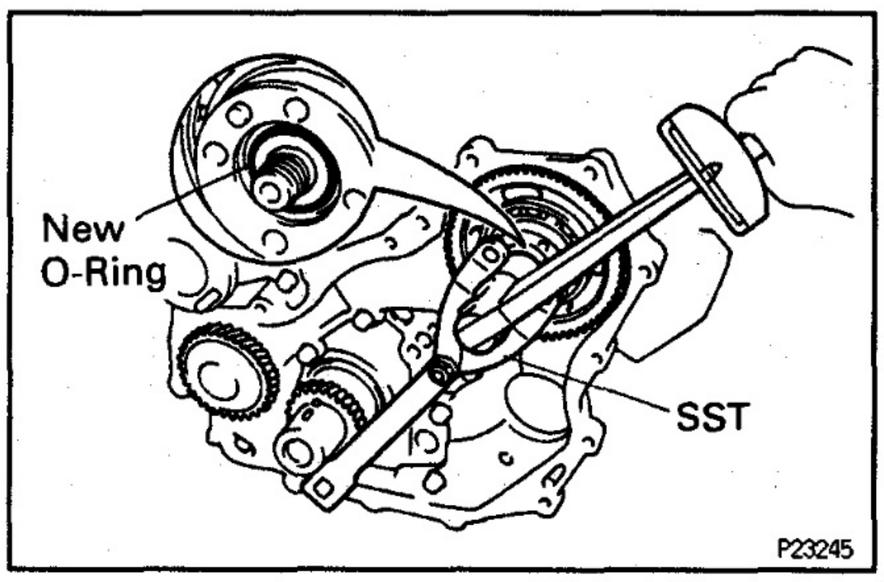
EGBRH–01

1. INSTALL CRANKSHAFT TIMING GEAR

(a) Put the timing gear with the timing mark facing forward.

(b) Align the set key on the crankshaft with the key groove of the timing gear.

(c) Using SST and a hammer, tap in the timing gear.
SST 09223–00010



2. INSTALL INJECTION PUMP DRIVE GEAR

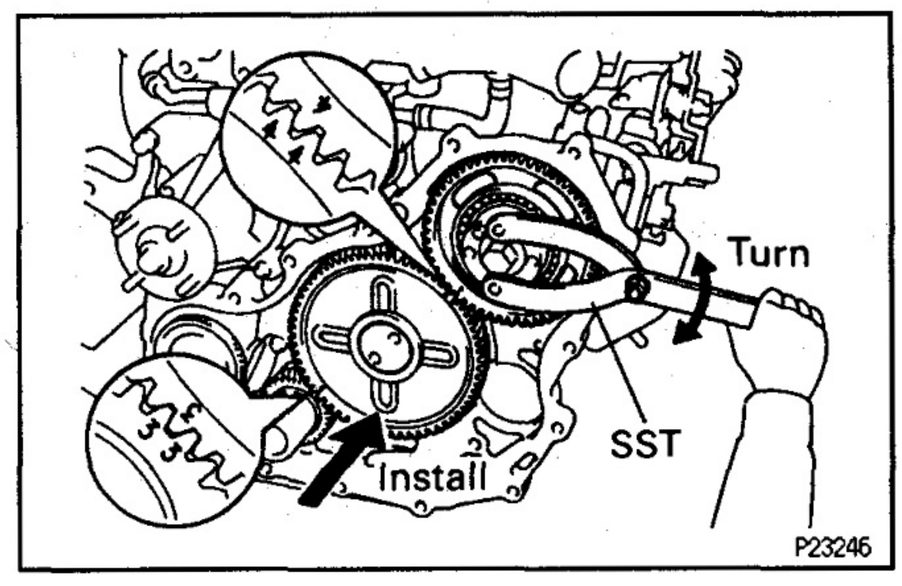
(a) Align the set key on the drive shaft with the key groove of the drive gear, and install the drive gear.

(b) Install a new O–ring to the drive gear groove.

(c) Install the gear nut.

(d) Using SST, tighten the gear nut.
SST 09960–10010 (09962–01000, 09963–00700)
Torque: 98 N·m (1,000 kgf·cm, 72 ft·lbf)

EG

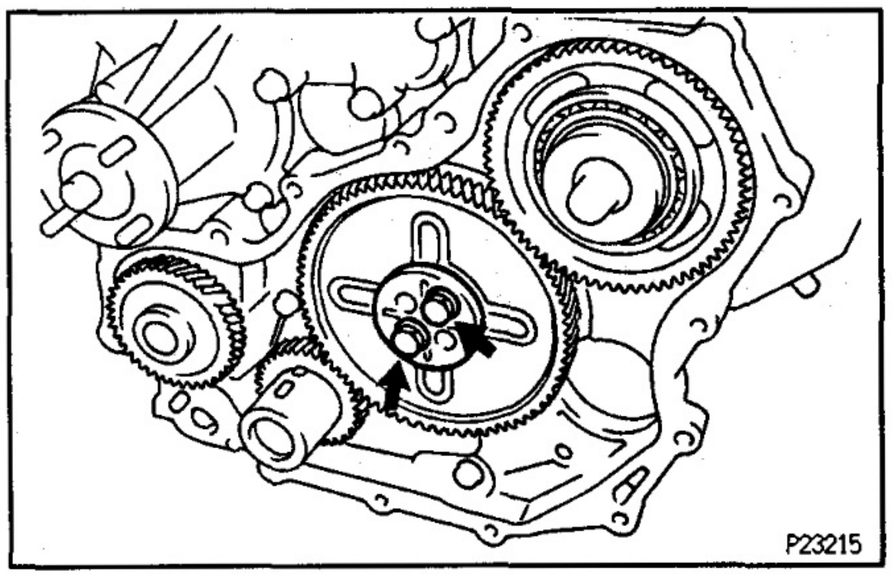


EG

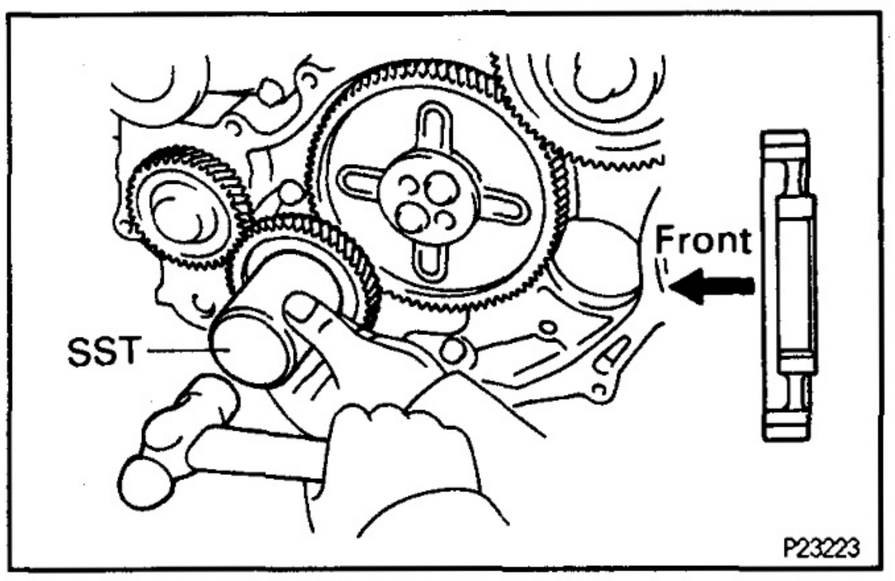
3. INSTALL IDLER GEAR

(a) Align the bolt holes of the idler gear shaft and cylinder block, and install the idler gear shaft.

(b) Using SST, turn the injection pump drive gear clockwise or counterclockwise, and align timing marks "3" and "4" of the idler gear with timing mark "3" of the crankshaft timing gear and timing mark "4" of the injection pump drive gear respectively, and mesh the gears.
SST 09960—10010 (09962—01000, 09963—00700)



(c) Install the thrust plate with the 2 bolts.
Torque: 68 N·m (694 kgf·cm, 50 ft·lbf)



4. INSTALL OIL PUMP DRIVE SHAFT GEAR

(a) Align the set key on the crankshaft with the key groove of the drive shaft gear.

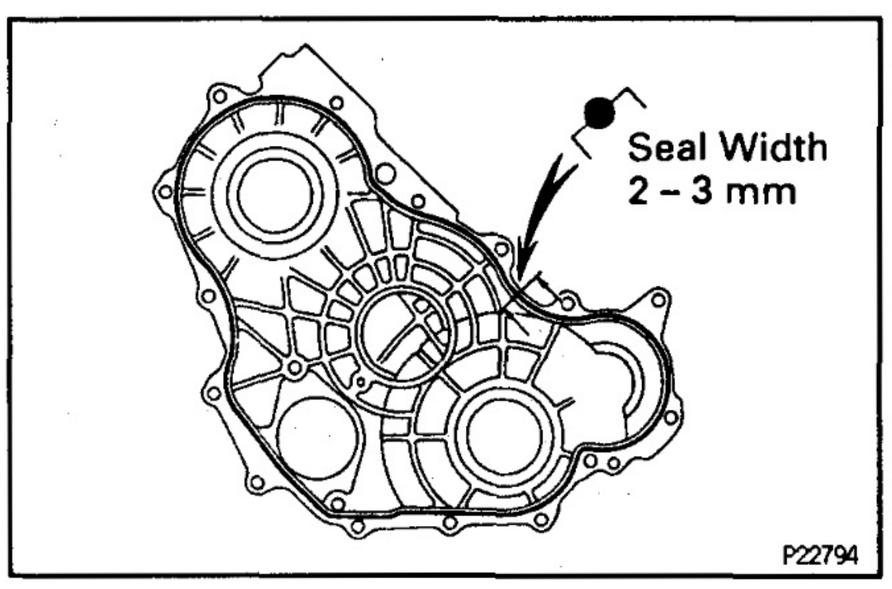
(b) Using SST and a hammer, tap in the drive shaft gear.
SST 09223—00010

5. INSTALL NO.2 CYLINDER BLOCK INSULATOR

6. INSTALL TIMING GEAR COVER

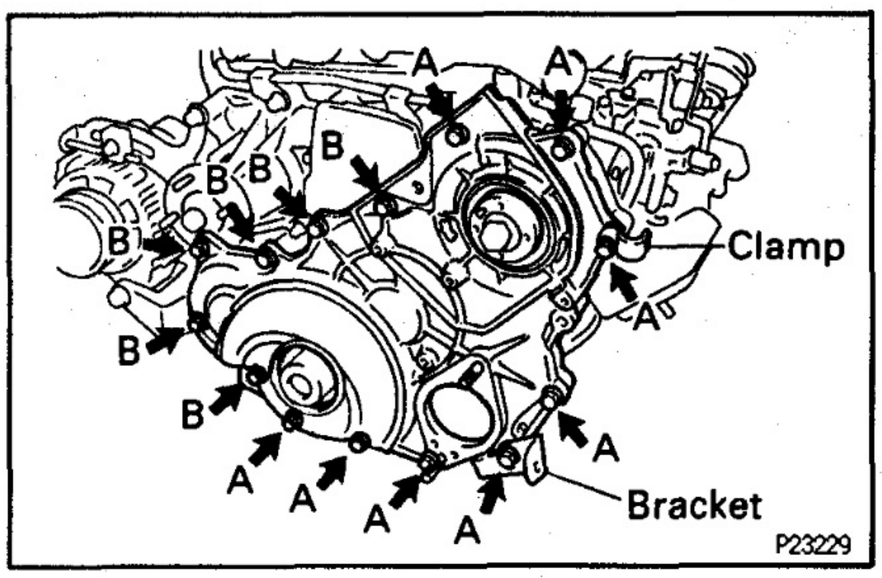
(a) Remove and old packing (FIPG) material and be careful not to drop any oil on the contact surface of the timing gear cover and cylinder block.

- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Using a non—residue solvent, clean both sealing surfaces.

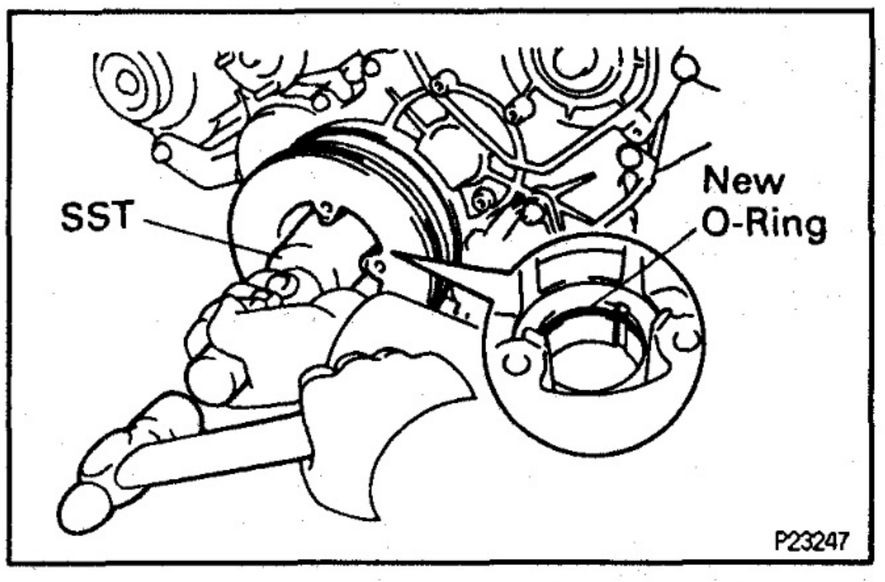


(b) Apply seal packing to the timing gear cover as shown in the illustration.
Seal packing:
Part No. 08826—00080 or equivalent

- Install a nozzle that has been cut to a 2 — 3 mm (0.08 — 0.12 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

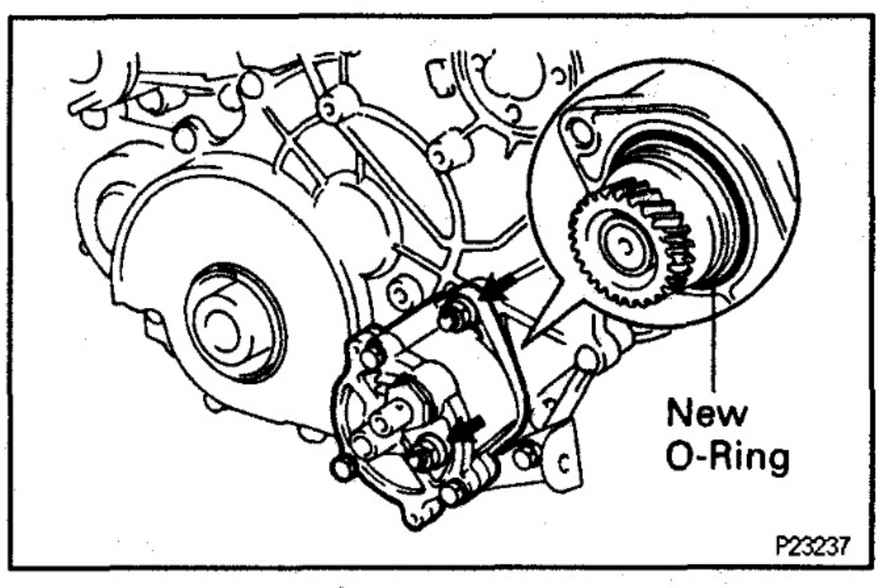


(c) Install the timing gear cover, clamp and bracket with the 14 bolts.
Torque: 19.6 N·m (200 kgf·cm, 14 ft·lbf)
HINT: Each bolt length is indicated in the illustration.
Bolt length:
A 25 mm (0.98 in.)
B 50 mm (1.97 in.)



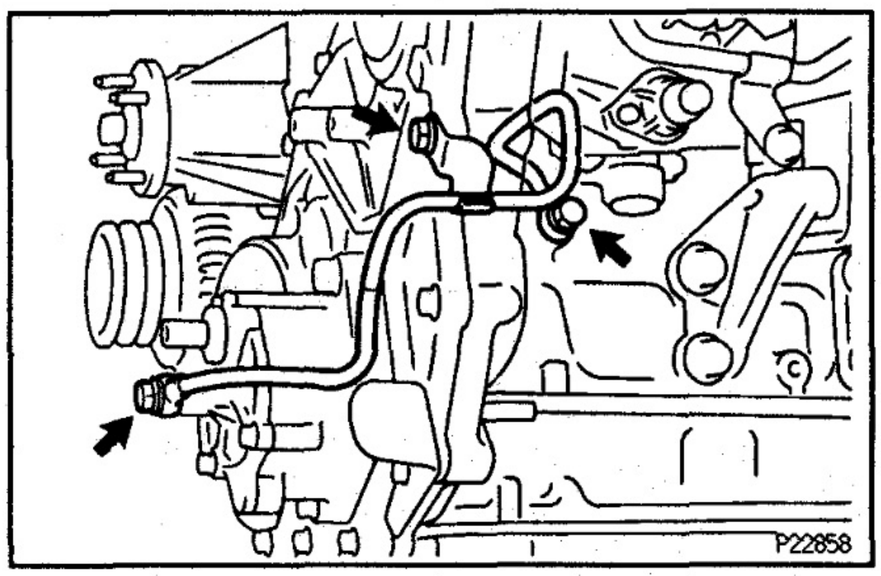
7. INSTALL CRANKSHAFT PULLEY

(a) Install a new O—ring to the crankshaft pulley groove.
(b) Align the set key on the crankshaft with the key groove of the crankshaft pulley.
(c) Using SST and a hammer, tap in the crankshaft pulley.
SST 09214—60010
(d) Temporarily install the plate washer and pulley nut.
NOTICE: Do not turn the crankshaft pulley. The valve heads will hit against the piston top.



8. INSTALL VACUUM PUMP

(a) Install a new O—ring to the vacuum pump.
(b) Install the vacuum pump with the 2 nuts.
Torque: 39 N·m (400 kgf·cm, 29 ft·lbf)



9. INSTALL OIL PIPE

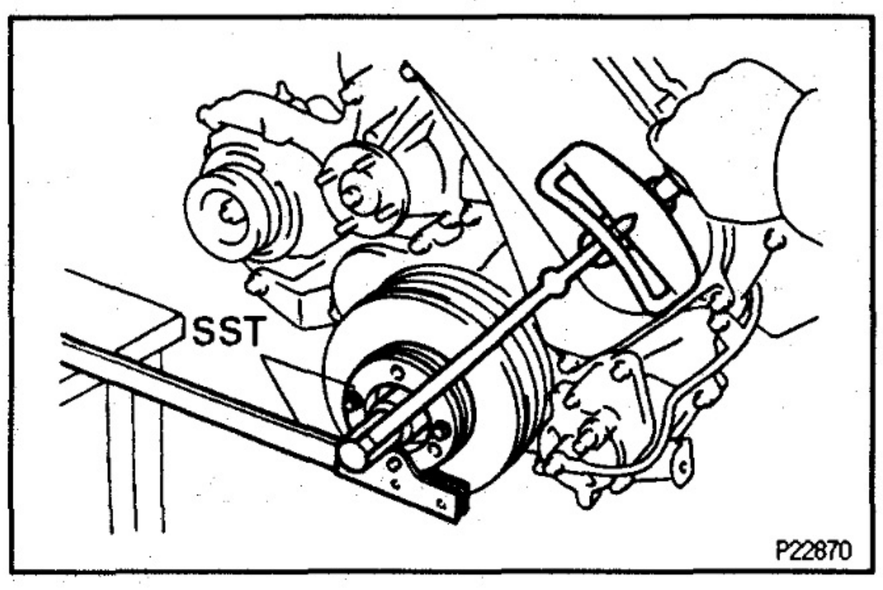
Install the oil pipe with the bolt, 2 union bolts and 4 new gaskets.
Torque:
Bolt
19.6 N·m (200 kgf·cm, 14 ft·lbf)
Union bolt
18 N·m (185 kgf·cm, 13 ft·lbf)

10. INSTALL CAMSHAFT OIL SEAL RETAINER

(See step 6 in cylinder head installation)

11. INSTALL TIMING PULLEYS AND TIMING BELT

(See steps 1 to 10 in timing belt installation)



12. TIGHTEN CRANKSHAFT PULLEY BOLT

Using SST, tighten the pulley nut.
SST 09213—58012 (90201—08131, 91111—50845),
09330—00021
Torque: 430 N·m (4,400 kgf·cm, 317 ft·lbf)

13. INSTALL WATER PUMP PULLEY, FAN, FLUID COUPLING AND DRIVE BELTS

(See step 7 in water pump installation in Cooling System)

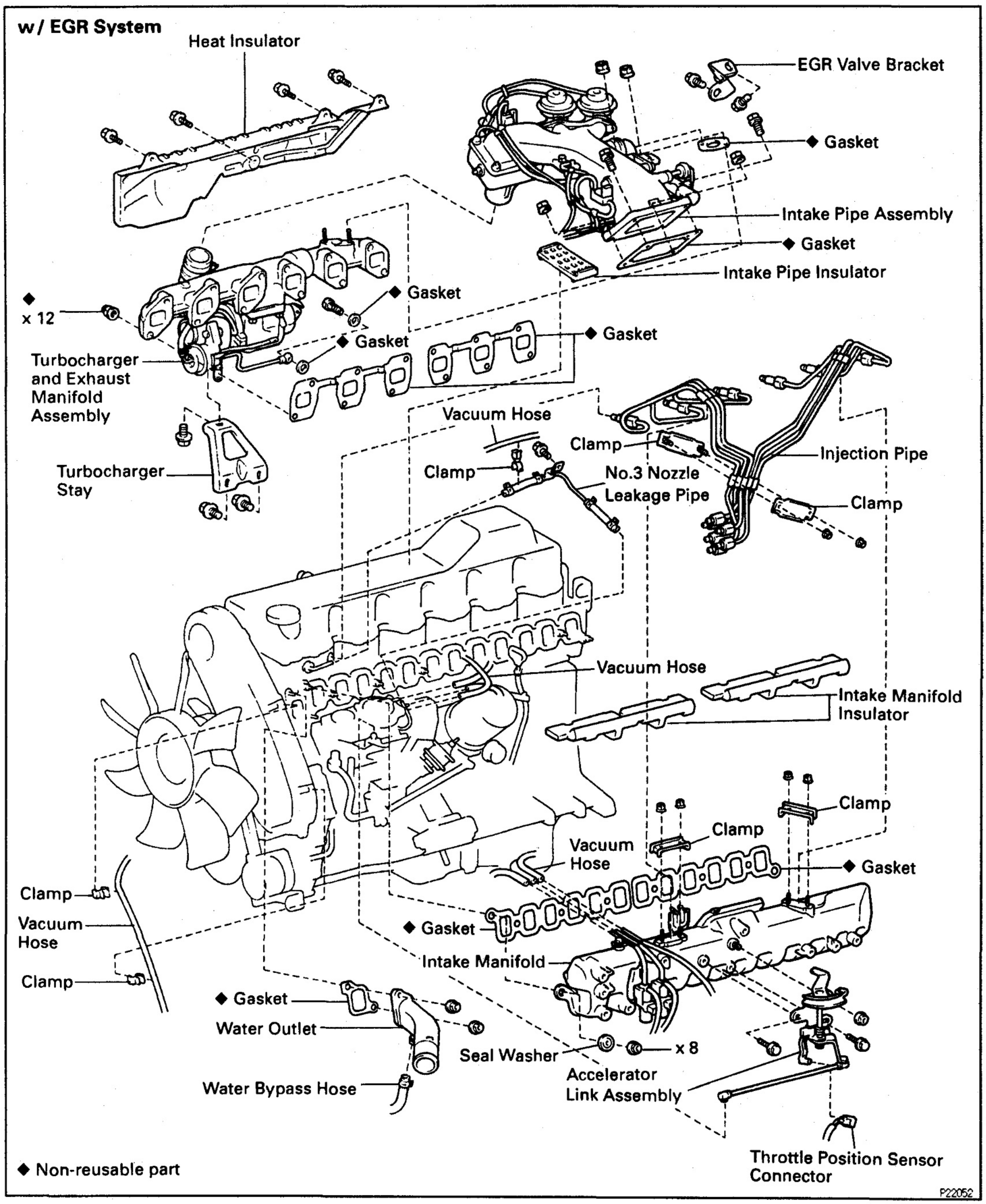
EG

EG

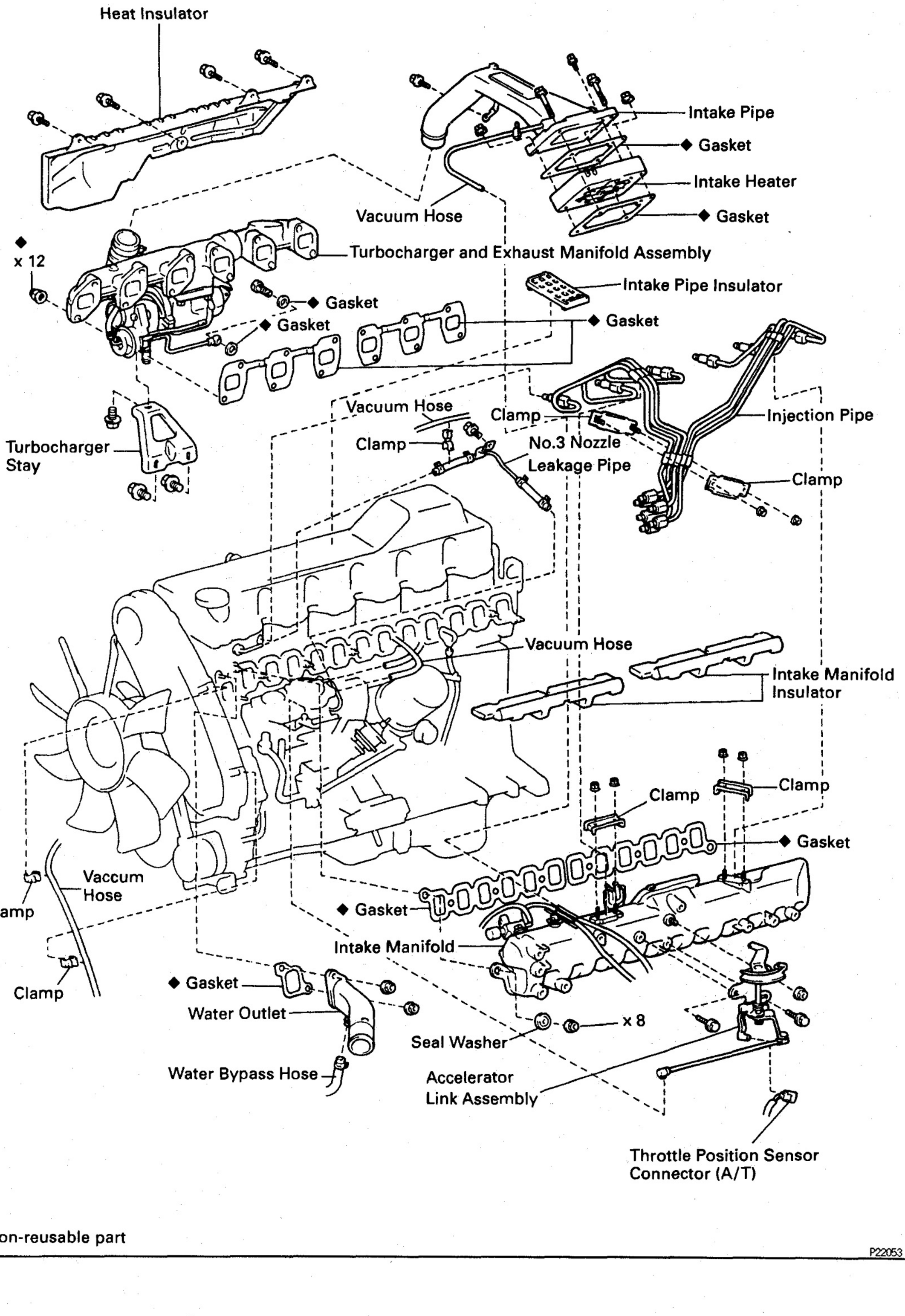
CYLINDER HEAD

COMPONENTS FOR REMOVAL AND INSTALLATION

EG8RN-01



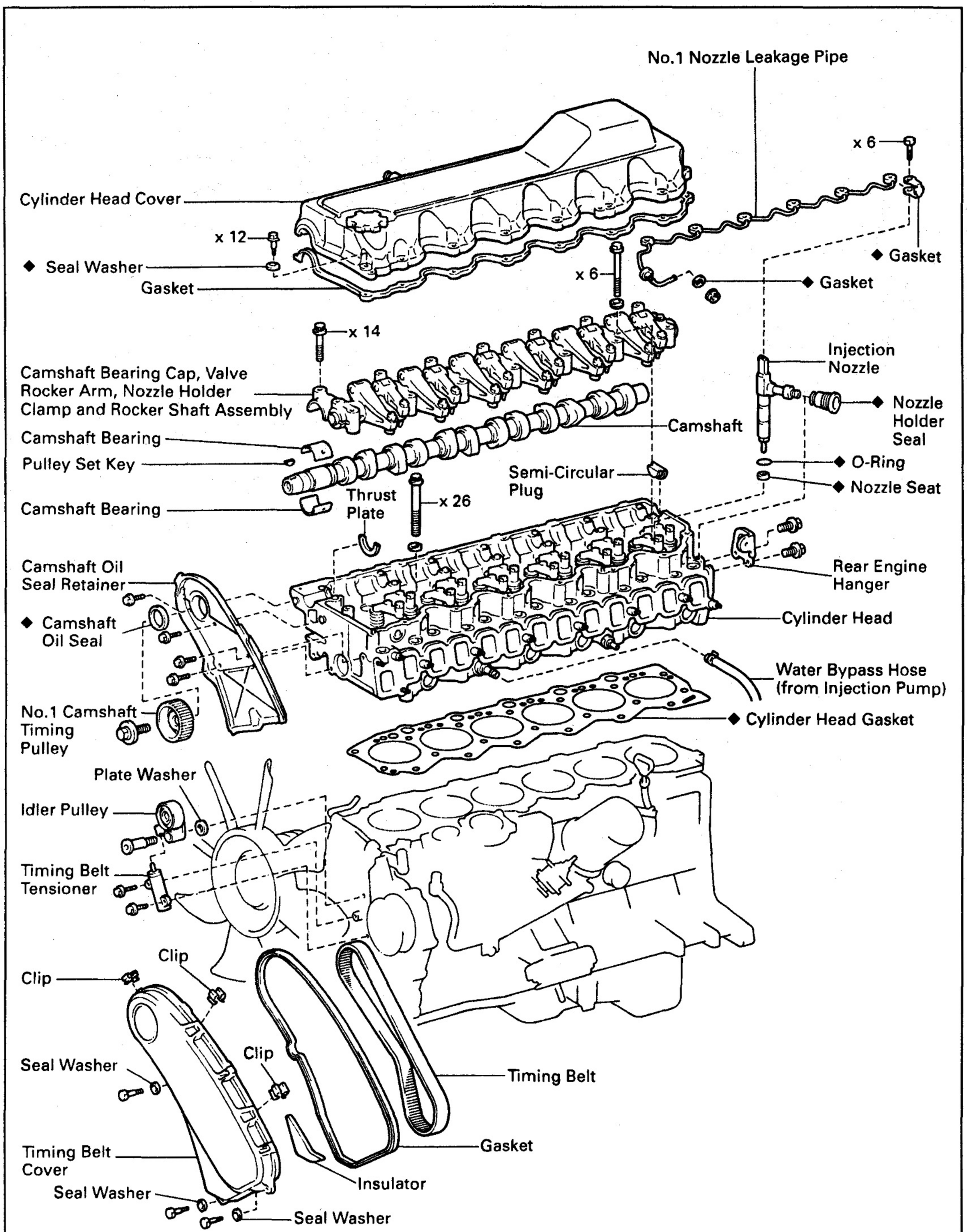
w/o EGR System



◆ Non-reusable part

P22053

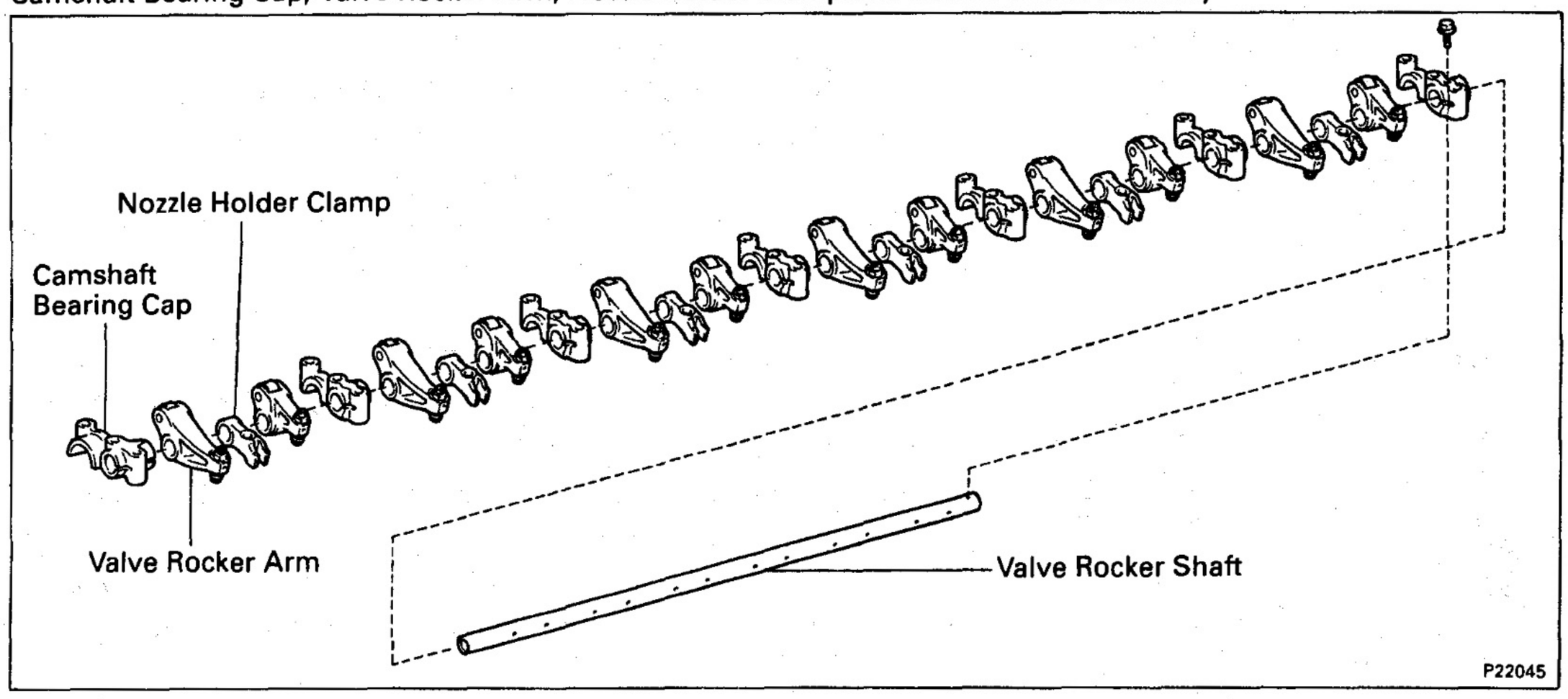
EG



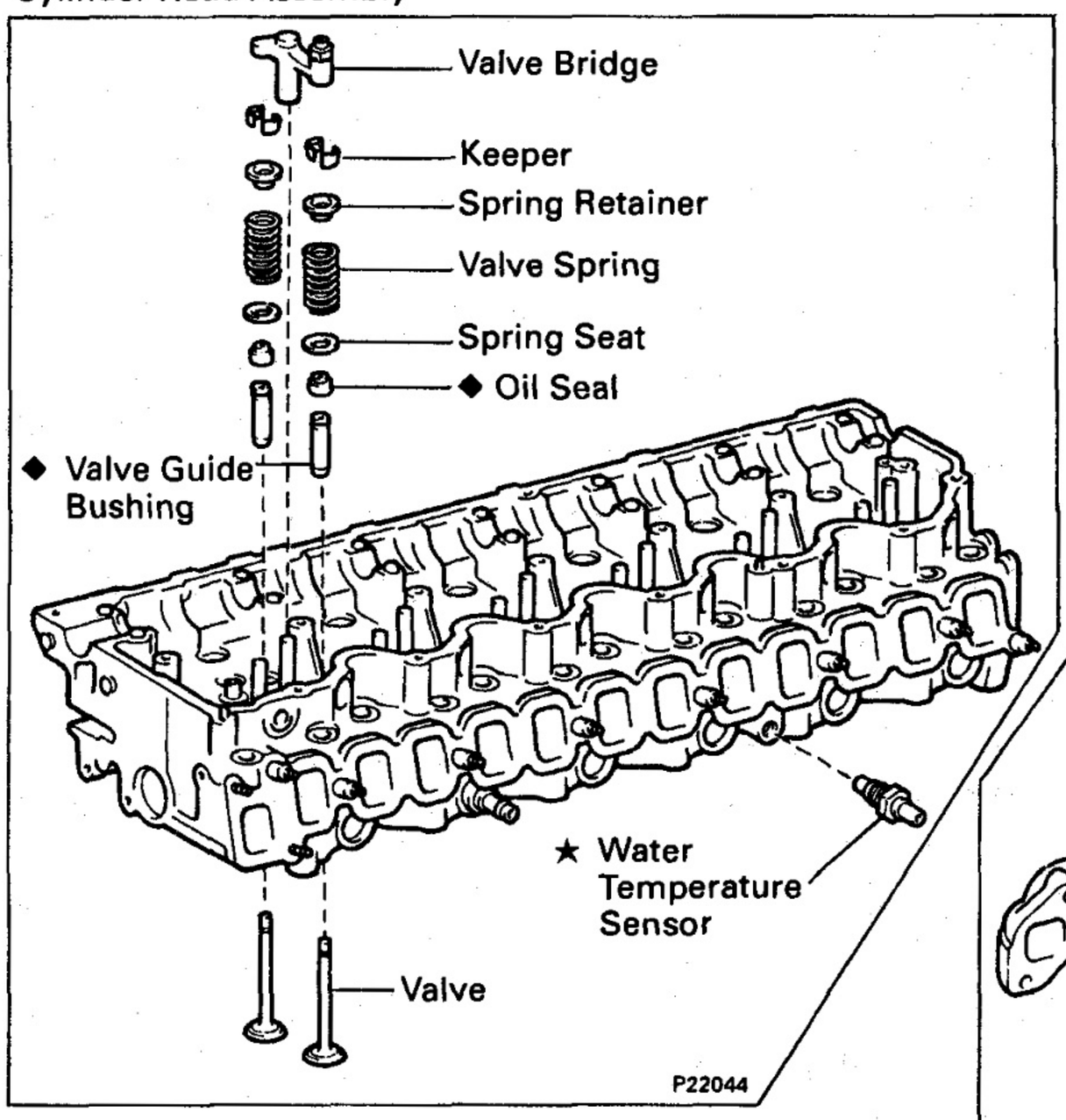
◆ Non-reusable part

P22035

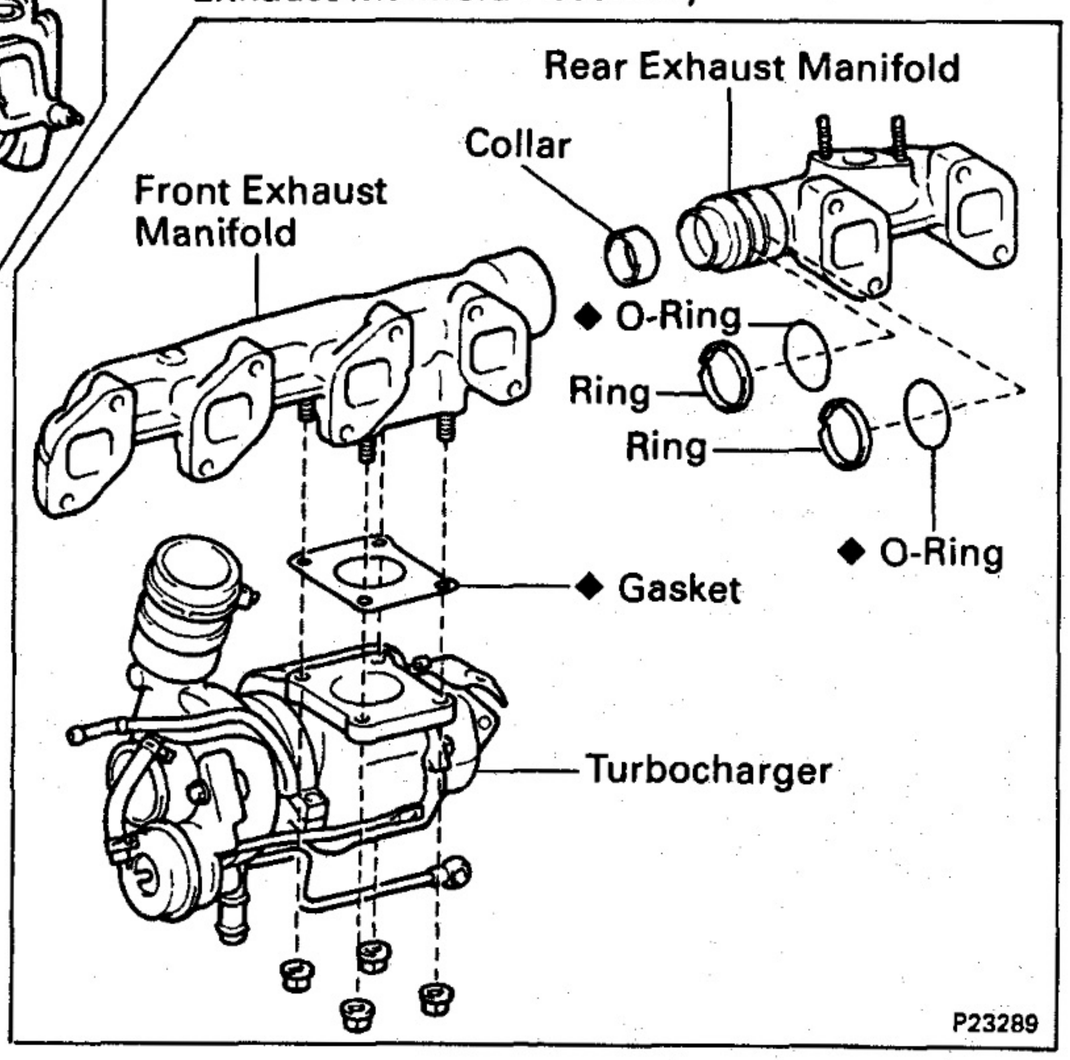
Camshaft Bearing Cap, Valve Rocker Arm, Nozzle Holder Clamp and Rocker Shaft Assembly



Cylinder Head Assembly

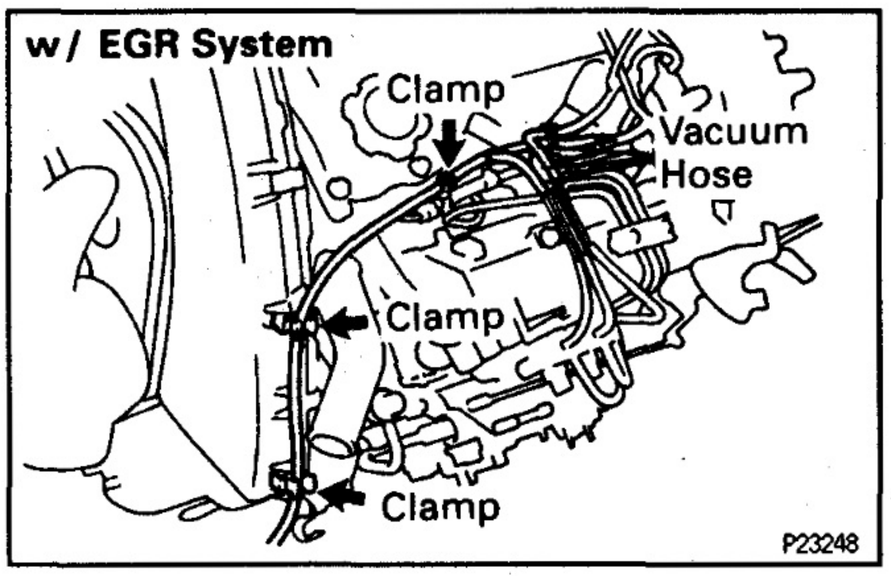


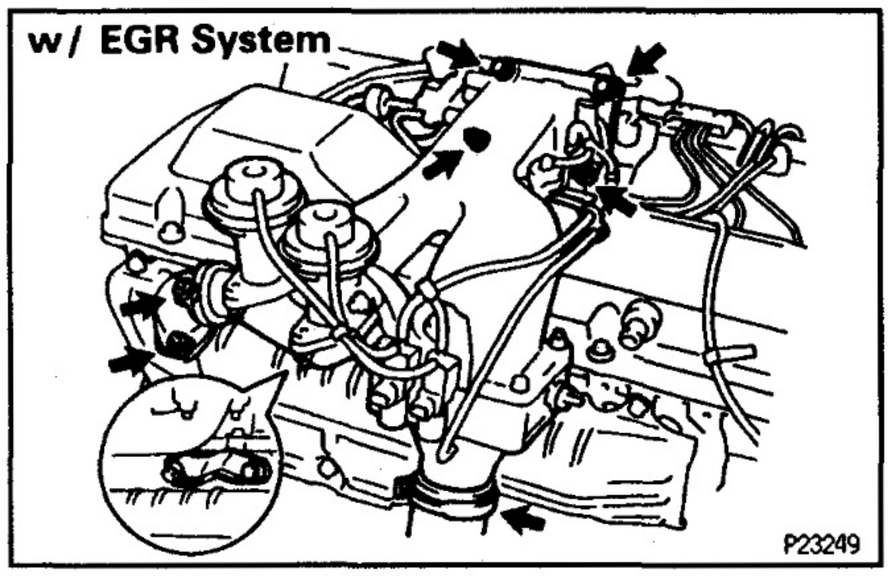
Turbocharger and Exhaust Manifold Assembly

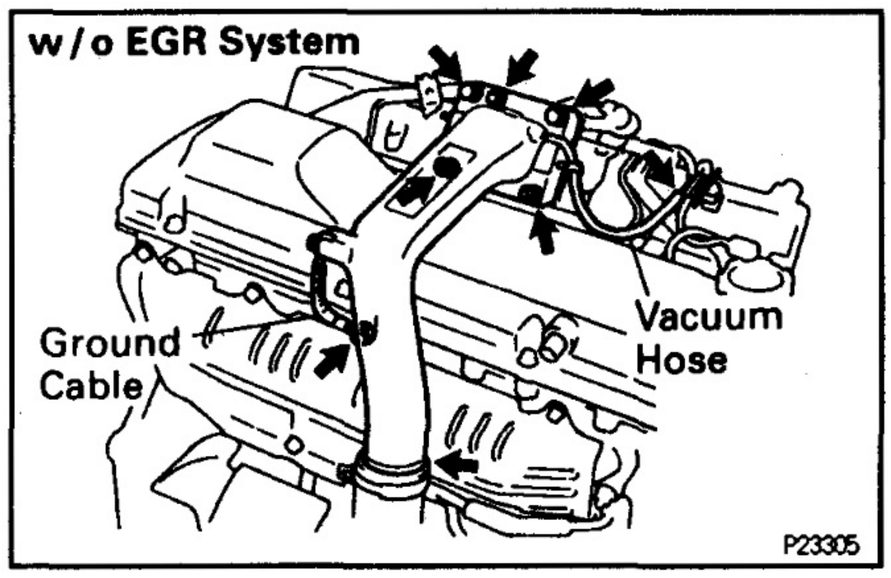


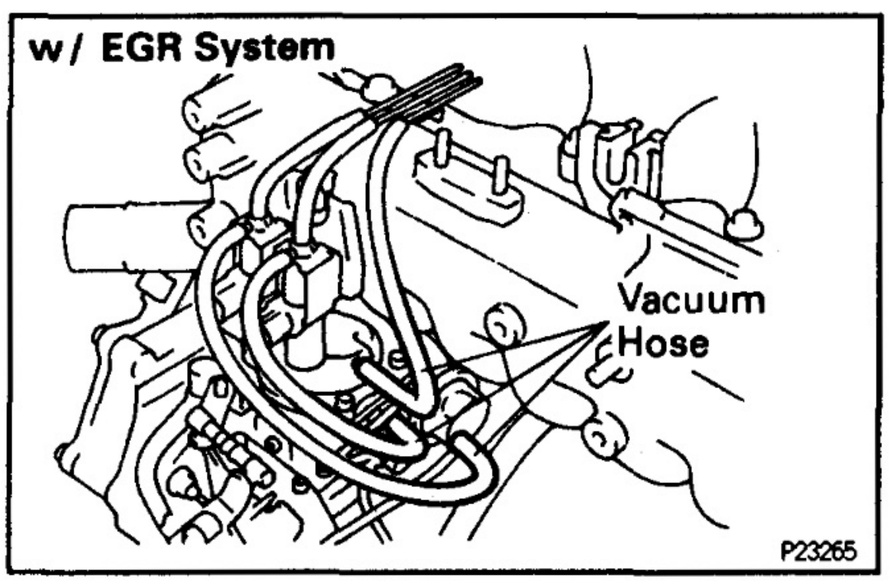
◆ Non-reusable part
★ Precoated part

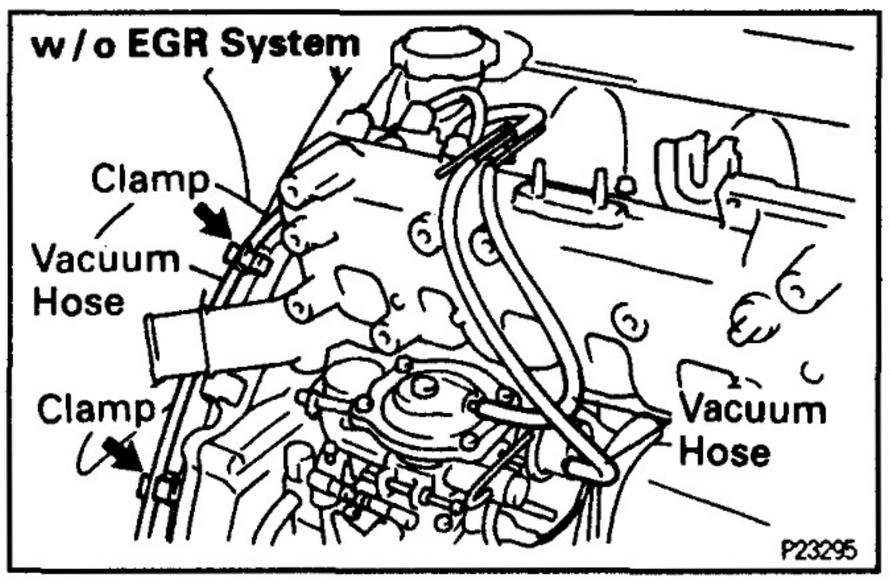
Z15508











CYLINDER HEAD REMOVAL

1. DRAIN ENGINE COOLANT

2. w/ EGR System:
REMOVE INTAKE PIPE ASSEMBLY

(a) Disconnect the 3 vacuum hoses from the vacuum pipe on the intake manifold.

(b) Disconnect the vacuum hose from the 3 clamps on the timing belt cover and fuel return hose.

(c) Remove the 2 bolts and EGR valve bracket.

(d) Remove the 2 nuts holding the EGR valve adapter to the exhaust manifold.

(e) Remove the 2 bolts and 2 nuts holding the intake pipe to the intake manifold.

(f) Disconnect the intake pipe from the air hose, and remove the intake pipe assembly, 2 gaskets and intake pipe insulator.

3. w/o EGR System:
REMOVE INTAKE PIPE AND INTAKE HEATER

(a) Disconnect the vacuum hose from the vacuum pipe on the intake manifold.

(b) Remove the bolt, and disconnect the ground cable from the cylinder head.

(c) Remove the 3 bolts and 2 nuts.

(d) Disconnect the intake pipe from the air hose, and remove the intake pipe, intake heater, 2 gaskets and intake pipe insulator.

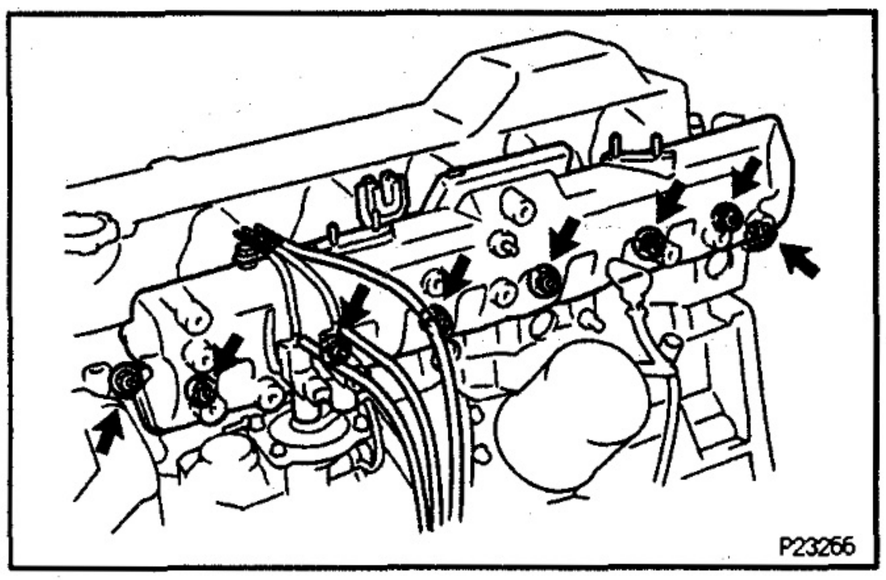
4. REMOVE INJECTION PIPES
(See steps 3 and 5 in injection nozzles removal in Fuel System)

5. REMOVE INTAKE MANIFOLD

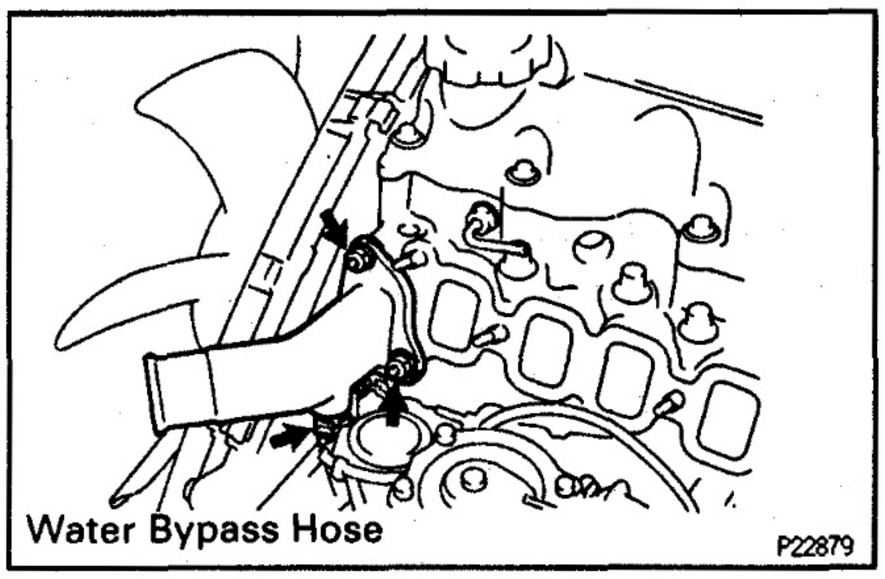
(a) w/ EGR System:
Disconnect the 3 vacuum hose from the injection pump.

(b) w/o EGR System:
Disconnect these vacuum hose:

- 2 vacuum hoses from injection pump
- Vacuum hose from 2 clamps on timing belt cover



(c) Remove the 8 nuts, 8 seal washers, intake manifold and 2 gaskets.



6. REMOVE WATER OUTLET

(a) Remove the 2 nuts.

(b) Disconnect the water bypass hose from the water outlet, and remove the water outlet.

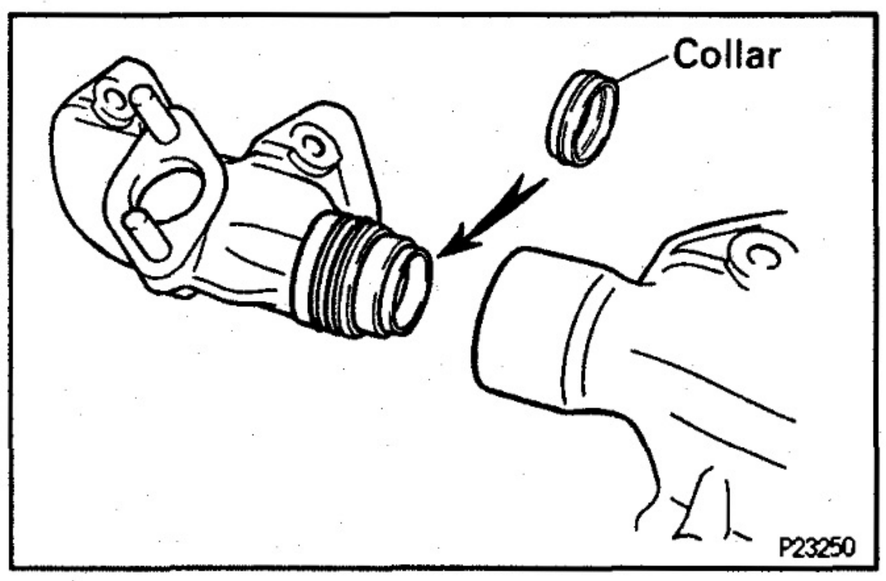
(c) Remove the gasket.

7. REMOVE TURBOCHARGER AND EXHAUST MANIFOLDS ASSEMBLY

(See steps 3 to 5, 7 and 8 in turbocharger removal in Turbocharger System)

8. REMOVE EXHAUST MANIFOLDS FROM TURBOCHARGER

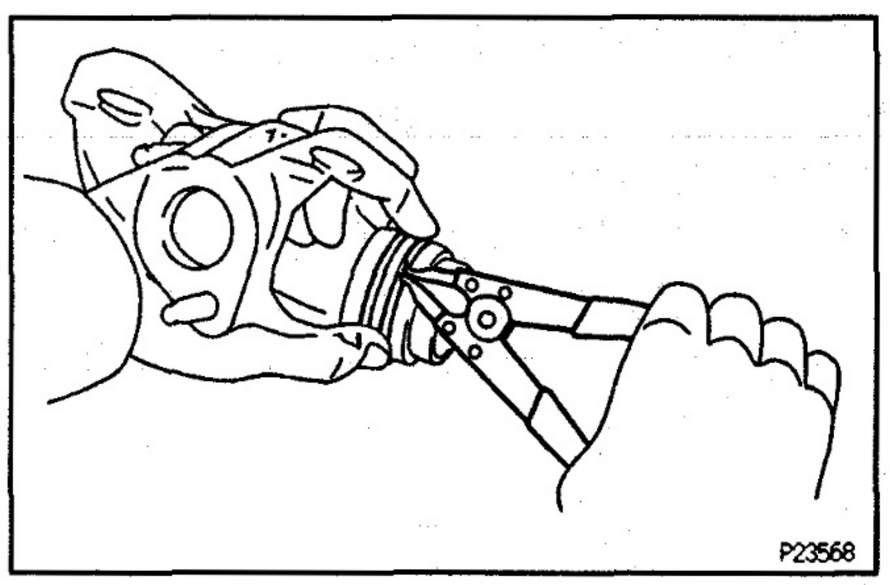
(See step 10 in turbocharger removal in Turbocharger System)



9. SEPARATE EXHAUST MANIFOLDS

(a) Separate the front and rear exhaust manifolds.

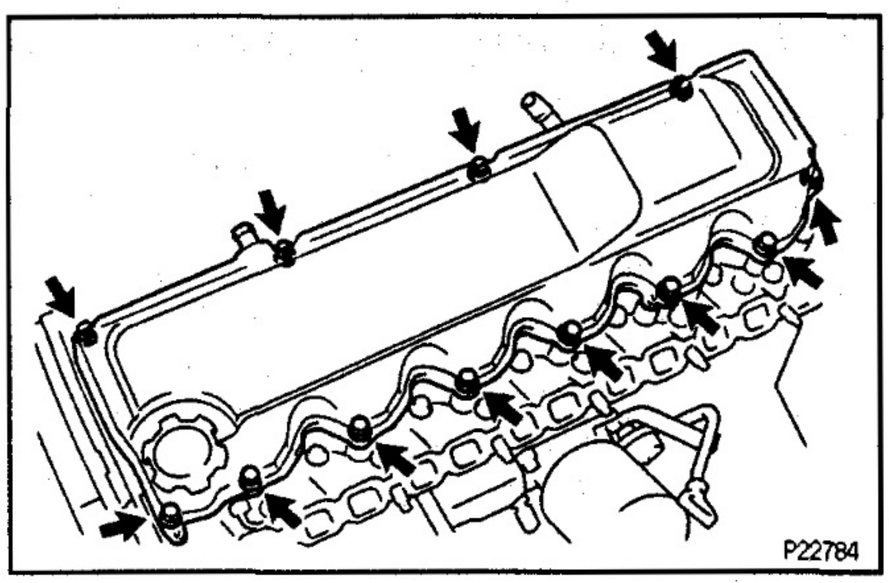
(b) Remove the collar.



(c) Using snap ring pliers, remove the 2 rings from the rear exhaust manifold.

(d) Remove all the O–ring materials from the rear exhaust manifold grooves.

10. REMOVE REAR ENGINE HANGER



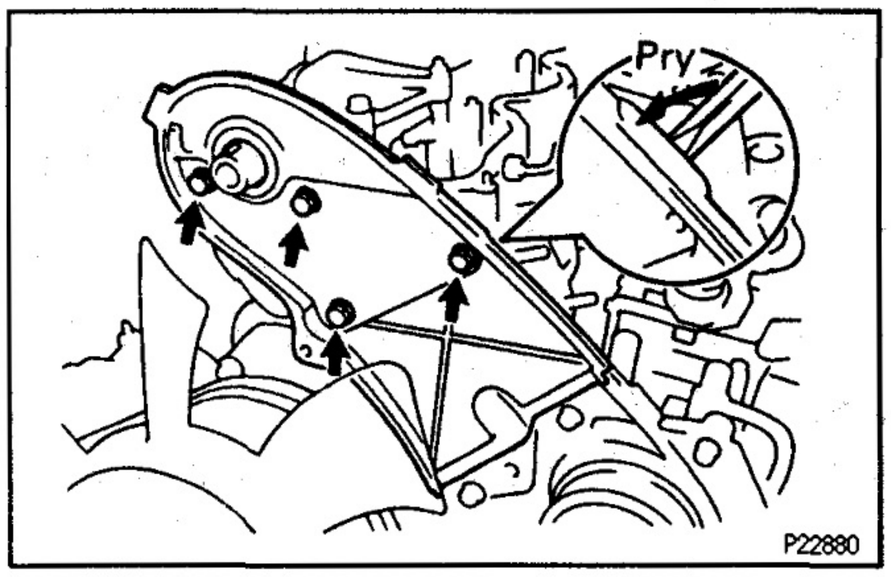
11. REMOVE CYLINDER HEAD COVER

Remove the 12 bolts, 12 seal washers, cylinder head cover and gasket.

12. REMOVE SEMI–CIRCULAR PLUG

13. REMOVE TIMING BELT AND PULLEYS

(See steps 1 to 4 and 7 in timing belt removal)



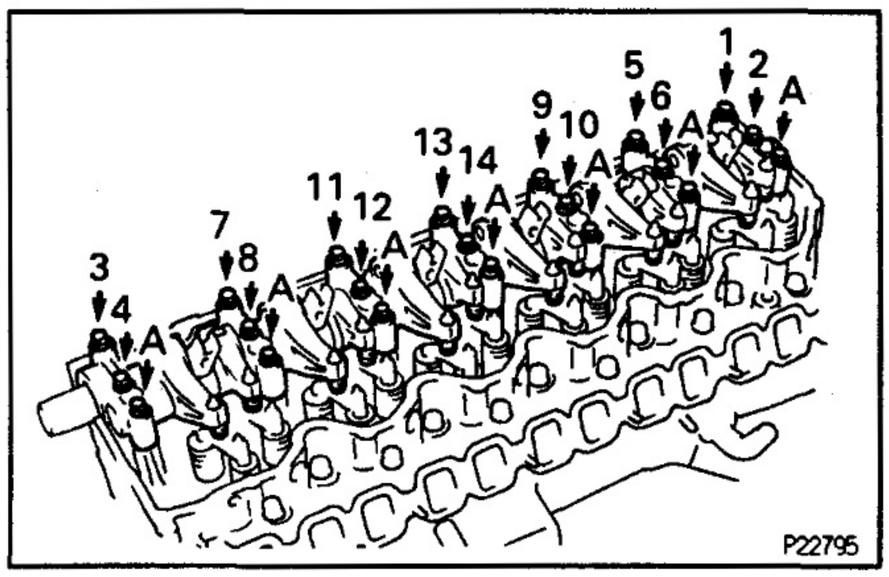
14. REMOVE CAMSHAFT OIL SEAL RETAINER

(a) Remove the 4 bolts.

(b) Pry out the oil seal retainer.

15. REMOVE INJECTION NOZZLES

(See steps 4, 6 and 7 in injection nozzles removal in Fuel System)



16. REMOVE CAMSHAFT BEARING CAPS, VALVE ROCKER ARMS, NOZZLE HOLDER CLAMPS, ROCKER SHAFT ASSEMBLY AND CAMSHAFT

(a) Remove the 7 bolts (A).

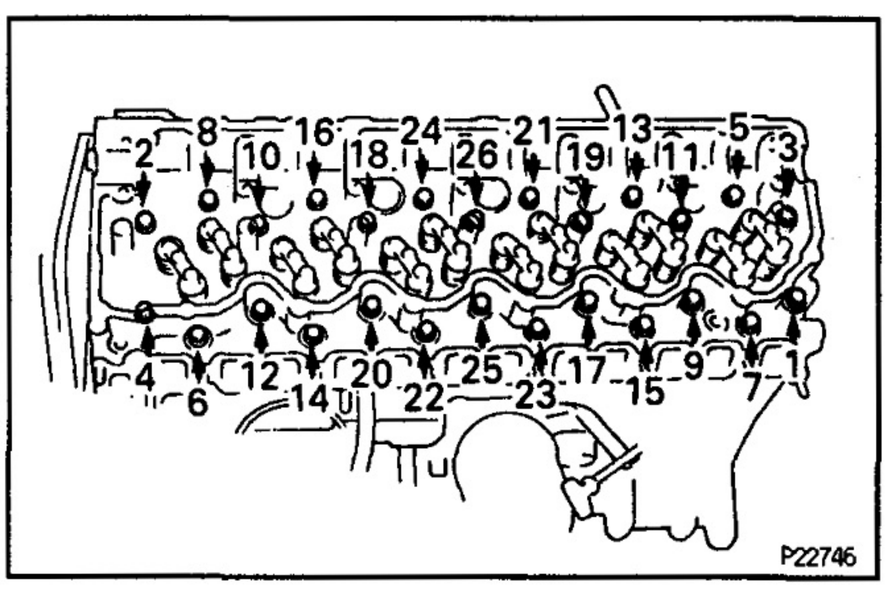
(b) Uniformly loosen and remove the 14 other bolts in several passes, in the sequence shown.

(c) Remove the 7 bearing caps, 12 rocker arms, 6 holder clamps, rocker shaft assembly and 7 upper camshaft bearings.

- Keep the bearing caps, rocker arms and nozzle holder clamps installed with the rocker shaft.
- Keep the bearings inserted with the bearing cap.

(d) Remove the camshaft, thrust plate and 7 lower camshaft bearings.

HINT: Arrange the bearings in correct order.

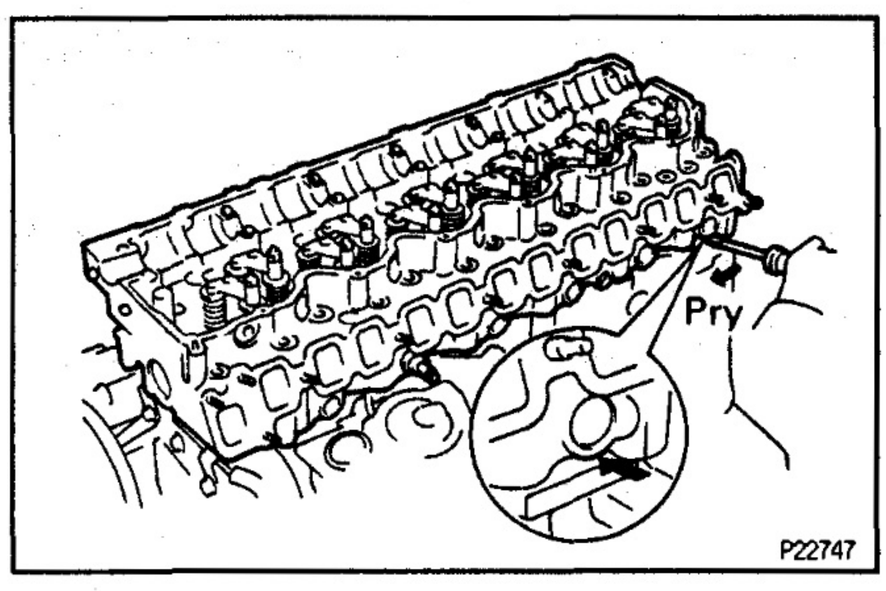


17. REMOVE CYLINDER HEAD ASSEMBLY

(a) Disconnect the water bypass hose (from the injection pump) from the cylinder head.

(b) Uniformly loosen and remove the 26 cylinder head bolts in several passes, in the sequence shown.

NOTICE: Head warpage or cracking could result from removing bolts in incorrect order.

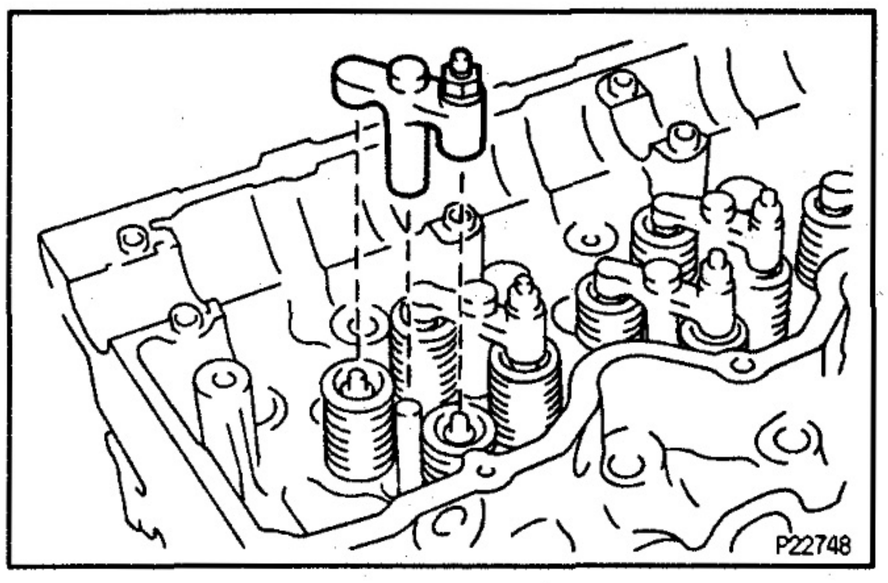


(c) Lift the cylinder head from the dowels on the cylinder block, and place the cylinder head on wooden blocks on a bench.
HINT: If the cylinder head is difficult to lift off, pry with a screwdriver between the cylinder head and block.
NOTICE: Be careful not to damage the contact surfaces of the cylinder head and cylinder block.

EG

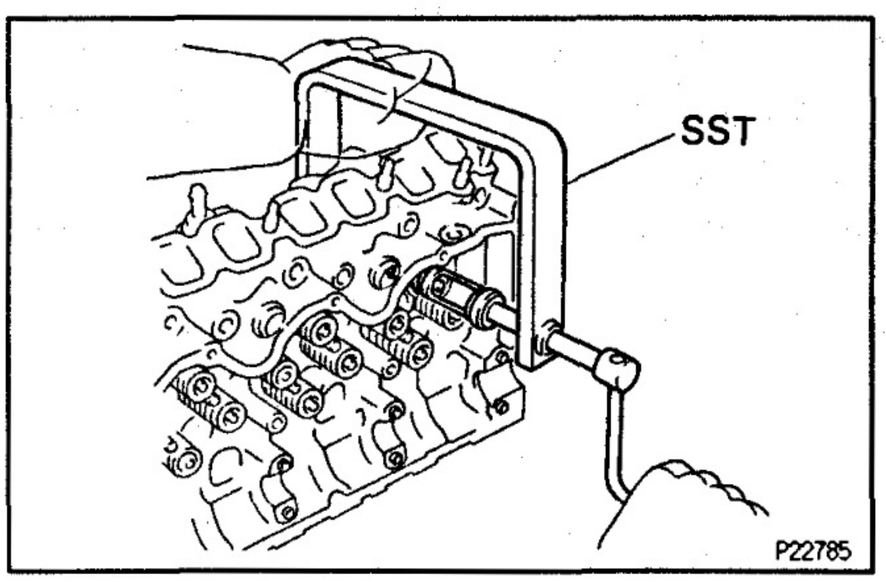
EG5RQ–01

CYLINDER HEAD DISASSEMBLY



1. REMOVE WATER TEMPERATURE SENDER GAUGE

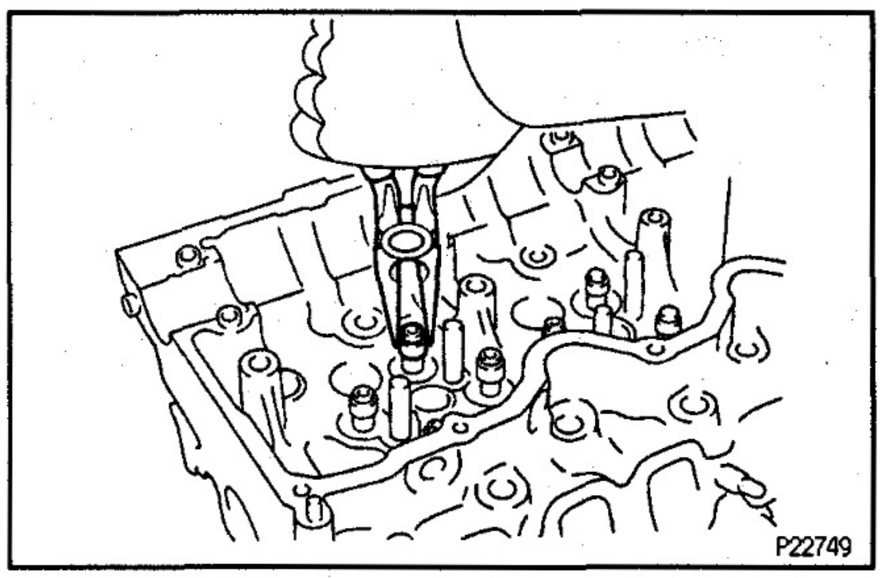
2. REMOVE VALVE BRIDGE
HINT: Arrange the valve bridge in correct order.



3. REMOVE VALVES

(a) Using SST, compress the valve spring and remove the 2 keepers.
SST 09202–70020 (09202–00010)

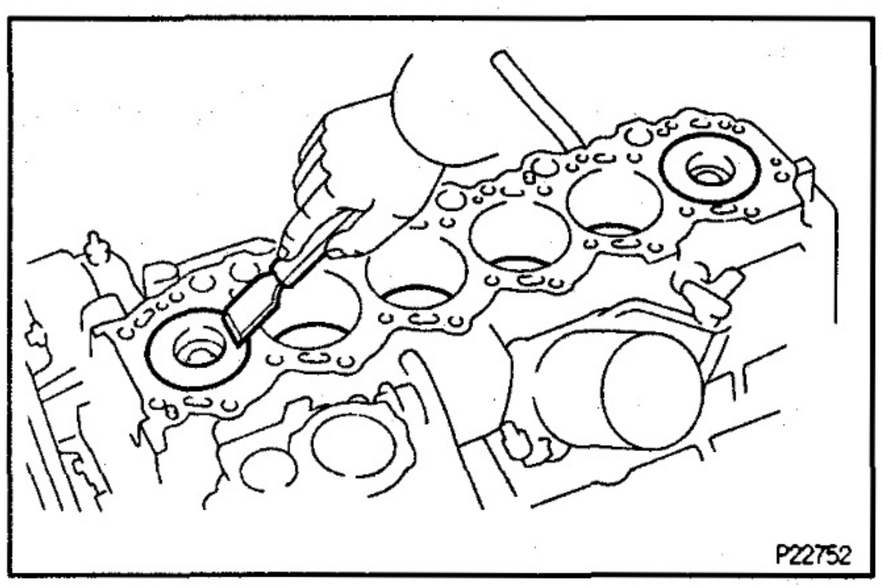
(b) Remove the spring retainer, valve spring, valve and spring seat.
HINT: Arrange the valves, valve springs, spring seats and spring retainers in correct order.



(c) Using needle–nose pliers, remove the oil seal.

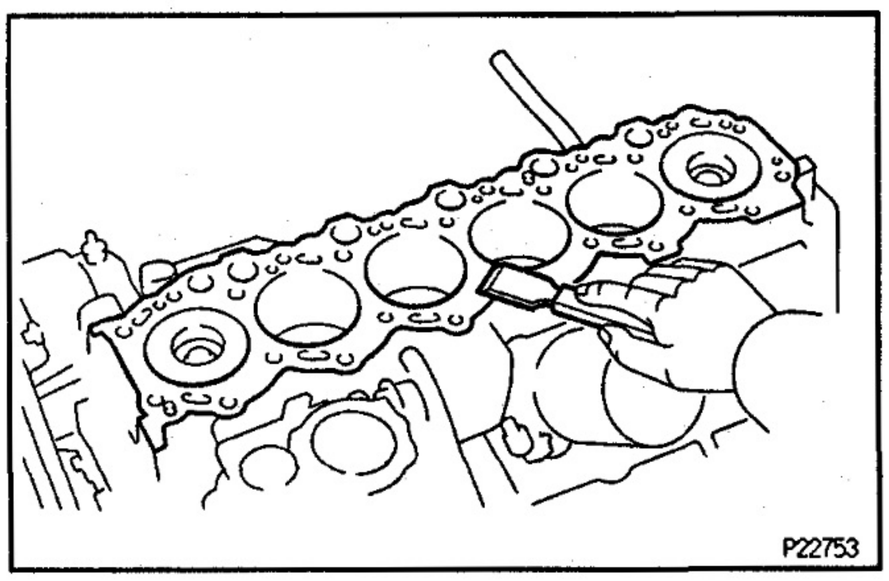
EG5TC–01

CYLINDER HEAD COMPONENTS INSPECTION AND REPAIR



1. CLEAN TOP SURFACES OF PISTONS AND CYLINDER BLOCK

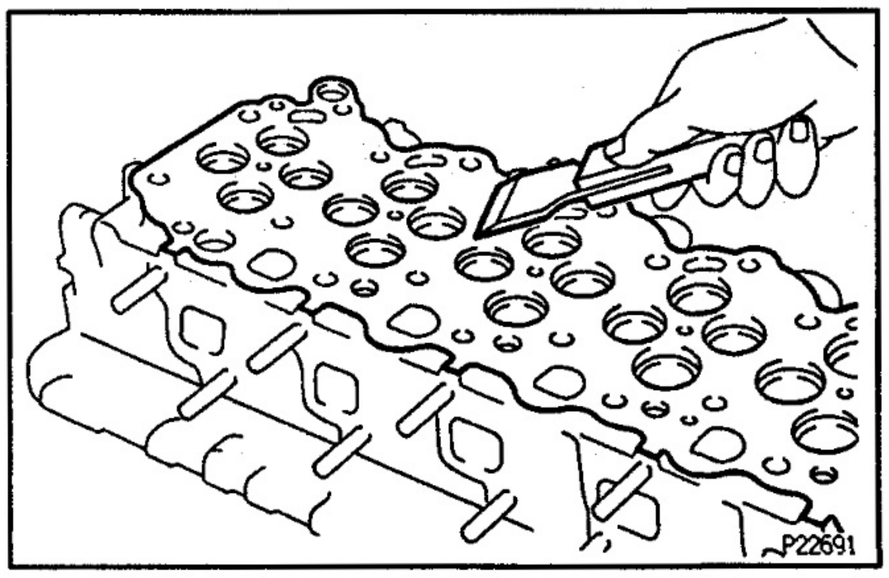
(a) Turn the crankshaft, and bring each piston to the top dead center (TDC). Using a gasket scraper, remove all the carbon from the piston top surface.



(b) Remove all the gasket material from the top of the cylinder block.
NOTICE: Be careful not to scratch the surfaces.

(c) Using compressed air, blow carbon and oil from the bolt holes.
CAUTION: Protect your eyes when using high — compressed air.

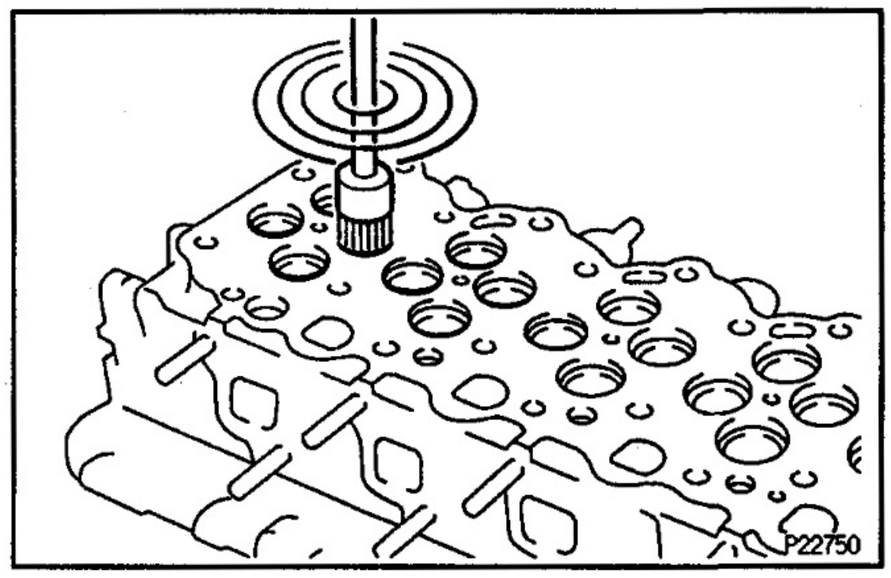
EG



2. CLEAN CYLINDER HEAD

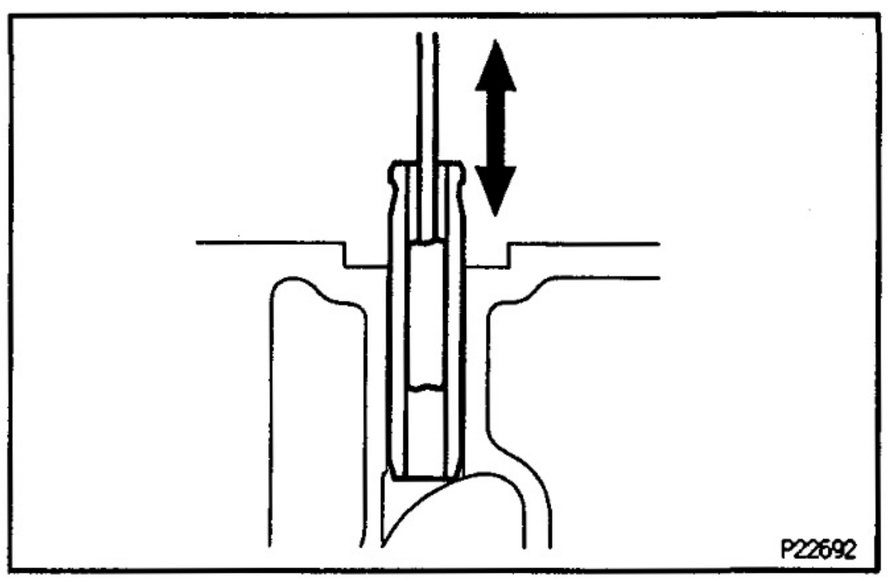
A. Remove gasket material

Using a gasket scraper, remove all the gasket material from the cylinder block contact surface.
NOTICE: Be careful not to scratch the cylinder block contact surface.



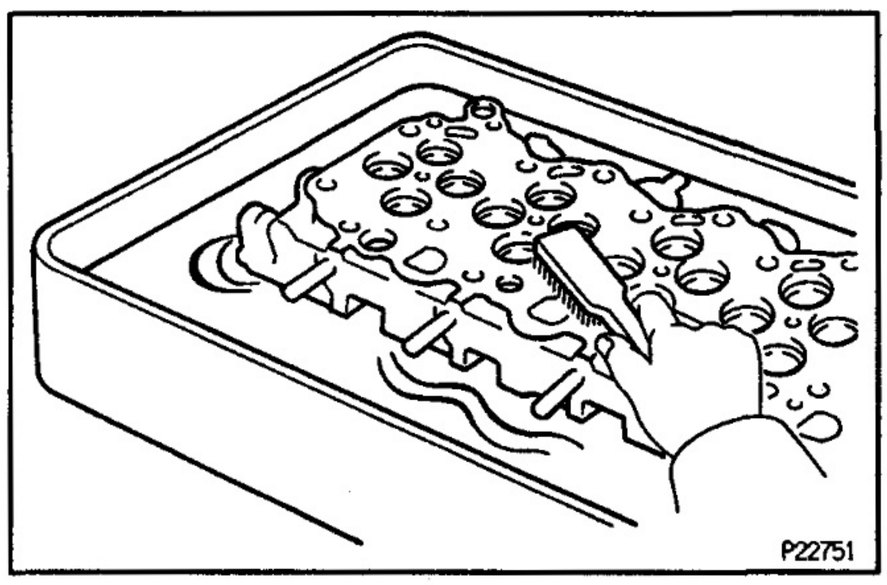
B. Clean intake and exhaust ports

Using a wire brush, remove all the carbon from the intake and exhaust ports.
NOTICE: Be careful not to scratch the valve contact surface.



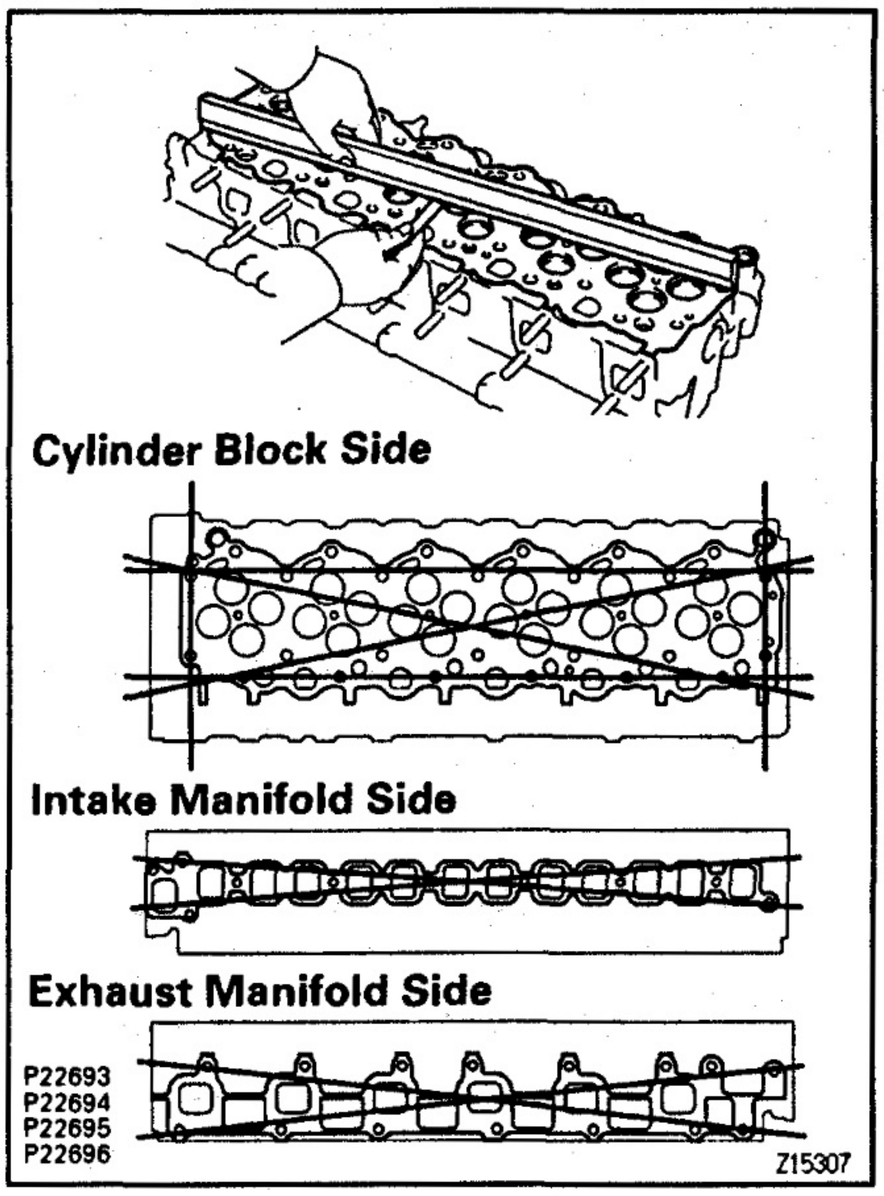
C. Clean valve guide bushings

Using a valve guide bushing brush and solvent, clean all the guide bushings.



D. Clean cylinder head

Using a soft brush and solvent, thoroughly clean the cylinder head.



3. INSPECT CYLINDER HEAD

A. Inspect for flatness

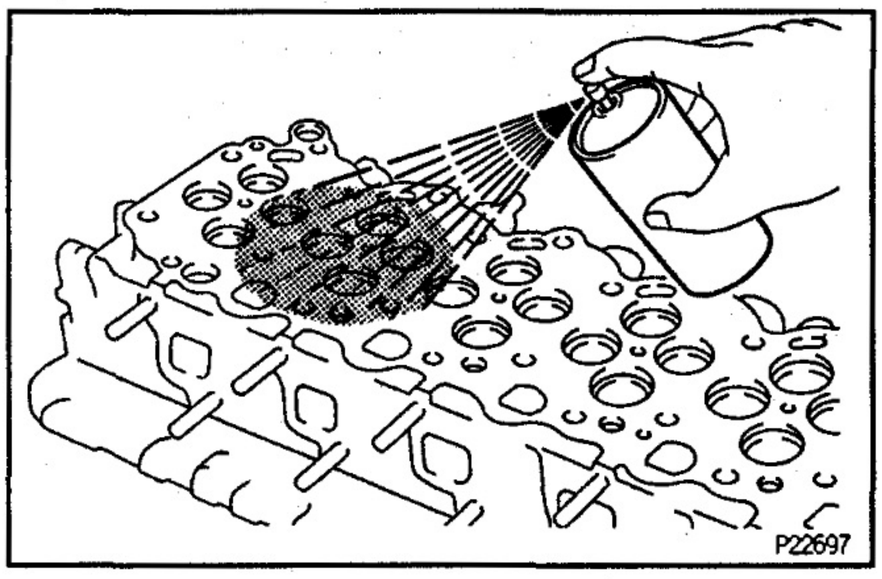
Using a precision straight edge and thickness gauge, measure the surfaces contacting the cylinder block and the manifolds for warpage.

Maximum warpage:

0.20 mm (0.0079 in.)

If warpage is greater than maximum, replace the cylinder head.

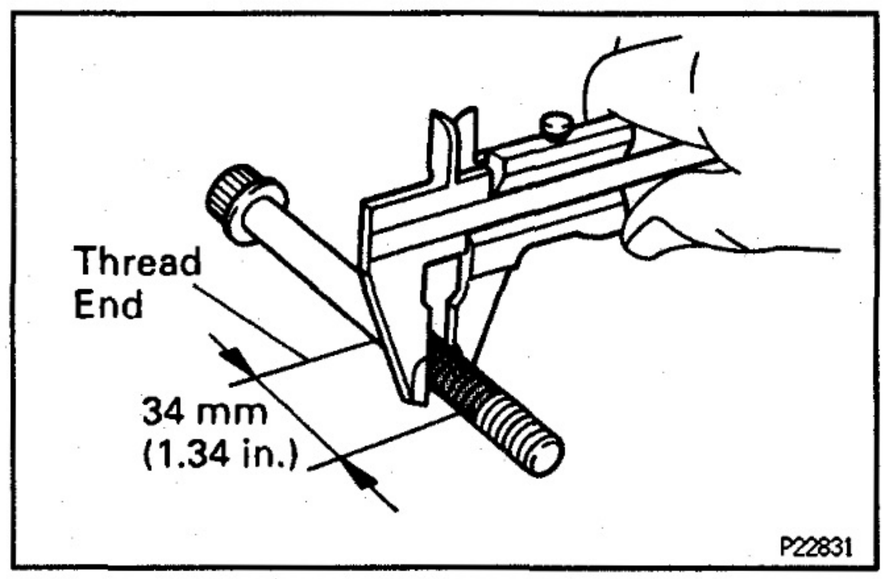
EG



B. Inspect for cracks

Using a dye penetrant, check the intake ports, exhaust ports and surface contacting the cylinder block.

If cracked, replace the cylinder head.



C. Inspect cylinder head bolts

Using vernier calipers, measure the minimum outer diameter of the compressed thread at the measuring point.

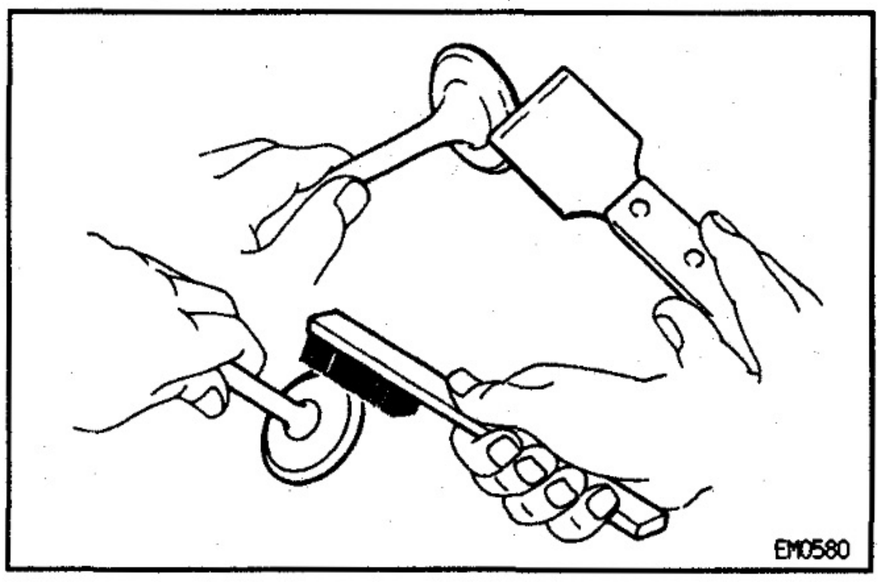
Standard outer diameter:

10.800 — 11.000 mm (0.4252 — 0.4331 in.)

Minimum outer diameter:

10.55 mm (0.4154 in.)

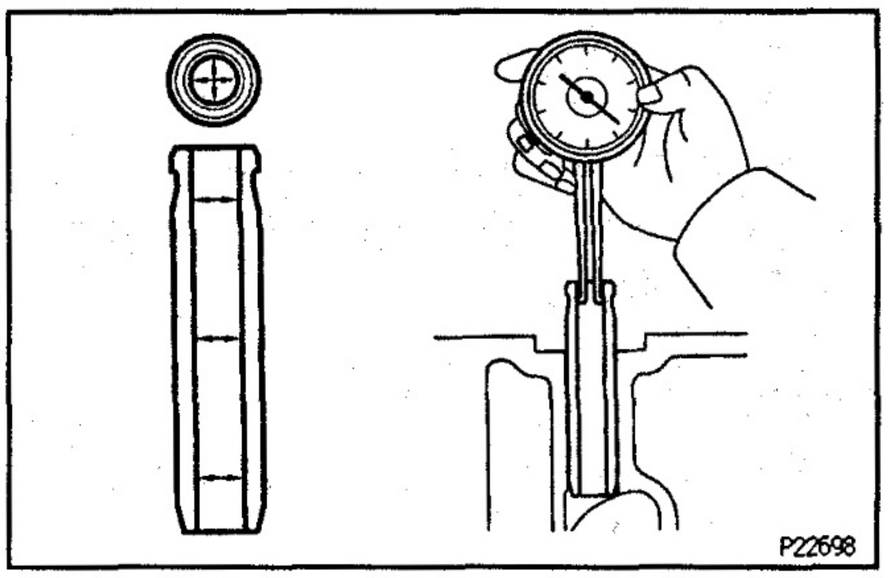
If the outer diameter is less than minimum, replace the bolt.



4. CLEAN VALVES

(a) Using a gasket scraper, chip off any carbon from the valve head.

(b) Using a wire brush, thoroughly clean the valve.

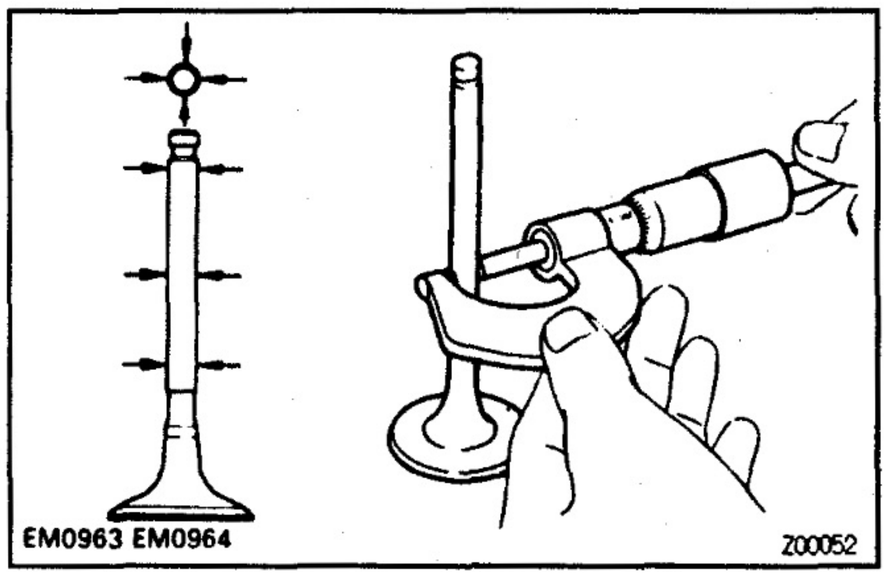


5. INSPECT VALVE STEMS AND GUIDE BUSHINGS

(a) Using a caliper gauge, measure the inside diameter of the guide bushing.

Bushing inside diameter:

7.010 – 7.030 mm (0.2760 – 0.2768 in.)



(b) Using a micrometer, measure the diameter of the valve stem.

Valve stem diameter:

Intake

6.970 – 6.985 mm (0.2744 – 0.2750 in.)

Exhaust

6.960 – 6.975 mm (0.2740 – 0.2746 in.)

(c) Subtract the valve stem diameter measurement from the guide bushing inside diameter measurement.

Standard oil clearance:

Intake

0.025 – 0.060 mm (0.0010 – 0.0024 in.)

Exhaust

0.035 – 0.070 mm (0.0014 – 0.0028 in.)

Maximum oil clearance:

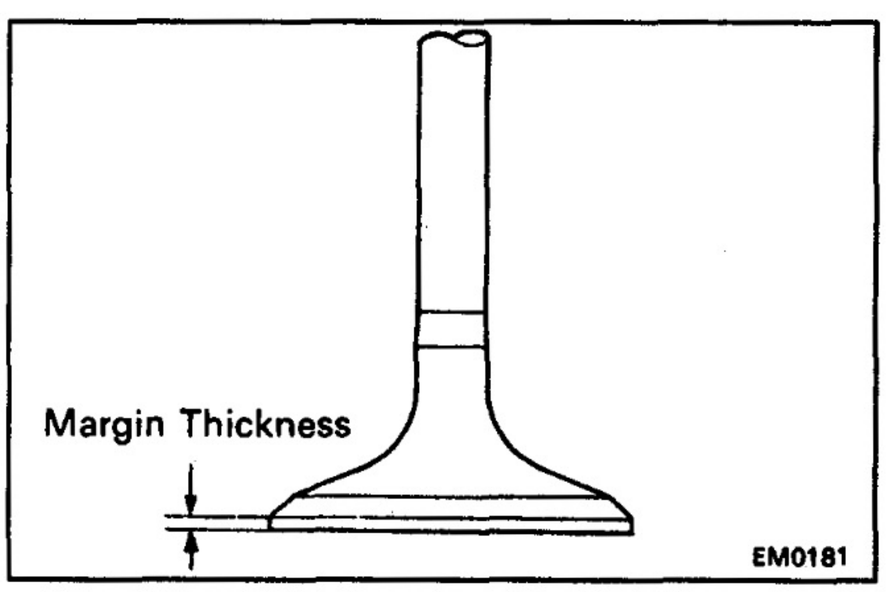
Intake

0.08 mm (0.0031 in.)

Exhaust

0.10 mm (0.0039 in.)

If the clearance is greater than maximum, replace the valve and cylinder head.



6. INSPECT AND GRIND VALVES

(a) Check the valve face for wear.

If the valve face is worn, replace the valve.

(b) Check the valve head margin thickness.

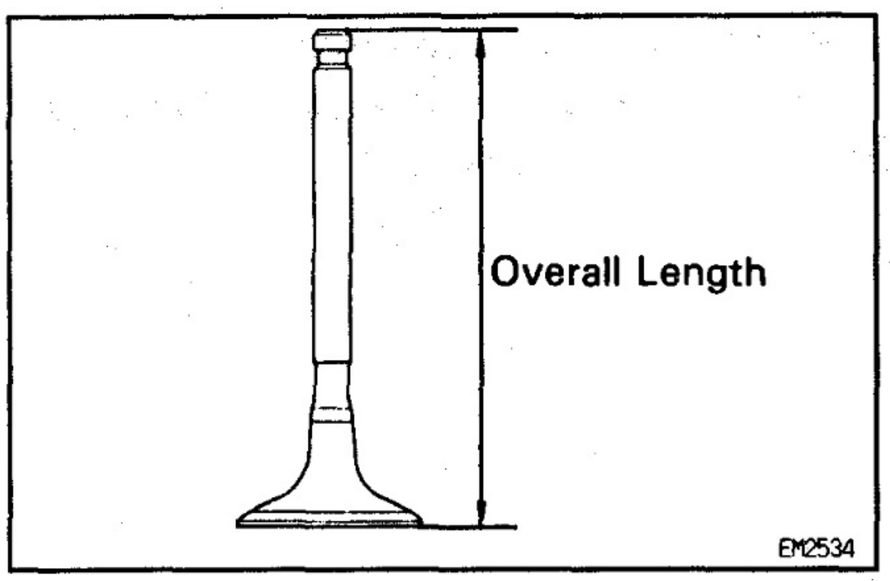
Standard margin thickness:

1.00 mm (0.0394 in.)

Minimum margin thickness:

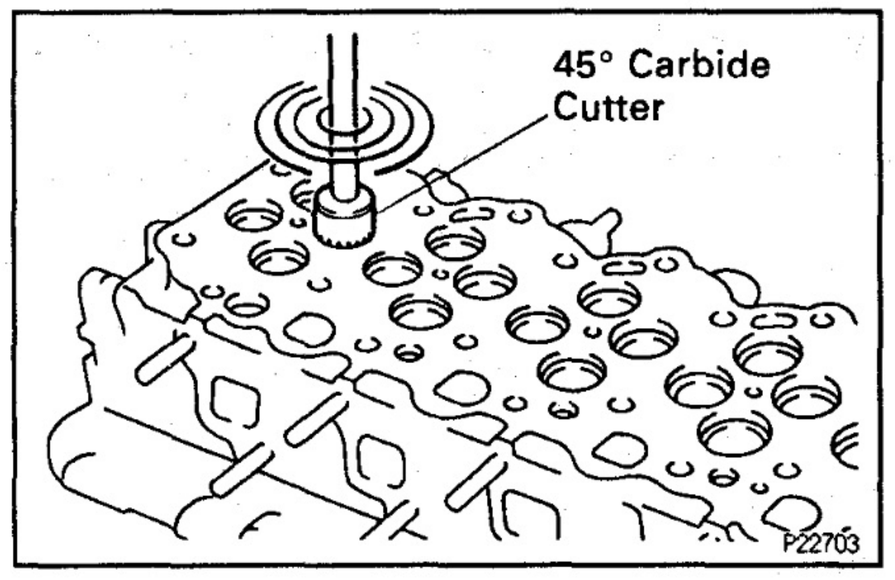
0.83 mm (0.0327 in.)

If the margin thickness is less than minimum, replace the valve.



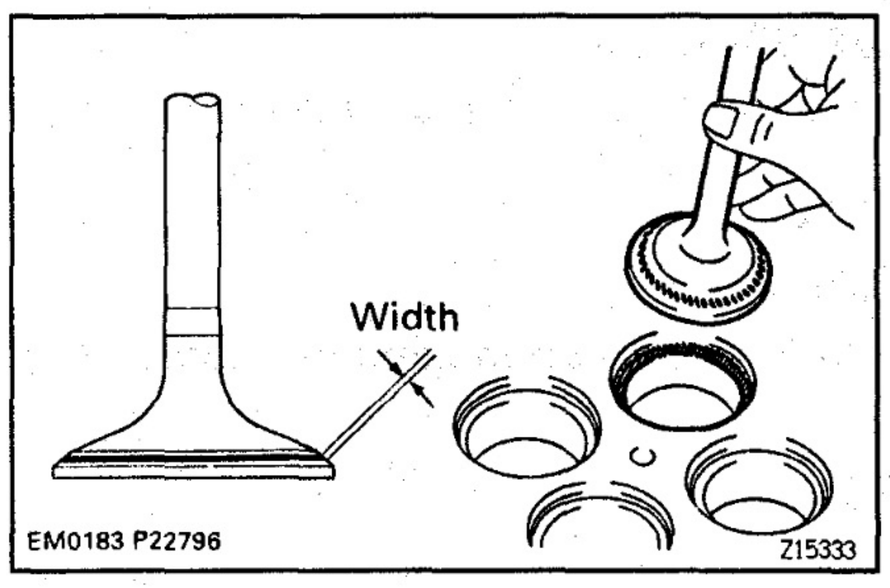
(c) Check the valve overall length.
Standard overall length:
Intake
126.85 – 127.45 mm (4.9941 – 5.0177 in.)
Exhaust
126.43 – 127.03 mm (4.9775 – 5.0012 in.)
Minimum overall length:
Intake
126.85 mm (4.9941 in.)
Exhaust
126.43 mm (4.9775 in.)
If the overall length is less than minimum, replace the valve.

(d) Check the valve stem tip for wear.
If the valve stem tip is worn, replace the valve.



7. INSPECT AND CLEAN VALVE SEATS

(a) Using a 45° carbide cutter, resurface the valve seats.
Remove only enough metal to clean the seats.

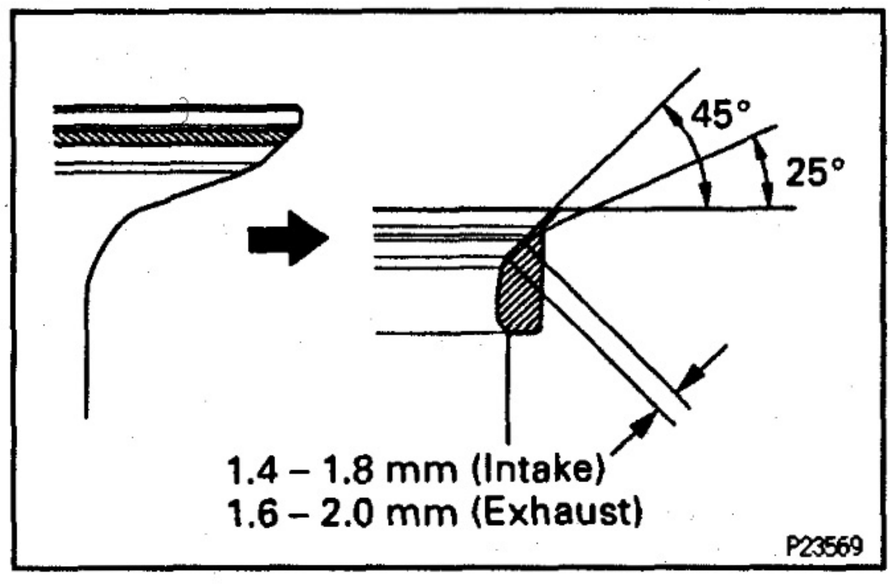


(b) Check the valve seating position.
Apply a light coat of prussian blue (or white lead) to the valve face. Lightly press the valve against the seat. Do not rotate valve.

(c) Check the valve face and seat for the following:
- If blue appears 360° around the valve face, the valve is concentric. If not, replace the valve.
- If blue appears 360° around the valve seat, the guide and face are concentric. If not, resurface the seat.
- Check that the seat contact is in the middle of the valve face with the following width:

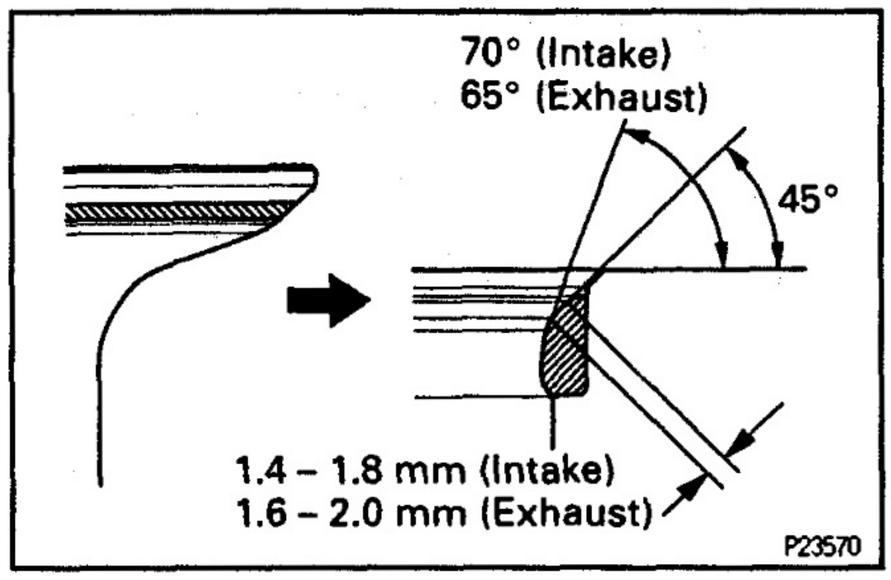
Intake
1.4 – 1.8 mm (0.055 – 0.071 in.)
Exhaust
1.6 – 2.0 mm (0.063 – 0.079 in.)

EG

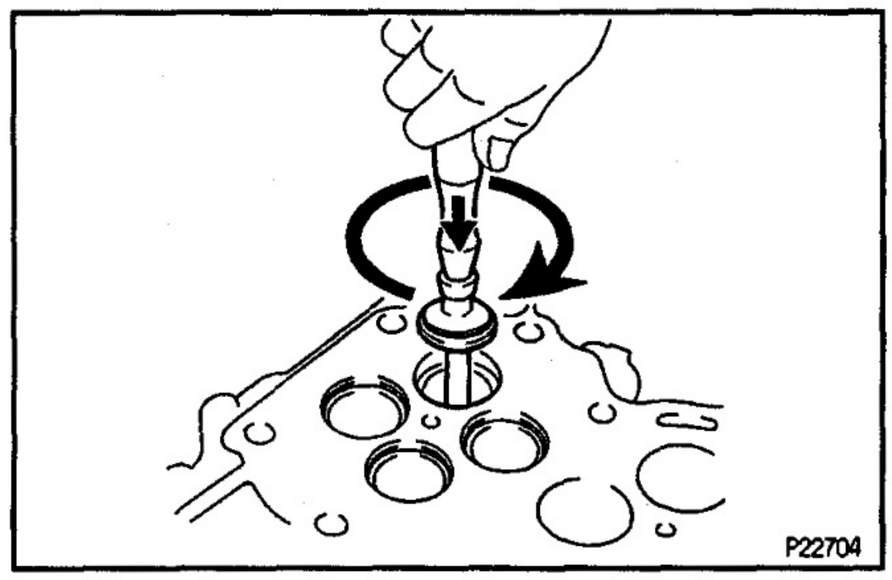


If not, correct the valve seats as follows:

(1) If the seating is too high on the valve face, use 25° and 45° cutters to correct the seat.

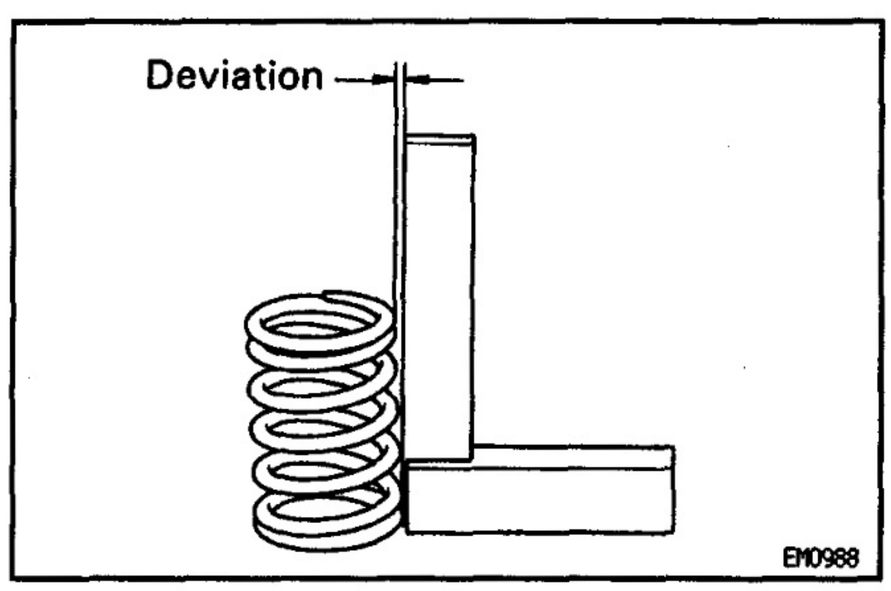


(2) If the seating is too low on the valve face, use 70° (intake) or 65° (exhaust) and 45° cutters to correct the seat.



(d) Hand—lap the valve and valve seat with an abrasive compound.

(e) After hand—lapping, clean the valve and valve seat.



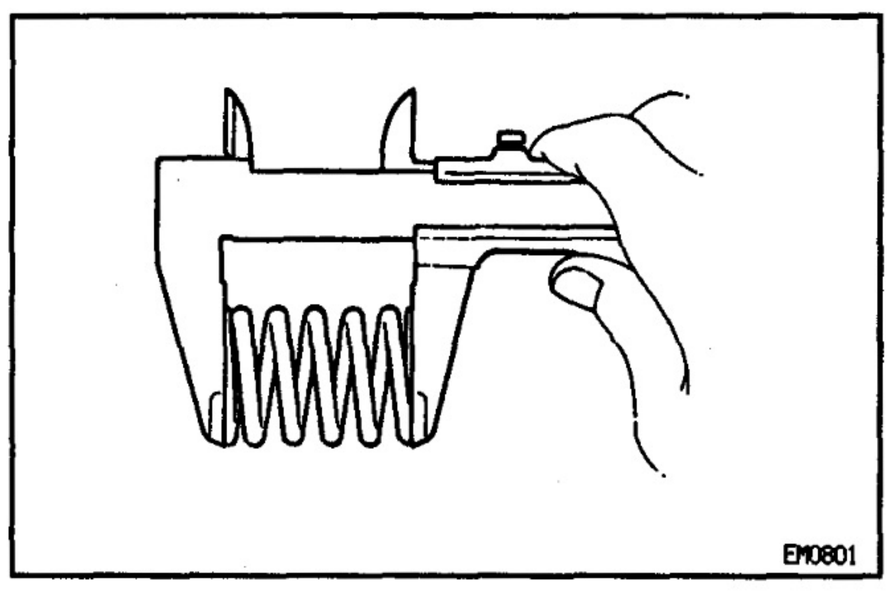
8. INSPECT VALVE SPRINGS

(a) Using a steel square, measure the deviation of the valve spring.

Maximum deviation:

2.0 mm (0.079 in.)

If the deviation is greater than maximum, replace the valve spring.

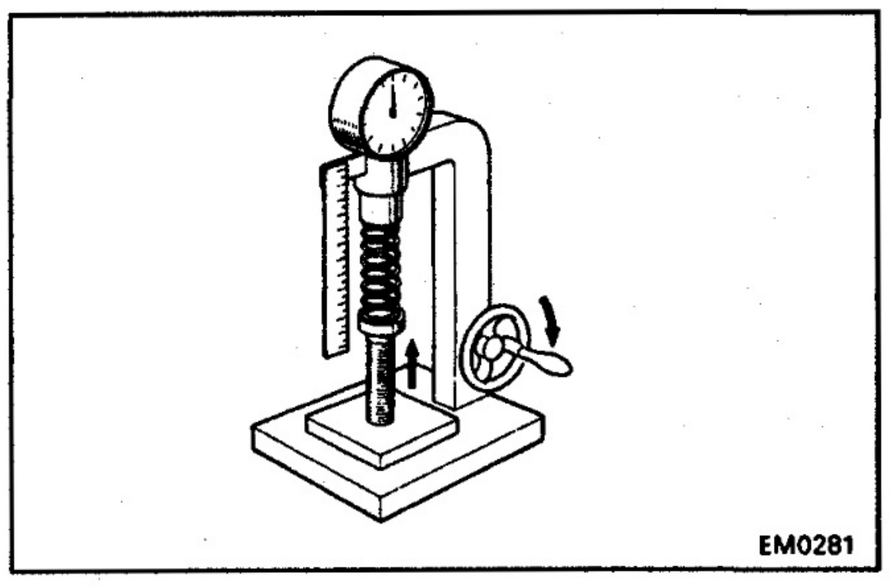


(b) Using vernier calipers, measure the free length of the valve spring.

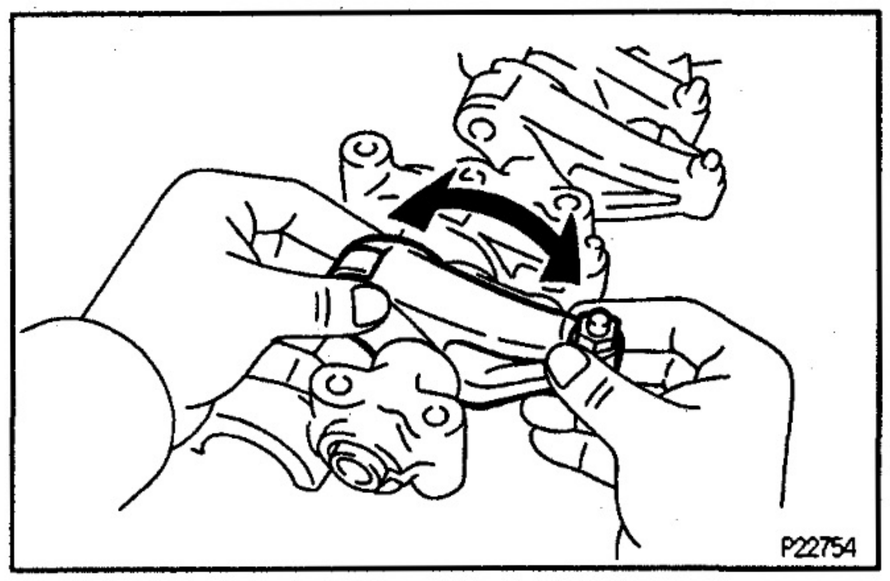
Free length:

49.6 mm (1.9527 in.)

If the free length is not as specified, replace the valve spring.



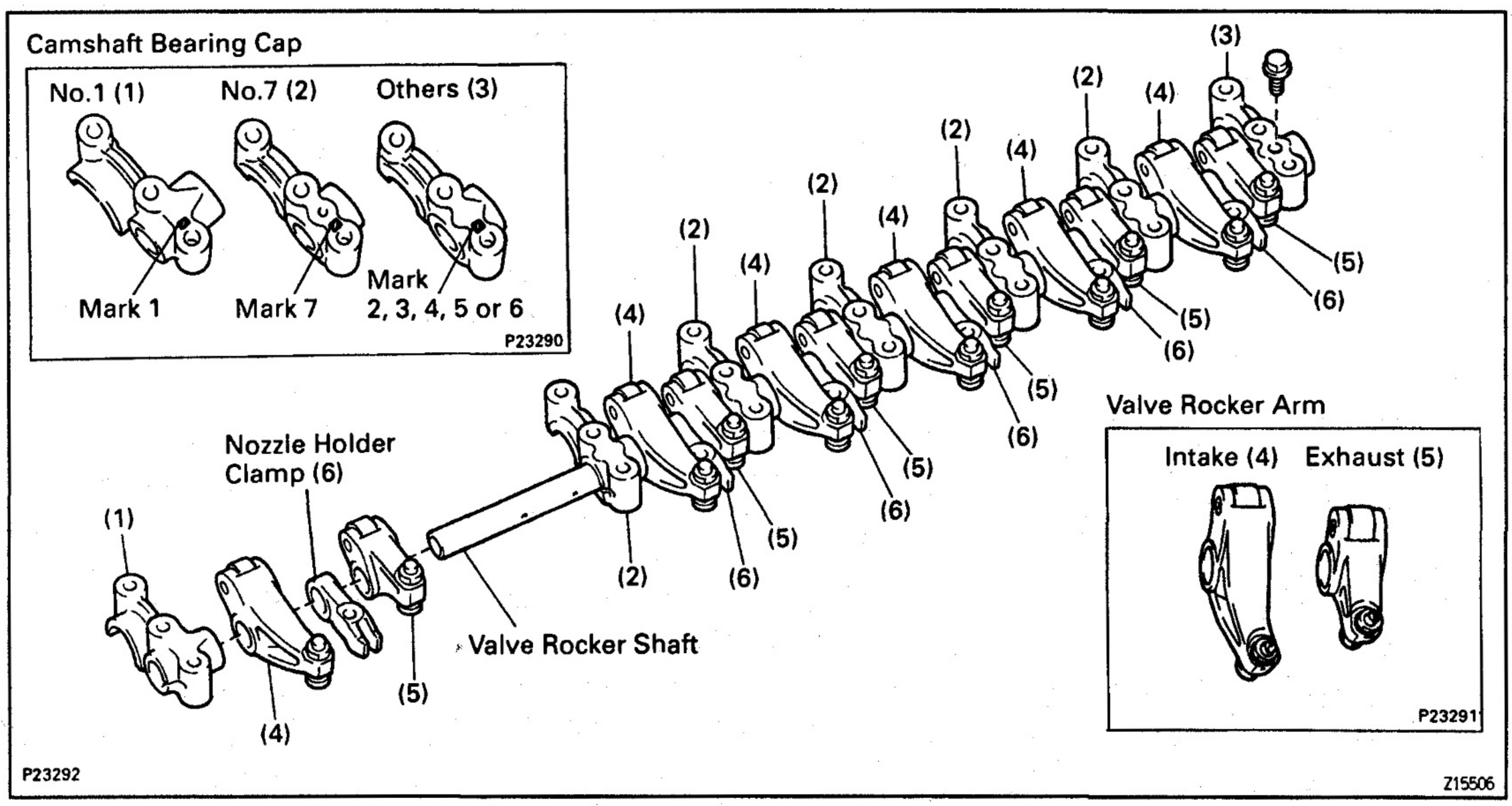
(c) Using a spring tester, measure the tension of the valve spring at the specified installed length.
Installed tension:
237 – 263 N (24.2 – 26.8 kgf, 53.4 – 59.1 lbf)
at 39.5 mm (1.555 in.)
If the installed tension is not as specified, replace the valve spring.

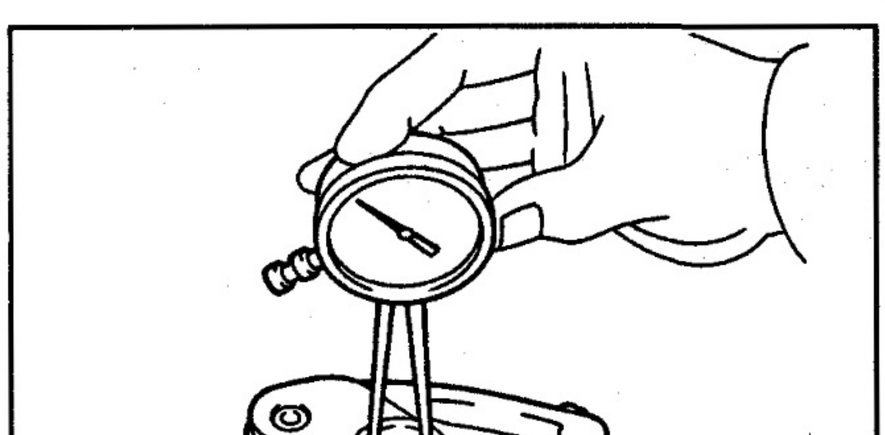


9. INSPECT VALVE ROCKER ARM AND SHAFT

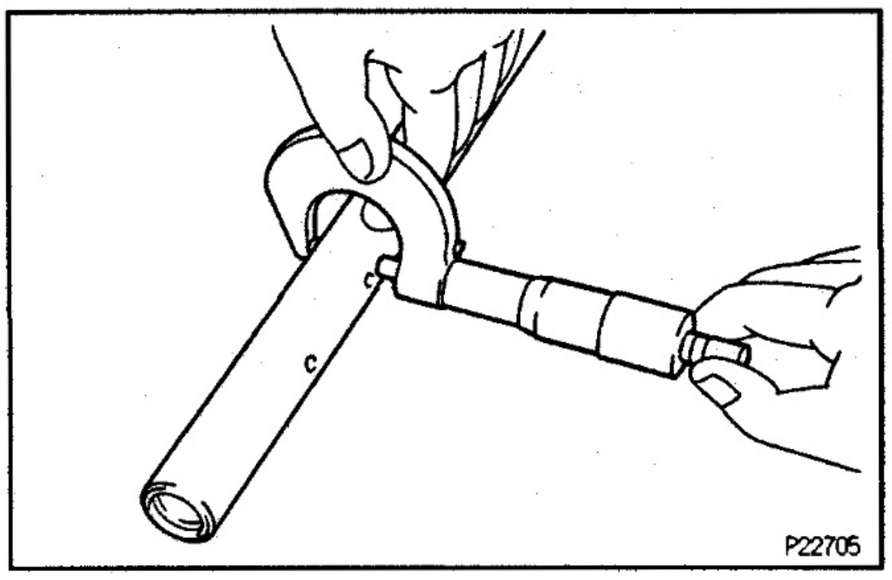
(a) Check that each rocker arm turns smoothly.
If movement is felt, disassemble and check.

(b) Remove the bolt, and disassemble the parts.
HINT: Arrange the disassembled parts in correct order.





(c) Using a caliper gauge, measure the inside diameter of the rocker arm.
Rocker arm inside diameter:
20.012 – 20.033 mm (0.7879 – 0.7887 in.)



(d) Using a micrometer, measure the diameter of the rocker arm shaft.

Shaft diameter:

19.972 — 19.993 mm (0.7863 — 0.7871 in.)

(e) Subtract the rocker arm shaft measurement from the rocker arm measurement.

Standard oil clearance:

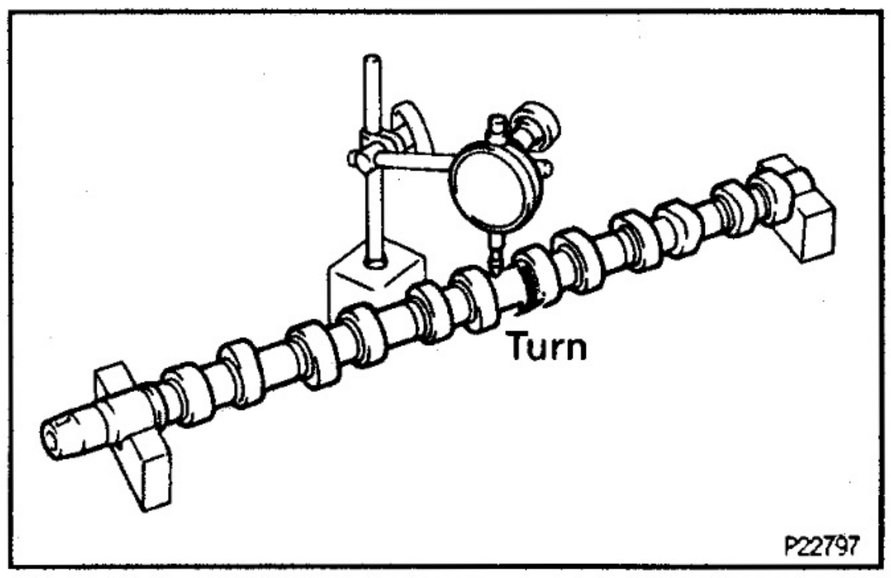
0.019 — 0.061 mm (0.0007 — 0.0024 in.)

Maximum oil clearance:

0.10 mm (0.0039 in.)

If the clearance is greater than maximum, replace the rocker shaft and shaft.

(f) Assemble the parts as shown in the illustration. (See step (b) above)



10. INSPECT CAMSHAFTS AND BEARINGS

A. Inspect camshaft for runout

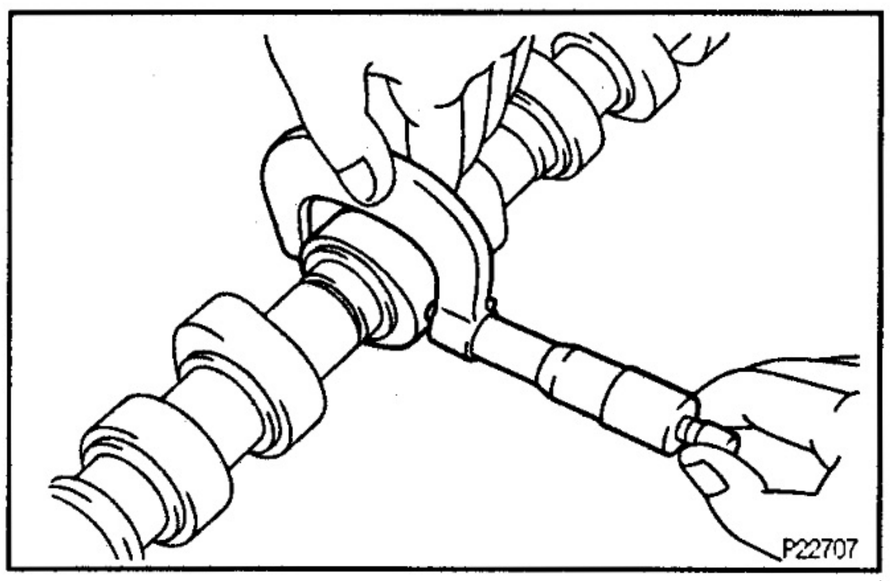
(a) Place the camshaft on V—blocks.

(b) Using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout:

0.10 mm (0.0039 in.)

If the circle runout is greater than maximum, replace the camshaft.



B. Inspect cam lobes

Using a micrometer, measure the cam lobe height.

Standard cam lobe height:

Intake

48.498 — 48.598 mm (1.9094 — 1.9133 in.)

Exhaust

50.734 — 50.834 mm (1.9974 — 2.0013 in.)

Minimum cam lobe height:

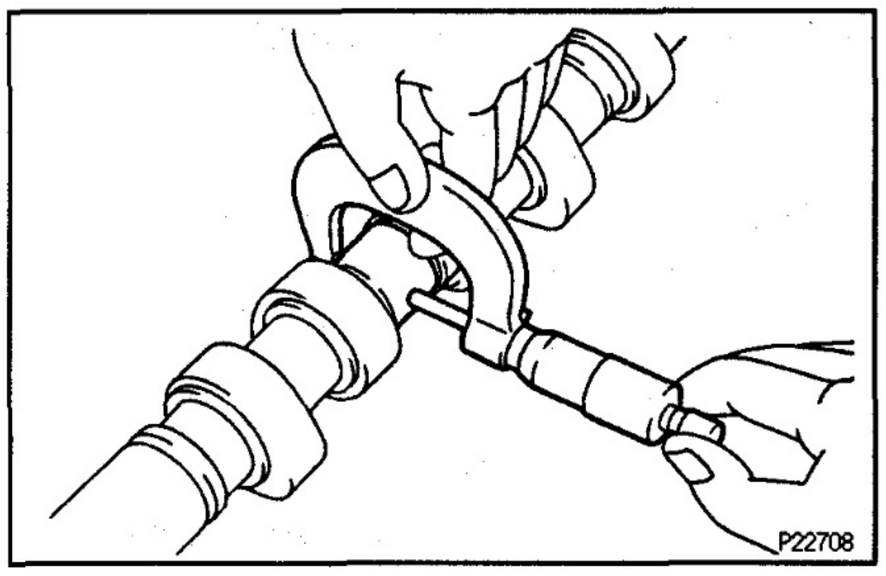
Intake

47.998 mm (1.8897 in.)

Exhaust

50.234 mm (1.9777 in.)

If the cam lobe height is less than minimum, replace the camshaft.



C. Inspect camshaft journals

Using a micrometer, measure the journal diameter.

Journal diameter:

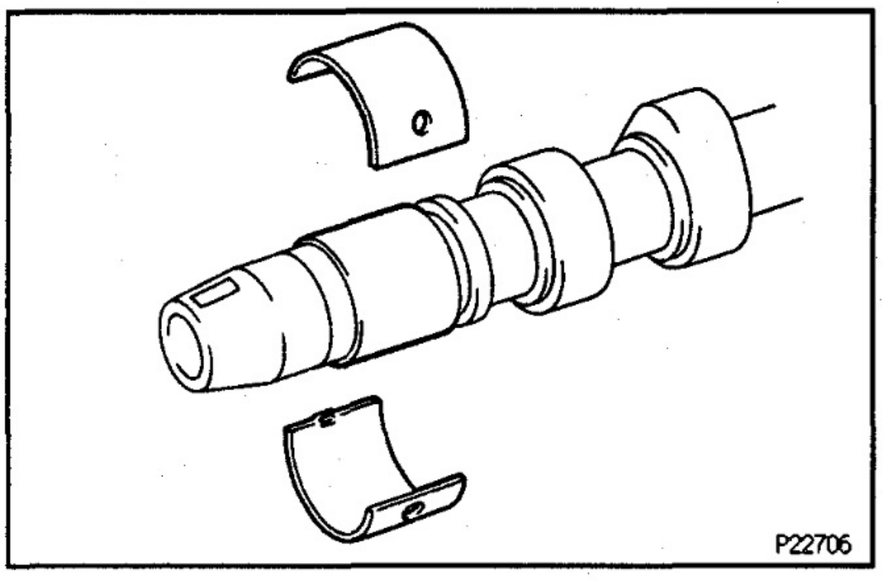
No.1

34.969 — 34.985 mm (1.3767 — 1.3774 in.)

Others

27.986 — 27.998 mm (1.1018 — 1.1023 in.)

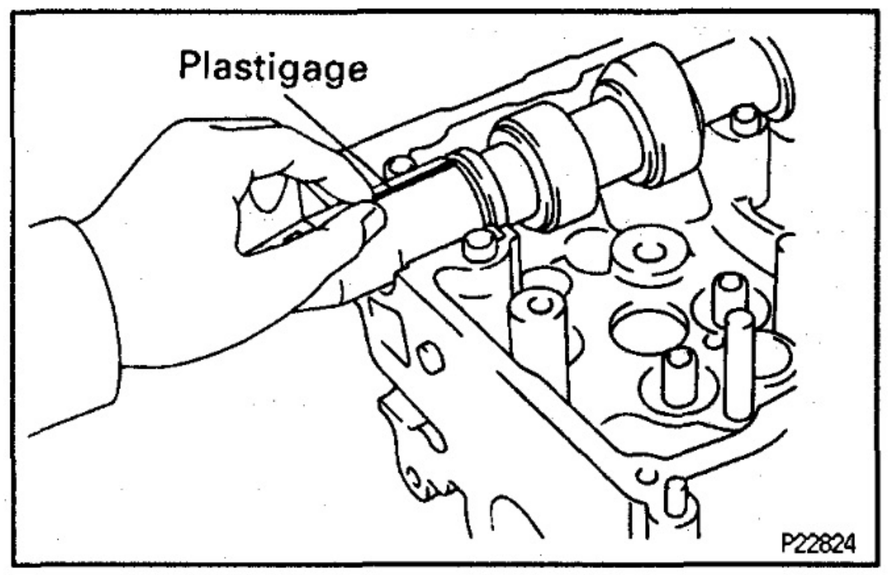
If the journal diameter is not as specified, check the oil clearance.



D. Inspect camshaft bearings

Check the bearings for flaking and scoring.

If the bearings are damaged, replace the bearing caps and cylinder head as a set.



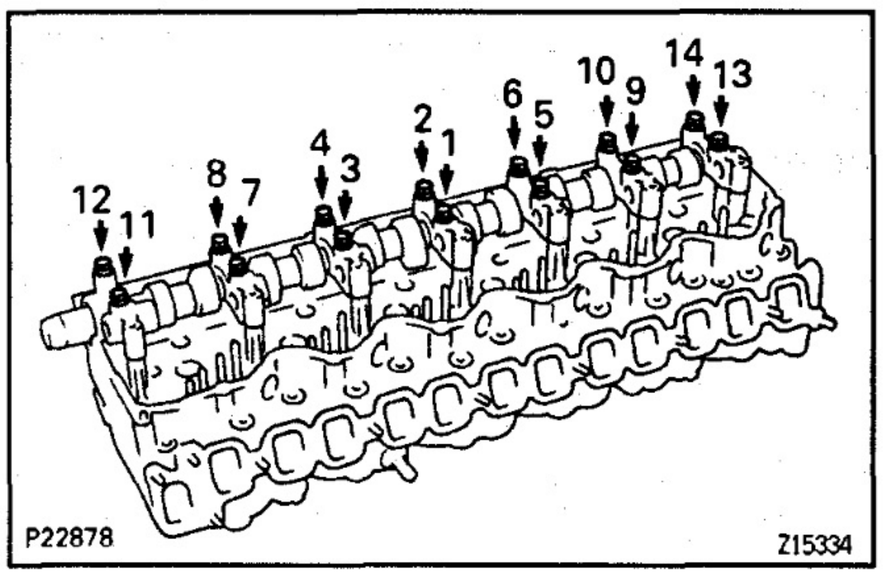
E. Inspect camshaft journal oil clearance

(a) Clean the bearing caps and camshaft journals.

(b) Place the camshaft on the cylinder head.

(c) Lay a strip of Plastigage across each of the camshaft journals.

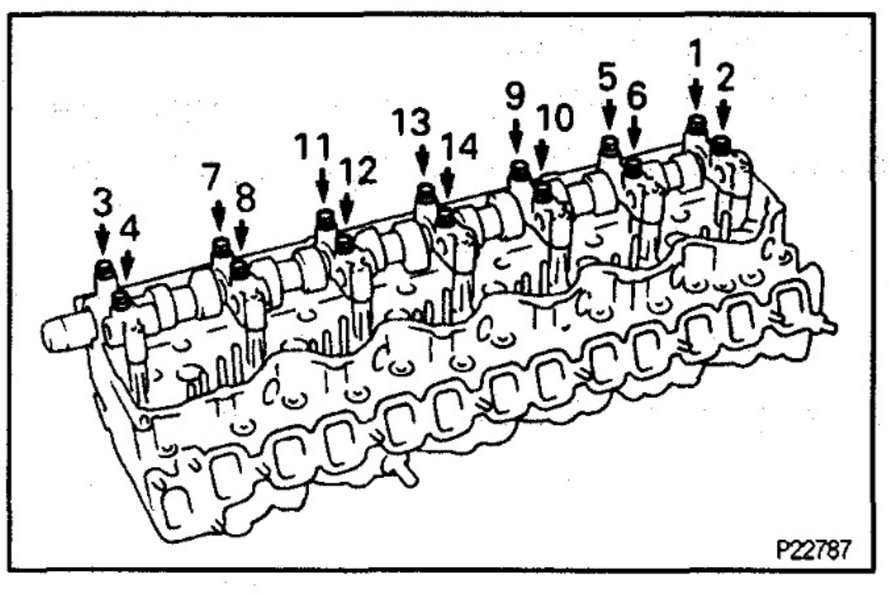
(d) Remove the 7 bearing caps from the valve rocker shaft. (See item E above)



(e) Install the 7 bearing caps with the 14 bolts. Uniformly tighten the bolts in several passes, in the sequence shown.

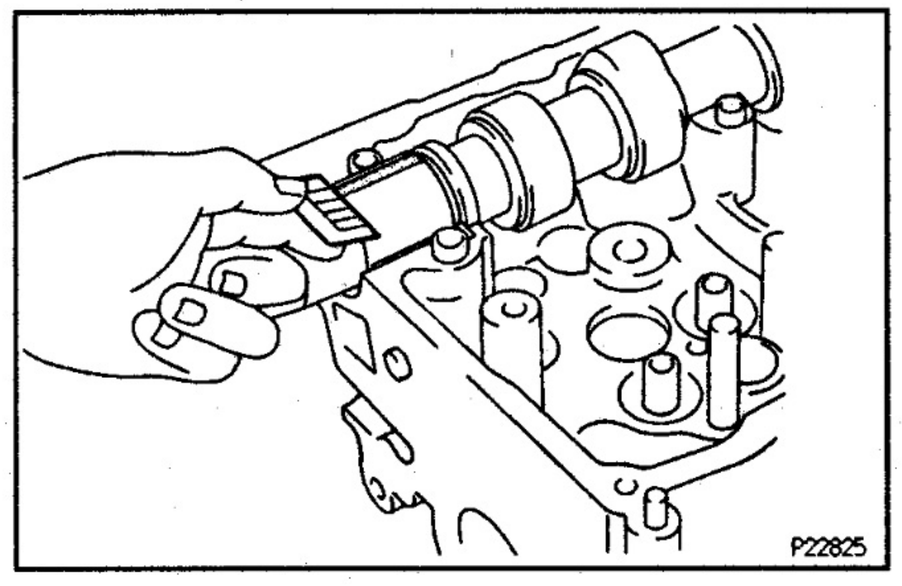
Torque: 25 N·m (250 kgf·cm, 18 ft·lbf)

NOTICE: Do not turn the camshaft.



(f) Uniformly loosen and remove the 14 bolts in several passes, in the sequence shown.

(g) Remove the 7 bearing caps.



(h) Measure the Plastigage at its widest point.

Standard oil clearance:

No.1

0.022 — 0.074 mm (0.0009 — 0.0029 in.)

Others

0.023 — 0.075 mm (0.0009 — 0.0030 in.)

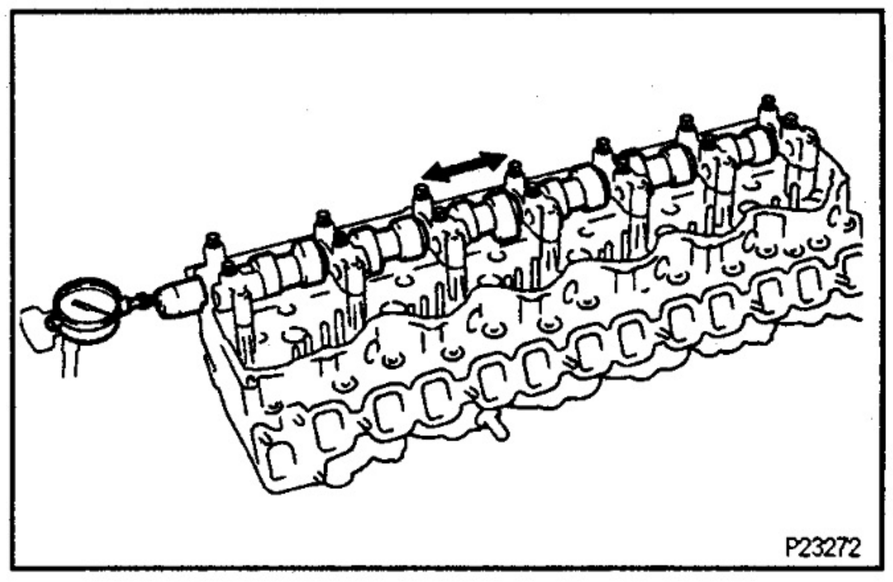
Maximum oil clearance:

0.10 mm (0.0039 in.)

If the oil clearance is greater than maximum, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set.

(i) Completely remove the Plastigage.

(j) Install the 7 bearing caps to the valve rocker shaft. (See item E above)



F. Inspect camshaft thrust clearance

(a) Install the camshaft.
(See procedure in item E above)

(b) Using a dial indicator, measure the thrust clearance while moving the camshaft back and forth.

Standard thrust clearance:

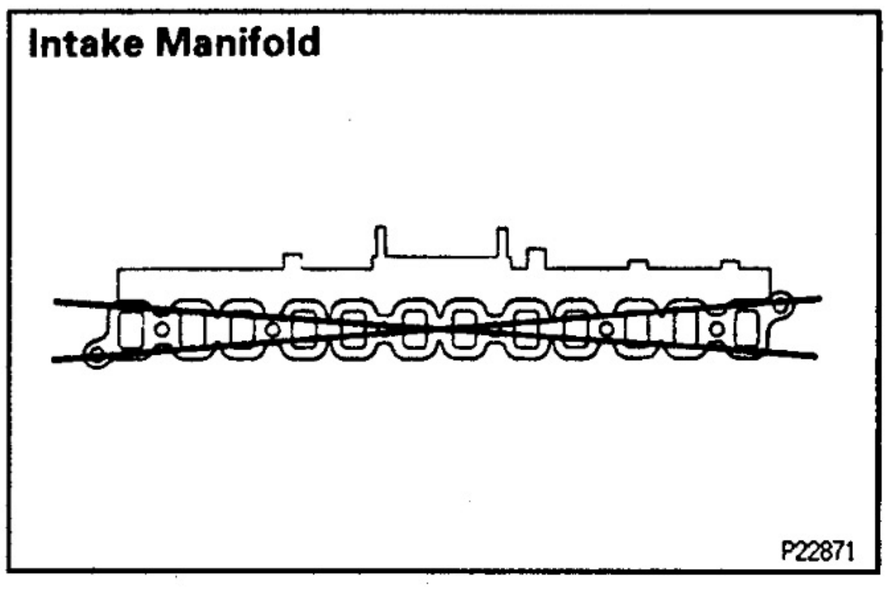
0.100 — 0.200 mm (0.0039 — 0.0079 in.)

Maximum thrust clearance:

0.30 mm (0.0118 in.)

If the thrust clearance is greater than maximum, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set.

(c) Remove the camshaft.



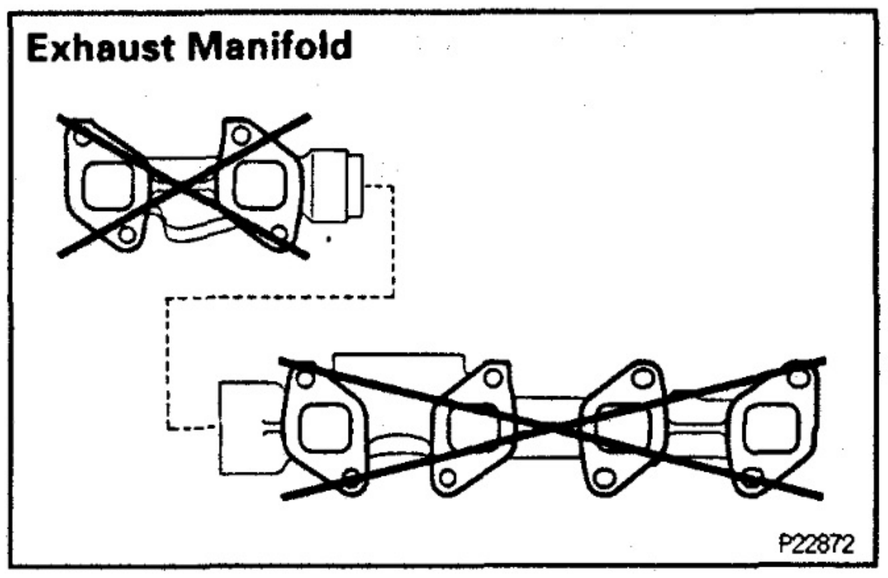
11. INSPECT INTAKE MANIFOLD

Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head for warpage.

Maximum warpage:

0.40 mm (0.0157 in.)

If warpage is greater than maximum, replace the manifold.



12. INSPECT EXHAUST MANIFOLD

Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head for warpage.

Maximum warpage:

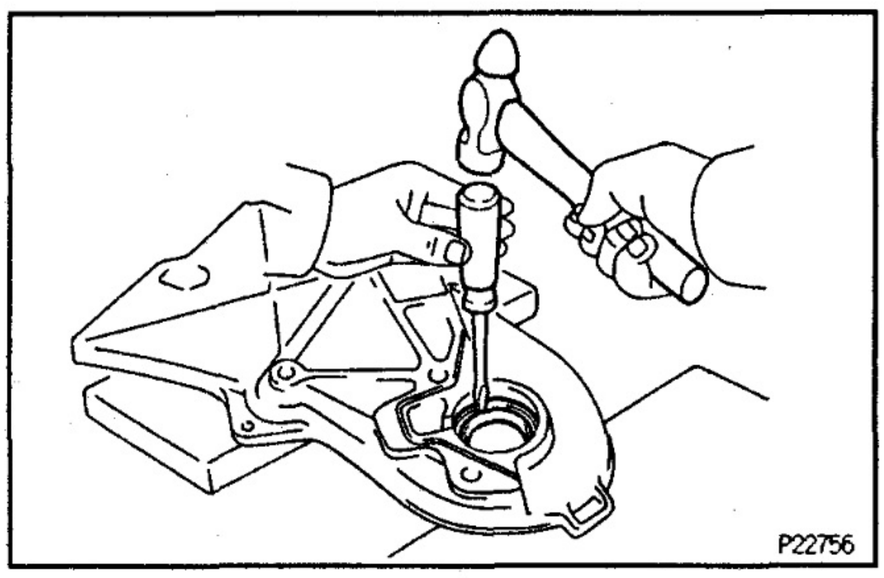
0.40 mm (0.0157 in.)

If warpage is greater than maximum, replace the manifold.

CAMSHAFT OIL SEAL REPLACEMENT

B038K-03

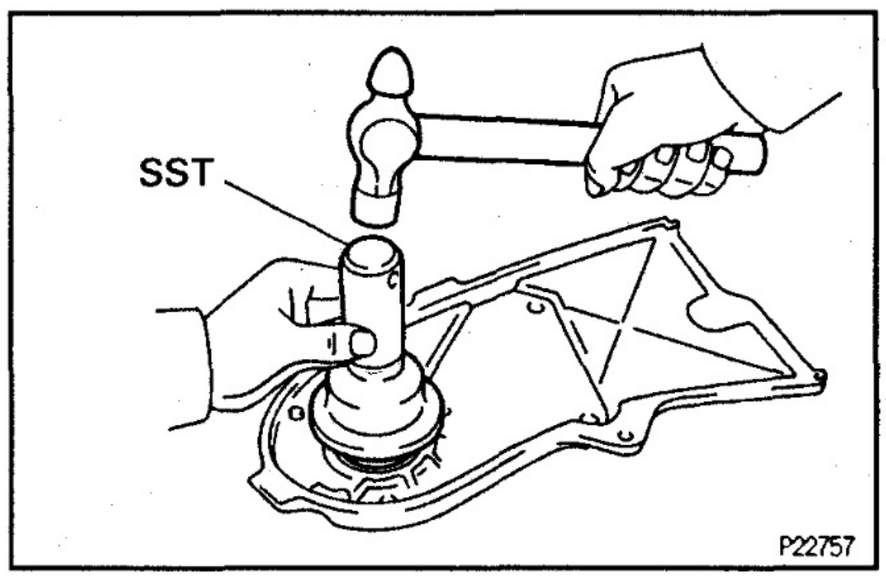
HINT: There are 2 methods (A and B) to replace the oil seal which are as follows:



REPLACE CAMSHAFT OIL SEAL

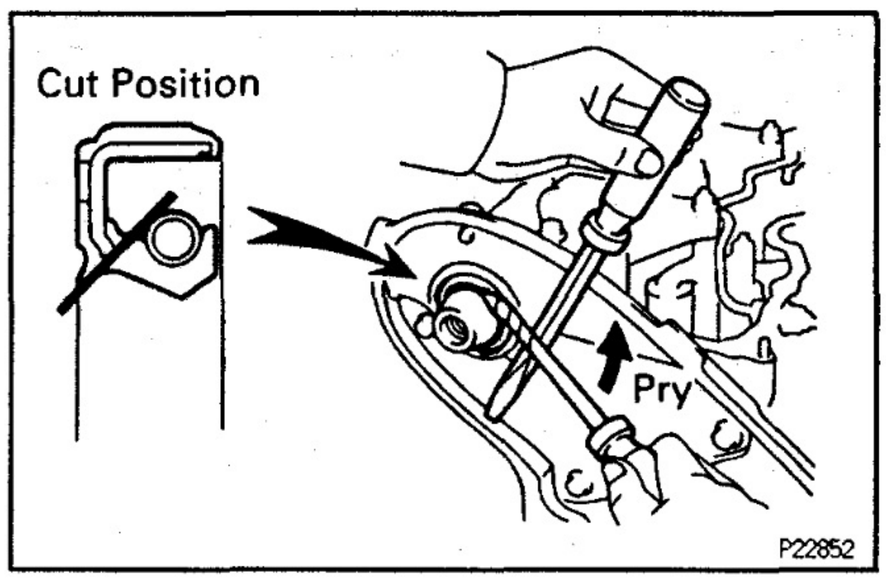
A. If camshaft oil seal retainer is removed from cylinder head:

(a) Using a screwdriver, tap out the oil seal.



(b) Using SST and a hammer, tap in a new oil seal until its surface is flush with the oil seal retainer edge.
SST 09223–46011

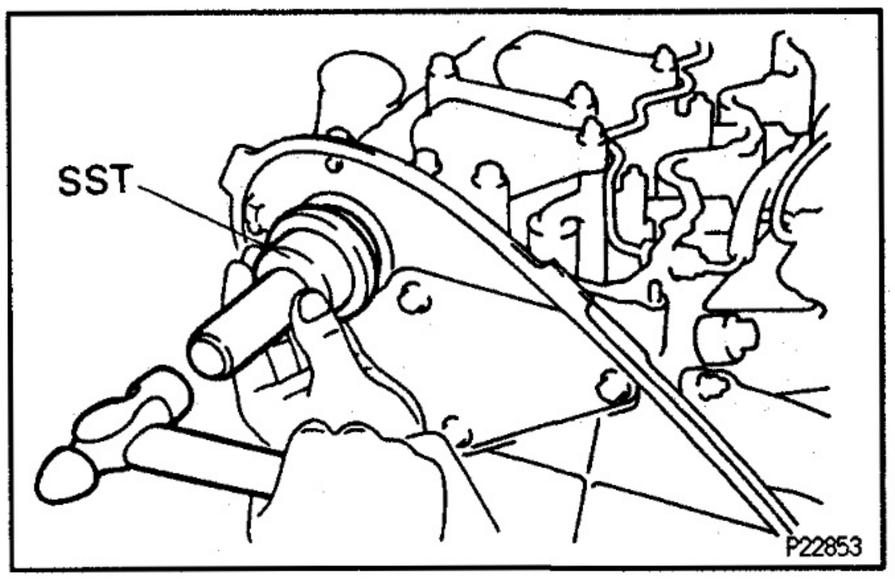
(c) Apply MP grease to the oil seal lip.



B. If camshaft oil seal retainer is installed to cylinder head:

(a) Using a knife, cut off the oil seal lip.

(b) Using 2 screwdrivers, pry out the oil seal.
NOTICE: Be careful not to damage the camshaft. Tape the screwdriver tip.



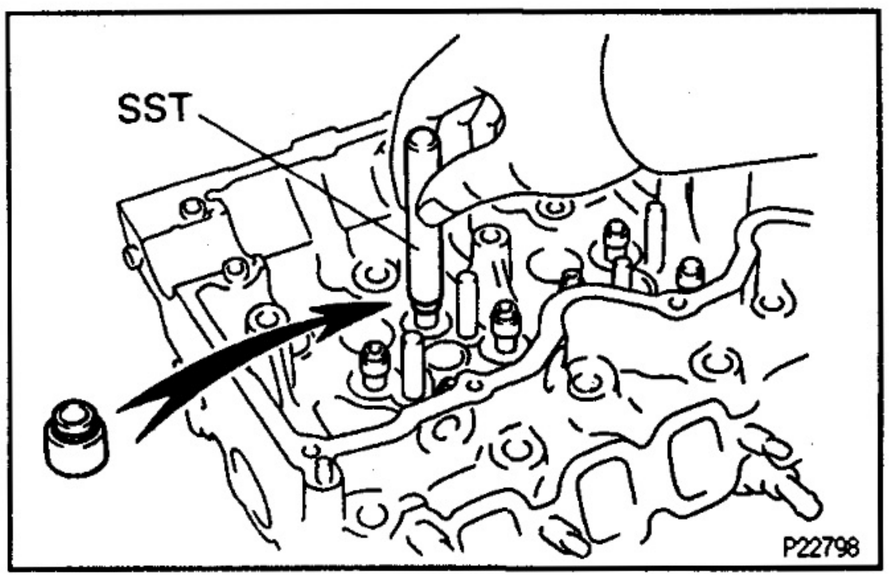
(c) Apply MP grease to a new oil seal lip.
(d) Using SST and a hammer, tap in the oil seal until its surface is flush with the oil seal retainer edge.
SST 09223–46011

EG

EG0A8–01

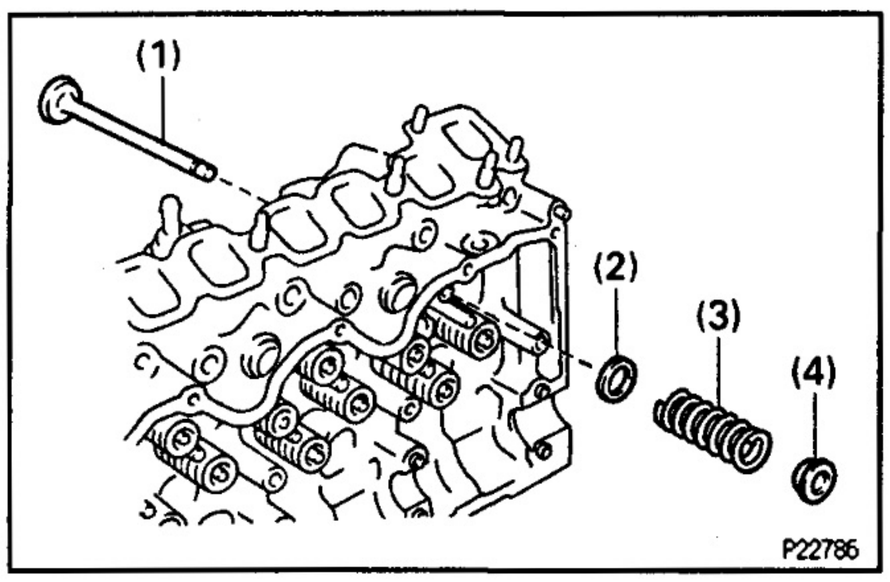
CYLINDER HEAD ASSEMBLY

HINT:
- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply new engine oil to all sliding and rotating surfaces.
- Replace all gaskets and oil seals with new ones.

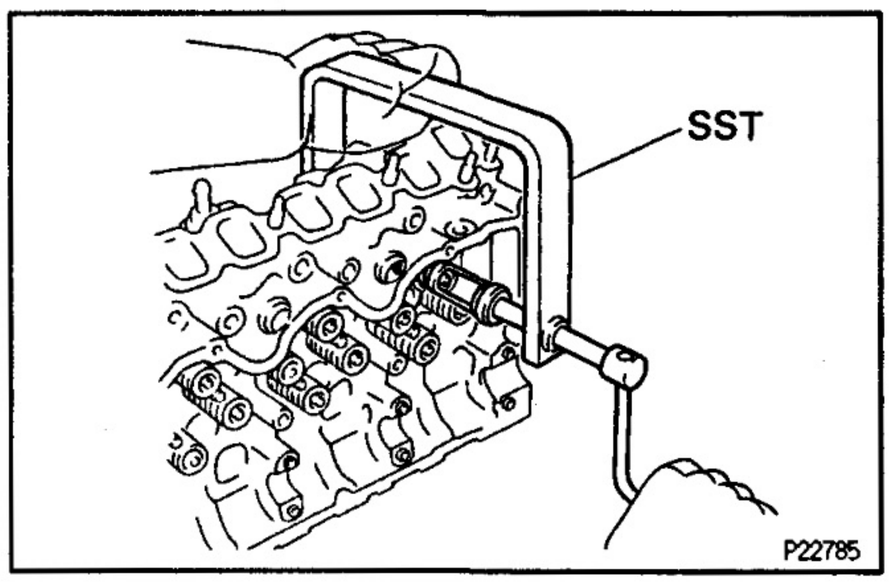


1. INSTALL VALVES

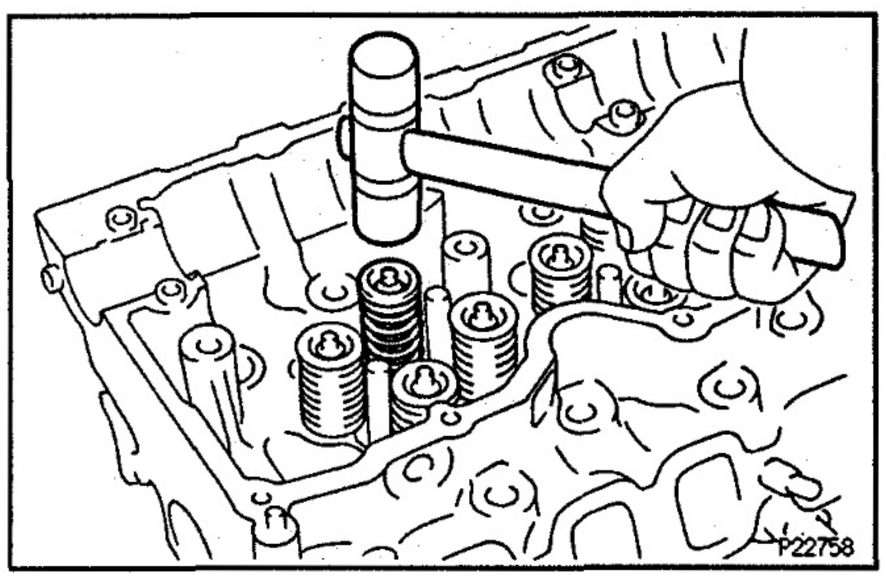
(a) Using SST, push in a new oil seal.
SST 09201–41020



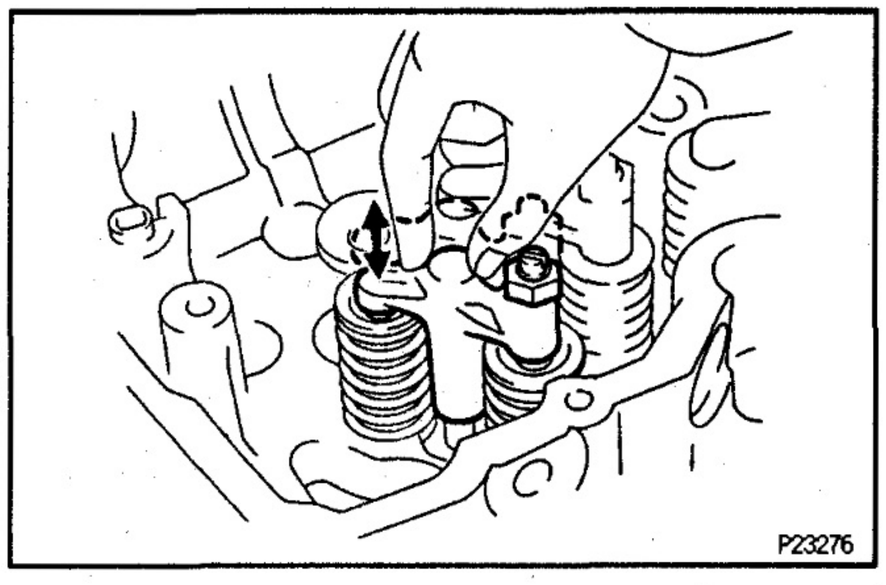
(b) Install these parts:
(1) Valve
(2) Spring seat
(3) Valve spring
(4) Spring retainer



(c) Using SST, compress the valve spring and place the 2 keepers around the valve stem.
SST 09202–70020 (09202–00010)



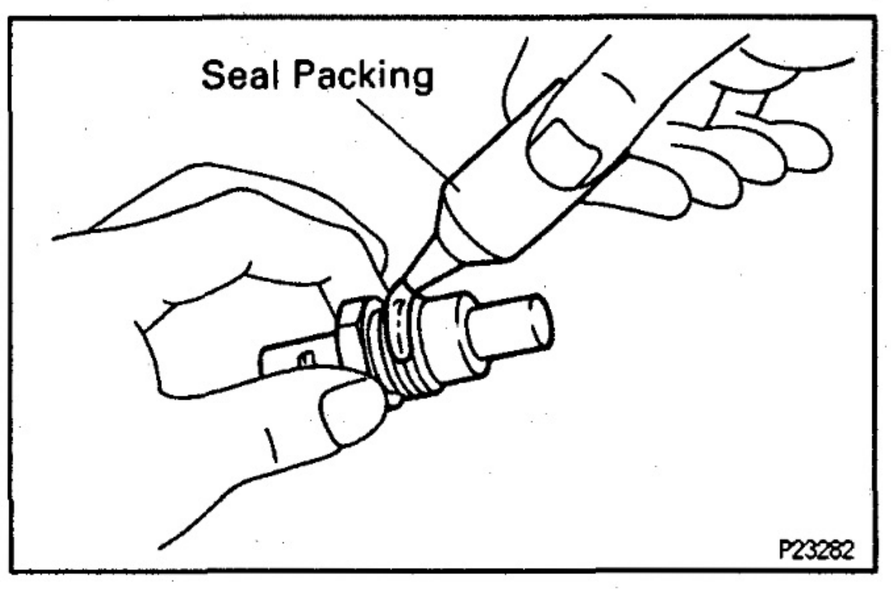
(d) Using a plastic–faced hammer, lightly tap the valve stem tip to assure a proper fit.



2. INSTALL VALVE BRIDGES

(a) Install the valve bridge.

(b) Check that the valve bridge rotates smoothly.



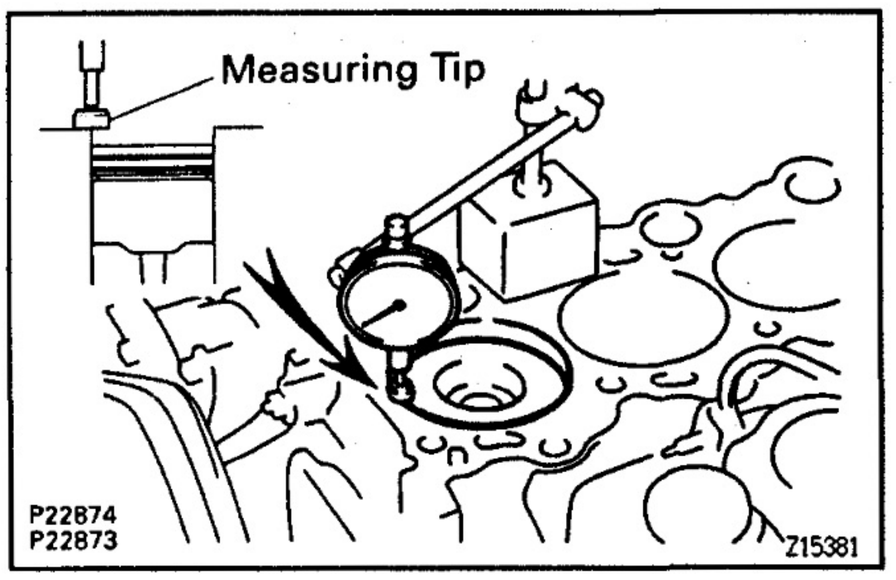
3. INSTALL WATER TEMPERATURE SENDER GAUGE

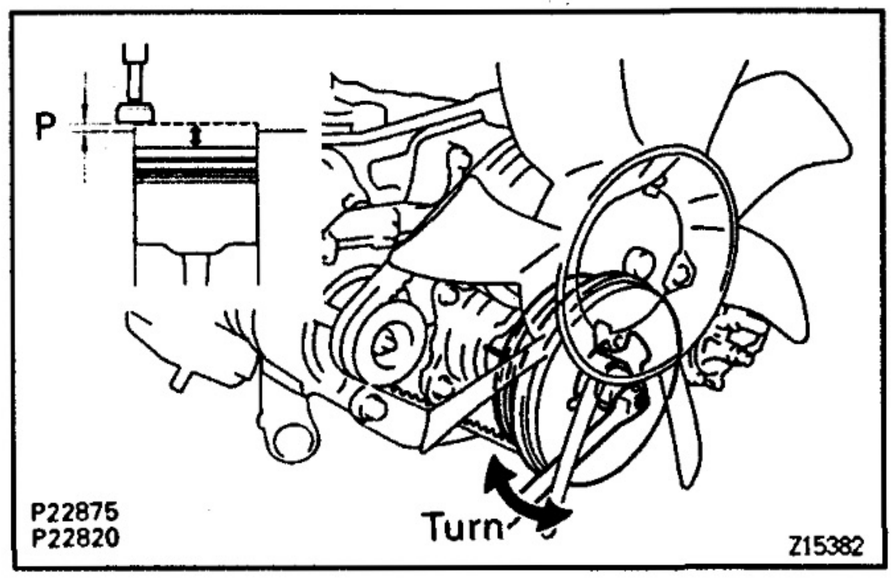
(a) Apply seal packing to 2 or 3 threads.

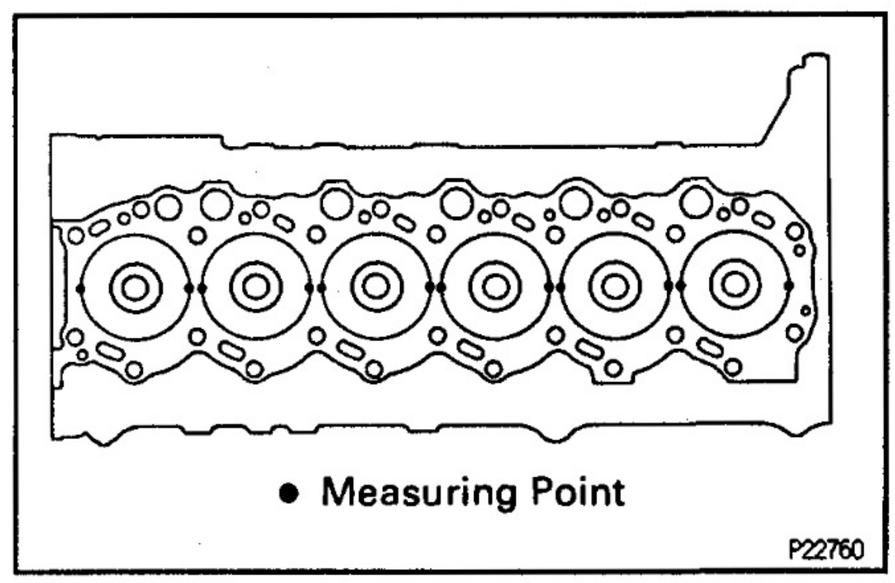
Seal packing:

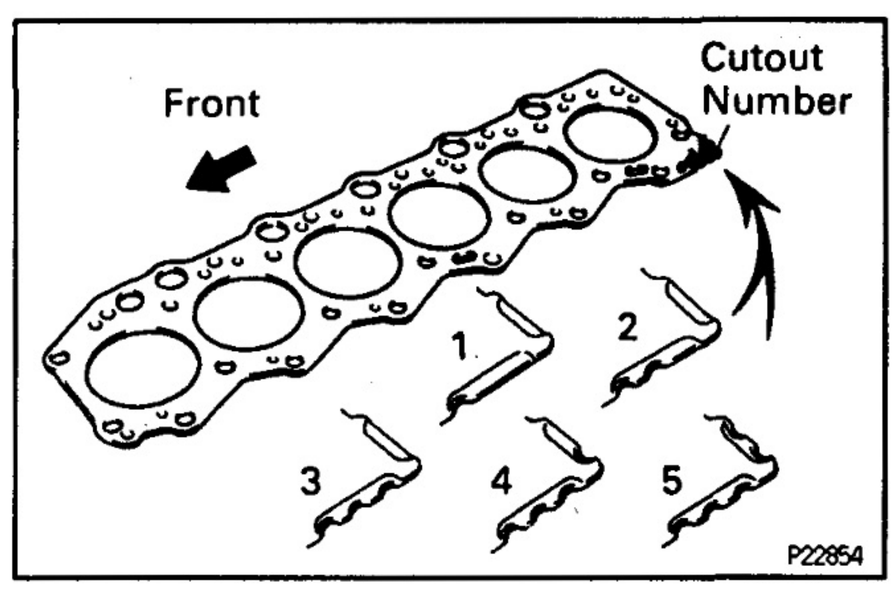
Part No. 08826 – 00100 or equivalent

(b) Install the sender gauge.









EG

EQSRT-02

CYLINDER HEAD INSTALLATION

1. CHECK PISTON PROTRUSION AND SELECT CYLINDER HEAD GASKET

A. Check piston protrusions for each cylinder

(a) Clean the cylinder block with solvent.

(b) Set the piston of the cylinder to be measured to slightly before TDC.

(c) Place a dial indicator on the cylinder block, and set the dial indicator at 0 mm (0 in.).

HINT:

- Use a dial indicator measuring tip as shown in the illustration.
- Make sure that the measuring tip is square to the cylinder block gasket surface and piston head when taking the measurements.

(d) Find where the piston head protrudes most by slowly turning the crankshaft clockwise and counterclockwise.

(e) Measure each cylinder at 2 places as shown in the illustration, making a total of 12 measurements.

(f) For the piston protrusion value of each cylinder, use the average of the 2 measurements of each cylinder.

Protrusion (P):

0.175 — 0.425 mm (0.0069 — 0.0167 in.)

When removing piston and connecting rod assembly:
If the protrusion is not as specified, remove the piston and connecting rod assembly and reinstall it.
(See cylinder block disassembly and assembly)

B. Select new cylinder head gasket

HINT: There are 5 types of gasket (cutout number 1 to 5) installed at factory, but only 3 types for supply parts (cutout number 1, 3 and 5), so when replacing the gasket select from one of 3 types above.

New installed cylinder head gasket thickness:

Cutout number 1

0.85 — 0.95 mm (0.0335 — 0.0374 in.)

Cutout number 3

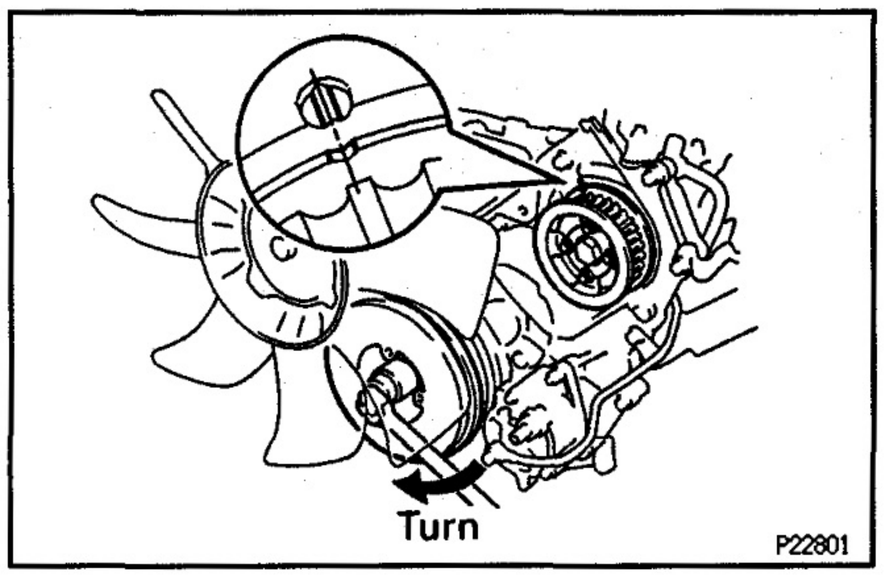
0.95 — 1.05 mm (0.0374 — 0.0414 in.)

Cutout number 5

1.05 — 1.15 mm (0.0414 — 0.0453 in.)

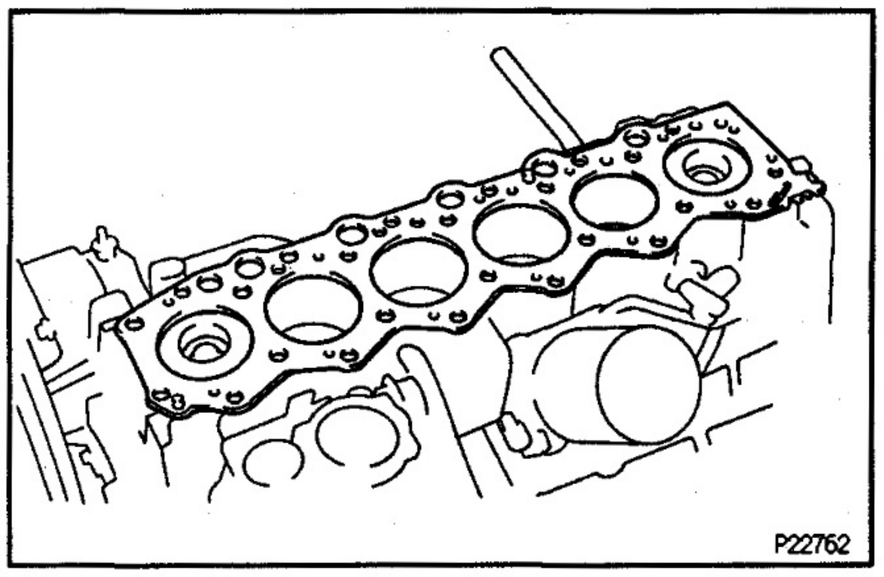
Select the largest piston protrusion value from the measurements made, then select a new appropriate gasket according to the table below.

Piston protrusion	Gasket size
0.225 mm (0.0089 in.) or less	Use 1
0.226 — 0.325 mm (0.0089 — 0.0128 in.)	Use 3
0.326 mm (0.0128 in.) or more	Use 5



2. SET NO.1 CYLINDER TO BDC/COMPRESSION

Turn the crankshaft pulley, and align the timing mark of the No.2 camshaft timing pulley, with the BDC mark of the timing gear cover.



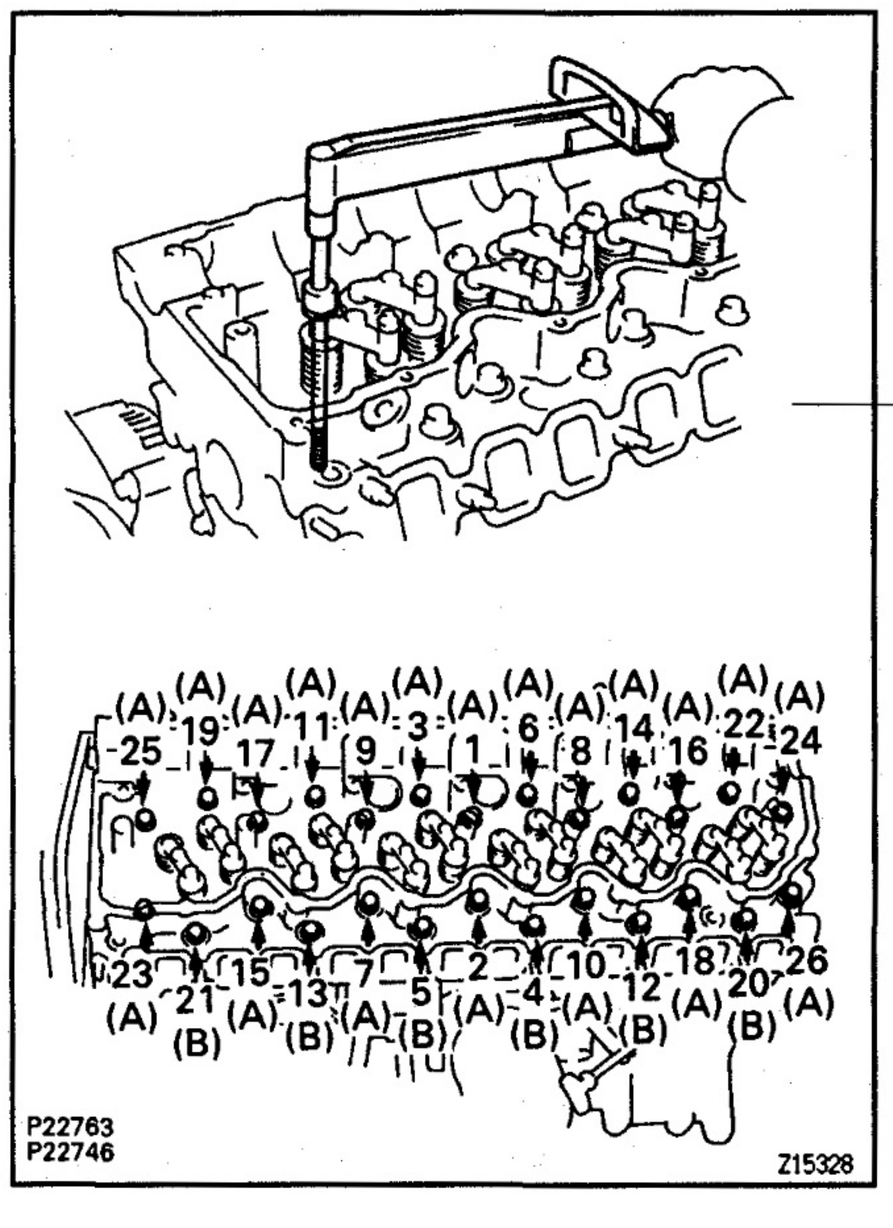
3. INSTALL CYLINDER HEAD

A. Place cylinder head on cylinder block

(a) Place a new cylinder head gasket in position on the cylinder block.

NOTICE: Be careful of the installation direction.

(b) Place the cylinder head in position on the cylinder head gasket.



B. Install cylinder head bolts

HINT:

- The cylinder head bolts are tightened in 3 progressive steps (steps (b), (d) and (e)).
- If any bolts is broken or deformed, replace it.

(a) Apply a light coat of engine oil on the threads and under the heads of the cylinder head bolts.

(b) Install and uniformly tighten the 26 cylinder head bolts in several passes, in the sequence shown.

Torque: 68.6 N·m (700 kgf·cm, 51 ft·lbf)

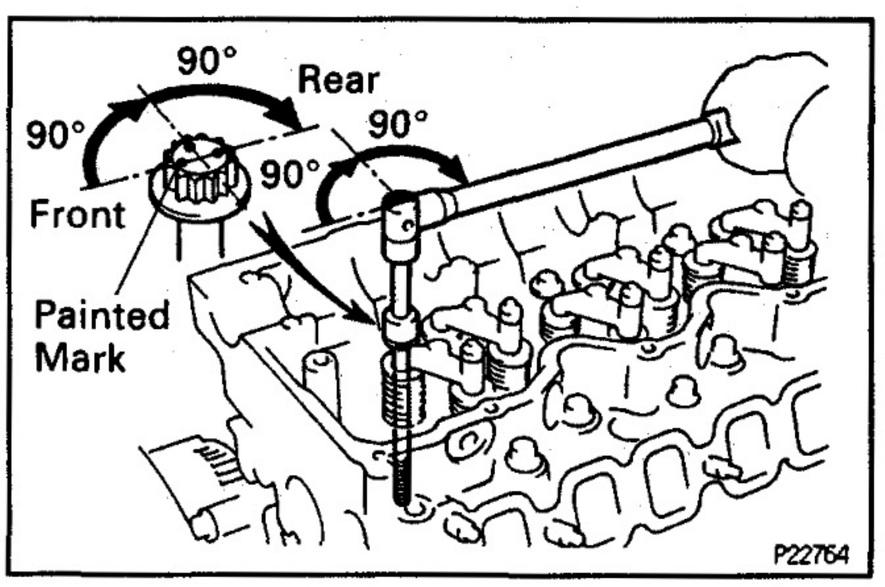
HINT: Each bolt length is indicated in the illustration.

Bolt length:

A 121.5 mm (4.783 in.)

B 133.5 mm (5.256 in.)

If any one of the cylinder head bolts does not meet the torque specification, replace the cylinder head bolt.



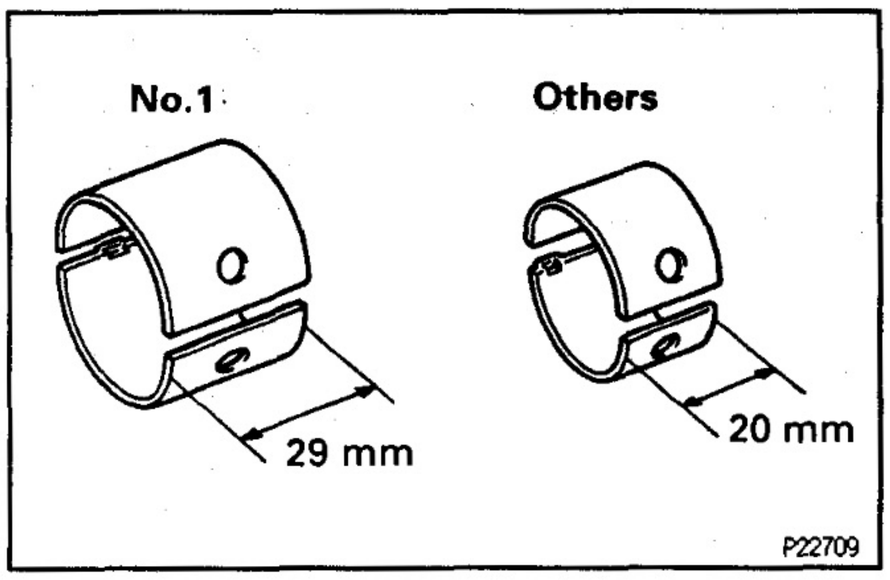
(c) Mark the front of the cylinder head bolt with paint.

(d) Retighten the cylinder head bolts 90° in the numerical order shown.

(e) Retighten cylinder head bolts by an additional 90°.

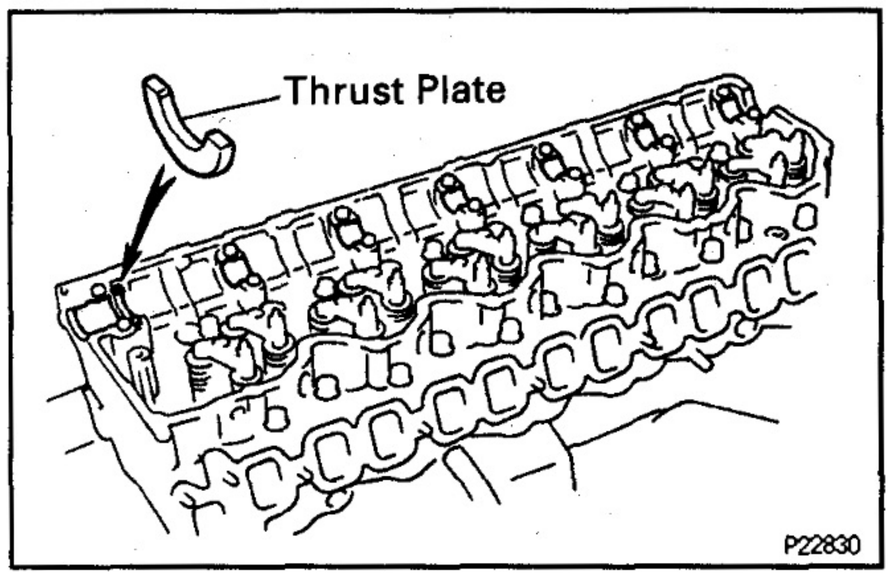
(f) Check that the painted mark is now facing rearward.

(g) Connect the water bypass hose (from the injection pump) to the cylinder head.

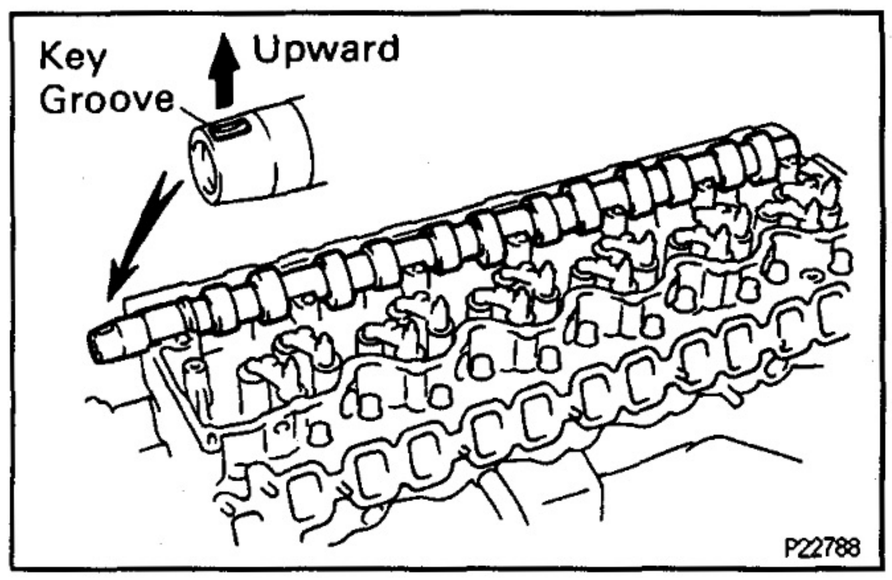


4. INSTALL CAMSHAFT, CAMSHAFT BEARING CAPS VALVE ROCKER ARMS NOZZLE HOLDER CLAMPS AND ROCKER SHAFT ASSEMBLY

HINT: Camshaft bearings come in widths of 20 mm (0.79 in.) and 29 mm (1.14 in.). Install the 29 mm (0.886 in.) bearings in the No.1 cylinder head journal positions with the camshaft bearing cap. Install the 20 mm (0.79 in.) bearings in the other positions.

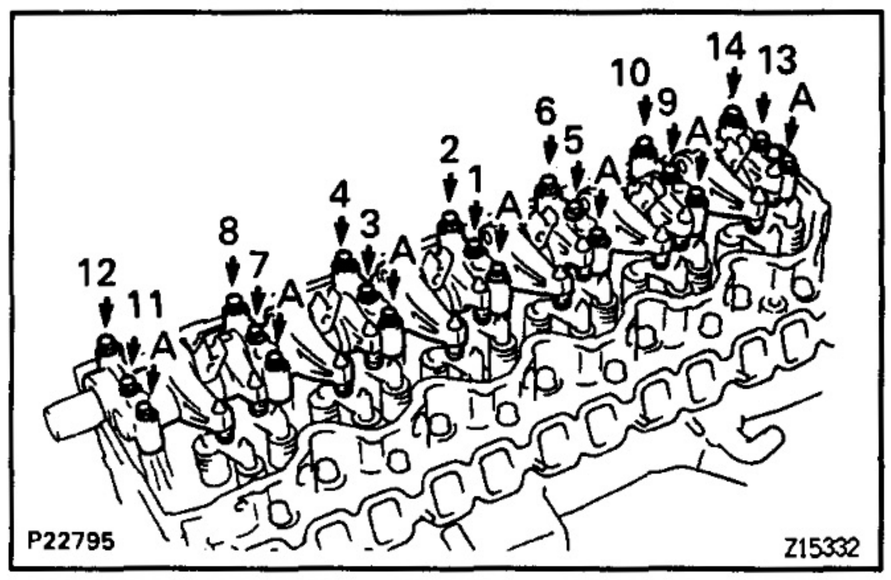


(a) Install the 7 lower camshaft bearings and thrust plate.



(b) Place the camshaft on the cylinder head, facing the key groove upward.

(c) Install the 7 upper camshaft bearings to the bearing caps.



(d) Install the 7 bearing caps, 12 rocker arms, 6 holder clamps and rocker shaft assembly.

(e) Install and uniformly tighten the 14 bearing cap bolts in several passes, in the sequence shown.
Torque: 25 N·m (250 kgf·cm, 18 ft·lbf)

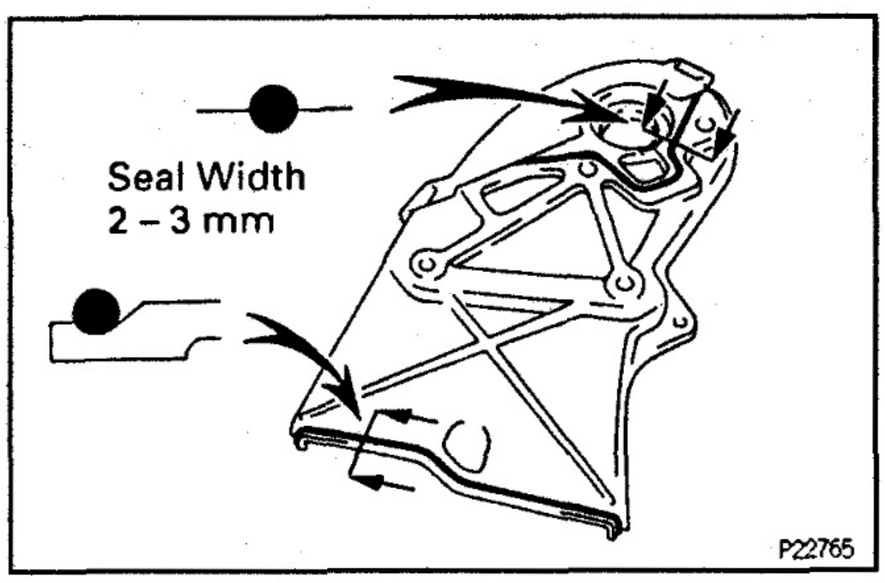
(f) Install the 7 others bolts.
Torque: 25 N·m (250 kgf·cm, 18 ft·lbf)

5. INSTALL INJECTION NOZZLES
(See steps 1, 2 and 4 in injection nozzles installation in Fuel System)

6. INSTALL CAMSHAFT OIL SEAL RETAINER

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the oil seal retainer and cylinder head.

- Using a razor blade and gasket scraper, remove all the oil packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.



- Using a non—residue solvent, clean both sealing surfaces.

(b) Apply seal packing to the oil seal retainer as shown in the illustration.

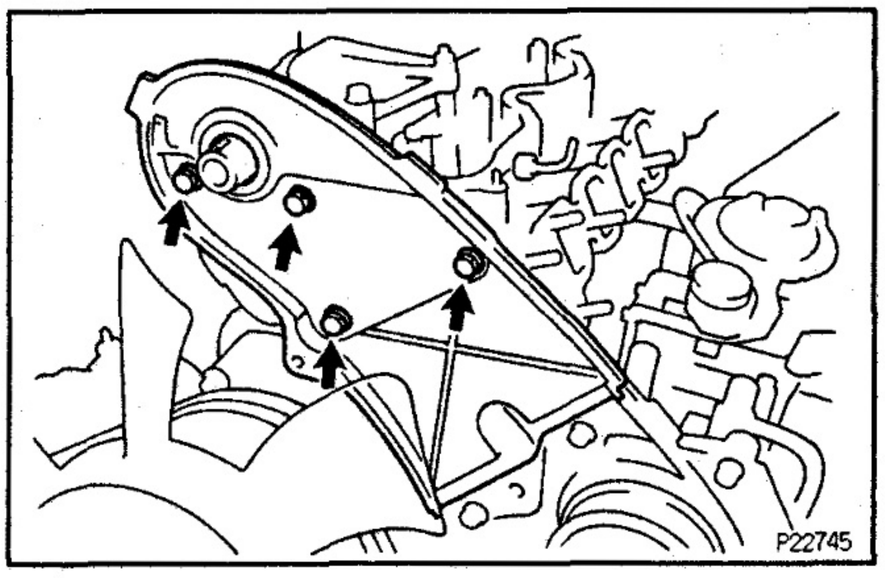
Seal packing:

Part No. 08826—00080 or equivalent

- Install a nozzle that has been cut to a 2 — 3 mm (0.08 — 0.12 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

(c) Install the oil seal retainer with the 4 bolts. Uniformly tighten the bolts in several passes.

Torque: 19.6 N·m (200 kgf·cm, 14 ft·lbf)



7. INSTALL PULLEYS AND TIMING BELT

(See steps 1 and 4 to 10 in timing belt installation)

8. CHECK AND ADJUST VALVE CLEARANCE

(See steps 2 to 4 in valve clearance inspection and adjustment)

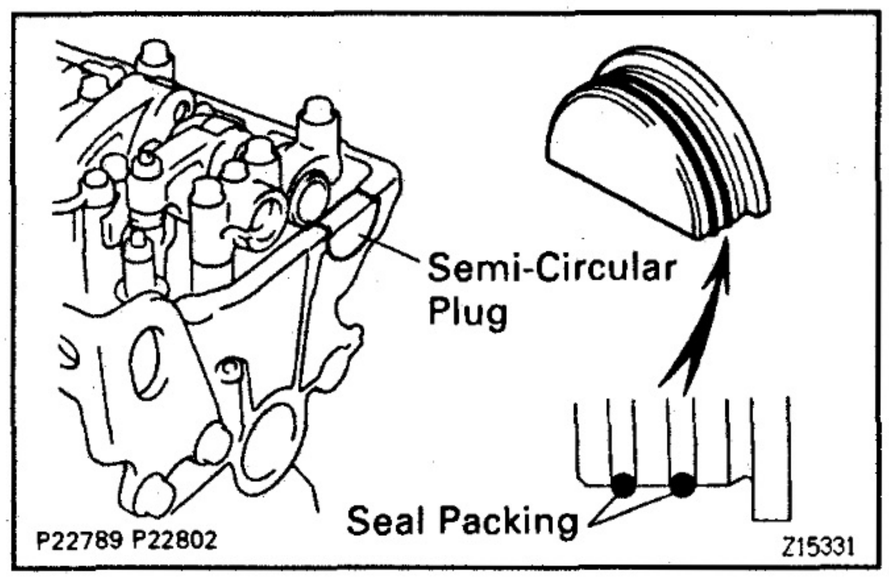
9. INSTALL SEMI—CIRCULAR PLUG

(a) Remove any old packing (FIPG) material.

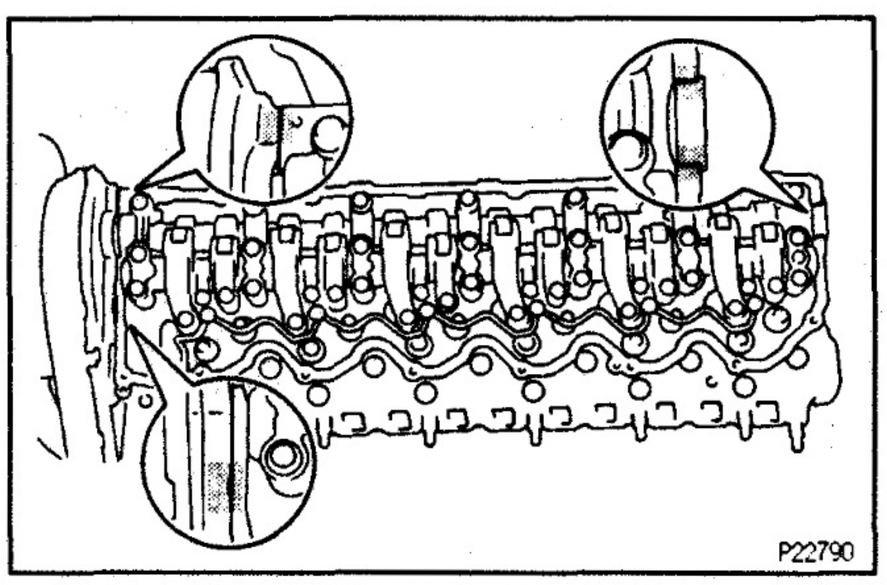
(b) Apply seal packing to the semi — circular plug as shown in the illustration.

Seal packing:

Part No. 08826—00080 or equivalent



(c) Install the semi—circular plug to the cylinder head.



10. INSTALL CYLINDER HEAD COVER

(a) Remove any old packing (FIPG) material.

(b) Apply seal packing to the cylinder head as shown in the illustration.

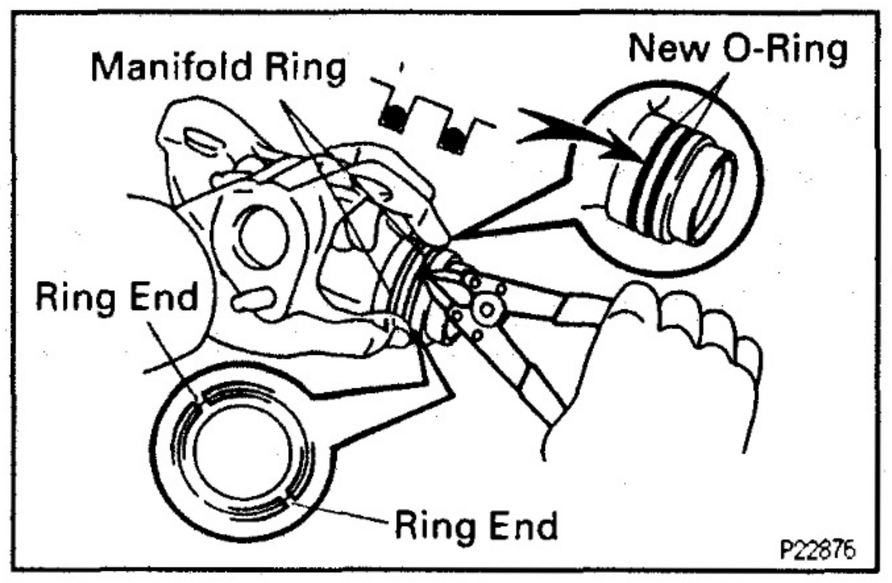
Seal packing:

Part No. 08826—00080 or equivalent

(c) Install the gasket to the cylinder head cover.

(d) Install the cylinder head cover with 12 new seal washers and 12 bolts. Uniformly tighten the bolts in several passes.

Torque: 6.4 N·m (65 kgf·cm, 57 in.·lbf)



11. INSTALL REAR ENGINE HANGER

Torque: 39.2 N·m (400 kgf·cm, 29 ft·lbf)

12. ASSEMBLE EXHAUST MANIFOLDS

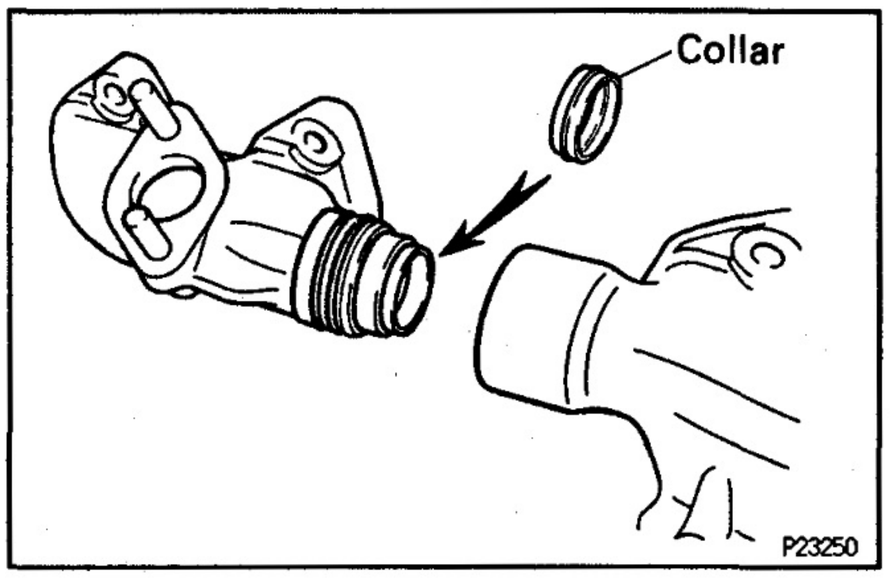
(a) Install 2 new O—rings to the rear exhaust manifold.

(b) Using snap ring pliers, install the 2 rings to the rear exhaust manifold.

(c) Position the rings so that the ring ends are as shown.

NOTICE: Do not align the ring ends.

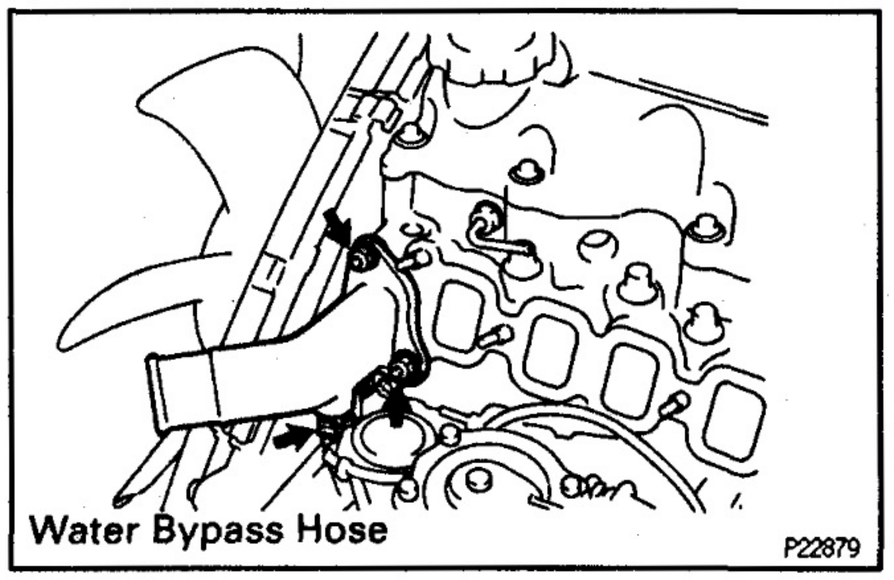
EG



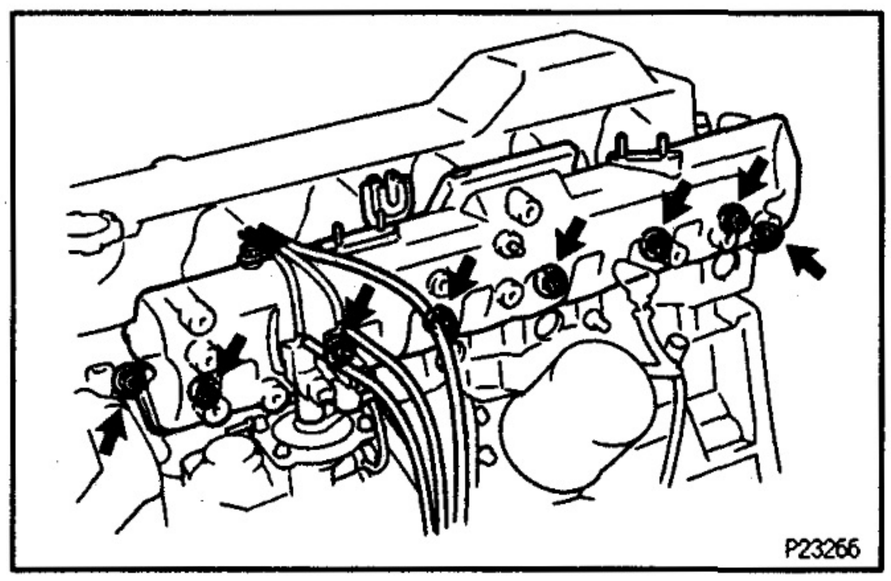
(d) Install the collar to the rear exhaust manifold.
(e) Assemble the front and rear exhaust manifolds.

13. INSTALL EXHAUST MANIFOLD TO TURBOCHARGER
(See step 2 in turbocharger installation in Turbocharger System)

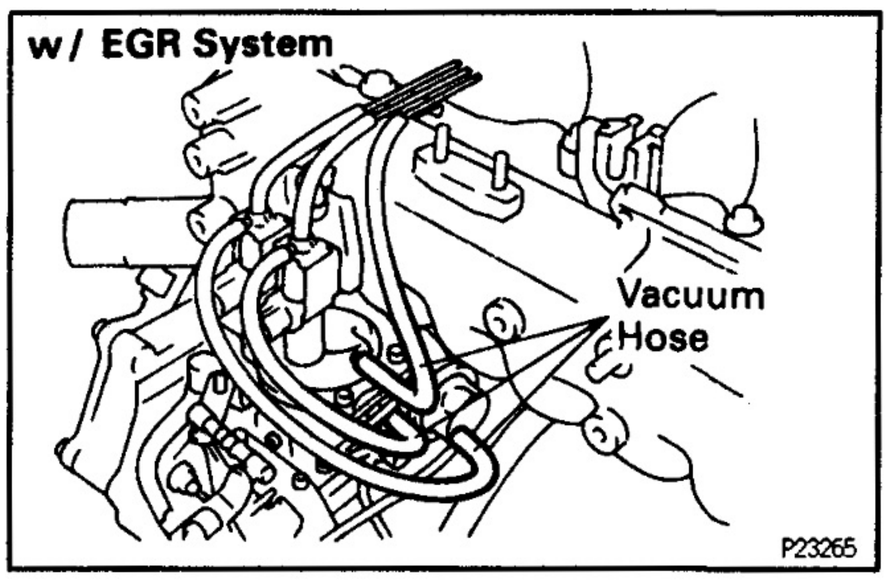
14. INSTALL TURBOCHARGER AND EXHAUST MANIFOLDS ASSEMBLY
(See steps 4, 5 and 6 to 9 in turbocharger installation in Turbocharger System)



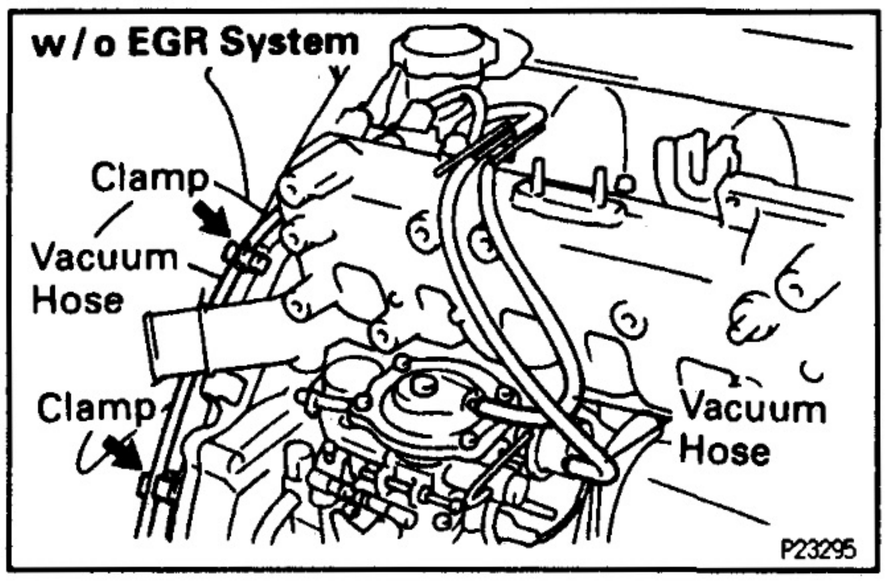
15. INSTALL WATER OUTLET
(a) Install a new gasket to the intake manifold.
(b) Connect the water bypass hose to the water outlet.
(c) Install the water outlet with the 2 nuts.
Torque: 19.6 N·m (200 kgf·cm, 14 ft·lbf)



16. INSTALL INTAKE MANIFOLD
(a) Install 2 new gaskets and the intake manifold with the 8 seal washers and 8 nuts. Uniformly tighten the nuts in several passes.
Torque: 19.6 N·m (200 kgf·cm, 14 ft·lbf)

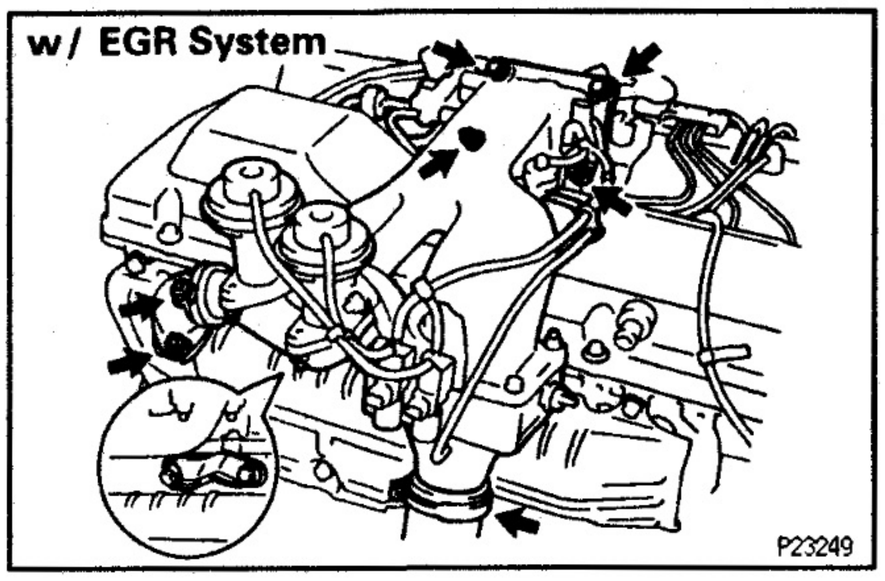


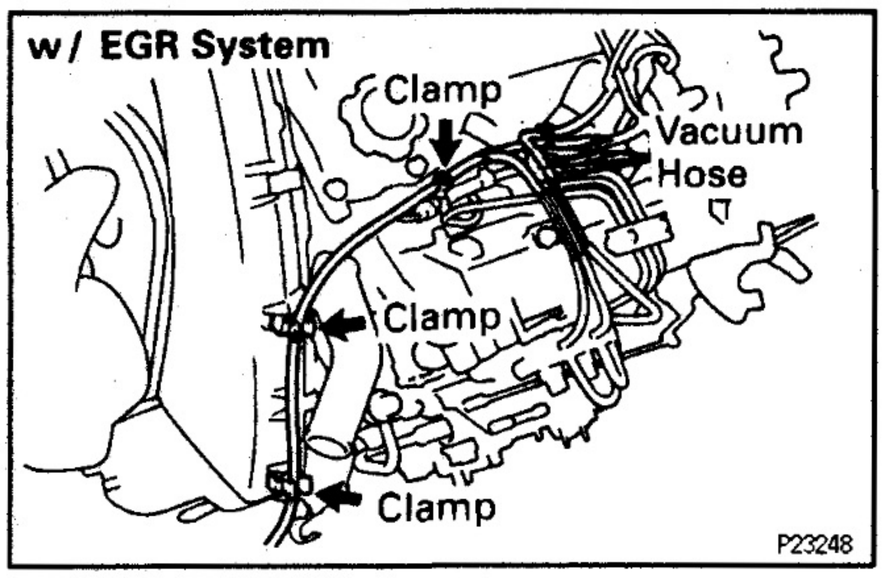
(b) w/ EGR System:
Connect the 3 vacuum hoses to the injection pump.

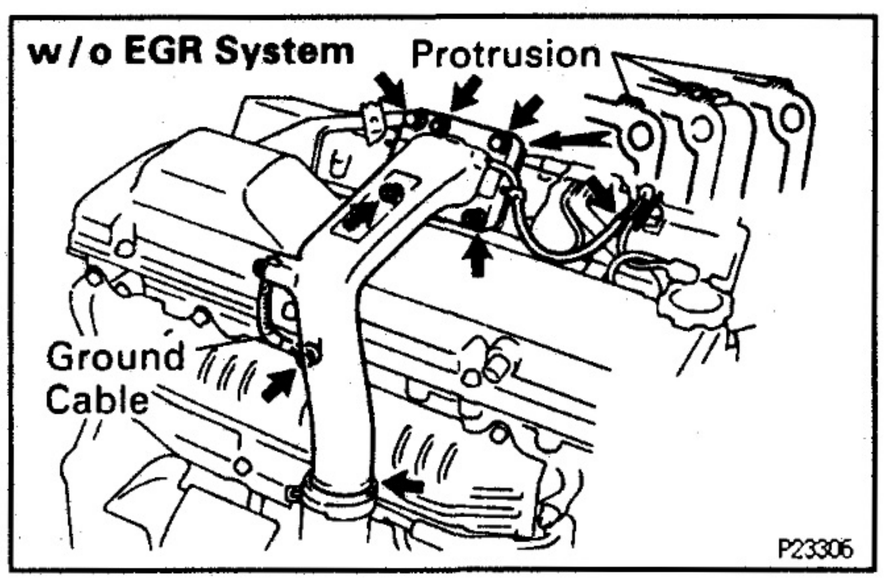


(c) w/o EGR System:
Connect these vacuum hoses:
- 2 vacuum hoses to injection pump
- Vacuum hose to 2 clamps on timing belt cover

17. INSTALL INJECTION PIPES
(See steps 3 and 5 in injection nozzles installation in Fuel System)







18. w/ EGR System:
INSTALL INTAKE PIPE ASSEMBLY

(a) Place the intake pipe insulator on the cylinder head.

(b) Install a new gasket to the intake manifold.
NOTICE: Be careful of the installation direction.

(c) Install a new gasket to the exhaust manifold.

(d) Connect the intake pipe to the air hose.

(e) Place the intake pipe assembly on the intake manifold and exhaust manifold.

(f) Install the 2 bolts and 2 nuts holding the intake pipe to the intake manifold.
Torque: 19.6 N·m (200 kgf·cm, 14 ft·lbf)

(g) Install the 2 nuts holding the EGR valve adapter to the exhaust manifold.
Torque: 40 N·m (400 kgf·cm, 26 ft·lbf)

(h) Install the EGR valve bracket with the 2 bolts. Alternately tighten the bolts in several passes.
Torque: 20 N·m (200 kgf·cm, 15 ft·lbf)

(i) Install the vacuum hose to the 3 clamps on the timing belt cover and fuel return hose.

(j) Connect the 3 vacuum hoses to the vacuum pipe on the intake manifold.

19. w/o EGR System:
INSTALL INTAKE PIPE AND INTAKE HEATER

(a) Place the intake pipe insulator on the cylinder head.

(b) Install a new gasket, the intake heater and a new gasket to the intake manifold.
NOTICE: Be careful of the installation direction.

(c) Connect the intake pipe to the air hose.

(d) Install the intake pipe to the intake manifold with the 3 bolts and 2 nuts.
Torque:
10 mm head
7.5 N·m (75 kgf·cm, 66 in.·lbf)
12 mm head
19.6 N·m (200 kgf·cm, 14 ft·lbf)

(e) Install the ground cable to the cylinder head with the bolt.

(f) Connect the vacuum hose to the vacuum pipe on the intake manifold.

20. FILL WITH ENGINE COOLANT

21. START ENGINE AND CHECK FOR LEAKS

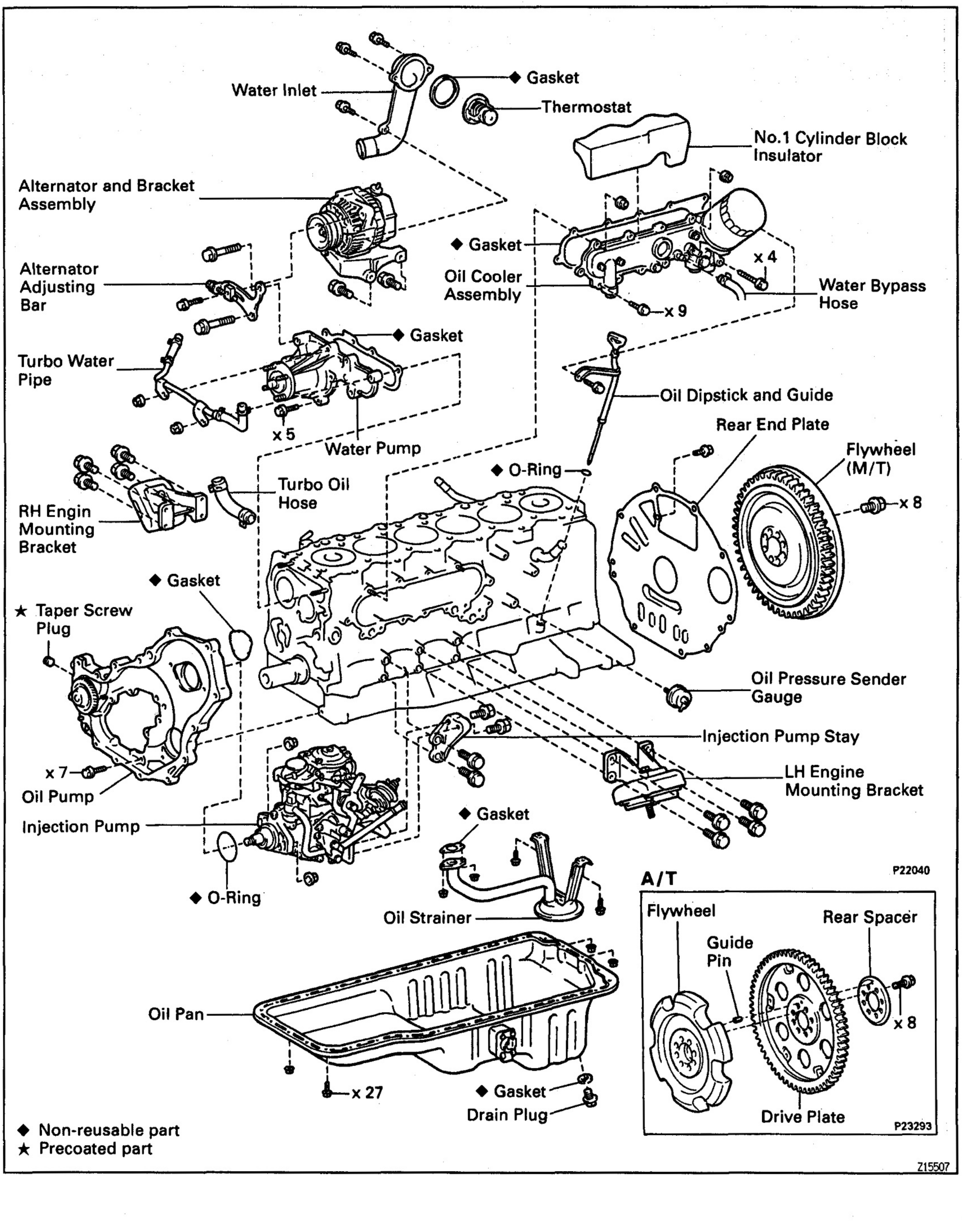
22. RECHECK ENGINE COOLANT LEVEL AND OIL LEVEL

EG

CYLINDER BLOCK

COMPONENTS FOR PREPARATION AND AFTER ASSEMBLY

E0580-01



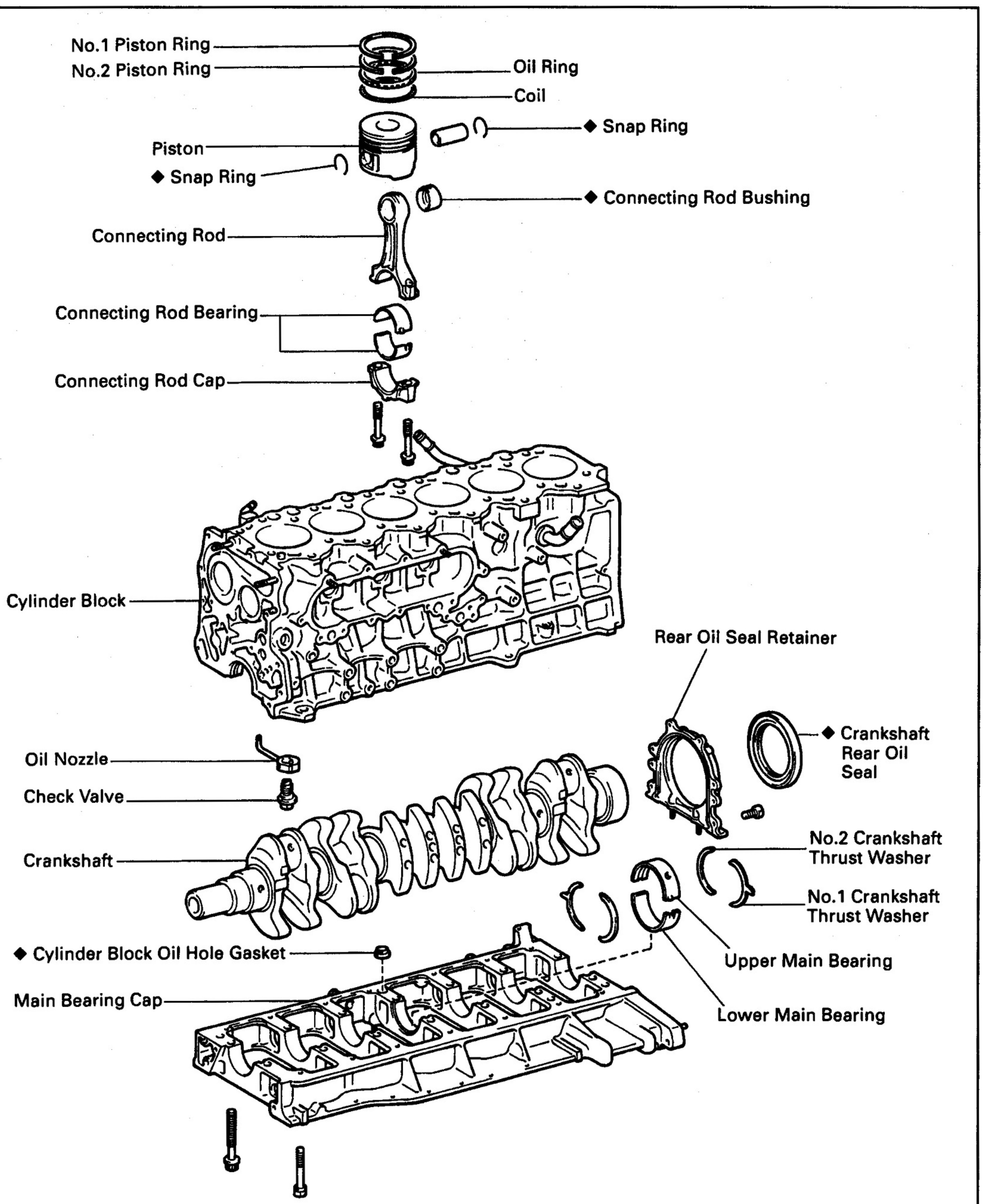
EG551-01

PREPARATION FOR DISASSEMBLY

1. M/T:
   REMOVE FLYWHEEL
2. A/T:
   REMOVE REAR PLATE, DRIVE PLATE AND FLYWHEEL
3. REMOVE REAR END PLATE
4. INSTALL ENGINE TO ENGINE STAND FOR DISASSEMBLY
5. REMOVE TIMING BELT AND PULLEYS
   (See timing belt removal)
6. REMOVE CYLINDER HEAD
   (See cylinder head removal)
7. REMOVE TIMING GEARS
   (See timing gears removal)
8. REMOVE ALTERNATOR ADJUSTING BAR, TURBO WATER PIPE AND WATER PUMP
   (See water pump removal in Cooling System)
9. REMOVE WATER INLET AND THERMOSTAT
   (See thermostat removal in Cooling System)
10. REMOVE ALTERNATOR AND BRACKET ASSEMBLY
11. REMOVE INJECTION PUMP
    (See injection pump removal in Fuel System)
12. REMOVE NO.1 CYLINDER BLOCK INSULATOR
13. REMOVE INJECTION PUMP STAY
14. REMOVE OIL PAN, OIL PUMP (TIMING GEAR CASE) AND OIL STRAINER
    (See oil pump removal in Lubrication System)
15. REMOVE OIL DIPSTICK, GUIDE AND OIL COOLER ASSEMBLY
    (See oil cooler removal in Lubrication System)
16. REMOVE OIL PRESSURE SENDER GAUGE
17. REMOVE TURBO OIL HOSE
18. REMOVE ENGINE MOUNTING BRACKETS

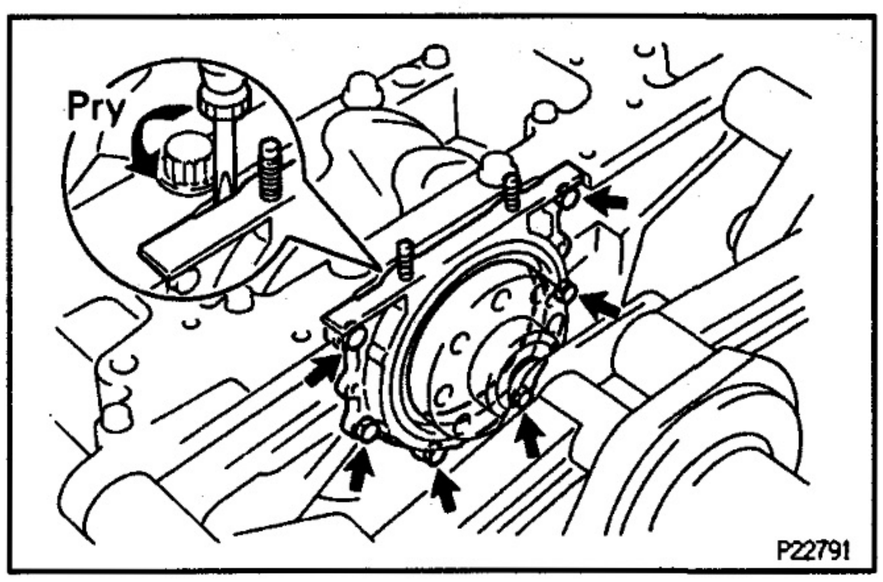
COMPONENTS FOR DISASSEMBLY AND ASSEMBLY

EG0066-1M



◆ Non-reusable part

P22036



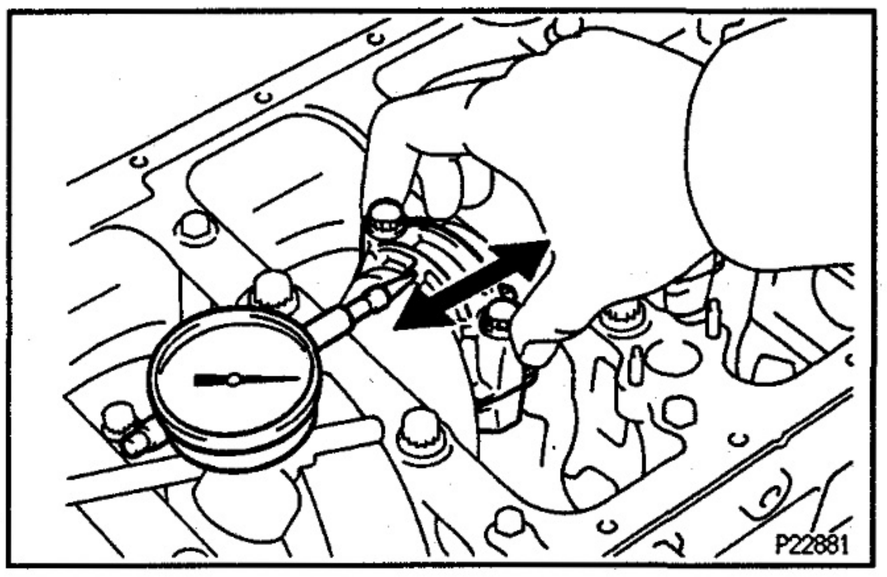
E0582-01

CYLINDER BLOCK DISASSEMBLY

1. REMOVE REAR OIL SEAL RETAINER

(a) Remove the 6 bolts.

(b) Using a screwdriver, remove the oil seal retainer by prying the portions between the oil seal retainer and main bearing cap.



2. CHECK CONNECTING ROD THRUST CLEARANCE

Using a dial indicator, measure the thrust clearance while moving the connecting rod back and forth.

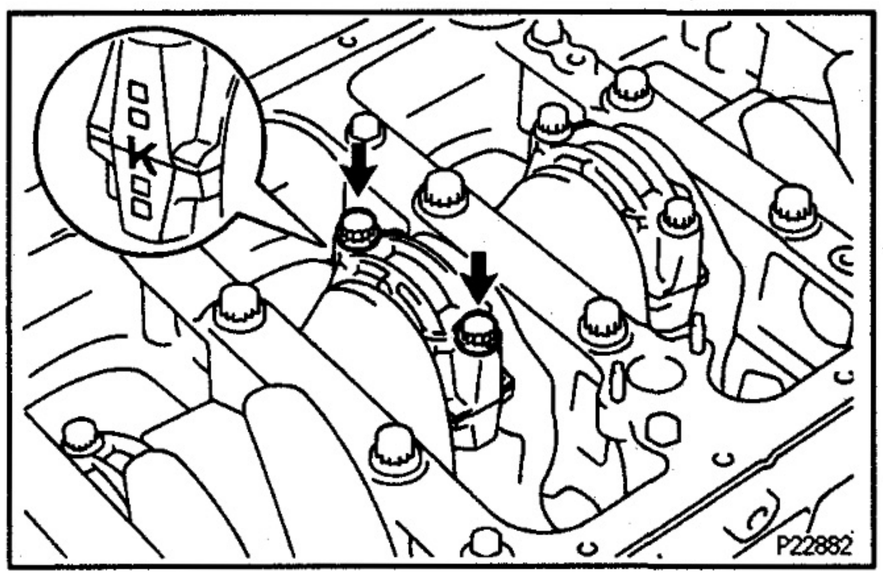
Standard thrust clearance:

0.100 – 0.200 mm (0.0039 – 0.0079 in.)

Maximum thrust clearance:

0.30 mm (0.0118 in.)

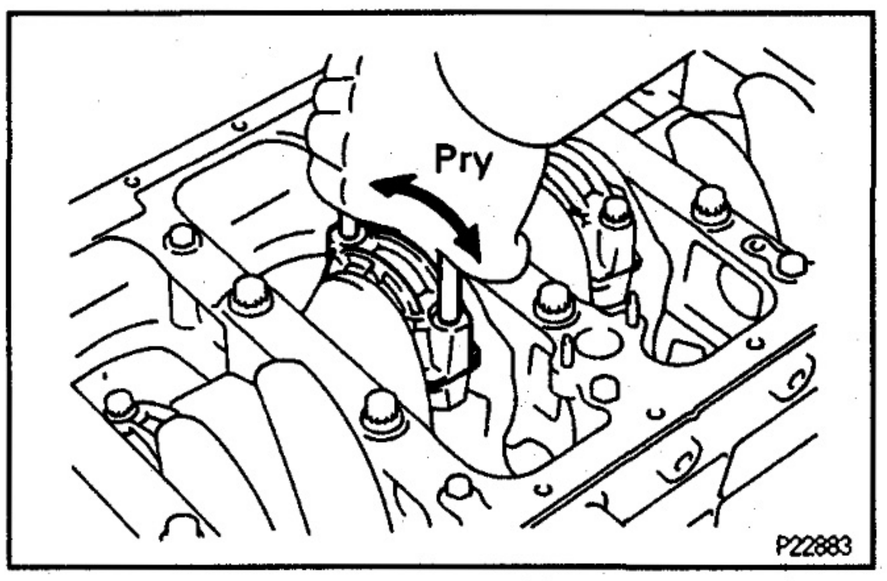
If the thrust clearance is greater than maximum, replace the connecting rod assembly. If necessary, replace the crankshaft.



3. REMOVE CONNECTING ROD CAPS AND CHECK OIL CLEARANCE

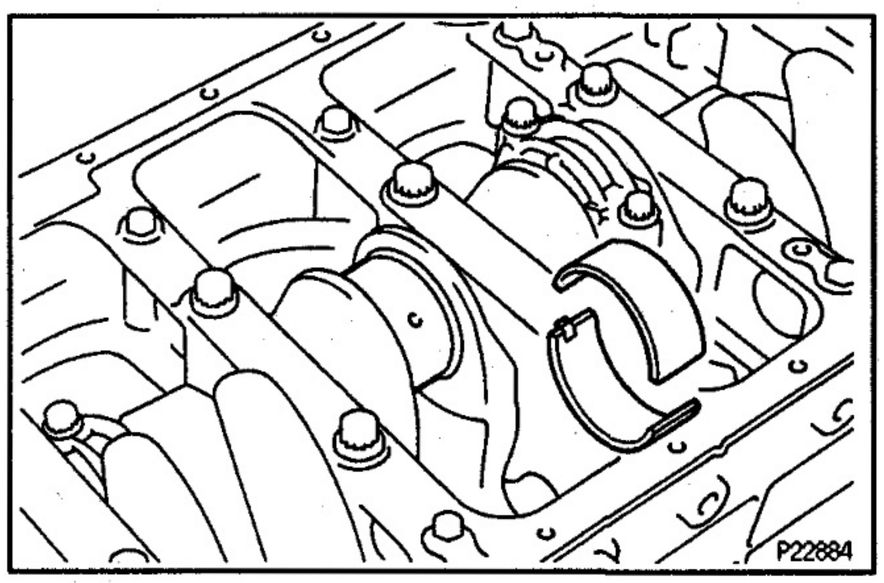
(a) Check the matchmarks on the connecting rod and cap to ensure correct reassembly.

(b) Remove the 2 connecting rod cap bolts.



(c) Using the 2 removed connecting rod cap bolts, and remove the connecting cap by wigging the connecting rod cap right and left.

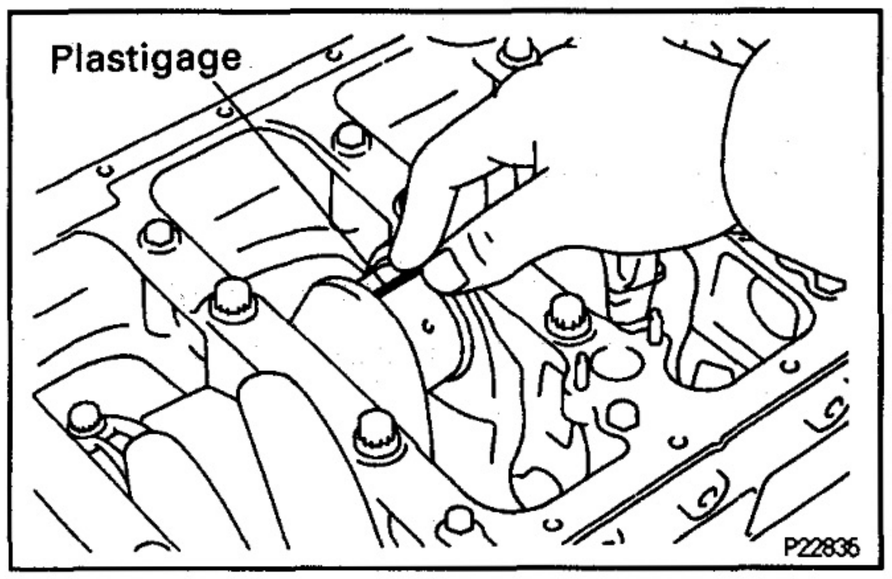
HINT: Keep the lower bearing inserted with the connecting rod cap.



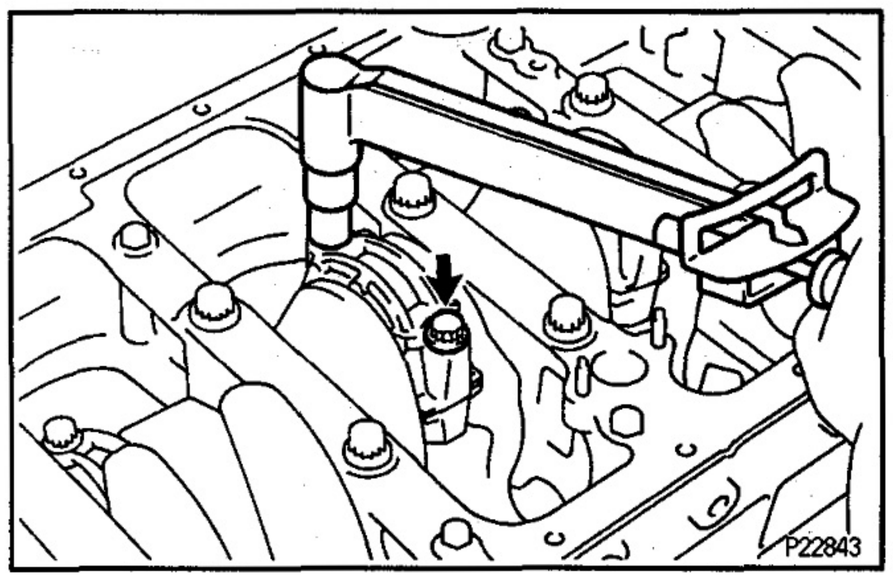
(d) Clean the crank pin and bearing.

(e) Check the crank pin and bearing for pitting and scratches.

If the crank pin or bearing is damaged, replace the bearings. If necessary, grind or replace the crankshaft.

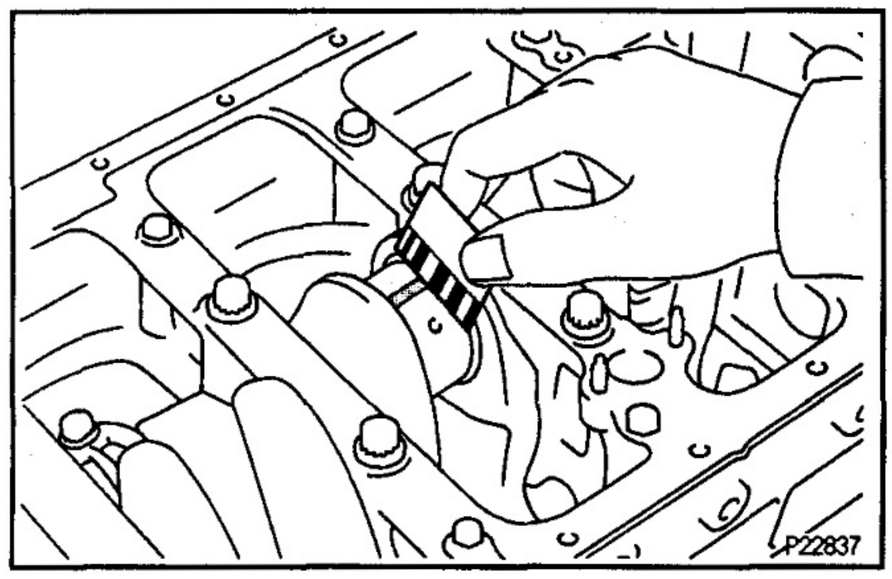


(f) Lay a strip of Plastigage across the crank pin.



(g) Install the connecting rod cap with the 2 bolts.
(See step 8 in cylinder block assembly)
Torque:
1st
37 N·m (375 kgf·cm, 27 ft·lbf)
2nd
Turn 90°
NOTICE: Do not turn the crankshaft.

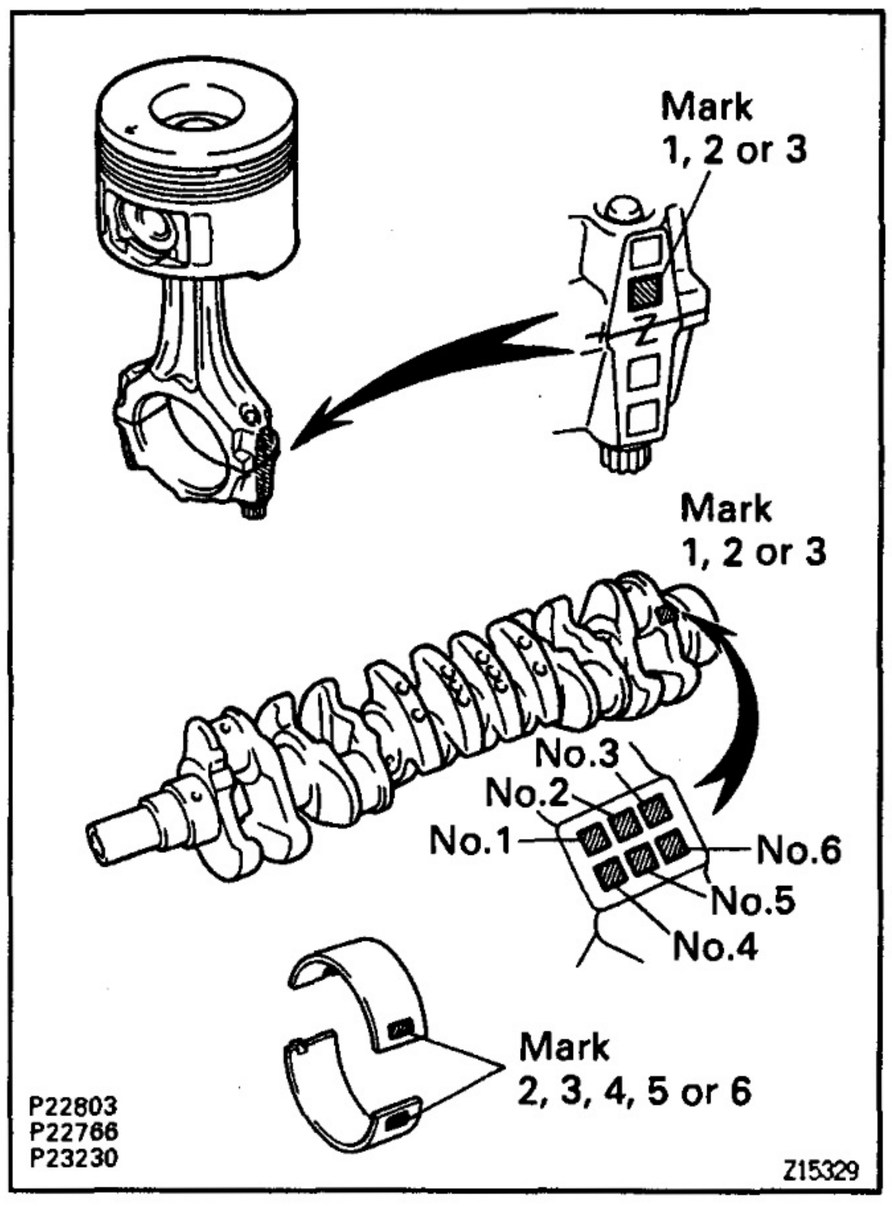
(h) Remove the 2 bolts, connecting rod cap and lower bearing. (See procedure (b) and (c) above)



(i) Measure the Plastigage at its widest point.
Standard oil clearance:
STD
0.036 – 0.054 mm (0.0014 – 0.0021 in.)
U/S 0.25 and U/S 0.50
0.037 – 0.077 mm (0.0015 – 0.0030 in.)
Maximum oil clearance:
0.10 mm (0.0039 in.)

If the oil clearance is greater than maximum, replace the bearings. If necessary, grind or replace the crankshaft.

HINT: If using a standard bearing, replace it with one having the same number. If the number of the bearing cannot be determined, select the correct bearing by adding together the numbers imprinted on the crankshaft and connecting rod, then selecting the bearing with the same number as the total. There are 5 sizes of standard bearings, marked "2", "3", "4", "5", and "6" accordingly.



	Number marked								
Connecting rod	1			2			3		
Crankshaft	1	2	3	1	2	3	1	2	3
Bearing	2	3	4	3	4	5	4	5	6

EXAMPLE: Connecting rod "2" + Crankshaft "1"
= Total number (Use bearing "3")

V06655

Reference

Connecting rod big end inside diameter:

Mark "1"	62.014 — 62.020 mm (2.4415 — 2.4417 in.)
Mark "2"	62.020 — 62.026 mm (2.4417 — 2.4420 in.)
Mark "3"	62.026 — 62.032 mm (2.4420 — 2.4422 in.)

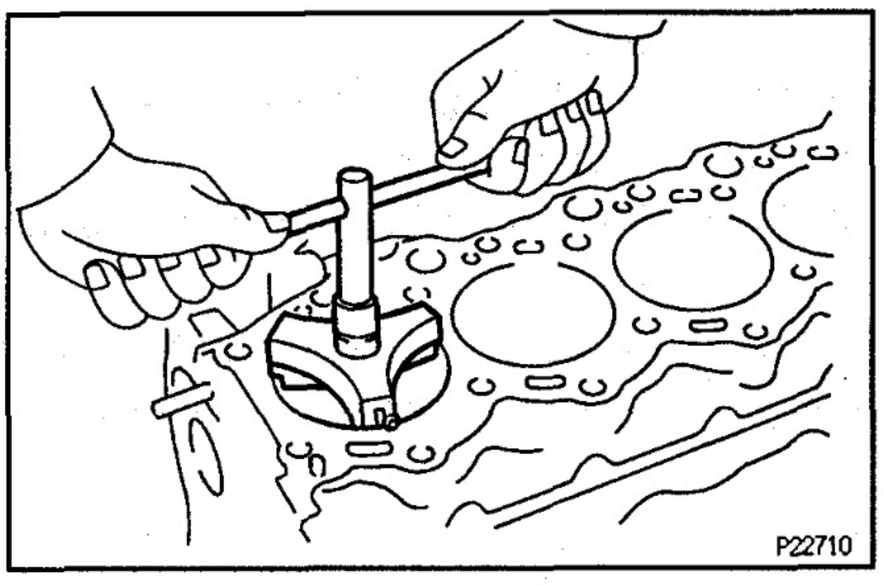
Crankshaft crank pin diameter:

Mark "1"	58.994 — 59.000 mm (2.3226 — 2.3228 in.)
Mark "2"	58.988 — 58.994 mm (2.3224 — 2.3226 in.)
Mark "3"	58.982 — 58.988 mm (2.3221 — 2.3224 in.)

Standard sized bearing center wall thickness:

Mark "2"	1.486 — 1.489 mm (0.0585 — 0.0586 in.)
Mark "3"	1.489 — 1.492 mm (0.0586 — 0.0587 in.)
Mark "4"	1.492 — 1.495 mm (0.0587 — 0.0589 in.)
Mark "5"	1.495 — 1.498 mm (0.0589 — 0.0590 in.)
Mark "6"	1.498 — 1.501 mm (0.0590 — 0.0591 in.)

(j) Completely remove the Plastigage.


P22710

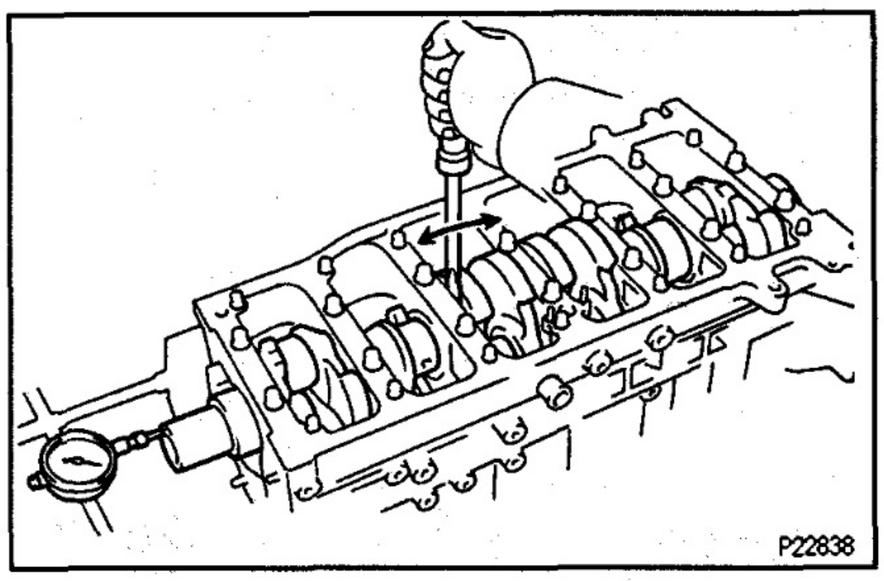
4. REMOVE PISTON AND CONNECTING ROD ASSEMBLIES

(a) Using a ridge reamer, remove all the carbon from the top of the cylinder.

(b) Push the piston, connecting rod assembly and upper bearing through the top of the cylinder block.

HINT:

- Keep the bearings, connecting rod and cap together.
- Arrange the piston and connecting rod assemblies in correct order.


P22838

5. CHECK CRANKSHAFT THRUST CLEARANCE

Using a dial indicator, measure the thrust clearance while prying the crankshaft back and forth with a screwdriver.

Standard thrust clearance:

0.040 — 0.240 mm (0.0016 — 0.0094 in.)

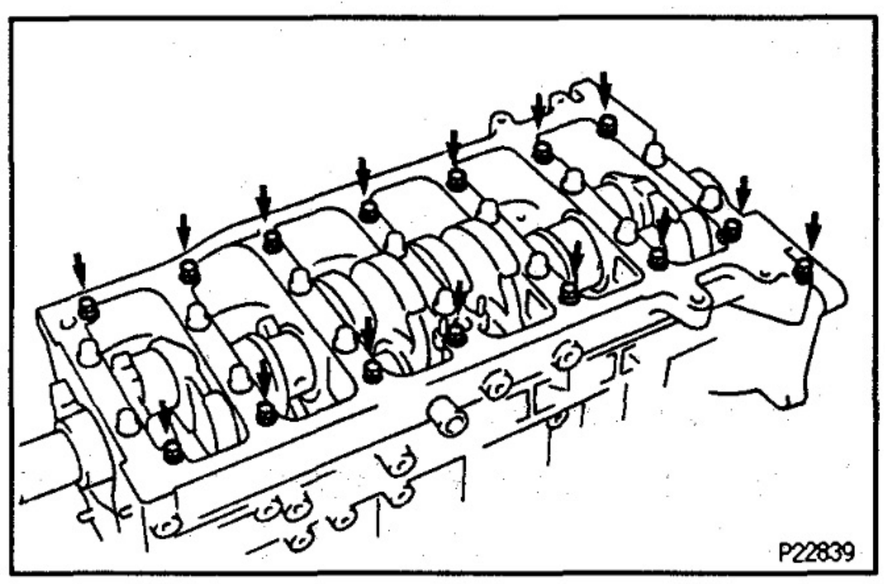
Maximum thrust clearance:

0.30 mm (0.0118 in.)

If the thrust clearance is greater than maximum, replace the thrust washers as a set.

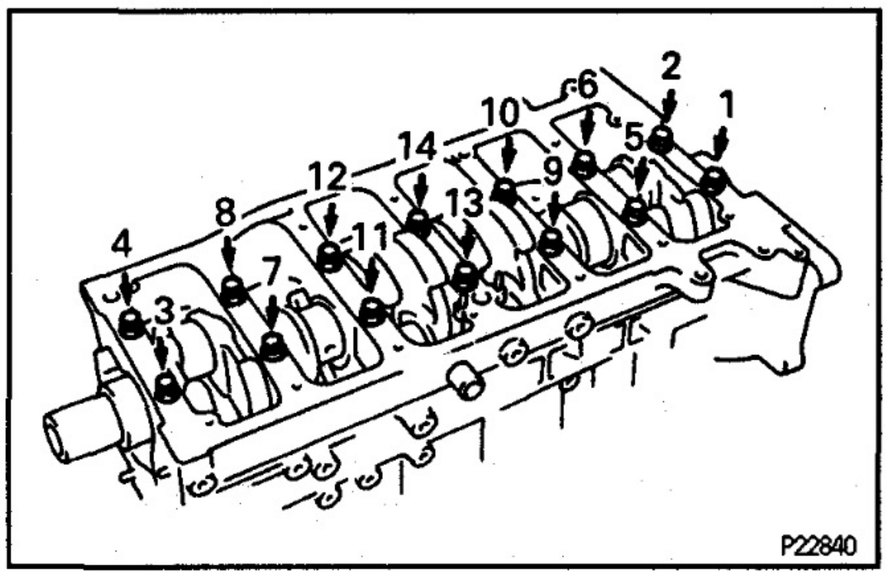
Thrust washer thickness:

2.930 — 2.980 mm (0.1154 — 0.1173 in.)

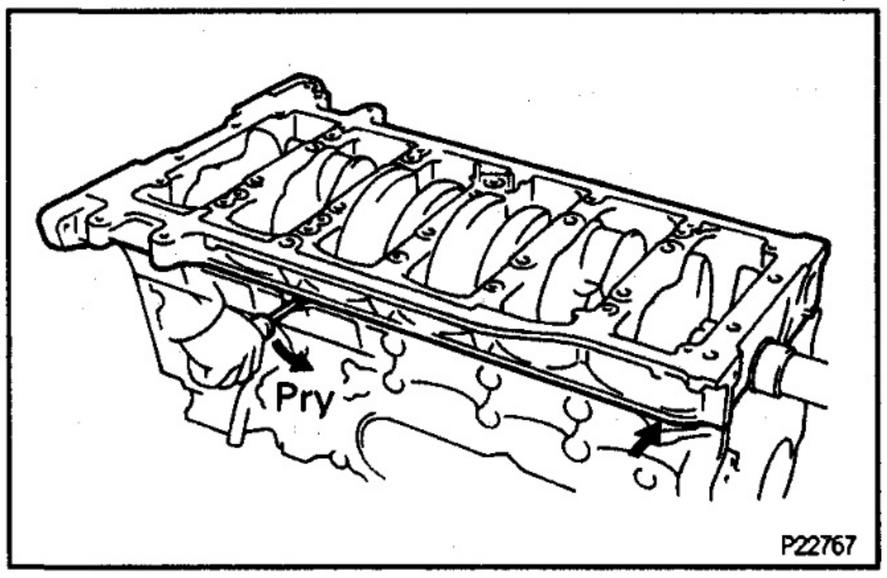

P22839

6. REMOVE MAIN BEARING CAP AND CHECK OIL CLEARANCE

(a) Remove the 15 main bearing cap bolts (6 pointed head).



(b) Uniformly loosen and remove the 14 main bering cap bolts (12 pointed head) in several passes, in the sequence shown.



(c) Using a screwdriver, remove the main bearing cap by prying the portions between the main bearing cap and cylinder block.

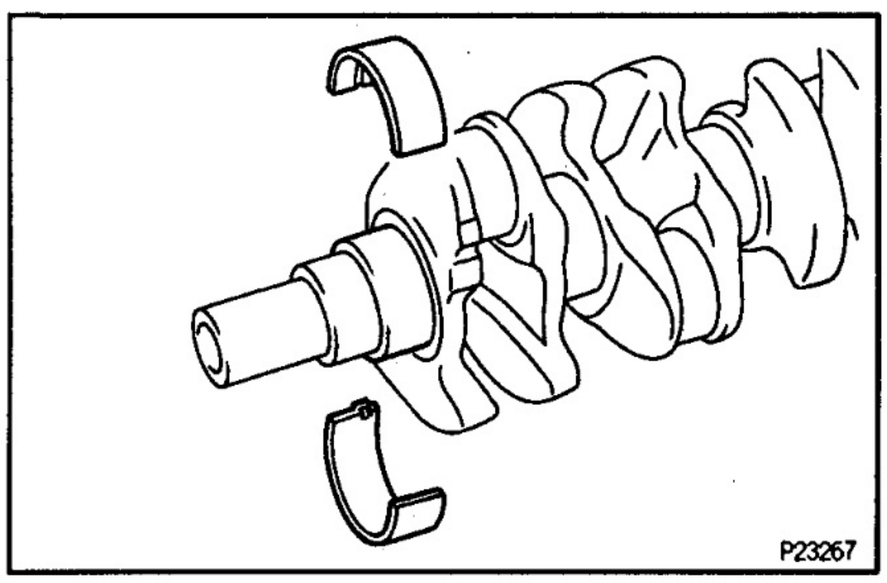
NOTICE: Be careful not to scratch the surfaces contacting the main bearing cap and cylinder block.

HINT: Keep the lower bearings inserted with the main bearing cap.

(d) Lift out the crankshaft.

HINT:

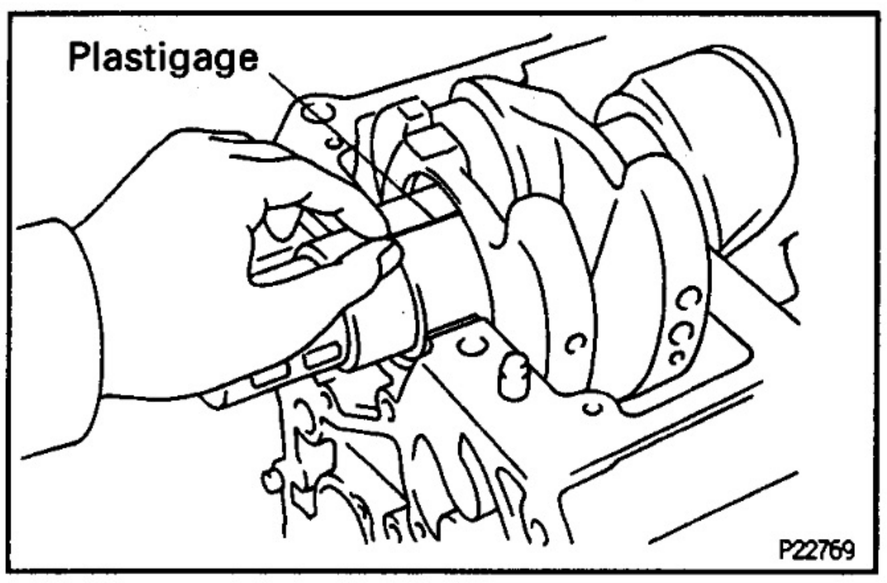
- Keep the upper bearings inserted with the cylinder block.
- Arrange the thrust washers in correct order.



(e) Clean each main journal and bearing.

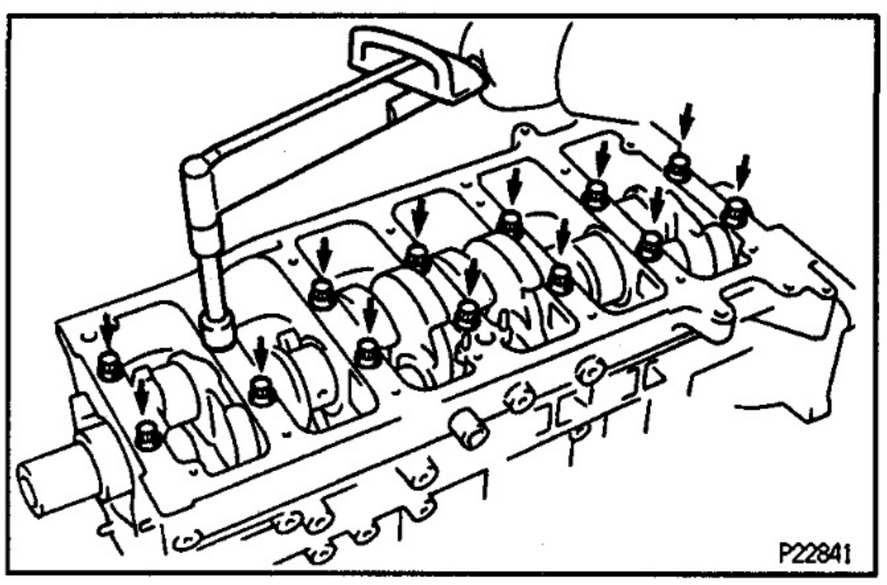
(f) Check each main journal and bearing for pitting and scratches.

If the journal or bearing is damaged, replace the bearings. If necessary, grind or replace the crankshaft.



(g) Place the crankshaft on the cylinder block.

(h) Lay a strip of Plastigage across each journal.



(i) Install the main bearing cap with the 14 bolts (12 pointed head).

(See step 5 in cylinder block assembly)

Torque:

1st

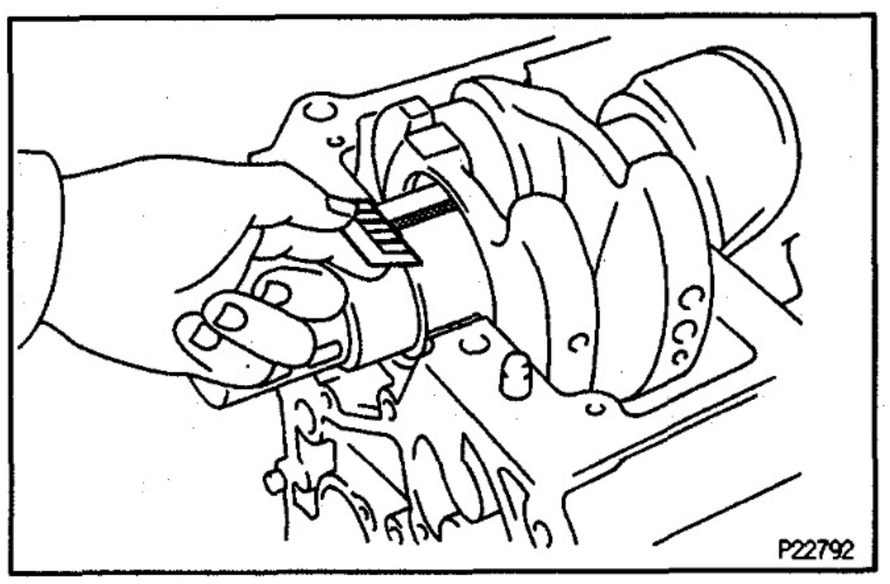
103 N·m (1,050 kgf·cm, 76 ft·lbf)

2nd

Turn 90°

NOTICE: Do not turn the crankshaft.

(j) Remove the 14 bolts (12 pointed head) and main bearing cap. (See procedure (b) and (c) above)



(k) Measure the Plastigage at its widest point.

Standard clearance:

STD

0.036 – 0.054 mm (0.0014 – 0.0021 in.)

U/S 0.25 and U/S 0.50

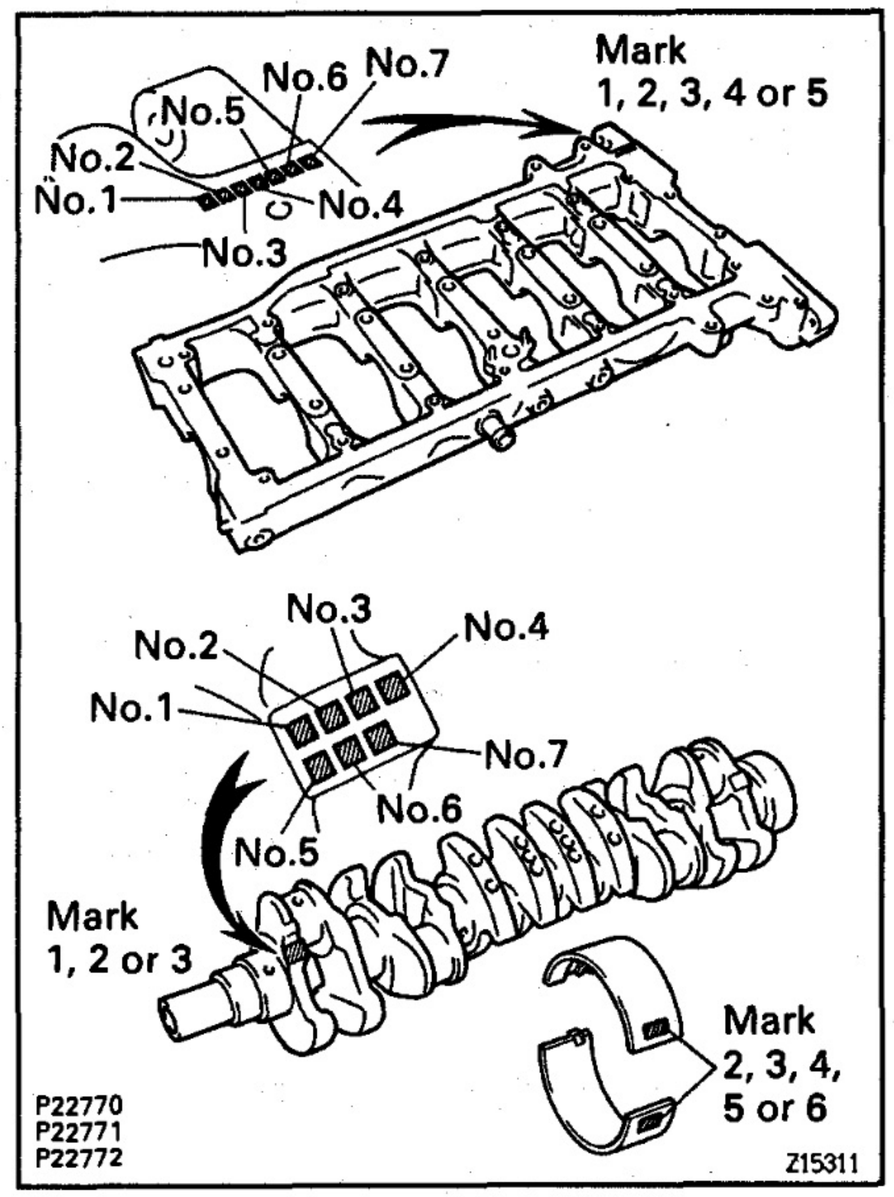
0.037 – 0.077 mm (0.0015 – 0.0030 in.)

Maximum clearance:

0.10 mm (0.0039 in.)

If the oil clearance is greater than maximum, replace the bearings. If necessary, grind or replace the crankshaft.

HINT: If using a standard bearing, replace it with one having the same number. If the number of the bearing cannot be determined, select the correct bearing by adding together the numbers imprinted on the main bearing cap and crankshaft, then selecting the bearing with the same number as the total. There are 5 sizes of standard bearings, marked "2", "3", "4", "5" and "6" accordingly.



	Number marked								
Main bearing cap	1			2			3		
Crankshaft	1	2	3	1	2	3	1	2	3
Bearing	2	3	4	3	4	5	4	5	6

EXAMPLE: Main bearing cap "2"" + Crankshaft "1"
= Total number (Use bearing "3")

V06654

Reference

Cylinder block main journal bore diameter:

Mark "1"	71.000 – 71.006 mm (2.7953 – 2.7955 in.)
Mark "2"	71.006 – 71.012 mm (2.7955 – 2.7957 in.)
Mark "3"	71.012 – 71.018 mm (2.7957 – 2.7960 in.)

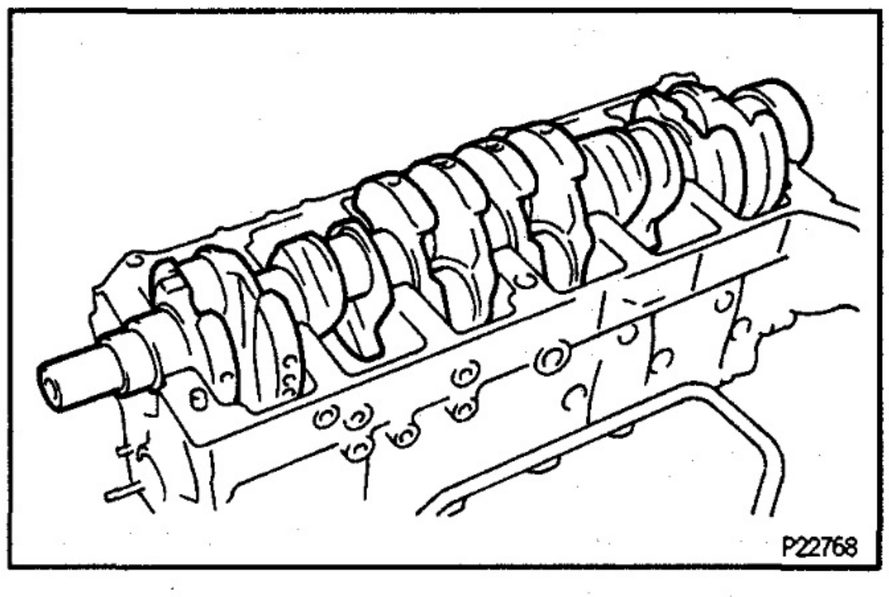
Crankshaft main journal diameter:

Mark "1"	66.994 – 67.000 mm (2.6376 – 2.6378 in.)
Mark "2"	66.988 – 66.994 mm (2.6373 – 2.6376 in.)
Mark "3"	66.982 – 66.988 mm (2.6371 – 2.6373 in.)

Standard sized bearing center wall thickness:

Mark "2"	1.979 – 1.982 mm (0.0779 – 0.0780 in.)
Mark "3"	1.982 – 1.985 mm (0.0780 – 0.0781 in.)
Mark "4"	1.985 – 1.988 mm (0.0781 – 0.0783 in.)
Mark "5"	1.988 – 1.991 mm (0.0783 – 0.0784 in.)
Mark "6"	1.991 – 1.994 mm (0.0784 – 0.0785 in.)

(l) Completely remove the Plastigage.



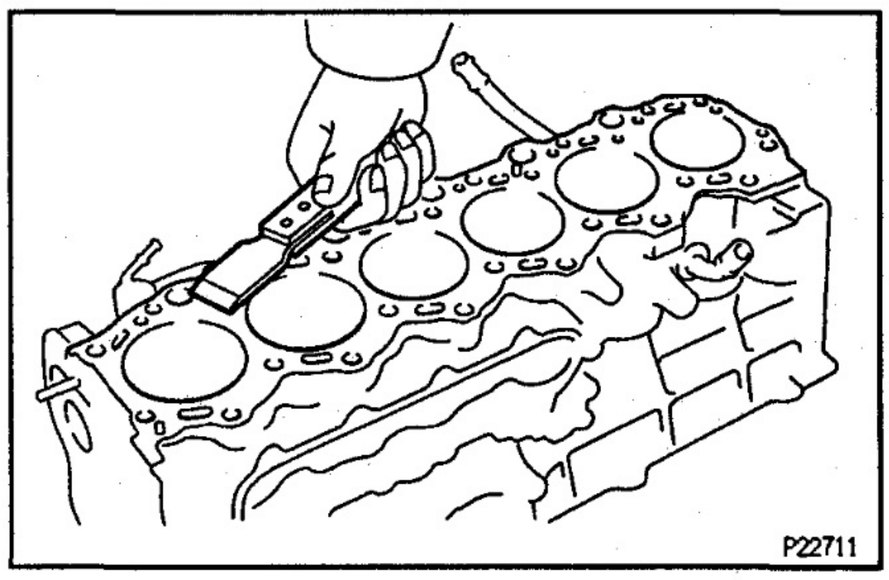
7. REMOVE CRANKSHAFT

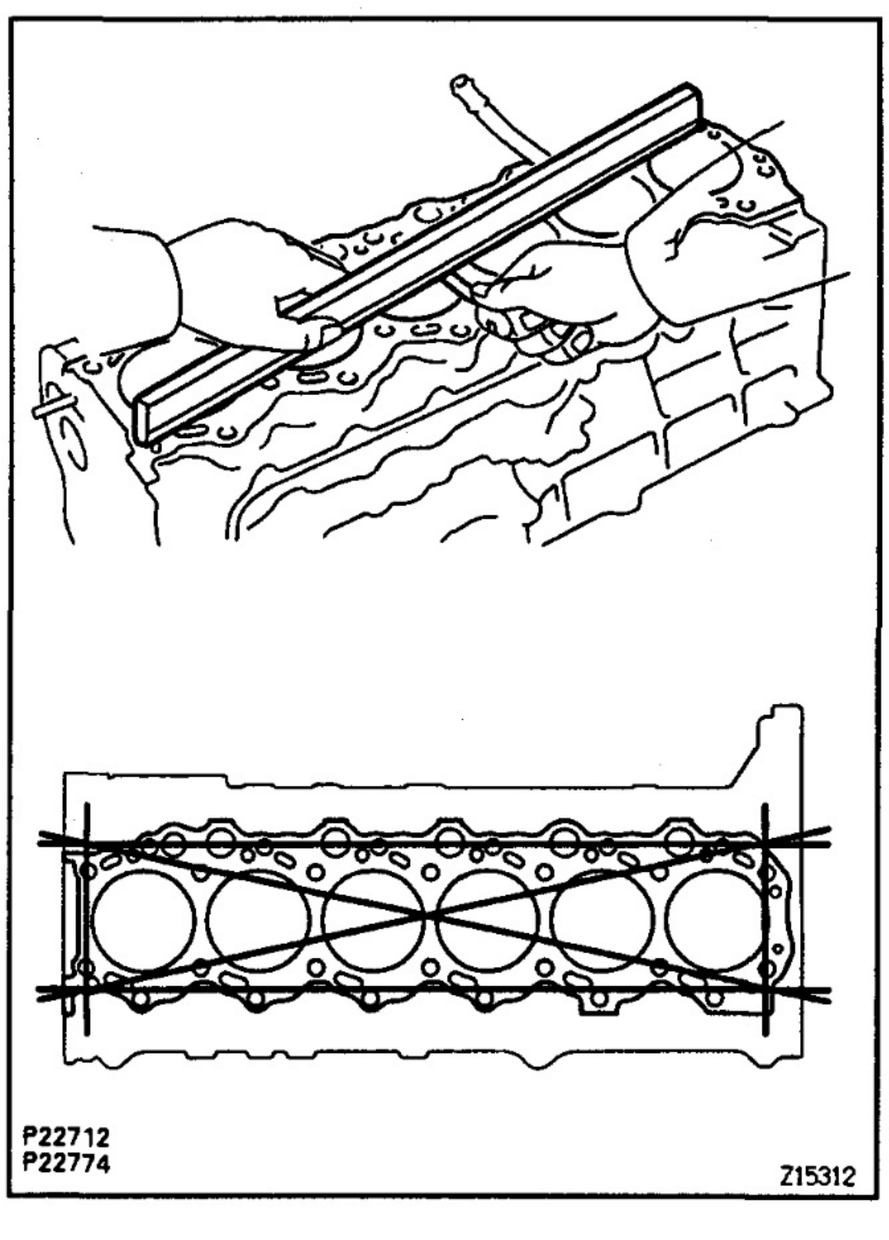
(a) Lift out the crankshaft.

(b) Remove the upper bearings and thrust washers from the cylinder block.

HINT: Arrange the main bearings and thrust washers in correct order.

8. REMOVE CHECK VALVES AND OIL NOZZLES (See step 2 in oil nozzles removal in Lubrication System)





CYLINDER BLOCK INSPECTION

1. CLEAN CYLINDER BLOCK

A. Remove gasket material

Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.

B. Clean cylinder block

Using a soft brush and solvent, thoroughly clean the cylinder block.

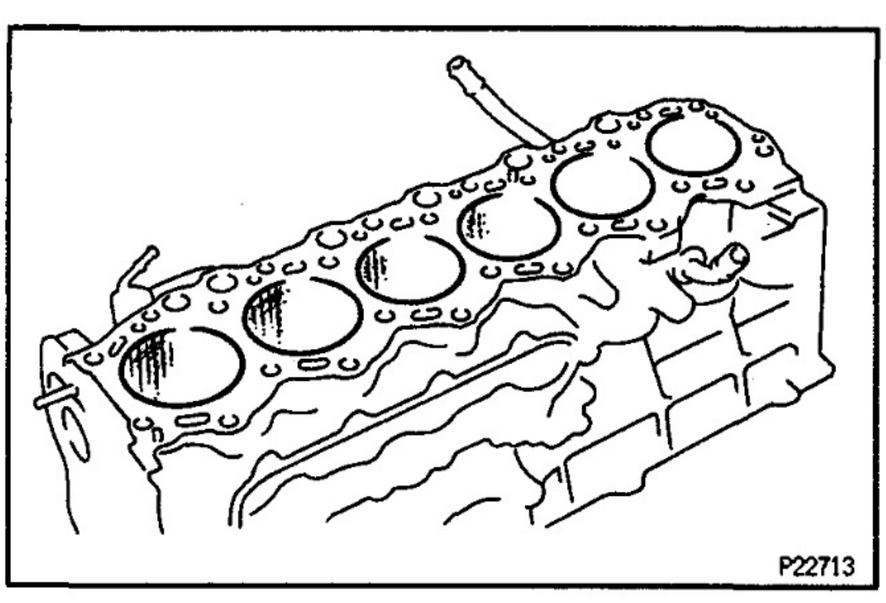
2. INSPECT TOP SURFACE OF CYLINDER BLOCK FOR FLATNESS

Using a precision straight edge and feeler gauge, measure the surfaces contacting the cylinder head gasket for warpage.

Maximum warpage:

0.20 mm (0.0079 in.)

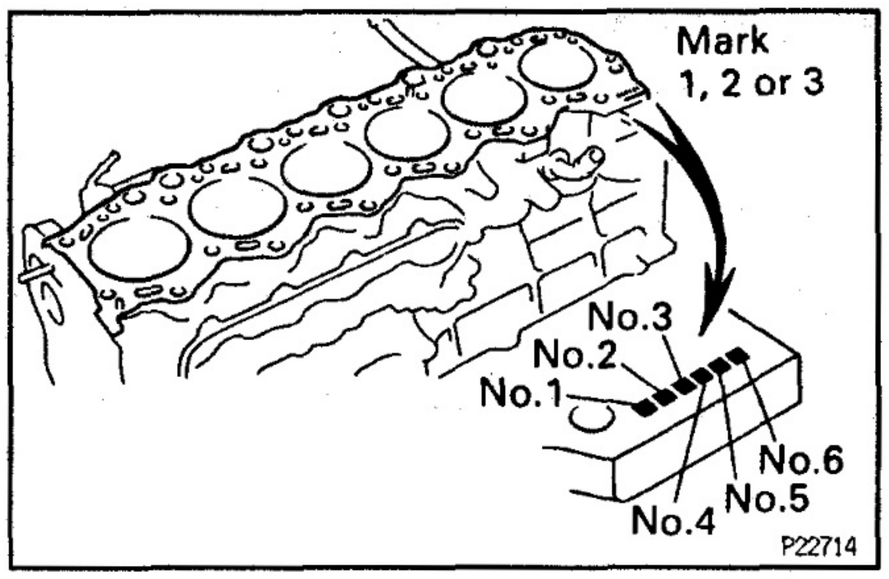
If warpage is greater than maximum, replace the cylinder block.



3. INSPECT CYLINDER FOR VERTICAL SCRATCHES

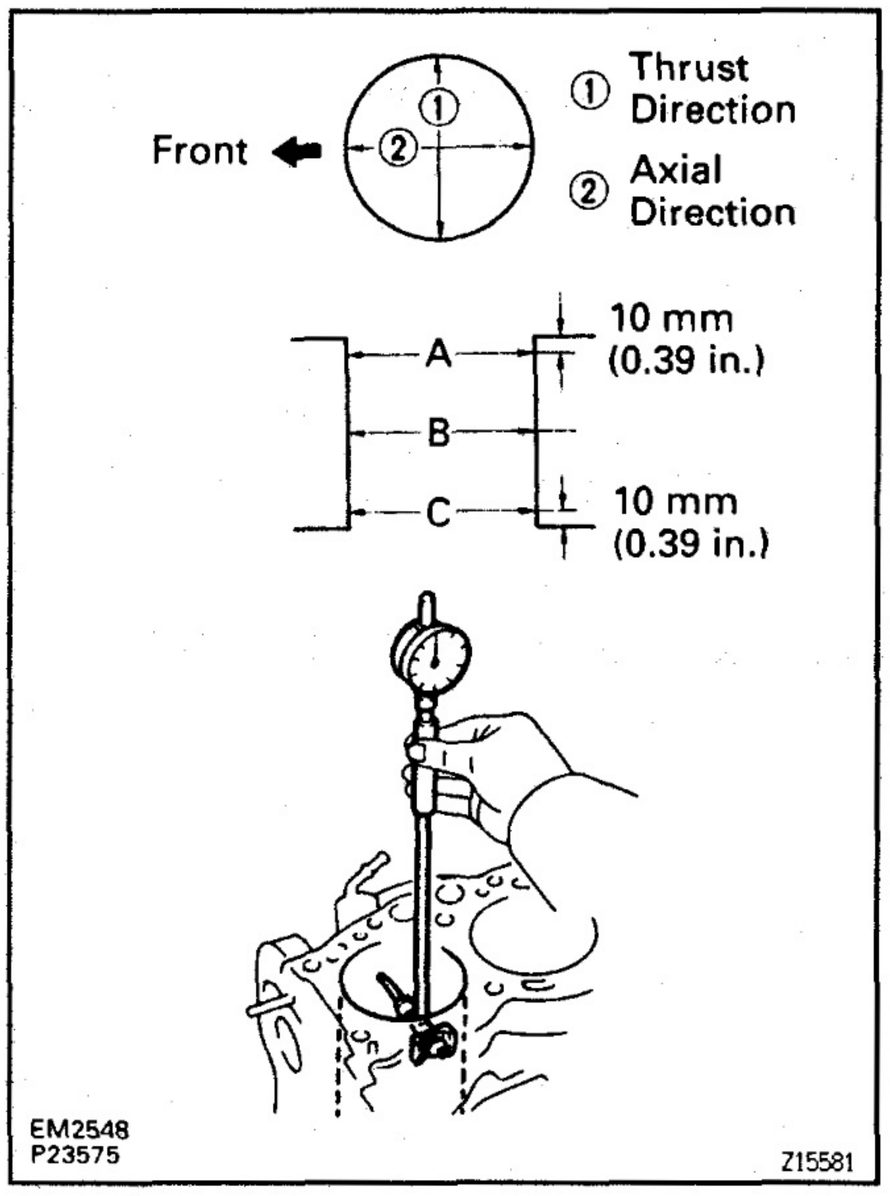
Visually check the cylinder for vertical scratches.

If deep scratches are present, rebore all the 6 cylinders. If necessary, replace the cylinder block.



4. INSPECT CYLINDER BORE DIAMETER

HINT: There are 3 sizes of the standard cylinder bore diameter, marked "1", "2" and "3" accordingly. The mark is stamped on the top of the cylinder block.



Using a cylinder gauge, measure the cylinder bore diameter at positions A, B and C in the thrust and axial directions.

Standard diameter:

STD

Mark "1"

94.000 — 94.010 mm (3.7001 — 3.7012 in.)

Mark "2"

94.010 — 94.020 mm (3.7012 — 3.7016 in.)

Mark "3"

94.020 — 94.030 mm (3.7016 — 3.7020 in.)

Maximum diameter:

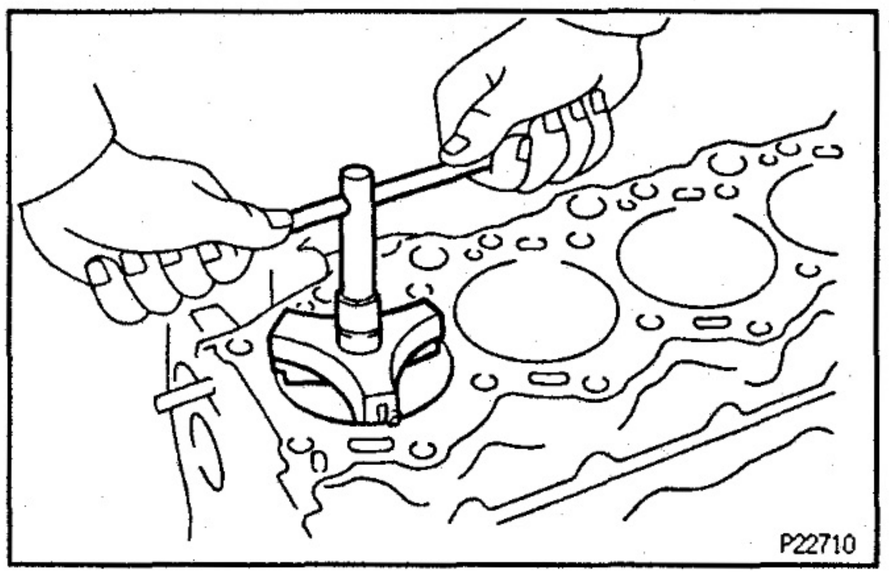
STD

94.23 mm (3.7098 in.)

O/S 0.50

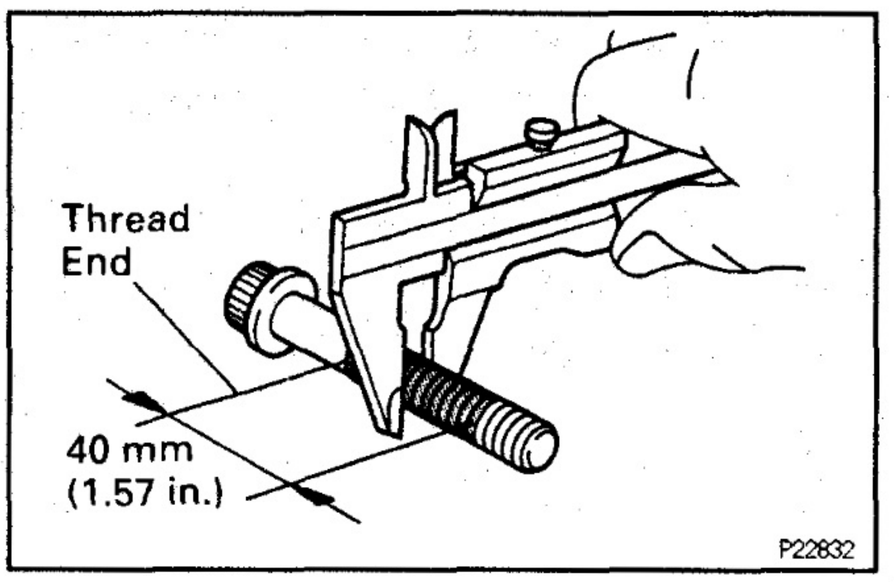
94.73 mm (3.7295 in.)

If the diameter is greater than maximum, rebore all the 6 cylinders. If necessary, replace the cylinder block.



5. REMOVE CYLINDER RIDGE

If the wear is less than 0.2 mm (0.008 in.), using a ridge reamer, grind the top of the cylinder.



6. INSPECT MAIN BEARING CAP BOLTS

Using vernier calipers, measure the thread outside diameter at the measuring point.

Standard diameter:

11.800 — 12.000 mm (0.4646 — 0.4724 in.)

Minimum diameter:

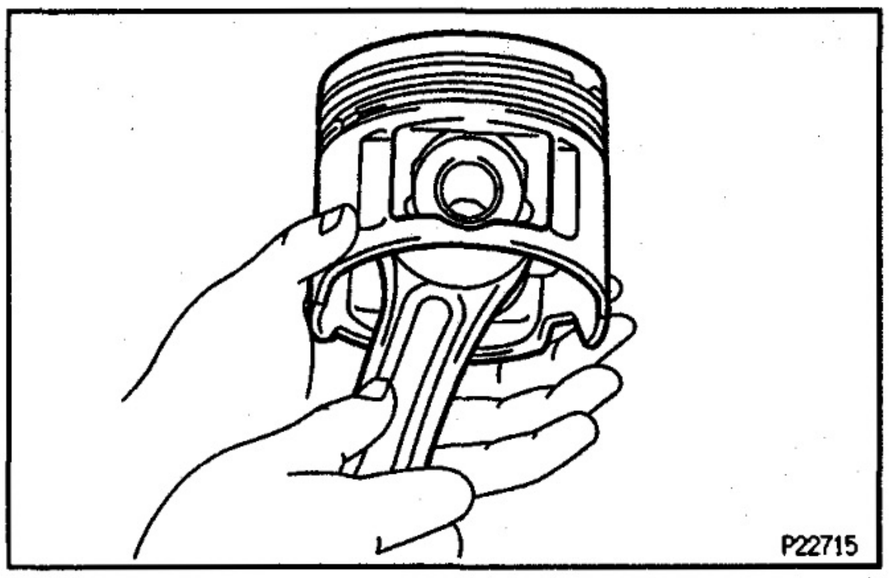
11.50 mm (0.4528 in.)

If the diameter is less than minimum, replace the bolt.

EG

EG584-01

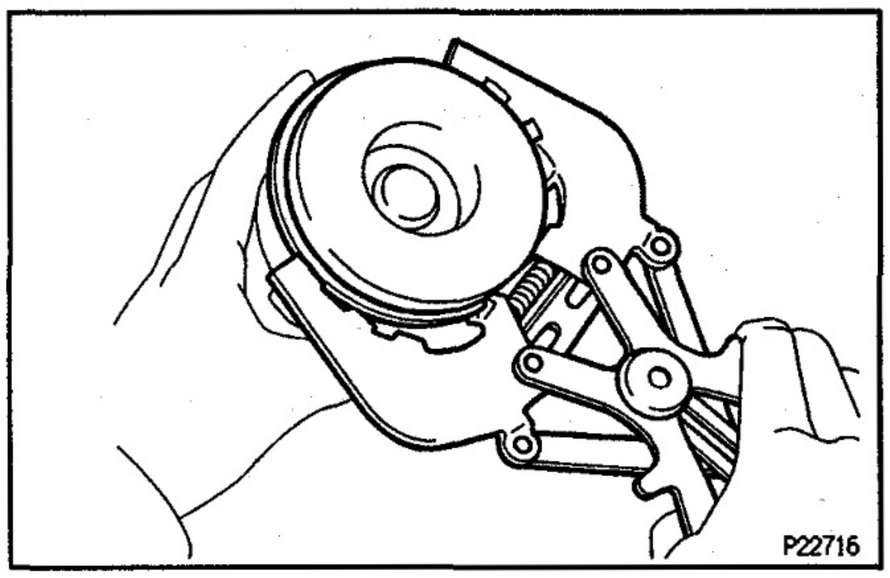
PISTON AND CONNECTING ROD DISASSEMBLY



1. CHECK FIT BETWEEN PISTON AND PISTON PIN

Try to move the piston back and forth on the piston pin.

If any movement is felt, replace the piston and pin as a set.

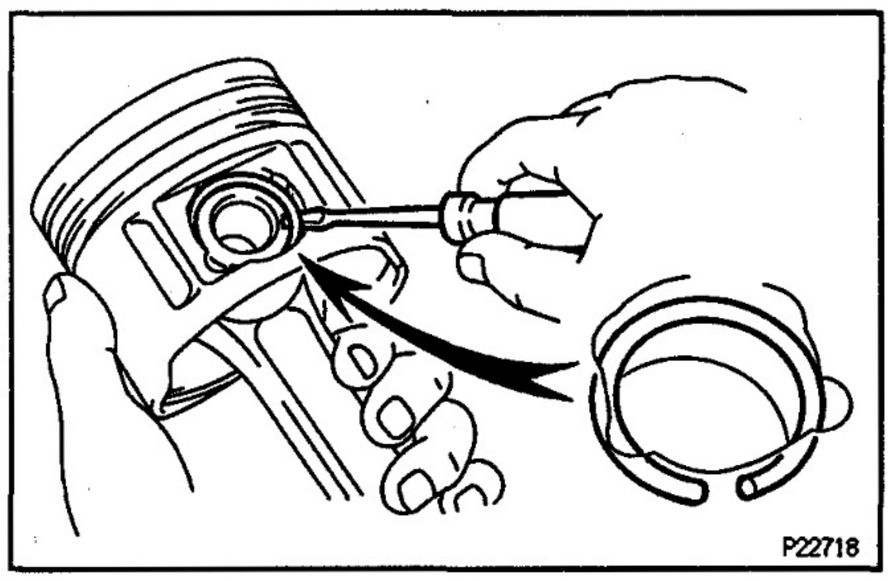


2. REMOVE PISTON RINGS

(a) Using a piston ring expander, remove the No.1, No.2 and oil rings.

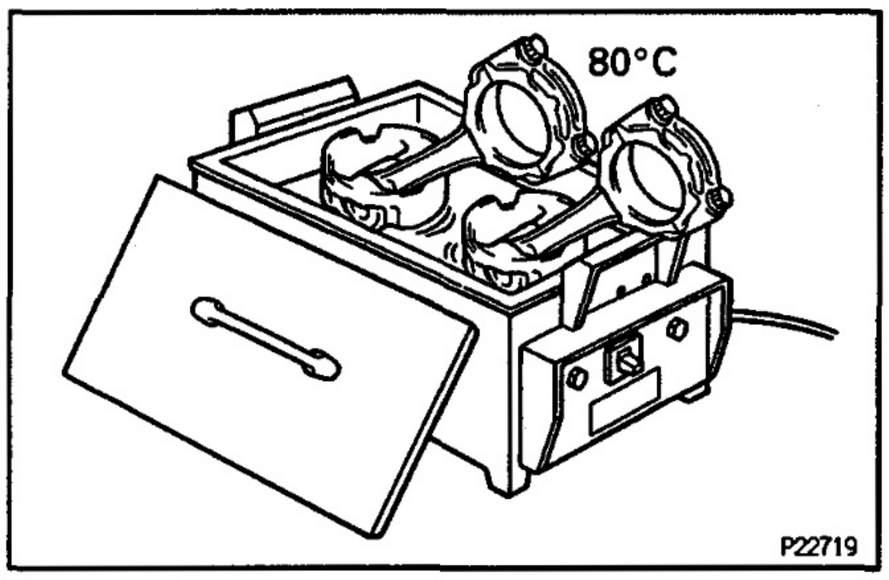
(b) Remove the coil by hand.

HINT: Arrange the rings in correct order only.

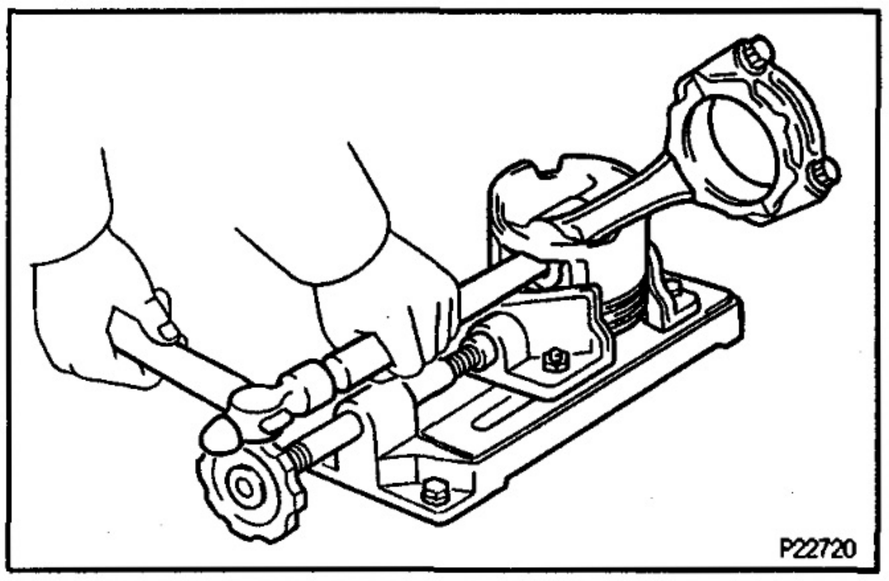


3. DISCONNECT CONNECTING ROD FROM PISTON

(a) Using a small screwdriver, pry off the snap ring from the piston.



(b) Gradually heat the piston to approx. 80°C (176°F).

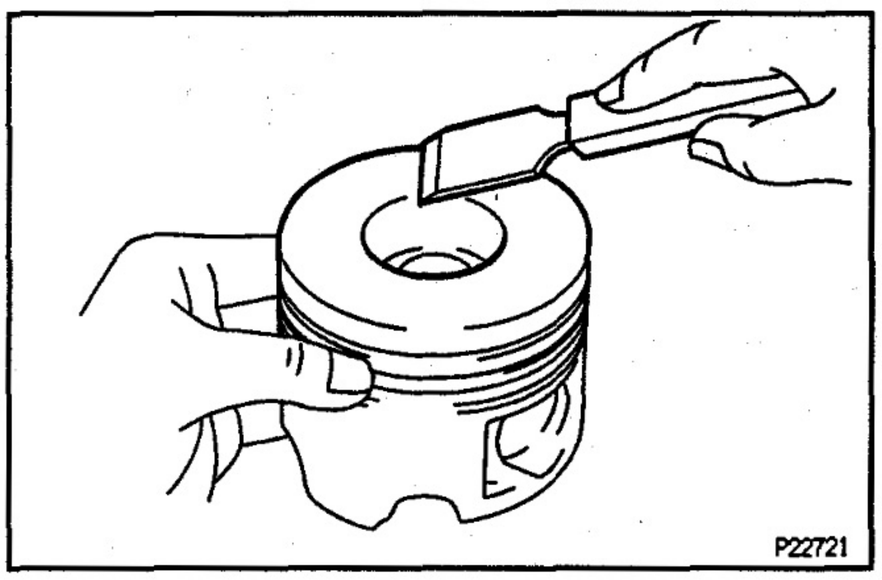


(c) Using a plastic—faced hammer and brass bar, lightly tap out the piston pin and remove the connecting rod.

HINT:

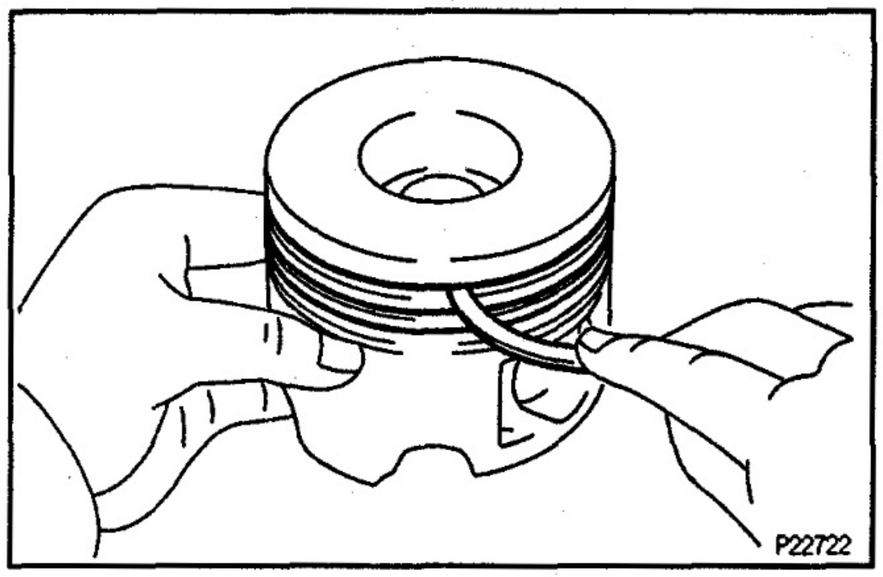
- The piston and pin are a matched set.
- Arrange the pistons, pins, rings, connecting rods and bearings in correct order.

PISTON AND CONNECTING ROD INSPECTION

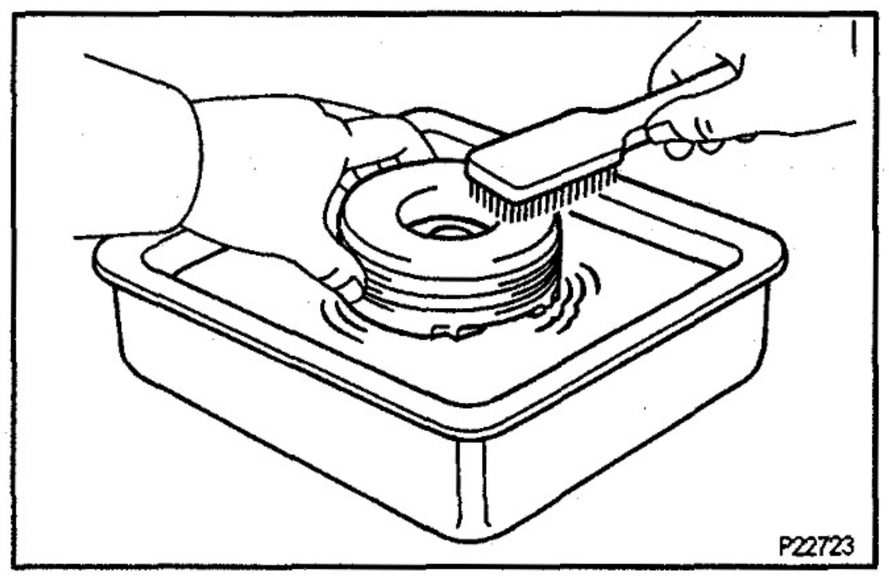


1. CLEAN PISTON

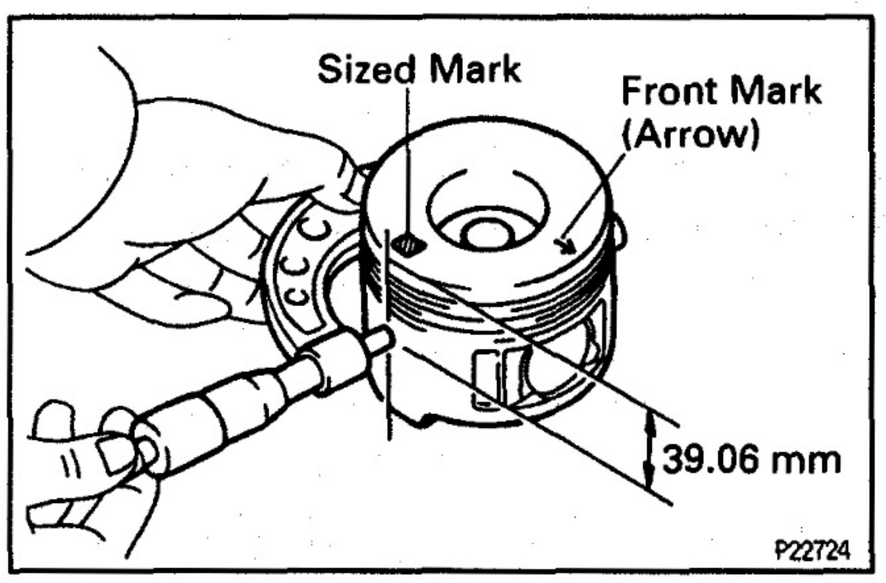
(a) Using a gasket scraper, remove the carbon from the piston top.



(b) Using a groove cleaning tool or broken ring, clean the piston ring grooves.



(c) Using solvent and a brush, thoroughly clean the piston.
NOTICE: Do not use a wire brush.



2. INSPECT PISTON AND PISTON RING

A. Inspect piston diameter and oil clearance

HINT: There are 3 sizes of the standard piston diameter, marked "1", "2" and "3" accordingly. The mark is stamped on the piston top.

(a) Using a micrometer, measure the piston diameter at right angles to the piston pin center line, 39.06 mm (1.5378 in.) from the piston head.

Piston diameter:

STD

Mark "1"

93.845 – 93.855 mm (3.6947 – 3.6951 in.)

Mark "2"

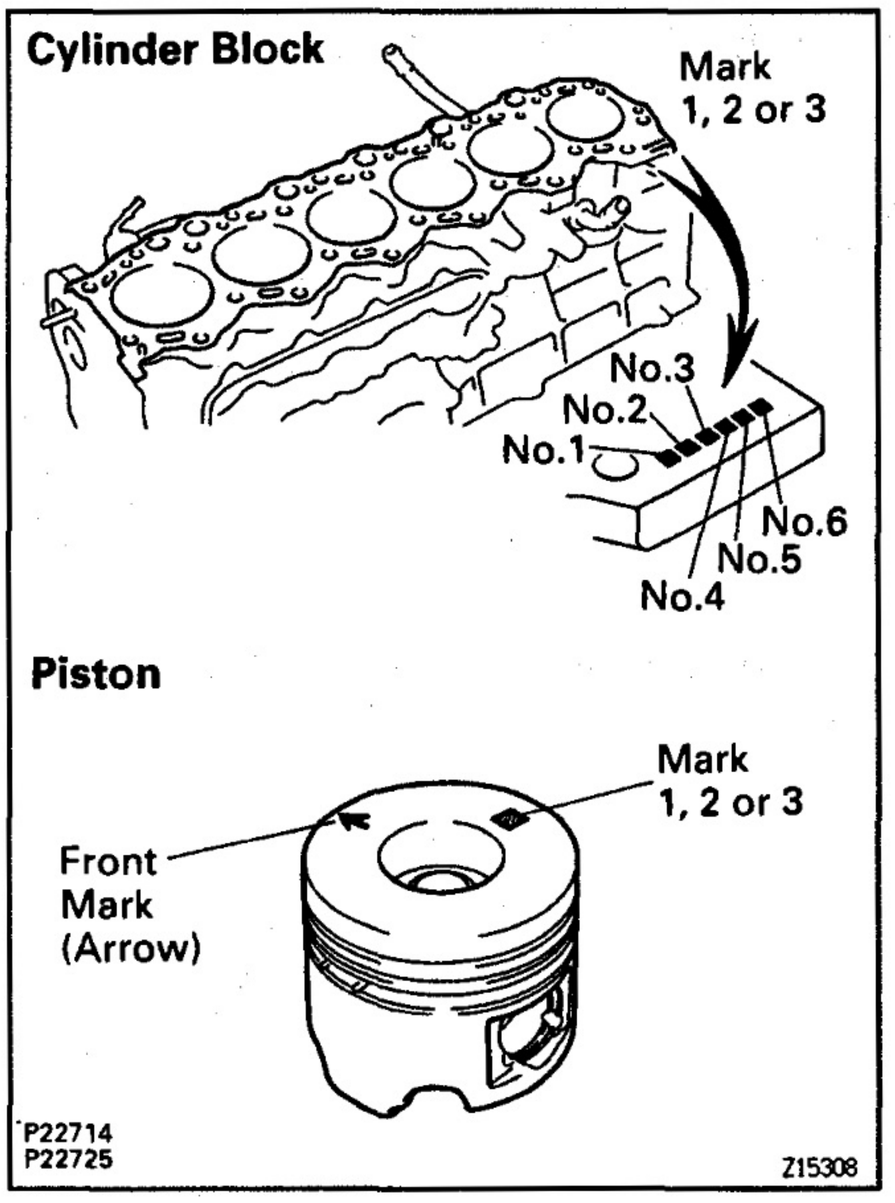
93.855 – 93.865 mm (3.6951 – 3.6955 in.)

Mark "3"

93.865 – 93.875 mm (3.6955 – 3.6959 in.)

O/S 0.50

94.345 – 94.375 mm (3.7144 – 3.7155 in.)



(b) Measure the cylinder bore diameter in the thrust directions. (See step 4 in cylinder block inspection)

(c) Subtract the piston diameter measurement from the cylinder bore diameter measurement.

Standard oil clearance:

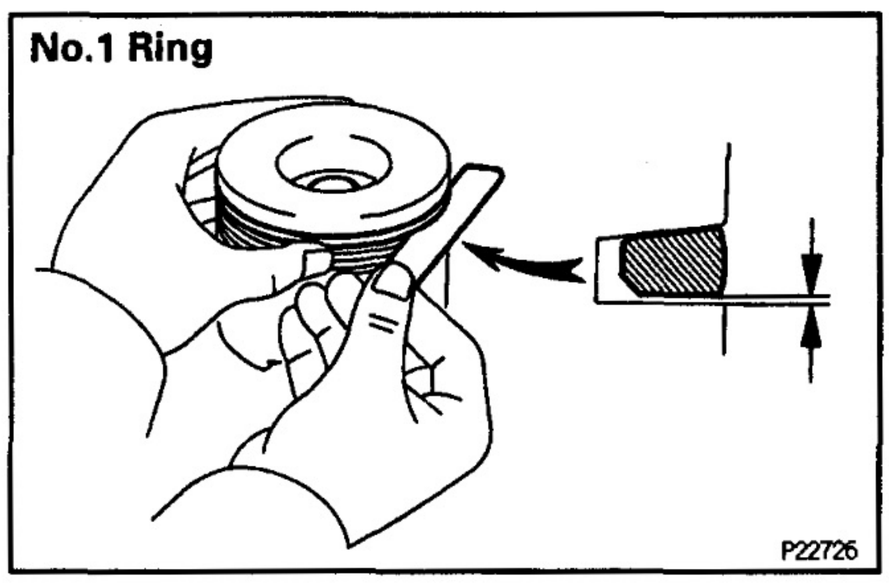
0.145 — 0.165 mm (0.0057 — 0.0065 in.)

Maximum oil clearance:

0.215 mm (0.0085 in.)

If the oil clearance is greater than maximum, replace all the 6 pistons and rebore all the 6 cylinders. If necessary, replace the cylinder block.

HINT (Use new cylinder block): Use a piston with the same number mark as the cylinder bore diameter marked on the cylinder block.



B. Inspect piston ring groove clearance

No.1 Ring:

Install a new piston ring to the piston. Using a feeler gauge, measure the clearance between the piston ring and the wall of the ring groove.

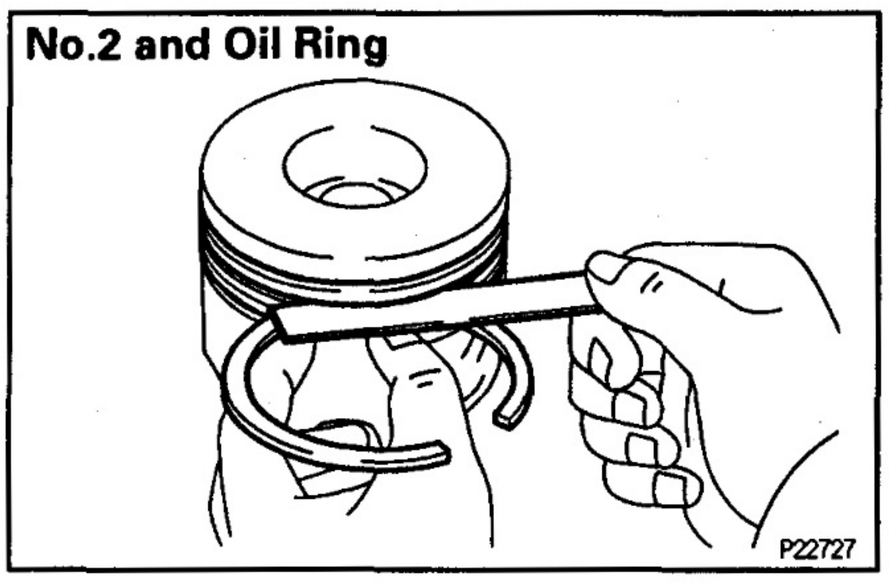
Standard groove clearance:

0.050 — 0.095 mm (0.0020 — 0.0037 in.)

Maximum groove clearance:

0.20 mm (0.0079 in.)

If the clearance is greater than maximum, replace the piston.



No.2 and Oil Rings:

Using a feeler gauge, measure the clearance between a new piston ring and the wall of the ring groove.

Standard groove clearance:

No.2

0.060 — 0.100 mm (0.0024 — 0.0039 in.)

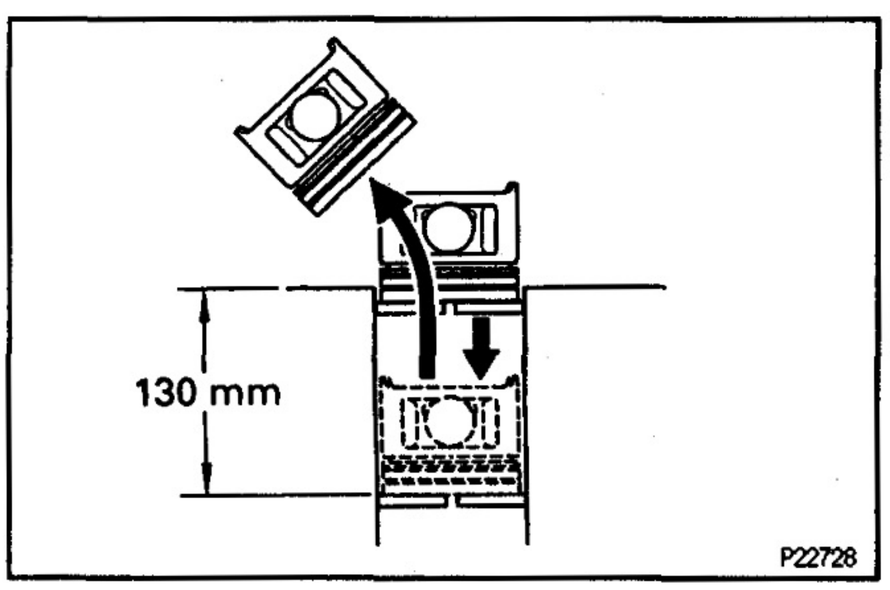
Oil

0.030 — 0.070 mm (0.0012 — 0.0028 in.)

Maximum groove clearance:

0.020 mm (0.0079 in.)

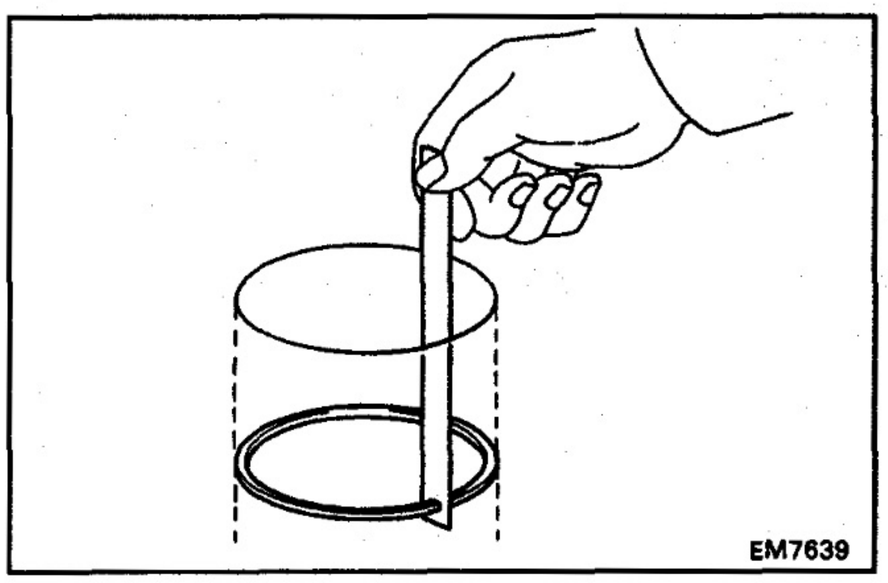
If the clearance is greater than maximum, replace the piston.



C. Inspect piston ring end gap

(a) Insert the piston ring into the cylinder bore.

(b) Using a piston, push the piston ring a little beyond the bottom of the ring travel, 130 mm (5.12 in.) from the top of the cylinder block.



(c) Using a feeler gauge, measure the end gap.

Standard end gap:

No.1

0.270 – 0.470 mm (0.0106 – 0.0185 in.)

No.2

0.400 – 0.650 mm (0.0157 – 0.0256 in.)

Oil

0.200 – 0.500 mm (0.0079 – 0.0197 in.)

Maximum end gap:

No.1

0.85 mm (0.0335 in.)

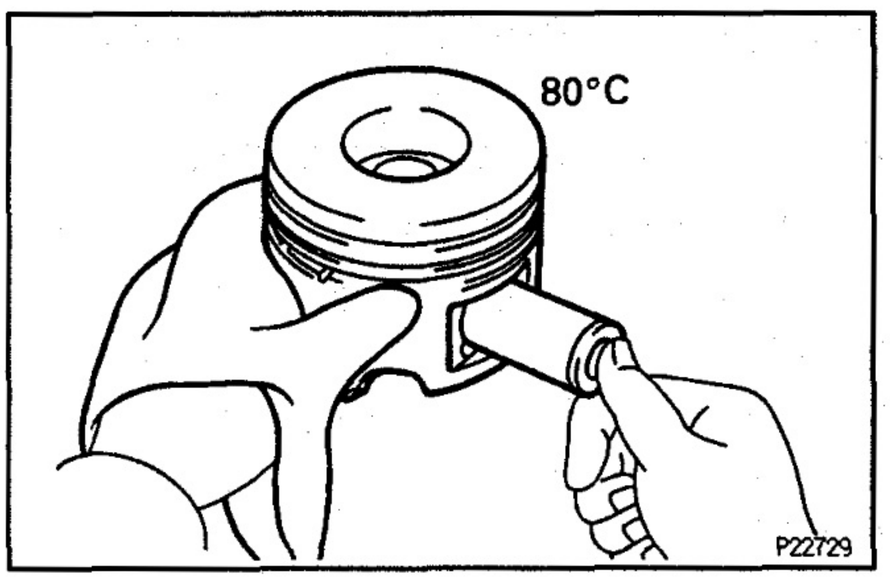
No.2

0.90 mm (0.0354 in.)

Oil

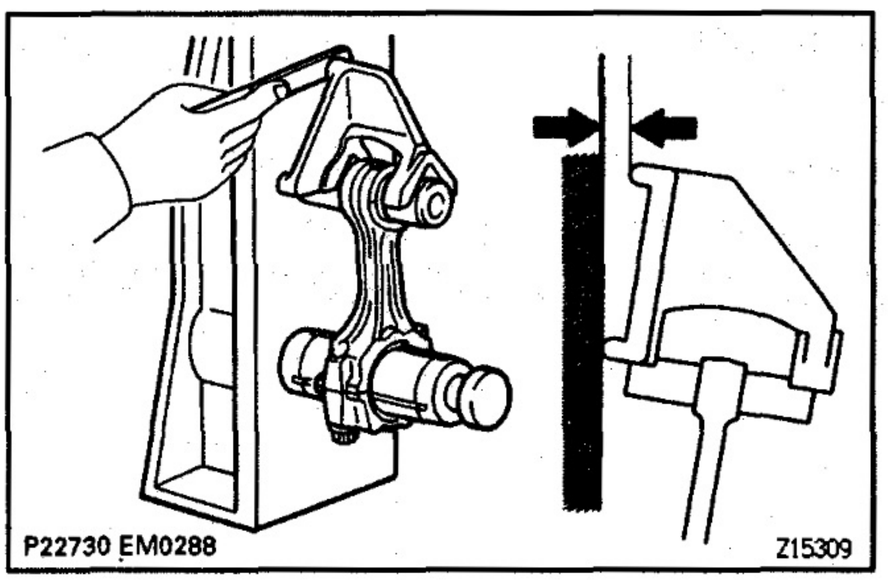
0.88 mm (0.0346 in.)

If the end gap is greater than maximum, replace the piston ring. If the end gap is greater than maximum, even with a new piston ring, rebore all the 6 cylinders or replace the cylinder block.



3. INSPECT PISTON PIN FIT

At 80°C (176°F), you should be able to push the piston pin into the piston pin hole with your thumb.



4. INSPECT CONNECTING ROD

A. Inspect connecting rod alignment

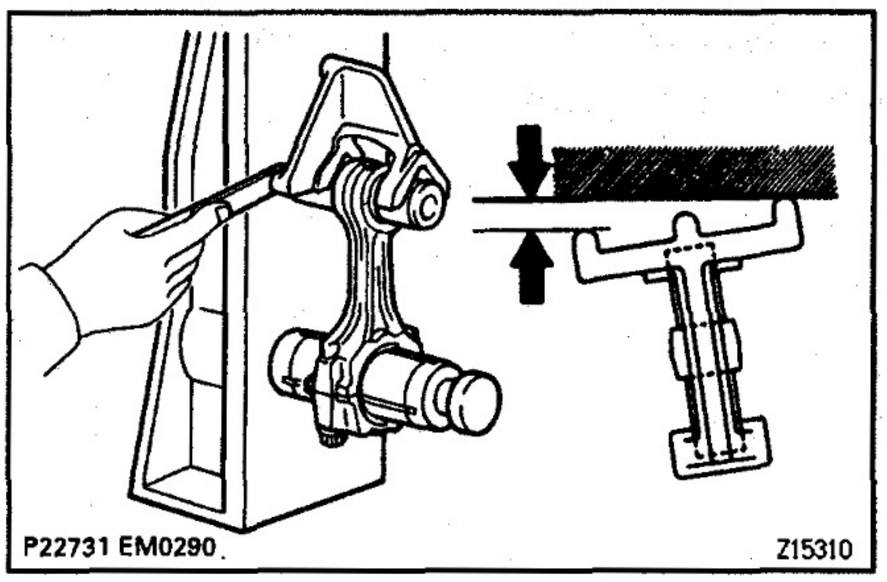
Using a rod aligner and feeler gauge, check the connecting rod alignment.

- Check for bend.

Maximum bend:

0.03 mm (0.0012 in.) per 100 mm (3.94 in.)

If bend is greater than maximum, replace the connecting rod assembly.

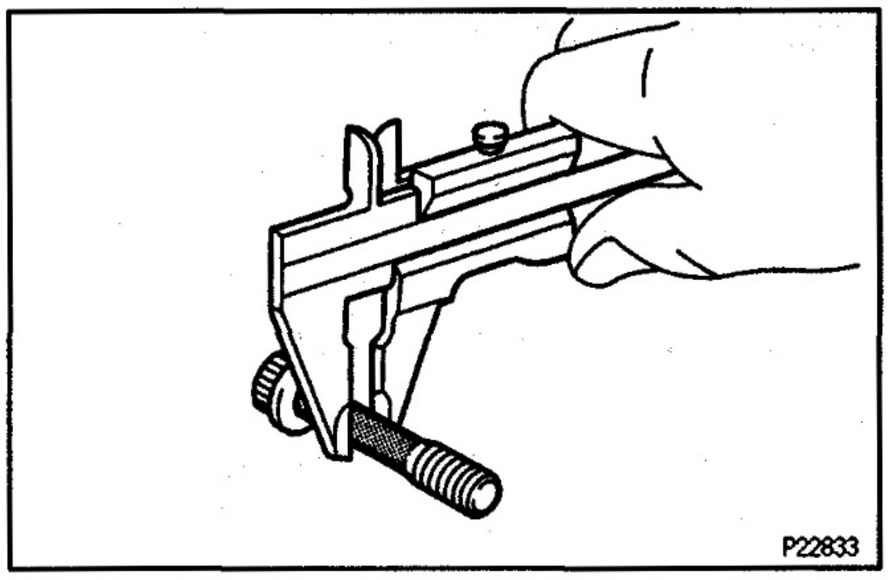


- Check for twist

Maximum twist:

0.15 mm (0.0059 in.) per 100 mm (3.94 in.)

If twist is greater than maximum, replace the connecting rod assembly.



B. Inspect connecting rod bolts

Using vernier calipers, measure the tension portion diameter.

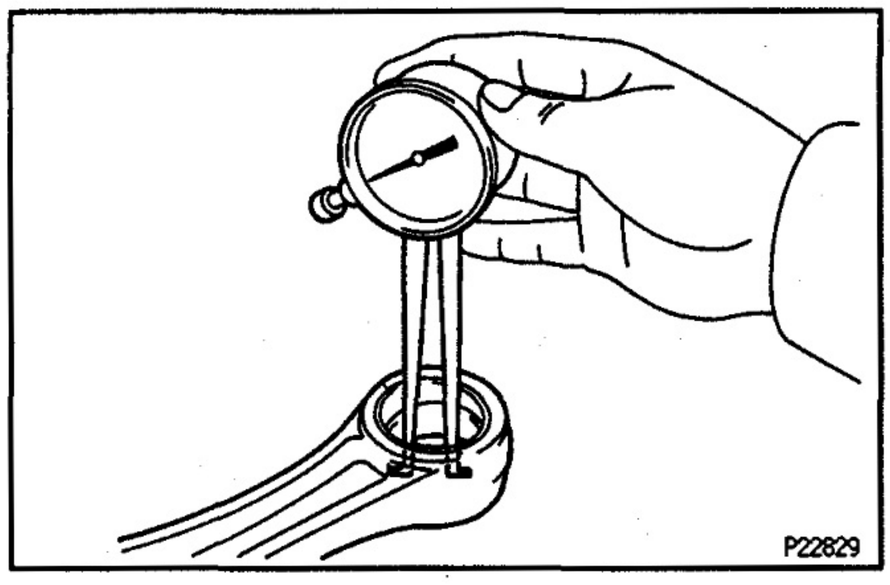
Standard diameter:

8.300 — 8.400 mm (0.3268 — 0.3307 in.)

Minimum diameter:

7.95 mm (0.3130 in.)

If the diameter is less than minimum, replace the connecting rod bolt.

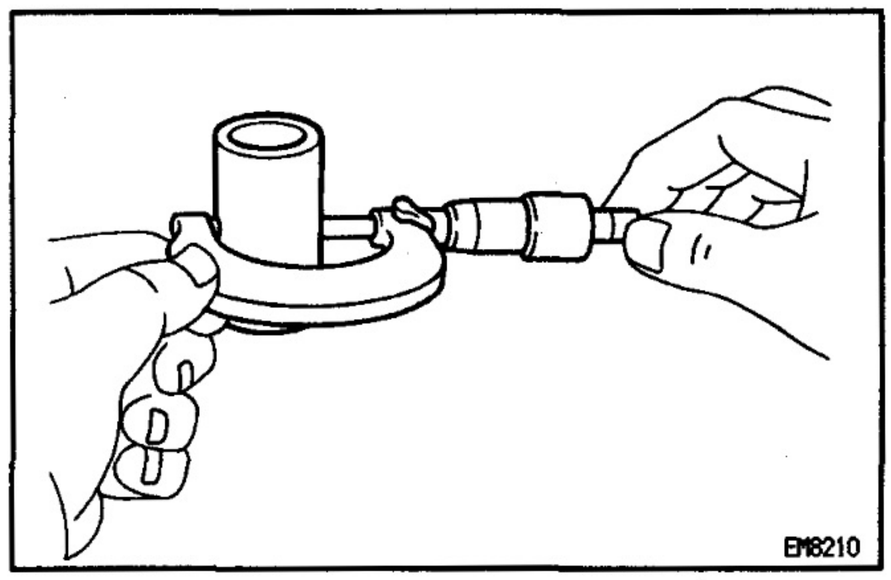


C. Inspect piston pin oil clearance

(a) Using caliper gauge, measure the inside diameter of the connecting rod bushing.

Bushing inside diameter:

33.008 — 33.020 mm (1.2995 — 1.3000 in.)



(b) Using micrometer, measure the piston pin diameter.

Piston pin diameter:

33.000 — 33.012 mm (1.2992 — 1.2997 in.)

(c) Subtract the piston pin diameter measurement from the bushing inside diameter measurement.

Standard oil clearance:

0.004 — 0.012 mm (0.0002 — 0.0005 in.)

Maximum oil clearance:

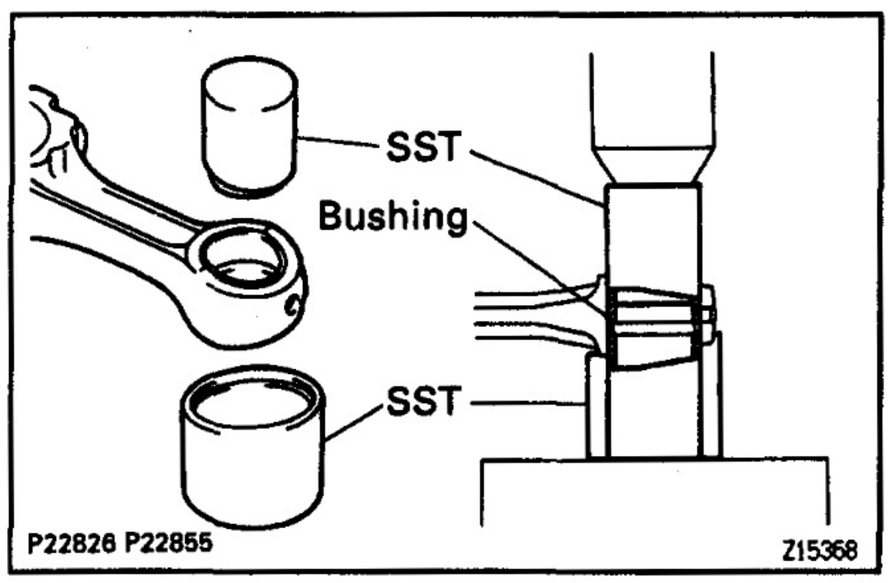
0.03 mm (0.0012 in.)

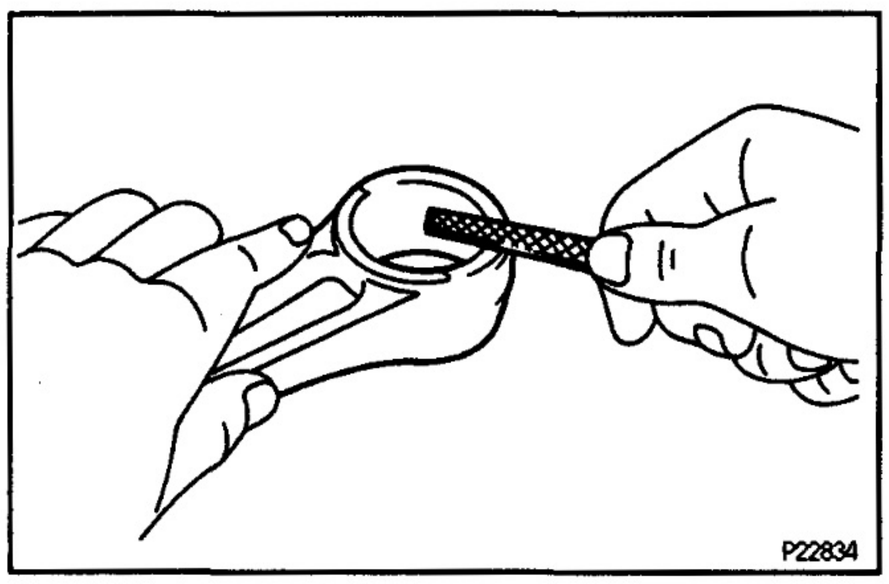
If the oil clearance is greater than maximum, replace the bushing. If necessary, replace the piston and piston pin as a set.

D. If necessary, replace connecting rod bushing

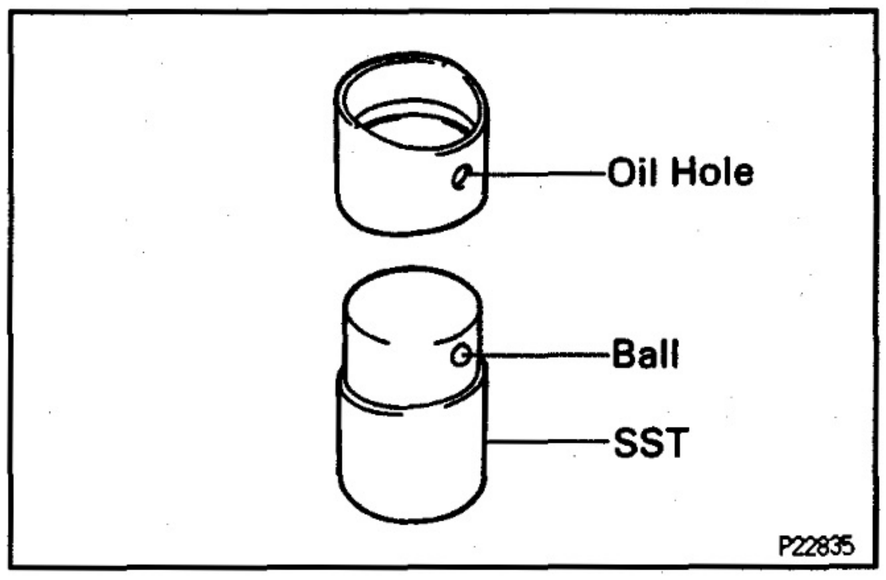
(a) Using SST and a press, press out the bushing.

SST 09222—17010 (09222—05020, 09222—05040)

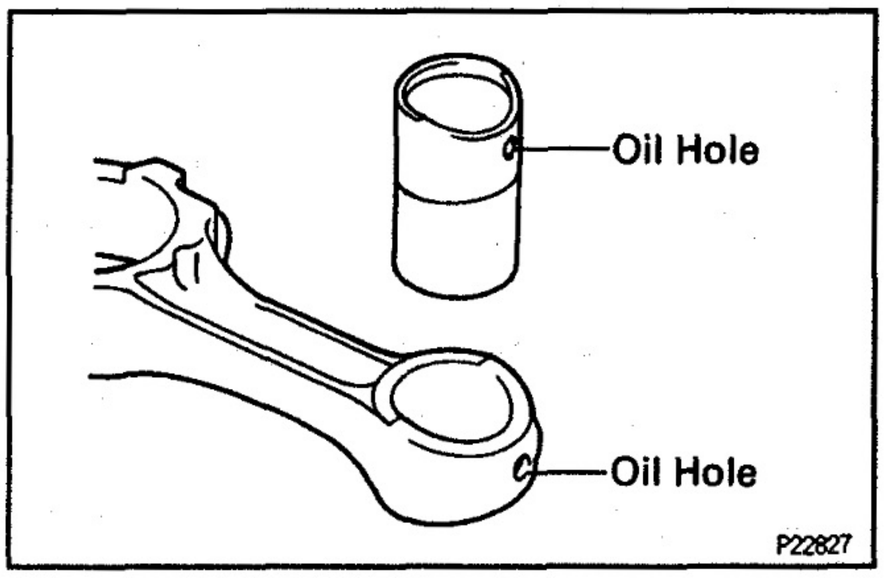




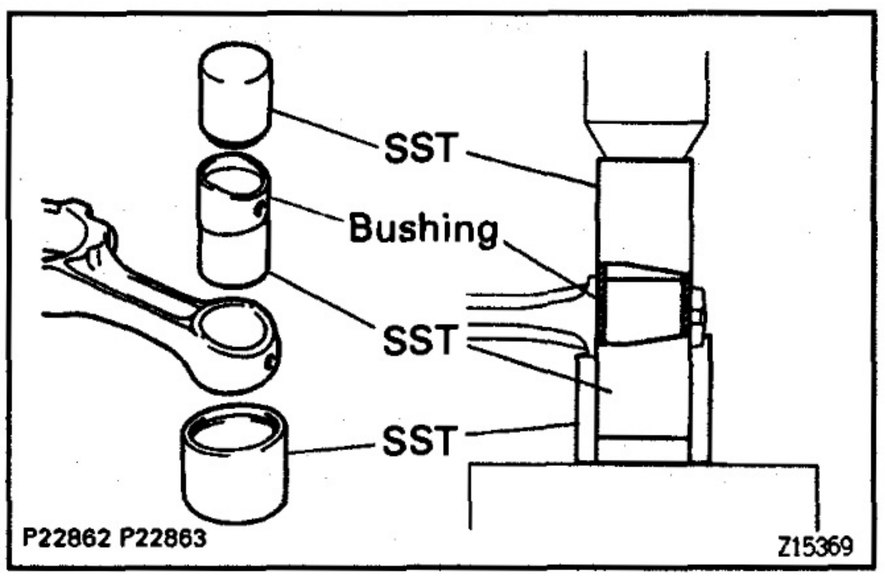
(b) Using a round file, lightly file off any roughness from the small end of the connecting rod.



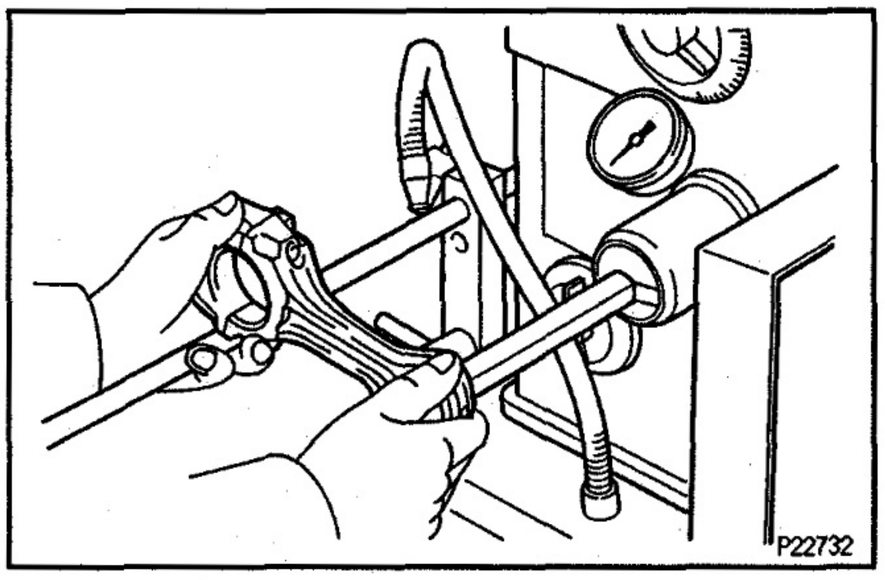
(c) Attach the bushing to SST with the ball of SST inside the oil hole of the bushing.
SST 09222–17010 (09222–05030)



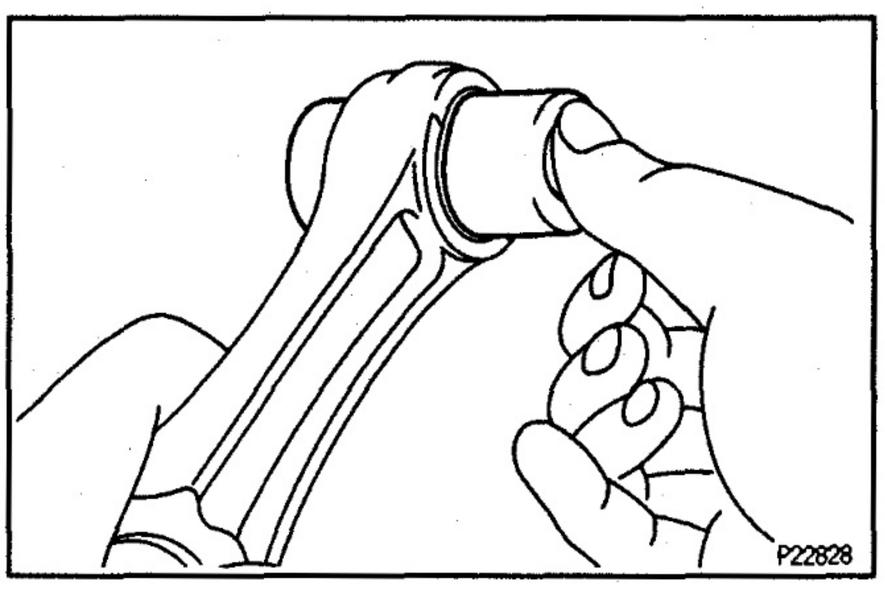
(d) Align the oil holes of a new bushing and the connecting rod.



(e) Using SST and a press, press in the bushing.
SST 09222–17010 (09222–05020, 09222–05030, 09222–05040)



(f) Using a pin hole grinder, hone the bushing to obtain the standard specified clearance (see item C above) between the bushing and piston pin.



(g) Check the piston pin fit at normal room temperature. Coat the piston pin with engine oil, and push it into the connecting rod ne oil, and push it into the connecting rod with your thumb.

EG

EG586-01

CYLINDER BORING

HINT:

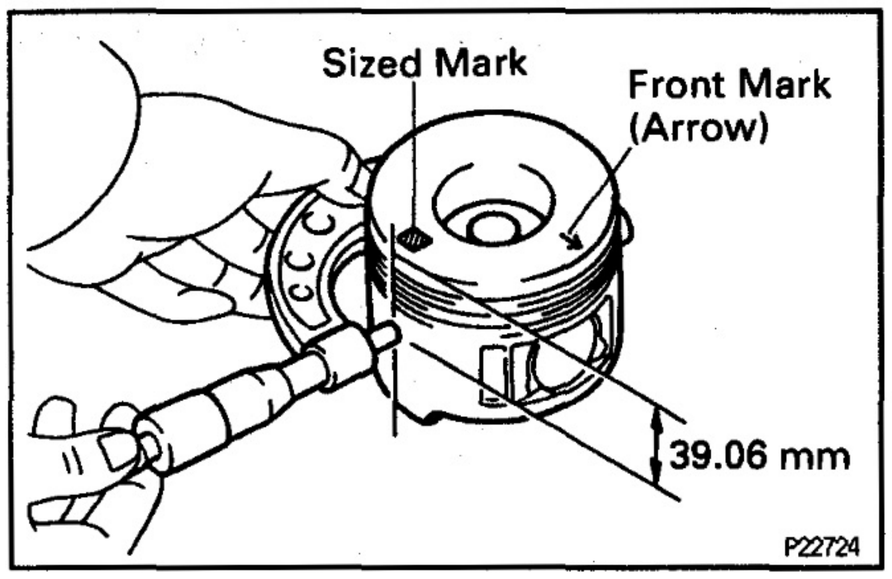
- Bore all the 6 cylinders to the oversized piston outside diameter.
- Replace all the piston rings with ones to match the oversized pistons.

1. KEEP OVERSIZED PISTONS

Oversized piston diameter:

O/S 0.50

94.345 – 94.375 mm (3.7144 – 3.7155 in.)



2. CALCULATE AMOUNT TO BORE CYLINDERS

(a) Using a micrometer, measure the piston diameter at right angles to the piston pin center line, 39.06 mm (1.5378 in.) from the piston head.

(b) Calculate the amount each cylinder is to be rebored as follows:

Size to be rebored = P + C – H

P = Piston diameter

C = Piston clearance

0.145 – 0.165 mm (0.0057 – 0.0065 in.)

H = Allowance for honing

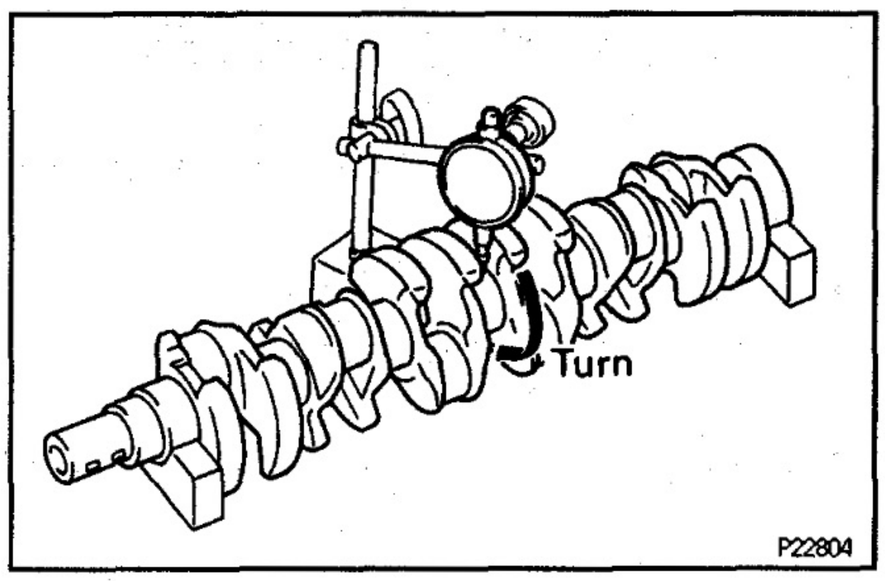
0.02 mm (0.0008 in.) or less

3. BORE AND HONE CYLINDER TO CALCULATED DIMENSIONS

Maximum honing:

0.02 mm (0.0008 in.)

NOTICE: Excess honing will destroy the finished roundness.



CRANKSHAFT INSPECTION AND REPAIR

EGOBY-18

1. INSPECT CRANKSHAFT FOR RUNOUT

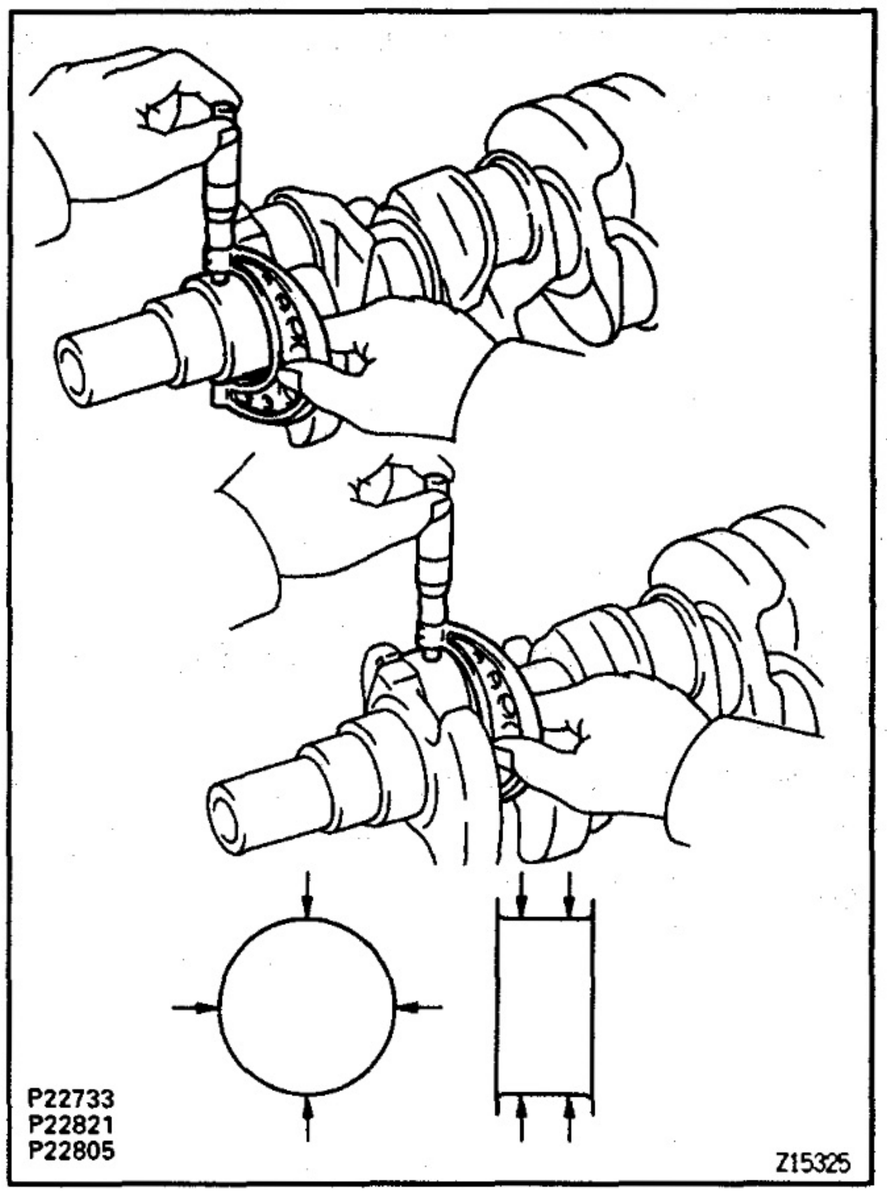
(a) Place the crankshaft on V—blocks.

(b) Using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout:

0.06 mm (0.0024 in.)

If the circle runout is greater than maximum, replace the crankshaft.



2. INSPECT MAIN JOURNALS AND CRANK PINS

(a) Using a micrometer, measure the diameter of each main journal and crank pin.

Main journal diameter:

STD

66.982 — 67.000 mm (2.6371 — 2.6378 in.)

U/S 0.25

66.745 — 66.755 mm (2.6278 — 2.6281 in.)

U/S 0.50

66.495 — 66.505 mm (2.6179 — 2.6183 in.)

Crank pin diameter:

STD

58.982 — 59.000 mm (2.3221 — 2.3228 in.)

U/S 0.25

58.745 — 58.755 mm (2.3128 — 2.3132 in.)

U/S 0.50

58.495 — 58.505 mm (2.3029 — 2.3033 in.)

If the diameter is not as specified, check the oil clearance. (See steps 6 and 9 in cylinder block assembly) If necessary, grind or replace the crankshaft.

(b) Check each main journal and crank pin for taper and out—of—round as shown.

Maximum taper and out—of—round:

0.020 mm (0.0008 in.)

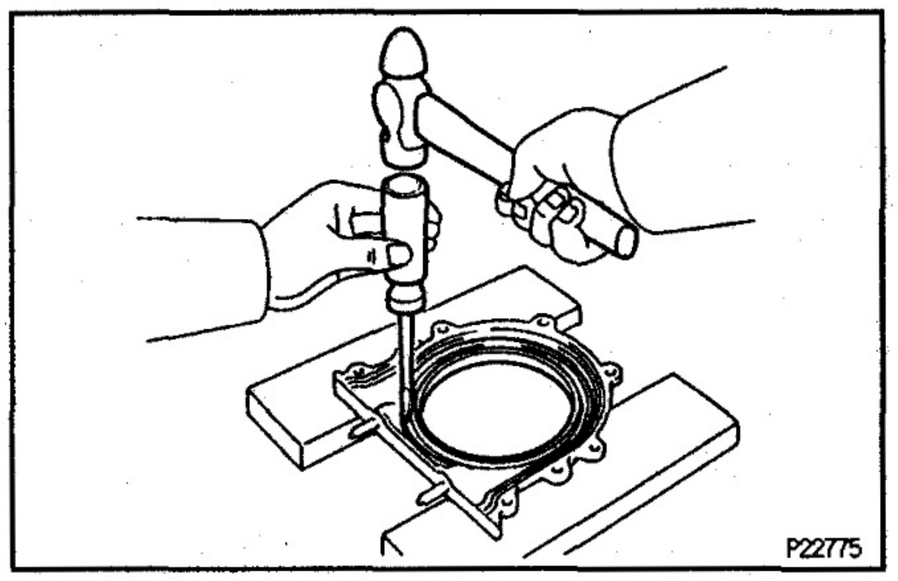
If the taper and out—of—round is greater than maximum, replace the crankshaft.

3. IF NECESSARY, GRIND AND HONE MAIN JOURNALS AND/OR CRANK PINS

Grind and hone the main journals and/or crank pins to the finished undersized diameter (See procedure in step 2).

Install new main journal and/or crankshaft pin undersized bearing.

EG



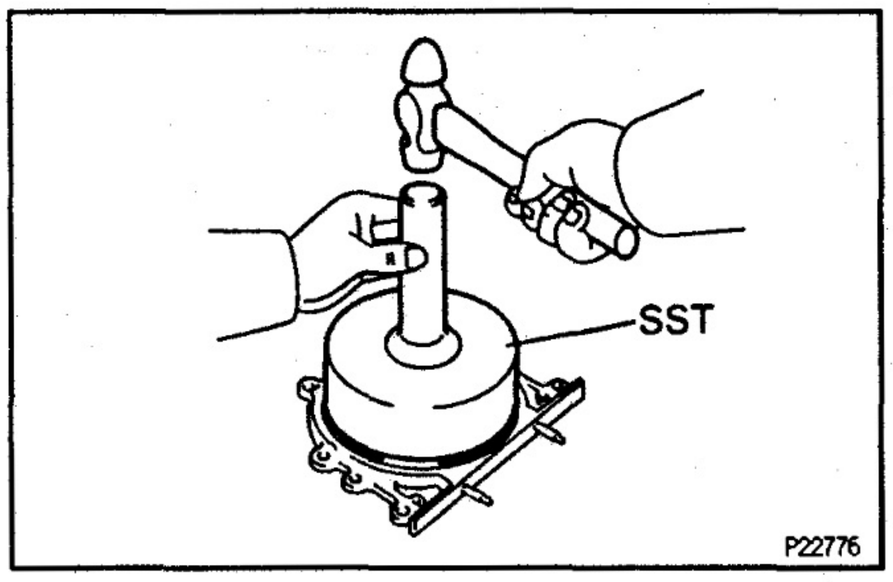
CRANKSHAFT OIL SEAL REPLACEMENT

HINT: There are 2 methods (A and B) to replace the oil seal which are as follows:

REPLACE CRANKSHAFT REAR OIL SEAL

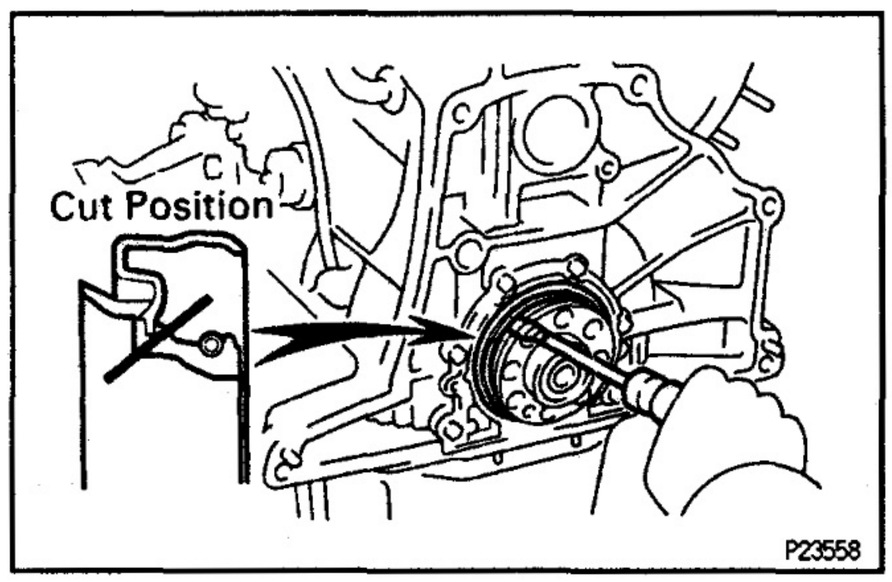
A. If rear oil seal retainer is removed from cylinder block:

(a) Using a screwdriver and hammer, tap out the oil seal.



(b) Using SST and a hammer, tap in a new oil seal until its surface is flush with the rear oil seal retainer edge.
SST 09223−56010

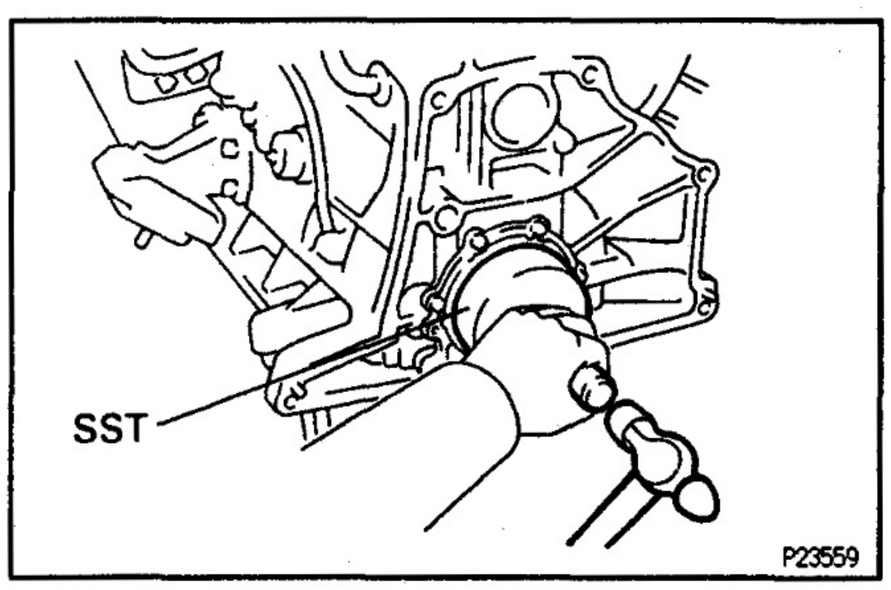
(c) Apply MP grease to a new oil seal lip.



B. If rear oil seal retainer is installed to cylinder block:

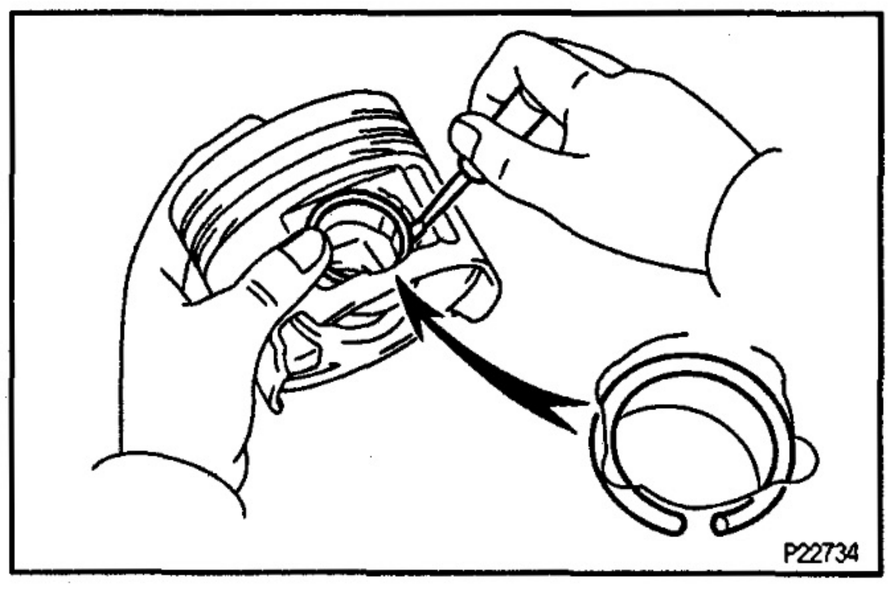
(a) Using a knife, cut off the oil seal lip.

(b) Using a screwdriver, pry out the oil seal.
NOTICE: Be careful not to damage the crankshaft. Tape the screwdriver tip.



(c) Apply MP grease to a new oil seal lip.

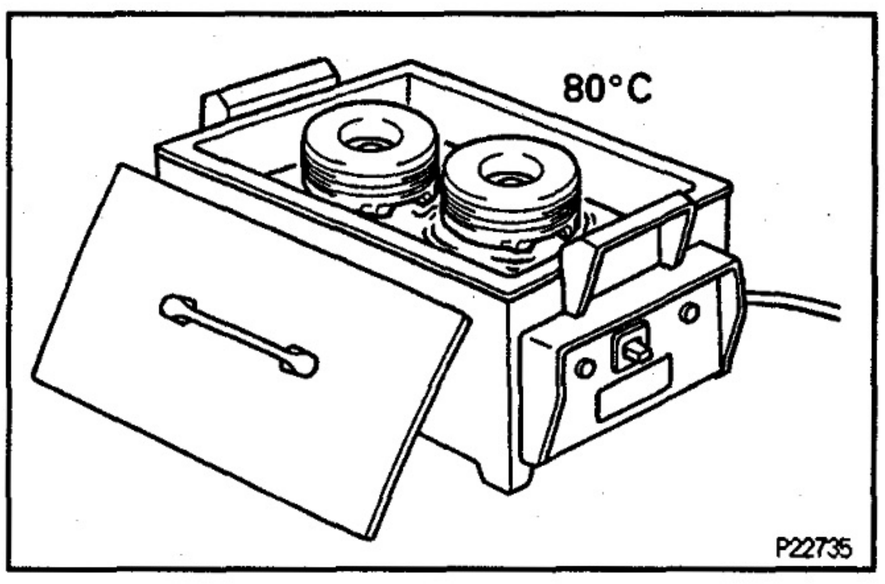
(d) Using SST and a hammer, tap in the oil seal until its surface is lush with the rear oil seal retainer edge.
SST 09223−56010



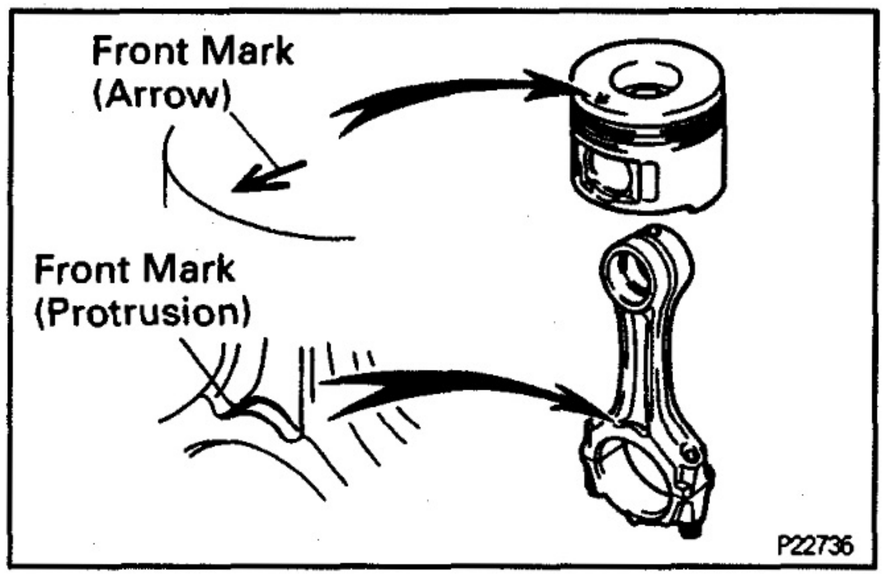
PISTON AND CONNECTING ROD ASSEMBLY

1. ASSEMBLE PISTON AND CONNECTING ROD

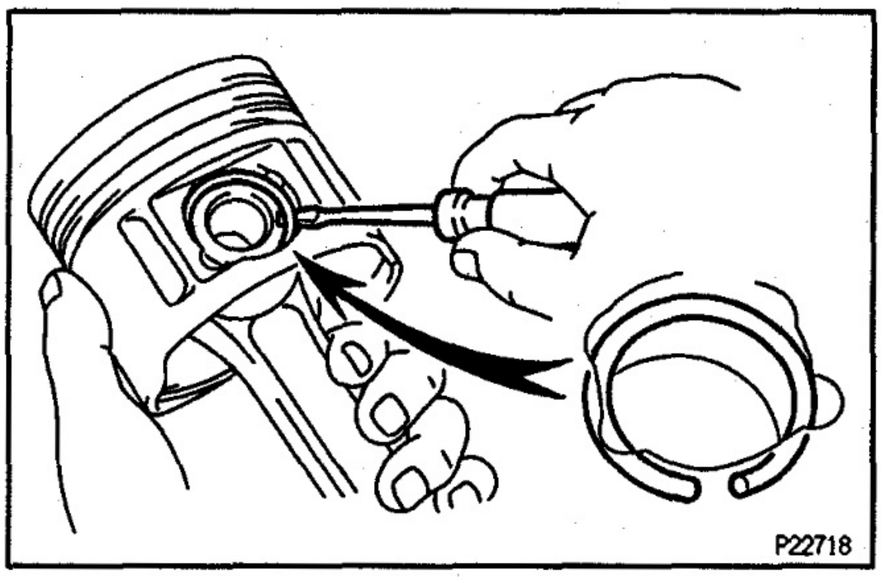
(a) Install a new snap ring on one side of the piston pin hole.



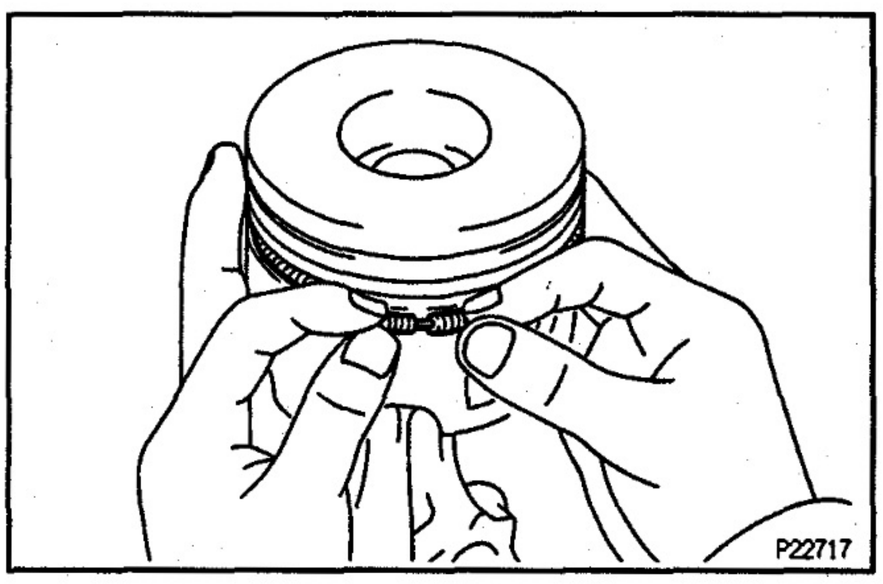
(b) Gradually heat the piston to 80°C (176°F).



(c) Coat the piston pin with engine oil.
(d) Align the front marks of the piston and connecting rod, and push in the piston pin with your thumb.

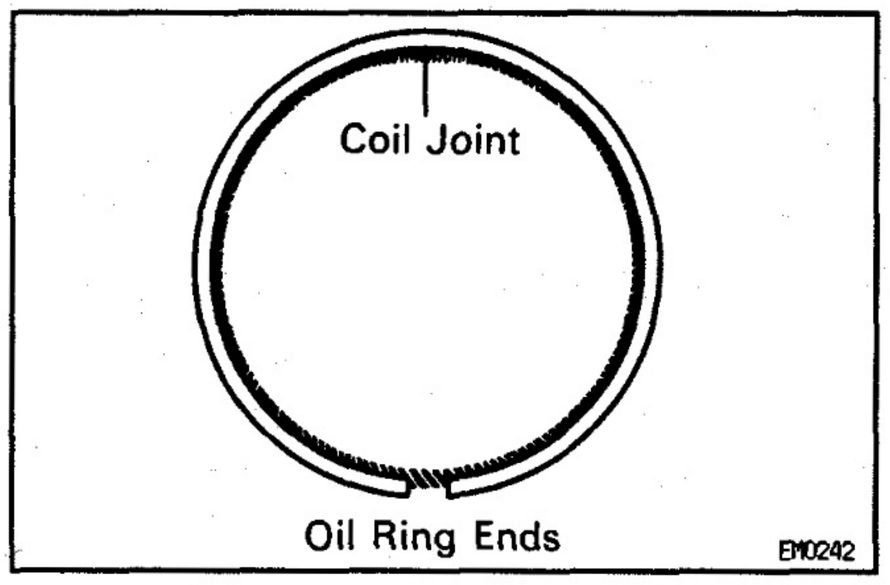


(e) Install a new snap ring on the other side of the piston pin hole.



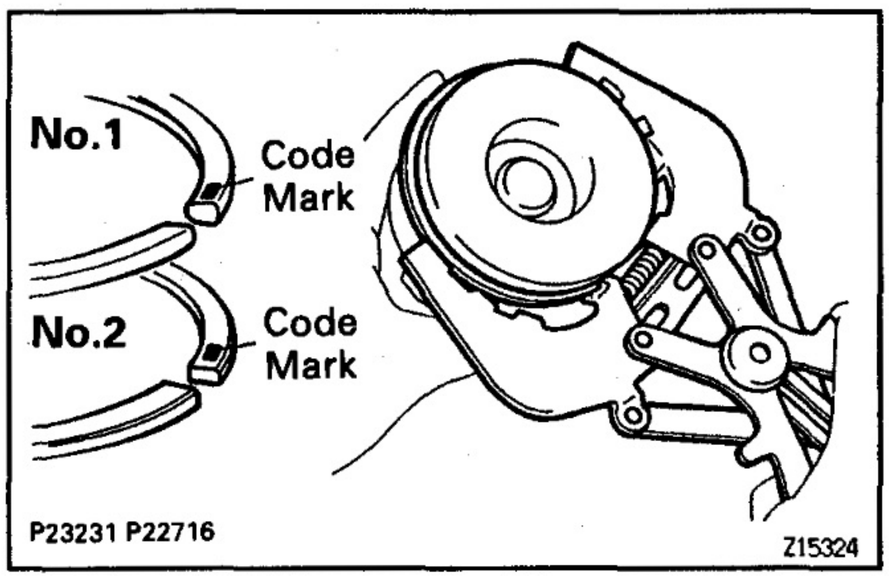
2. INSTALL PISTON RINGS

(a) Install the coil by hand.
(b) Install a piston ring expander, install the oil ring.

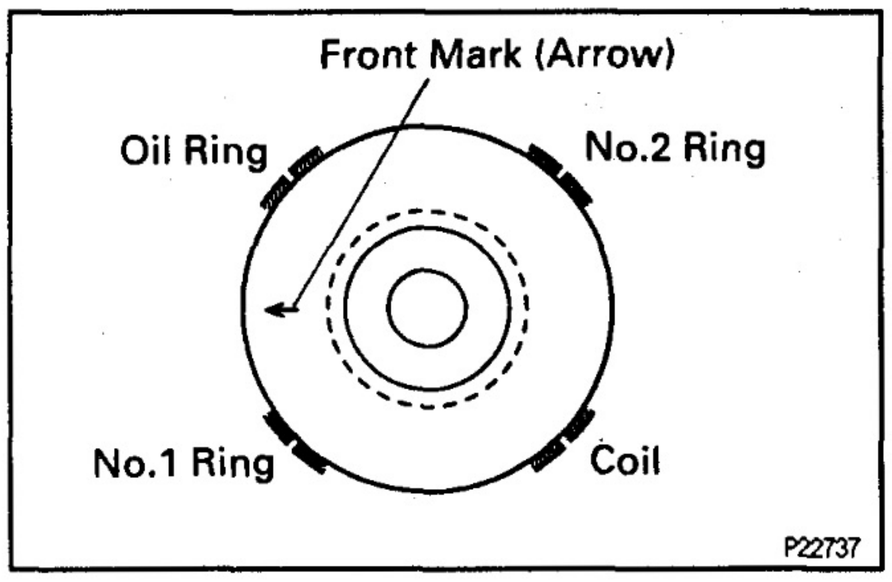


HINT: Face the end gap of the oil ring in the opposite direction of coil joint.

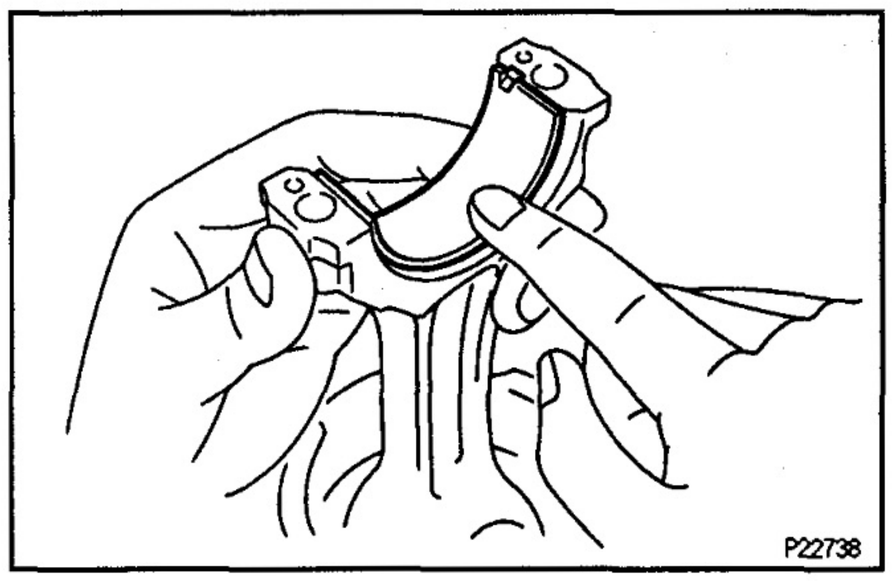
EG



(c) Using a piston ring expander, install the No.1 and No. 2 piston rings with the code mark facing upward.
Code mark:
No.1
T1
No.2
2T



(d) Position the piston rings so that the ring ends are as shown.
NOTICE: Do not align the ring ends.



3. INSTALL CONNECTING ROD BEARINGS

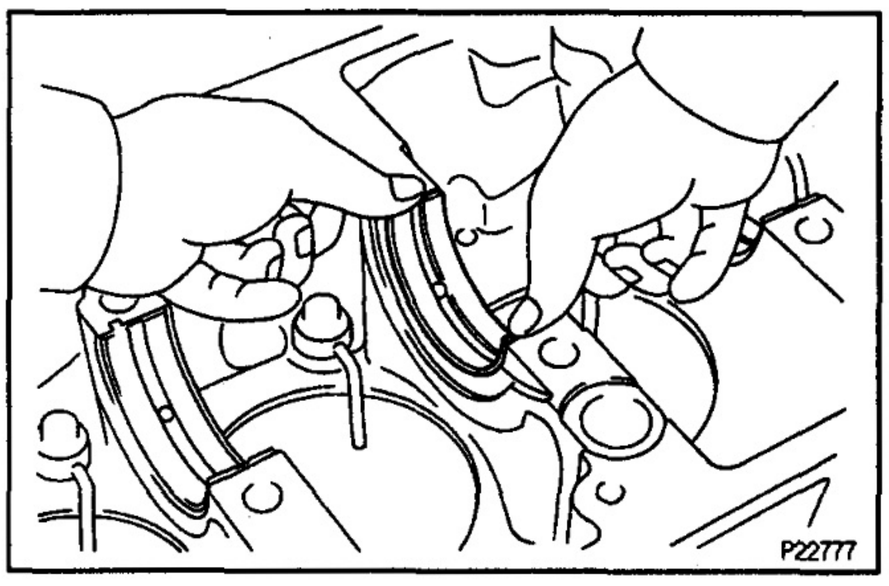
(a) Align the bearing claw with the groove of the connecting rod or connecting rod cap.
(b) Install the bearings in the connecting rod and connecting rod cap.

CYLINDER BLOCK ASSEMBLY

EG0588-01

HINT:

- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply new engine oil to all sliding and rotating surfaces.
- Replace all gaskets, O–rings and oil seals with new parts.



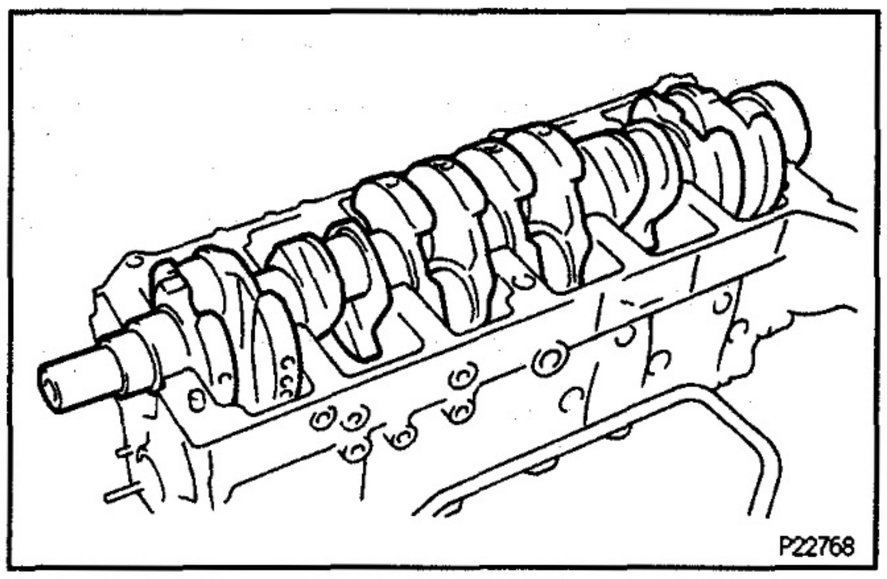
1. INSTALL OIL NOZZLES AND CHECK VALVES

(See step 1 in oil nozzles installation in Lubrication System)

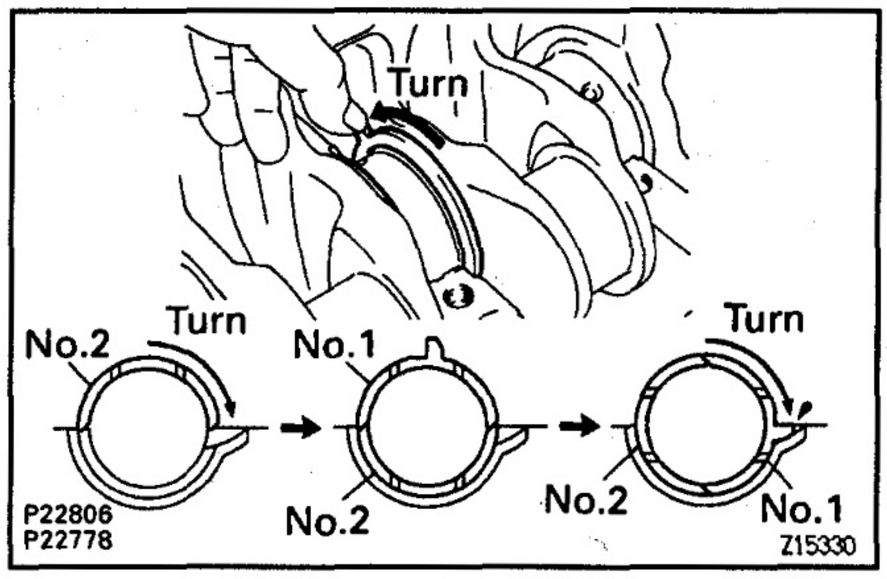
2. INSTALL MAIN BEARINGS

HINT: Upper bearings have an oil groove and oil hole; lower bearings do not.

(a) Align the bearing claw with the claw groove of the cylinder block, and push in the 7 upper bearings.
(b) Align the bearing claw with the claw groove of the main bearing cap, and push in the 7 lower bearings.



3. PLACE CRANKSHAFT ON CYLINDER BLOCK



4. INSTALL THRUST WASHERS

(a) Push the crankshaft toward the front (rear) side.

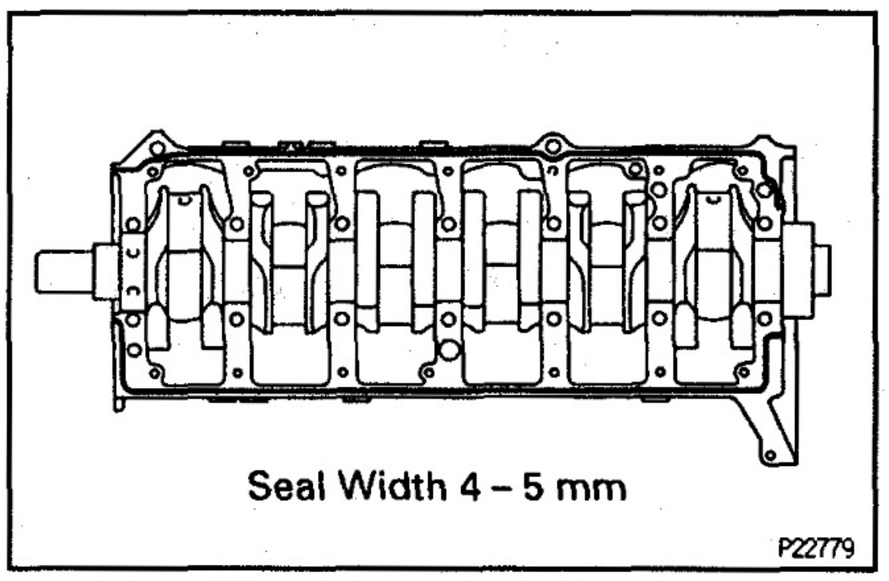
(b) Install the 4 thrust washers to the No.4 journal position of the cylinder block with the oil grooves facing outward.

5. INSTALL MAIN BEARING CAPS

A. Place main bearing cap on cylinder block

(a) Remove any old packing (FIPG) material and be careful not to drop any oil the contact surfaces of the main bearing cap and cylinder block.

- Thoroughly clean all components to remove all the loose material.
- Using a non—residue solvent, clean both sealing surfaces.

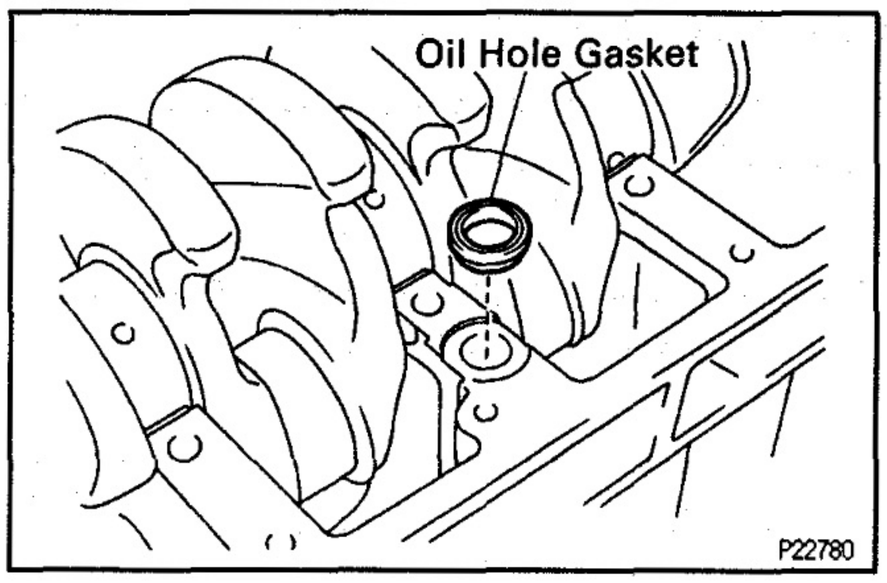


(b) Apply seal packing to the cylinder block as shown in the illustration.

Seal packing:

Part No. 08826—00080 or equivalent

- Install a nozzle that has been cut to a 4 — 5 mm (0.16 — 0.20 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.



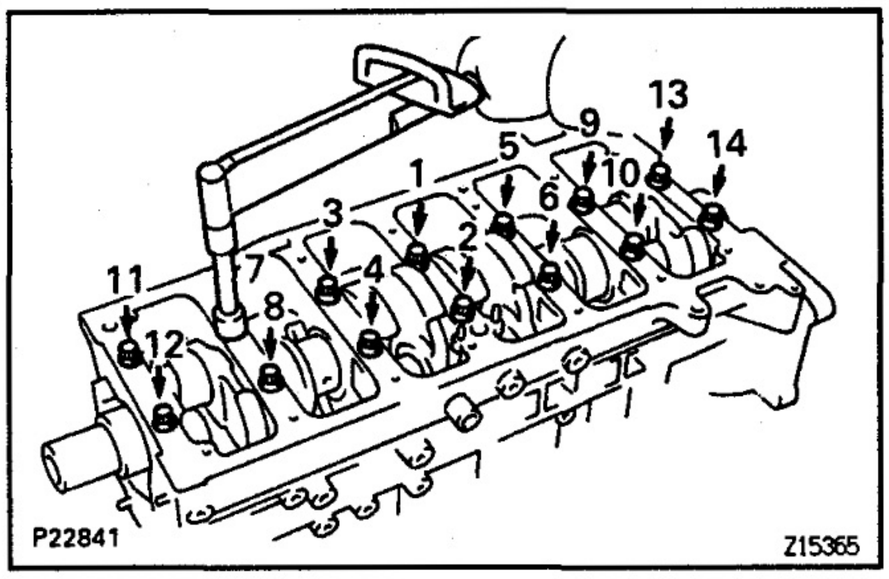
(c) Install a new cylinder block hole gasket.

(d) Place the main bearing cap on the cylinder block.

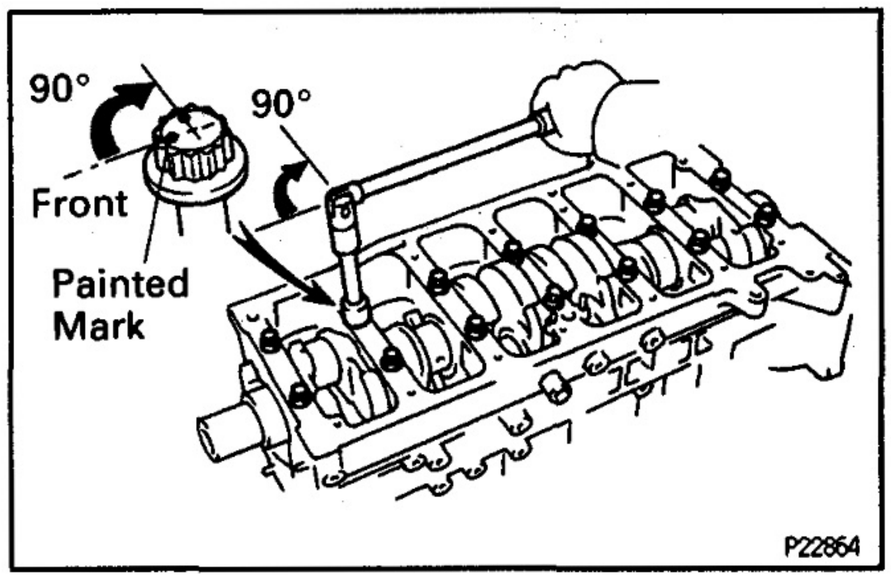
B. Install main bearing cap bolts (12 pointed head)

HINT:

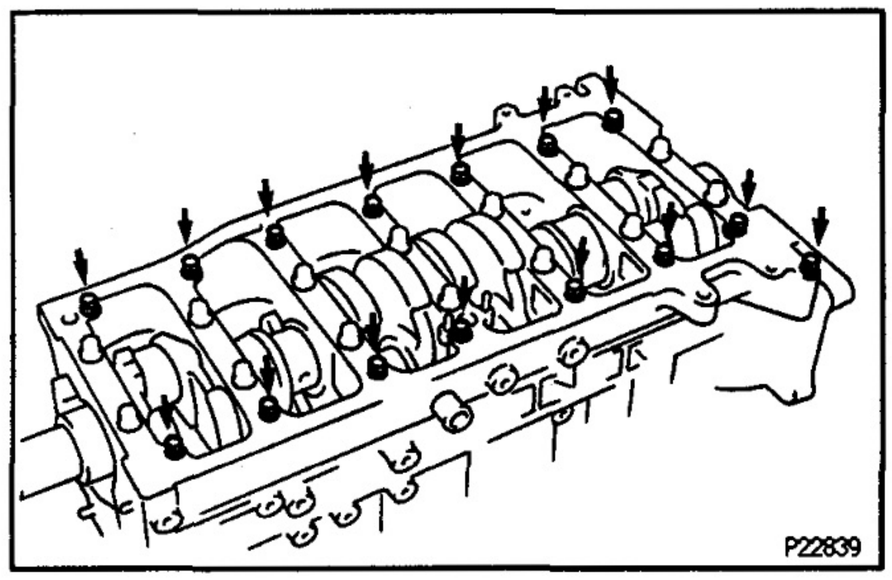
- The main bearing cap bolts are tightened in 2 progressive steps (steps (b) and (d)).
- If any one of the main bearing cap bolts is broken or deformed, replace it.



(a) Apply a light coat of engine oil on the threads and under the heads of the main bearing cap bolts.
(b) Install and uniformly tighten the 14 main bearing cap bolts in several passes, in the sequence shown.
Torque: 103 N·m (1,050 kgf·cm, 76 ft·lbf)
If any one of the main bearing cap bolts does not meet the torque specification, replace the main bearing cap bolt.

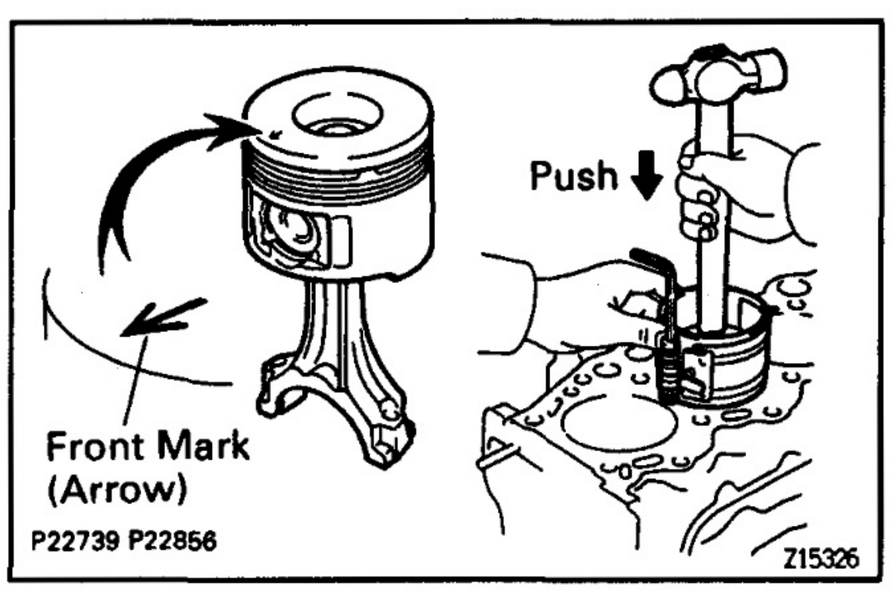


(c) Mark the front of the main bearing cap bolt with paint.
(d) Retighten the main bearing cap bolts 90° in the numerical order shown above.
(e) Check that the painted mark is now at a 90° angle to the front.
(f) Check that the crankshaft turns smoothly.

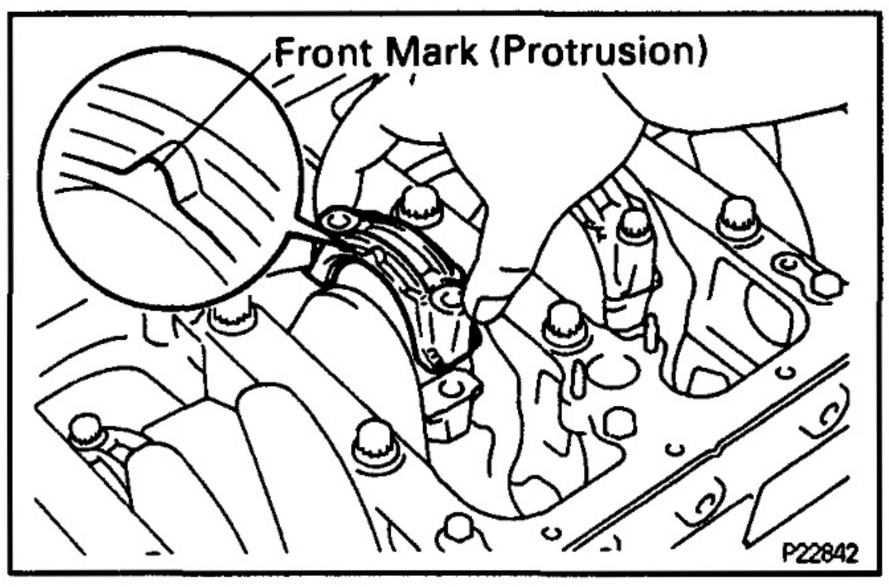


C. Install main bearing cap bolts (6 pointed head)
Install the 15 main bearing bolts.
Torque: 18.1 N·m (185 kgf·cm, 13 ft·lbf)

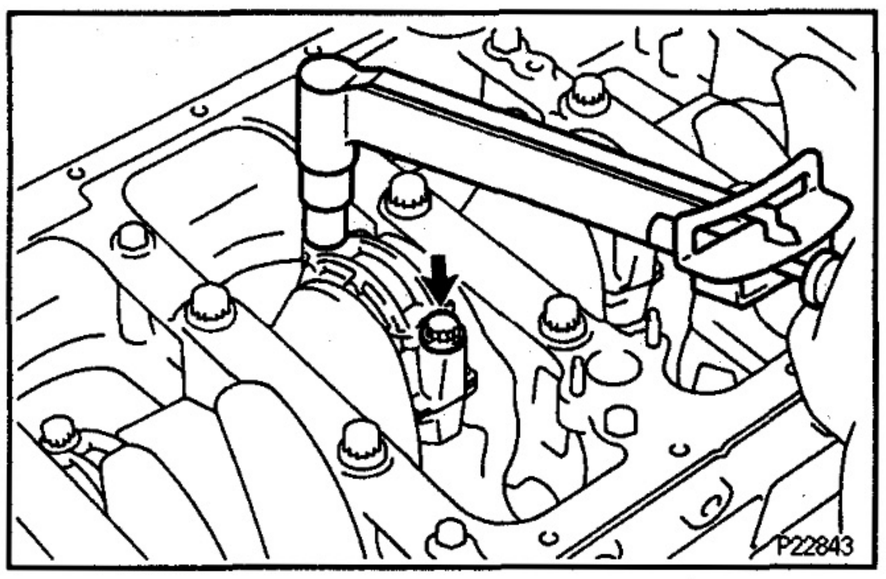
6. CHECK CRANKSHAFT THRUST CLEARANCE
(See step 5 in cylinder block disassembly)



7. INSTALL PISTON AND CONNECTING ROD ASSEMBLIES
Using a piston ring compressor, push the correctly numbered piston and connecting rod assemblies into each cylinder with the front mark of the piston facing forward.



8. INSTALL CONNECTING ROD CAPS
A. Place connecting rod cap on connecting rod
(a) Match the numbered connecting rod cap with the connecting rod.
(b) Install the connecting rod cap with the front mark facing forward.



B. Install connecting rod cap bolts

HINT:

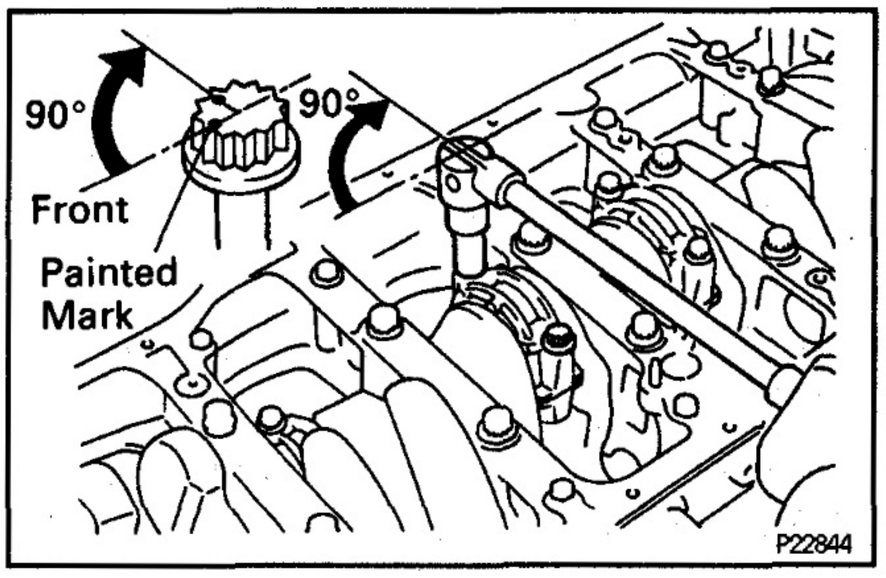
- The connecting rod cap nuts are tightened in 2 progessive steps (steps (b) and (d)).
- If any connecting rod bolt is broken or deformed, replace it.

(a) Apply a light of engine oil on the threads and under the heads of the connecting rod cap bolts.

(b) Install and alternately tighten the bolts of the connecting rod cap in several passes.

Torque: 36.8 N·m (375 kgf·cm, 27 ft·lbf)

If any one of the connecting rod cap bolts does not meet the torque specification, replace the cap bolt.



(c) Mark the front of the connecting rod cap bolt with paint.

(d) Retighten the connecting rod cap bolts 90° as shown.

(e) Check that the painted mark is now at a 90° angle to the front.

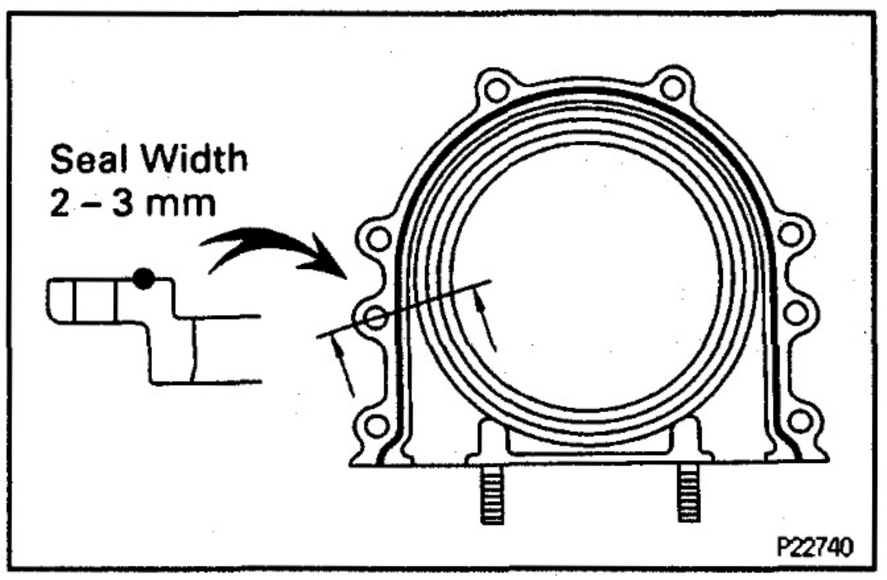
(f) Check that the crankshaft turns smoothly.

9. CHECK CONNECTING ROD THRUST CLEARANCE (See step 2 in cylinder block disassembly)

10. INSTALL REAR OIL SEAL RETAINER

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the retainer and cylinder block.

- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Using a non—residue solvent, clean both sealing surfaces.



(b) Apply seal packing to the retainer as shown in the illustration.

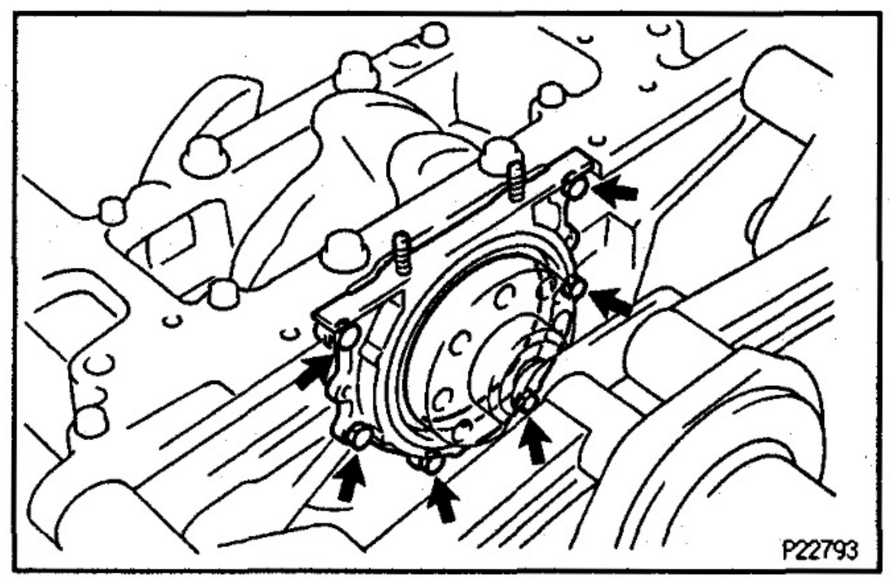
Seal packing:

Part No. 08826—00080 or equivalent

- Install a nozzle that has been cut to a 2 — 3 mm (0.08 — 0.12 in.) opening.

HINT: Avoid applying an excessive amount to the surface.

- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall



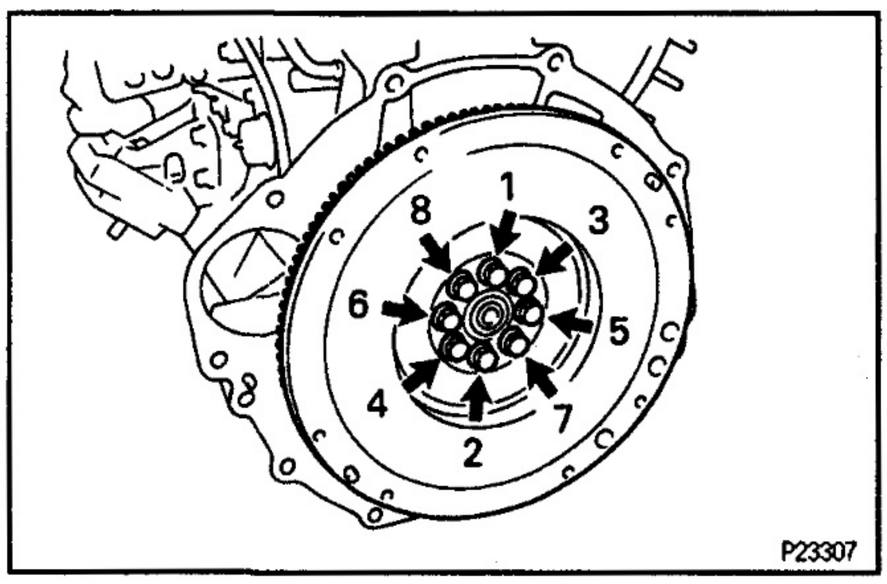
(c) Install the retainer with the 6 bolts.

Torque: 6.4 N·m (65 kgf·cm, 57 in.·lbf)

EG5S9–01

POST ASSEMBLY

1. **INSTALL ENGINE MOUNTING BRACKETS**
   Torque: 68.6 N·m (700 kgf·cm, 51 ft·lbf)
2. **INSTALL TURBO OIL HOSE**
3. **INSTALL OIL PRESSURE SENDER GAUGE**
   (See oil pressure check in Lubrication System)
4. **INSTALL OIL COOLER ASSEMBLY, OIL DIPSTICK AND GUIDE**
   (See oil cooler installation in Lubrication System)
5. **INSTALL OIL STRAINER, TIMING GEAR CASE (OIL PUMP) AND OIL PAN**
   (See oil pump installation in Lubrication System)
6. **INSTALL INJECTION PUMP STAY**
   Torque: 69 N·m (700 kgf·cm, 51 ft·lbf)
7. **INSTALL NO.1 CYLINDER BLOCK INSULATOR**
8. **INSTALL INJECTION PUMP**
   (See injection pump installation in Fuel System)
9. **INSTALL ALTERNATOR AND BRACKET ASSEMBLY**
   Torque: 68.6 N·m (700 kgf·cm, 51 ft·lbf)
10. **INSTALL WATER INLET AND THERMOSTAT**
    (See thermostat installation in Cooling System)
11. **INSTALL WATER PUMP, TURBO WATER PIPE AND ALTERNATOR ADJUSTING BAR**
    (See water pump installation in Cooling System)
12. **INSTALL TIMING GEARS**
    (See timing gears installation)
13. **INSTALL CYLINDER HEAD**
    (See cylinder head installation)
14. **INSTALL TIMING BELT AND PULLEYS**
    (See timing belt installation)
15. **DISCONNECT ENGINE FROM ENGINE STAND**
16. **INSTALL REAR END PLATE**
    Install the rear end plate with the bolt.
    Torque: 18.1 N·m (185 kgf·cm, 13 ft·lbf)



17. **M/T:**
    INSTALL FLYWHEEL
    (a) Install the flywheel on the crankshaft.
    (b) Install and uniformly tighten the bolts in several passes, in the sequence shown.
    Torque: 127.4 N·m (1,300 kgf·cm, 94 ft·lbf)
18. **A/T:**
    INSTALL FLYWHEEL, DRIVE PLATE AND REAR PLATE (See procedure step 17)

SERVICE SPECIFICATIONS

SERVICE DATA

EGOCS-10

Compression pressure		at 250 rpm STD	3,432 kPa (35.0 kgf/cm², 498 psi) or more
		Minimum	2,452 kPa (25.0 kgf/cm², 356 psi)
	Difference of pressure between each cylinder		490 kPa (5.0 kgf/cm², 71 psi) or less
Valve clearance		at cold Intake	0.17 — 0.23 mm (0.007 — 0.009 in.)
		Exhaust	0.47 — 0.53 mm (0.019 — 0.021 in.)
Injection timing	Plunger stroke	Europe	1.52 — 1.58 mm (0.0598 — 0.0622 in.)
		Australia	1.37 — 1.43 mm (0.0539 — 0.0563 in.)
Idle speed		M/T	700 ± 50 rpm
		A/T	800 ± 50 rpm
Maximum speed	—		4,400 ± 100 rpm
PS idle—up speed	—		650 — 750 rpm
A/C idle—up speed	—		775 — 850 rpm
Timing belt tensioner	Protrusion from housing end		9.0 — 9.8 mm (0.354 — 0.386 in.)
Timing gear	Idler gear thrust clearance	STD	0.05 — 0.15 mm (0.0020 — 0.0059 in.)
		Maximum	0.30 mm (0.0118 in.)
	Idler gear inside diameter		45.000 — 45.025 mm (1.7717 — 1.7726 in.)
	Idler gear shaft diameter		44.950 — 44.975 mm (1.7697 — 1.7707 in.)
	Idler gear oil clearance	STD	0.025 — 0.075 mm (0.0010 — 0.0030 in.)
		Maximum	0.20 mm (0.0079 in.)
	Gear backlash	STD	0.05 — 0.15 mm (0.0020 — 0.0059 in.)
		Maximum	0.30 mm (0.0118 in.)
Cylinder head	Warpage	Maximum	0.20 mm (0.079 in.)
	Valve seat		
	Refacing angle	Intake	25°, 45°, 70°
		Exhaust	25°, 45°, 65°
	Contacting angle		45°
	Contacting width	Intake	1.4 — 1.8 mm (0.055 — 0.071 in.)
		Exhaust	1.6 — 2.0 mm (0.063 — 0.079 in.)
	Cylinder head bolt thread inside diameter	STD	10.800 — 11.000 mm (0.4252 — 0.4331 in.)
		Minimum	10.55 mm (0.4154 in.)
Valve guide bushing	Inside diameter		7.010 — 7.030 mm (0.2760 — 0.2768 in.)
Valve	Valve overall length	STD Intake	126.85 — 127.45 mm (4.9941 — 5.0177 in.)
		Exhaust	126.43 — 127.03 mm (4.9775 — 5.0012 in.)
		Minimum Intake	126.85 mm (4.9941 in.)
		Exhaust	126.43 mm (4.9775 in.)
	Stem diameter	Intake	6.970 — 6.985 mm (0.2744 — 0.2750 in.)
		Exhaust	6.960 — 6.975 mm (0.2740 — 0.2746 in.)

EG

Valve (cont'd)	Stem oil clearance	STD Intake	0.025 — 0.060 mm (0.0010 — 0.0024 in.)
		Exhaust	0.035 — 0.070 mm (0.0014 — 0.0028 in.)
		Maximum Intake	0.08 mm (0.0031 in.)
		Exhaust	0.10 mm (0.0039 in.)
	Margin thickness	STD	1.00 mm (0.0394 in.)
		Minimum	0.83 mm (0.0327 in.)
Valve spring	Deviation	Maximum	2.0 mm (0.079 in.)
	Free length		49.6 mm (1.9527 in.)
	Installed tension at 32.9 mm (1.295 in.)		237 — 263 N (24.2 — 26.8 kgf, 53.4 — 59.1 lbf)
Valve rocker arm and shaft	Valve rocker arm inside diameter		20.012 — 20.033 mm (0.7879 — 0.7887 in.)
	Valve rocker shaft diameter		19.972 — 19.993 mm (0.7863 — 0.7871 in.)
	Oil clearance	STD	0.019 — 0.061 mm (0.0007 — 0.0024 in.)
		Maximum	0.10 mm (0.0039 in.)
Camshaft	Thrust clearance	STD	0.100 — 0.200 mm (0.0039 — 0.0079 in.)
		Maximum	0.30 mm (0.0118 in.)
	Journal oil clearance	STD No.1	0.022 — 0.074 mm (0.0009 — 0.0029 in.)
		Others	0.023 — 0.075 mm (0.0009 — 0.0030 in.)
		Maximum	0.10 mm (0.0039 in.)
	Journal diameter	No.1	34.969 — 34.985 mm (1.3767 — 1.3774 in.)
		Others	27.986 — 27.998 mm (1.1018 — 1.1023 in.)
	Circle runout	Maximum	0.10 mm (0.0039 in.)
	Cam lobe height	STD Intake	48.498 — 48.598 mm (1.9094 — 1.9133 in.)
		Exhaust	50.734 — 50.834 mm (1.9974 — 2.0013 in.)
		Minimum Intake	47.998 mm (1.8897 in.)
		Exhaust	50.234 mm (1.9777 in.)
Manifold	Warpage	Maximum	0.40 mm (0.0157 in.)
Cylinder block	Cylinder head surface warpage	Maximum	0.20 mm (0.0079 in.)
	Cylinder bore diameter	STD STD Mark 1	94.000 — 94.010 mm (3.7001 — 3.7012 in.)
		Mark 2	94.010 — 94.020 mm (3.7012 — 3.7016 in.)
		Mark 3	94.020 — 94.030 mm (3.7016 — 3.7020 in.)
		Maximum STD	94.23 mm (3.7098 in.)
		O/S 0.50	94.73 mm (3.7295 in.)
	Main bearing cap stud bolt tension portion diameter		
		STD	11.800 — 12.000 mm (0.4646 — 0.4724 in.)
		Minimum	11.50 mm (0.4528 in.)
Piston and piston ring	Piston diameter	STD Mark 1	93.845 — 93.855 mm (3.6947 — 3.6951 in.)
		Mark 2	93.855 — 93.865 mm (3.6951 — 3.6955 in.)
		Mark 3	93.865 — 93.875 mm (3.6955 — 3.6959 in.)
		O/S 0.50	94.345 — 94.375 mm (3.7144 — 3.7155 in.)
	Piston oil clearance	STD	0.145 — 0.165 mm (0.0057 — 0.0065 in.)
		Minimum	0.215 mm (0.0085 in.)
	Piston ring groove clearance	STD No.1	0.050 — 0.095 mm (0.0020 — 0.0037 in.)
		No.2	0.060 — 0.100 mm (0.0024 — 0.0039 in.)
		Oil	0.030 — 0.070 mm (0.0012 — 0.0028 in.)
		Maximum	0.20 mm (0.0079 in.)

Piston and piston ring (cont'd)	Piston ring end gap	STD No.1	0.270 — 0.470 mm (0.0106 — 0.0185 in.)
		No.2	0.400 — 0.650 mm (0.0157 — 0.0256 in.)
		Oil	0.200 — 0.500 mm (0.0079 — 0.0197 in.)
		Maximum No.1	0.85 mm (0.0335 in.)
		No.2	0.90 mm (0.0354 in.)
		Oil	0.88 mm (0.0346 in.)
Connecting rod	Thrust clearance	STD	0.100 — 0.200 mm (0.0039 — 0.0079 in.)
		Maximum	0.30 mm (0.0118 in.)
	Connecting rod oil clearance STD	STD	0.036 — 0.054 mm (0.0014 — 0.0021 in.)
		U/S 0.25, U/S 0.50	0.037 — 0.077 mm (0.0015 — 0.0030 in.)
		Maximum	0.10 mm (0.0039 in.)
	Connecting rod bearing center wall thickness		
	(Reference)	STD Mark 2	1.484 — 1.489 mm (0.0585 — 0.0586 in.)
		Mark 3	1.489 — 1.492 mm (0.0586 — 0.0587 in.)
		Mark 4	1.492 — 1.495 mm (0.0587 — 0.0589 in.)
		Mark 5	1.495 — 1.498 mm (0.0589 — 0.0590 in.)
		Mark 6	1.498 — 1.501 mm (0.0590 — 0.0591 in.)
	Rod bend	Maximum per 100 mm (3.94 in.)	0.03 mm (0.0012 in.)
	Rod twist	Maximum per 100 mm (3.94 in.)	0.15 mm (0.0059 in.)
	Bushing inside diameter		33.008 — 33.020 mm (12.995 — 1.3000 in.)
	Piston pin diameter		33.000 — 33.012 mm (1.2992 — 1.2997 in.)
	Bushing oil clearance	STD	0.004 — 0.012 mm (0.0002 — 0.0005 in)
		Maximum	0.03 mm (0.0012 in.)
	Connecting rod bolt tension portion diameter	STD	8.300 — 8.400 mm (0.3268 — 0.3307 in.)
		Minimum	7.95 mm (0.3130 in.)
Crankshaft	Thrust clearance	STD	0.040 — 0.240 mm (0.0016 — 0.0094 in.)
		Maximum	0.30 mm (0.0118 in.)
	Thrust washer thickness		2.930 — 2.980 mm (0.1154 — 0.1173 in.)
	Main journal oil clearance STD	STD	0.036 — 0.054 mm (0.0014 — 0.0021 in.)
		U/S 0.25, U/S 0.50	0.037 — 0.077 mm (0.0015 — 0.0030 in.)
		Maximum	0.10 mm (0.0039 in.)
	Main journal diameter	STD	66.982 — 67.000 mm (2.6371 — 2.6378 in.)
		U/S 0.25	66.745 — 66.755 mm (2.6278 — 2.6281 in.)
		U/S 0.50	66.495 — 66.505 mm (2.6179 — 2.6183 in.)
	Main bearing center wall thickness (Reference)		
		STD Mark 2	1.979 — 1.982 mm (0.0779 — 0.0780 in.)
		Mark 3	1.982 — 1.985 mm (0.0780 — 0.0781 in.)
		Mark 4	1.985 — 1.988 mm (0.0781 — 0.0783 in.)
		Mark 5	1.988 — 1.991 mm (0.0783 — 0.0784 in.)
		Mark 6	1.991 — 1.994 mm (0.0784 — 0.0785 in.)
	Crank pin diameter	STD	58.982 — 59.000 mm (2.3221 — 2.3228 in.)
		U/S 0.25	58.745 — 58.755 mm (2.3128 — 2.3132 in.)
		U/S 0.50	58.495 — 58.505 mm (2.3029 — 2.3033 in.)
	Circle runout	Maximum	0.06 mm (0.0024 in.)
	Main journal taper and out—of—round	Maximum	0.02 mm (0.0008 in.)
	Crank pin taper and out—of—round	Maximum	0.02 mm (0.0008 in.)

EG0C6–1A

TORQUE SPECIFICATION

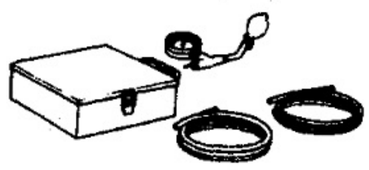
Part tightened		N·m	kgf·cm	ft·lbf
Injection pump x Timing gear case		18	185	13
Injection pump x Injection pump stay		69	700	51
Plug bolt x Distributive head plug on injection pump		25.5	260	19
Injection pipe x Injection pump		24.5	250	18
No.1 camshaft timing pulley x Camshaft		98	1,000	72
No.2 camshaft timing pulley x Injection pump drive gear		31	315	23
Idler pulley x Timing gear cover		34.5	350	25
Timing belt tensioner x Timing gear cover		13	130	10
Injection pump drive gear x Injection pump		98	1,000	72
Idler gear x Cylinder block		68	694	50
Timing gear cover, Oil pipe x Timing gear case		19.6	200	14
Vacuum pump x Timing gear cover		39	400	29
Oil pipe x Vacuum pump, Cylinder block		18	185	13
Crankshaft pulley x Crankshaft		430	4,400	317
Cylinder head x Cylinder block	1st	68.6	700	51
	2nd	Turn 90°	Turn 90°	Turn 90°
	3rd	Turn 90°	Turn 90°	Turn 90°
Camshaft bearing cap x Cylinder head		25	250	18
Camshaft oil seal retainer x Cylinder head		19.6	200	14
Cylinder head cover x Cylinder head		6.4	65	57 in.·lbf
Rear engine hanger x Cylinder head		39.2	400	29
Water outlet x Cylinder head		19.6	200	14
Intake manifold x Cylinder head		19.6	200	14
Intake pipe x Intake manifold		19.6	200	14
EGR valve adapter x Exhaust manifold		40	400	26
EGR valve bracket x EGR valve dapter, Cylinder head (w/ EGR system)		20	200	15
Intake pipe x Intake heater (w/o EGR system)		7.5	75	66 in.·lbf
Main bearing cap x Cylinder block	12 pointed head 1st	103	1,050	76
	2nd	Turn 90°	Turn 90°	Turn 90°
	6 pointed head	18.1	185	13
Connecting rod cap x Connecting rod	1st	36.8	375	27
	2nd	Turn 90°	Turn 90°	Turn 90°
Rear oil seal retainer x Cylinder block, Main bearing cap		6.4	65	57 in.·lbf
Engine mounting bracket x Cylinder block		68.6	700	51
Injection pump stay x Cylinder block		69	700	51
Alternator bracket x Cylinder block		68.6	700	51
Rear end plate x Cylinder block		18.1	185	13
Flywheel (M/T), Drive plate (A/T) x Crankshaft		127.4	1,300	94

TURBOCHARGER SYSTEM

PREPARATION

SST (SPECIAL SERVICE TOOLS)

IG00R-0E

	09992-00241 Turbocharger Pressure Gauge	

EG

EQUIPMENT

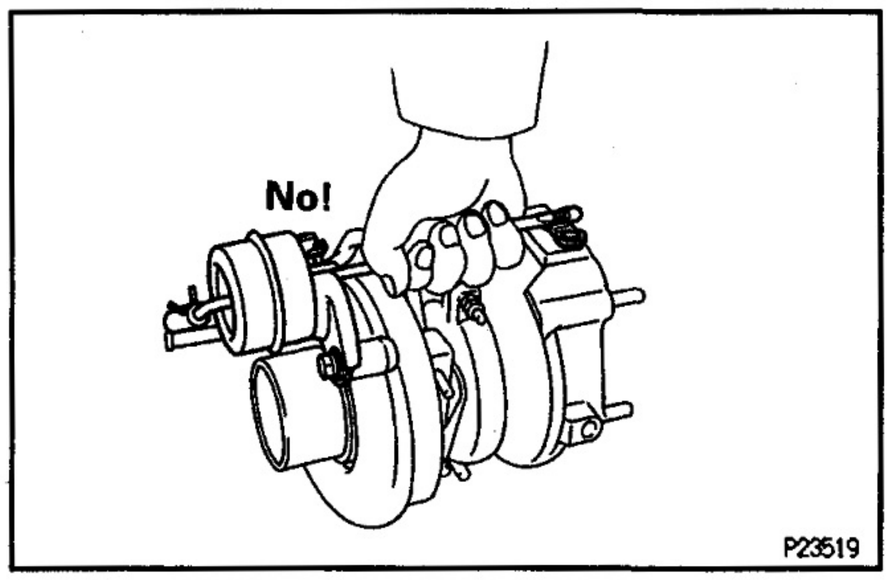
IG00T-0P

Dial indicator	Impeller wheel
Torque wrench	

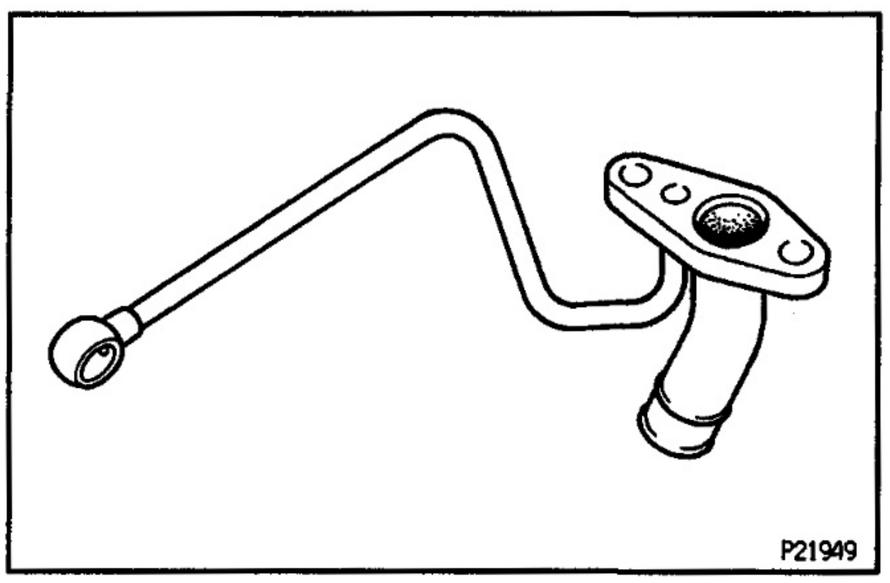
PRECAUTION

EGOWY-00

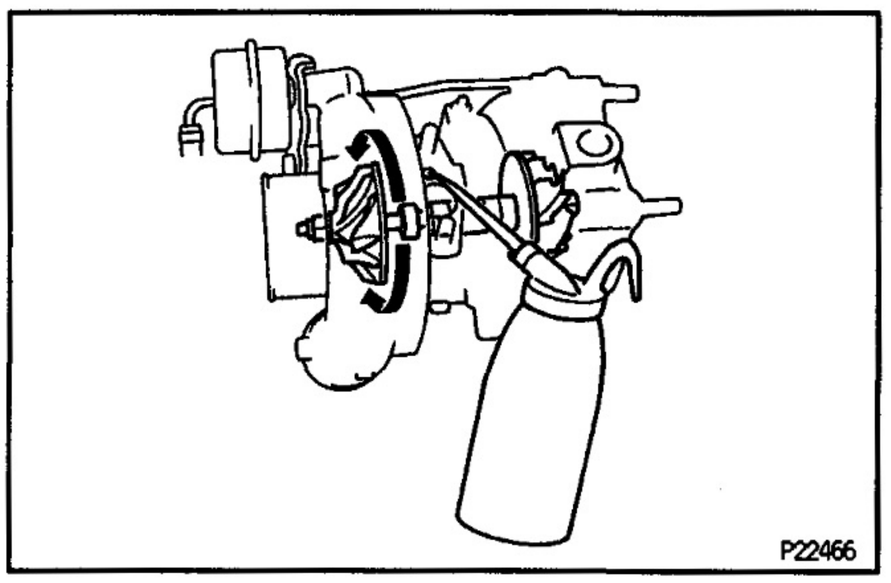
1. Do not stop the engine immediately after pulling a trailer or after high speed or uphill driving. Idle the engine for 20 — 120 seconds, depending on how hard the vehicle has been driven.
2. Avoid sudden acceleration or racing immediately after starting a cold engine.
3. Do not run the engine with air cleaner removed, as this may cause foreign material to enter and damage the impeller wheel operating at high speed.
4. If the turbocharger is found to be defective and must be replaced, check for the cause, and repair or replace these items as necessary:
   - Engine oil level and quality
   - Conditions under which the turbocharger was used
   - Oil lines leading to the turbocharger



5. Use caution when removing and reinstalling the turbocharger assembly. Do not drop it or bang it against anything or grasp it by easily—deformed parts, such as the actuator or rod, when moving it.
6. Before removing the turbocharger, plug the intake and exhaust ports and oil inlet to prevent entry of dirt or other foreign material.



7. If replacing the turbocharger, check for accumulation of sludge particles in the oil pipes, and if necessary, replace the oil pipes.
8. Completely remove the gasket adhered to the lubrication oil pipe flange and turbocharger oil flange.
9. When replacing bolt or nuts, use only anthorized replacement parts to prevent breakage or deformation.



10. If replacing the turbocharger, put 20 cm^3 (1.2 cu in.) of oil into the turbocharger oil inlet and turn the impeller wheel by hand to spread oil to the bearing.
11. If overhauling or replacing the engine, cut the fuel supply after reassembly and crank the engine for 30 seconds to distribute oil throughout the engine. Then allow the engine to idle for 60 seconds.

TROUBLESHOOTING

HINT: Before troubleshooting the turbocharger, first check the engine itself. (Valve clearance, engine compression, ignition timing etc.) EGOWZ-06

INSUFFICIENT ACCELERATION, LACK OF POWER OR EXCESSIVE FUEL CONSUMPTION

(Possible Cause)	(Check Procedure and Correction Method)
1. TURBOCHARGING PRESSURE TOO LOW	Check turbocharging pressure. (See page EG-97) **Turbocharging pressure:** **38.6 – 50.0 kPa** **(0.39 – 0.50 kgf/cm², 5.6 – 7.3 psi)** If the pressure is below specifications, begin diagnosis from item 2.
2. RESTRICTED INTAKE SYSTEM	Check intake air system, and repair or replace parts as necessary. (See page EG-97)
3. LEAK IN INTAKE AIR SYSTEM	Check intake air system, and repair or replace parts as necessary. (See page EG-97)
4. RESTRICTED EXHAUST SYSTEM	Check exhaust system, and repair or replace parts as necessary. (See page EG-97)
5. LEAK IN EXHAUST SYSTEM	Check exhaust system, and repair or replace parts as necessary. (See page EG-97)
6. ERRATIC TURBOCHARGER OPERATION	Check rotation of impeller wheel. If it does not turn on turns with a heavy drag, replace the turbocharger assembly. Check axial and radial plays of turbine shaft. (See page EG-101) **Maximum axial play: 0.13 mm (0.0051 in.) or less** **Maximum radial play: 0.18 mm (0.0071 in.) or less** If not within specification, replace the turbocharger assembly.

V06635

ABNORMAL NOISE

(Possible Cause)	(Check Procedure and Correction Method)
1. TURBOCHARGING HEAT INSULATOR RESONANCE	Check for loose, improperly installed or dedormed insulator mount bolts, and repair or replace as necessary.
2. EXHAUST PIPE LEAKING OR VIBRATING	Check for deformed exhaust pipe, loose mount bolts or damaged gasket, and repair or replace as necessary.
3. ERRATIC TURBOCHARGER OPERATION	Refer to Item 6 of INSUFFICIENT ACCELERATION, LACK OF POWER OR EXCESSIVE FUEL CONSUMPTION.

EXCESSIVE OIL CONSUMPTION OR WHITE EXHAUST

(Possible Cause)	(Check Procedure and Correction Method)
FAULTY TURBOCHARGER OIL SEAL	Check for oil leakage in exhaust system. • Remove the turbine elbow from the turbocharger and check for excessive carbon deposits on the turbine wheel. Excessive carbon deposits indicate a faulty turbocharger. Check for oil leakage in intake air system. • Check for axial and radial plays in turbine wheel, and replace the turbocharger if necessary. (See page EG-101) **Maximum axial play: 0.13 mm (0.0051 in.) or less** **Maximum radial play: 0.18 mm (0.0071 in.) or less** **NOTICE: Some oil mist in the blowby from the PCV is normal. Do not mistake it for an oil leak from the turbocharger.**

V06634

TURBOCHARGER

ON—VEHICLE INSPECTION

EGMX-02

1. INSPECT INTAKE AIR SYSTEM

Check for leakage or clogging between the air cleaner housing and turbocharger inlet and between the turbocharger outlet and cylinder head.

- Clogged air cleaner .... Clean or replace element
- Hoses collapsed or deformed .... Repair or replace
- Leakage from connections .... Check each connection and repair
- Cracks in components .... Check and replace

2. INSPECT EXHAUST SYSTEM

Check for leakage or clogging between the cylinder head and turbocharger inlet and between the turbocharger outlet and exhaust pipe.

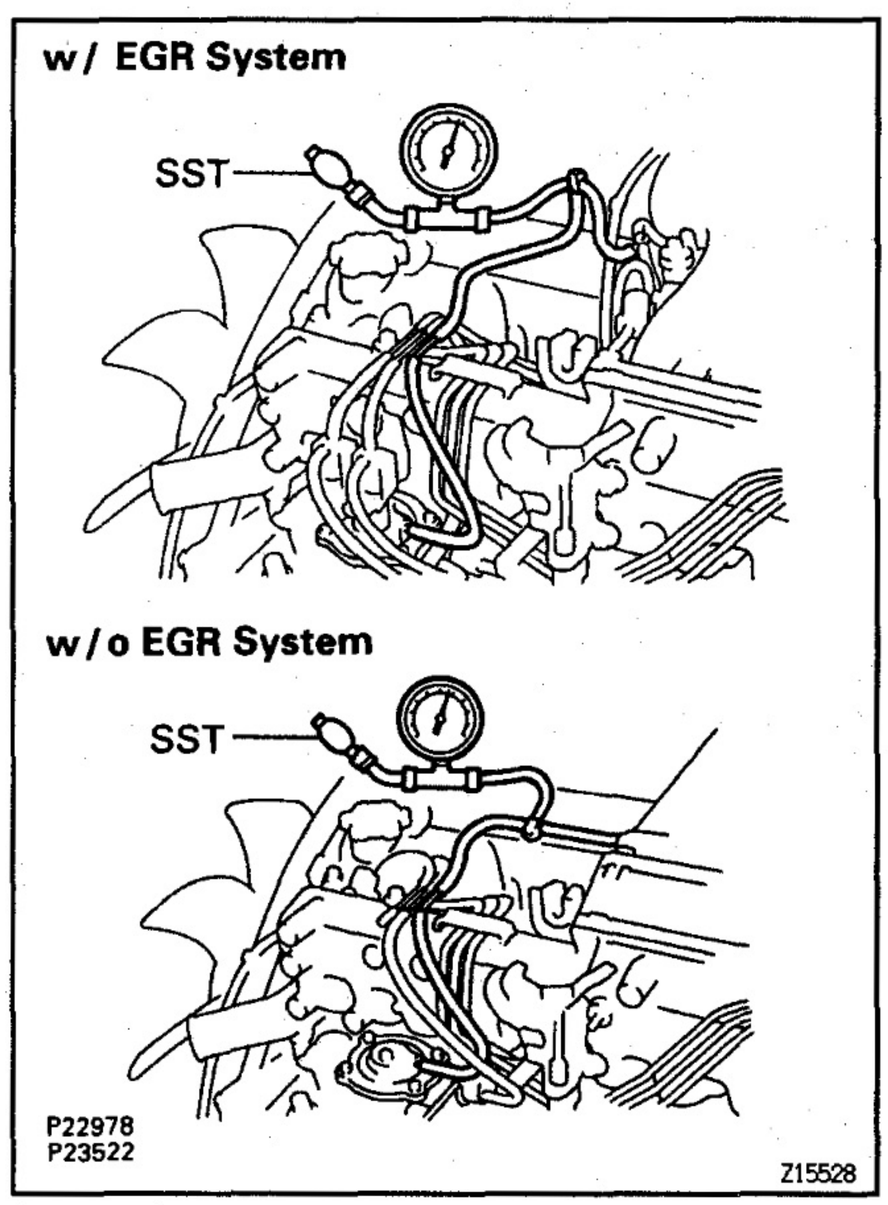
- Deformed components .... Repair or replace
- Foreign material in passages .... Remove
- Leakage from components .... Repair or replace
- Cracks in components .... Check and replace

3. CHECK TURBOCHARGING PRESSURE

(a) Warm up engine.

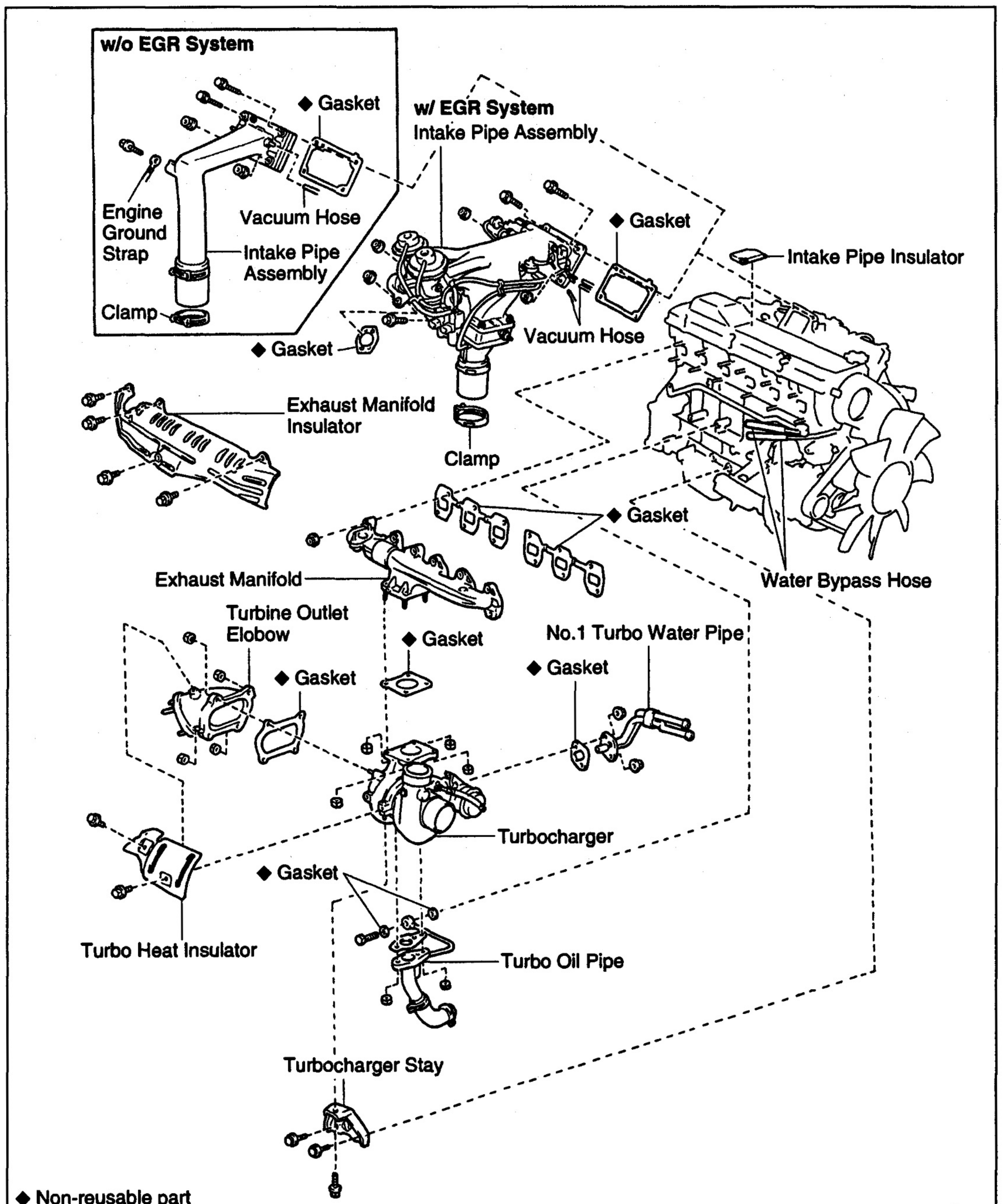
(b) Using a 3—way connector, connect SST (turbocharger pressure gauge) to the hose between the vacuum pipe and intake pipe.
SST 09992—00241

(c) Press in the clutch pedal, then press the accelerator pedal down as far as it will go. Measure the turbocharging pressure at maximum speed (4,400 rpm).
Standard pressure:
38.6 — 50.0 kPa (0.39 — 0.50 kgf/cm², 5.6 — 7.3 psi)
If the pressure is less than that specification, check the intake air and exhaust systems for leakage.
If there is no leakage, replace the turbocharger assembly.
If the pressure is above specification, check if the actuator hose is disconnected or cracked. If not, replace the turbocharger assembly.



EG2XJ-04

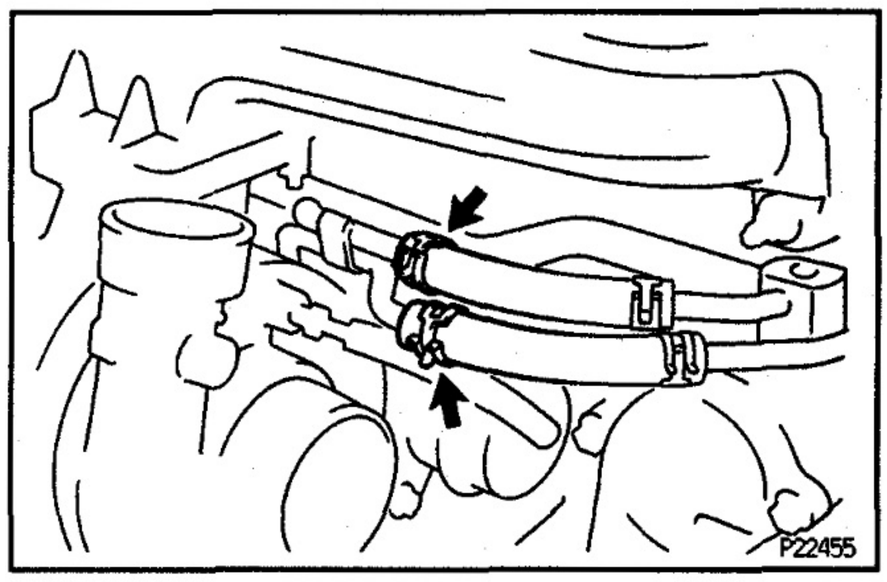
COMPONENTS FOR REMOVAL AND INSTALLATION



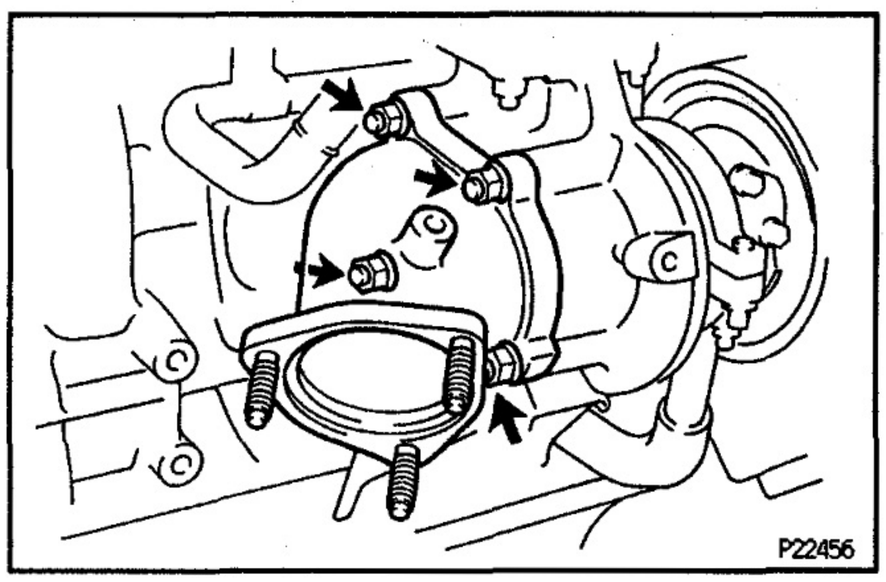
EGSRC-01

TURBOCHARGER REMOVAL

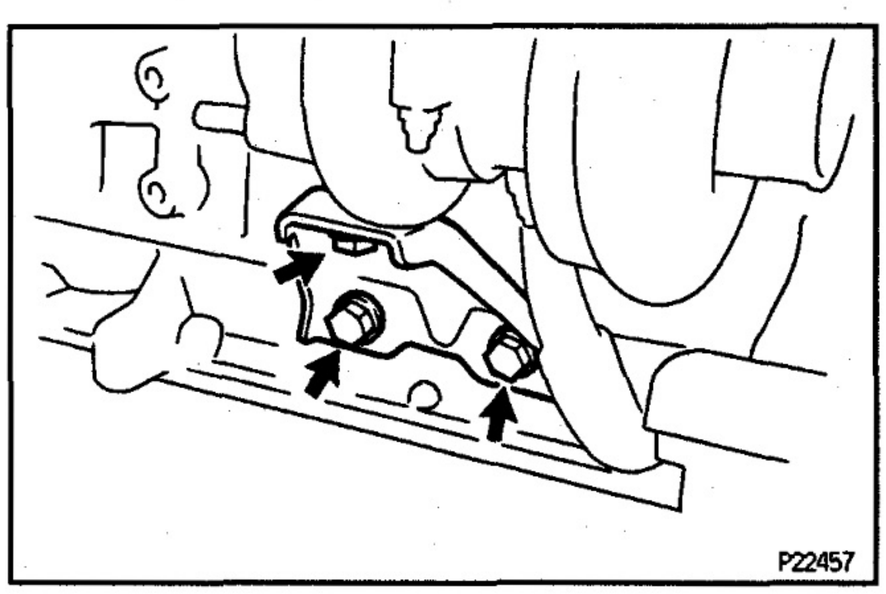
1. **DRAIN ENGINE COOLANT**
2. **REMOVE INTAKE PIPE**
   (See step 2 or 3 in cylinder head removal in Engine Mechanical)
3. **REMOVE EXHAUST MANIFOLD HEAT INSULATOR**
   Remove the 4 bolts and heat insulator.
4. **REMOVE TURBOCHARGER HEAT INSULATOR**
   Remove the 2 bolts and heat insulator.



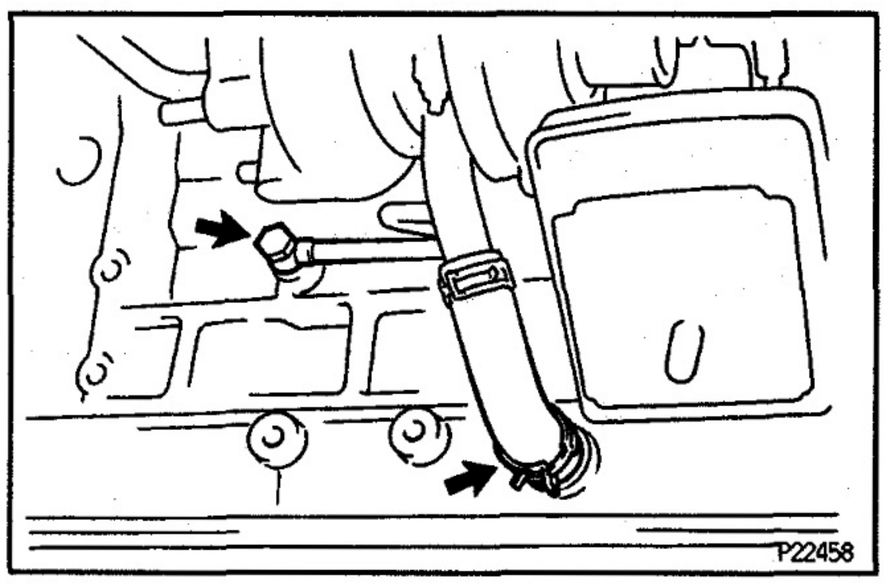
5. **DISCONNECT WATER BY PASS HOSES FROM NO.1 TURBO WATER PIPE**



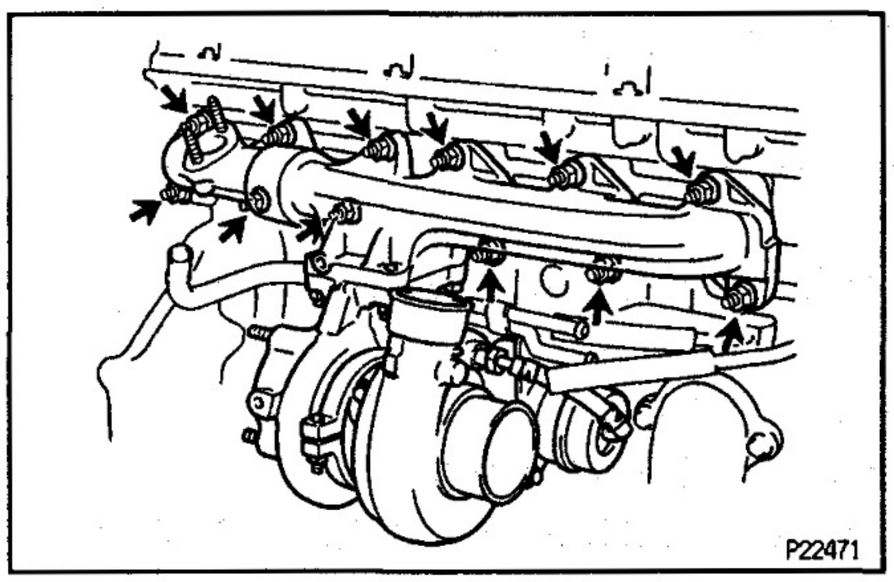
6. **REMOVE TURBINE OUTLET ELBOW**
   Remove the 4 nuts, turbine outlet elbow and gasket.



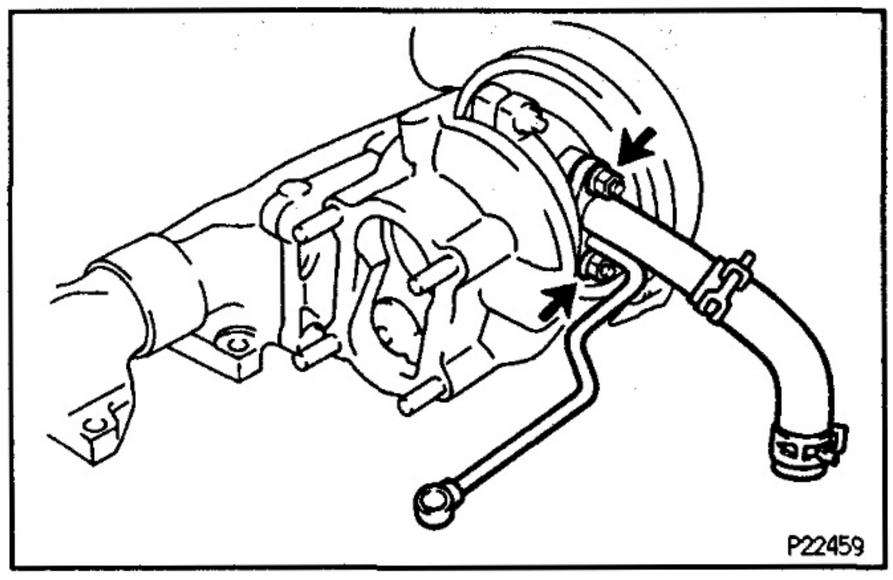
7. **REMOVE TURBOCHARGER STAY**
   Remove the 3 bolts and turbocharger stay.



8. **REMOVE TURBOCHARGER AND EXHAUST MANIFOLDS ASSEMBLY**
   (a) Disconnect the turbo oil hose from the cylinder block.
   (b) Remove the union bolt and 2 gaskets holding the turbo oil pipe to the cylinder block.

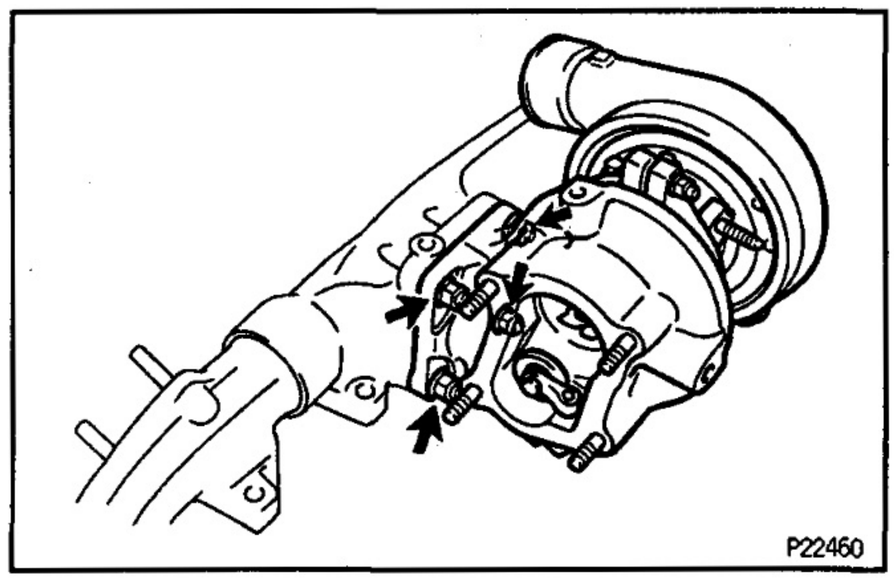


(c) Remove the 12 nuts, the turbocharger, exhaust manifolds assembly and 2 gaskets.



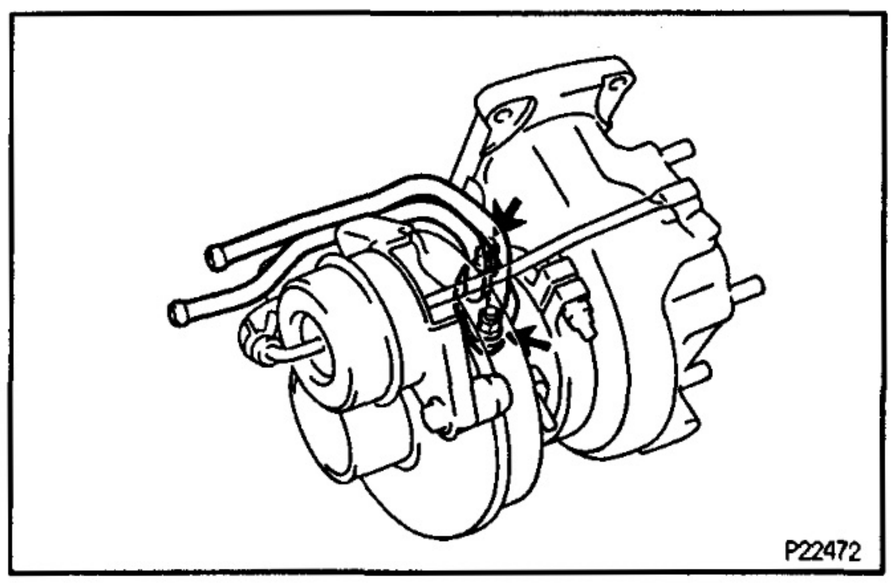
9. REMOVE TURBO OIL PIPE

Remove the 2 nuts, turbo oil pipe and gasket.



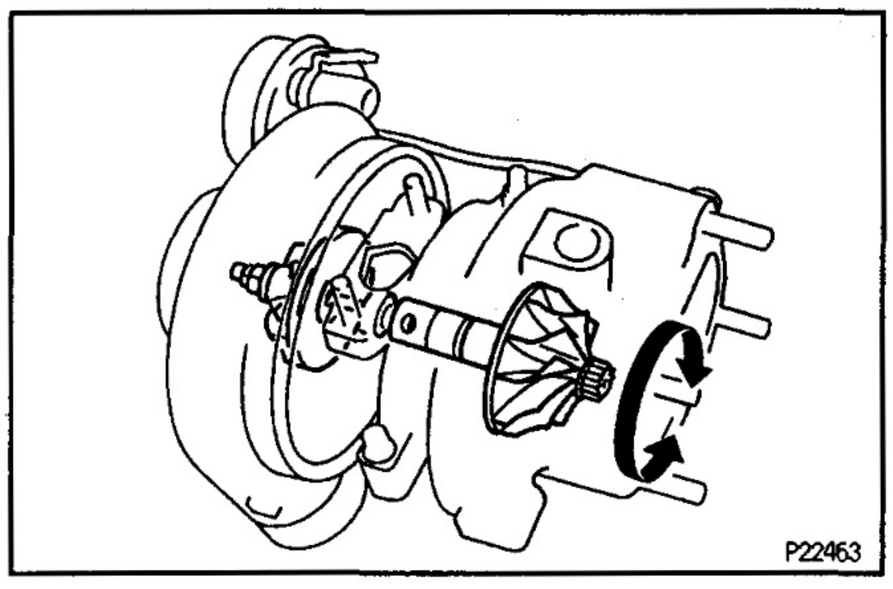
10. REMOVE TURBOCHARGER FROM EXHAUST MANIFOLDS

Remove the 4 nuts, turbocharger and gasket.



11. REMOVE NO.1 TURBO WATER PIPE

Remove the 2 nuts, No.1 turbo water pipe and gasket.

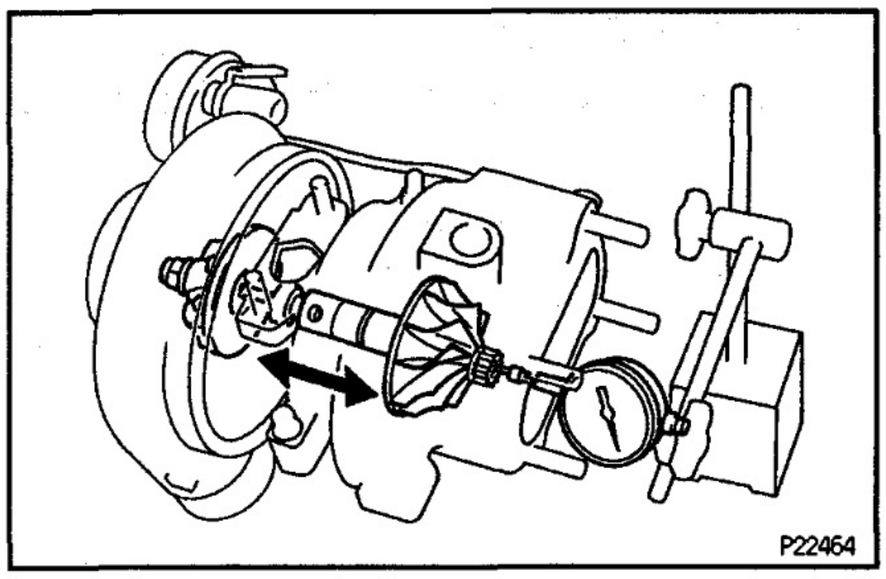


EG34Z-02

TURBOCHARGER INSPECTION

1. INSPECT IMPELLER WHEEL ROTATION

Grasp the edge of the turbine wheel and turn it. Check that the impeller wheel turns smoothly.
If the impeller wheel does not turn or if it turns with a heavy drag, replace the turbocharger assembly.



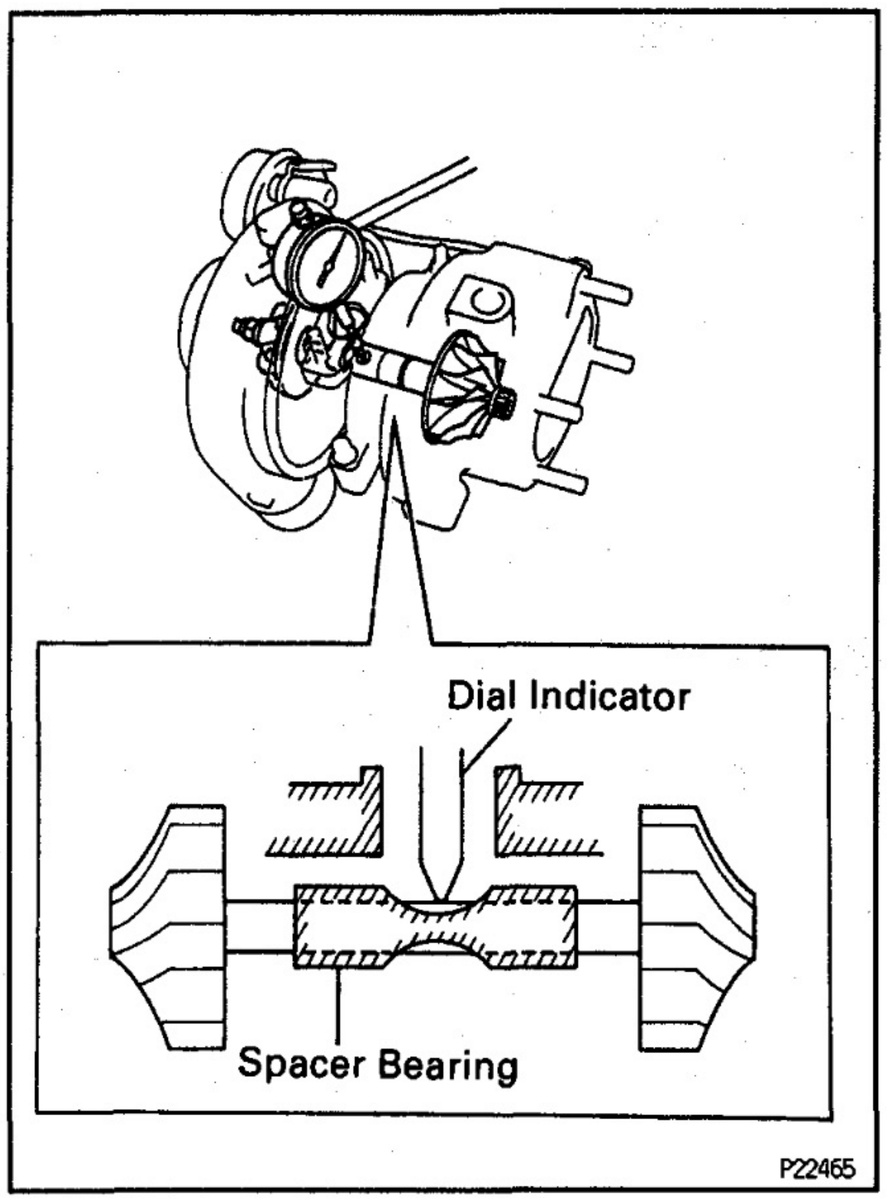
2. INSPECT AXIAL PLAY OF TURBINE SHAFT

Insert a dial indicator into the exhaust side hold the turbine wheel edge by hand, and check the axial play.

Maximum oil clearance:

0.13 mm (0.0051 in.) or less

If the axial play is not as specified, replace the turbocharger assembly.



3. INSPECT RADIAL PLAY OF TURBINE SHAFT

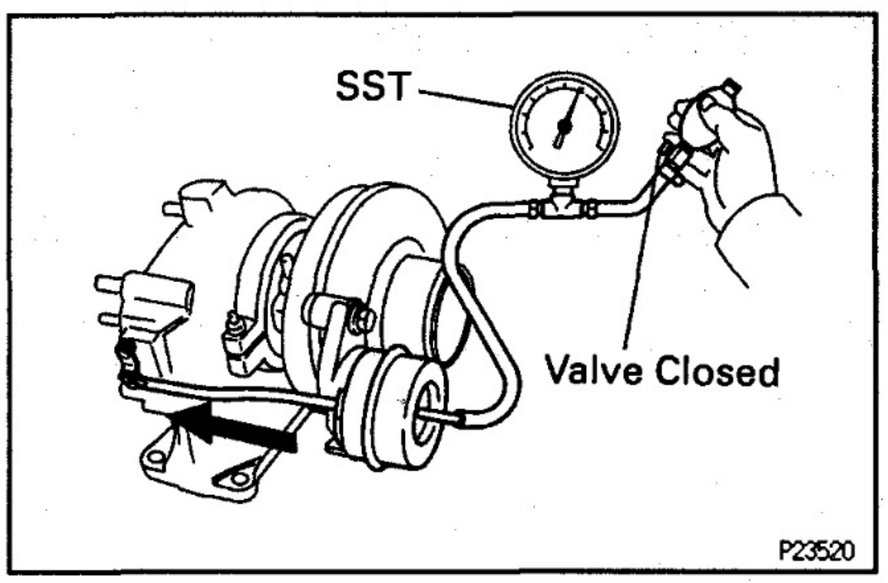
(a) From oil outlet hole, insert a dial indicator through the hole in the spacer bearing and set it in the center of the turbine shaft.

(b) Move the impeller shaft in a radial direction, measure the radial play of the turbine shaft.

Maximum oil clearance:

0.18 mm (0.0071 in.) or less

If the radial play is not as specified, replace the turbocharger assembly.



4. INSPECT ACTUATOR OPERATION

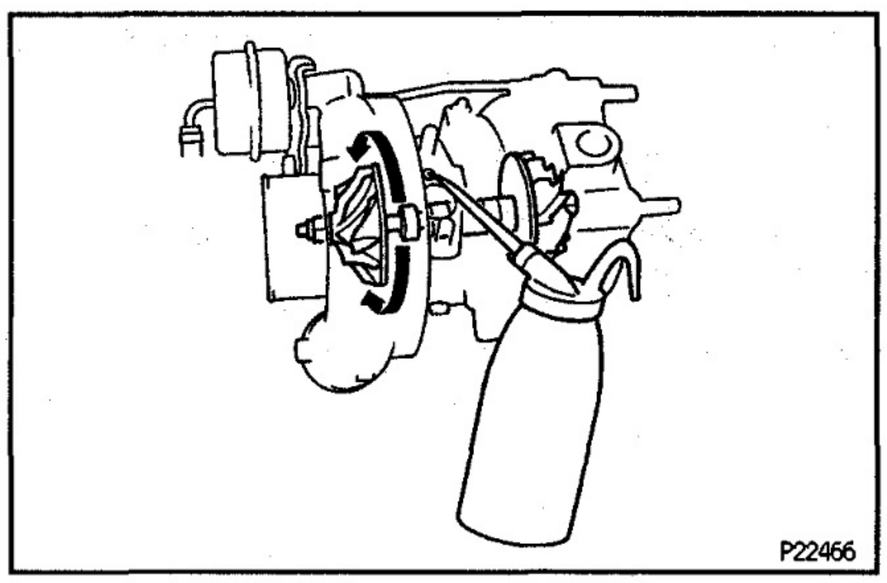
(a) Disconnect the actuator hose.

(b) Using SST (turbocharger pressure gauge), 88 — 96 kpa (0.90 — 0.98 kgf/cm², 12.8 — 13.9 psi) of pressure to the actuator and check that the rod moves.

If the rod does not move, replace the turbocharger assembly.

SST 09992—00241

NOTICE: Never apply more than 124 kPa (1.26 kgf/cm², 18 psi) of pressure to the actuator.

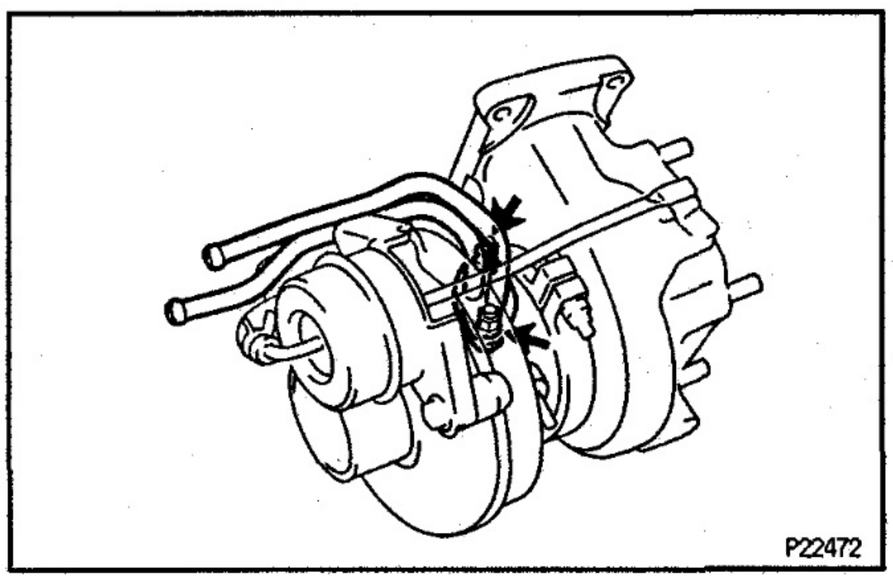


TURBOCHARGER INSTALLATION

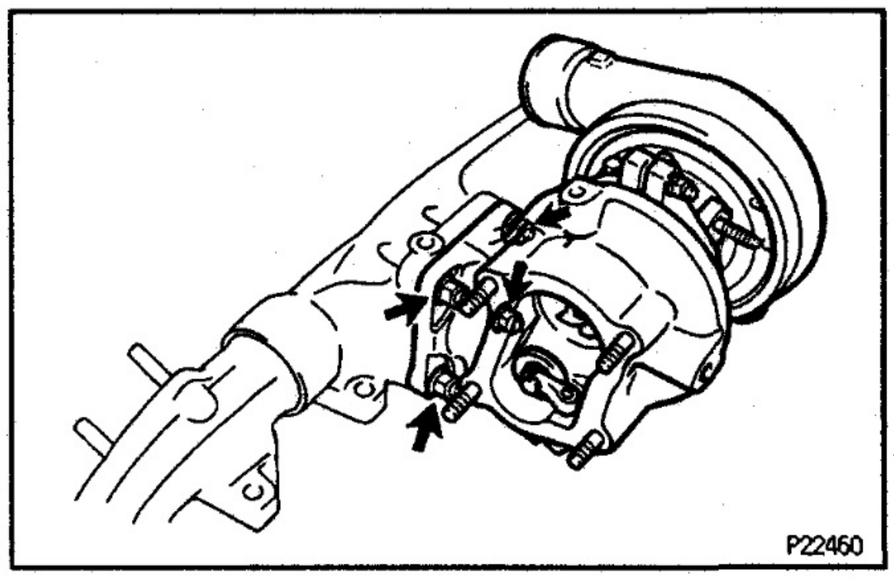
EG5RD—01

NOTICE: After replacing the turbocharger assembly, pour approx. 20 cm³ (1.2 cu in.) of fresh oil into the oil inlet and turn the impeller wheel by hand to splash oil on the bearing.

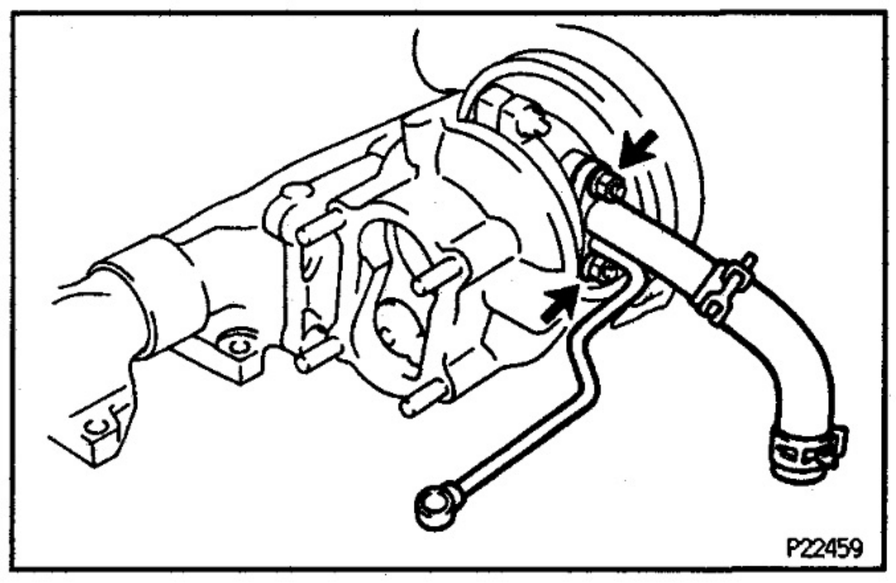
EG



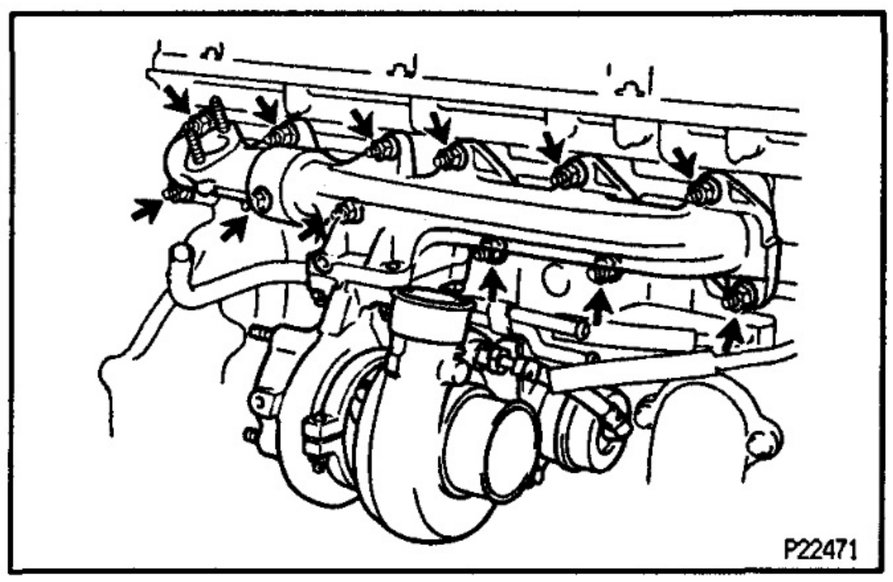
1. **INSTALL NO.1 TURBO WATER PIPE**
Install a new gasket and the water pipe with the 2 nuts.
Torque: 7.8 N·m (80 kgf·cm, 69 in.·lbf)



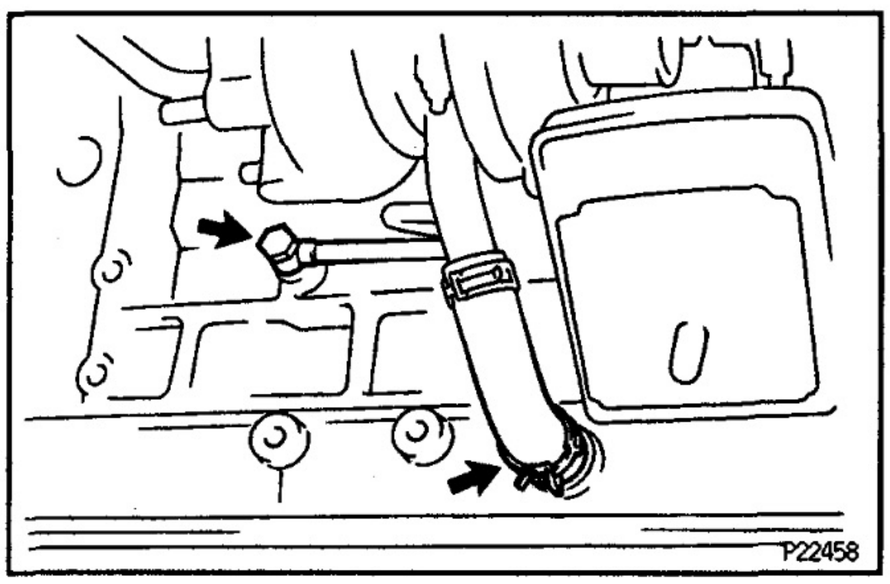
2. **INSTALL TURBOCHARGER TO EXHAUST MANIFOLDS**
Install a new gasket and the turbocharger to the exhaust manifolds with the 4 nuts.
Torque: 52 N·m (530 kgf·cm, 38 ft·lbf)



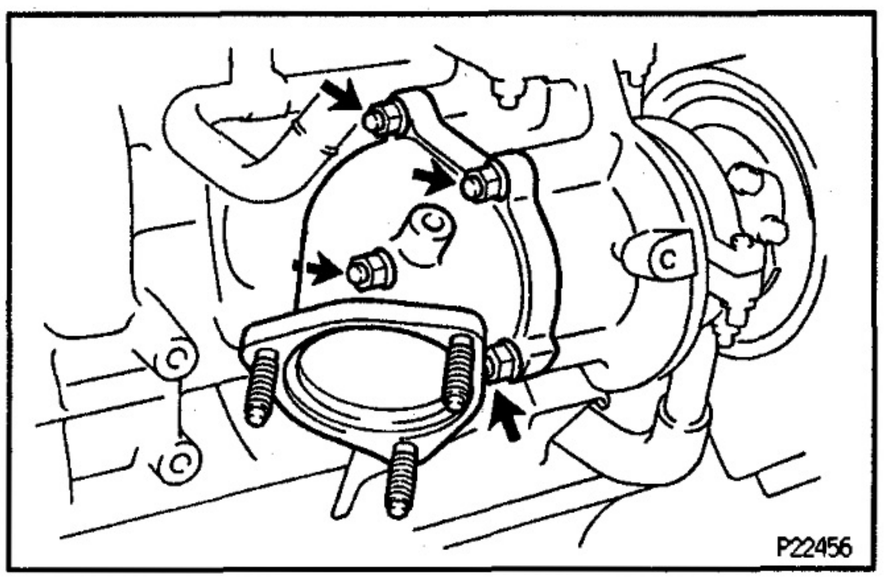
3. **INSTALL TURBO OIL PIPE**
Install a new gasket and the oil pipe with the 2 nuts.
Torque: 18.1 N·m (185 kgf·cm, 13 ft·lbf)



4. **INSTALL TURBOCHARGER AND EXHAUST MANIFOLDS ASSEMBLY**
(a) Install 2 new gasket to the cylinder head.
(b) Install the turbocharger and exhaust manifolds assembly with the 12 nuts.
Torque: 41.7 N·m (425 kgf·cm, 31 ft·lbf)



(d) Install 2 new gaskets and the union bolt of the turbo oil pipe.
Torque: 24.5 N·m (250 kgf·cm, 18 ft·lbf)
(e) Connect the turbo oil hose to the cylinder block.
5. **INSTALL TURBOCHARGER STAY**
Torque: 117.7 N·m (1200 kgf·cm, 87 ft·lbf)



6. **INSTALL TURBINE OUTLET ELBOW**
   Install a new gasket and the outlet elbow with the 4 nuts.
   Torque: 52 N·m (530 kgf·cm, 38 ft·lbf)
7. **CONNECT WATER BY PASS HOSES TO NO.1 TURBO WATER PIPE**
8. **INSTALL TURBOCHARGER HEAT INSULATOR**
   Torque: 7.8 N·m (80 kgf·cm, 69 in.·lbf)
9. **INSTALL EXHAUST MANIFOLD HEAT INSULATOR**
   Torque: 18.1 N·m (185 kgf·cm, 13 ft·lbf)
10. **INSTALL INTAKE PIPE**
    (See step 18 or 19 in cylinder head installation in Engine Mechanical)
12. **FILL WITH ENGINE COOLANT**
13. **START ENGINE AND CHECK FOR LEAKS**
14. **CHECK ENGINE OIL LEVEL**

EG

SERVICE SPECIFICATIONS

SERVICE DATA

EG0X8–0C

Turbocharger	Turbocharging pressure		38.6 – 50.0 kPa (0.39 – 0.50 kgf/cm², 5.6 – 7.3 psi)
	Impeller wheel axial play	Maximum	0.13 mm (0.0051 in.) or less
	Impeller wheel radial play	Maximum	0.18 mm (0.0071 in.) or less

TORQUE SPECIFICATIONS

EG0X9–0D

Part tightened	N·m	kgf·cm	ft·lbf
No.1 turbo water pipe, Turbocharger heat insulator x Turbocharger	7.8	80	69 in.·lbf
Turbocharger x Exhaust manifold	52	530	38
Turbo oil pipe x Turbocharger	18.1	185	13
Exhaust manifold x Cylinder head	41.7	425	31
Turbo oil pipe x Cylinder block	24.5	250	18
Turbocharger stay x Turbocharger, Cylinder block	117.7	1200	87
Turbine outlet elbow x Turbocharger	52	530	38
Exhaust manifold heat insulator x Exhaust manifold	18.1	185	13

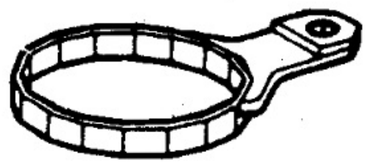
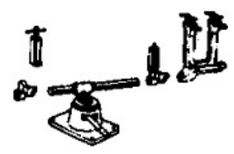
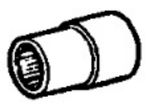
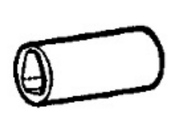
FUEL SYSTEM

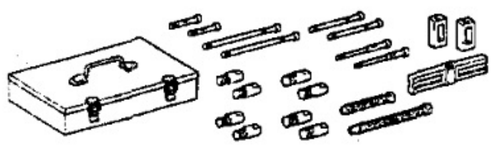
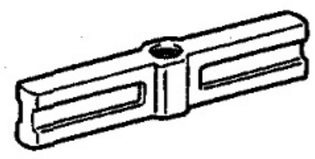
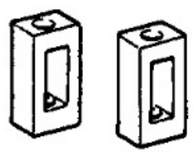
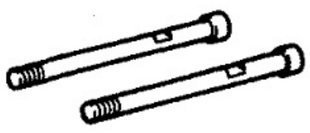
PREPARATION

SST (SPECIAL SERVICE TOOLS)

EG0CF–14

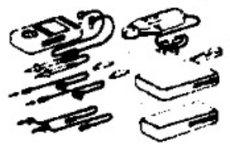
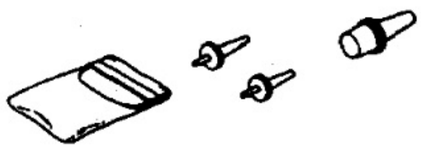
EG

	09228–64010 Fuel Filter Wrench	
	09236–00101 Water Pump Overhaul Tool Set	
	(09237–00070) Shaft "C"	Governor sleeve plug
	09241–76022 Injection Pump Stand Set	
	09245–54010 Injection Pump Stand Arm	
	09260–54012 Injection Pump Tool Set	
	(09262–54010) Distributor Head Plug Wrench	
 I00830	(09269–54020) Socket 14 mm	
	(09269–54040) Tweezers	
	(09269–54040) Governor Lever Support Bolt Wrench	
	(09262–54020) Regulator Valve Wrench	
	09268–17010 2 Spring Nozzle Tool set	

	09268–17020 Master Spring Seat	
	09950–40010 Puller B Set	
	(09957–04010) Attachment	Injection pump
	09950–50010 Puller C Set	
	(09951–05010) Hanger 150	Injection pump
	(09952–05010) Slide Arm	Injection pump
	(09953–05020) Center Bolt 150	Injection pump
	(09954–05030) Claw No.3	Injection pump
	09992–00241 Turbocharger Pressure Gauge	

ST01C–QD

RECOMMENDED TOOLS

	09082–00050 TOYOTA Electrical Tester Set.	
	09200–00010 Engine Adjust Kit .	
	09258–00030 Hose Plug Set .	Plug for fuel hose

BBOCH-0Y

EQUIPMEMT

Angle gauge	
Brass brush	
Dial indicator with magnetic base	
Graduated cylinder	
Injection nozzle tester	
Injection pump tester	
Inner pressure gauge	
Micrometer	
Steel square	
Timer measuring device	
Torque wrench	
Vernier calipers	
Wooden stick	

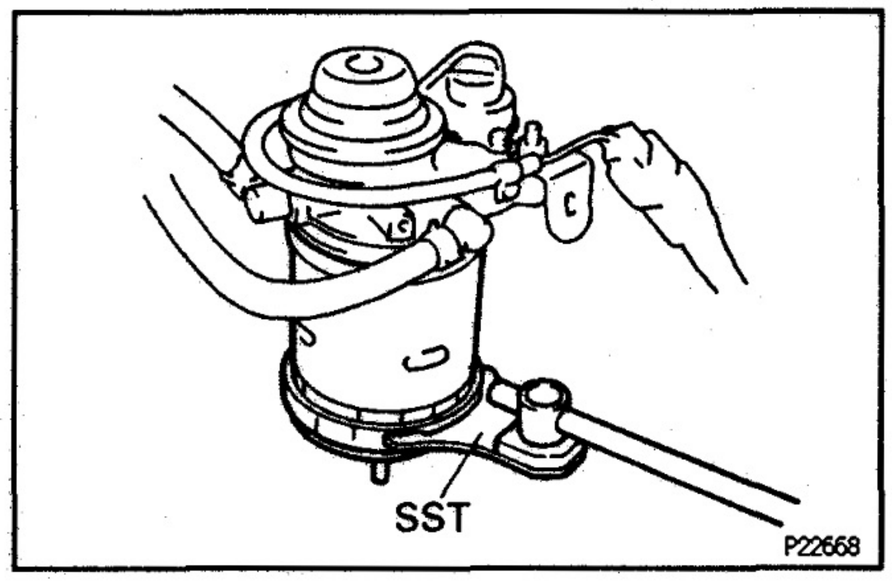
FUEL FILTER

1. DISCONNECT FUEL FILTER WARNING SWITCH CONNECTOR E03TF-01

2. DRAIN FUEL FROM FUEL FILTER

(a) Install a vinyl hose to the drain cock, and insert the other end of the vinyl hose in a container.

(b) Loosen the drain plug, and drain the fuel.

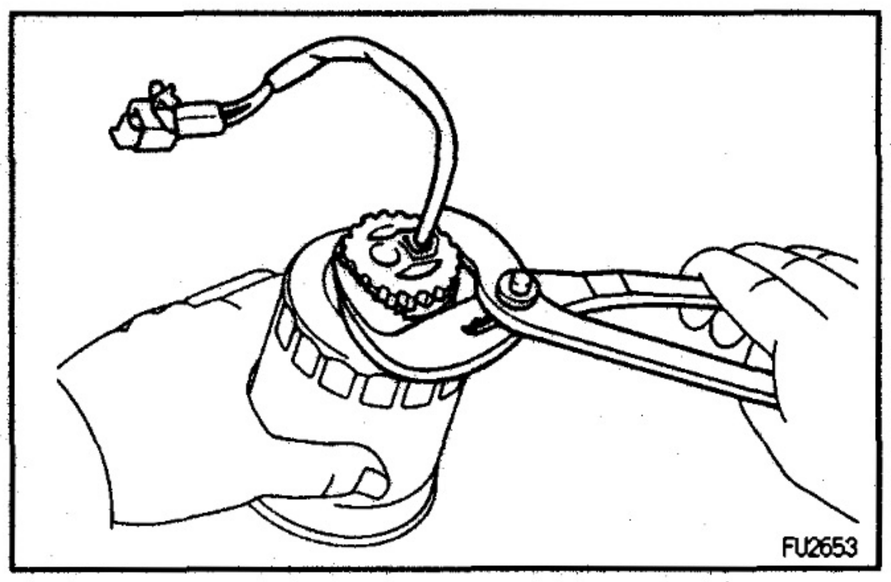


3. REPLACE FUEL FILTER

A. Remove fuel filter

Using SST, remove the fuel filter.

SST 09228—64010



B. Remove fuel filter warning switch from fuel filter

Using pliers, remove the warning switch and O—ring.

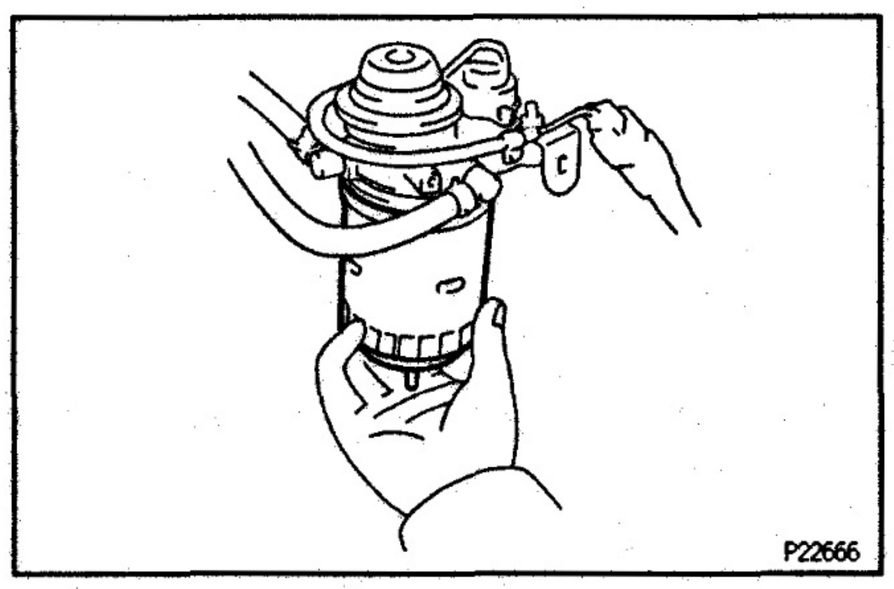
NOTICE: Be careful not to damage the warning switch.

C. Install fuel filter warning switch to new fuel filter

(a) Install a new O—ring to the warning switch.

(b) Apply fuel to the O—ring of the warning switch.

(c) Install the warning switch to a new fuel filter by hand.



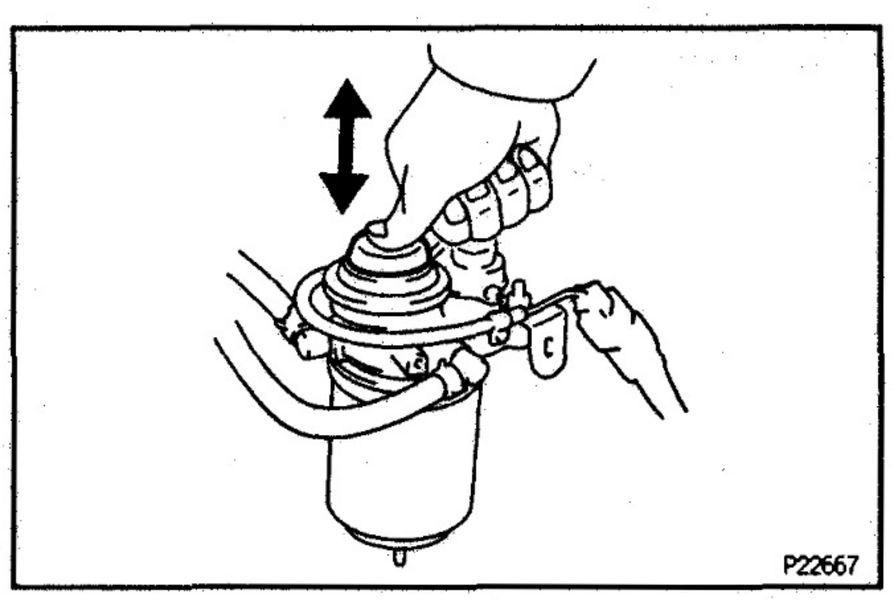
D. Install new fuel filter

(a) Check and clean the fuel filter installation surface.

(b) Apply fuel to the gasket of a new fuel filter.

(c) Lightly screw the fuel filter into place, and tighten it until the gasket comes into contact with the seat.

(d) Tighten it additional 3/4 turn by hand.



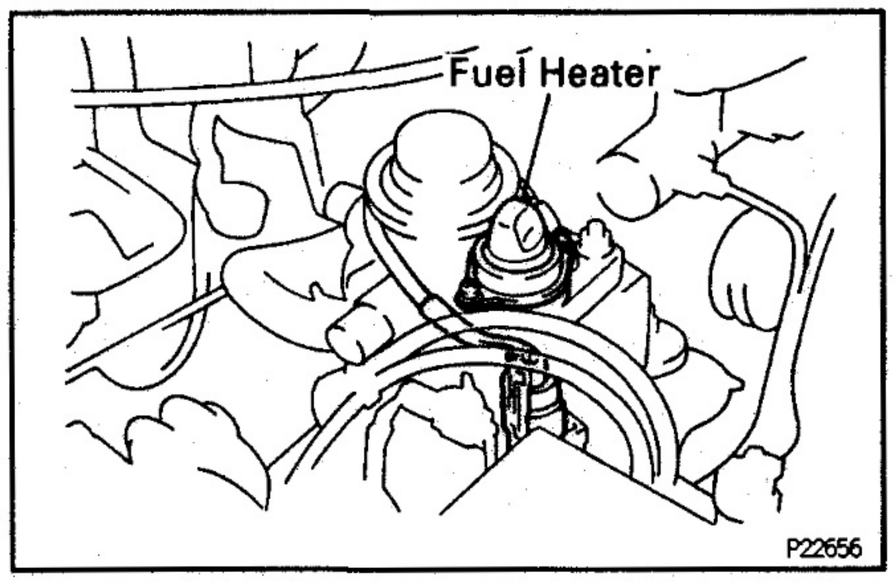
4. FILL FUEL FILTER WITH FUEL

Operate the hand pump until you feel more resistance.

5. CONNECT FUEL FILTER WARNING SWITCH CONNECTOR

6. START ENGINE AND CHECK FOR FUEL LEAKS

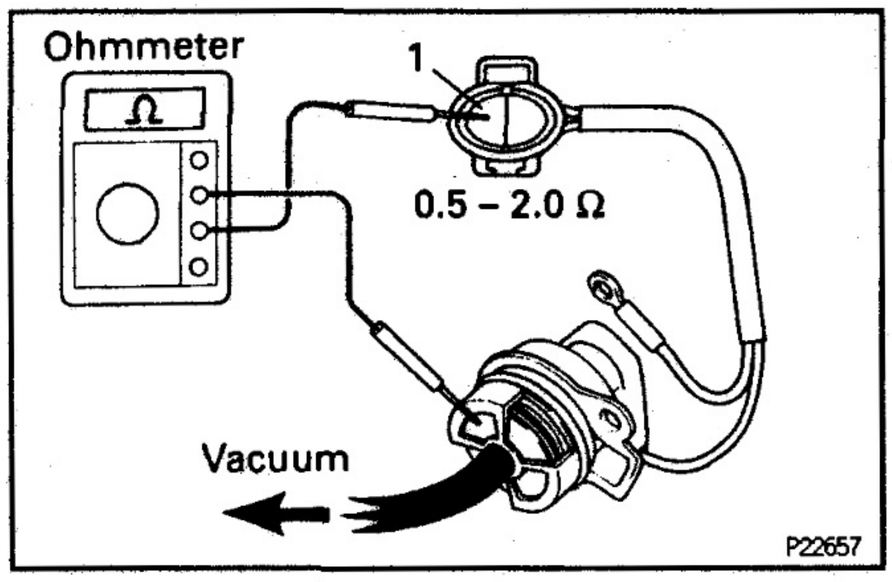
EG



FUEL HEATER SYSTEM
COMPONENTS INSPECTION

E0MRL-01

1. REMOVE FUEL HEATER



2. INSPECT FUEL HEATER

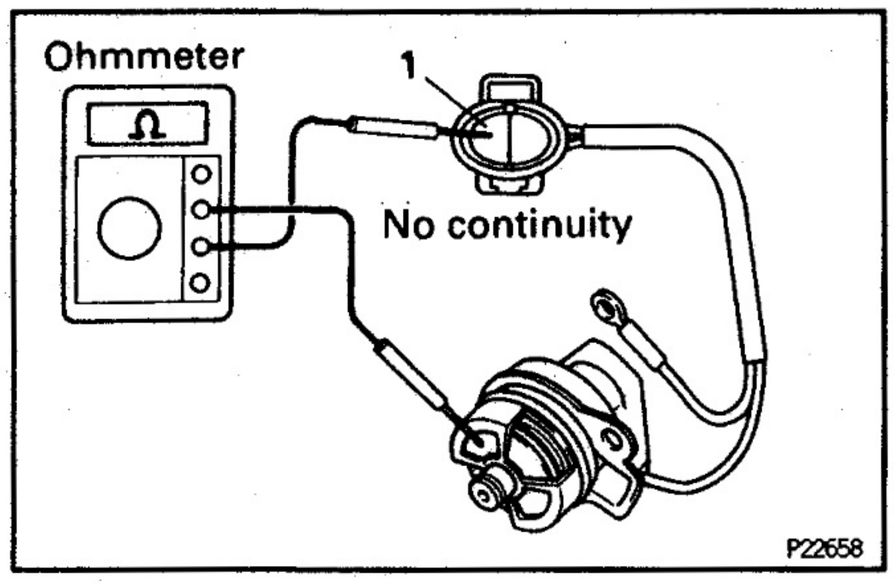
(a) Apply a vacuum of 34.7 ± 5.3 kPa (260 ± 40 mmHg, 10.24 ± 1.57 in.Hg) or more to the vacuum switch port.

(b) Using an ohmmeter, measure the resistance between terminal 1 and and the switch body.

Resistance:

At 20°C (68°F): 0.5 — 2.0 Ω

If the resistance is not as specified, replace the fuel heater and vacuum switch assembly.

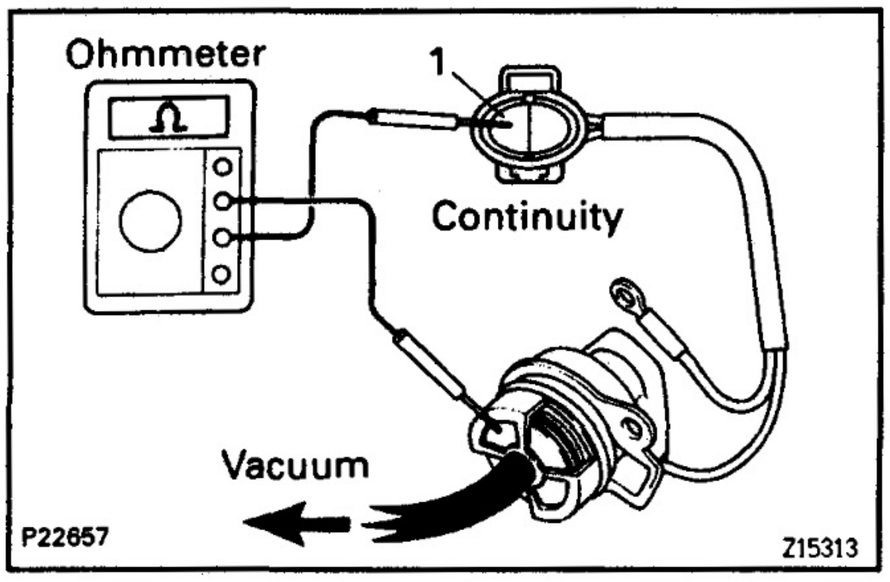


3. INSPECT VACUUM SWITCH

A. Inspect switch continuity

Using an ohmmeter, check that there is no continuity between terminal 1 and the switch body.

If continuity is not as specified, replace the fuel heater and vacuum switch assembly.



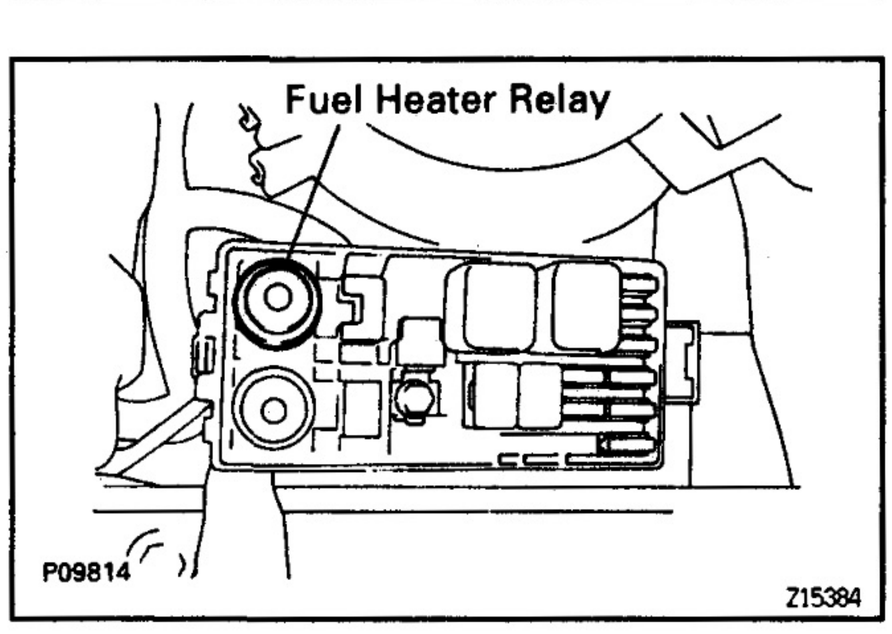
B. Inspect switch operation

(a) Apply a vacuum of 34.7 ± 5.3 kPa (260 ± 40 mmHg, 10.24 ± 1.57 in.Hg) or more to the vacuum switch port.

(b) Using an ohmmeter, check that there is continuity between terminal 1 and the switch body.

If operation is not as specified, replace the fuel heater and vacuum switch assembly.

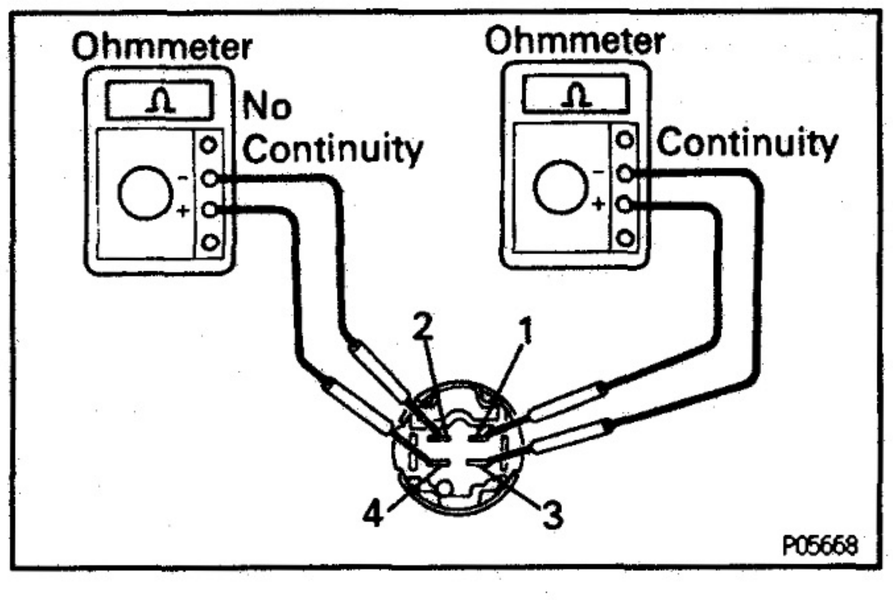
4. REINSTALL FUEL HEATER



FUEL HEATER RELAY

B2SRM-01

1. REMOVE FUEL HEATER RELAY

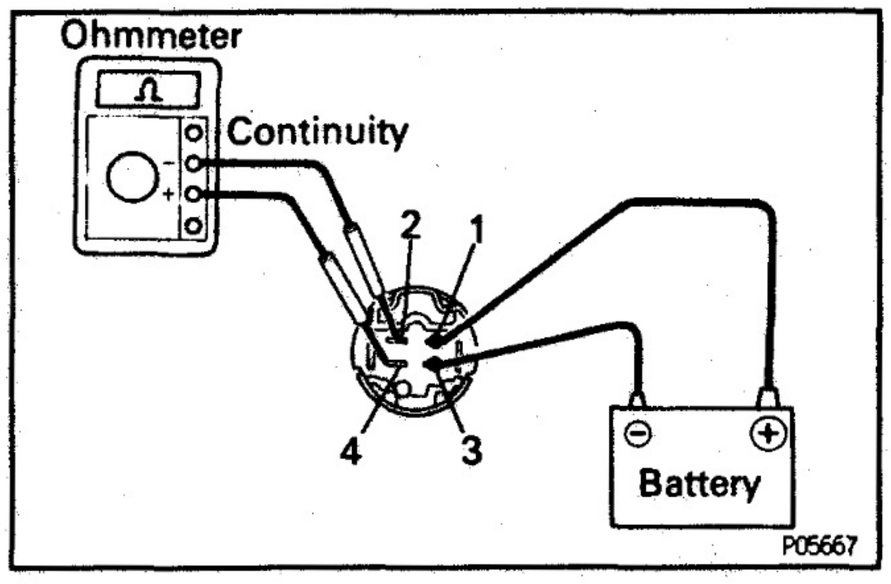


2. INSPECT RELAY CONTINUITY

(a) Using an ohmmeter, check that there is continuity between terminals 1 and 3.

(b) Check that there is no continuity between terminals 2 and 4.

If continuity is not as specified, replace the relay.



3. INSPECT RELAY OPERATION

(a) Apply battery voltage across terminals 1 and 3.

(b) Using an ohmmeter, check that there is continuity between terminals 2 and 4.

If operation is not as specified, replace the relay.

4. REINSTALL FUEL HEATER RELAY

EG

INJECTION NOZZLE
COMPONENTS FOR REMOVAL AND INSTALLATION

E035W-02

w/o EGR System

w/ EGR System

Intake Pipe
Vacuum Hose
Intake Heater
◆ Gasket
Intake Pipe Insulator
EGR Valve Bracket
◆ Gasket
Intake Pipe Assembly
◆ Gasket
Cylinder Head Cover
◆ Seal Washer
Gasket
Injection Nozzle
Nozzle Holder Seal
◆ O-Ring
◆ Nozzle Seat
◆ Gasket
No.1 Nozzle Leakage Pipe
Vacuum Hose (w/ EGR System)
Vacuum Hose
Clamp
◆ Gasket
Clamp
Clamp
Injection Pipe
Clamp
No.3 Nozzle Leakage Pipe
Vacuum Hose (w/ EGR System)
Intake Manifold Insulator
Accelerator Link Assembly
Throttle Position Sensor Connector (Except Australia M/T)

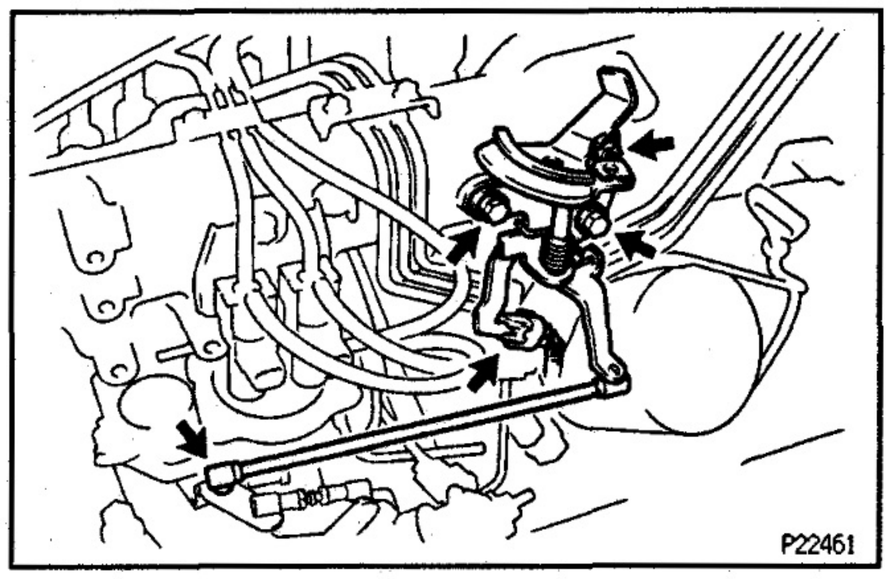
◆ Non-reusable part

P23530

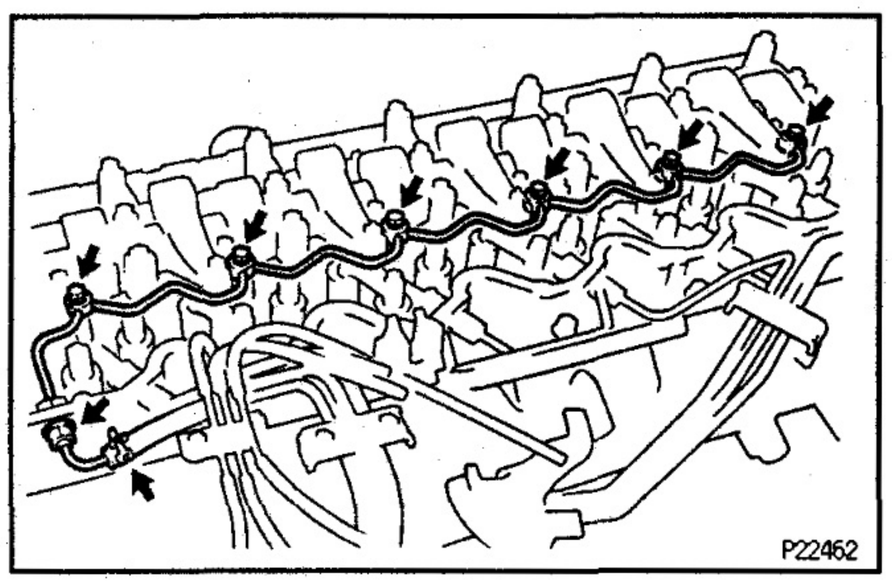
E0ERU-01

INJECTION NOZZLES REMOVAL

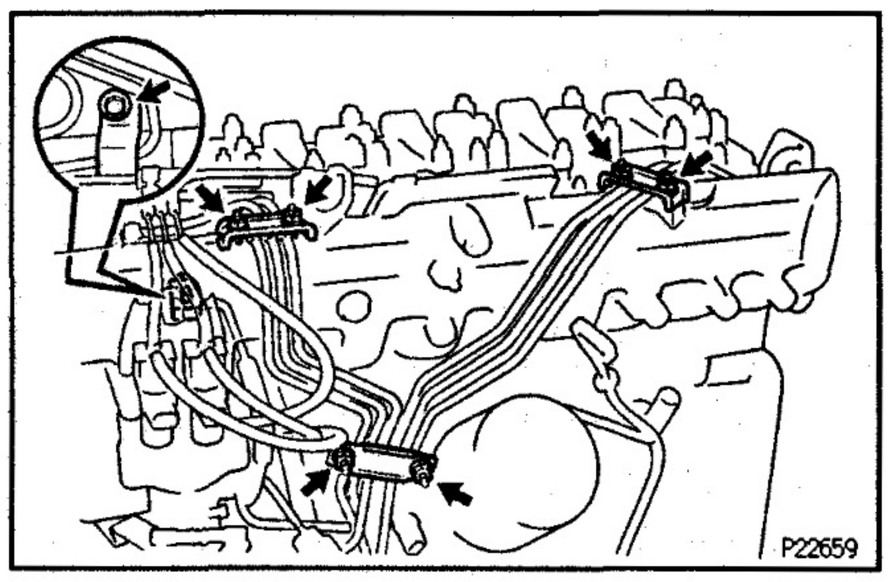
1. **REMOVE INTAKE PIPE**
   (See step 2 or 3 in cylinder head removal in Engine Mechanical)
2. **REMOVE CYLINDER HEAD COVER**
   (See step 11 in cylinder head removal in Engine Mechanical)



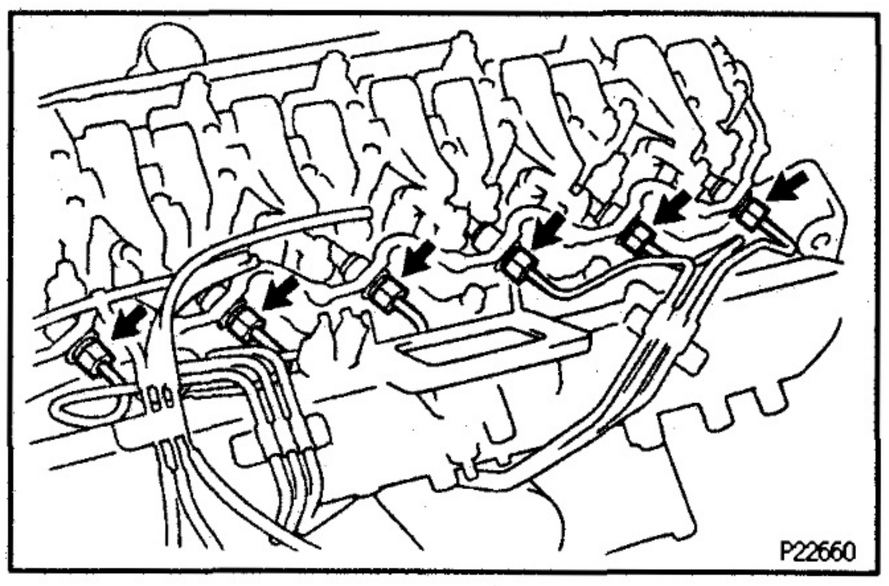
3. **REMOVE ACCELERATOR LINK ASSEMBLY**
(a) w/o Australia M/T:
Disconnect the throttle position sensor connector from the bracket.
(b) Disconnect the accelerator link from the injection pump.
(c) Remove the 2 bolts, nut and the accelerator link assembly.



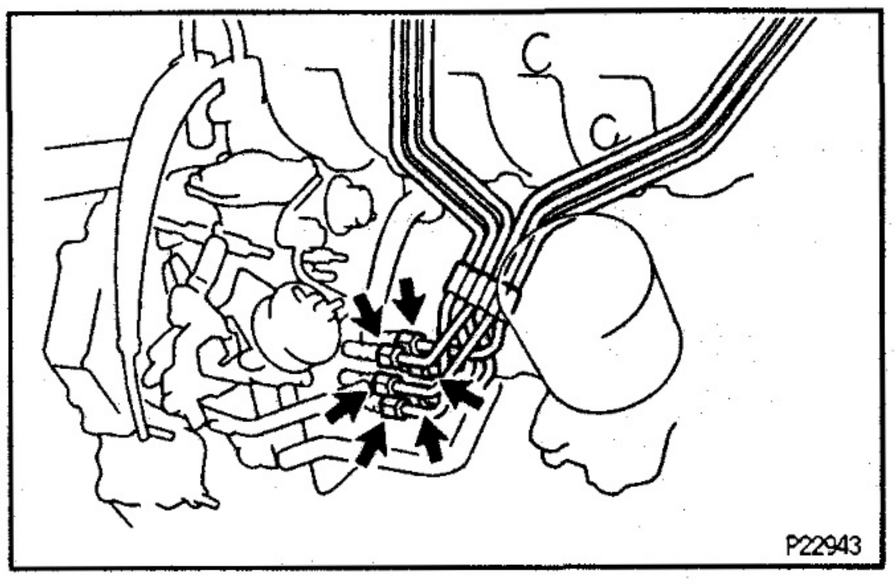
4. **REMOVE NO.1 NOZZLE LEAKAGE PIPE**
(a) Disconnect the fuel return hose from the No.1 nozzle leakage pipe.
(b) Remove the nut holding the No.1 nozzle leakage pipe to the cylinder head.
(c) Remove the 6 hollow bolts, 7 gaskets and No.1 nozzle leakage pipe.



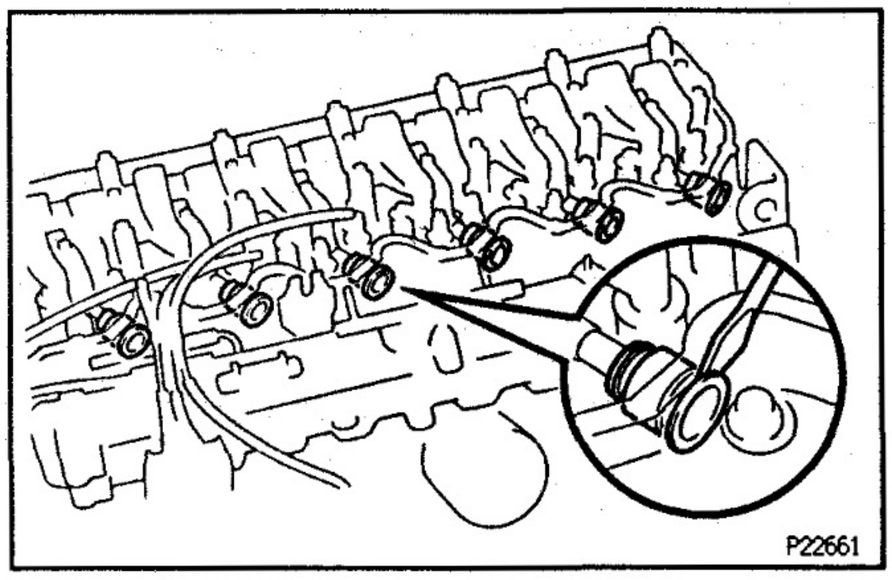
5. **REMOVE INJECTION PIPES**
(a) Remove the bolt holding the No.3 nozzle leakage pipe to the intake manifold.
(b) Remove the 4 nuts and 2 clamps from the intake manifold.
(c) Remove the 2 nuts and 2 clamps.



(d) Loosen the 6 union nuts of the injection pipes from the injection nozzles.

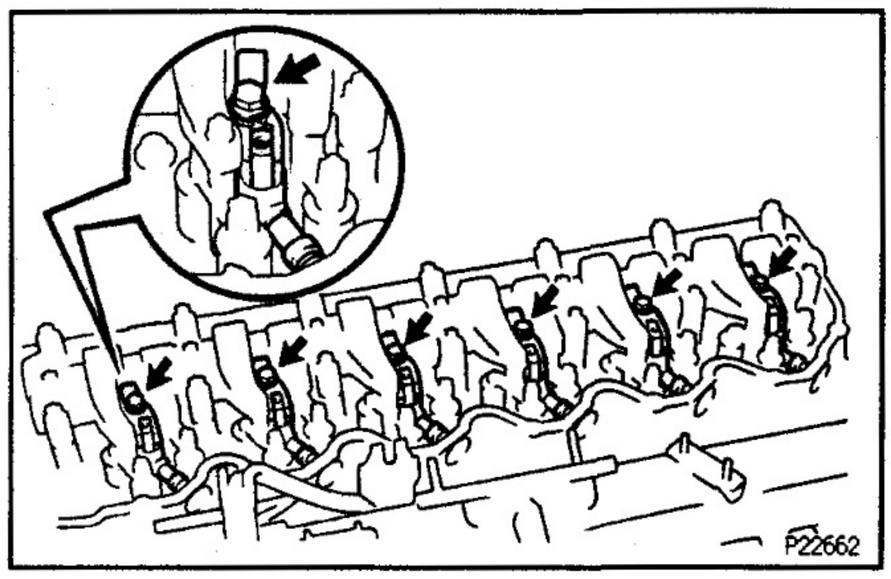


(e) Loosen the 6 union nuts of the injection pipes from the injection pump.
(f) Remove the 6 injection pipes.
(g) Remove the 2 intake manifold insulators.



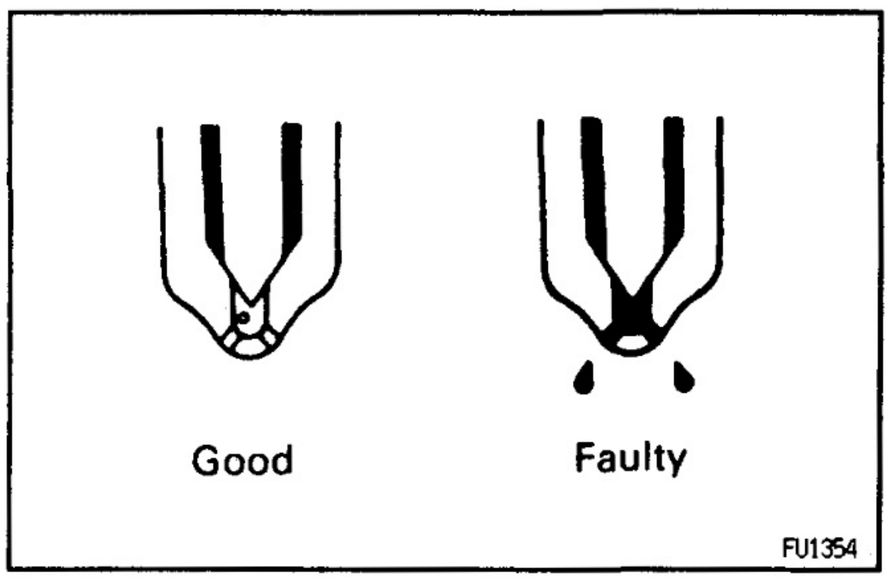
6. REMOVE NOZZLE HOLDER SEALS

Using a screwdriver, pry out the nozzle holder seals from the cylinder head.



7. REMOVE INJECTION NOZZLES

(a) Remove the bolt holding the nozzle holder clamp to the cylinder head.
(b) Remove the 6 injection nozzles and seats from the cylinder head.
(c) Remove the O–ring from the injection nozzle.
HINT: Arrange the injection nozzles in correct order.

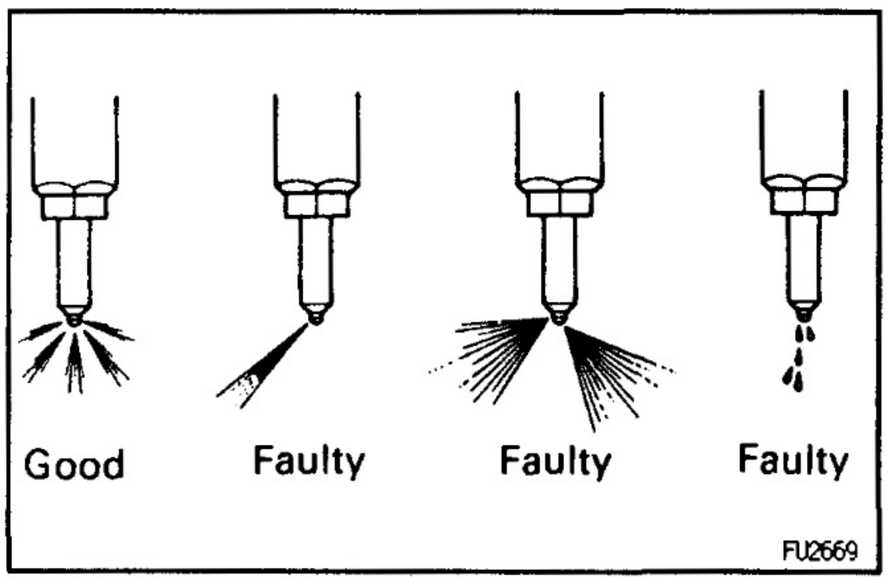


INJECTION NOZZLES TEST

EGSRV–01

1. LEAKAGE TEST

While maintaining pressure at about 981 – 1,961 kPa (10 – 20 kgf/cm² 142 – 284 psi), below No.1 opening pressure (adjust by tester handle), check that there is not dripping for 10 seconds from the injection hole or around the retaining nut.
If the nozzle drips within 10 seconds, replace or clean and overhaul the nozzle assembly.

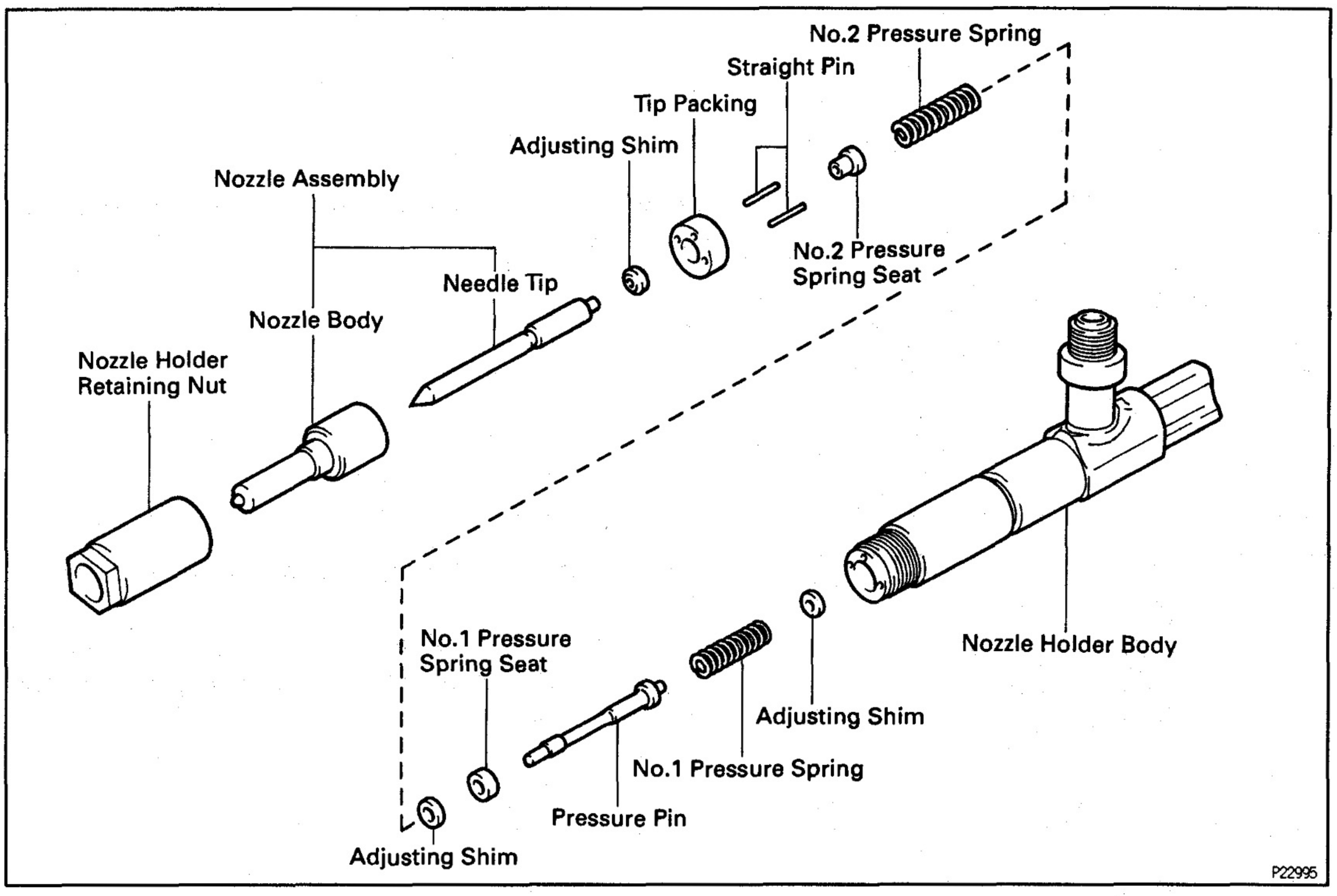


2. SPRAY PATTERN TEST

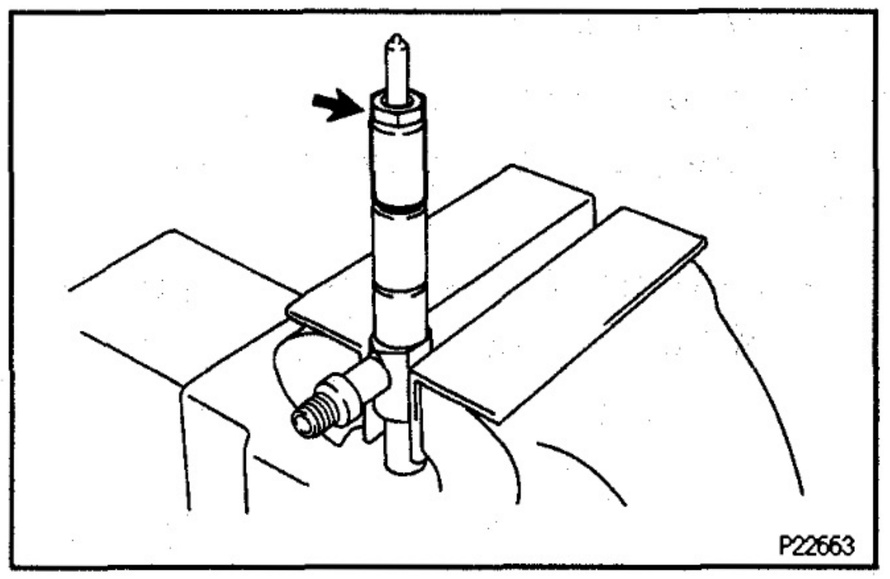
(a) The injection nozzle should shudder at a certain pumping speed between 15 – 60 times (old nozzle) or 30 – 60 times (new nozzle) per minute.
(b) Check the spray pattern during shuddering.
If the spray pattern is not correct during shuddering, the nozzle must be replaced or cleaned.

COMPONENTS FOR DISASSEMBLY AND ASSEMBLY

EG33Z-03



P22995



P22663

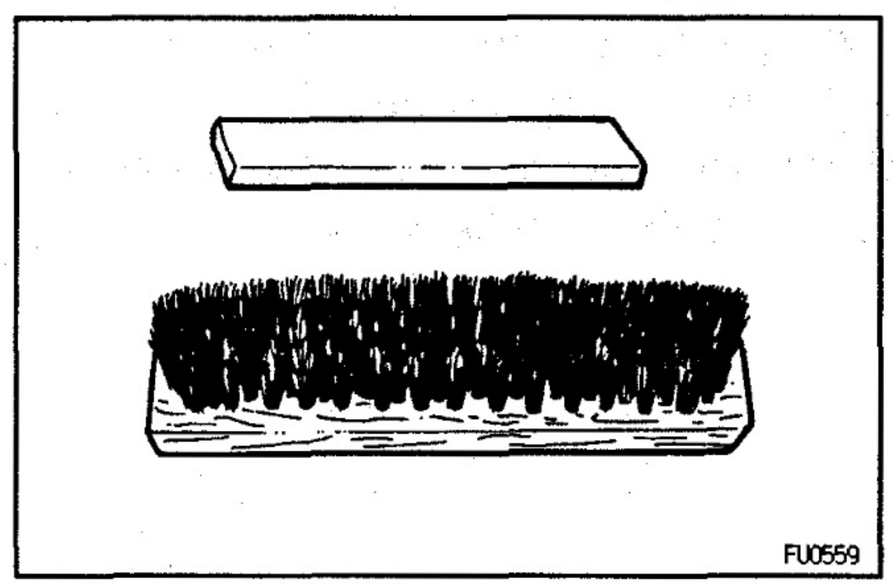
INJECTION NOZZLE DISASSEMBLY

EG340-02

DISASSEMBLE INJECTION NOZZLES

(a) Remove the nozzle holder retaining nut.
NOTICE: When disassembling the nozzle, be careful not to drop the inner parts.

(b) Disassemble the injection nozzle.



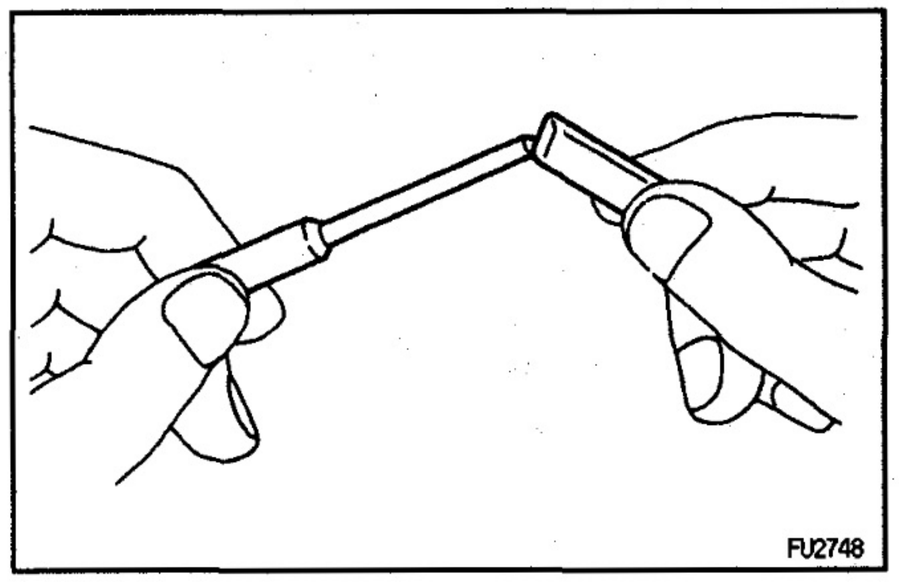
FU0559

INJECTION NOZZLES CLEANING AND INSPECTION

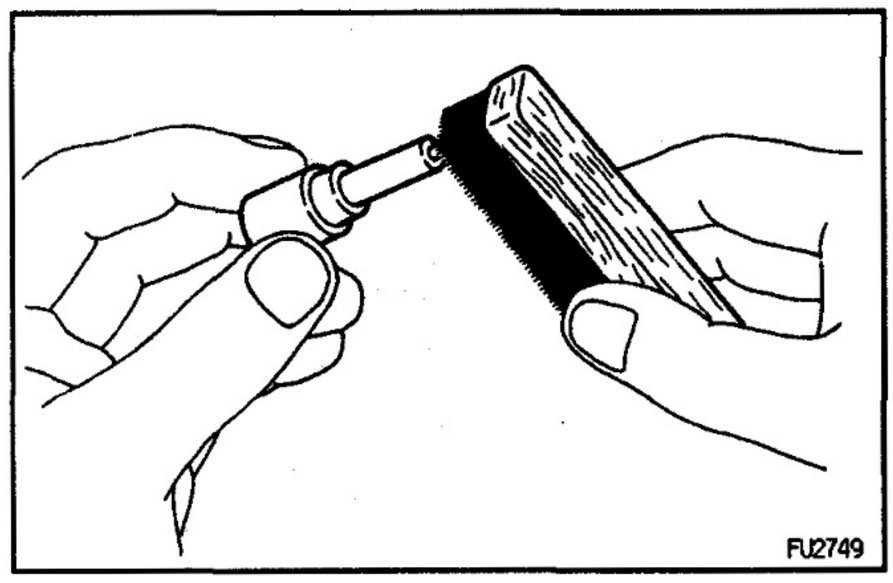
EG341-02

1. NOZZLE CLEANING

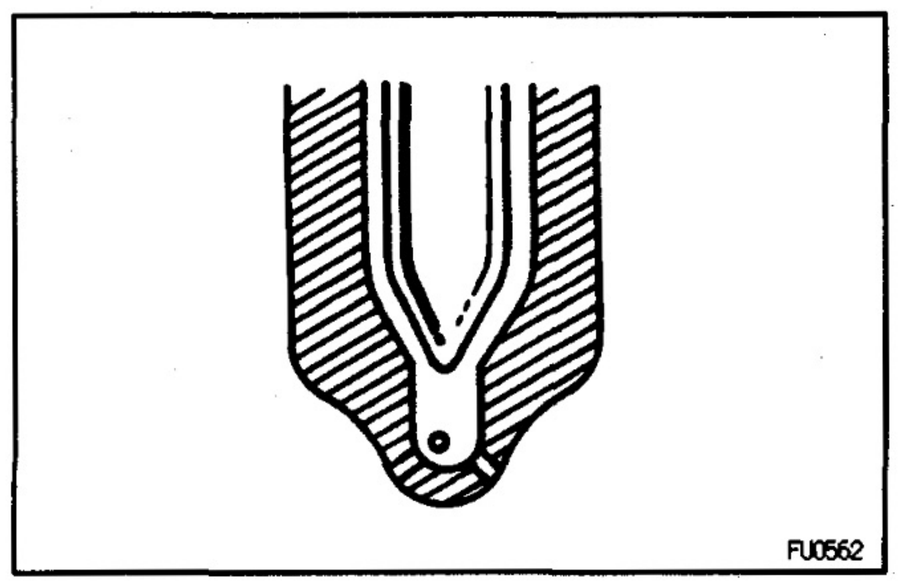
(a) To wash the nozzles, use a wooden stick and brass brush. Wash them in clean diesel fuel.
HINT: Do not touch the nozzle mating surfaces with your fingers.



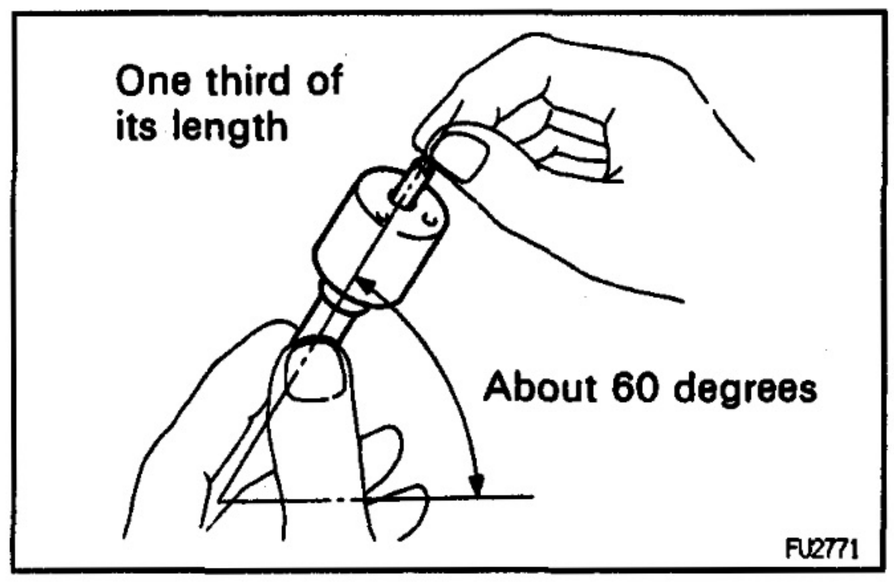
(b) Using a wooden stick, remove the carbon adhering to the nozzle needle tip.



(c) Using a brass brush, remove the carbon from the exterior of the nozzle body (except lapped surface).

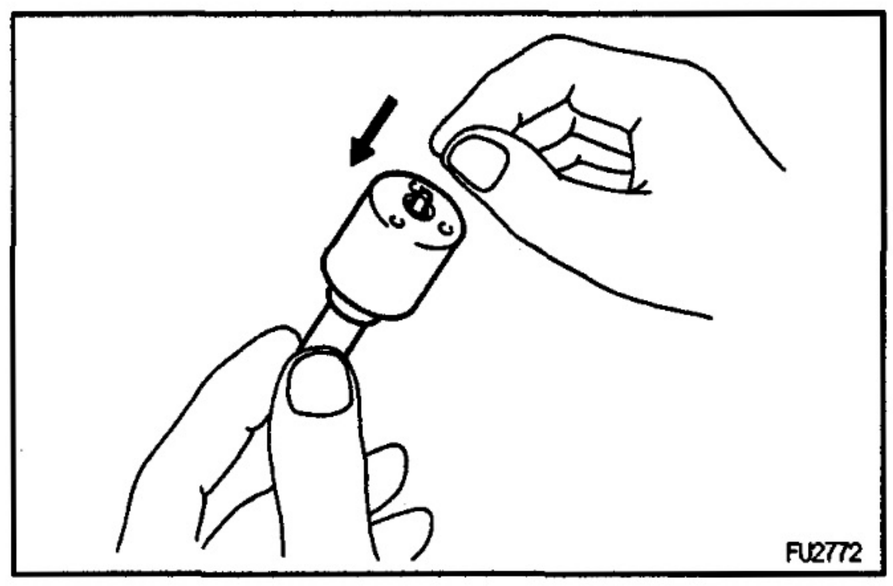


(d) Check the seat of the nozzle body for burns or corrosion.
(e) Check the nozzle needle tip for damage or corrosion.
If any of these conditions are present, replace the nozzle assembly.

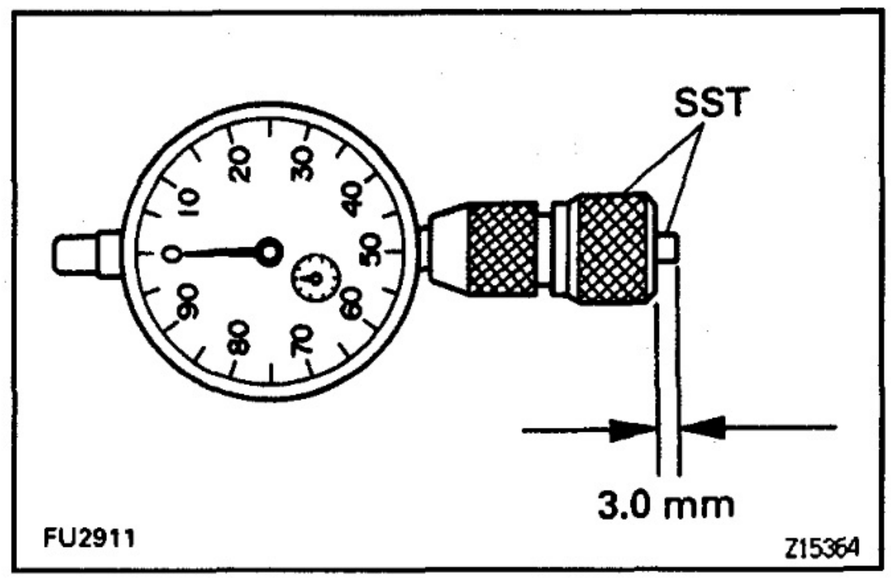


2. INSPECT NOZZLE ASSEMBLY

(a) Wash the nozzle in clean diesel fuel.
HINT: Do not touch the nozzle mating surfaces with your fingers.
(b) Tilt the nozzle body about 60 degrees and pull the needle out about one third of its length.



(c) When released, the needle should stick down into the body vent smoothly by its own weight.
(d) Repeat this test, rotating the needle slightly each time.
If the needle does not sink freely, replace the nozzle assembly.



INJECTION NOZZLES ASSEMBLY AND ADJUSTMENT

EQSRW–01

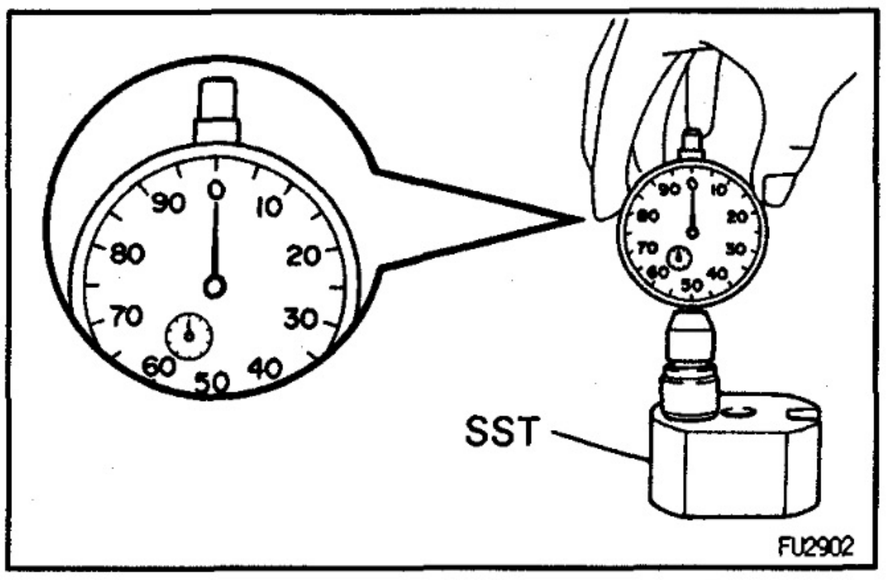
1. ADJUST NEEDLE–LIFT AND PRE–LIFT

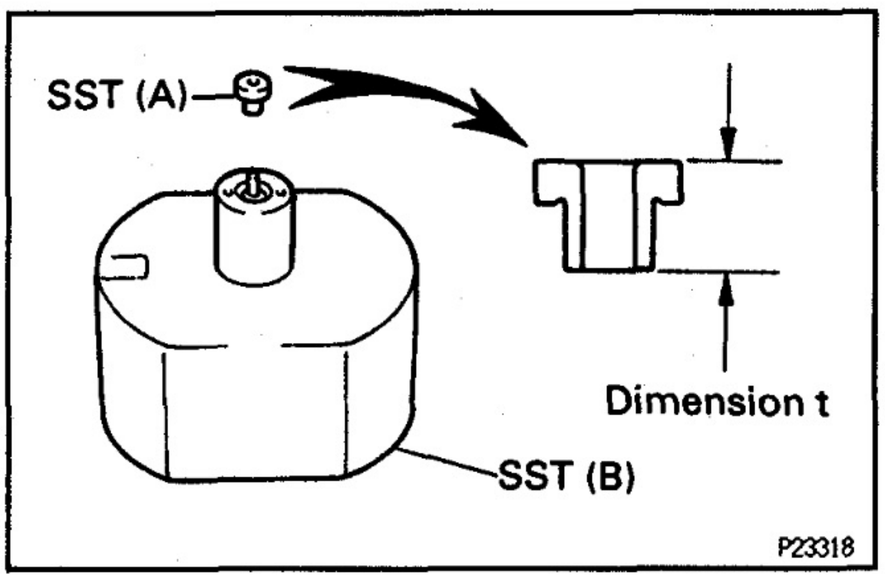
NOTICE: Needle–lift and pre–lift adjustment requires great precision, so when doing this operation, make sure everything is clean and that no foreign substances are trapped.

A. Adjust needle–lift

(a) Using SST, install the SST to the dial indicator so that the protrusion shown in the illustration is 3.0 mm (0.118 in.) or less.
SST 09268–17010

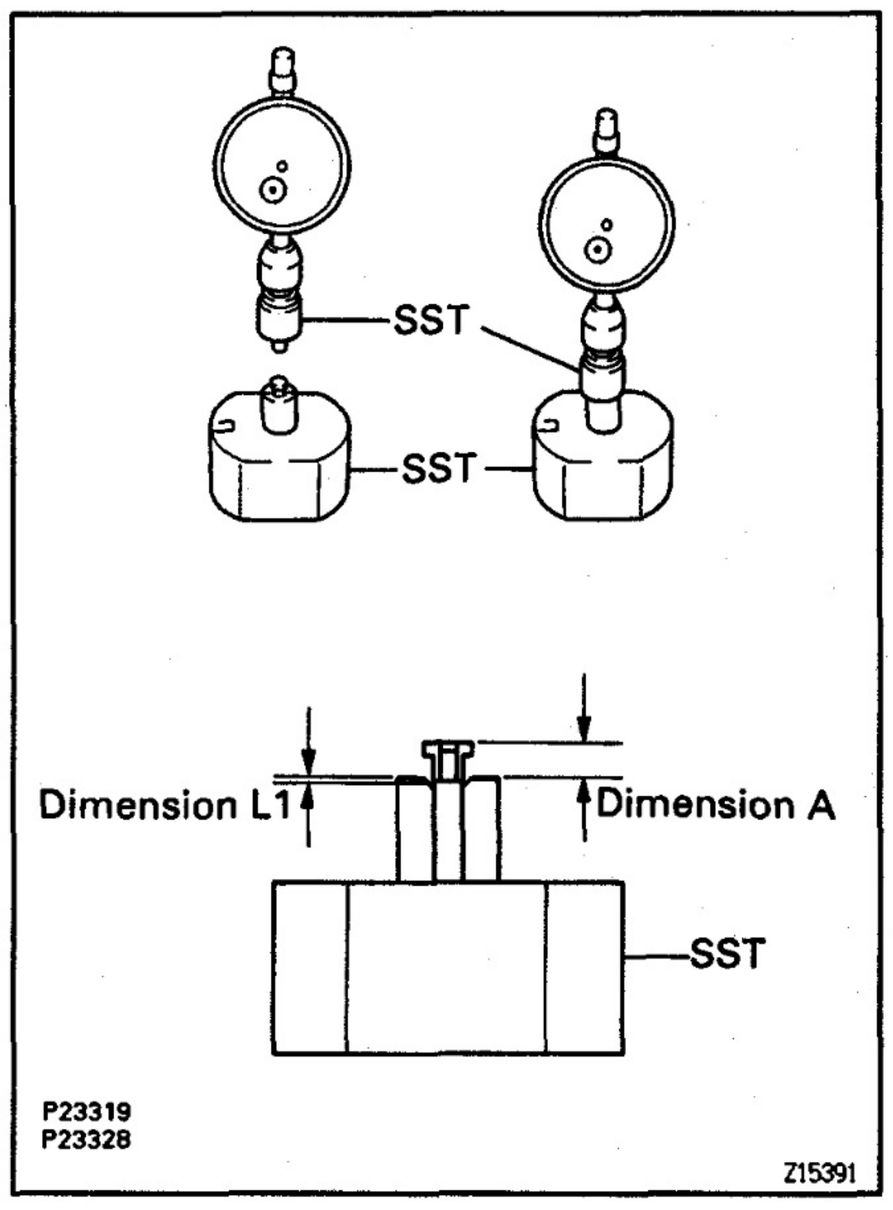
(b) Using SST, set the dial indicator scale to 0 mm (0 in.) on top of the SST or the surface plate.
SST 09268–17010





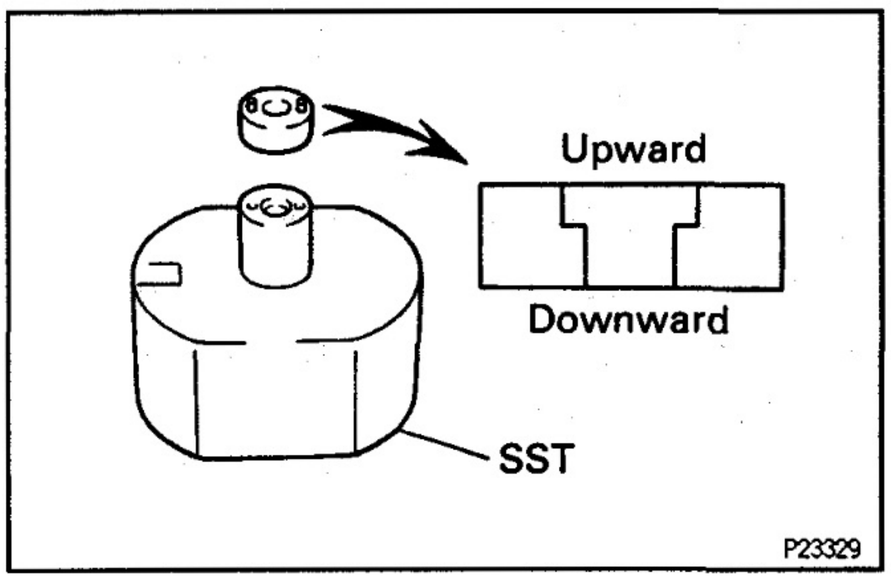
(c) Using a micrometer, measure dimension t of the SST (A).
SST(A) 09268–17020

(d) Using SST, place the nozzle assembly and SST (A) on the SST (B) as shown in the illustration.
SST(A) 09268–17020
(B) 09268–17010

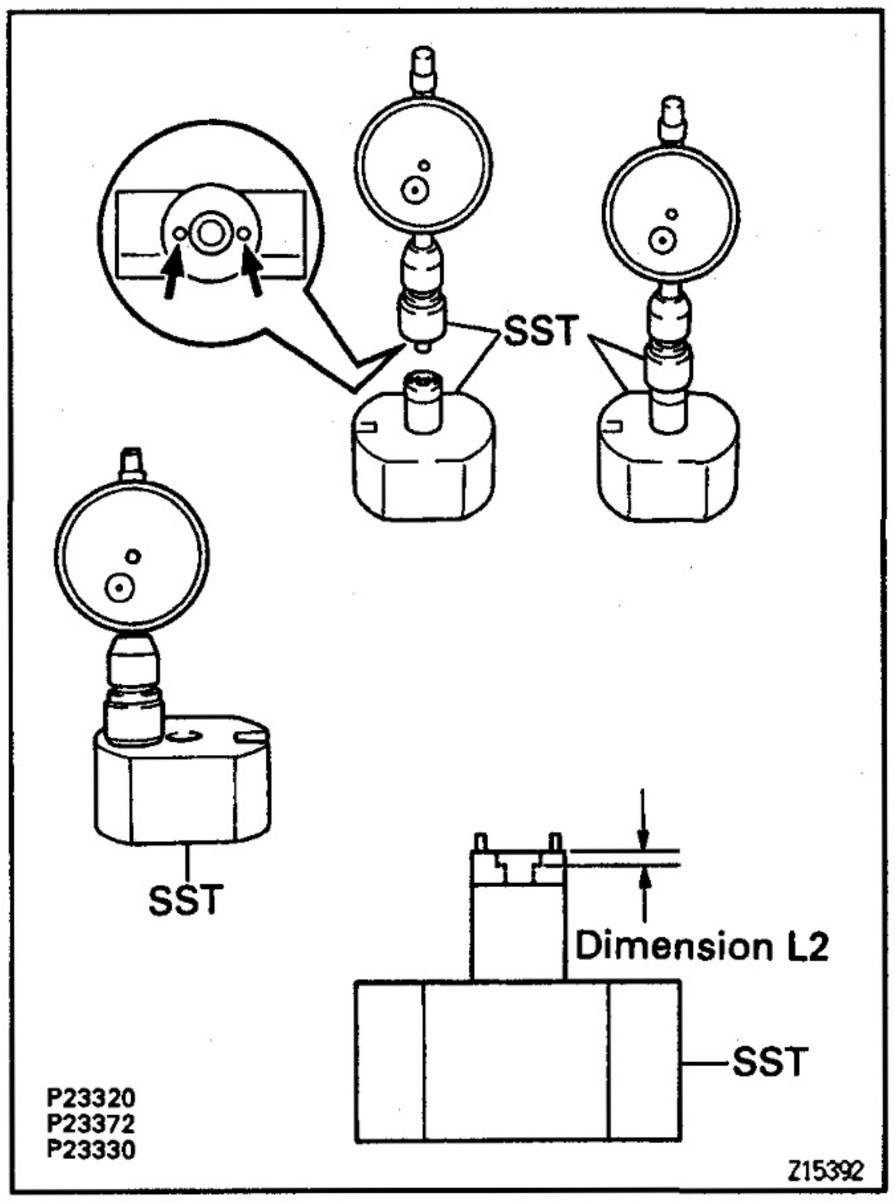


(e) Using SST, set the SST above the nozzle, and measure dimension A.
SST 09268–17010
Dimension L1 = t – A

(f) Remove the SST and needle tip from the nozzle body.
SST 09268–17020

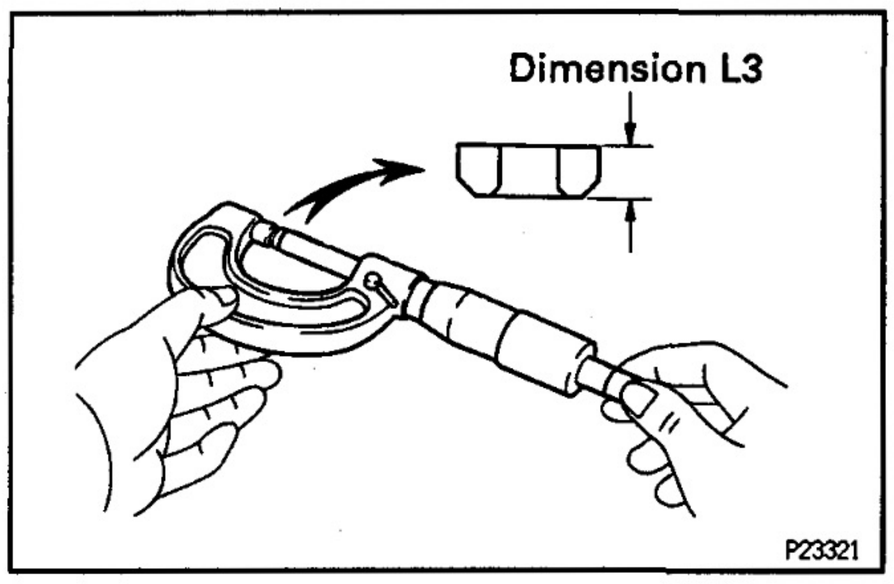


(g) Place the tip packing and straight pins on the nozzle body as shown in the illustration.
NOTICE: Position the tip packing on top of the nozzle body in the direction shown in the illustration.



(h) Using SST, install SST holes to the straight pins, and set dial indicator scale to 0 mm (0 in.) on top of the nozzle assembly.
SST 09268–17010

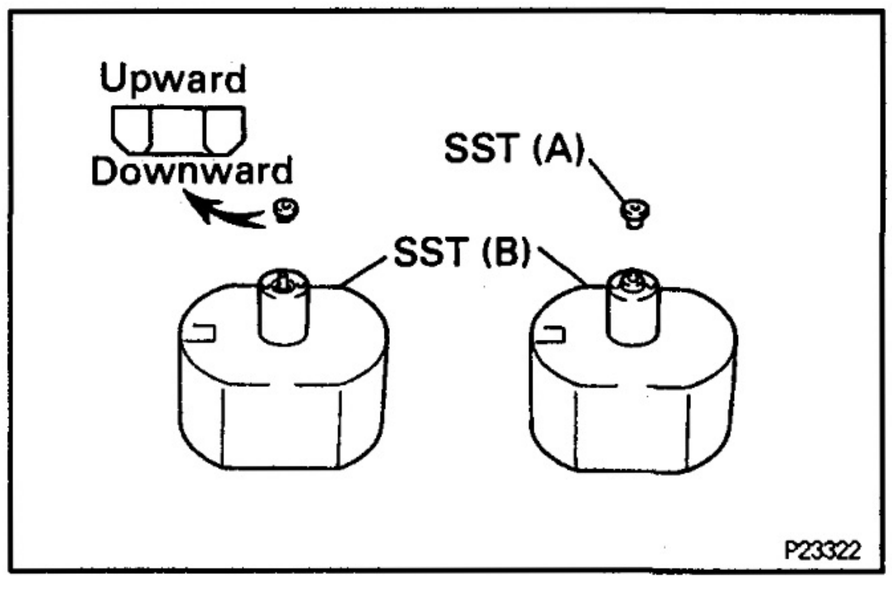
(i) Using SST, set the dial indicator above the SST or the surface plate, and measure dimension L2.
SST 09268–17010



(j) Using a micrometer, measure dimension L3 of the adjusting shim.
Needle–lift = (L1 + L2) – L3
Needle–lift: 0.23 – 0.28 mm (0.0091 – 0.0110 in.)
If the needle – lift dimension is not as specified, change the adjusting shim.
Adjusting shim thickness mm (in.):

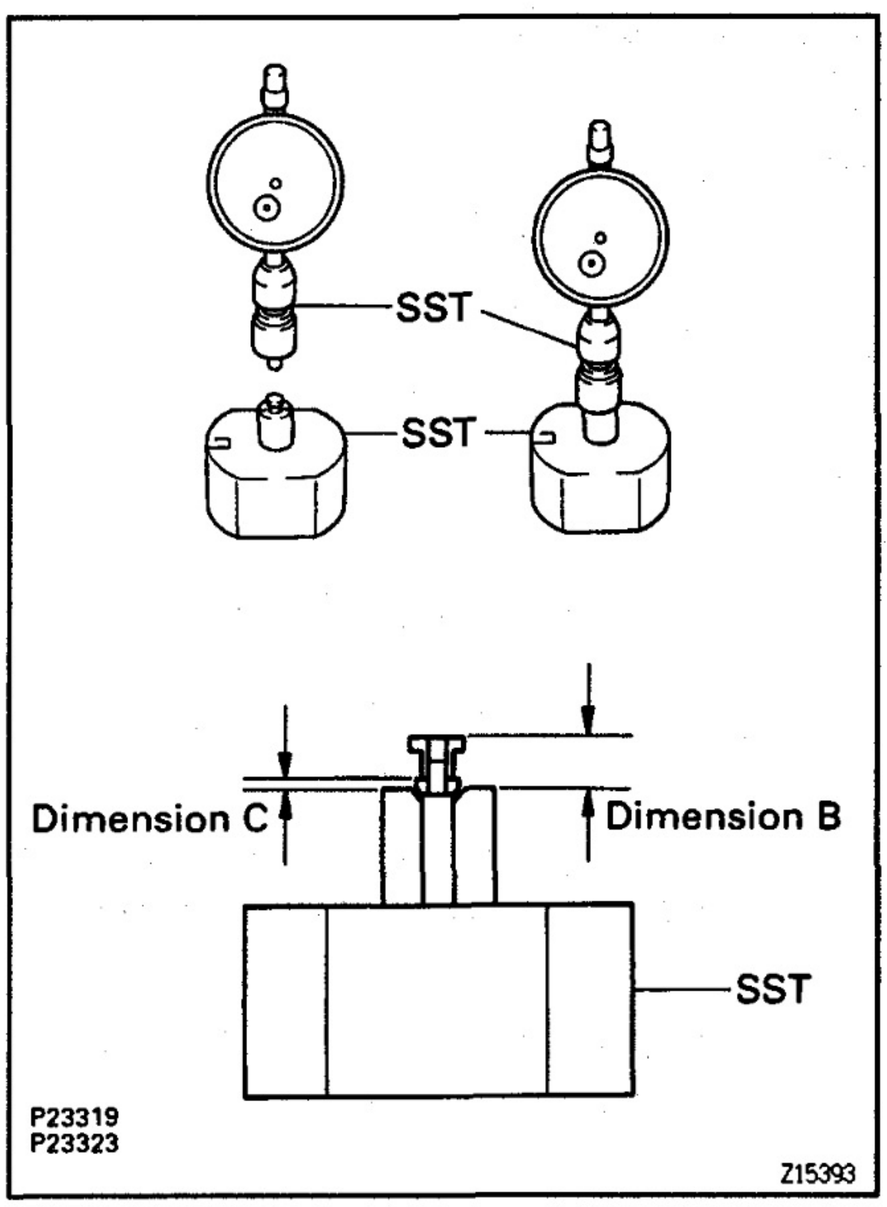
1.900 (0.0748)	1.925 (0.0758)	1.950 (0.0768)
1.975 (0.0778)	2.000 (0.0787)	–

HINT: If the shim is made thicker, the needle–lift is decreased.

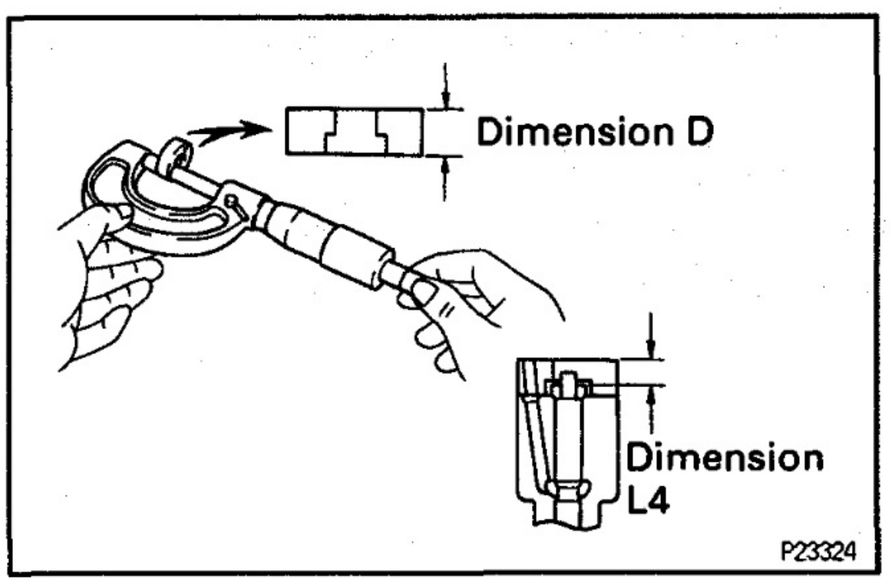


B. Adjust pre–lift
(See steps (a) to (c) in step A)

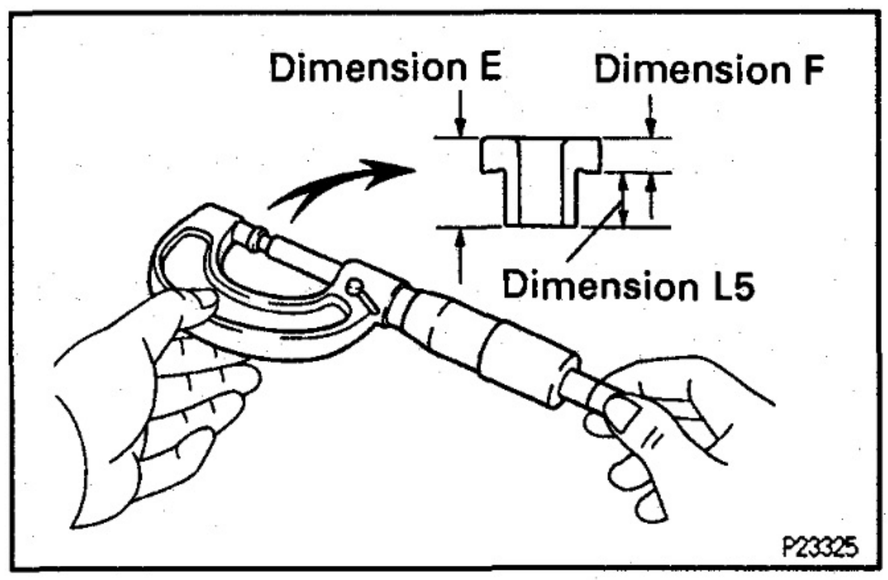
(a) Using SST, place the nozzle assembly, the adjusting shim selected step A and SST (A) on the SST (B) as shown in the illustration.
SST(A) 09268–17020
(B) 09268–17010



(b) Using SST, set the SST above the nozzle, and measure dimension B.
SST 09268–17010
t ..... Dimension of the SST (A) (See step (c) in step A)
Dimension C = B – t



(c) Using a micrometer, measure dimension D of the tip packing.
Dimension L4 = D – C

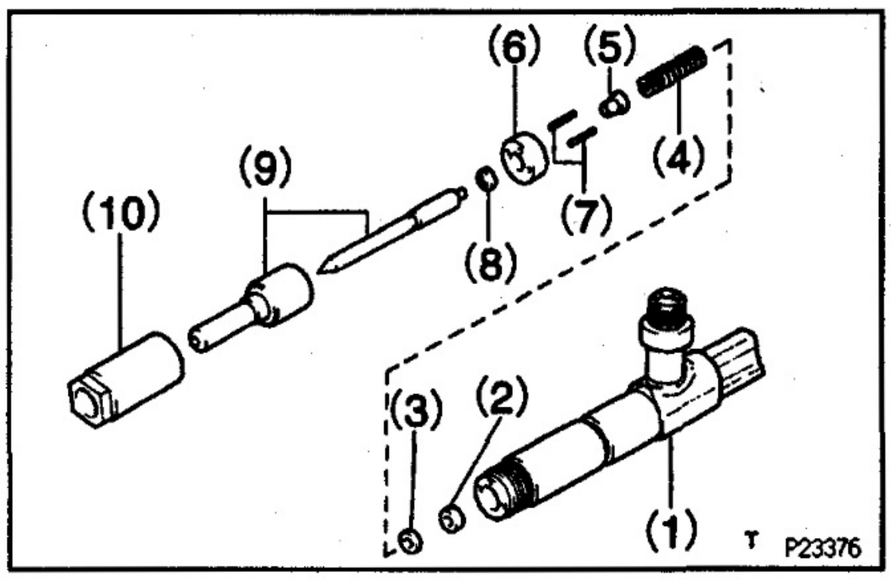


(d) Using a micrometer, measure dimension E and F of the No.2 pressure spring seat.
Dimension L5 = E – F
Pre–lift = L4 – L5
Pre–lift: 0.085 – 0.105 mm (0.00335 – 0.00413 in.)
If the pre–lift dimension is not as specified, change the adjusting No.2 pressure spring seat.
Adjusting spring seat thickness mm (in.):

3.09 (0.1217)	3.12 (0.1228)	3.15 (0.1240)
3.18 (0.1252)	3.21 (0.1264)	3.24 (0.1276)
3.27 (0.1287)	–	–

HINT: If the shim is made thicker, the pre–lift is decreased.

EG



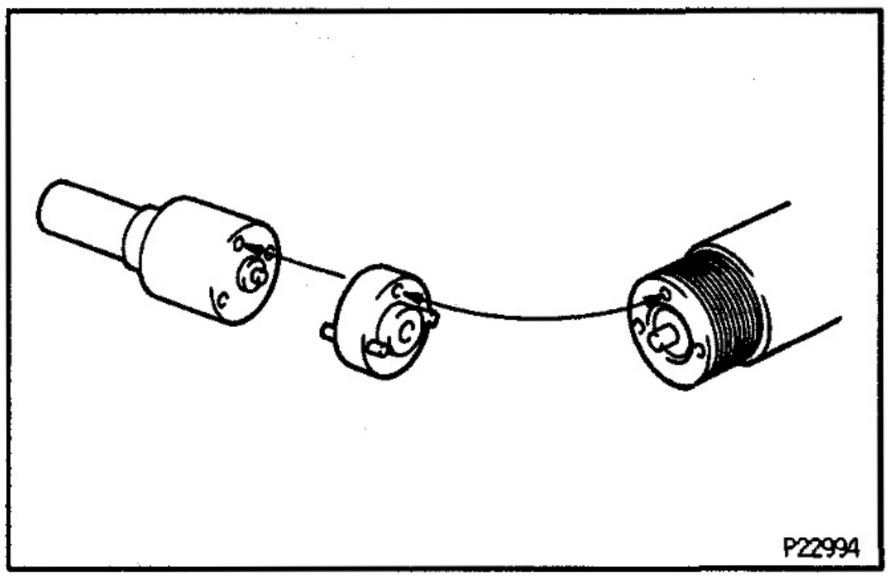
2. CHECK NO.2 OPENING PRESSURE

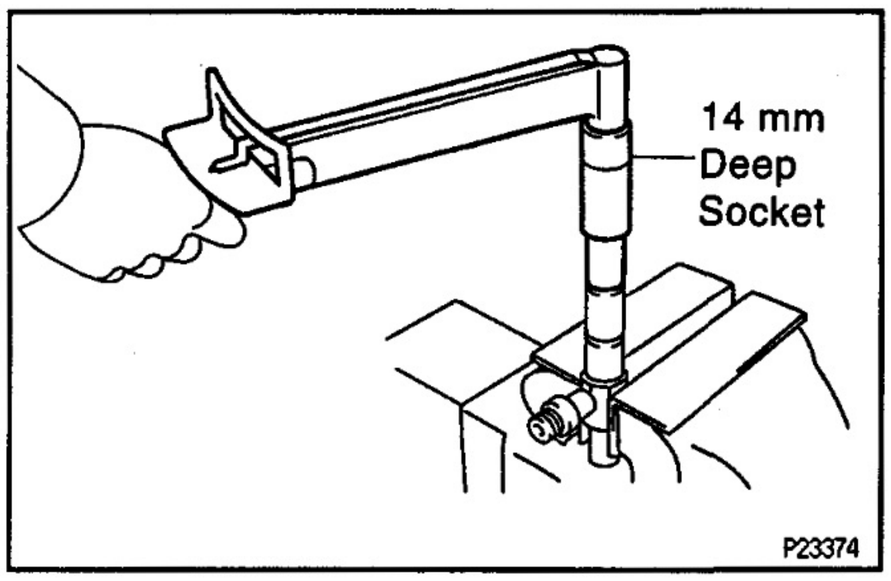
(a) Assemble these parts:
- (1) Nozzle holder body
- (2) No.1 pressure spring seat
- (3) Adjusting shim
- (4) No.2 pressure spring
- (5) SST
- (6) Tip packing
- (7) Straight pins
- (8) Adjusting shim selected in step 1. A above
- (9) Nozzle assembly
- (10) Retaining nut

SST 09268–17020

NOTICE: Do not assemble the No.1 pressure spring, No.1 pressure pin and adjusting shim for adjustment of the No. 1 opening pressure.

HINT: Align the holes of the nozzle body, tip packing and nozzle holder body.

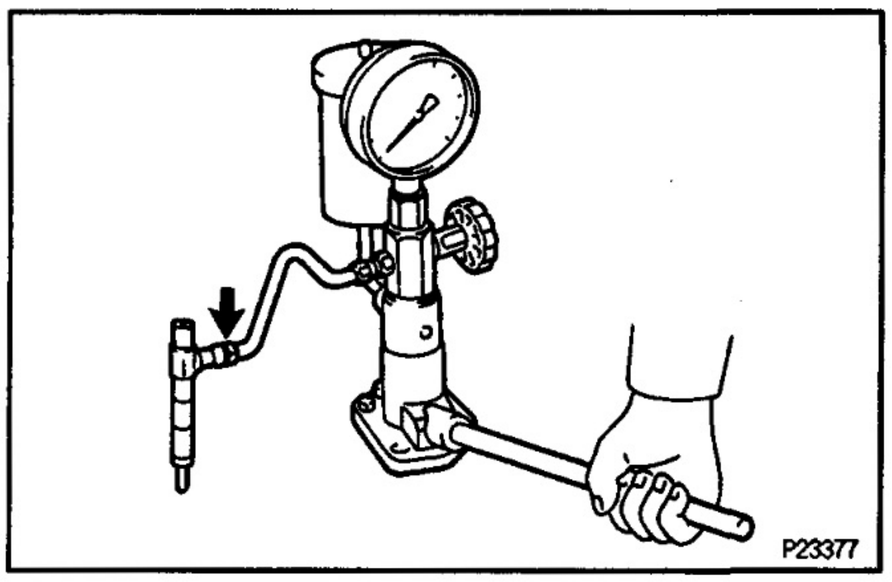




(b) Using a 14 mm deep socket wrench, torque the retaining nut.

Torque: 30 N·m (300 kgf·cm, 22 ft·lbf)

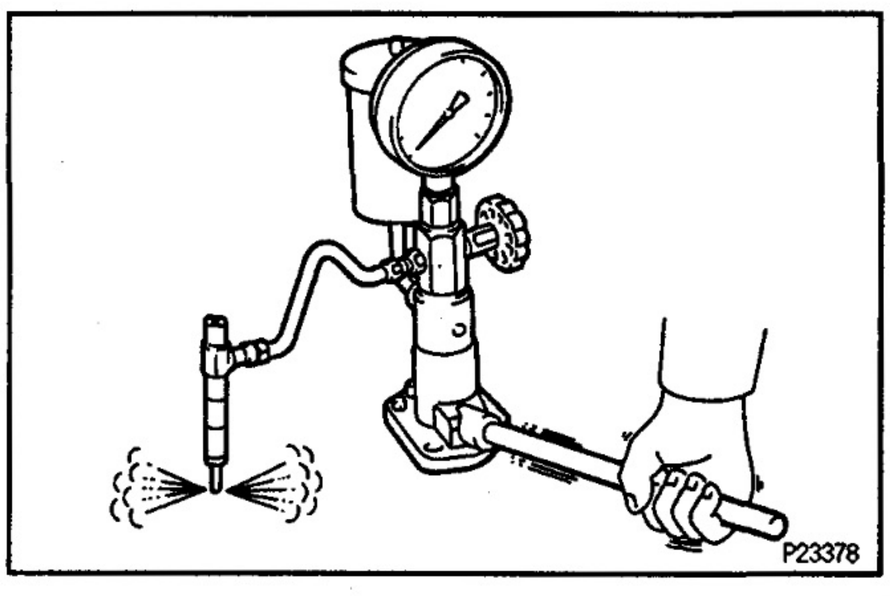
NOTICE: Over torquing could cause the nozzle deformation and the needle adhesion or other defects.



(c) Install the injection nozzle to the injection nozzle hand tester and bleed air from the union nut.

CAUTION: Do not place your finger over the nozzle injection hole.

(d) Pump the tester handle a few times as fast as possible to discharge the carbon from the injection hole.



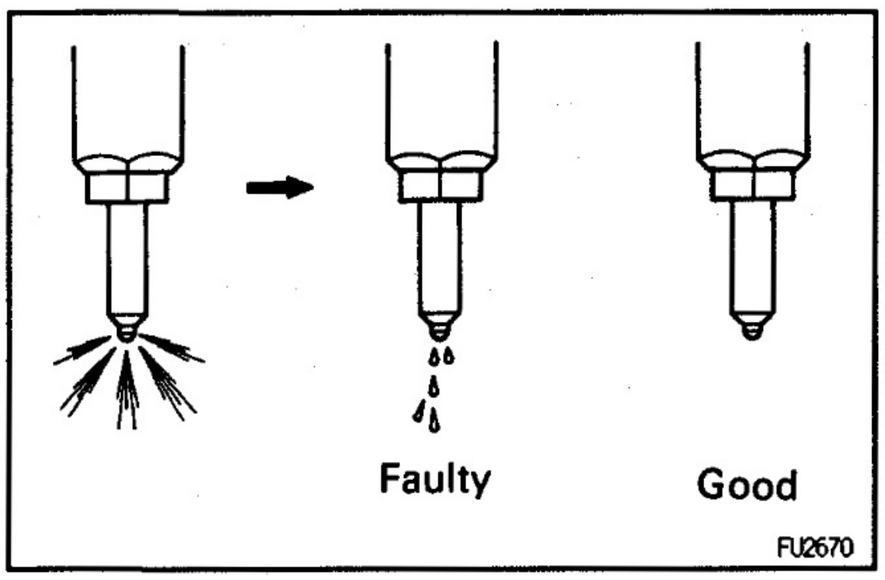
(e) Pump the tester handle slowly and observe the pressure gauge.

(f) Read the pressure gauge just as the injection pressure begins to drop.

No.2 opening pressure (Inspection pressure):

23,046 – 24,026 kpa (235 – 245 kgf/cm², 3,342 – 3,485 psi)

HINT: Proper nozzle operation can be determined by a swishing sound.



If the opening pressure is not as specified, disassemble the nozzle and change the adjusting shim on the top of the No.2 pressure spring.

Adjusting shim thickness mm (in.):

0.700 (0.0276)	0.850 (0.0335)	1.000 (0.0394)
1.025 (0.0404)	1.150 (0.0453)	1.175 (0.0463)
1.275 (0.0502)	1.300 (0.0512)	1.425 (0.0561)
1.450 (0.0571)	1.575 (0.0620)	1.600 (0.0630)
1.725 (0.0679)	1.750 (0.0689)	1.900 (0.0748)
2.050 (0.0807)	–	–

HINT:

- Varying the adjusting shim thickness by 0.025 mm (0.0010 in.) changes the injection pressure by about 470 kpa (3.8 kgf/cm², 54 psi).
- Only one adjusting shim should be used.

(g) There should be no dripping after injection.

(h) After checking the No.2 opening pressure, disassemble the nozzle.

3. ADJUST NO.1 OPENING PRESSURE

(a) Assemble the nozzle holder body, adjusting shim for adjustment of No.1 opening pressure, No.1 pressure spring, No.1 pressure pin, adjusting shim, No.1 pressure spring seat, adjusting shim selected in step 2 above, No.2 pressure spring, adjusting No.2 pressure spring seat selected in step 1. B, tip packing, straight pins, adjusting shim selected in step 1. A and nozzle assembly, and finger tighten the retaining nut.

HINT:

- Align the holes of the nozzle body, the distance piece and the nozzle holder body.
- When the thickness of the originally used adjusting shim is not known, use a shim 1.5 mm (0.59 in.) thick instead.

(b) Read the pressure gauge just as the injection pressure begins to drop.

(See steps (b) to (f) in step 2 above)

No.1 opening pressure:

17,652 – 18,633 kpa (180 – 190 kgf/cm², 2,560 – 2,702 psi)

HINT: Proper nozzle operation can be determined by a swishing sound.

If the opening pressure is not as specified, disassemble the nozzle and change the adjusting shim on the top of the No.1 pressure spring.

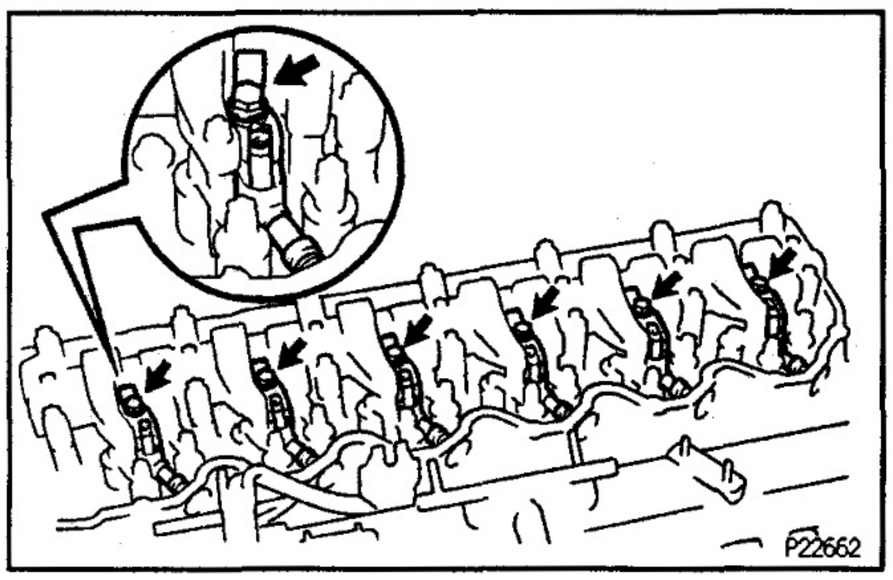
Adjusting shim thickness mm (in.):

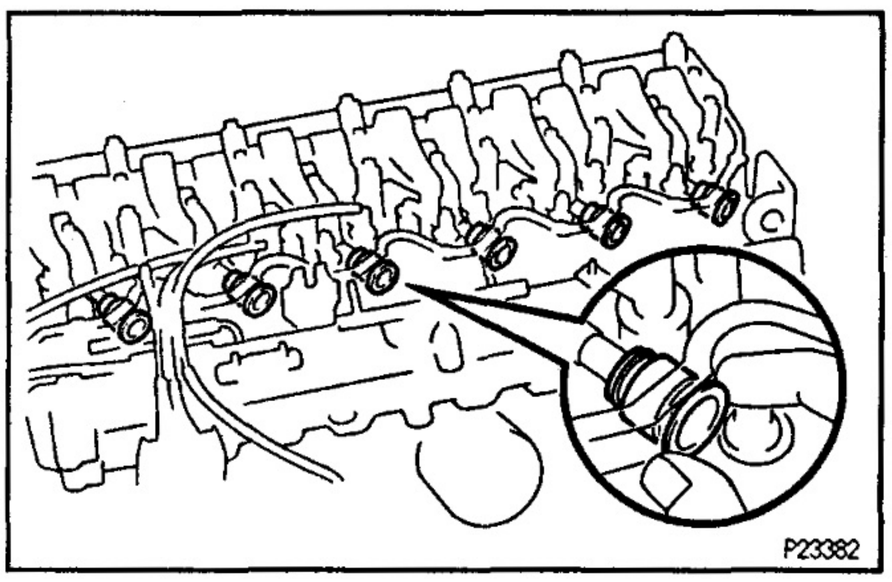
0.825 (0.0325)	0.900 (0.0354)	0.975 (0.0384)
1.050 (0.0413)	1.125 (0.0443)	1.200 (0.0472)
1.275 (0.0502)	1.350 (0.0532)	1.425 (0.0561)
1.500 (0.0591)	1.575 (0.0620)	1.650 (0.0650)
1.725 (0.0679)	1.800 (0.0709)	1.875 (0.0738)
1.950 (0.0768)	2.000 (0.0787)	2.100 (0.0827)
2.175 (0.0856)	–	–

HINT:

- Varying the adjusting shim thickness by 0.025 mm (0.0010 in.) changes the injection pressure by about 470 kpa (3.8 kgf/cm², 54 psi).
- Only one adjusting shim should be used.

(c) There should be no dripping after injection.
(See step (g) in step 2 above)





INJECTION NOZZLES INSTALLATION

EGSRX-01

1. INSTALL INJECTION NOZZLES

(a) Install a new O–ring to the injection nozzle.

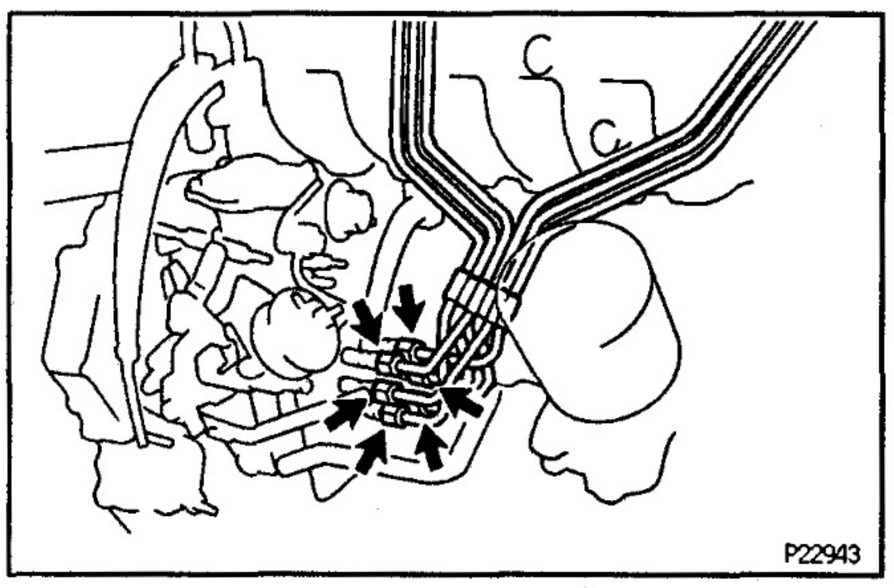
(b) Place 6 new nozzle seats into the injection nozzle holes of the cylinder head.

(c) Install the injection nozzles with the nozzle holder clamp, washer and bolt to the cylinder head.
Torque: 25 N·m (255 kgf·cm, 18 ft·lbf)

(d) Inspect the valve clearance.
(See steps 2 to 4 in valve clearance inspection and adjustment)

2. INSTALL NOZZLE HOLDER SEALS

Install the 6 new nozzle holder seals to the cylinder head with your hand.

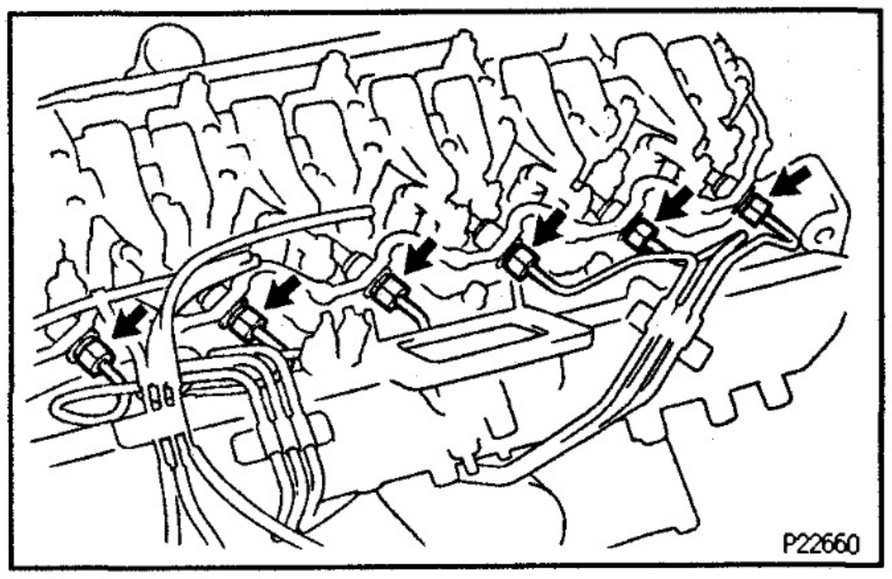


3. INSTALL INJECTION PIPES

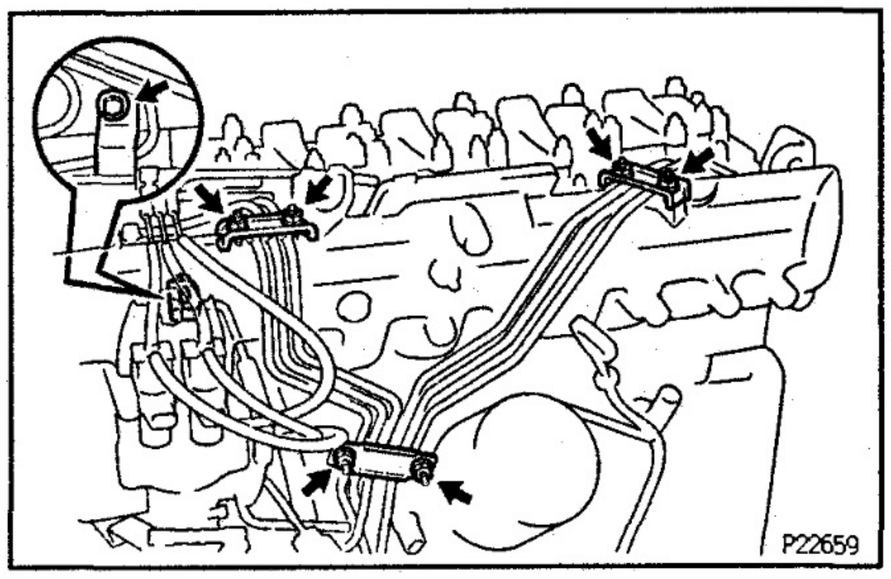
(a) Place the 2 intake manifold insulators on the intake manifold.

(b) Attach the 6 injection pipes to the injection nozzle and injection pump.

(c) Tighten the 6 union nuts to the injection pump.
Torque: 24.5 N·m (250 kgf·cm, 25 ft·lbf)



(d) Tighten the 6 union nuts to the injection nozzle.
Torque: 24.5 N·m (250 kgf·cm, 25 ft·lbf)



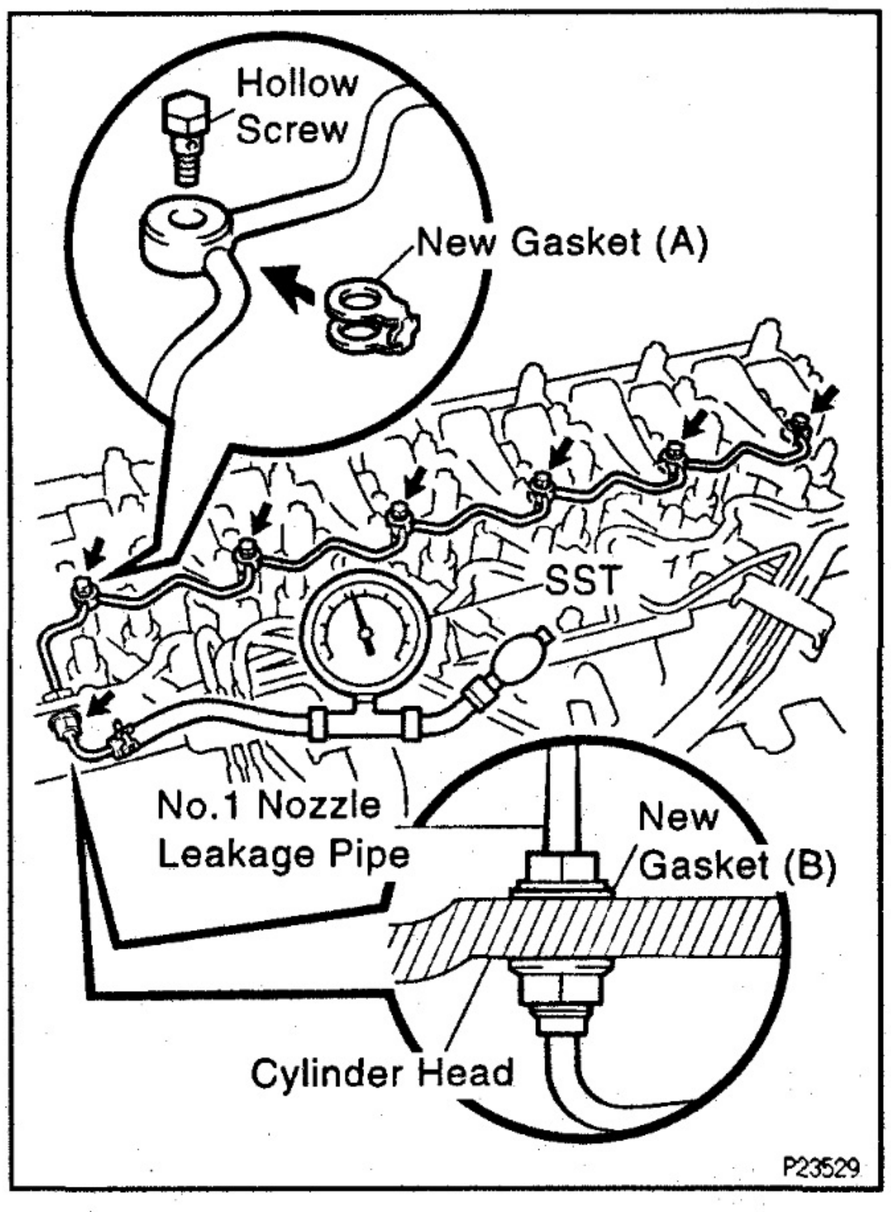
(e) Install the 2 clamps with the 2 nuts.
Torque: 6.4 N·m (65 kgf·cm, 56 in.·lbf)

(f) Install the 2 clamps with the 4 nuts to the intake manifold.
Torque: 6.4 N·m (65 kgf·cm, 56 in.·lbf)

(g) Install the No.3 nozzle leakage pipe with the bolt.
Torque: 19.6 N·m (200 kgf·cm, 15 ft·lbf)

4. INSTALL NO.1 NOZZLE LEAKAGE PIPE

(a) Install the 7 new gaskets, No.1 nozzle leakage pipe to the cylinder head, injection nozzle with the 6 hollow screw and nut.
Torque:
Hollow screw: 18 N·m (176 kgf·cm, 13 in.·lbf)
Nut: 19 N·m (186 kgf·cm, 14 ft·lbf)
NOTICE: Install the gasket (A) so that its connecting part is between the pipe as shown in the illustration.



(b) Using SST, apply the SST to the fuel return side of the No.1 nozzle leakage pipe, and maintain 49 kPa (0.5 kgf/cm², 7.1 psi) of pressure for 10 seconds to check that there are no leaks.
SST 09992–00241

(c) Connect the fuel return hose to the No.1 nozzle leakage pipe.

5. INSTALL ACCELERATOR LINK ASSEMBLY

(a) Install the accelerator link assembly with the 2 bolts and nut.
Torque: 19.6 N·m (200 kgf·cm, 14 in.·lbf)

(b) Connect the accelerator link to the injection pump.

(c) w/o Australia M/T:
Connect the throttle position sensor connector to the bracket.

6. INSTALL CYLINDER HEAD COVER
(See step 10 in cylinder head installation in Engine Mechanical)

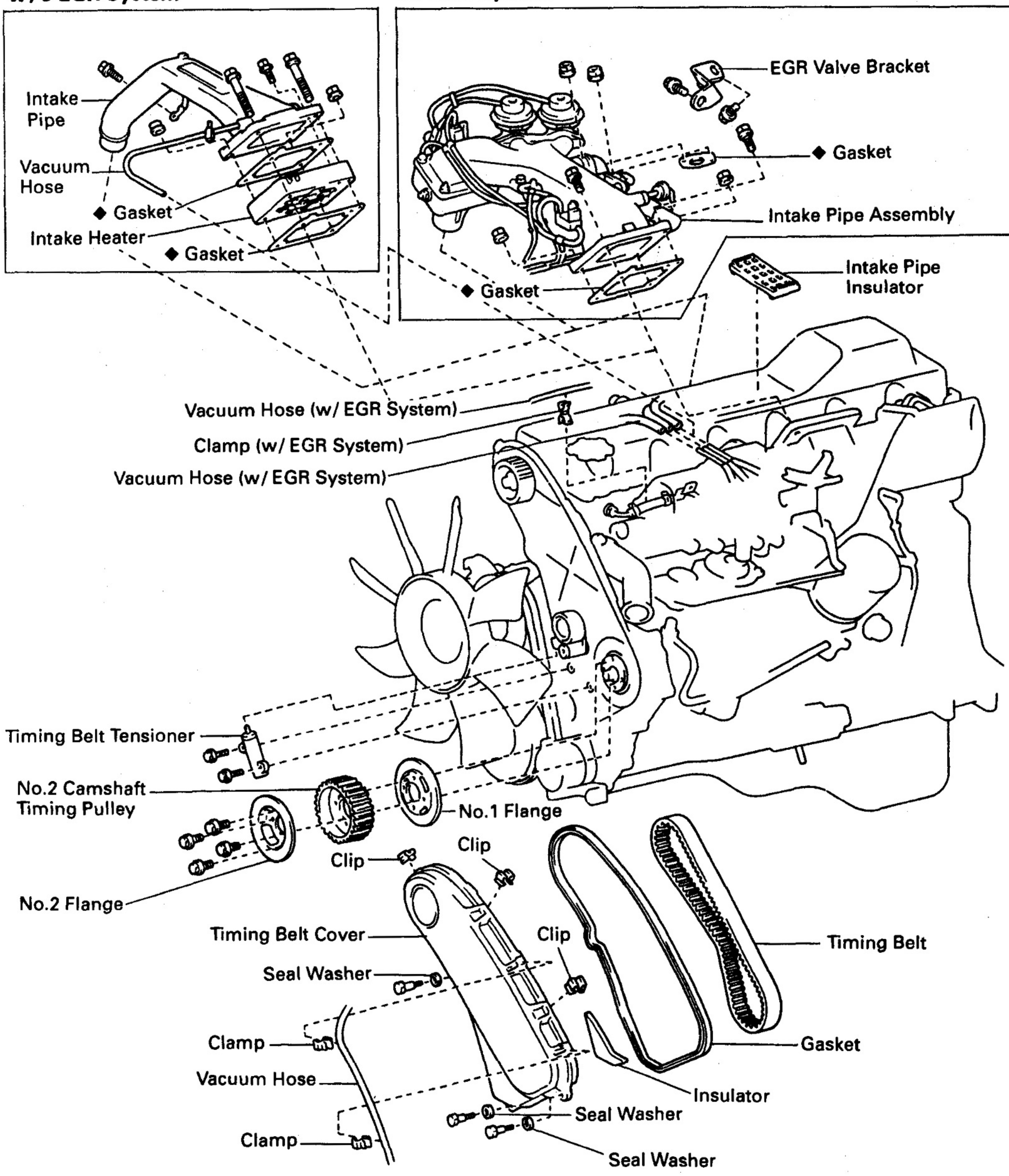
7. INSTALL INTAKE PIPE
(See step 18 or 19 in cylinder head installation in Engine Mechanical)

8. START ENGINE AND CHECK FOR FUEL LEAKAGE

INJECTION PUMP
COMPONENTS FOR REMOVAL AND INSTALLATION

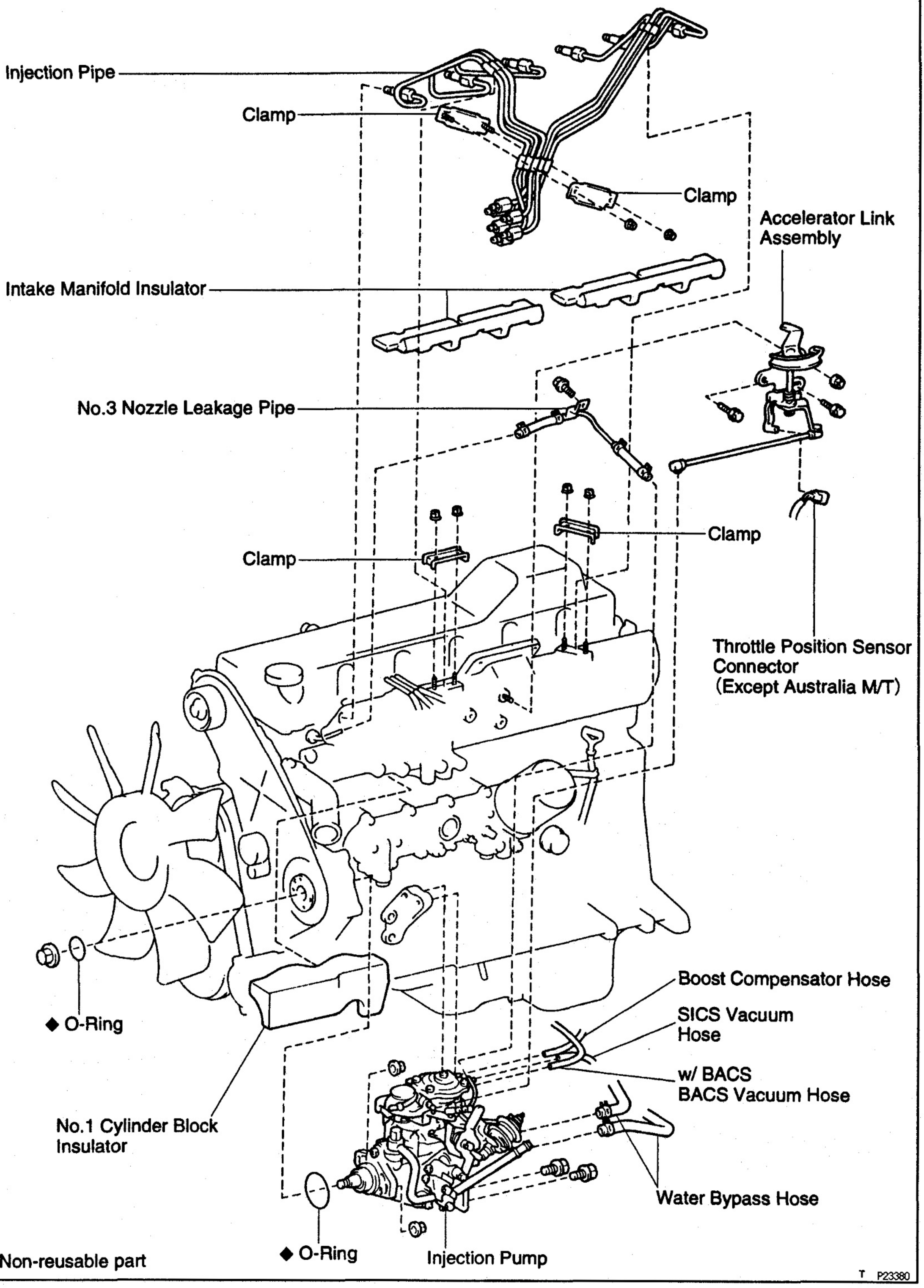
EGSSA-01

EG



◆ Non-reusable part

P22051


Injection Pipe
Clamp
Clamp
Accelerator Link Assembly
Intake Manifold Insulator
No.3 Nozzle Leakage Pipe
Clamp
Clamp
Throttle Position Sensor Connector (Except Australia M/T)
◆ O-Ring
Boost Compensator Hose
SICS Vacuum Hose
w/ BACS
BACS Vacuum Hose
No.1 Cylinder Block Insulator
Water Bypass Hose
◆ O-Ring
Injection Pump
◆ Non-reusable part
T P23380

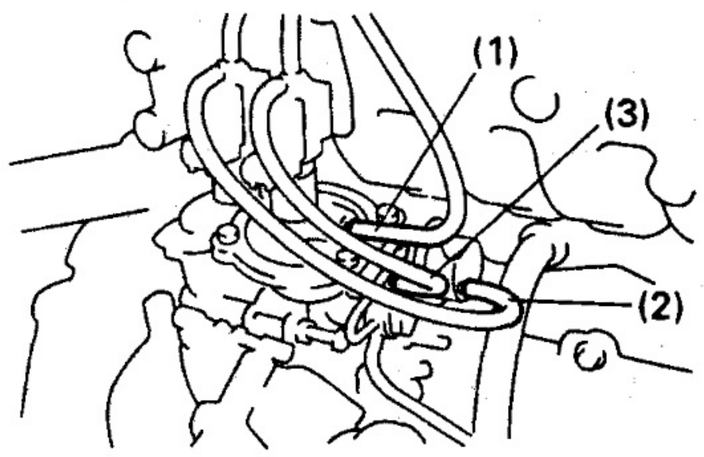
EG

EG5SS-01

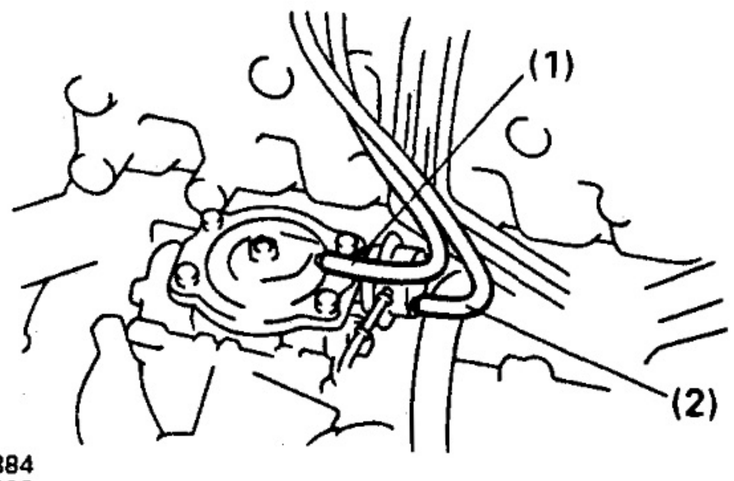
INJECTION PUMP REMOVAL

1. **DRAIN ENGINE COOLANT**
   (See coolant replacement in Cooling System)
2. **REMOVE TIMING BELT**
   (See steps 1 to 3 in timing belt removal in Engine Mechanical)
3. **REMOVE NO.2 CAMSHAFT TIMING PULLEY**
   (See step 5 in timing belt removal in Engine Mechanical)
4. **REMOVE INJECTION PIPES**
   (See steps 1, 3 and 5 in injection nozzle removal)
5. **DISCONNECT WATER BYPASS HOSES FROM THERMO WAX**
6. **DISCONNECT HOSES**
   Disconnect these hoses from the injection pump.
   (1) SICS vacuum hose
   (2) Boost compensator hose
   (3) w/ BACS:
   BACS vacuum hose

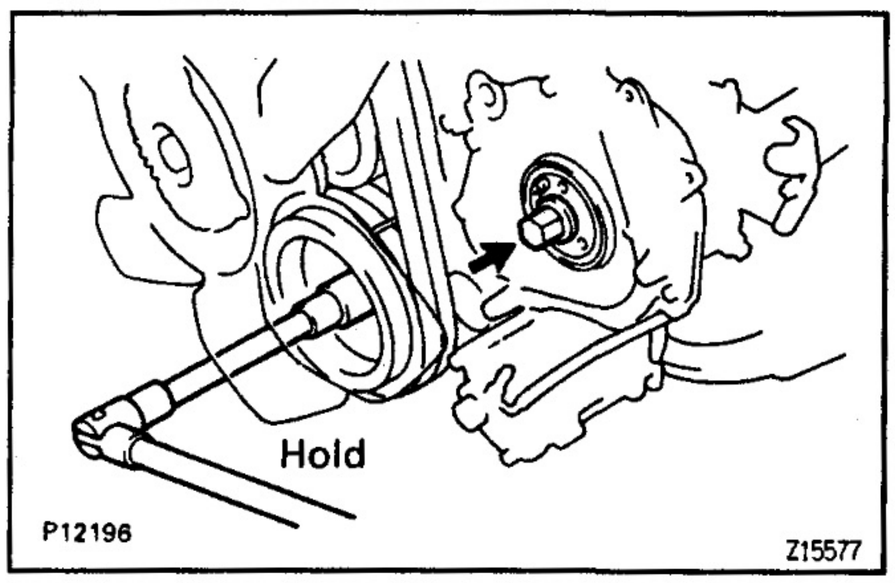
w / EGR System



w / o EGR System



P23384
P23383
Z15523

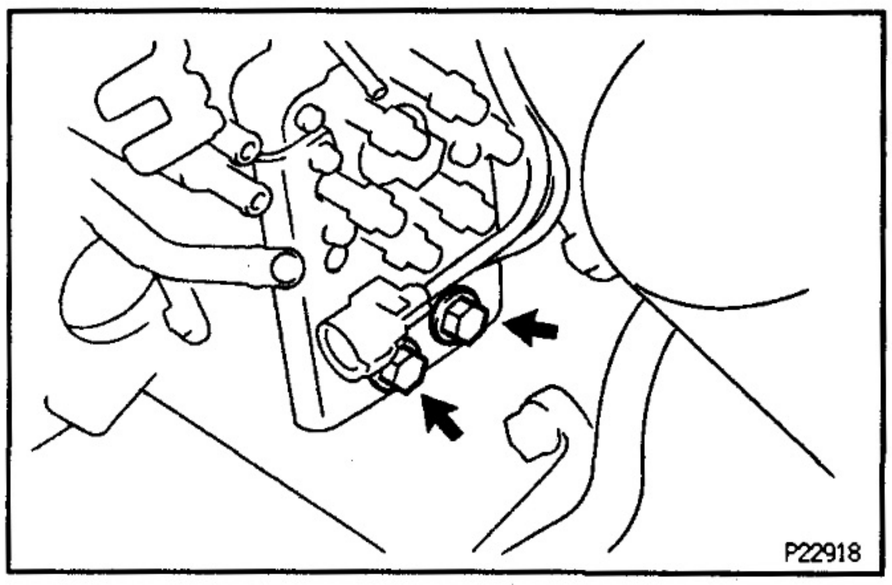


P12196
Z15577

7. **REMOVE INJECTION PUMP**

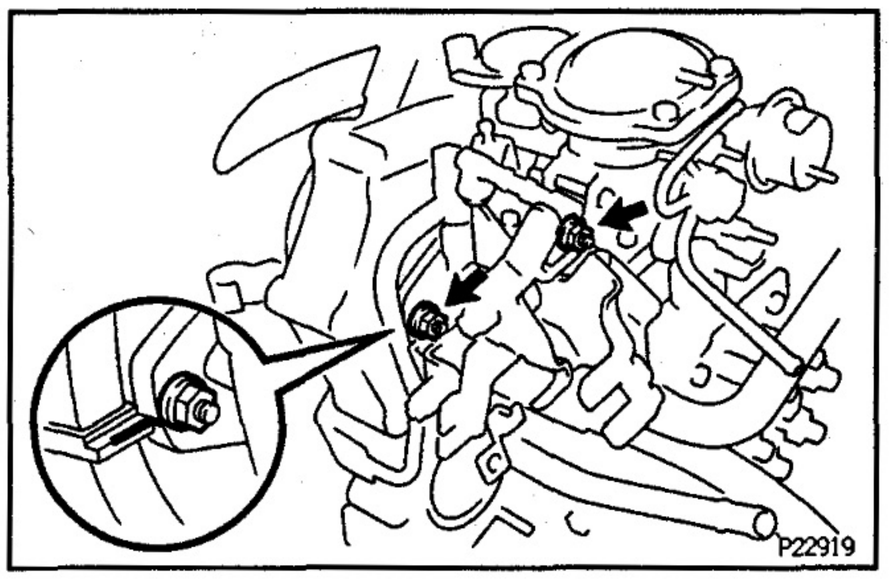
(a) Hold the crankshaft pulley, and remove the injection pump drive gear set nut.
NOTICE: Do not turn the crankshaft pulley. The valve heads will hit against the piston top.

(b) Remove the O—ring from the injection pump drive gear.



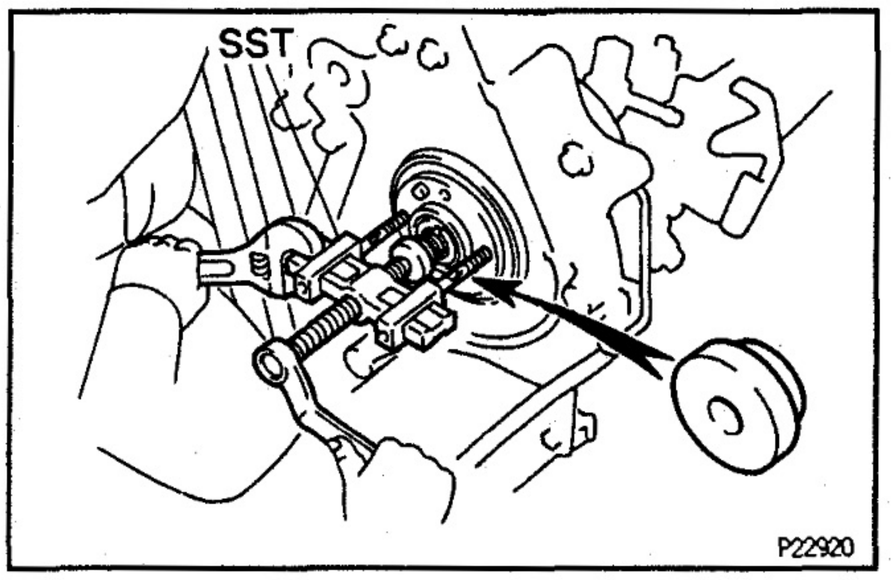
P22918

(c) **Remove the 2 bolts holding the injection pump to the injection pump stay.**



(d) Before removing the injection pump, check if the period lines are aligned.
If not, place new matchmarks for reinstallation.

(e) Remove the 2 nuts holding the injection pump to the timing gear case.



(f) Using SST, remove the injection pump.
SST 09950–40010 (09957–04010),
09950–50010 (09951–05010, 09952–05010,
09953–05020, 09954–05030)

NOTICE:

- **Tighten the 2 bolts more than 8 mm (0.31 in.).**
- **Set SST so that it is balanced.**
- **Do not hold or carry the injection pump by the adjusting lever.**
- **Do not put the injection pump at an angle more than 45° from the horizontal.**

(g) Remove the No.1 cylinder block insulator.

(h) Remove the O–ring from the injection pump.

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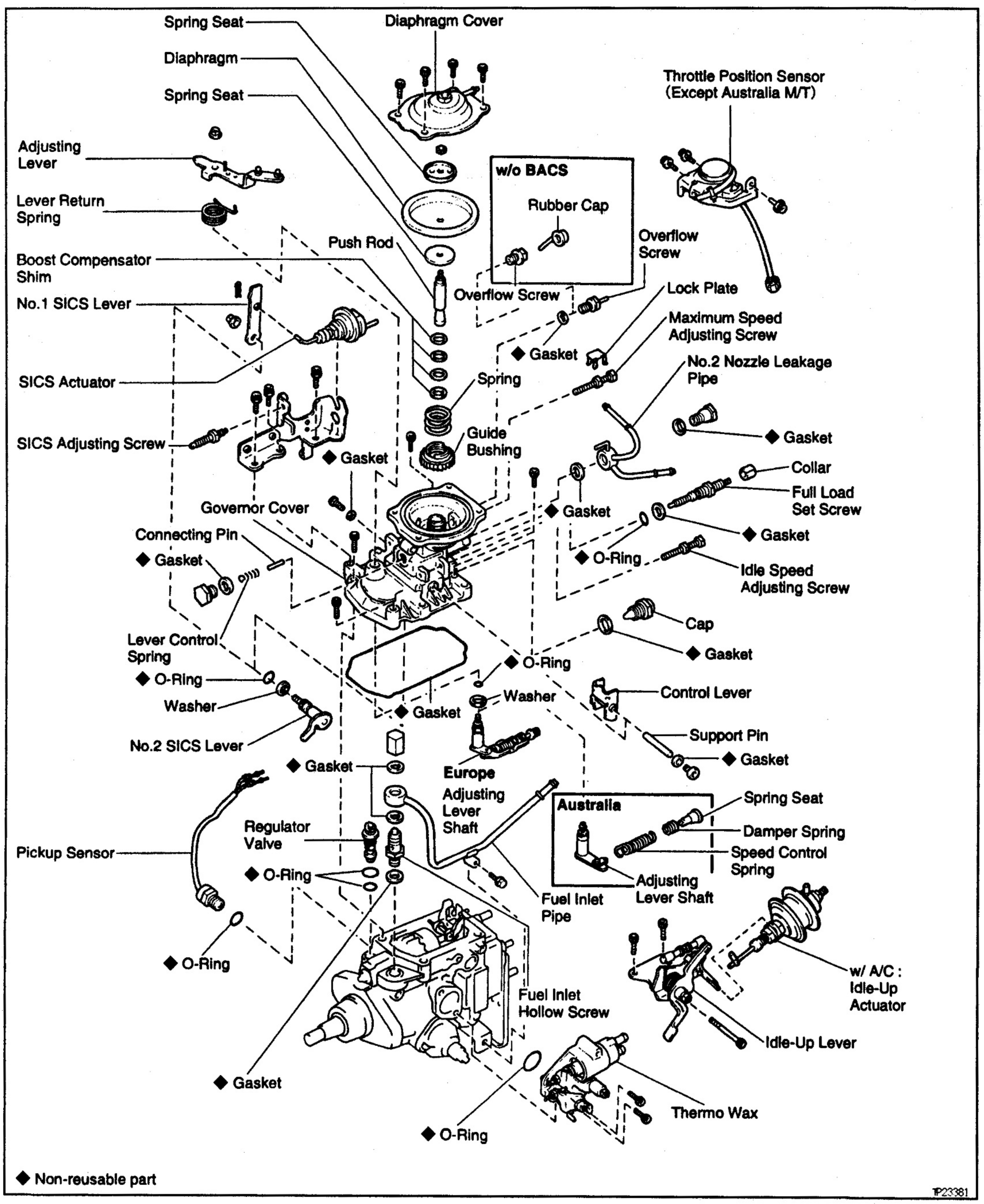
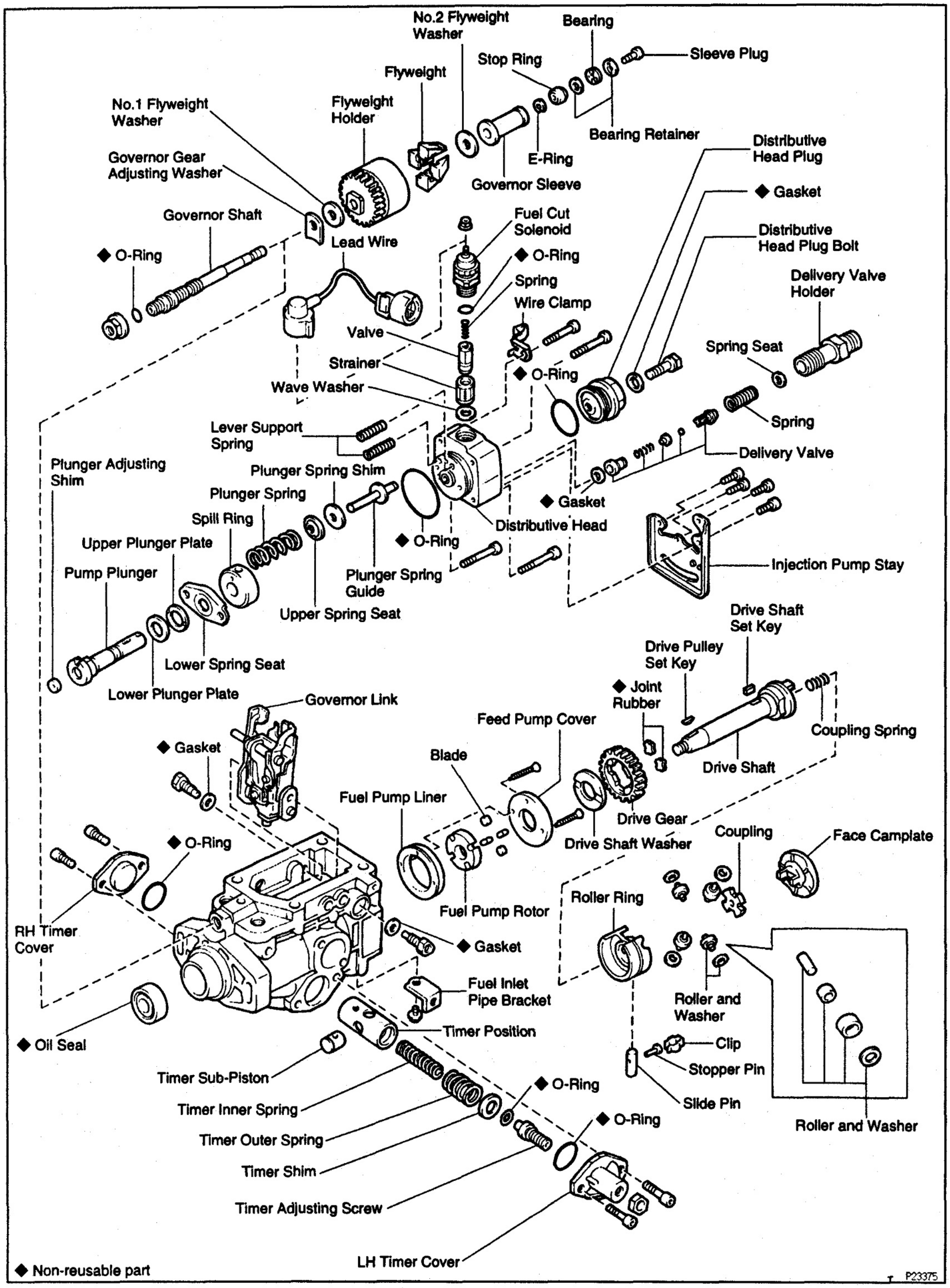
COMPONENTS FOR DISASSEMBLY AND ASSEMBLY

EG946-04




No.2 Flyweight Washer
Bearing
Stop Ring
Sleeve Plug
Flyweight
No.1 Flyweight Washer
Flyweight Holder
Governor Gear Adjusting Washer
Governor Shaft
Bearing Retainer
E-Ring
Governor Sleeve
Distributive Head Plug
◆ Gasket
Distributive Head Plug Bolt
Fuel Cut Solenoid
◆ O-Ring
Lead Wire
◆ O-Ring
Spring
Wire Clamp
Delivery Valve Holder
Valve
Strainer
Wave Washer
Spring Seat
◆ O-Ring
Spring
Lever Support Spring
Plunger Adjusting Shim
Plunger Spring Shim
Plunger Spring
Spill Ring
Upper Plunger Plate
Pump Plunger
Plunger Spring Guide
Upper Spring Seat
◆ O-Ring
Delivery Valve
◆ Gasket
Distributive Head
Injection Pump Stay
Drive Shaft Set Key
Drive Pulley Set Key
Lower Spring Seat
Lower Plunger Plate
Governor Link
◆ Joint Rubber
Feed Pump Cover
Coupling Spring
◆ Gasket
Blade
Drive Shaft
Fuel Pump Liner
Drive Gear
Drive Shaft Washer
Coupling
Face Camplate
◆ O-Ring
Roller Ring
RH Timer Cover
Fuel Pump Rotor
◆ Gasket
Fuel Inlet Pipe Bracket
Roller and Washer
Clip
Timer Position
Stopper Pin
◆ Oil Seal
Slide Pin
Timer Sub-Piston
◆ O-Ring
Roller and Washer
Timer Inner Spring
◆ O-Ring
Timer Outer Spring
Timer Shim
Timer Adjusting Screw
LH Timer Cover
◆ Non-reusable part
P23375

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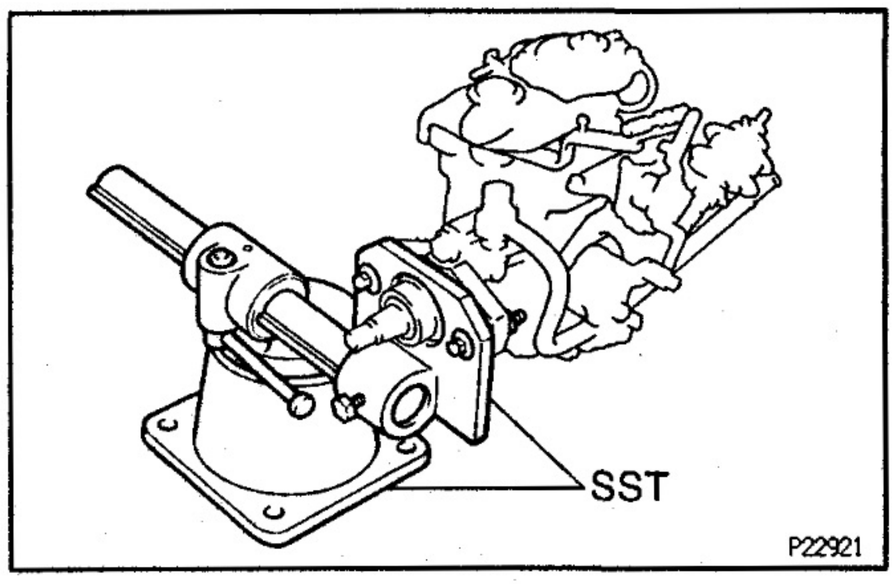
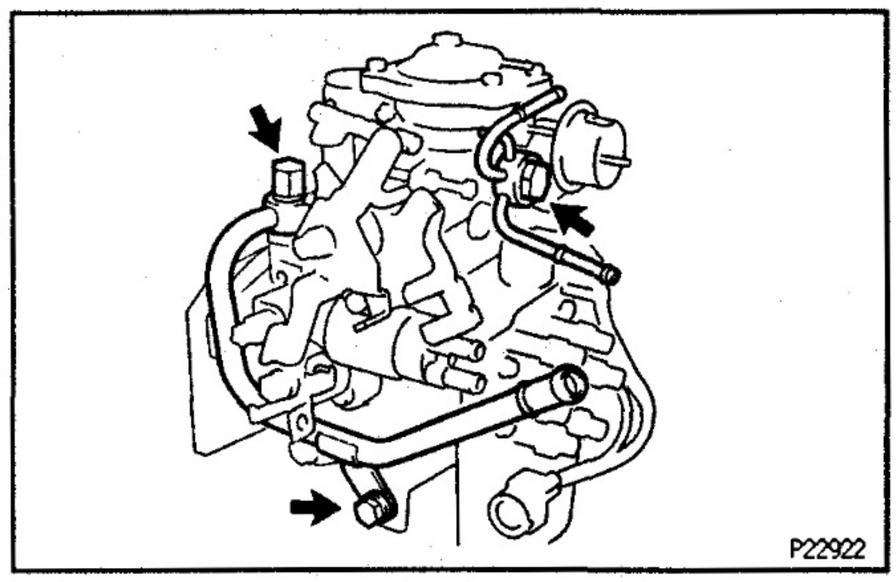
EG0BC-01

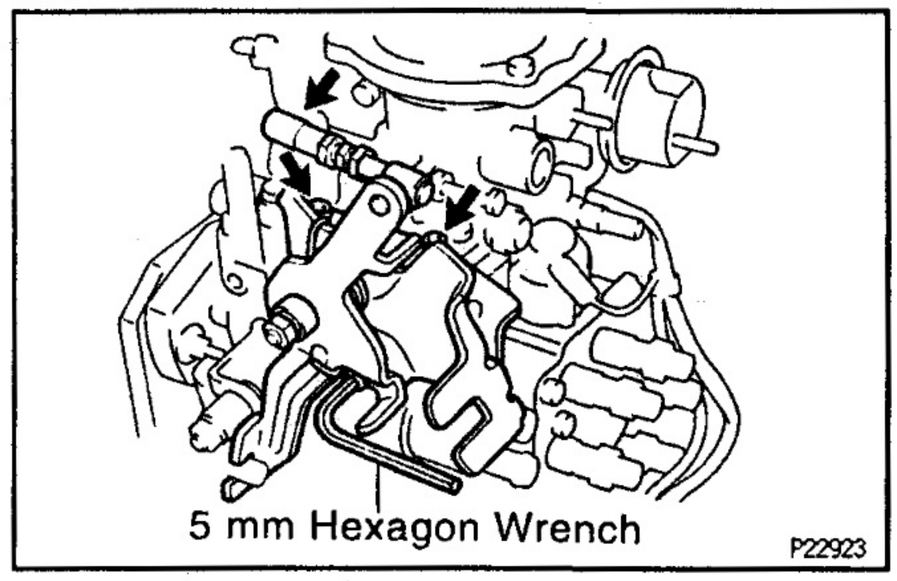
INJECTION PUMP DISASSEMBLY



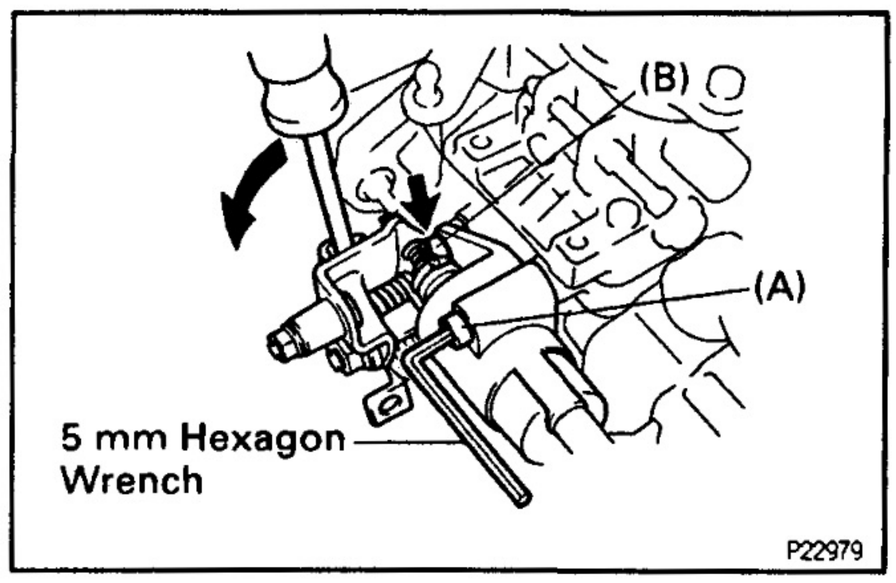
1. MOUNT PUMP ASSEMBLY TO SST (STAND)
   SST 09241—76022, 09245—54010
2. REMOVE SET KEY OF DRIVE PULLEY FROM DRIVE SHAFT
3. w/ A/C:
   REMOVE IDLE—UP ACTUATOR



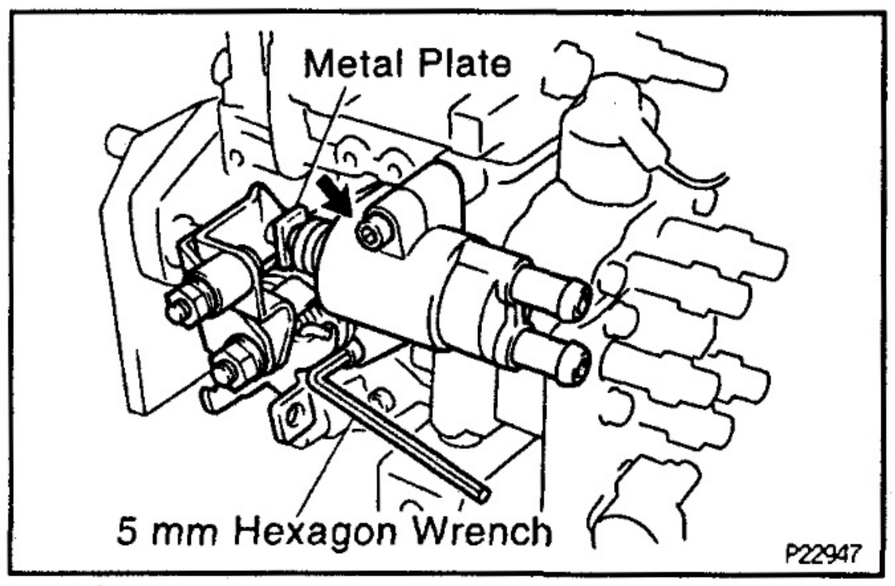
4. REMOVE FUEL PIPES
(a) Remove the cap nut, bolts, fuel inlet pipe and 2 gaskets.
(b) Remove the union bolt, No.2 nozzle leakage pipe and 2 gaskets.



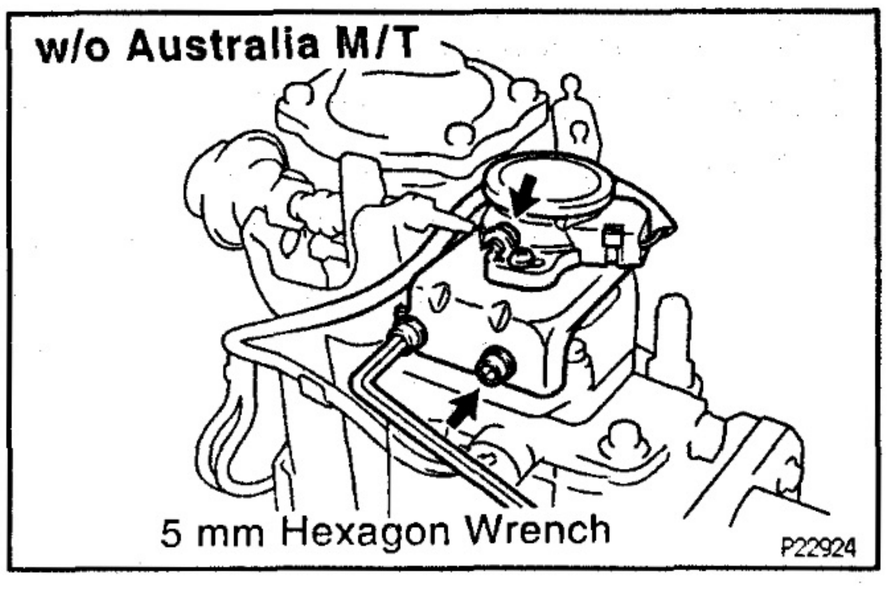
5. REMOVE IDLE—UP LEVER
(a) Remove the idle—up lever link from the adjusting lever.
(b) Using a 5 mm hexagon wrench, remove the 3 bolts and idle—up lever.



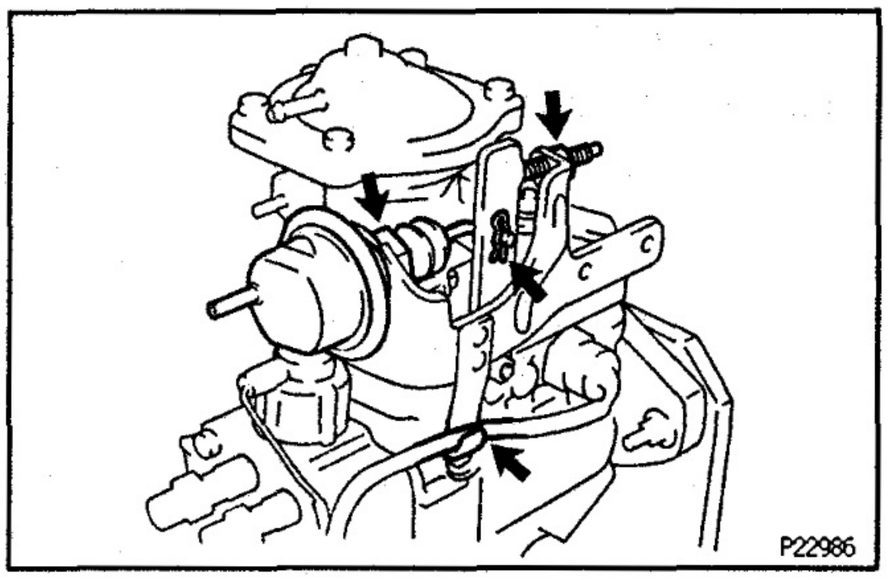
6. REMOVE THERMO WAX
(a) Using a 5 mm hexagon wrench, temporality install the bolt (A).
(b) Using a screwdriver, turn the cold starting lever counterclockwise.
(c) Using a 5 mm hexagon wrench, remove the bolt (B).



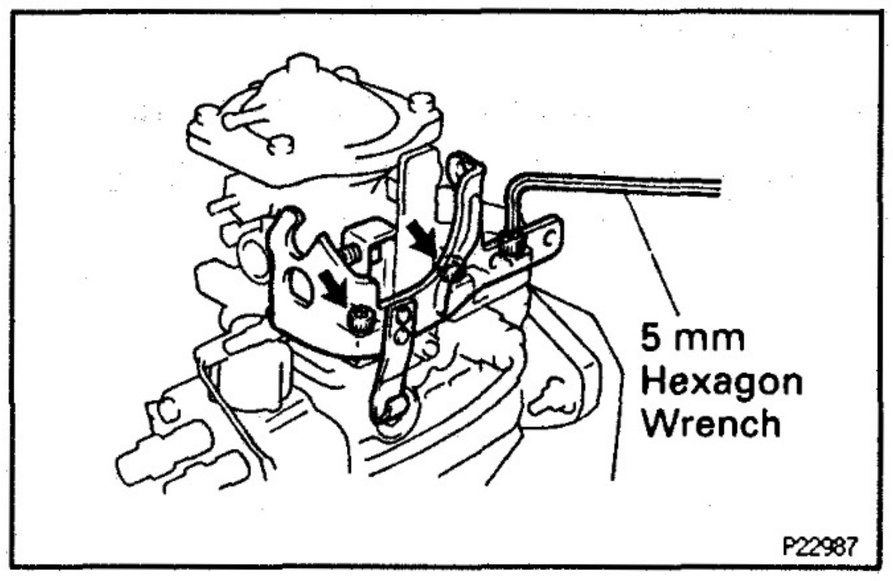
(d) Put a metal plate (thickness of 5.0 — 8.0 mm (0.20 — 0.31 in.)) between the cold starting lever and thermo wax plunger.
(e) Using a 5 mm hexagon wrench, remove the 2 bolts, thermo wax and O—ring.



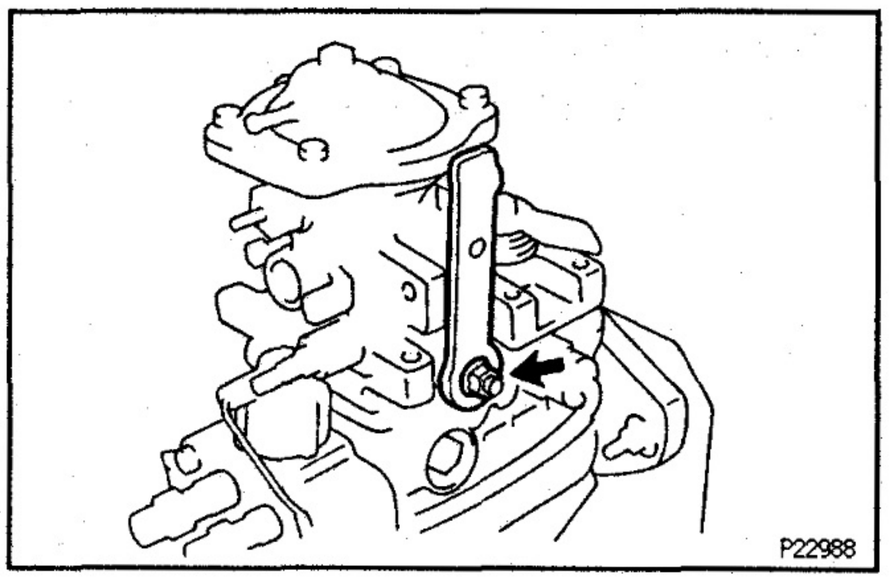
7. **w/o Australia M/T:**
REMOVE THROTTLE POSITION SENSOR AND BRACKET ASSEMBLY
Using a 5 mm hexagon wrench, remove the 3 bolts, the throttle position sensor and bracket assembly.



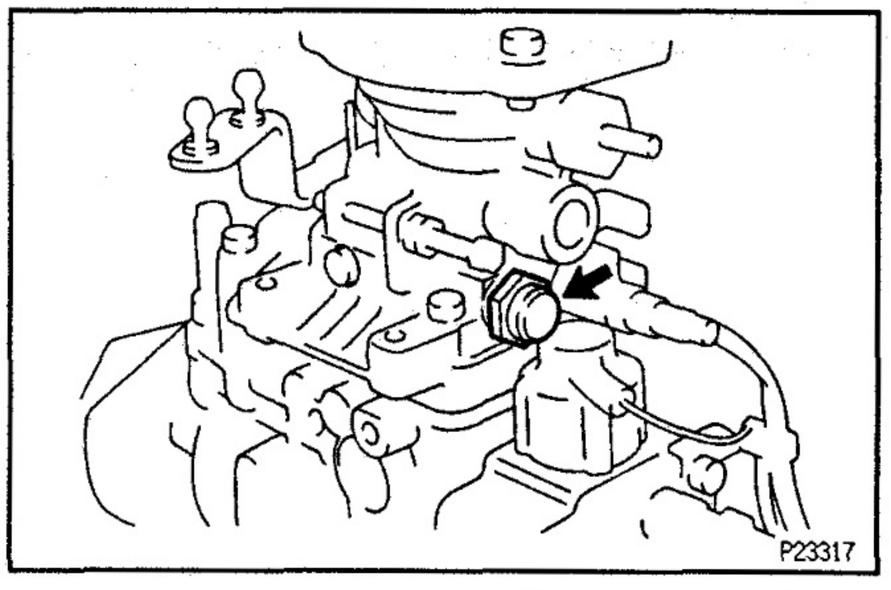
8. **REMOVE SICS ACTUATOR**
(a) Remove the SICS adjusting screw.
(b) Remove the clip.
(c) Disconnect the wire harness.
(d) Remove the nuts and SICS actuator.



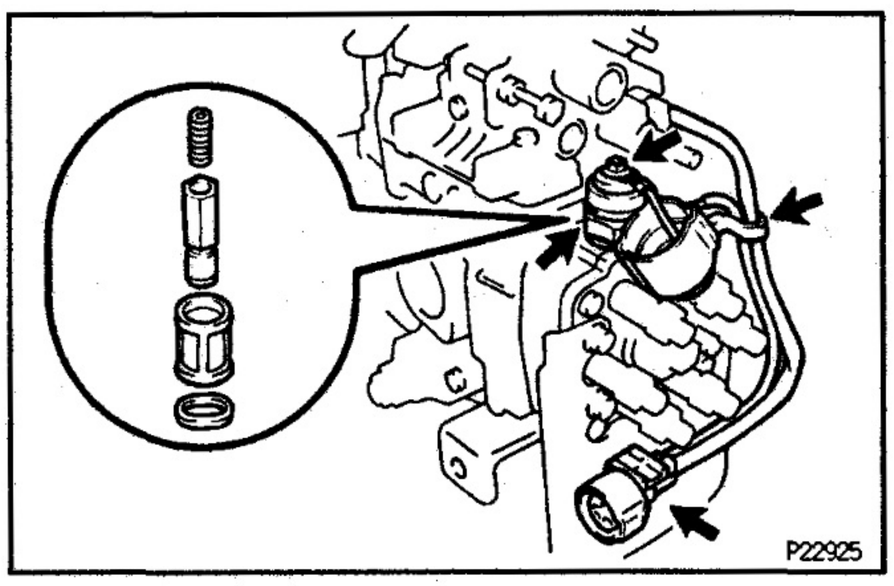
(e) Remove the lock plate.
(f) Remove the maximum speed adjusting screw.
(g) Using a 5 mm hexagon wrench, remove the 3 bolts and SICS actuator bracket.



9. **REMOVE NO.1 SICS LEVER**
Remove the nut and No.1 SICS lever.

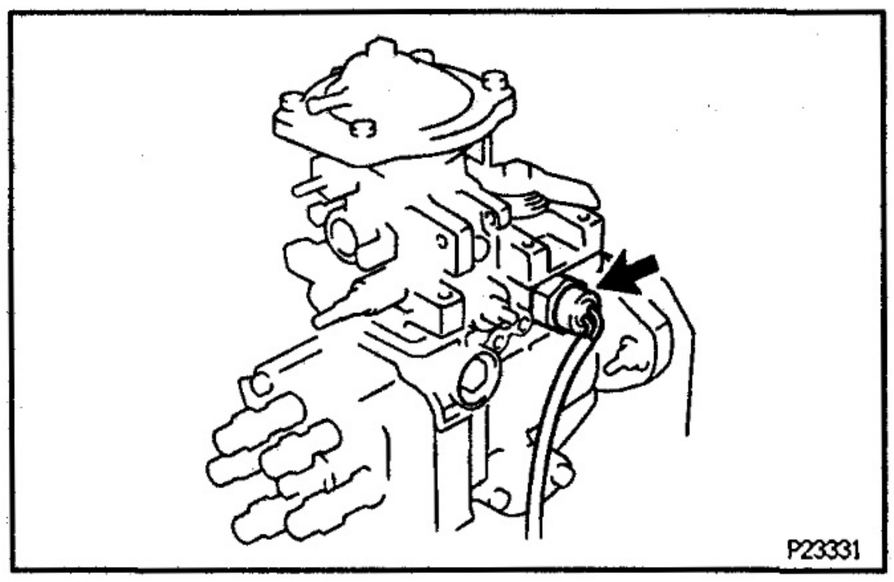


10. **REMOVE CAP**
Remove the cap and gasket.



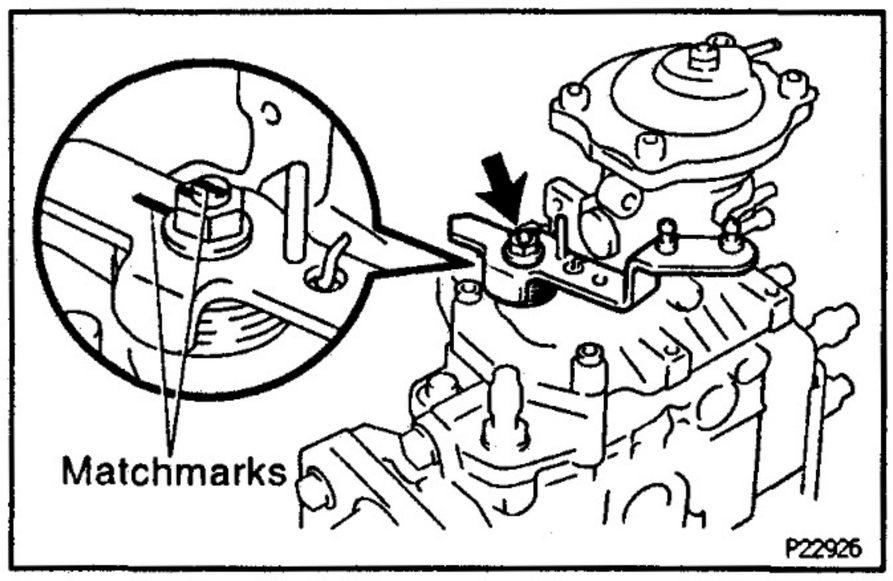
11. REMOVE FUEL CUT SOLENOID

(a) Disconnect the lead wire connector from the bracket.
(b) Disconnect the wire harness from the wire clamp.
(c) Disconnect the dust cover from the fuel cut solenoid.
(d) Remove the nut, lead wire and dust cover.
(e) Remove the fuel cut solenoid, O–ring, spring, valve, strainer and wave washer.



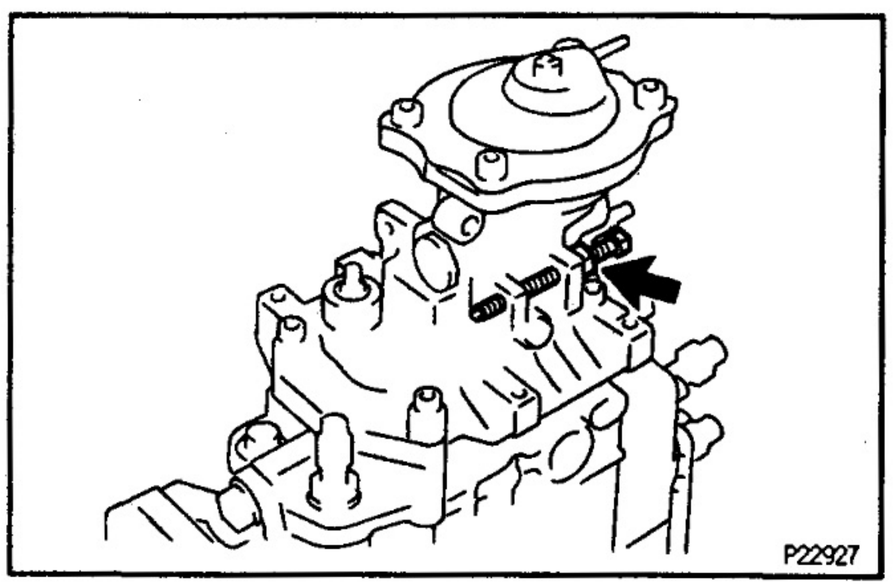
12. REMOVE PICKUP SENSOR

(a) Remove the pickup sensor and O–ring.
(b) Disconnect the sensor lead wires from the connector.



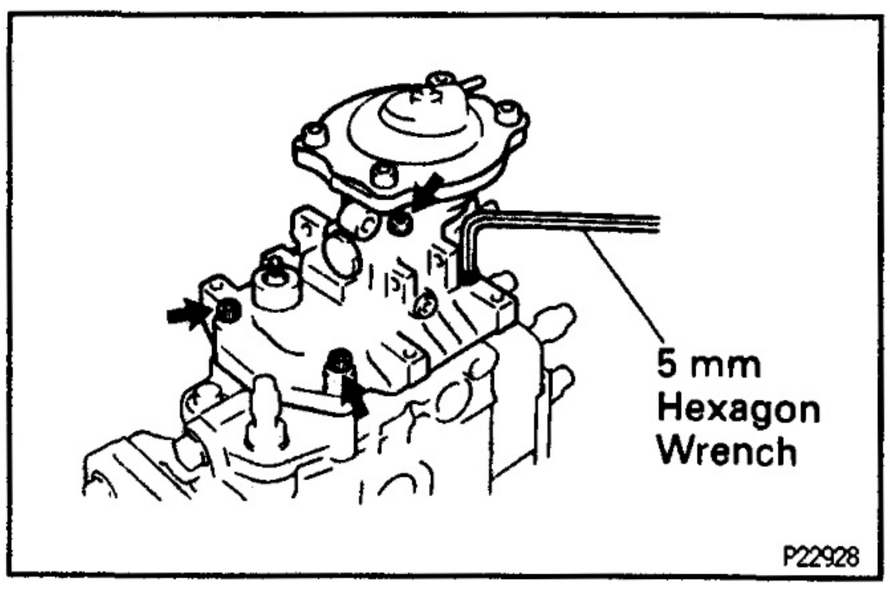
13. REMOVE ADJUSTING LEVER

(a) Place the matchmarks on adjusting lever and shaft.
(b) Remove the nut, adjusting lever and return spring.

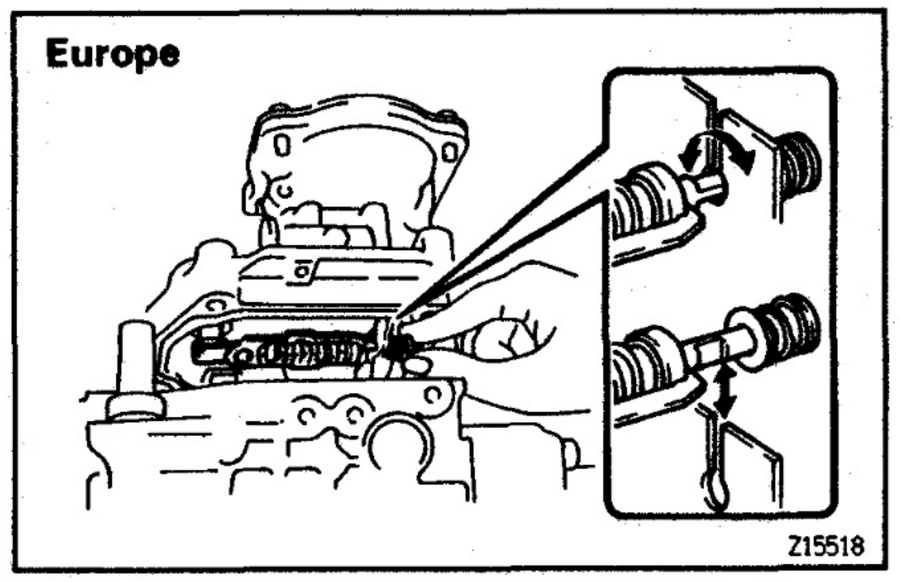


14. REMOVE GOVERNOR COVER

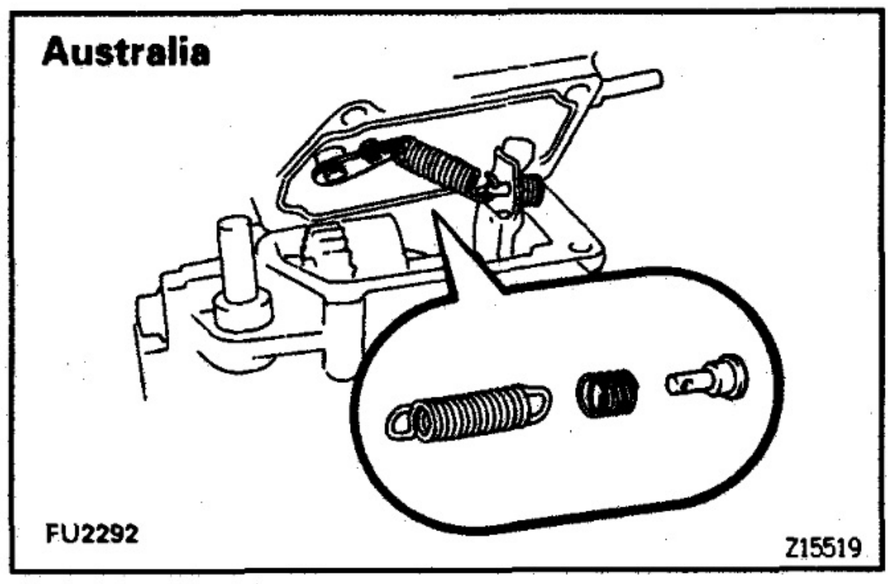
(a) Remove the idle speed adjusting screw.



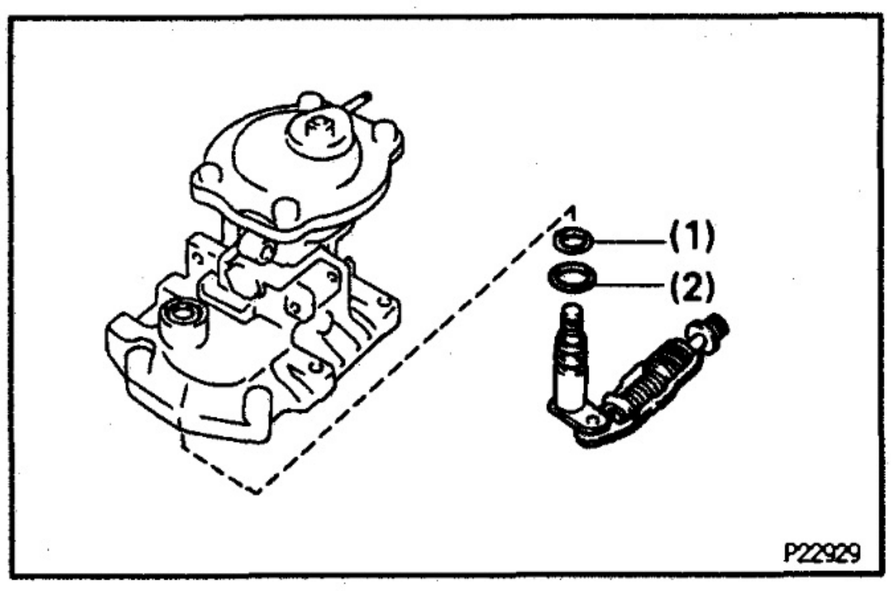
(b) Using a 5 mm hexagon wrench, remove the 4 bolts.



(c) Europe:
Disconnect the adjusting lever shaft assembly from the governor link, and remove the governor cover and gasket.



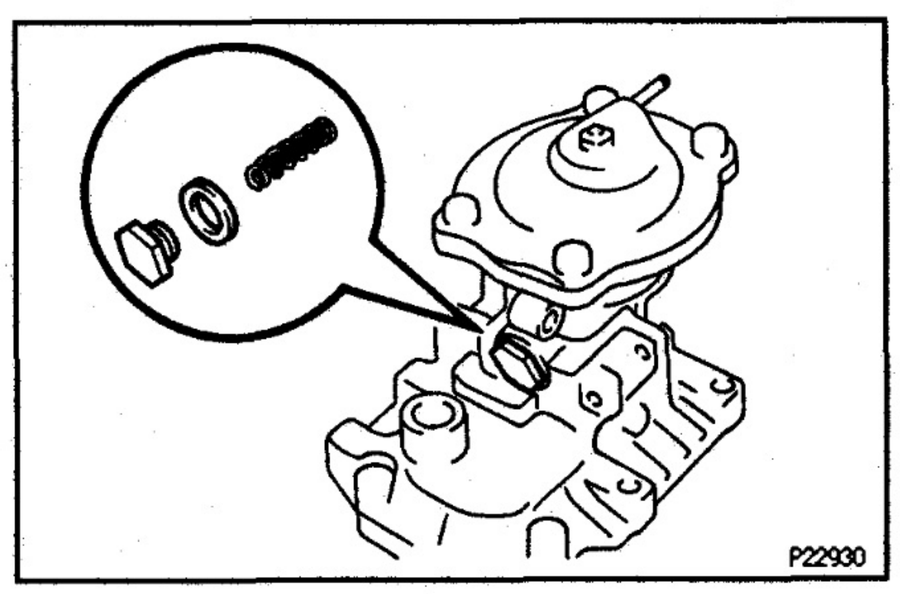
(d) Australia:
Disconnect the speed control spring from the spring seat, and remove the spring seat, damper spring, speed control spring, the governor cover, adjusting lever shaft assembly and gasket.



15. REMOVE GOVERNOR ADJUSTING LEVER SHAFT FROM GOVERNOR COVER

(a) Remove the adjusting lever shaft assembly from the governor cover.

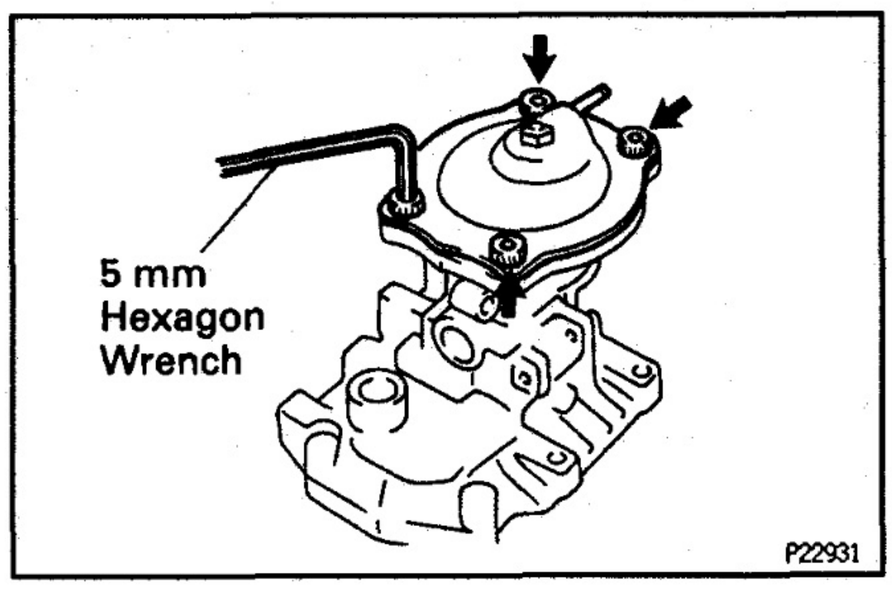
(b) Disassemble these parts:
(1) O–ring
(2) Washer



16. DISASSEMBLE BOOST COMPENSATOR

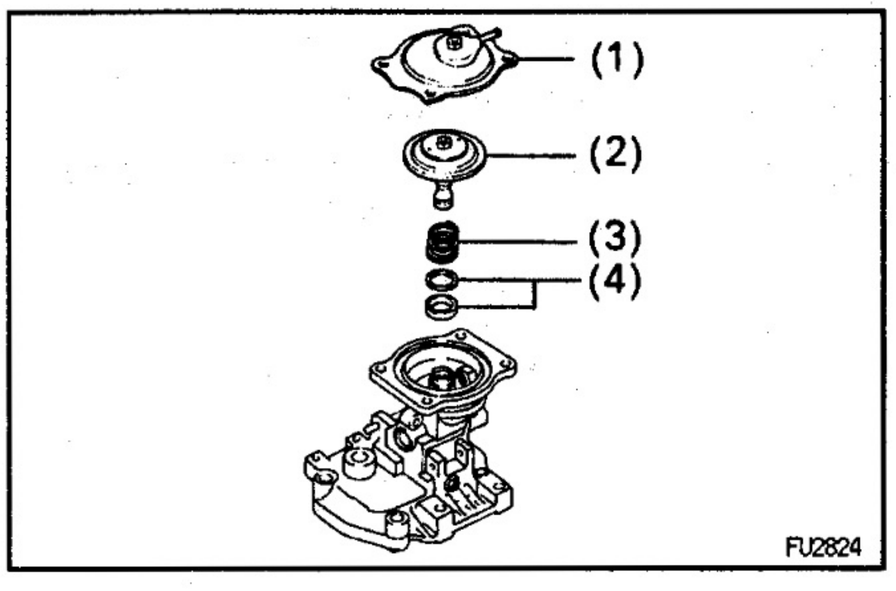
A. Remove lever control spring

Remove the bolt, gasket and lever control spring.

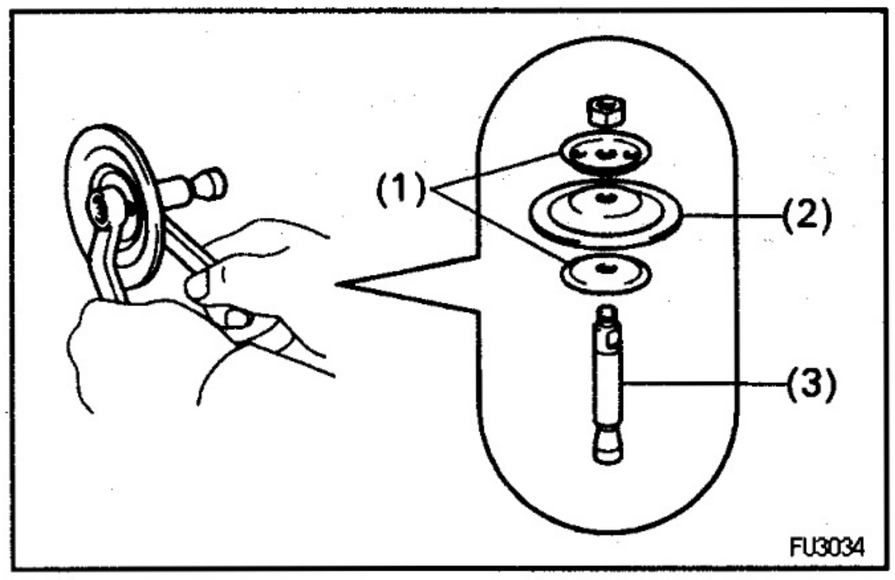


B. Remove boost compensator diaphragm

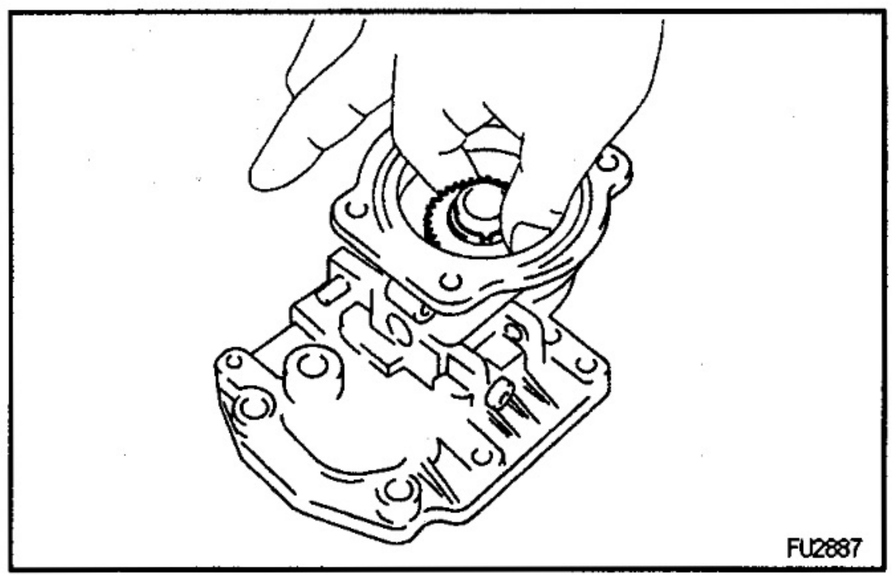
(a) Using a 5 mm hexagon wrench, remove the 4 bolts.



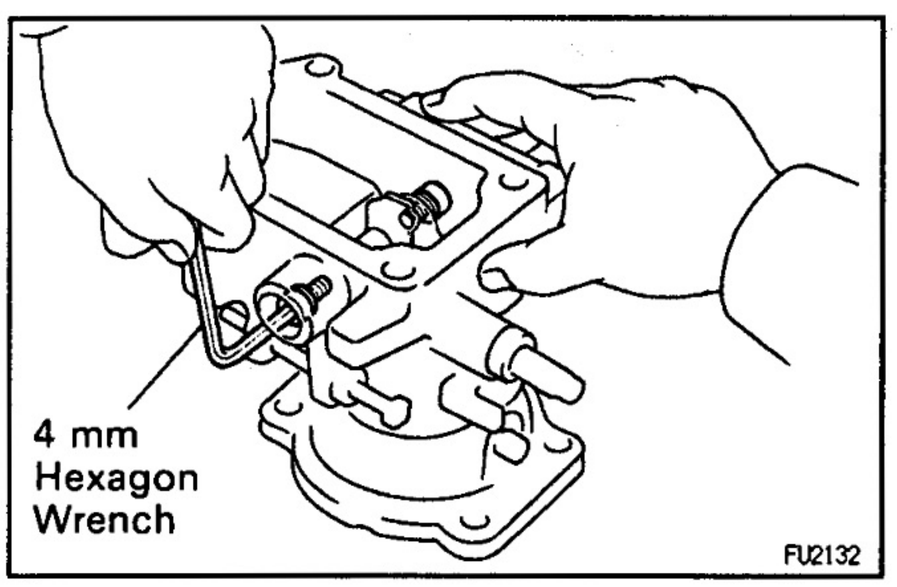
(b) Remove these parts:
(1) Diaphragm cover
(2) Diaphragm assembly
(3) Spring
(4) Boost compensator shim



(b) Remove the nut, and disassemble these parts:
(1) 2 spring seats
(2) Diaphragm
(3) Push rod

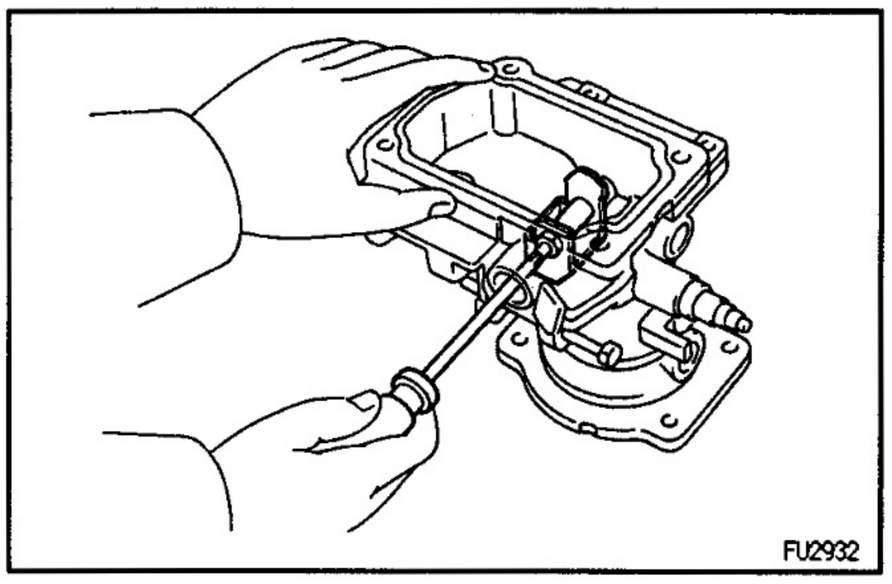


C. Remove guide bushing

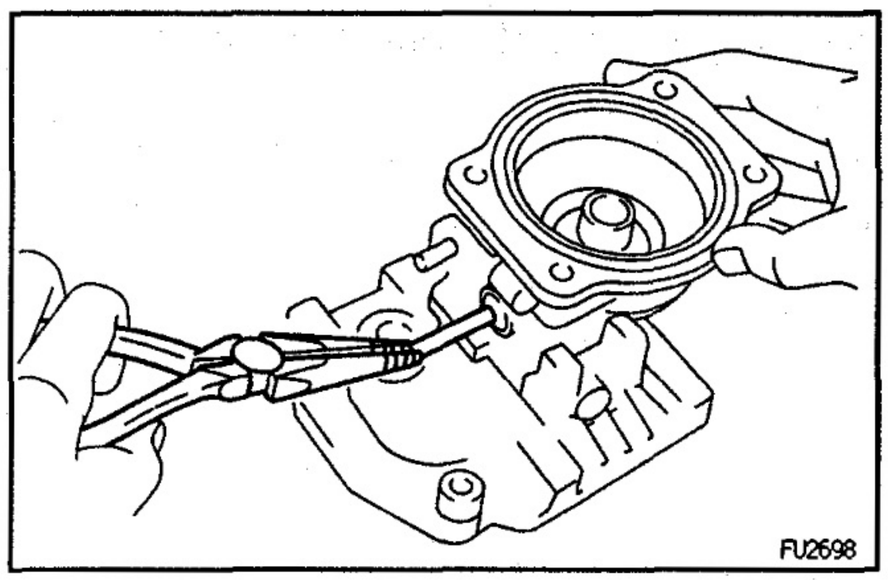


D. Remove control lever

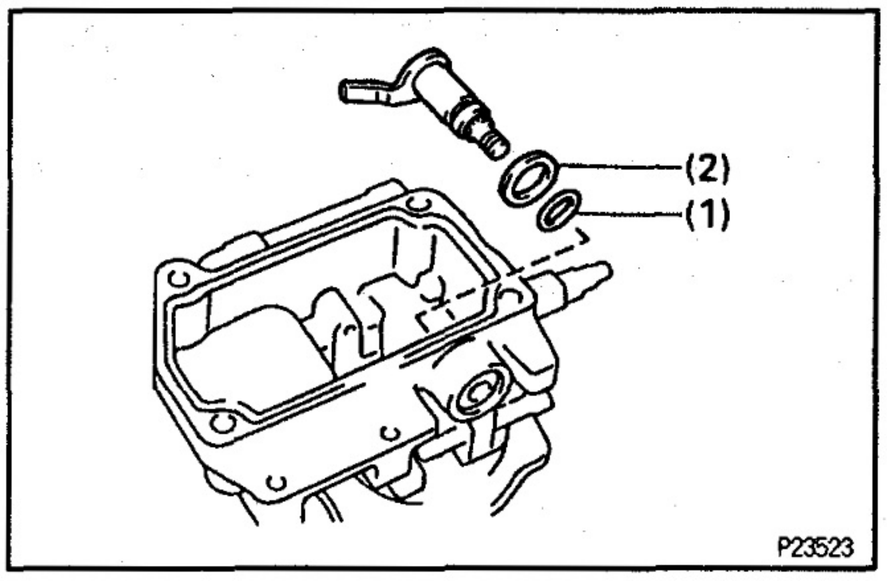
(a) Using a 4 mm hexagon wrench, remove the 2 bolts and gaskets.



(b) Using a small screwdriver, push out the support pin and remove the control lever.



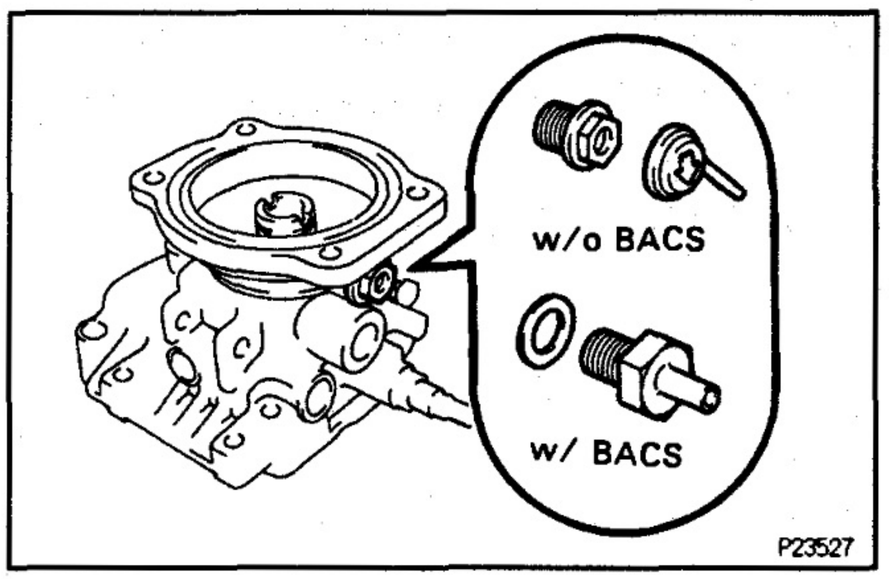
(c) Using needle nose pliers, remove the connecting pin.
NOTICE: Be careful not to damage the connecting pin. Tape the tip of the pliers.



E. Remove No.2 SICS lever

(a) Remove the No.2 SICS lever, O–ring and washer assembly from the governor cover.

(b) Disassemble these parts from the No.2 SICS lever, O–ring and washer assembly.
(1) O–ring
(2) Washer



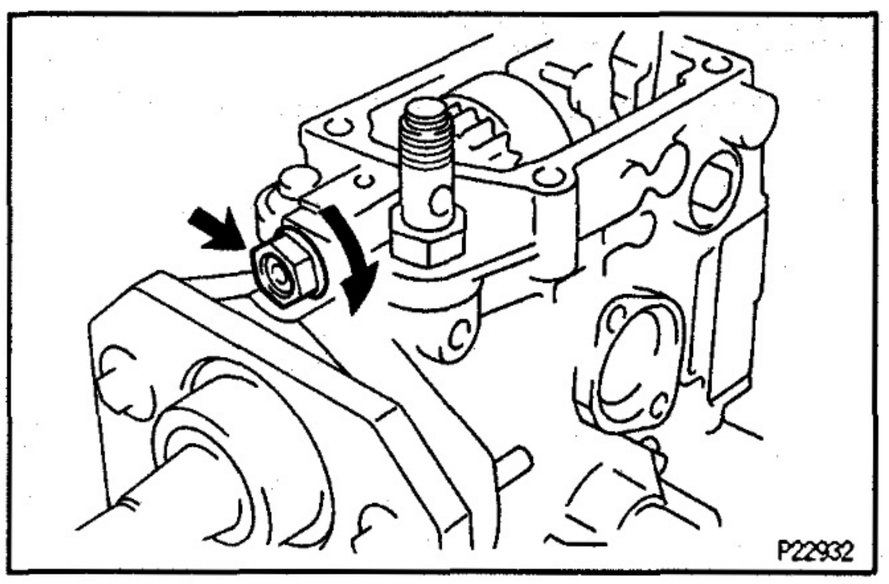
F. Remove overflow screw

(a) w/o BACS:
Remove the rubber cap and overflow screw.

(b) w/ BACS:
Remove the overflow screw and gasket.

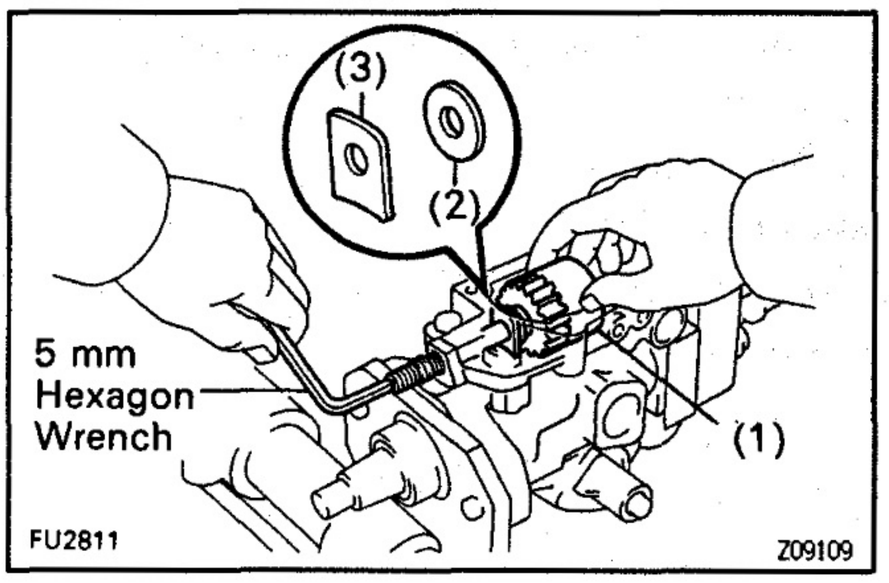
G. Remove full load set screw

17. CHECK FLYWEIGHT HOLDER THRUST CLEARANCE
(See step 16 in injection pump assembly)
Thrust clearance:
0.15 – 0.35 mm (0.0059 – 0.0138 in.)

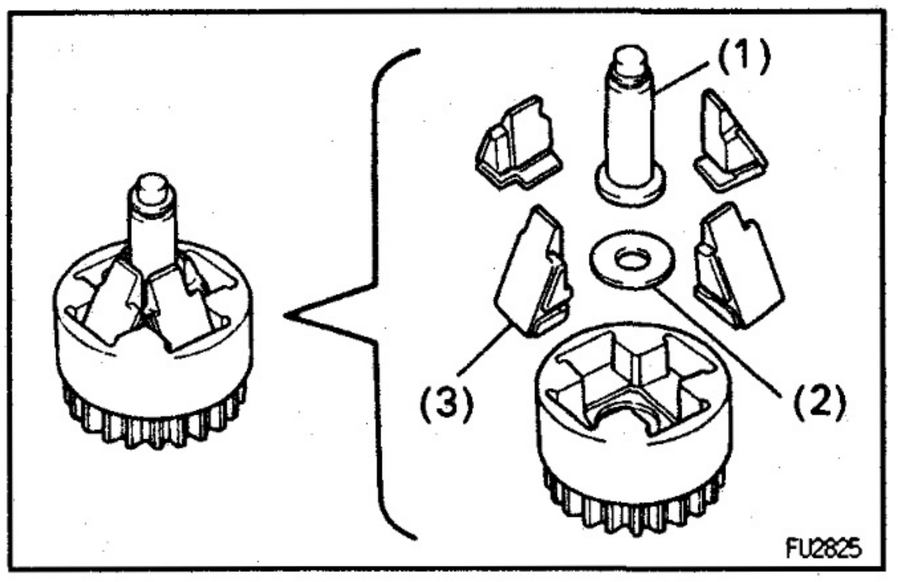


18. REMOVE GOVERNOR SHAFT AND FLYWEIGHT HOLDER

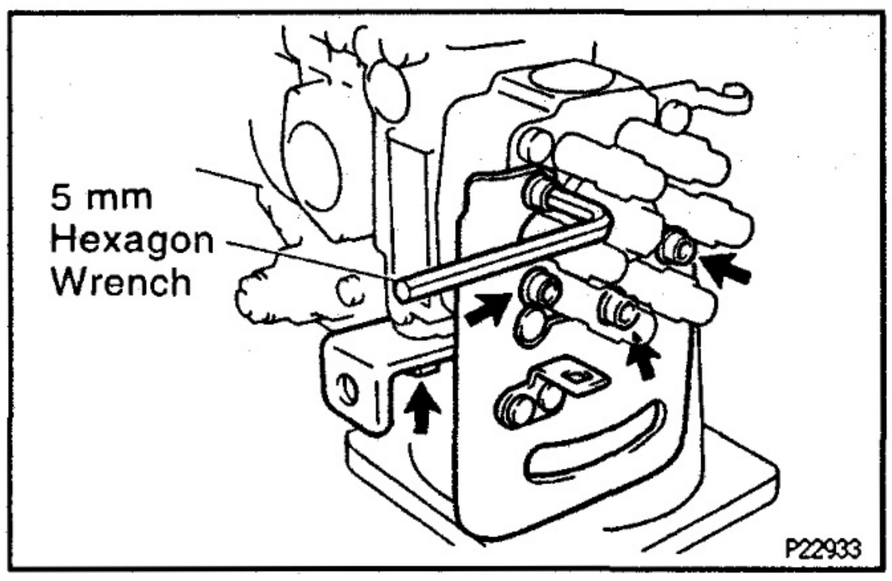
(a) Remove the governor shaft lock nut by turning it clockwise.
NOTICE: The governor shaft and lock nut have LH threads.



(b) Using a 5 mm hexagon wrench, remove the governor shaft, O–ring clockwise and remove these parts:
(1) Flyweight holder assembly
(2) No.1 flyweight washer
(3) Governor gear adjusting washer
HINT: Be careful not to drop the 2 washers into the pump housing.

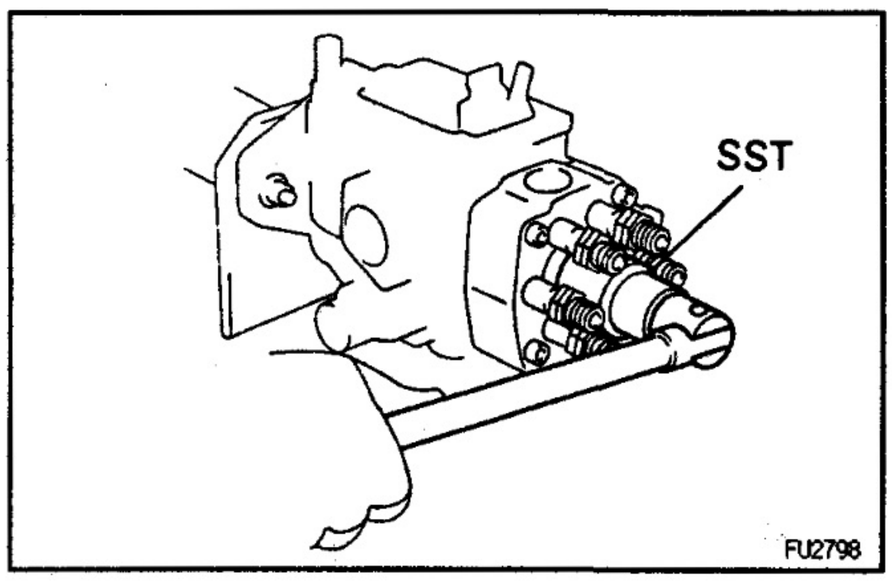


(c) Remove these parts from the flyweight holder:
(1) Governor sleeve
(2) No.2 flyweight washer
(3) 4 flyweights



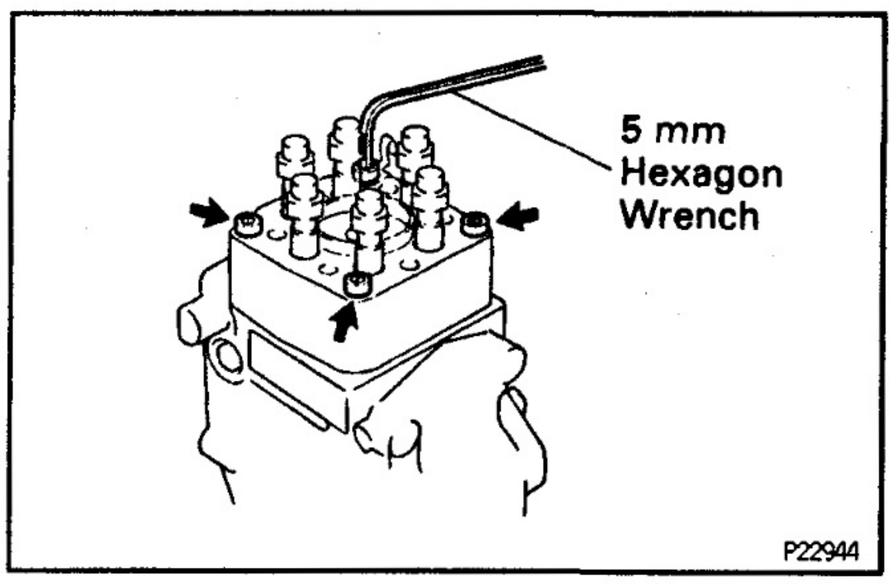
19. REMOVE INJECTION PUMP STAY AND FUEL PIPE BRACKET

(a) Using a 5 mm hexagon wrench, remove the 4 bolts and injection pump stay.
(b) Remove the bolt and fuel pipe bracket.



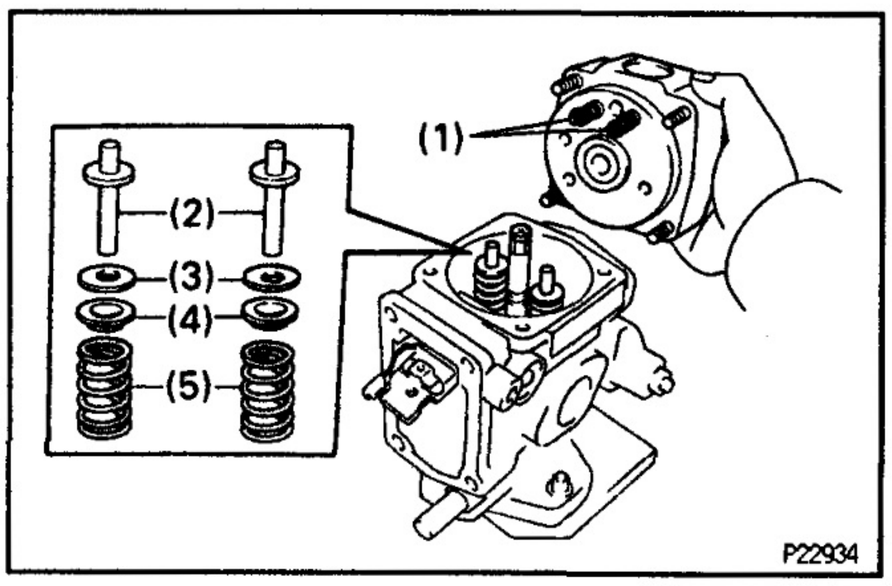
20. REMOVE DISTRIBUTIVE HEAD PLUG

Using SST, remove the distributive head plug and O–ring.
SST 09260–54012 (09262–54010)

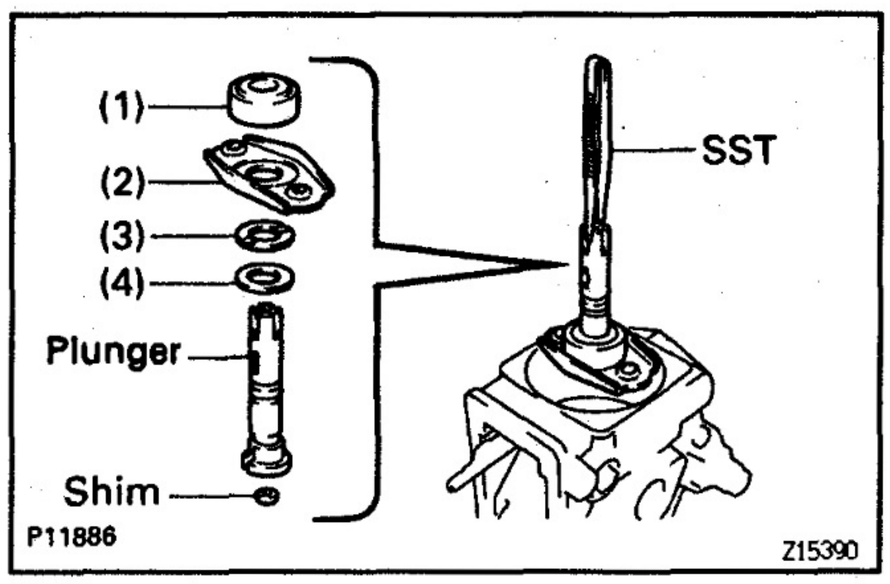


21. REMOVE DISTRIBUTIVE HEAD

(a) Using a 5 mm hexagon wrench, remove the 4 bolts and wire clip.



(b) Remove the distributive head and these parts:
(1) 2 lever support springs
(2) 2 plunger spring guides
(3) 2 plunger spring shims
(4) 2 upper spring seats
(5) 2 plunger springs



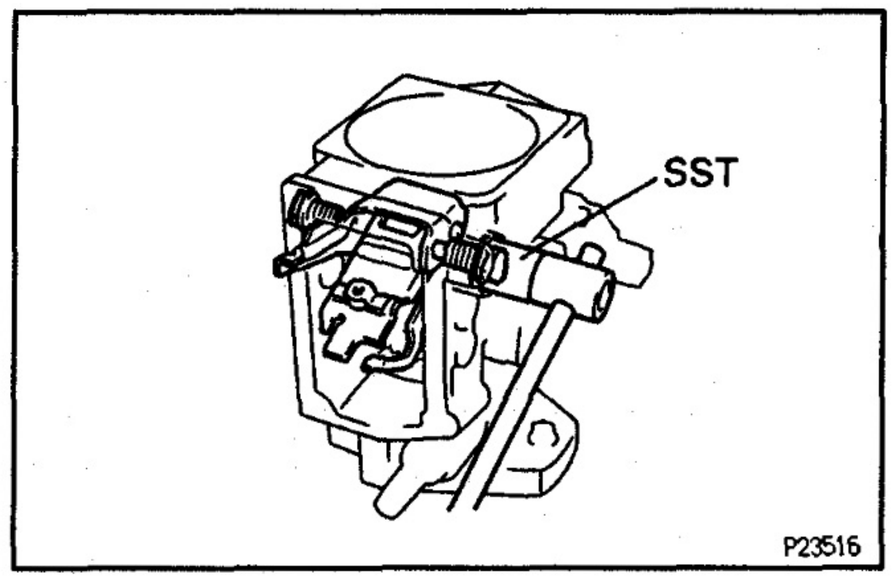
22. REMOVE PUMP PLUNGER

Using SST, remove the pump plunger and plunger adjusting shim together with these parts:

(1) Spill ring
(2) Lower spring seat
(3) Upper plunger plate
(4) Lower plunger plate

SST 09260–54012 (09269–54030)

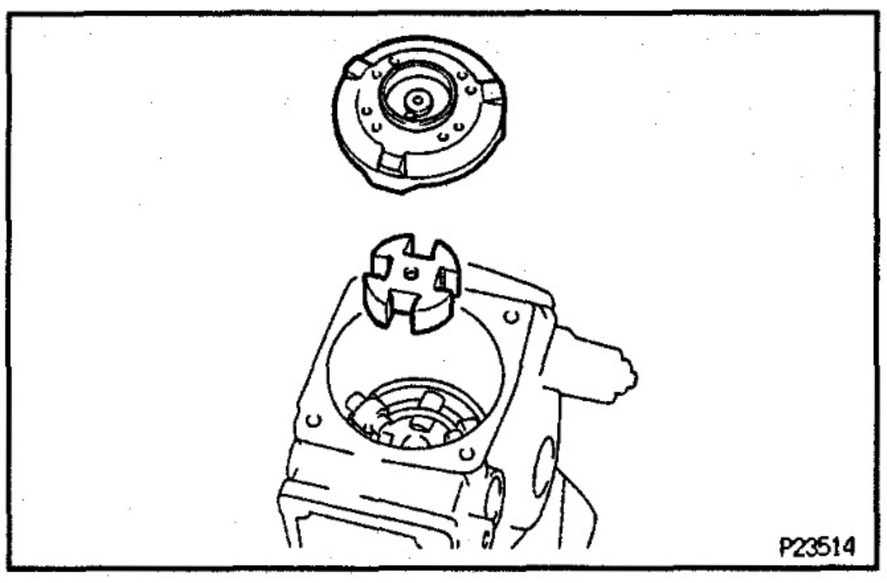
NOTICE: Do not touch the sliding surfaces of the pump plunger with your hand.



23. REMOVE GOVERNOR LINK

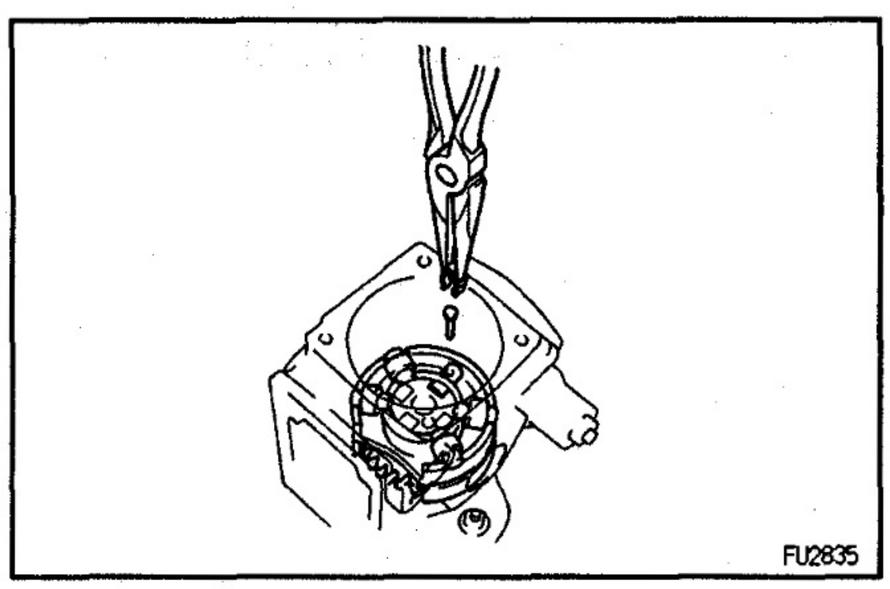
Using SST, remove the 2 support bolts, gaskets and governor link.

SST 09260–54012 (09269–54040)



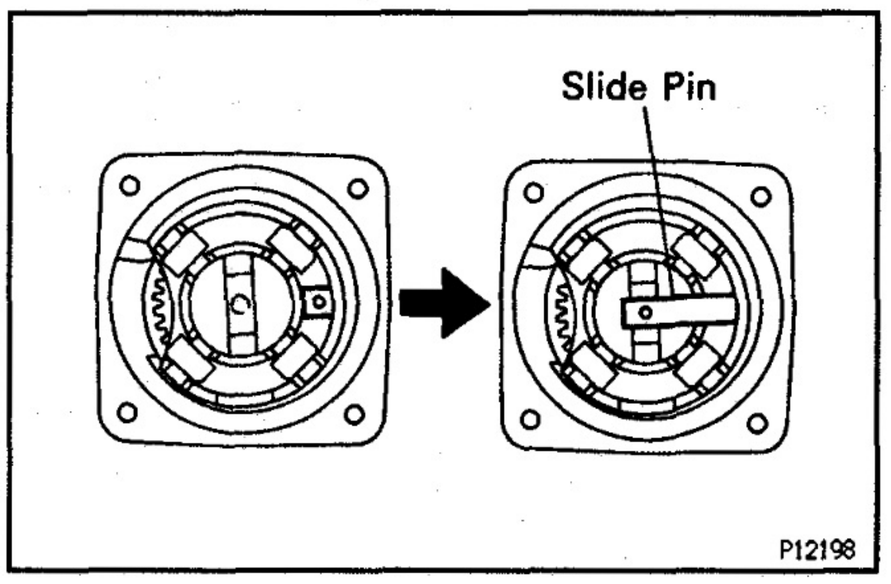
24. REMOVE FACE CAMPLATE AND COUPLING

Remove the face camplate and coupling.

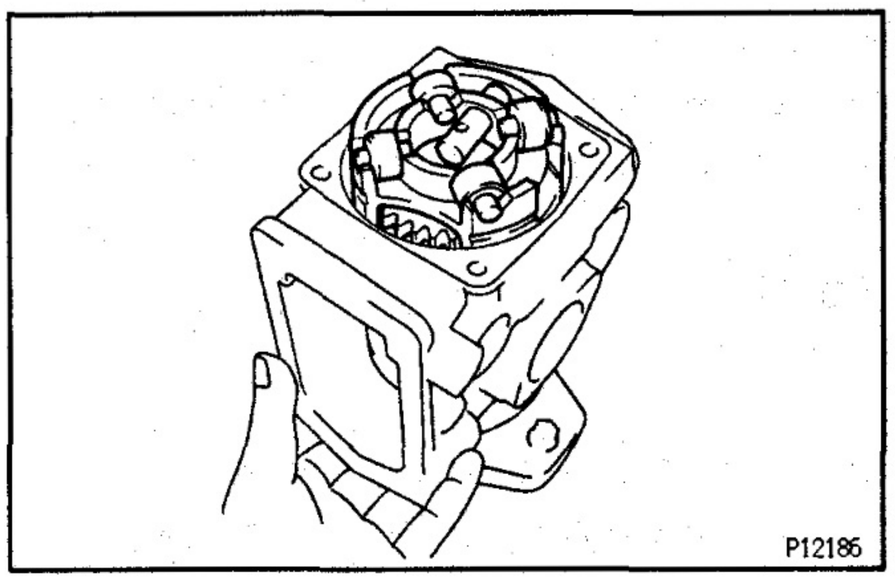


25. REMOVE ROLLER RING AND DRIVE SHAFT

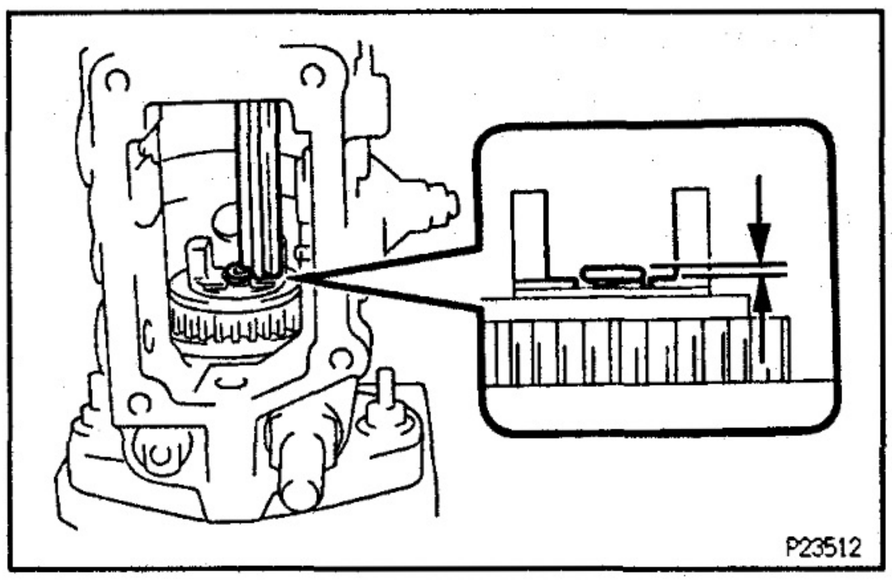
(a) Remove the timer clip and stopper pin.



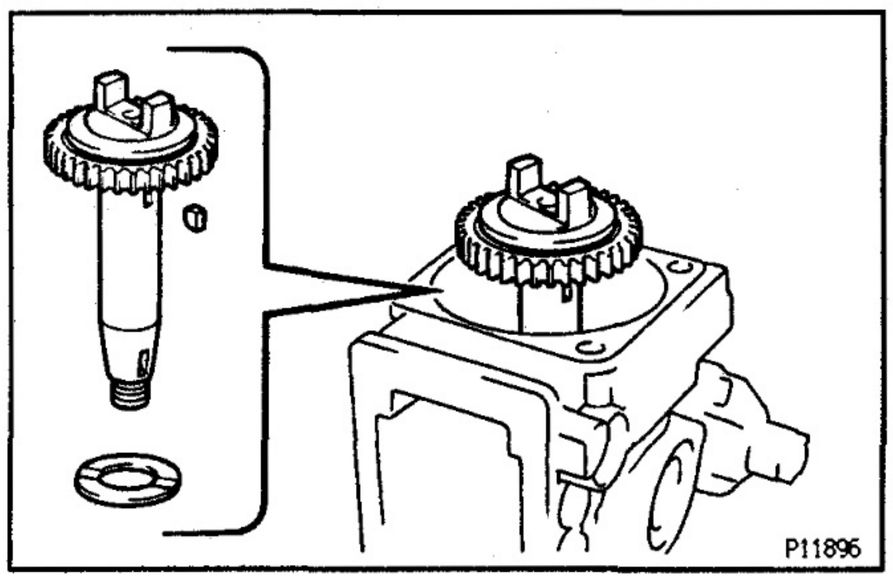
(b) Push the slide pin toward inside.



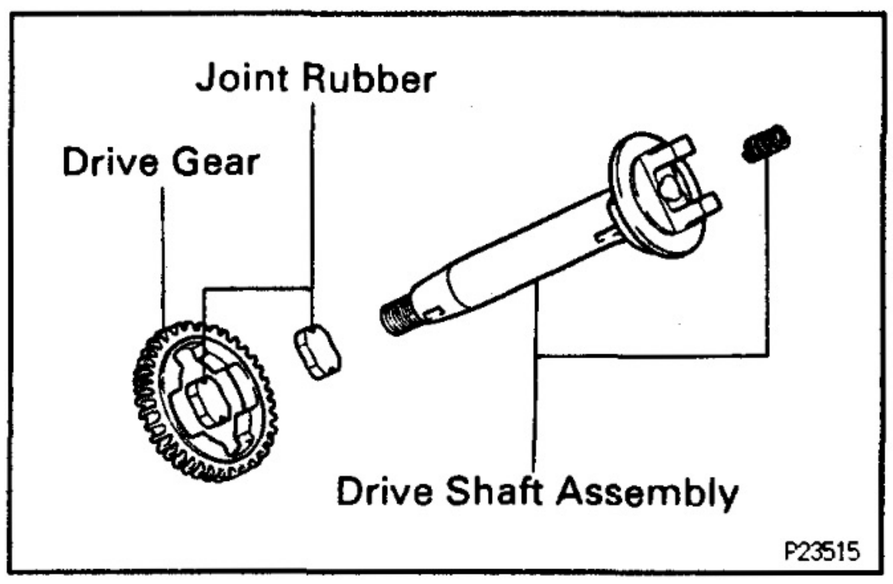
(c) Push the drive shaft, and remove the roller ring, 4 rollers and shims assembly.
NOTICE:
- **Be careful not to drop the rollers.**
- **Do not alter the position or assembly of the rollers.**



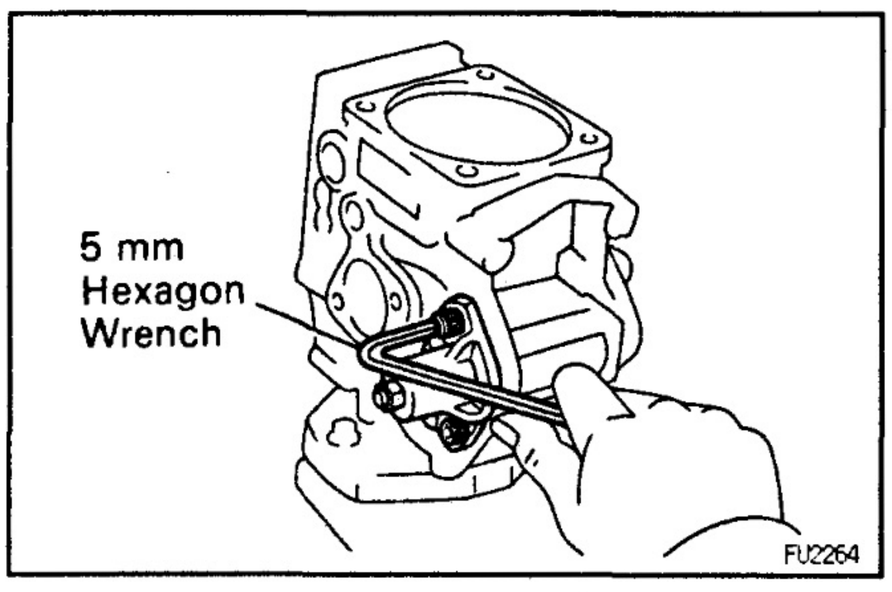
(d) Using vernier calipers, measure the protrusion of the coupling spring.
Protrusion:
1.0 – 1.4 mm (0.03937 – 0.05512 in.)
If the protrusion is not as specified, replace the coupling spring.
NOTICE: Do not remove the coupling spring unless necessary. If you remove the coupling spring, replace it with a new one.



(e) Remove the drive shaft, governor drive gear, 2 joint rubbers assembly, set key and drive shaft washer.

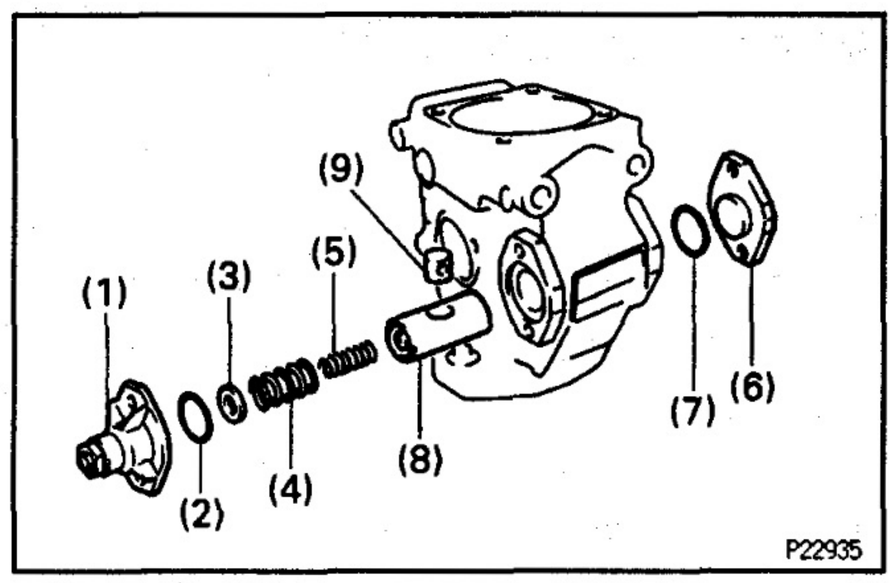


(f) **Remove the drive gear and 2 joint rubbers from the drive shaft assembly.**



26. REMOVE TIMER

(a) Using a 5 mm hexagon wrench, remove the 4 bolts.

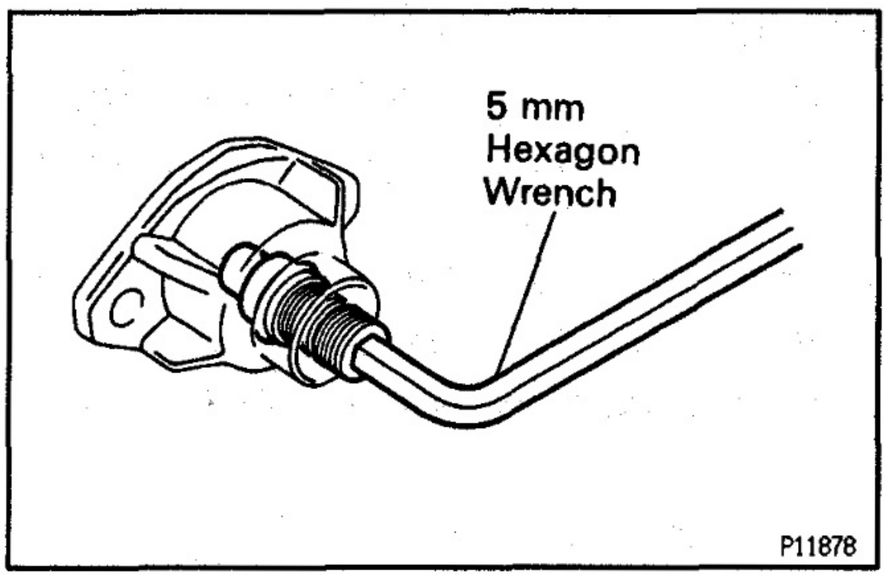


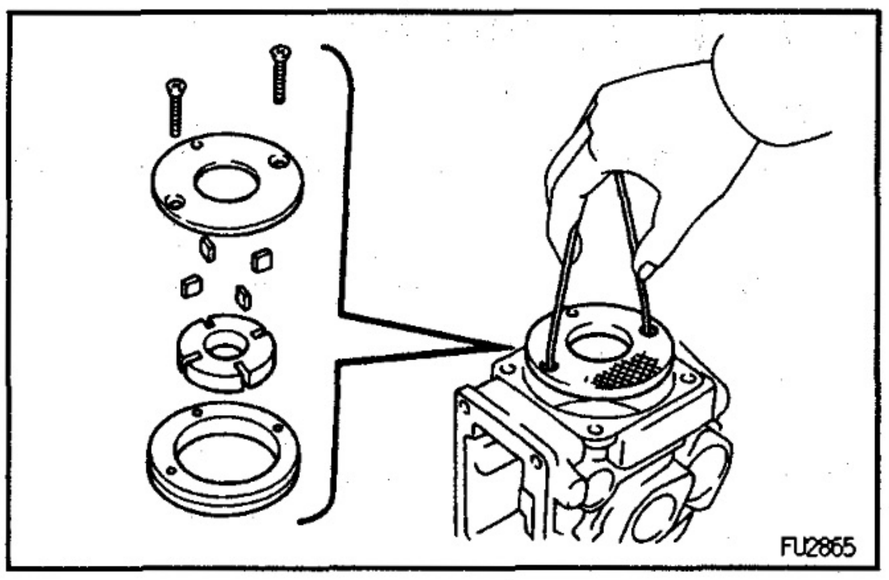
(b) Remove these parts:
(1) LH timer cover, timer adjusting screw and nut assembly
(2) O–ring
(3) Shim
(4) Outer spring
(5) Inner spring
(6) RH timer cover
(7) O–ring
(8) Piston
(9) Sub–piston

(c) Remove the nut from the LH timer cover.

(d) Using a 5 mm hexagon wrench, remove the timer adjusting screw.

(e) Remove the O–ring from the timer adjusting ring.





27. REMOVE FUEL FEED PUMP

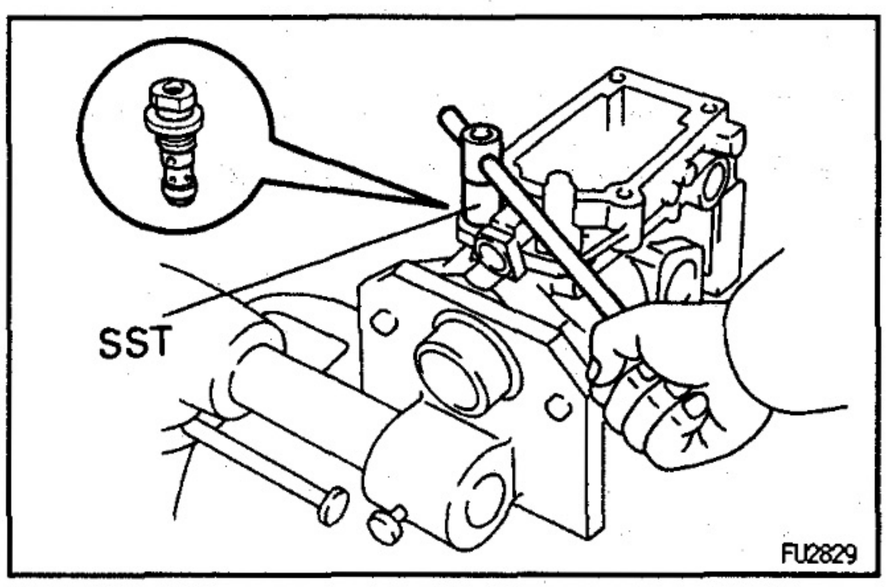
(a) Remove the 2 screws.

(b) Using a piece of wire, remove the feed pump cover.

(c) Remove the feed pump rotor, 4 blades and liner.

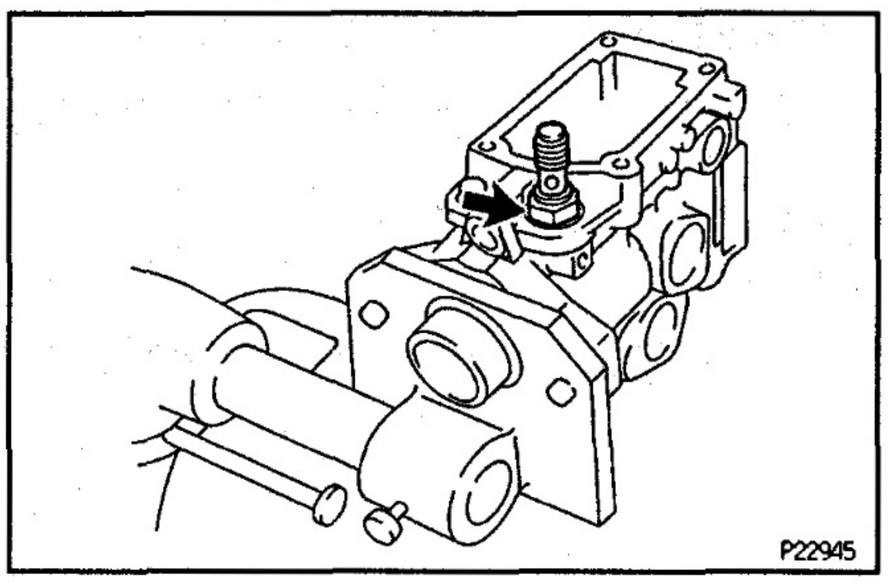
NOTICE:

- **Be careful not to interchange the blade positions.**
- **Be careful not to damage the pump body.**



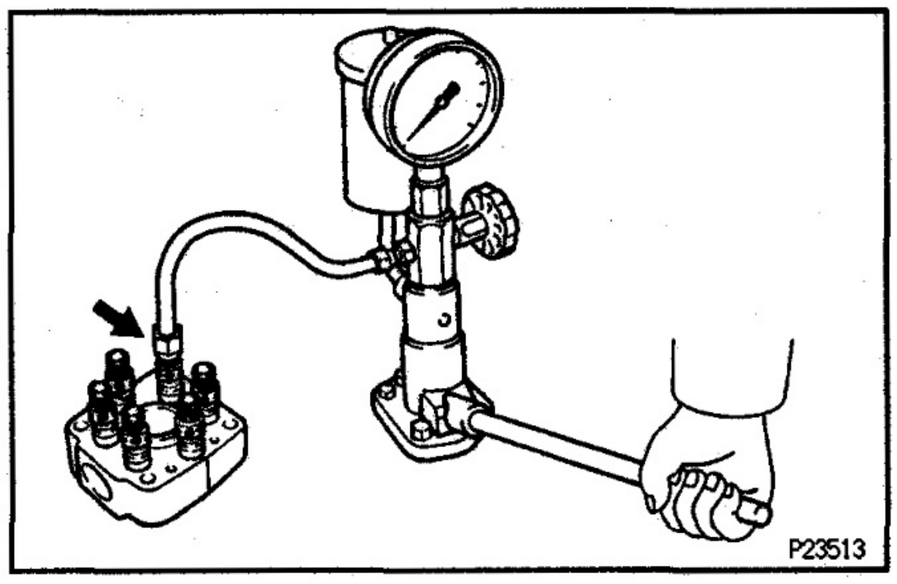
28. REMOVE REGULATOR VALVE

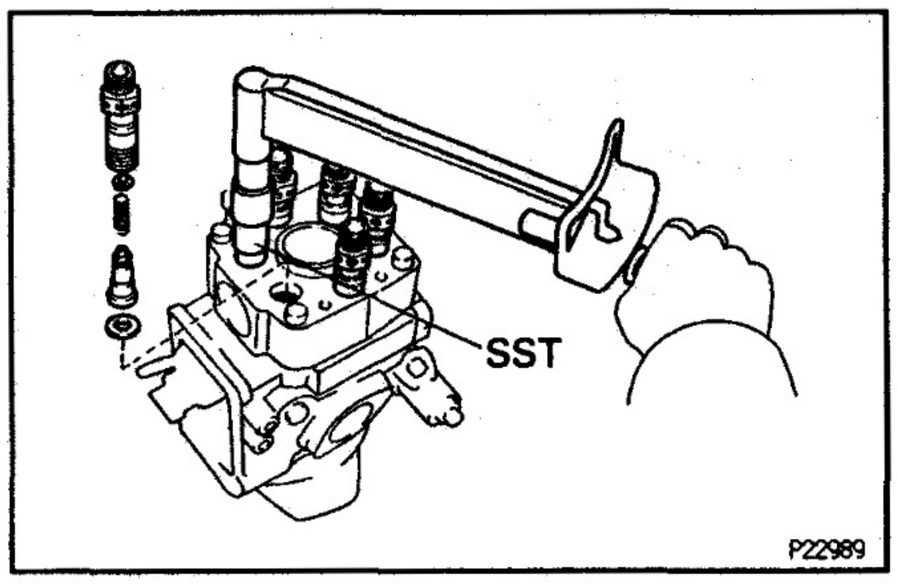
Using SST, remove the regulator valve and 2 O–rings.
SST 09260–54012 (09262–54020)

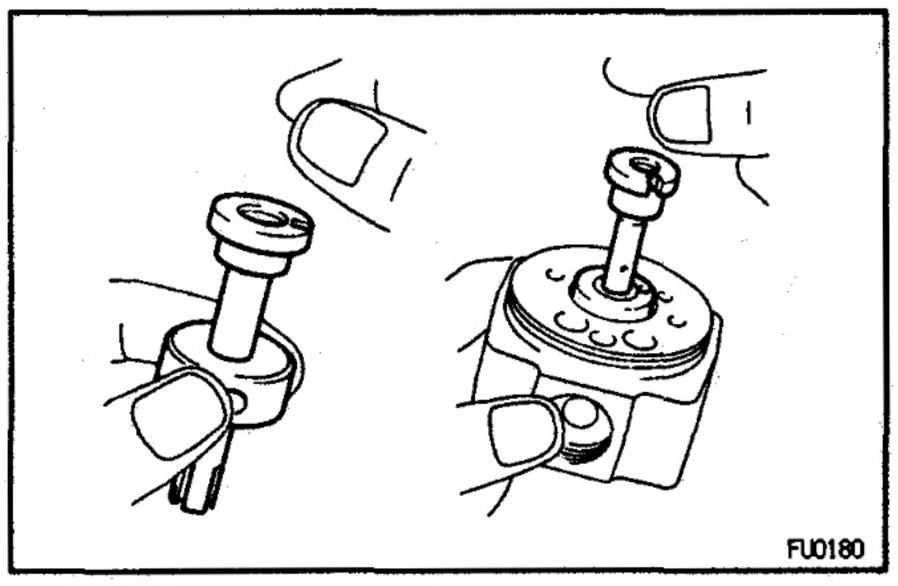


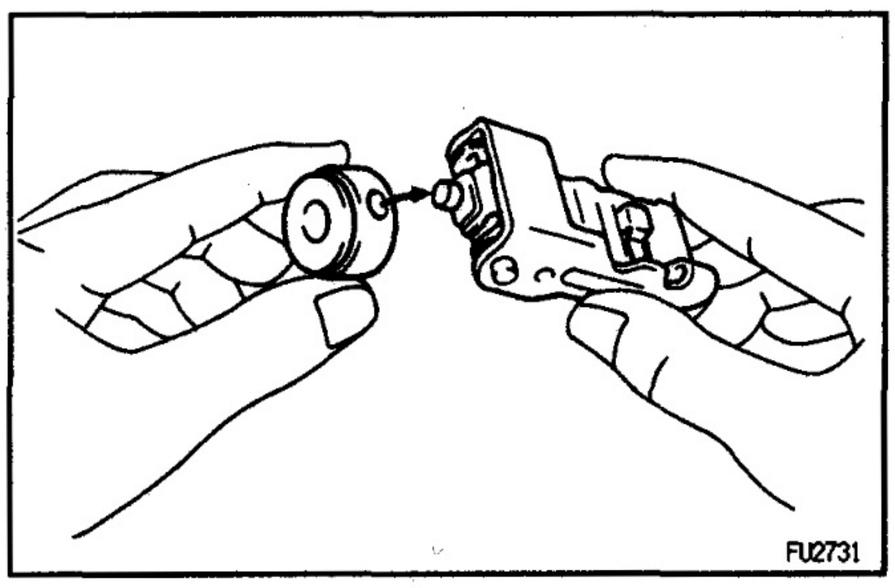
29. REMOVE FUEL INLET HOLLOW SCREW

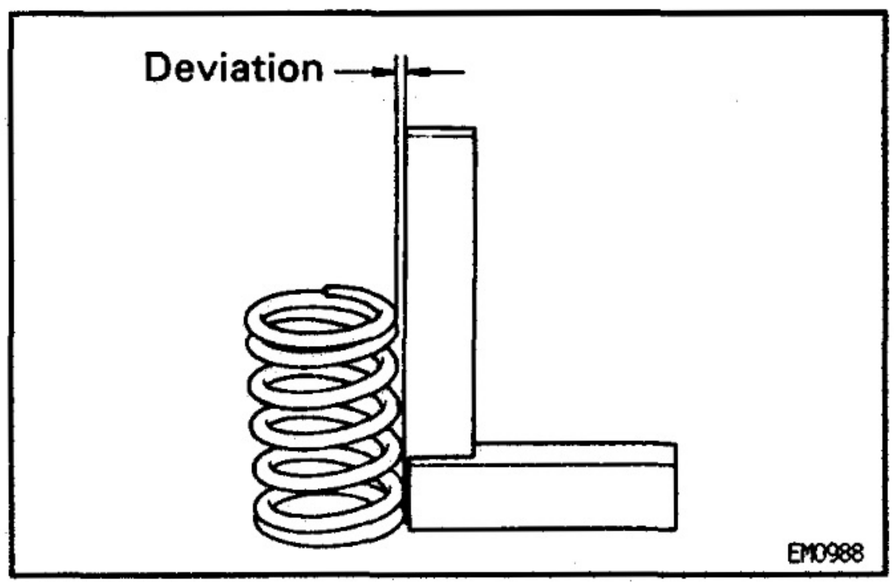
Remove the hollow screw and gasket.











INJECTION PUMP COMPONENTS INSPECTION

B0SD-01

1. INSPECT DELIVERY VALVES

(a) Attach the nozzle tester to the delivery valve holder of the pipe you wish to measure.

(b) Use the nozzle tester to check the valve opening pressure of the delivery valve.

Standard valve opening pressure:

7,350 – 8,330 kPa

(75 – 85 kgf/cm², 1,067 – 1,209 psi)

If the valve opening pressure of the delivery valve is not within specification, replace the delivery valve assembly.

SST 09260–54012 (09269–54020)

Torque: 59 N·m (600 kgf·cm, 43 ft·lbf)

NOTICE: Do not lose the steel ball when doing an overhaul.

2. INSPECT PUMP PLUNGER, SPILL RING AND DISTRIBUTIVE HEAD

(a) Tilt the spill ring (distributive head) slightly and pull out the plunger.

(b) When released, the plunger should sink down smoothly into the spill ring (distributive head) by its own weight.

(c) Rotate the plunger and repeat the test at various positions.

If the plunger sticks at any position, replace the parts as a set.

(d) Insert the governor link ball pin into the spill ring and check that it moves smoothly without any play.

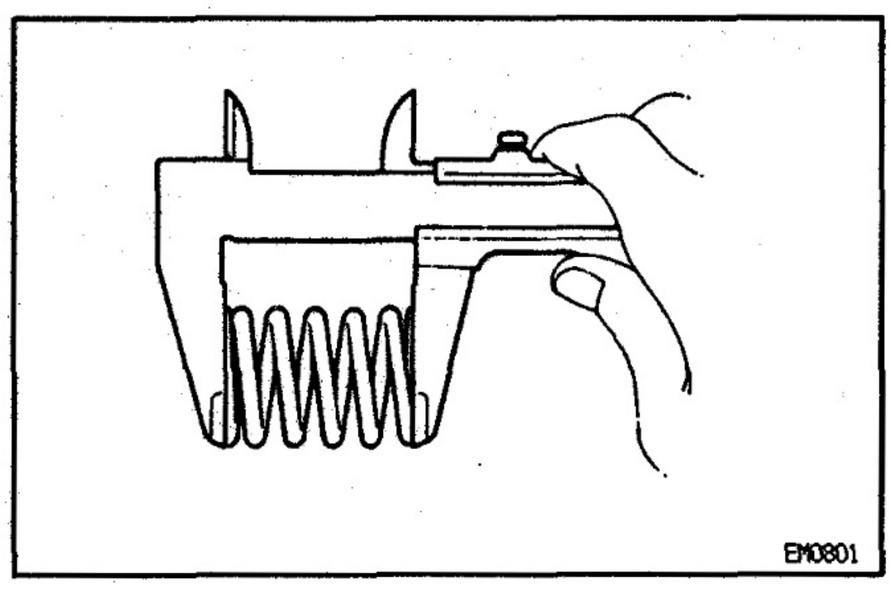
3. INSPECT PLUNGER SPRINGS FOR DEVIATION

Using a steel square, check the deviation of the plunger springs.

Maximum deviation:

2.0 mm (0.079 in.)

If deviation is greater than maximum, replace the springs.



4. INSPECT SPRING LENGTH

Using vernier calipers, measure the free length of each spring.

Spring free length:

Delivery valve spring

12.6 mm (0.496 in.)

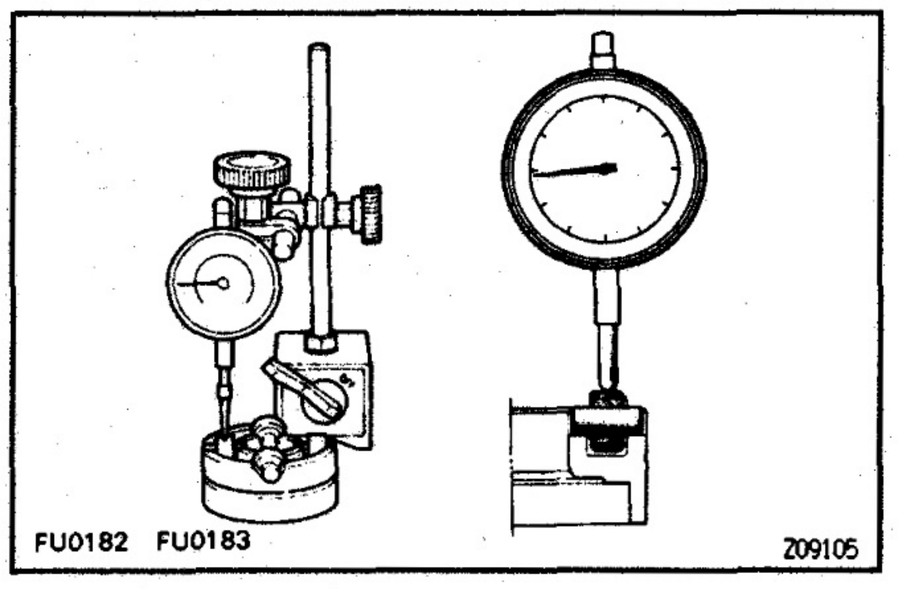
Plunger spring

34.09 mm (1.342 in.)

Boost compensator spring

19.4 mm (0.764 in.)

If the free length is not as specified, replace the spring (s).



5. INSPECT ROLLER RING AND ROLLERS

Using a dial indicator, measure the roller height.

Maximum roller height variation:

0.02 mm (0.0008 in.)

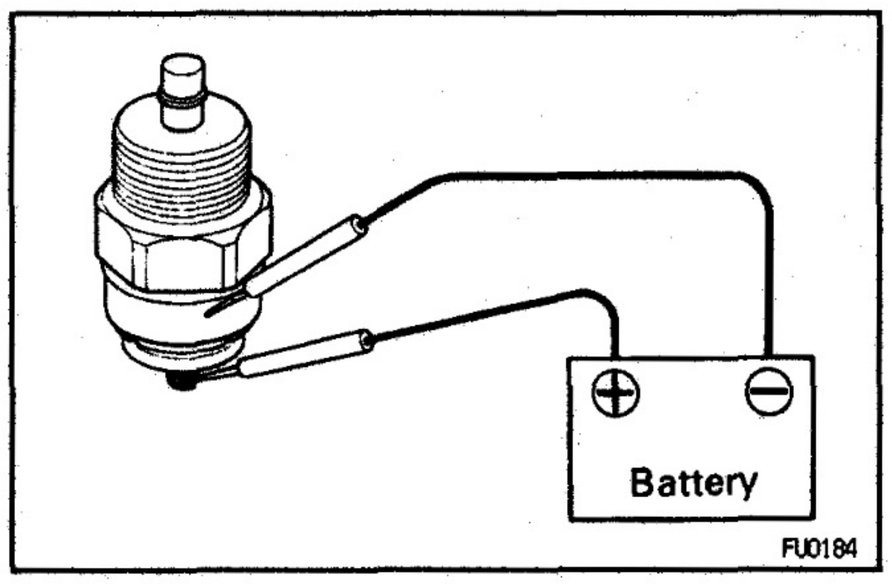
If the variation is greater than specification, replace the roller ring and roller as a set.

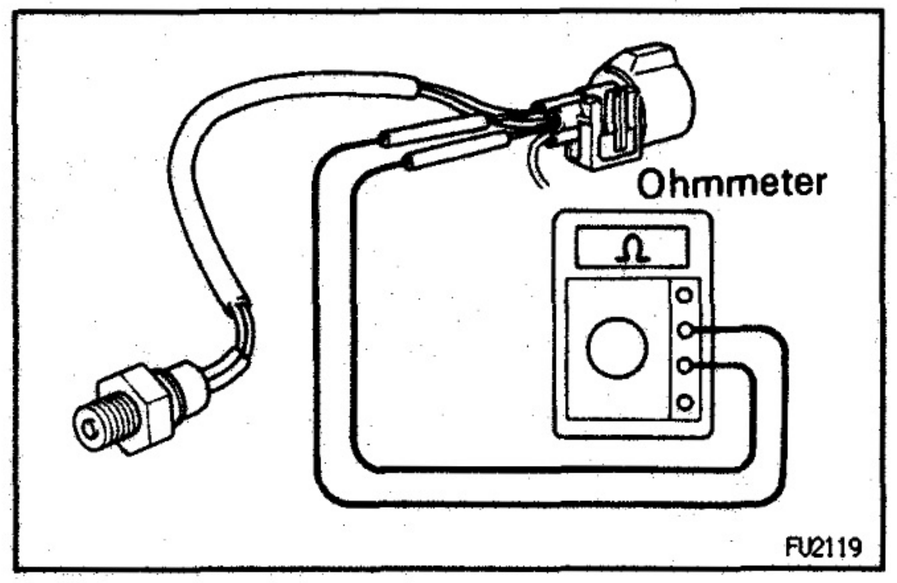
6. INSPECT FUEL CUT SOLENOID

(a) Connect the solenoid valve body and terminal to the battery terminals.

(b) You should feel the click from the solenoid valve when the battery power is connected and disconnected.

If the solenoid valve is not operating properly, replace it.





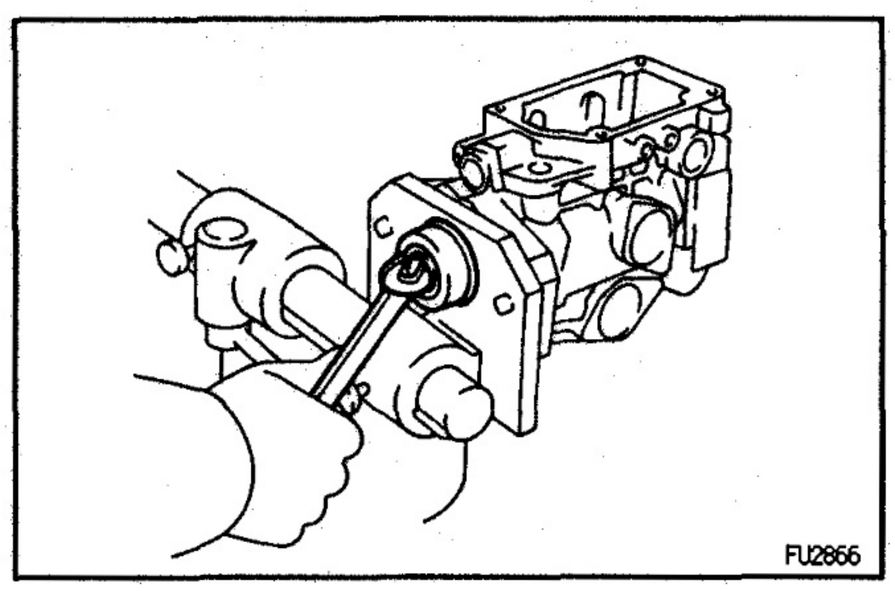
7. INSPECT PICKUP SENSOR

Using an ohmmeter, measure the resistance between the terminals.

Resistance:

650 – 970 Ω

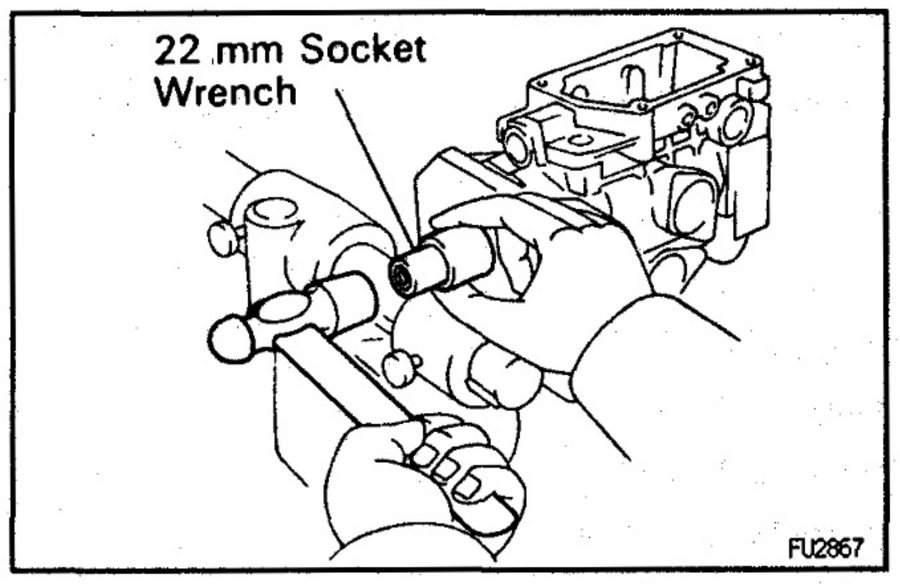
If resistance is not as specified, replace the sensor.



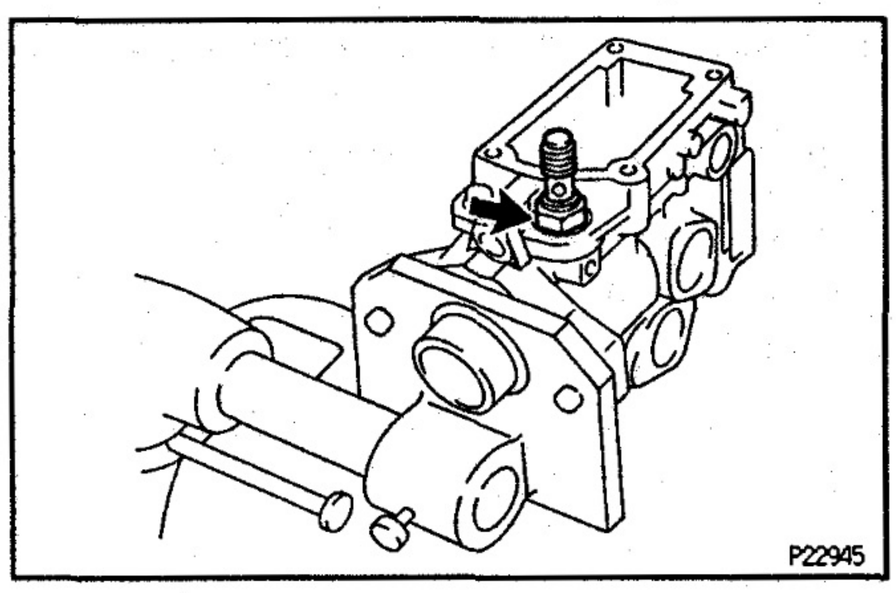
8. IF NECESSARY, REPLACE OIL SEAL

(a) Using a wrench, pry out the oil seal.

NOTICE: Be careful not to damage to the pump body.



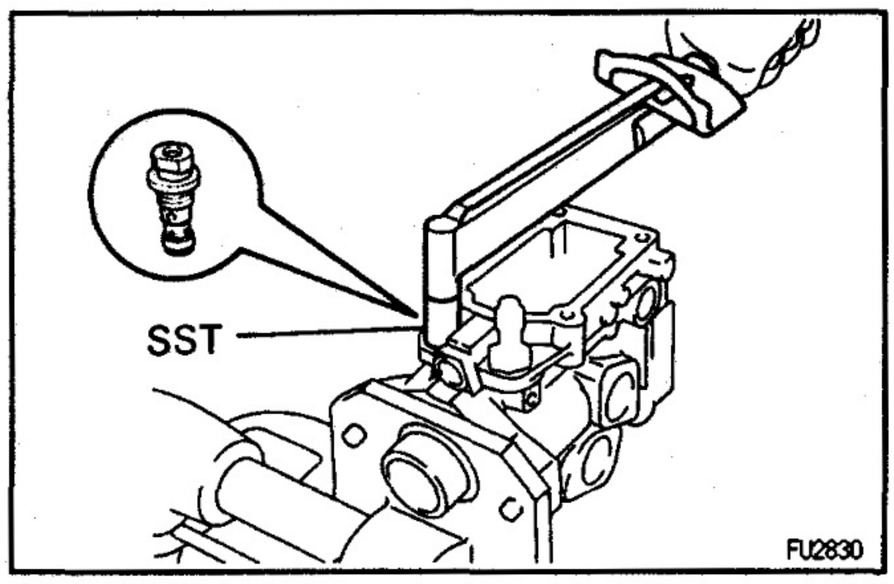
(b) Apply MP grease to the lip of a new oil seal.
(c) Using a 22 mm socket wrench, tap in the oil seal until its surface is flush with the pump housing.



INJECTION PUMP ASSEMBLY

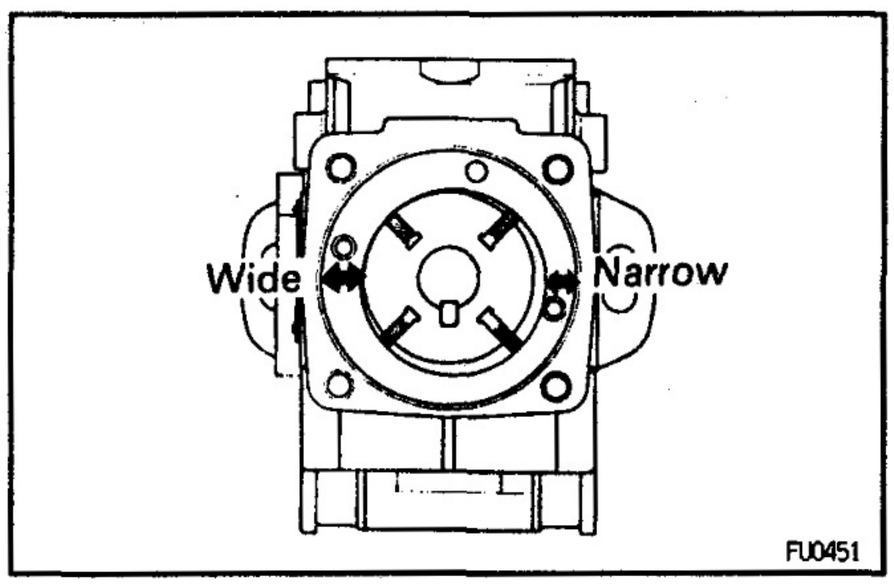
1. INSTALL FUEL INLET HOLLOW SCREW

Install a new gasket and the hollow screw.
Torque: 37 N·m (375 kgf·cm, 27 ft·lbf)



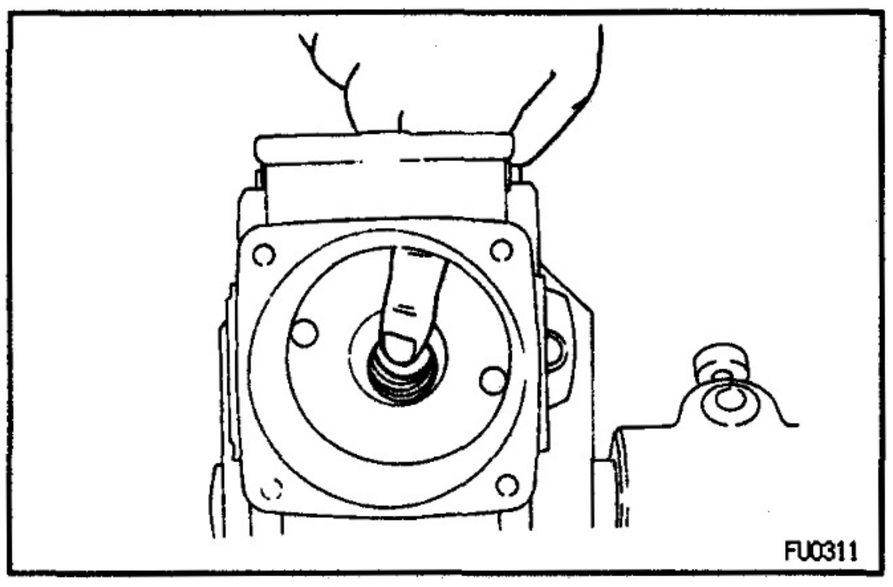
2. INSTALL REGULATOR VALVE

(a) Install 2 new O–rings to the regulator valve.
(b) Using SST, install the regulator valve.
SST 09260–54012 (09262–54020)
Torque: 8.8 N·m (90 kgf·cm, 78 in.·lbf)

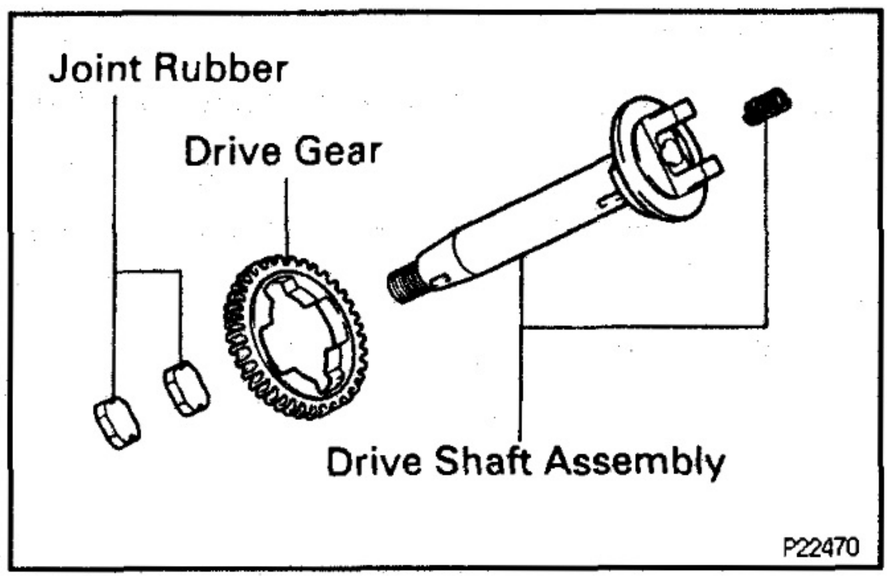


3. INSTALL FUEL FEED PUMP

(a) Install the liner, rotor and 4 blades.
(b) Check that the liner and blades are facing in the correct direction, as shown.
(c) Check that the blades move smoothly.
(d) Align the fuel outlet holes of the cover and liner.
(e) Install the pump cover with the 2 screws.
Torque: 3.0 N·m (31 kgf·cm, 27 in.·lbf)



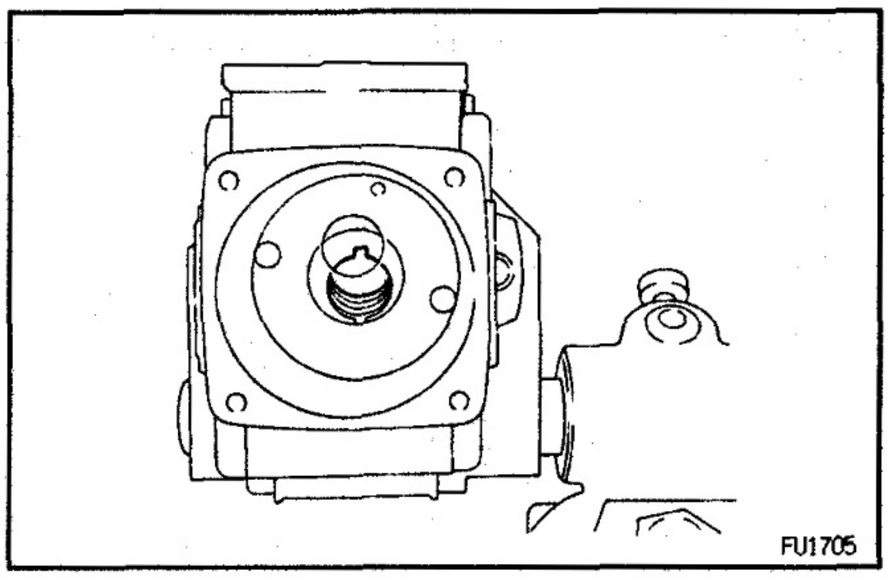
(f) Check that the rotor moves smoothly.



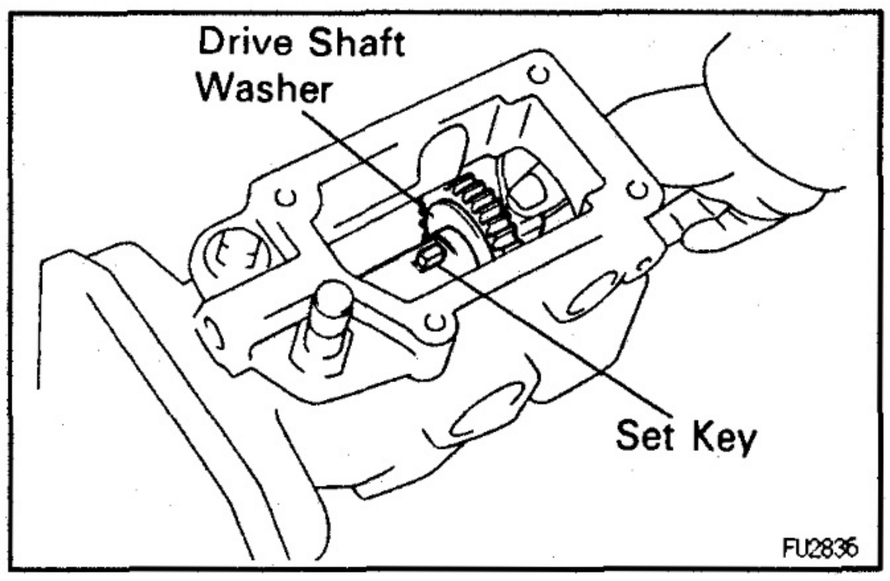
4. INSTALL DRIVE SHAFT

(a) Install the drive gear on the drive shaft assembly as shown.

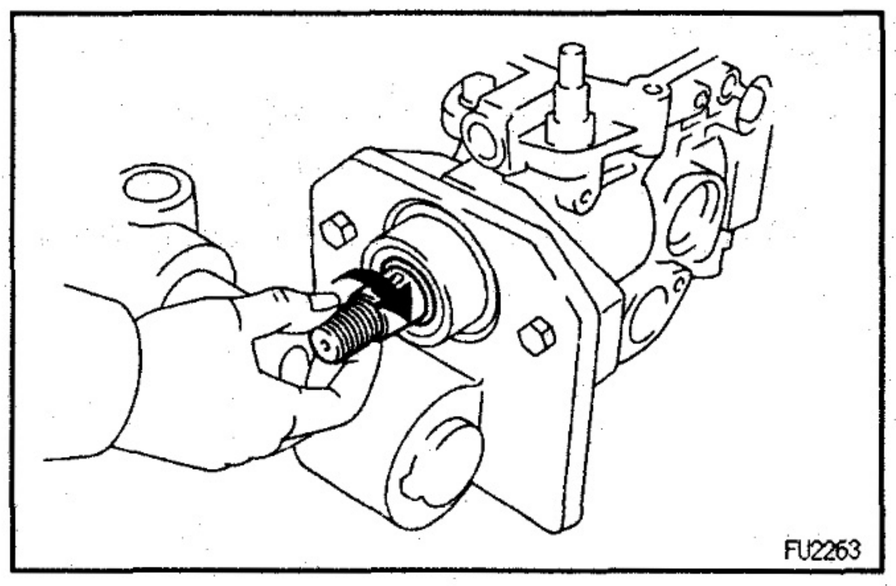
(b) Install 2 new joint rubbers into the drive gear.



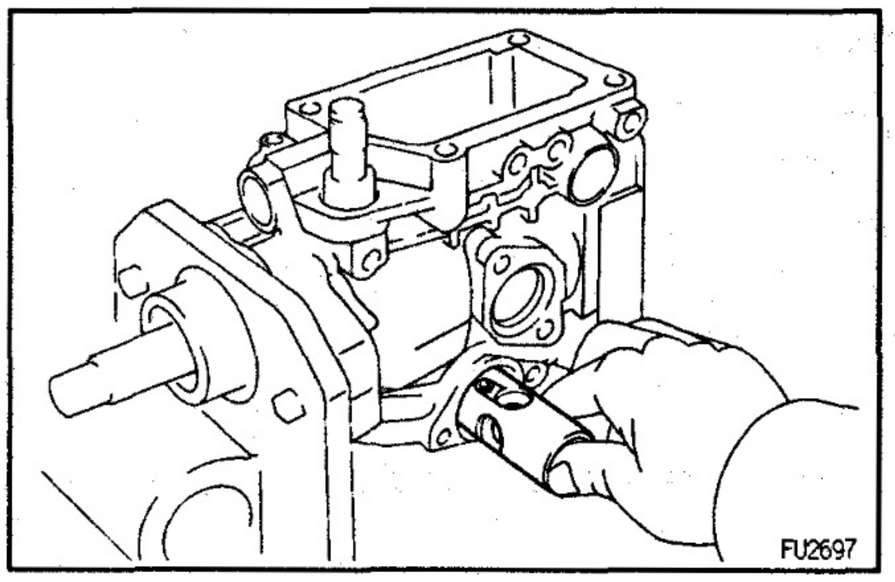
(c) Position the key groove of the feed pump rotor upward.



(d) Install the drive shaft washer and set key on the drive shaft and insert the drive shaft assembly into the pump housing.



(e) Check that the drive shaft turns without catching.



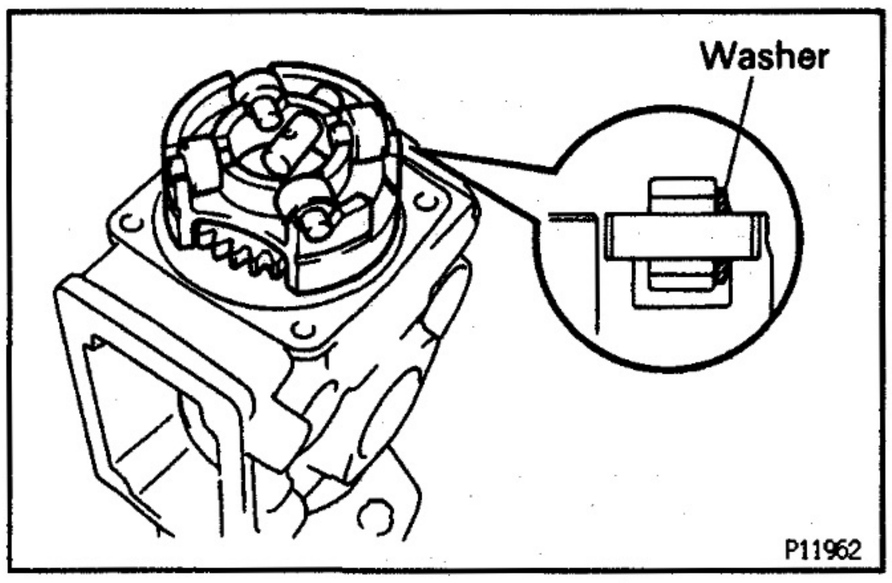
5. INSTALL TIMER PISTON

(a) Apply grease to the timer piston.

(b) Install the sub–piston into the timer piston.

(c) Insert the timer piston into the pump housing.

EG

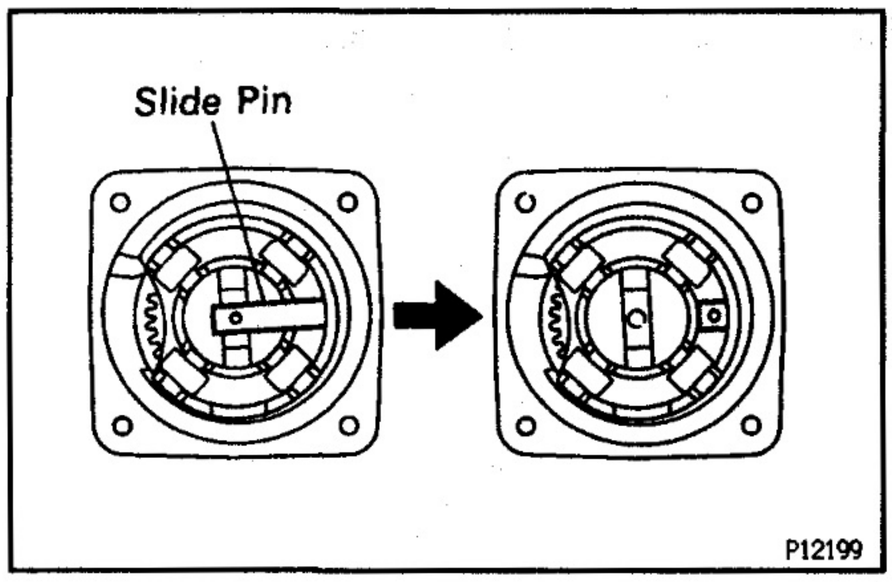


6. INSTALL ROLLER RING

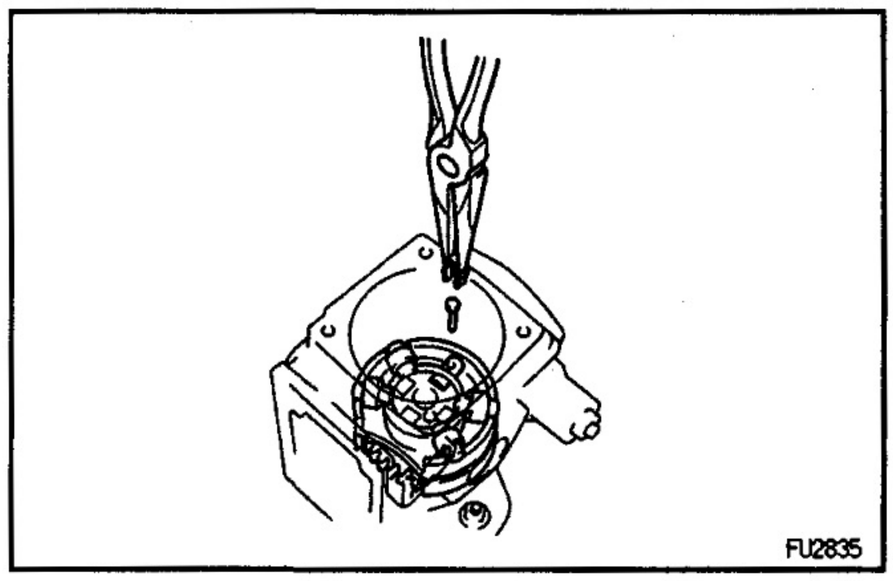
(a) Install the slide pin, 4 rollers and 4 washers on the roller ring.

(b) Check that the roller is facing the flat surface of the washer.

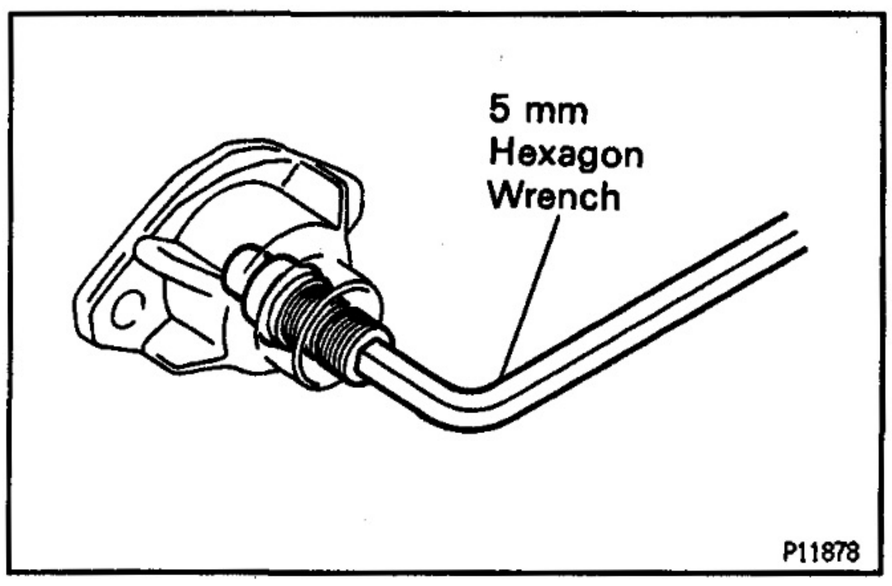
(c) Install the roller ring into the pump housing.



(d) Carefully install the slide pin into the sub–piston.



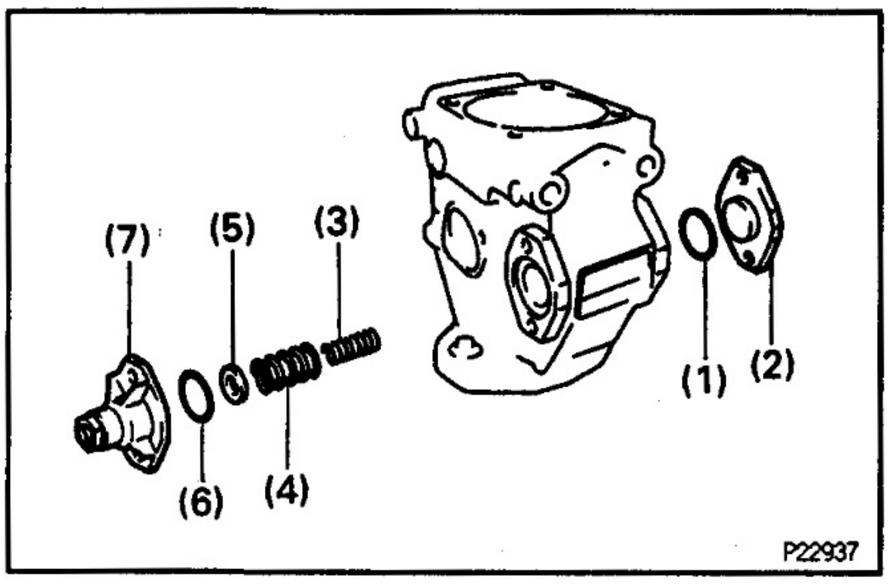
(e) Install the stopper pin and clip.



7. INSTALL TIMER SPRING

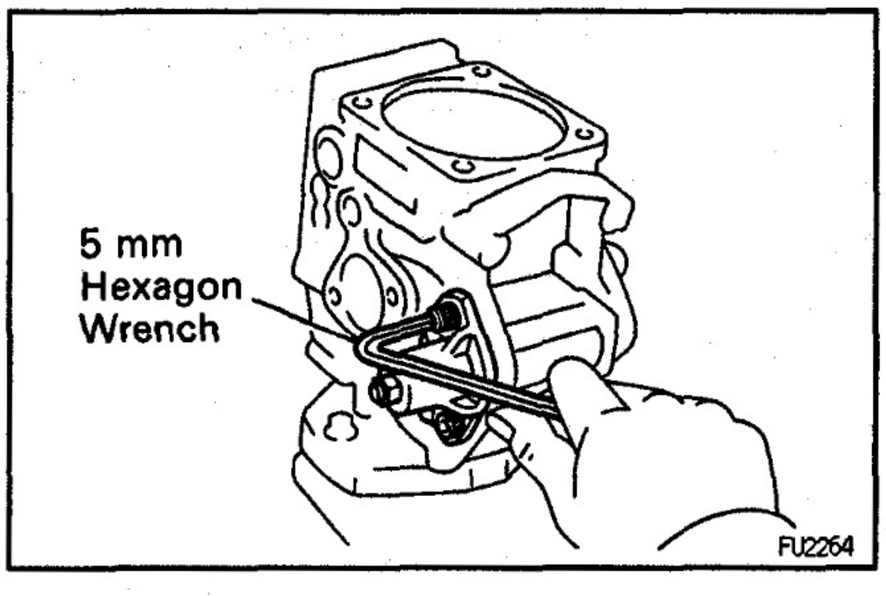
(a) Install a new O–ring to the timer adjusting screw.

(b) Using a 5 mm hexagon wrench, install the timer adjusting screw to the LH timer cover and temporarily install the nut.

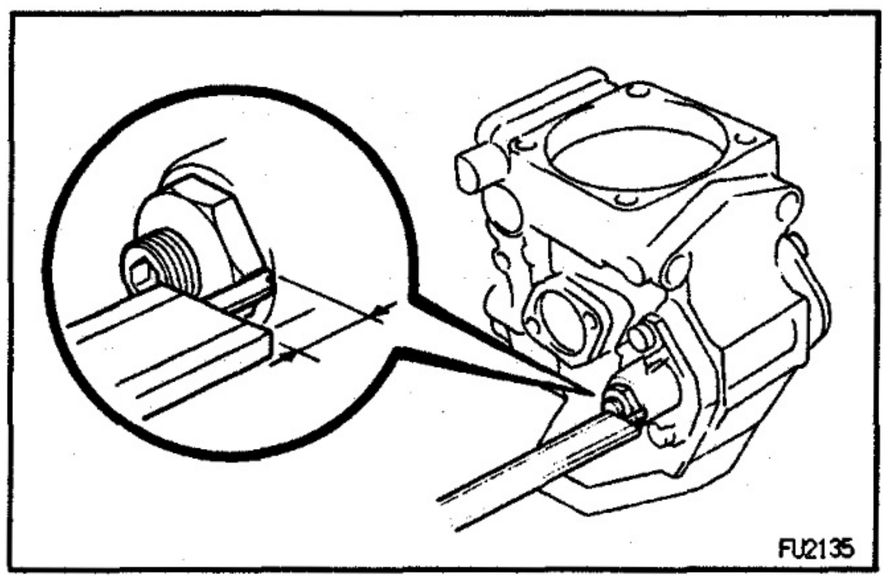


(c) Install these parts:

(1) New O–ring
(2) RH timer cover
(3) Inner spring
(4) Outer spring
(5) Shim
(6) New O–ring
(7) LH timer cover, timer adjusting screw and nut assembly

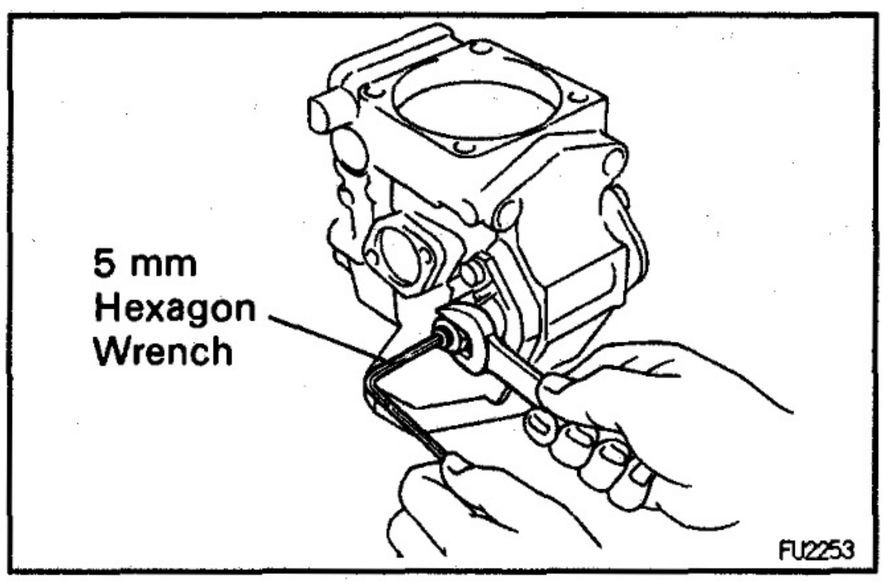


(d) Using a 5 mm hexagon wrench, install the 4 bolts.
Torque: 8.35 N·m (85 kgf·cm, 74 in.·lbf)



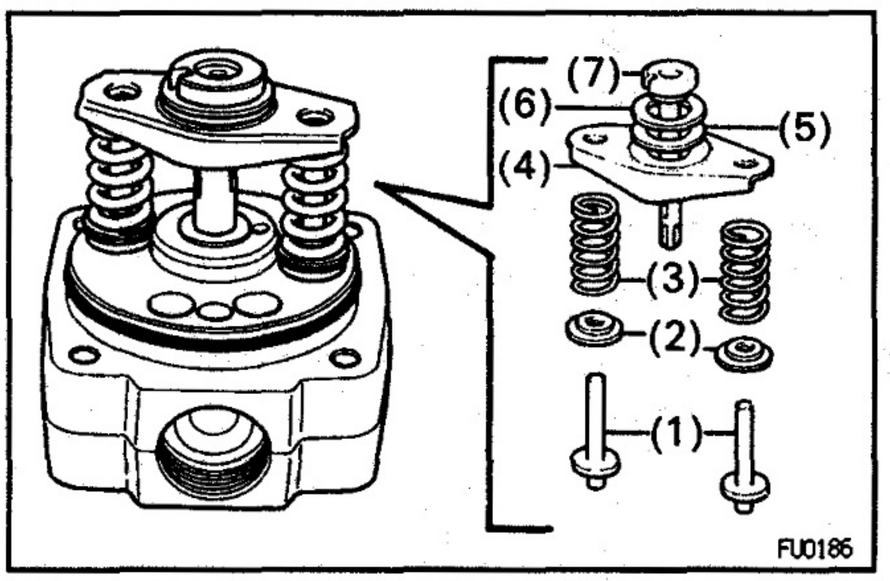
8. PRESET TIMER ADJUSTING SCREW

(a) Using vernier calipers, measure the protrusion of the adjusting screw from the timer cover.
Protrusion:
7.5 – 8.0 mm (0.295 – 0.315 in.)



(b) Using a 5 mm hexagon wrench, adjust the protrusion of the adjusting screw from the timer cover.

(c) Tighten the nut.
Torque: 14.2 N·m (145 kgf·cm, 11 ft·lbf)



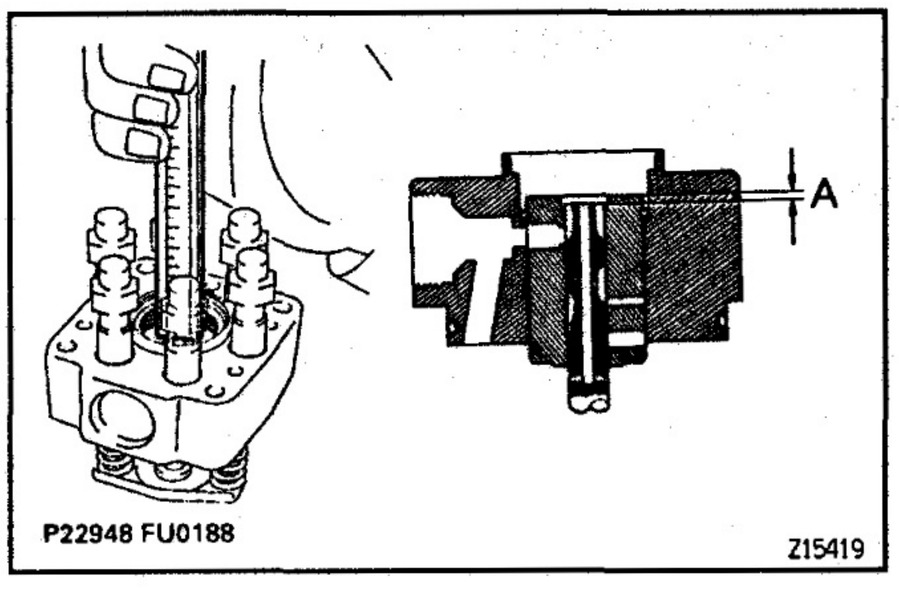
9. ADJUST PLUNGER SPRING SHIM

(a) Install these parts to the distributive head:
(1) 2 plunger spring guides
(2) 2 upper spring seats
(3) 2 plunger springs
(4) Lower spring seat
(5) Upper plunger plate
(6) Lower plunger plate
(7) Pump plunger
HINT: Do not assemble the plunger spring shims at this time.

(b) Using vernier calipers, measure clearance A indicated in the illustration.

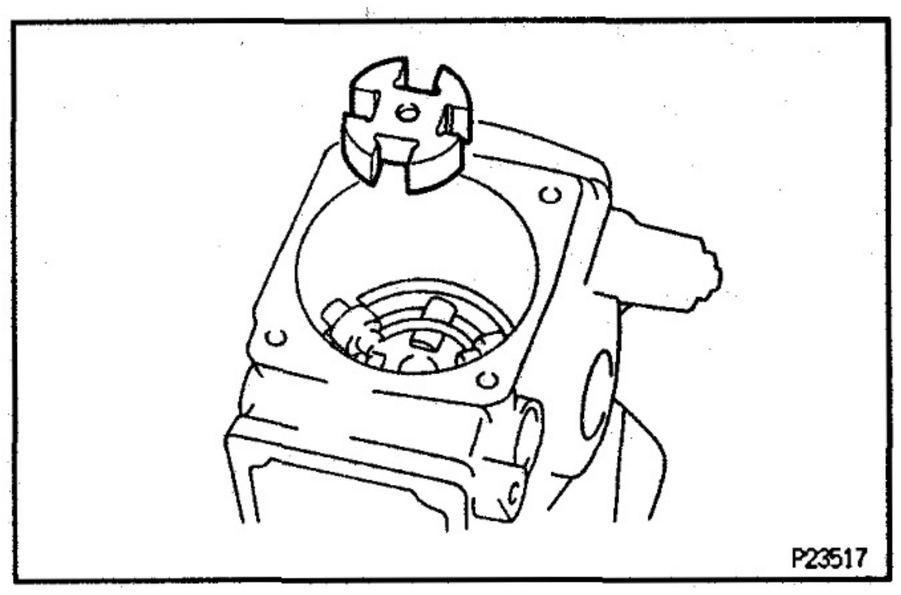
(c) Determine the plunger spring shim size by using these formula and chart.
New plunger spring shim thickness = 7.0 – A
A ... Measured plunger position

EG



Plunger spring shim selection chart: mm (in.)

Measured clearance	Shim thickness
More than 6.5 (0.256)	0.5 (0.020)
6.2 – 6.4 (0.248 – 0.252)	0.8 (0.031)
6.0 – 6.1 (0.236 – 0.240)	1.0 (0.039)
5.8 – 5.9 (0.228 – 0.232)	1.2 (0.047)
5.5 – 5.7 (0.217 – 0.224)	1.5 (0.059)
5.2 – 5.4 (0.205 – 0.213)	1.8 (0.071)
Less than 5.0 (0.197)	2.0 (0.079)

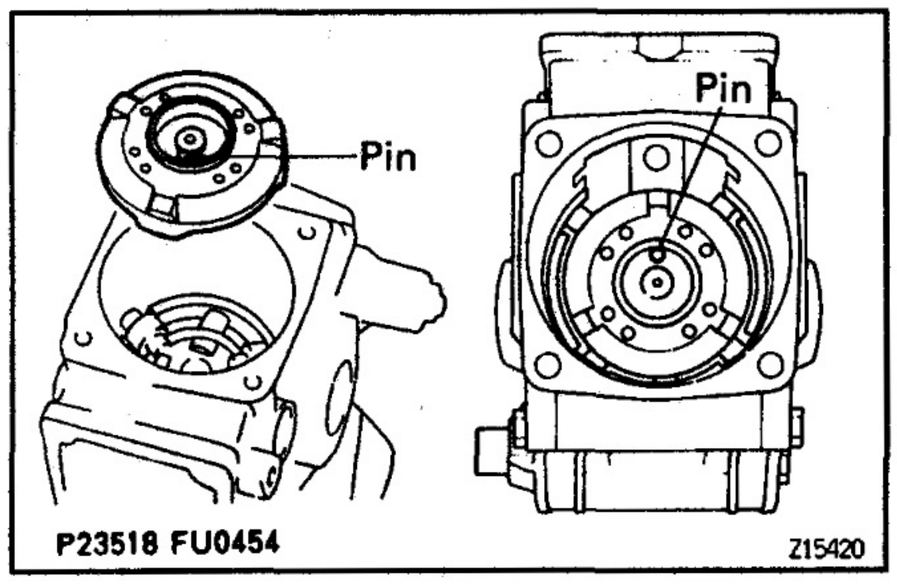


HINT:

- For a measurement between listed sizes, use the next larger size. For example, if thickness is 1.1 mm (0.043 in.) by calculation, use a 1.2 mm (0.047 in.) shim.
- Select 2 shims which have the same thickness.

10. INSTALL COUPLING

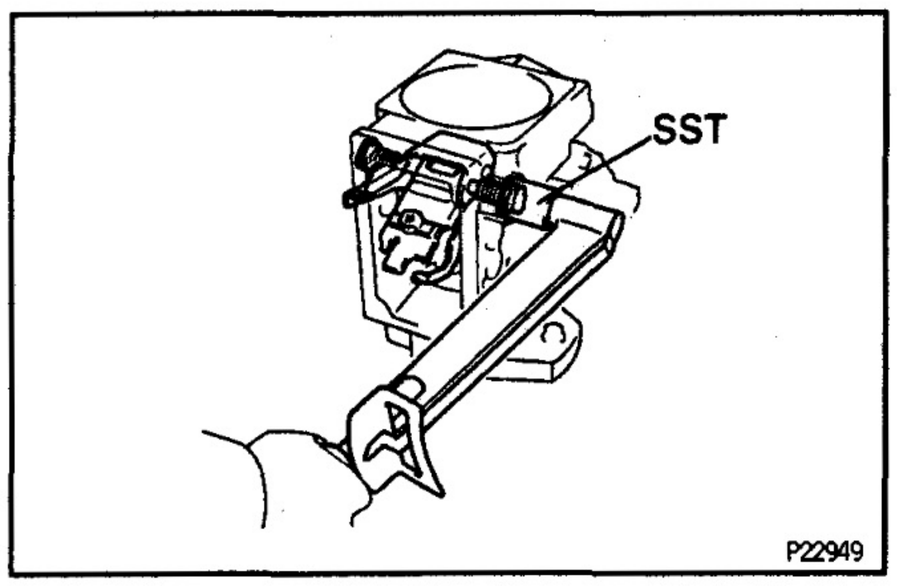
Install the coupling.



11. INSTALL FACE CAMPLATE

(a) Face the drive shaft with the key groove facing upward.

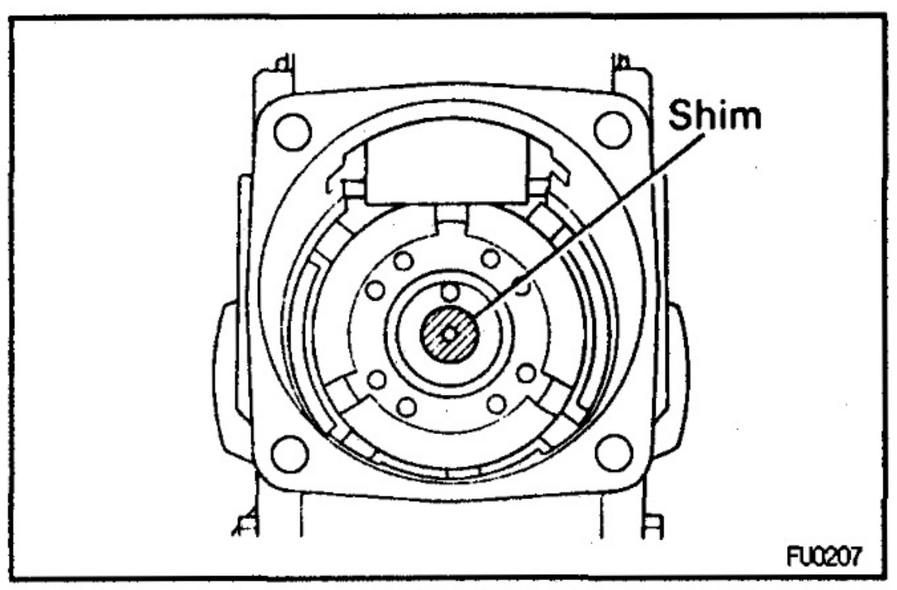
(b) Install the camplate with the camplate pin facing the governor cover side.



12. INSTALL GOVERNOR LINK

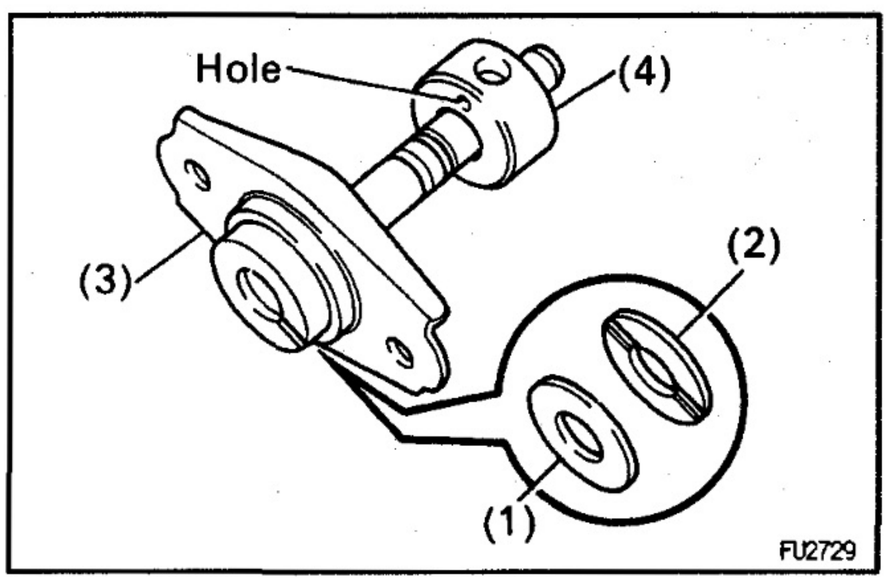
(a) Using SST, install the governor link with 2 new gaskets and the 2 support bolts.
Torque: 14 N·m (140 kgf·cm, 10 ft·lbf)
SST 09260–54012 (09269–54040)

(b) Check that the governor link moves smoothly.

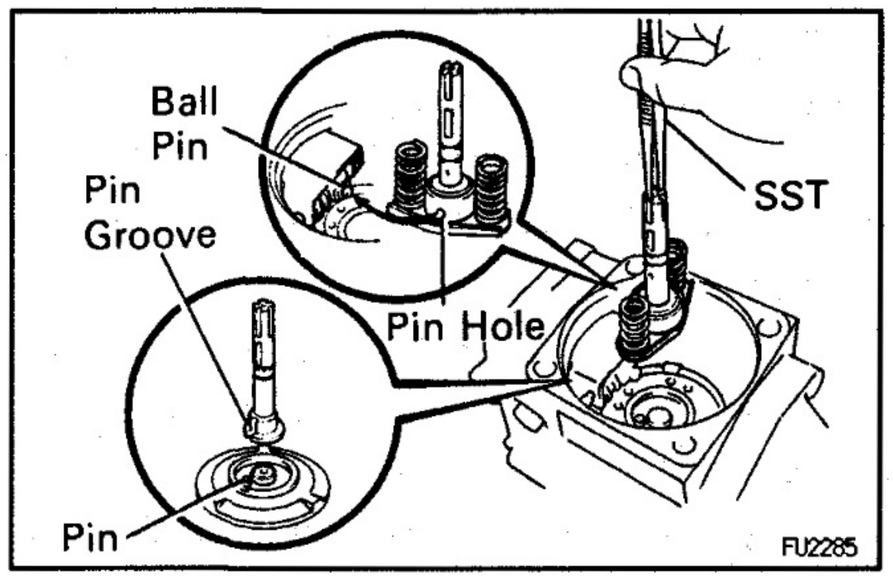


13. INSTALL PUMP PLUNGER

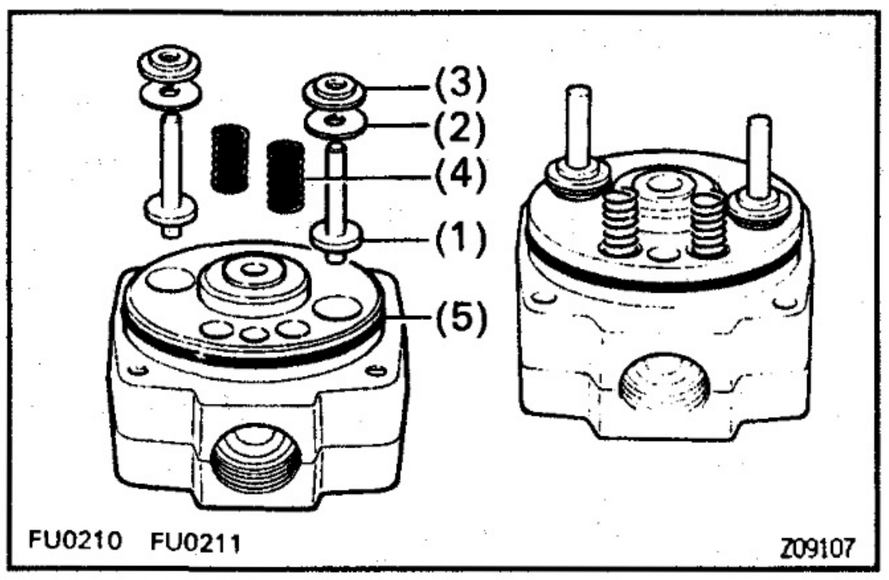
(a) Place the previously used plunger adjusting shim on the center of the camplate.
NOTICE: Do not apply grease to the shim.



(b) Install these parts to the pump plunger:
(1) Lower plunger plate
(2) Upper plunger plate
(3) Lower spring seat
(4) Spill ring
HINT: Face the spill ring with the hole facing the lower spring seat.

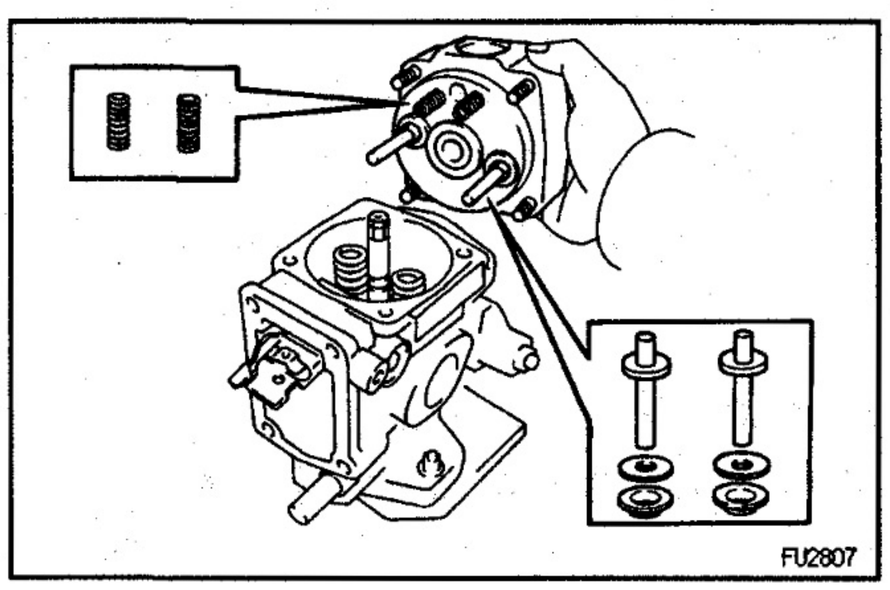


(c) Align the pin groove of the plunger with the pin of the face camplate.
(d) Align the ball pin of the governor link with the pin hole of the spill ring.
(e) Using SST, install the pump plunger and 2 plunger springs.
SST 09260–54012 (09269–54030)

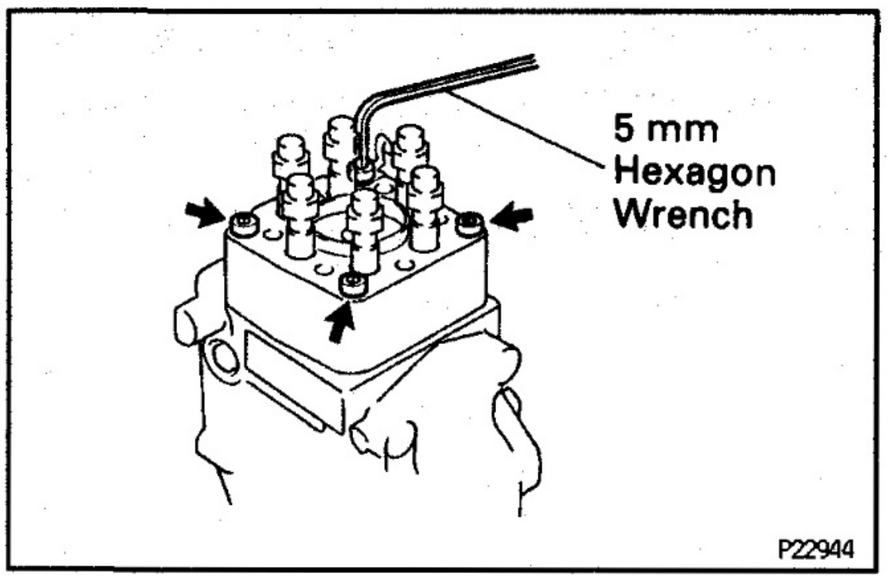


14. INSTALL DISTRIBUTIVE HEAD

(a) Apply grease to these parts and install them to the distributive head:
(1) 2 plunger spring guides
(2) 2 new selected plunger spring shims
(3) 2 upper spring seats
(4) 2 lever support springs
(5) New O–ring

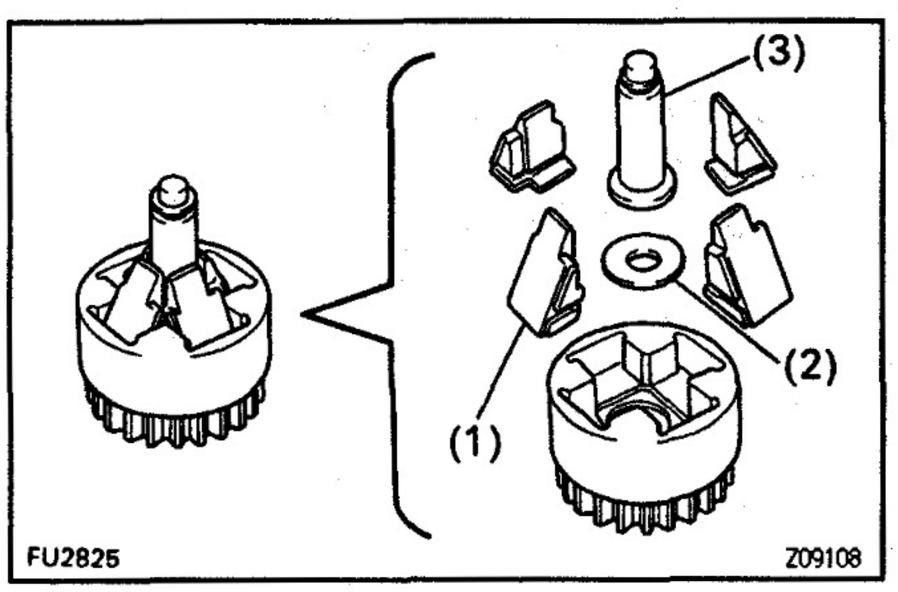


(b) Install the distributive head.
NOTICE: Be careful not to damage the pump plunger.



(c) Using a 5 mm hexagon wrench, install the 4 bolts and wire clip.
Torque: 12 N·m (120 kgf·cm, 9 ft·lbf)
HINT: Use the bolt which is 45 mm (1.77 in.) in length.

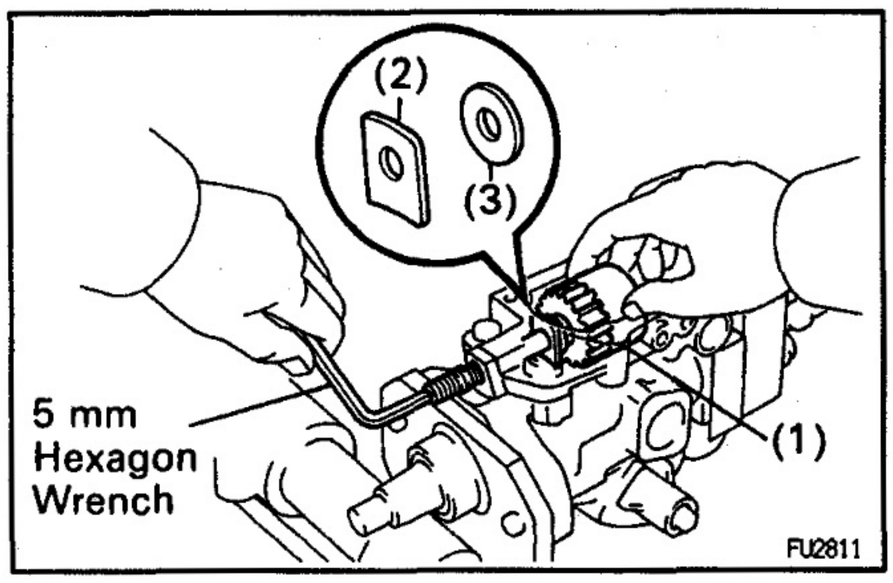
EG



15. INSTALL GOVERNOR SHAFT AND FLYWEIGHT HOLDER

(a) Install these parts to the flyweight holder:
- (1) 4 flyweight
- (2) No.2 flyweight washer
- (3) Governor sleeve

HINT: Replace the 4 flyweights as a set.

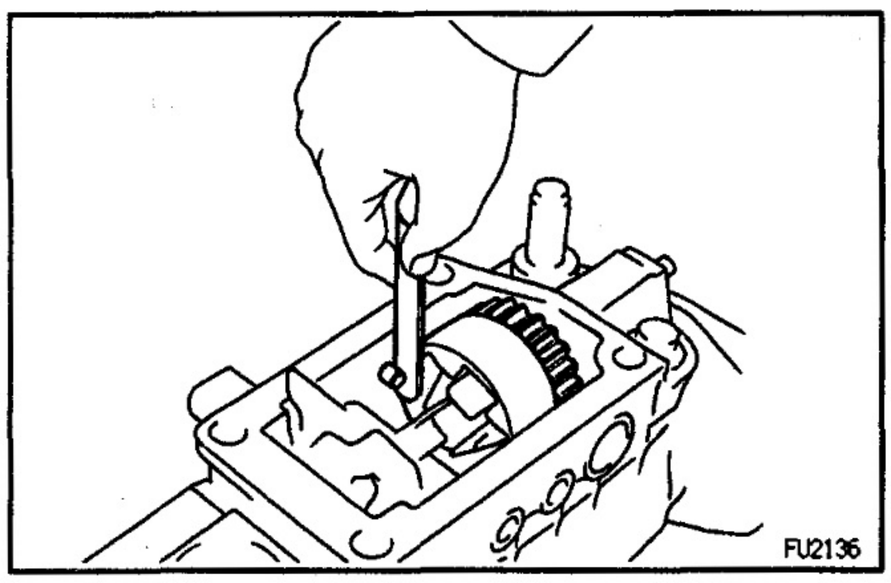


(b) Install a new O—ring to the governor shaft.

(c) Place the flyweight holder assembly (1) in position, and install the governor gear adjusting washer (2) and No. 1 flyweight washer (3) between the flyweight holder and pump housing.

(d) Install the governor shaft through the governor gear adjusting washer, No. 1 flyweight washer and flyweight holder assembly.

(e) Using a 5 mm hexagon wrench, turn the governor shaft counterclockwise.



16. CHECK FLYWEIGHT HOLDER THRUST CLEARANCE

Using a thickness gauge, measure the thrust clearance between the housing pin and flyweight holder.

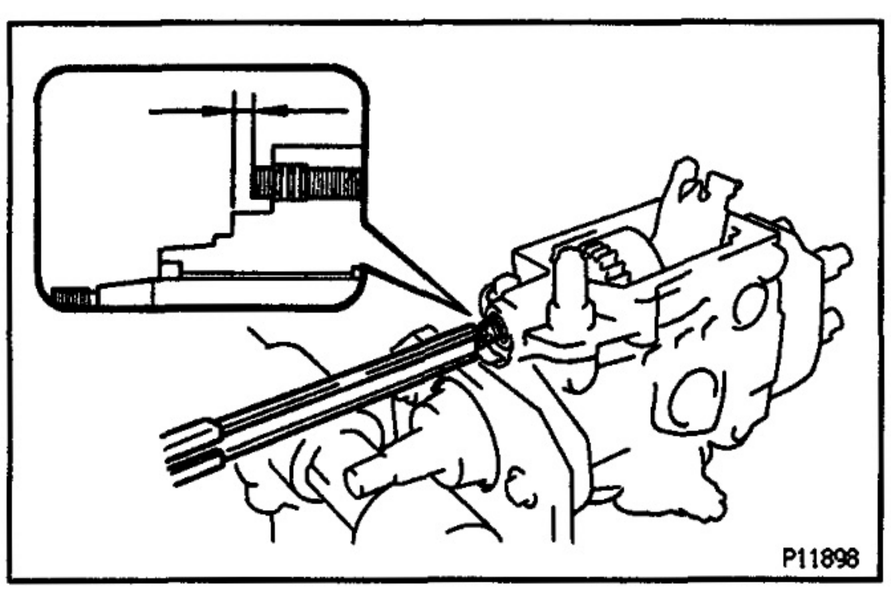
Thrust clearance:

0.15 — 0.35 mm (0.0059 — 0.0138 in.)

If the thrust clearance is not as specified, adjust with a governor gear adjusting washer.

Governor gear adjusting washer thickness:

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



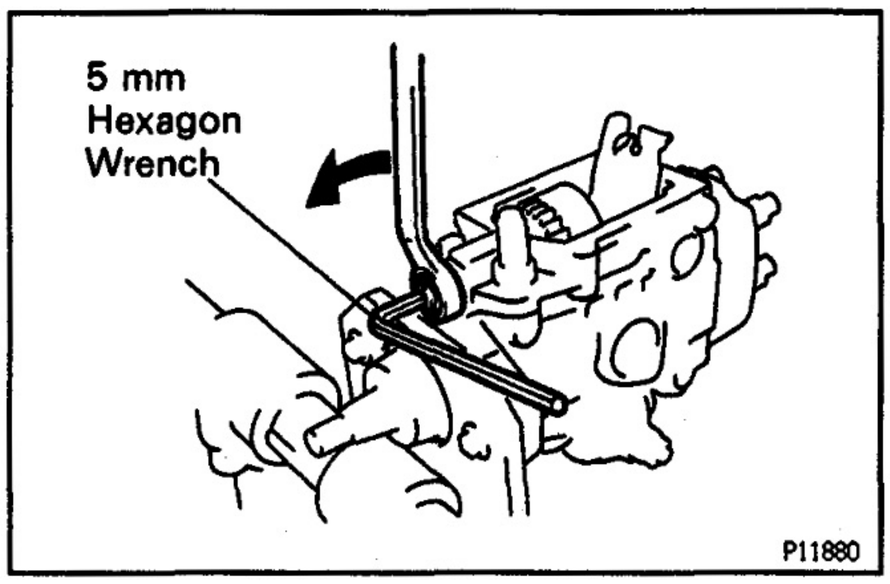
17. ADJUST PROTRUSION OF GOVERNOR SHAFT

(a) Using vernier calipers, measure the protrusion of the governor shaft.

Protrusion:

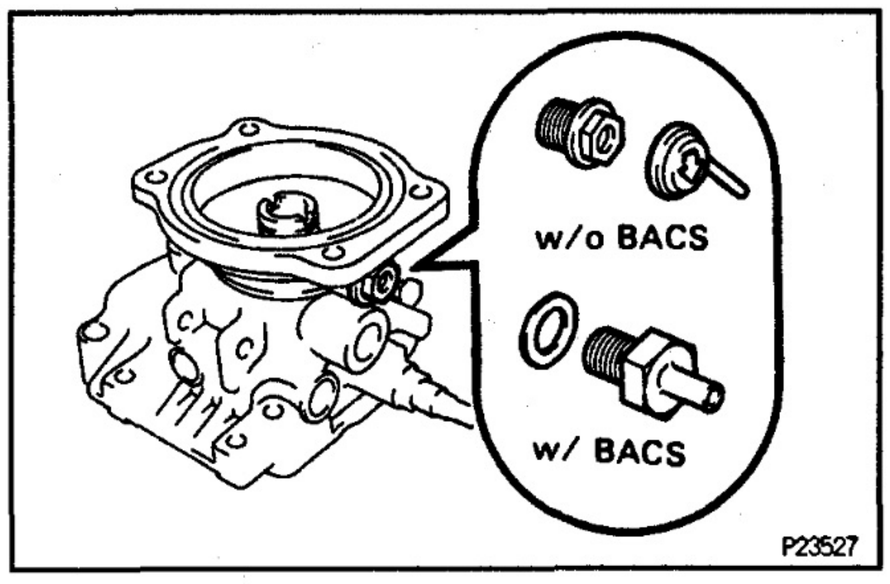
0.5 — 2.0 mm (0.020 — 0.079 in.)

If the protrusion is not as specified, adjust by turning the governor shaft.



(b) Using a 5 mm hexagon wrench, install and tighten the nut while holding the governor shaft with a 5 mm hexagon wrench.

Torque: 27 N·m (275 kgf·cm, 20 ft·lbf)



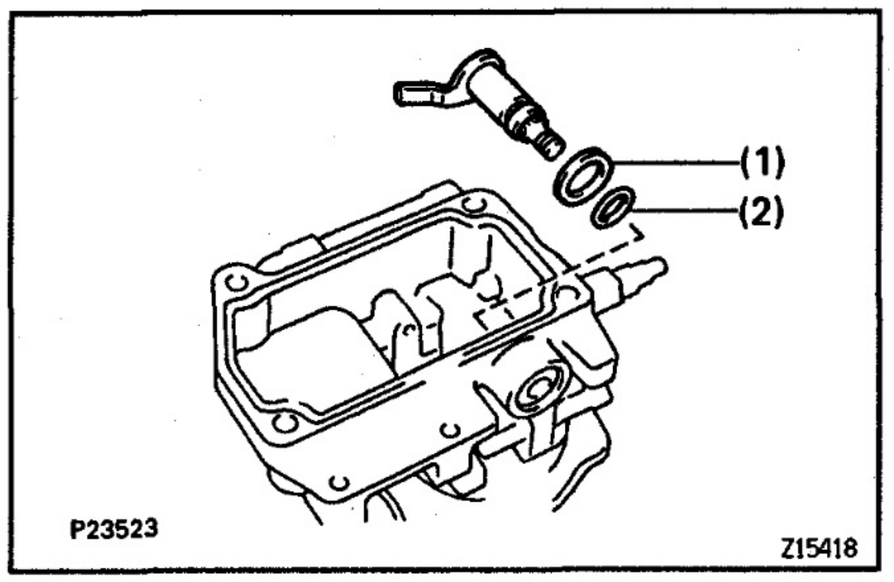
18. ASSEMBLE BOOST COMPENSATOR

A. Install overflow screw

(a) w/ BACS:
Install the overflow screw with a new gasket.
Torque: 24.55 N·m (250 kgf·cm, 18 ft·lbf)

(b) w/o BACS:
Install the overflow screw.
Torque: 24.55 N·m (250 kgf·cm, 18 ft·lbf)

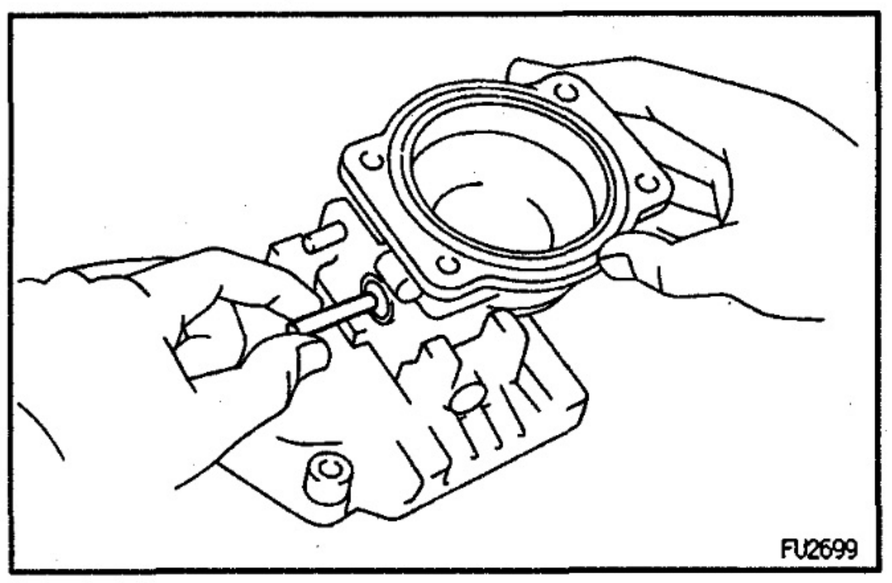
(c) w/o BACS:
Install the rubber cap facing the arrow downward.



B. Install No.2 SICS lever

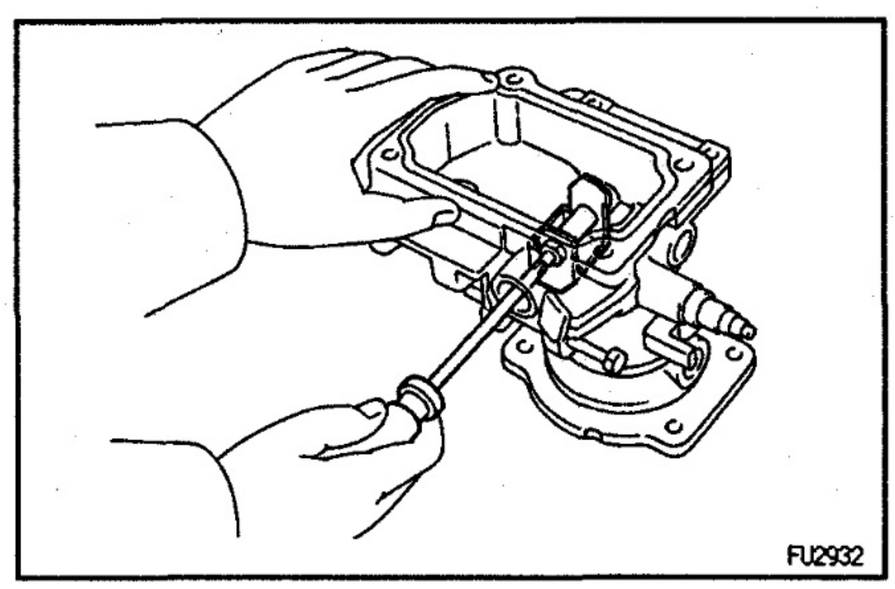
(a) Assemble these parts to the No.2 SICS lever.
(1) Washer
(2) New O–ring

(b) Install the No.2 SICS lever, washer and O–ring assembly to the governor cover.

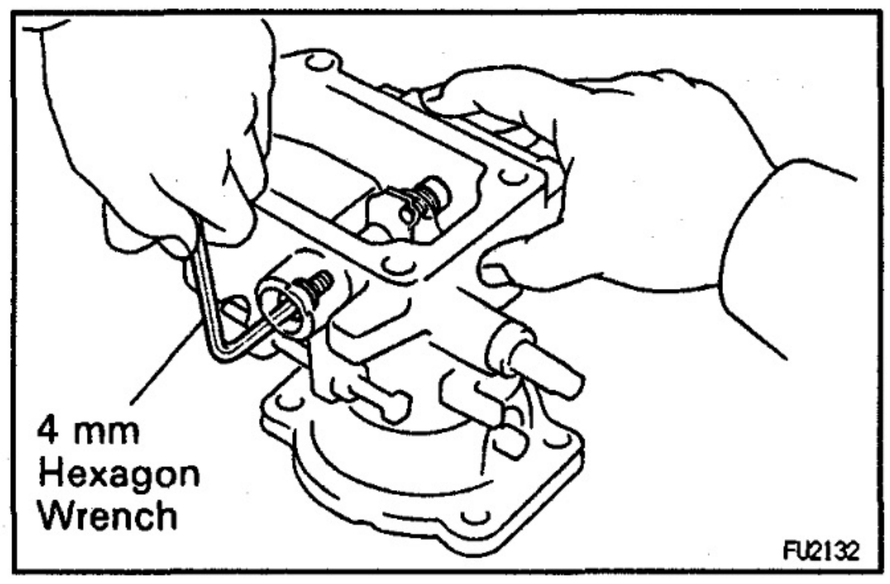


C. Install control lever

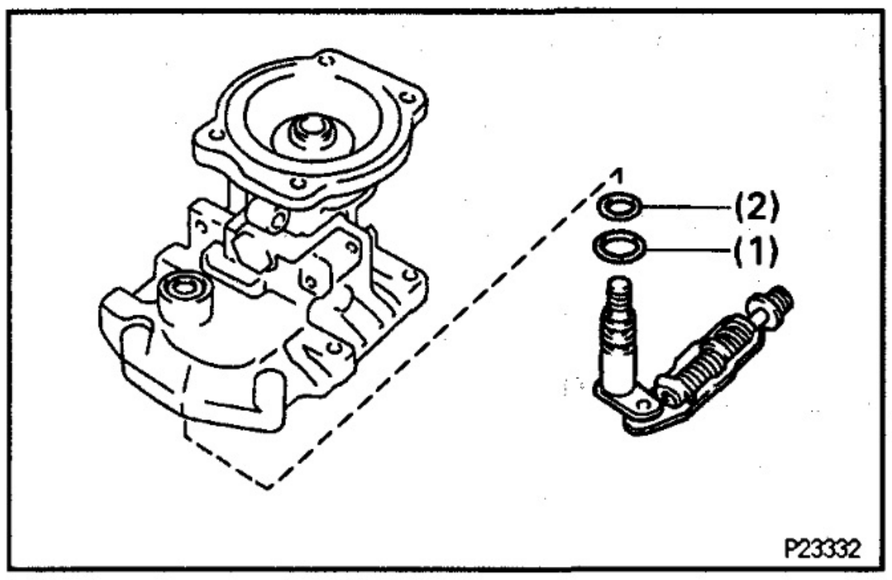
(a) Insert the connecting pin into the governor cover.



(b) Using a small screwdriver, install the control lever with the support pin.



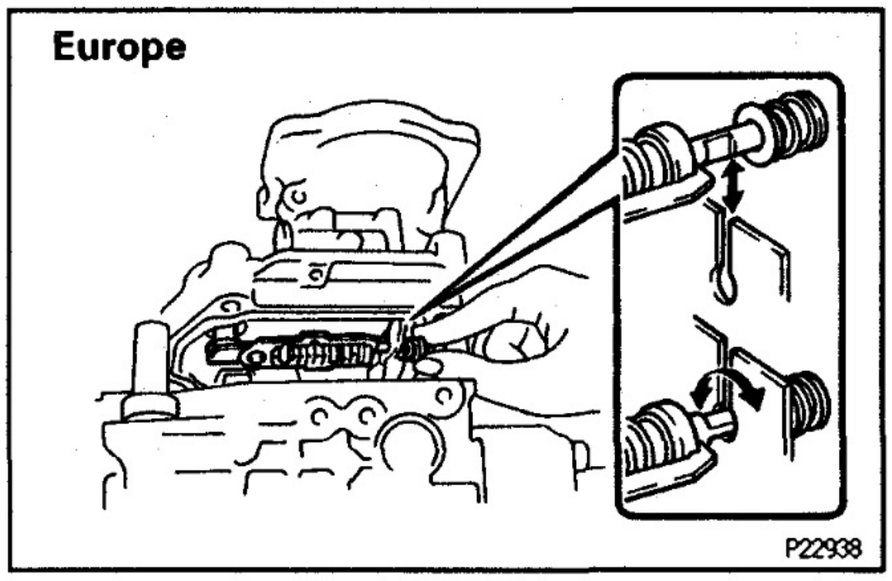
(c) Using a 4 mm hexagon wrench, install 2 new gaskets and the 2 bolts.
Torque: 6.85 N·m (70 kgf·cm, 61 in.·lbf)



19. INSTALL ADJUSTING LEVER SHAFT TO GOVERNOR SHAFT

(a) Install these parts to the adjusting lever shaft.
  (1) Washer
  (2) New O–ring

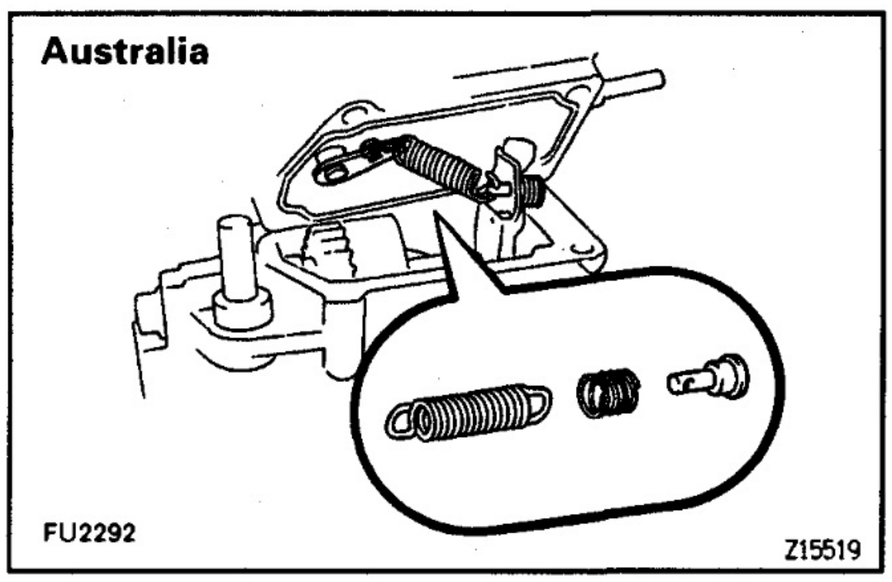
(b) Install the adjusting lever shaft, washer and O–ring assembly to the governor cover.



20. INSTALL GOVERNOR COVER

(a) Europe:
Install a new gasket to the groove of the governor cover.

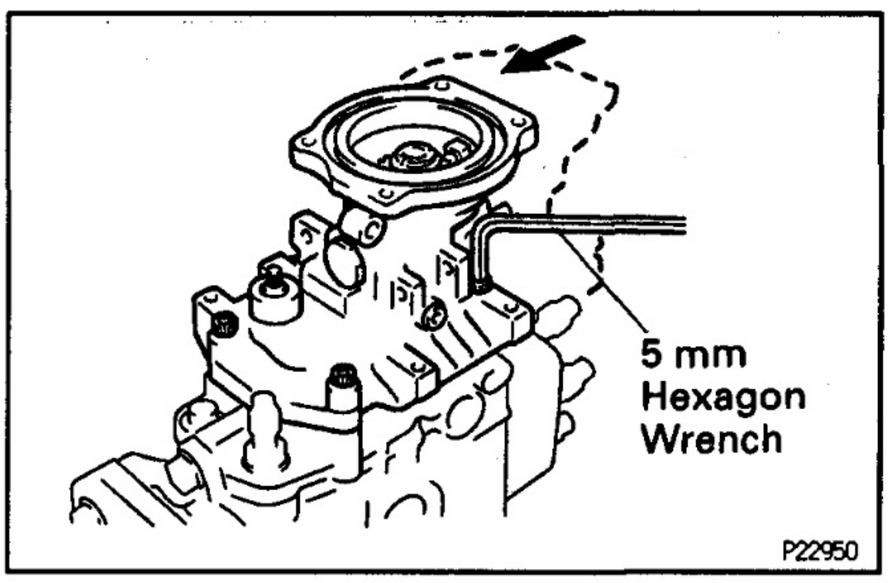
(b) Europe:
Connect the adjusting lever shaft to the governor link and twist the shaft lightly.



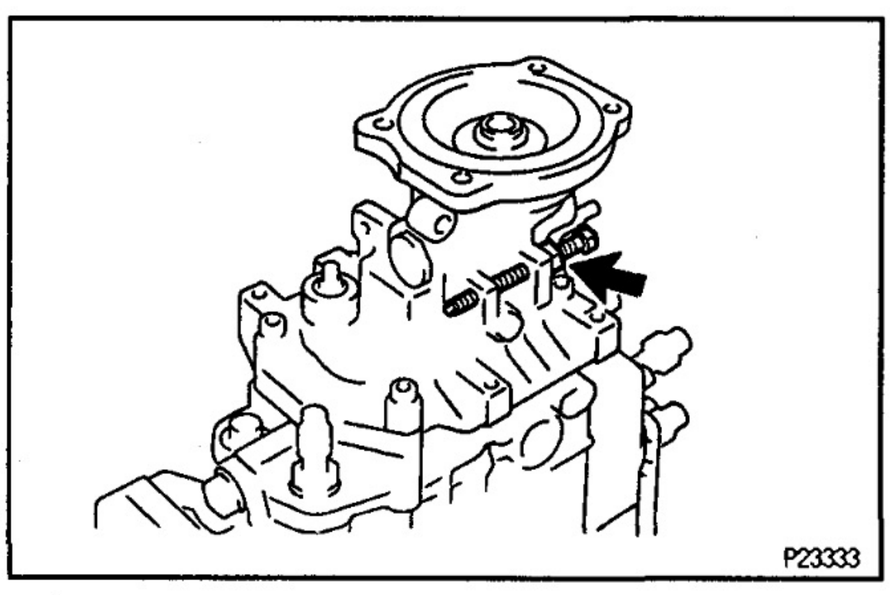
(c) Australia:
Install the speed control spring to the adjusting shaft.

(d) Australia:
Install a new gasket to the groove of the governor cover.

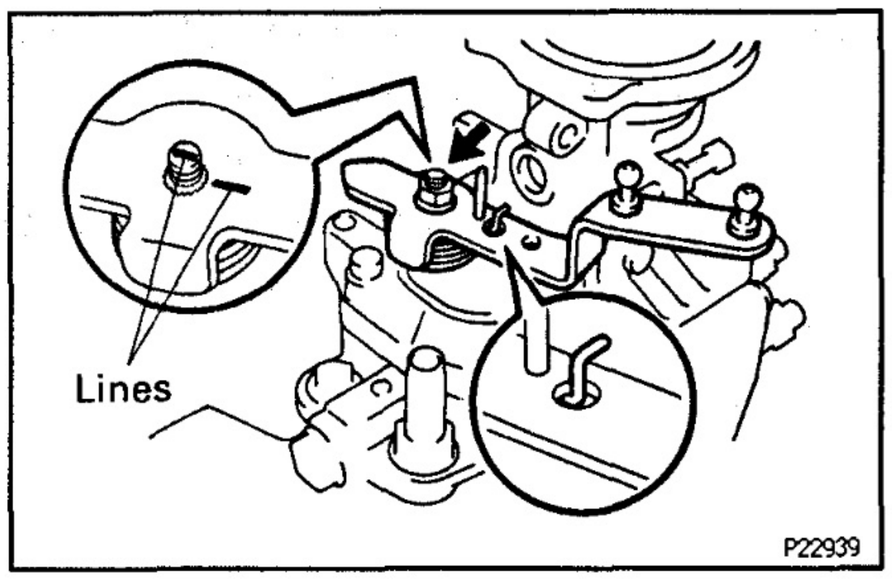
(e) Australia:
Install the damper spring and spring seat, and connect the speed control spring to the spring seat.



(f) Using a 5 mm hexagon wrench, install the governor cover with the 4 bolts.
Torque: 8.3 N·m (85 kgf·cm, 74 in.·lbf)
HINT: Use the bolt which is 35 mm (1.38 in.) length.



(g) Install the idle speed adjusting screw and lock nut.
Torque: 6.9 N·m (70 kgf·cm, 61 in.·lbf)



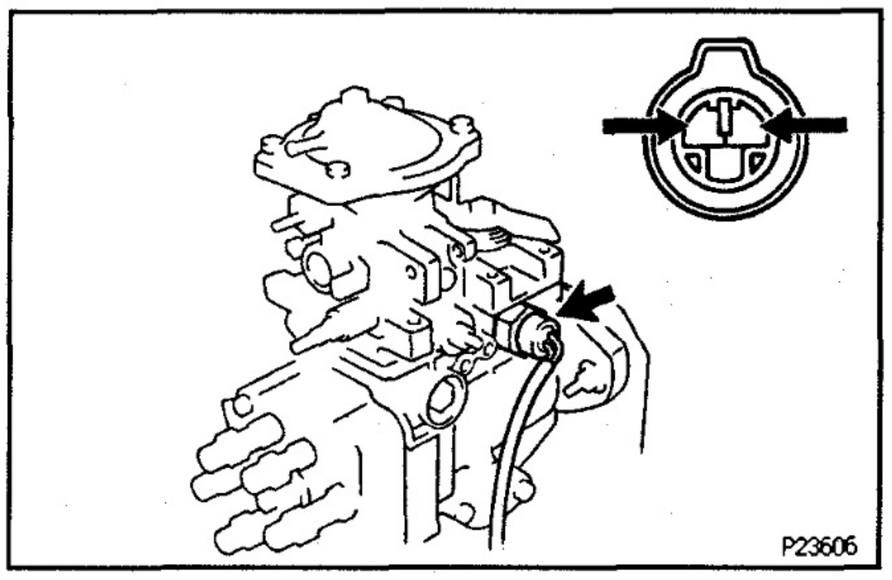
21. INSTALL ADJUSTING LEVER

(a) Place the return spring on the governor cover.

(b) Hook the return spring to the adjusting lever, and turn and place the adjusting lever on the governor shaft.

(c) Align the lines of the adjusting lever shaft and adjusting lever.

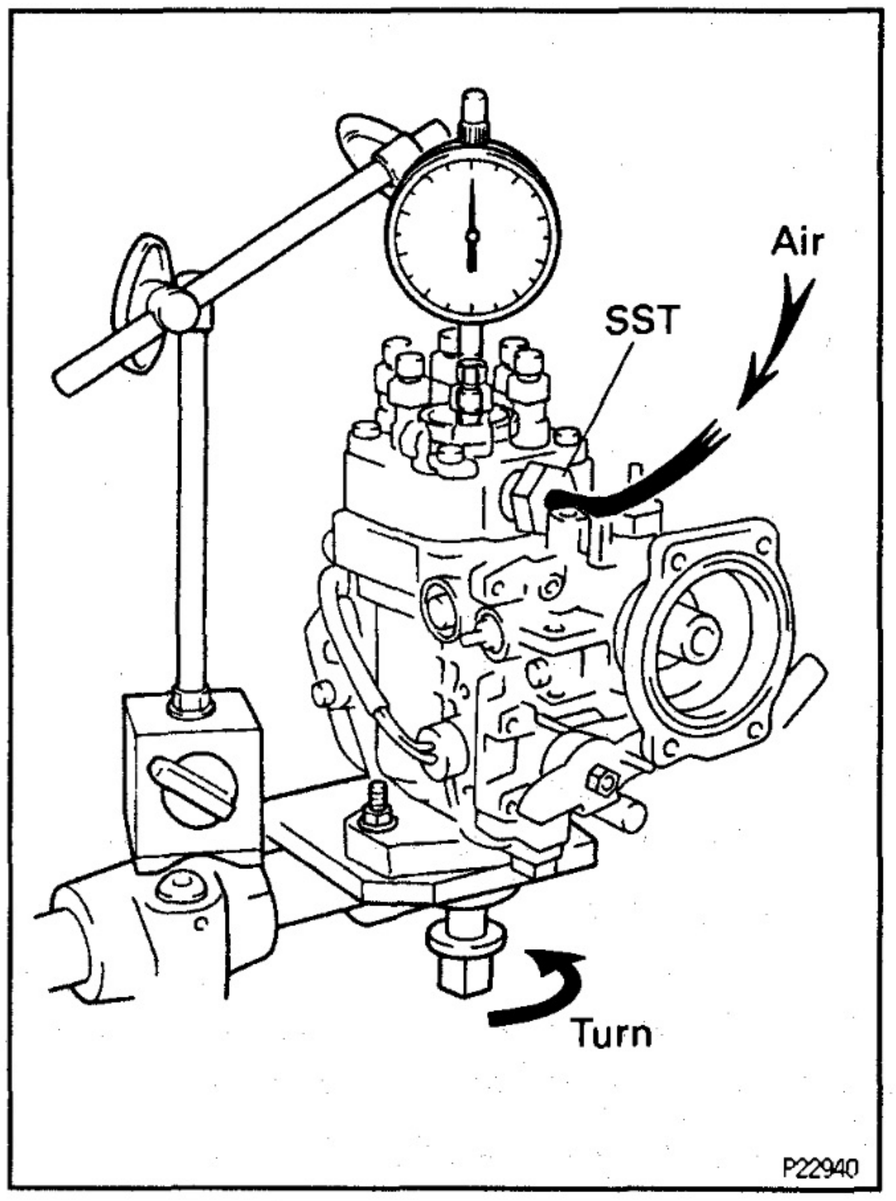
(d) Install the nut.
Torque: 8.35 N·m (85 kgf·cm, 74 in.·lbf)



22. INSTALL PICKUP SENSOR

(a) Connect the sensor lead wires to the connector.

(b) Install a new O–ring and pickup sensor.
Torque: 22.1 N·m (225 kgf·cm, 16 ft·lbf)



23. ADJUST PLUNGER PRE–STROKE

(a) Using SST, install SST to the fuel cut solenoid installation screw section.
SST 09275–17010

(b) Set the dial indicator so that the tip of the dial indicator push rod touches the upper surface of the plunger.

(c) Install the set nut to the drive shaft.

(d) Rotate the drive shaft, set the plunger to BDC and set the scale on the dial indicator to 0 mm (0 in.).

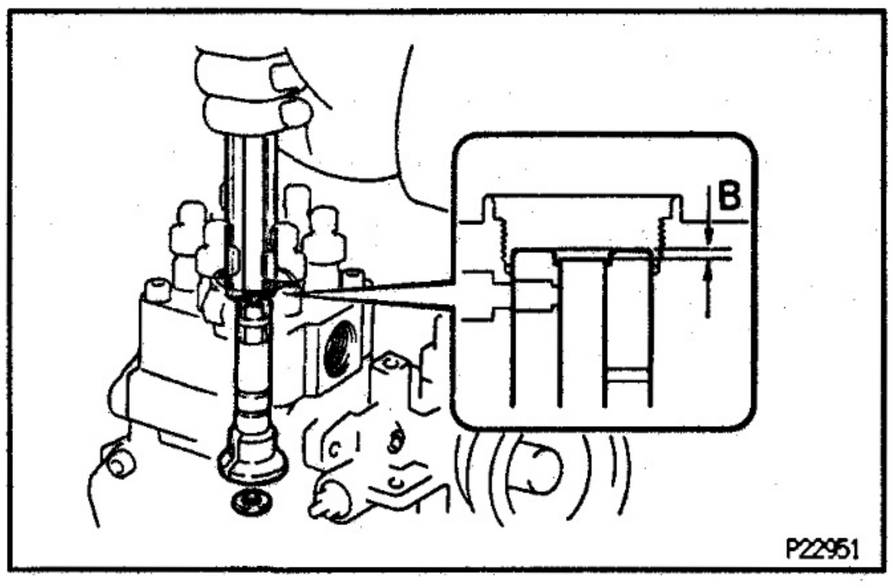
(e) Apply a few drops of light oil (diesel fuel) to the top surface of the plunger, and when 49 kpa (0.1 kgf/cm², 1.4 psi) of air is applied to SST, bubbles appear on the upper surface of the plunger.

(f) Slowly rotate the drive shaft in the pump rotation direction (clockwise) and read the dial indicator when the bubbles on the top of the plunger disappear.
Pre–stroke: 0.48 – 0.52 mm (0.0189 – 0.0205 in.)
If the pre–stroke is not as specified, replace the plunger adjusting shim under the plunger with a different sized shim.
HINT:
- Shims are available in 131 sized in increments 0.01 mm (0.004 in.), from 1.90 mm (0.0748 in.) to 3.20 mm (0.1260 in.).
- If the shim is made thicker, the pre–stroke is decreased.

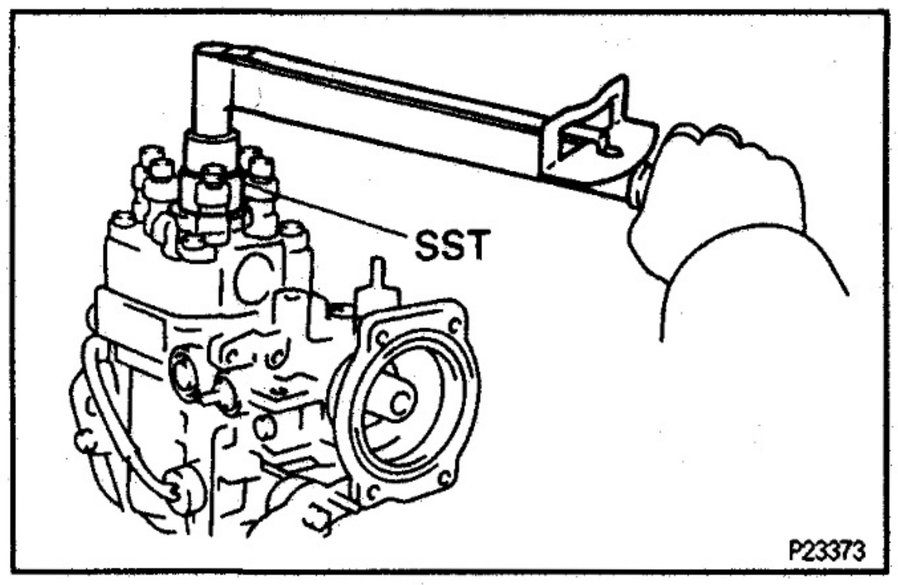
(g) Remove the SST from the fuel cut solenoid installation screw section.

(h) Remove the set nut from the drive shaft.

EG



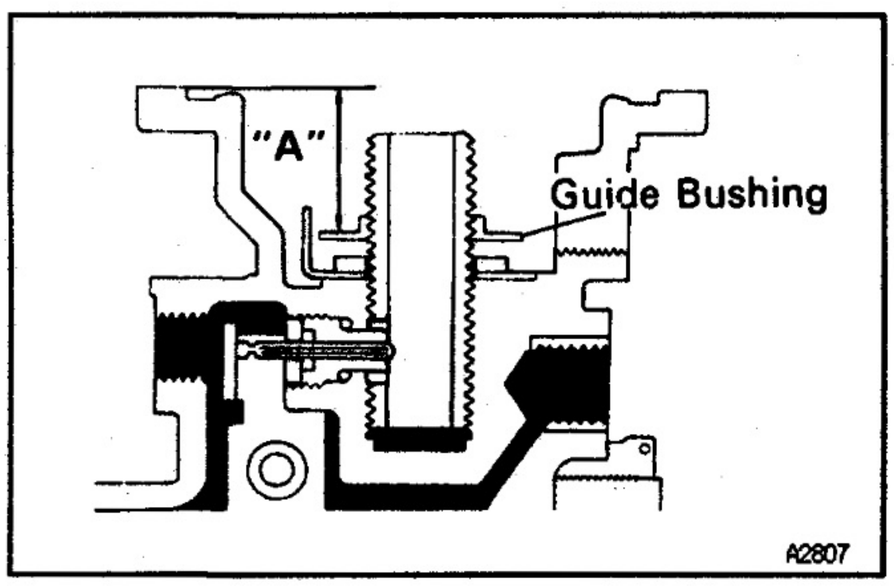
(i) After completing the pre–stroke adjustment, check that dimension B is within the specifications.
Dimension B: 3.4 – 3.6 mm (0.134 – 0.142 in.)
If dimension B is not within the specification, replace the distributor head.



24. INSTALL DISTRIBUTIVE HEAD PLUG

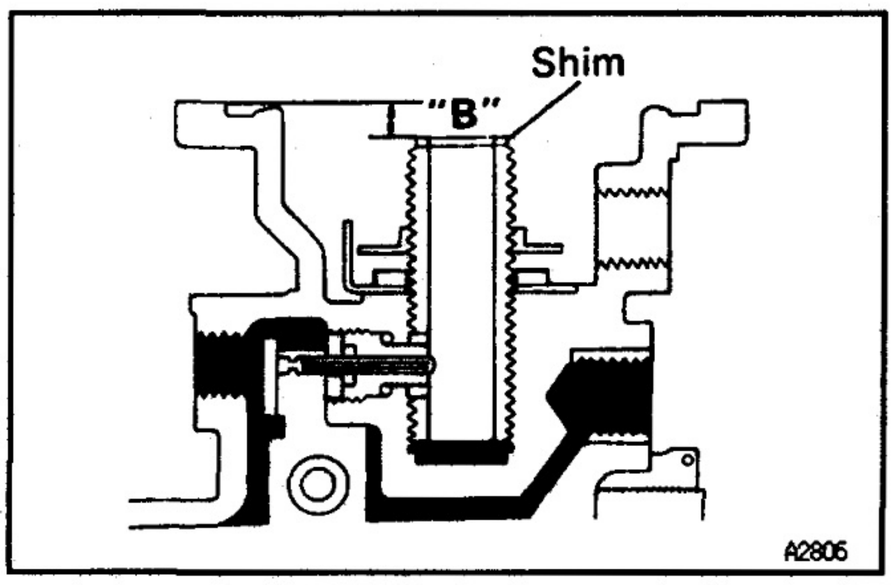
(a) Install a new O–ring to the head plug.

(b) Using SST, install the head plug.
SST 09260–54012 (09262–54010)
Torque: 88 N·m (900 kgf·cm, 65 ft·lbf)



25. ASSEMBLE BOOST COMPENSATOR

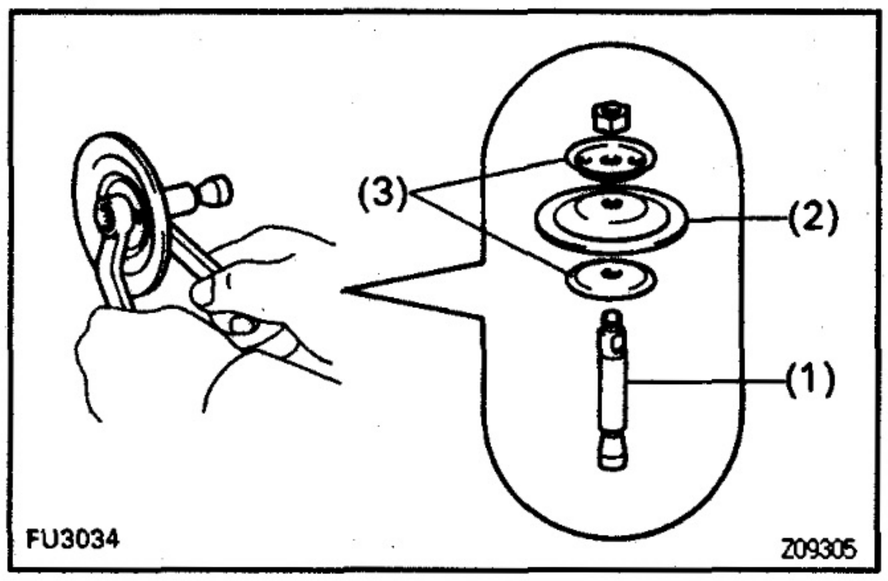
A. Install guide bushing
Install and adjust the guide bushing to the dimension "A" as shown in the illustration.
Dimension "A":
Europe 17.3 – 17.4 mm (0.681 – 0.685 in.)
Australia 18.9 – 19.0 mm (0.744 – 0.748 in.)



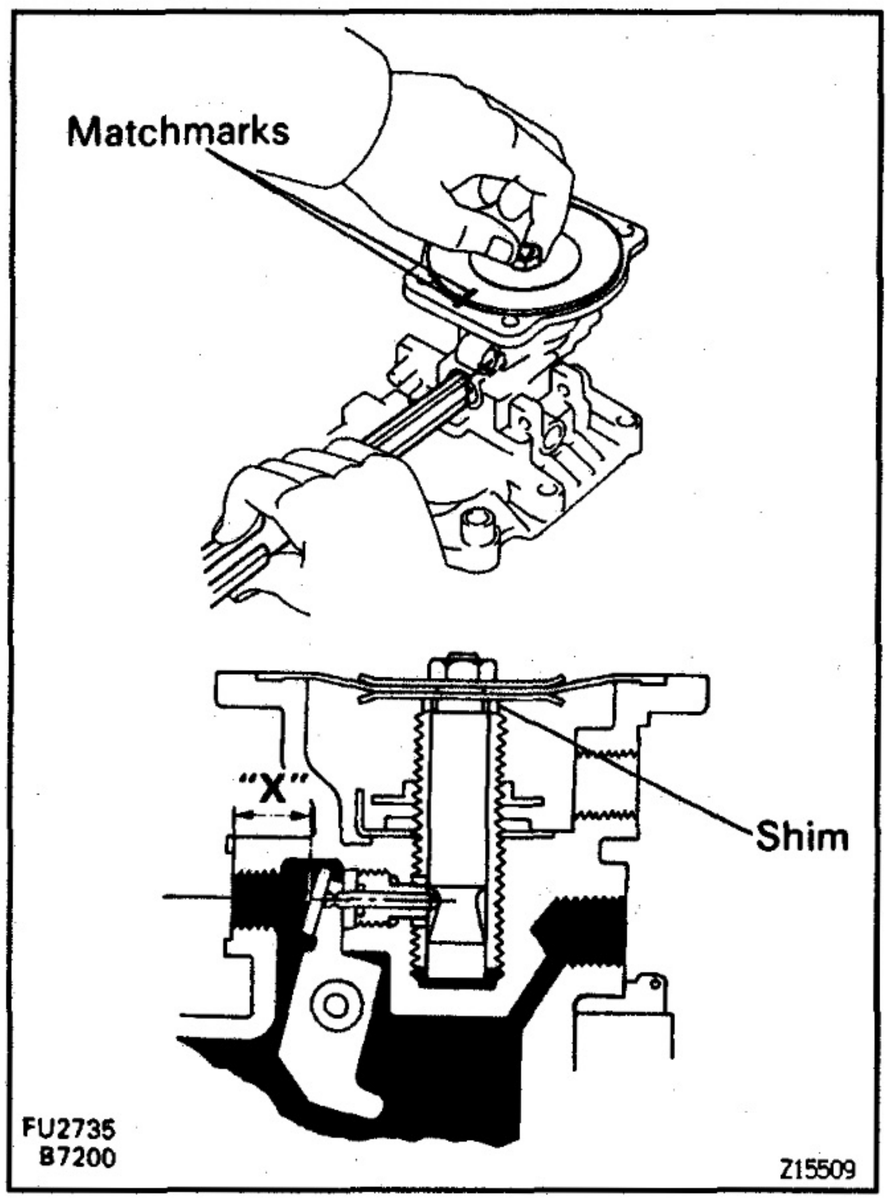
B. Install boost compensator diaphragm

(a) Adjust boost compensator shim.
- Place the shim on the guide bushing.
- Using vernier calipers, measure the dimension "B" as shown in the illustration.

Dimension "B":
Europe 3.6 – 3.8 mm (0.142 – 0.150 in.)
Australia 3.1 – 3.3 mm (0.122 – 0.130 in.)
If the dimension is not within specification, select and install the correct shim.
HINT: Shim are available in sized in increments 0.2 mm (0.008 in.), from 1.1 mm (0.043 in.) to 3.3 mm (0.130 in.).



(b) Assemble these parts with the nut.
Torque: 7.35 N·m (75 kgf·cm, 65 in.·lbf)
(1) Push rod
(2) Diaphragm
(3) 2 spring seats

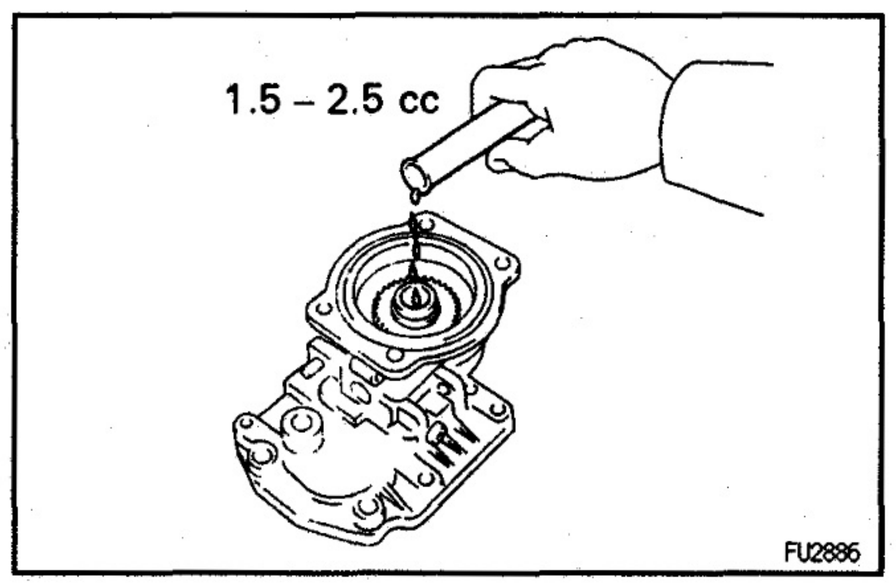


(c) Adjust the installation direction of boost compensator diaphragm assembly.
- Install the shim and diaphragm assembly.

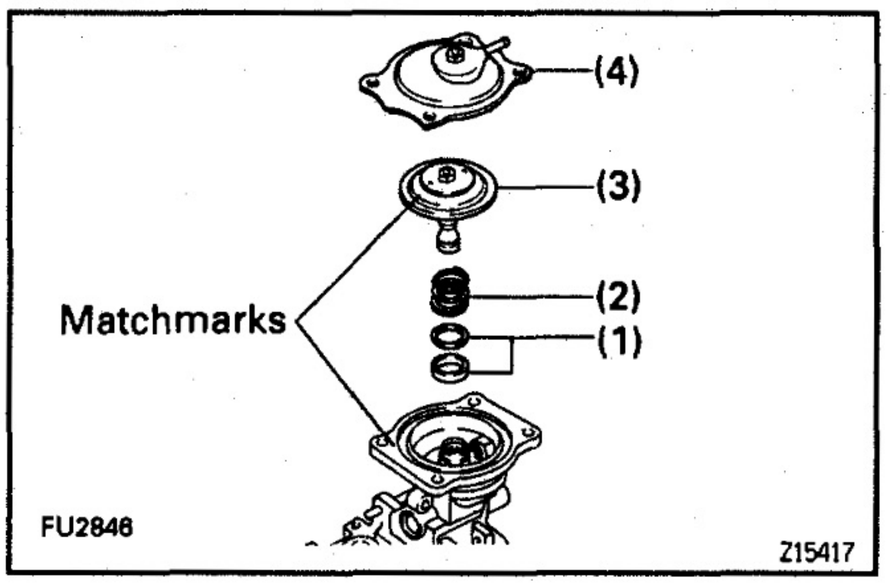
HINT: Do not assemble the spring.
- Using vernier calipers, while pushing on the diaphragm assembly dimension "X" with vernier calipers as shown.

Dimension "X":
w/ BACS: 8.8 – 9.0 mm (0.346 – 0.354 in.)
w/o BACS: 8.5 – 8.7 mm (0.335 – 0.343 in.)

HINT: Measure at the center of the hole.
- Place matchmarks on the diaphragm assembly and governor cover.
- Remove the diaphragm assembly.

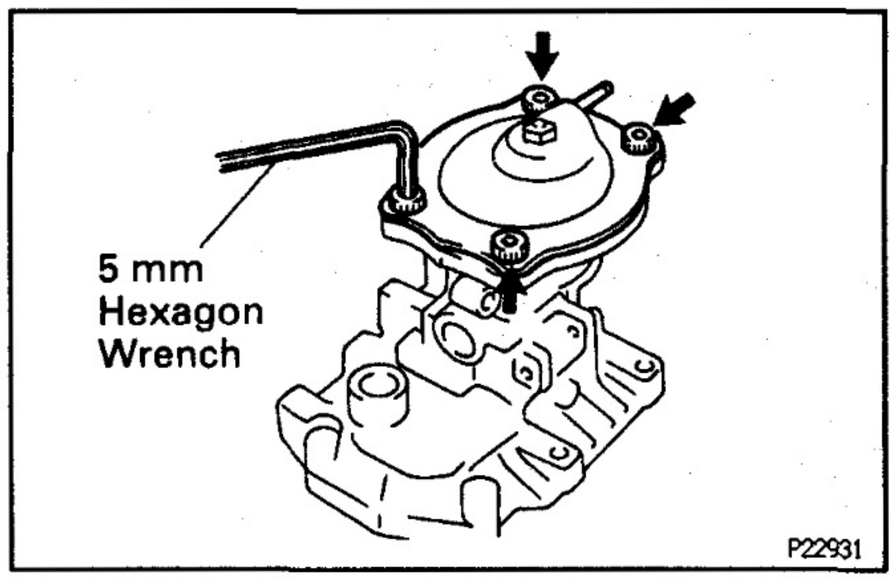


(d) Insert 1.5 – 2.5 cc (0.09 – 0.15 cu in.) of engine oil into the bushing hole.

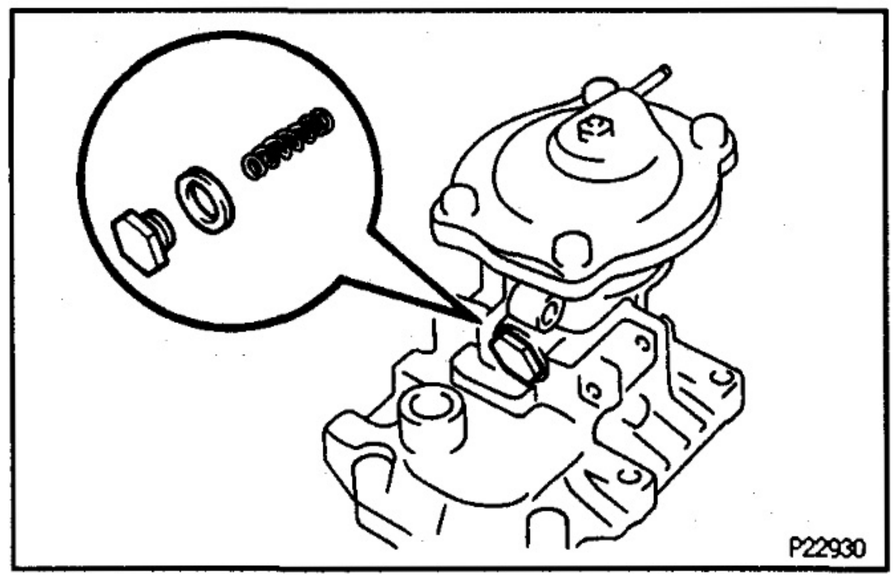


(e) Install these parts to the governor cover.
(1) Boost compensator shim
(2) Spring
(3) Diaphragm assembly
(4) Diaphragm cover

EG

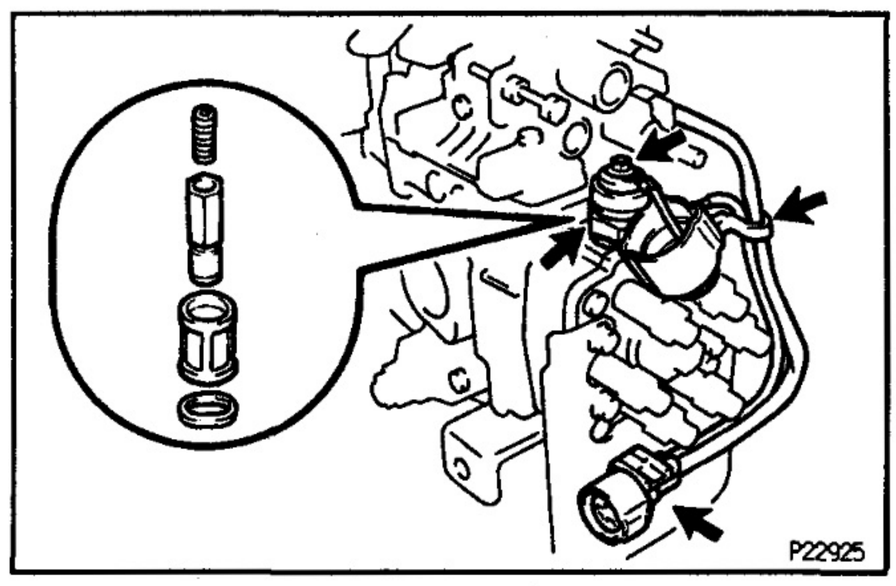


(f) Using a 5 mm hexagon wrench, install the diaphragm cover with the 4 bolts.
Torque: 7.35 N·m (75 kgf·cm, 65 in.·lbf)

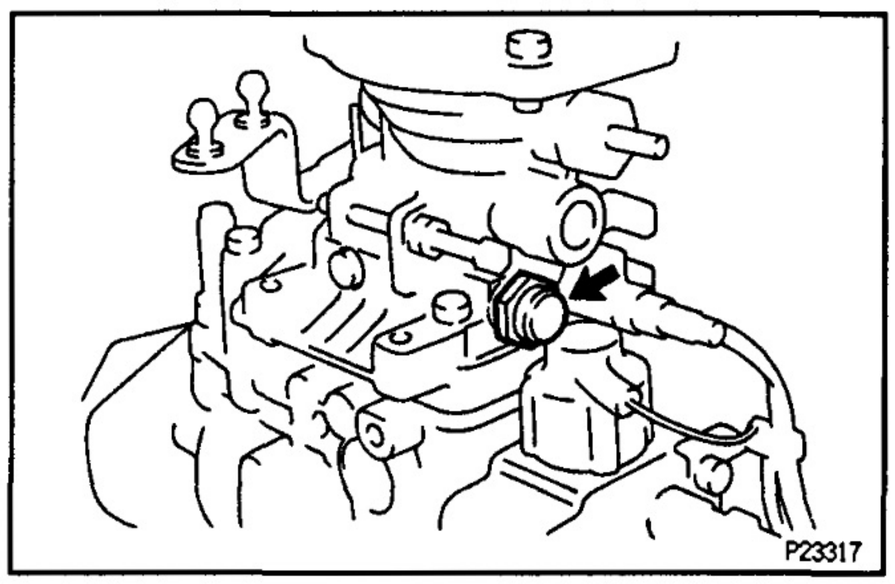


C. Install lever control spring
Install the lever control spring with a new gasket and the bolt.
Torque: 11.3 N·m (115 kgf·cm, 8 ft·lbf)

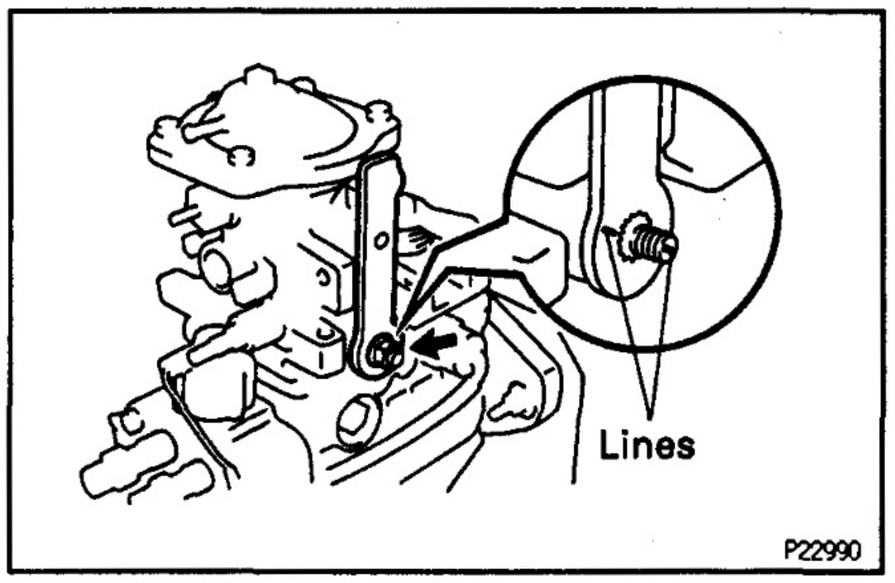
26. INSTALL INJECTION PUMP STAY
Torque: 8.35 N·m (85 kgf·cm, 74 in.·lbf)



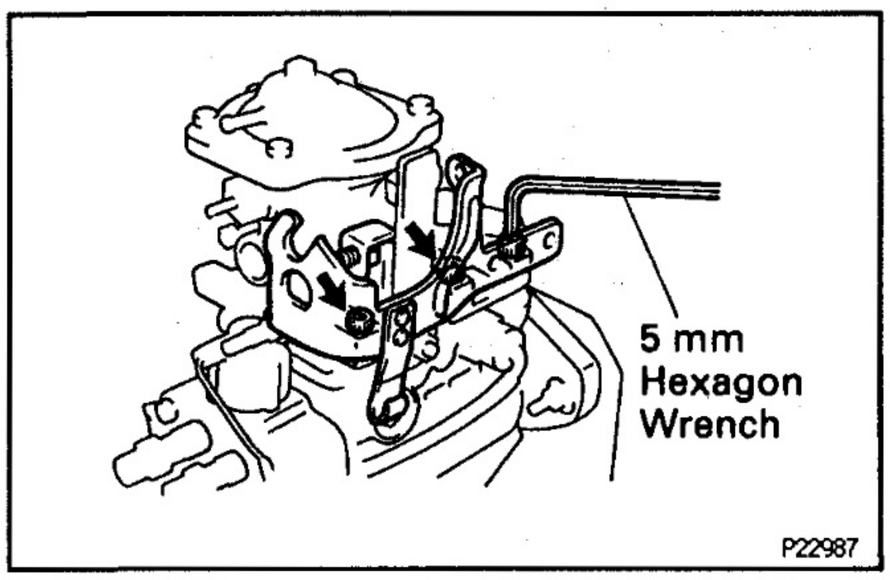
27. INSTALL FUEL CUT SOLENOID
(a) Install a new O–ring on the fuel cut solenoid.
(b) Install the wave washer, strainer, valve, spring and fuel cut solenoid.
Torque: 22 N·m (225 kgf·cm, 16 ft·lbf)
(c) Install the lead wire to the fuel cut solenoid with the nut.
Torque: 1.7 N·m (17 kgf·cm, 15 in.·lbf)
(d) Install the dust cover to the fuel cut solenoid.
(e) Install the wire harness to the wire clip.
(f) Install the lead wire connector to the bracket.



28. INSTALL CAP
Install a new gasket and the cap.
Torque: 11 N·m (115 kgf·cm, 8 ft·lbf)



29. INSTALL NO.1 SICS LEVER
(a) Align the lines of the levers.
(b) Install the nut.
Torque: 6.9 N·m (70 kgf·cm, 61 in.·lbf)

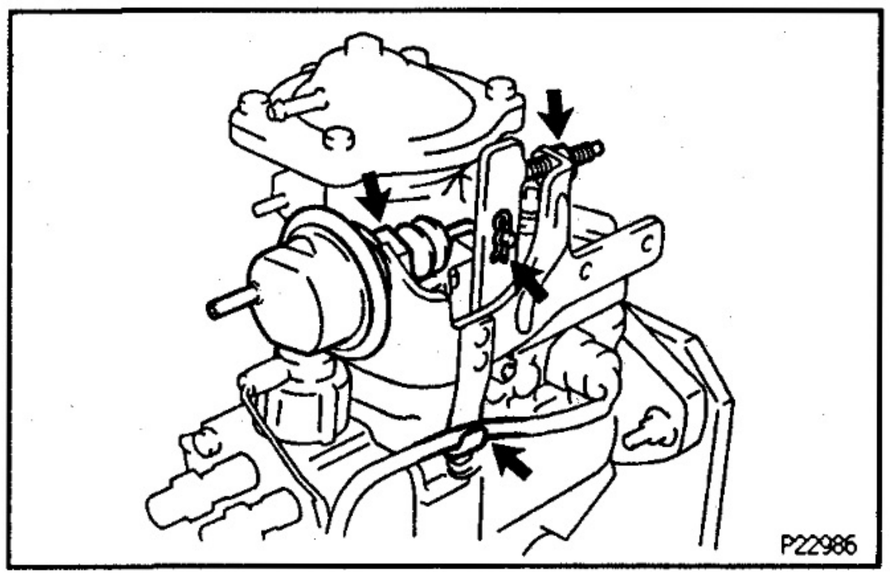


30. INSTALL SICS ACTUATOR

(a) Using a 5 mm hexagon wrench, install the SICS actuator bracket with the 3 bolts.
Torque: 9.3 N·m (95 kgf·cm, 82 in.·lbf)

(b) Install the maximum speed adjusting screw.

(c) Install the lock plate to the maximum speed adjusting screw.

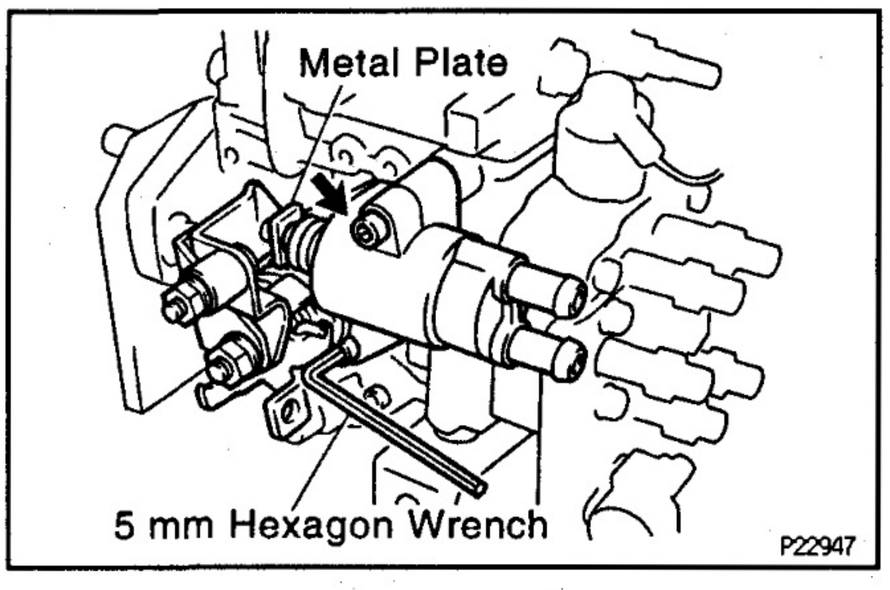


(d) Install the SICS actuator with a nut.
Torque: 9.35 N·m (95 kgf·cm, 83 in.·lbf)
NOTICE: Install 2 actuator adjusting washers on the side with the nut.

(e) Install the clip.

(f) Install the SICS adjusting screw.
Torque: 6.9 N·m (70 kgf·cm, 61 in.·lbf)

(g) Connect the wire harness.



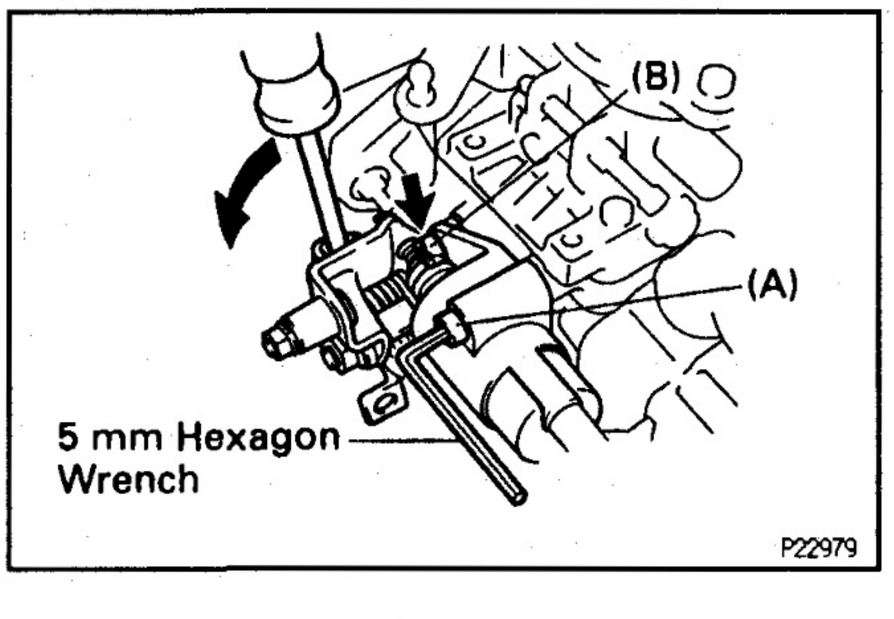
31. INSTALL THERMO WAX

(a) Using a screwdriver, turn the cold starting lever counterclockwise approx. 20°.

(b) Put a metal plate (thickness of 5.0 – 8.0 mm (0.20 – 0.31 in.)) between the cold starting lever and thermo wax plunger.

(c) Install a new O–ring to the pump body.

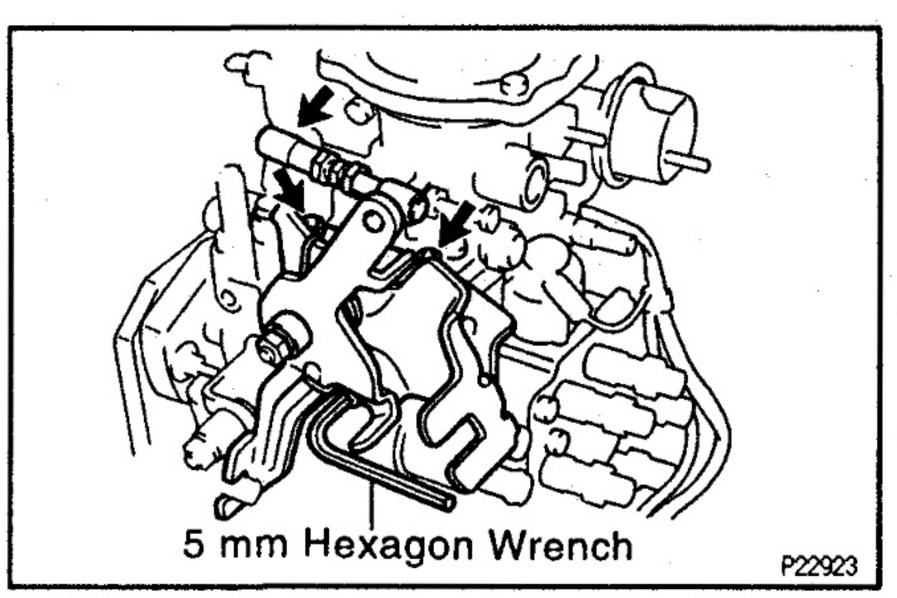
(d) Using a 5 mm hexagon wrench, temporality install the thermo wax with the 2 bolts.



(e) Using a screwdriver, turn the cold starting lever counterclockwise.

(f) Using a 5 mm hexagon wrench, install the bolt (B),and removal the bolt (A).
Torque: 8.35 N·m (85 kgf·cm, 74 in.·lbf)

(g) Using a 5 mm hexagon wrench, tighten the bolt.
Torque: 8.35 N·m (85 kgf·cm, 74 in.·lbf)

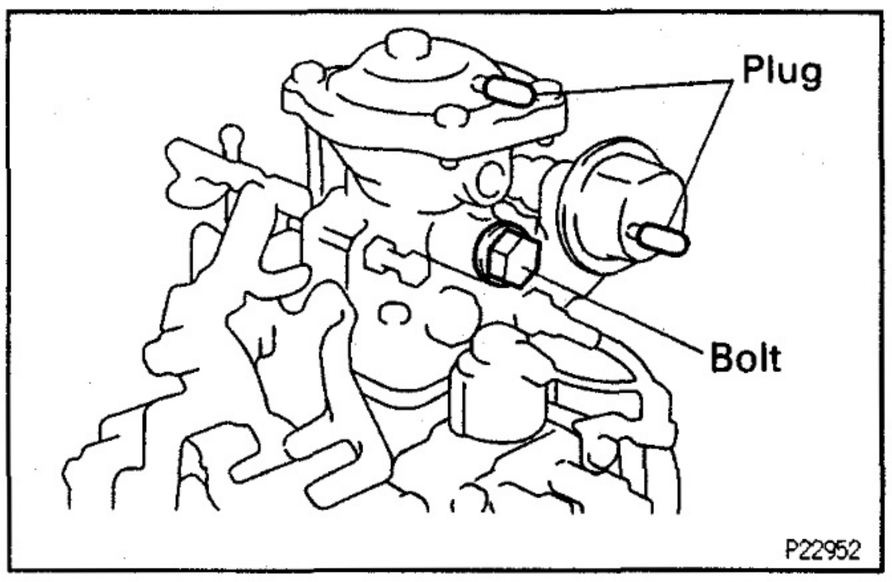


32. INSTALL IDLE–UP LEVER

Using a 5 mm hexagon wrench, install the idle–up lever with the 3 bolts.
Torque:
Short bolt: 8.35 N·m (85 kgf·cm, 74 in.·lbf)
Long bolt: 11.75 N·m (120 kgf·cm, 9 ft·lbf)

33. REMOVE INJECTION PUMP FROM SST (STAND)

SST 09241–76022, 09245–54010

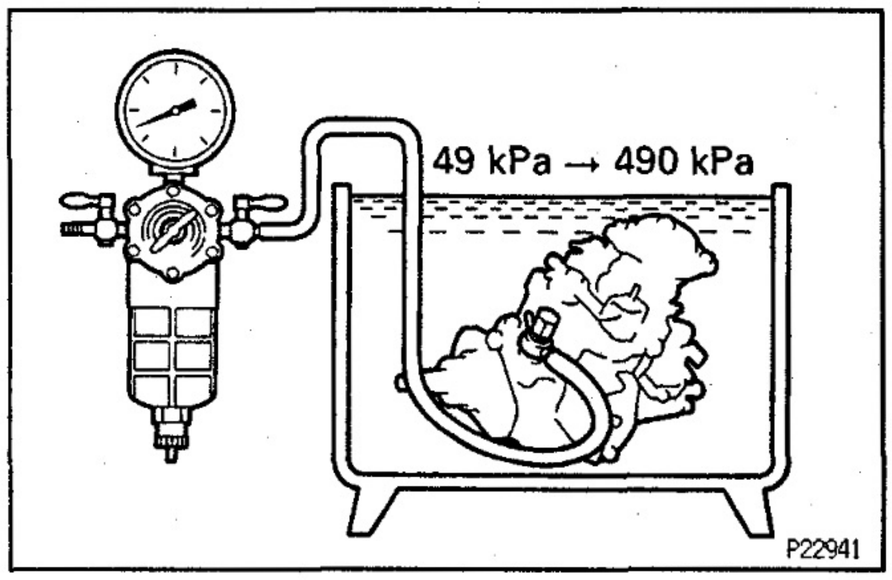


34. PERFORM AIR TIGHT TEST

(a) w/ BACS:
Install a bolt and gasket to the overflow port.

(b) w/o BACS:
Install a bolt to the overflow port.

(c) Install the plug to each port of the boost compensator and SICS actuator.

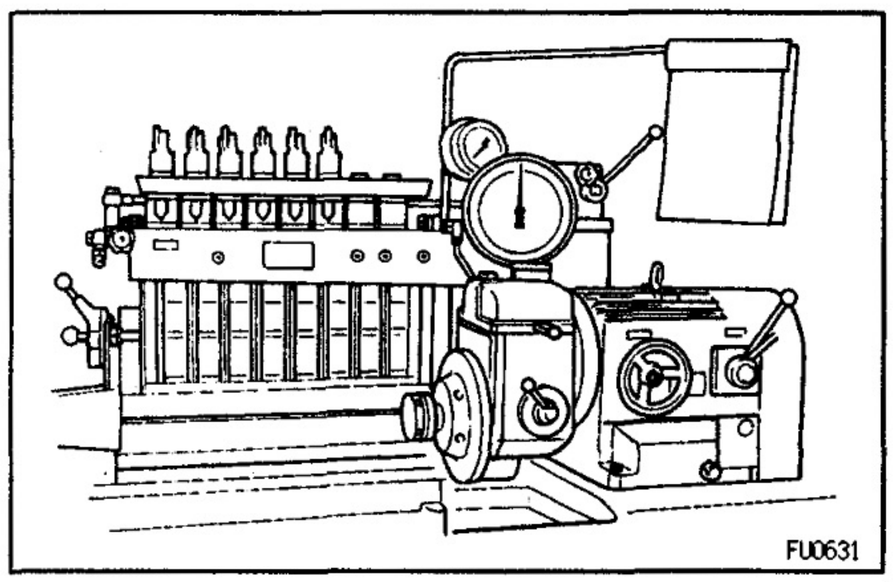


(c) Connect an air hose to the fuel inlet pipe and place the injection pump into diesel fuel.

(d) Apply 49 kPa (0.5 kgf/cm², 7 psi) of pressure and confirm that there are no leaks.

(e) Next check that there are no leaks with 490 kPa (5.0 kgf/cm², 71 psi) of pressure applied.

35. INSTALL SET KEY OF INJECTION PUMP DRIVE PULLEY ON DRIVE SHAFT



INJECTION PUMP ADJUSTMENT

EG5SF-02

1. PRE–TEST CHECK AND PREPARATION

(a) The specifications for test nozzle and nozzle holders are as follows.

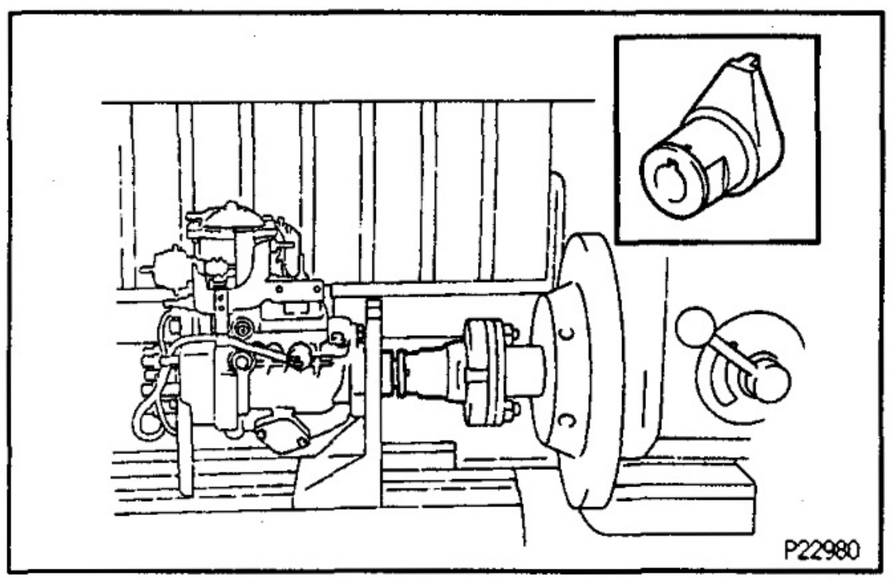
Test nozzle:

DN12SD12 (NIPPONDENSO)

Test nozzle opening pressure:

14,220 – 15,200 kPa

(145 – 155 kgf/cm², 2,062 – 2,205 psi)



(b) Check the accuracy of the tachometer.

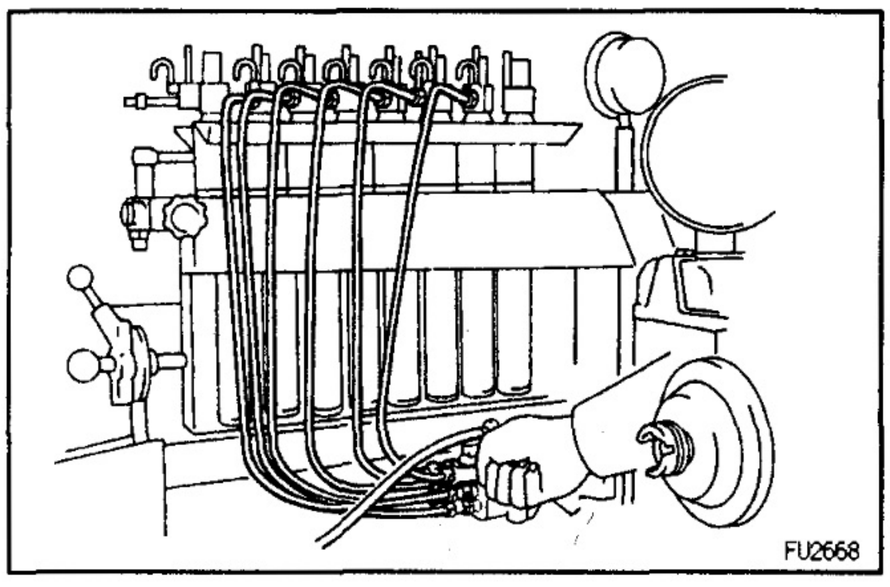
Allowable error:

± 40 rpm

(c) Install the angle gauge stand.

(d) Mount the injection pump body on the pump tester.
HINT: Place a mark on the key groove portion of the coupling.

NOTICE:To prevent vibration or dislocation of the injection pump, fix in place the distributive head of the injection pump.



(e) Install an injection pipe with these specifications.

Outer diameter:

6.0 mm (0.236 in.)

Inner diameter:

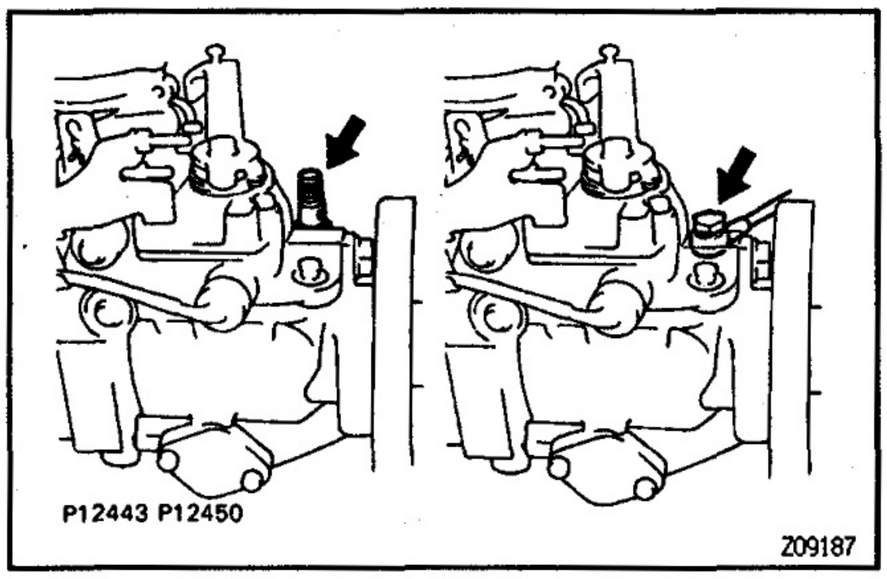
2.0 mm (0.079 in.)

Length:

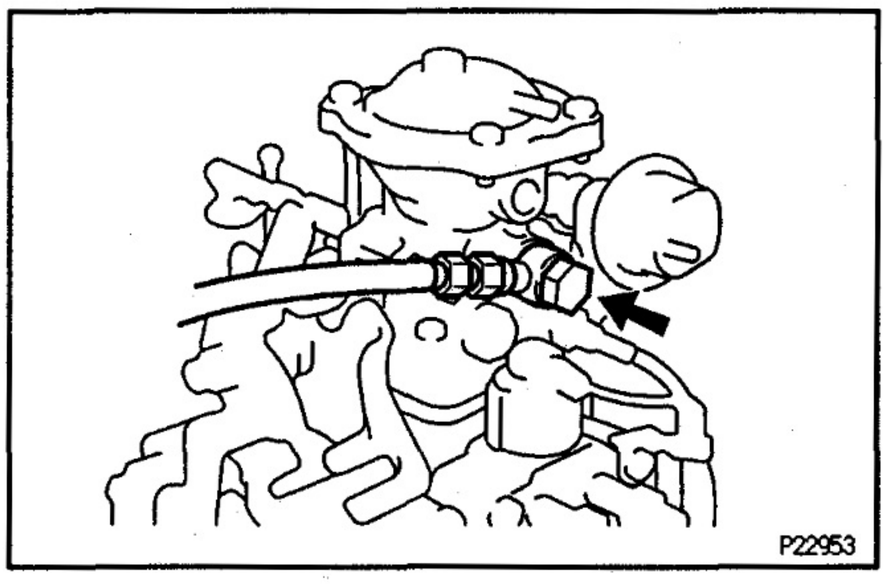
840 mm (33.07 in.)

Minimum bending radius:

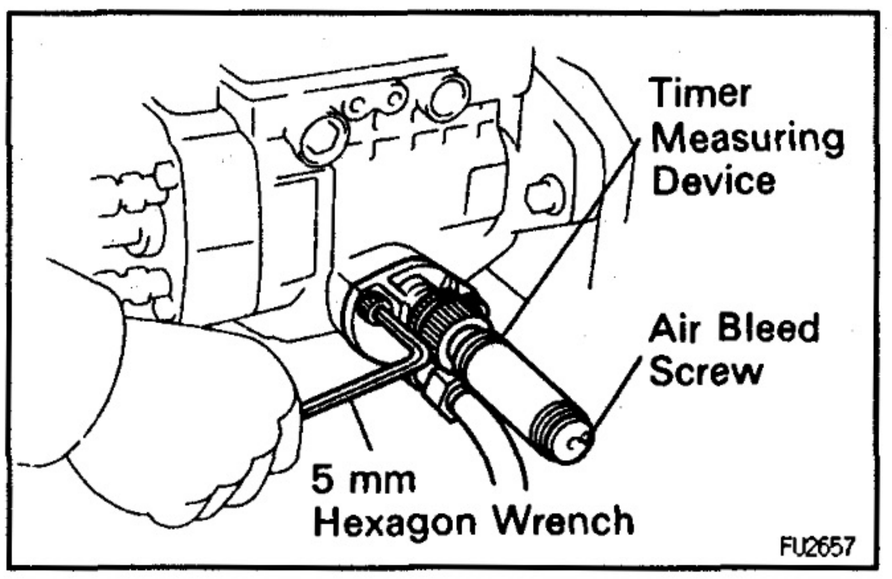
25 mm (0.98 in.) or more



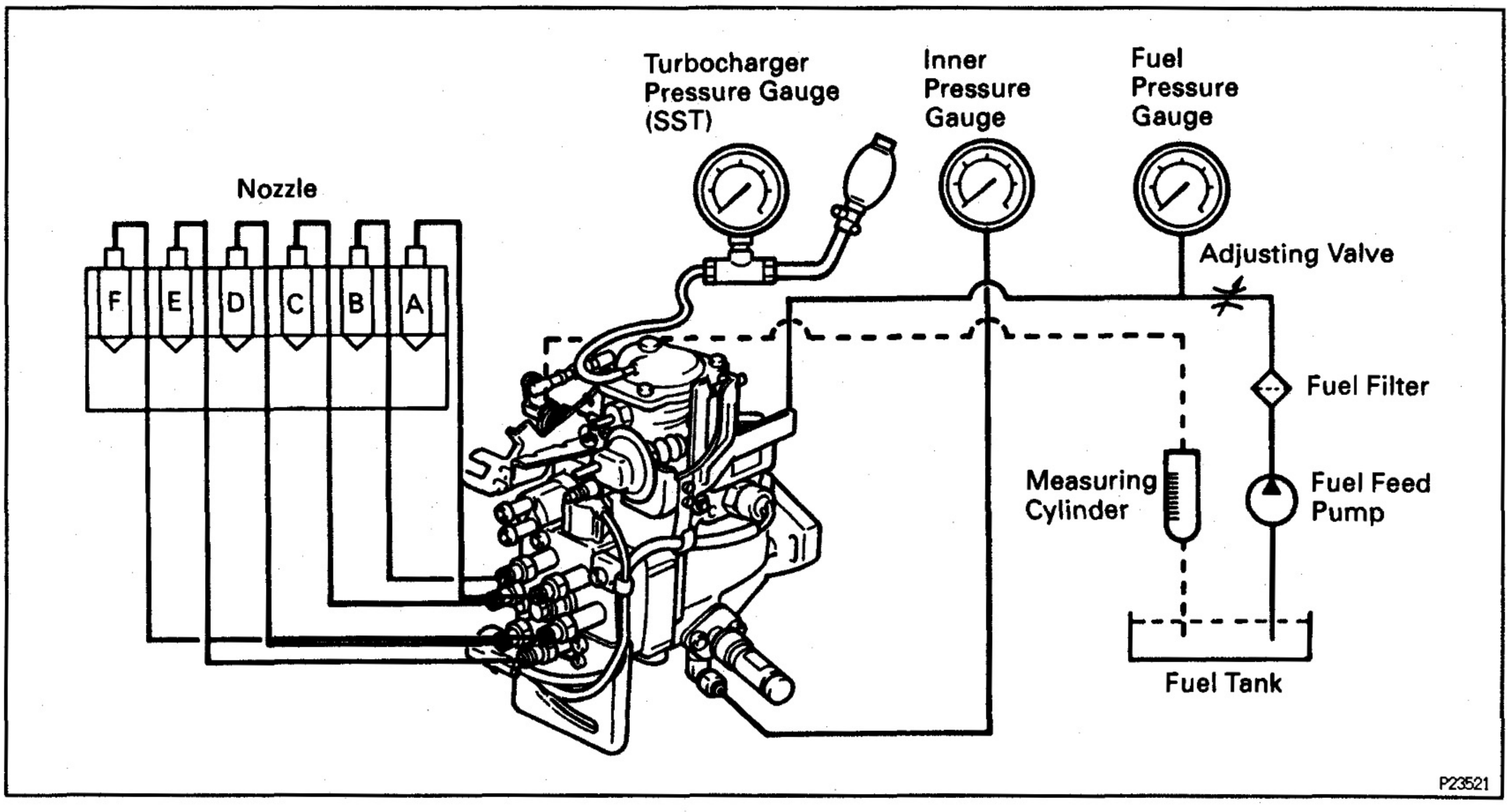
(f) Remove the fuel inlet hollow screw.
(g) Connect the fuel inlet pipe with an adapter.

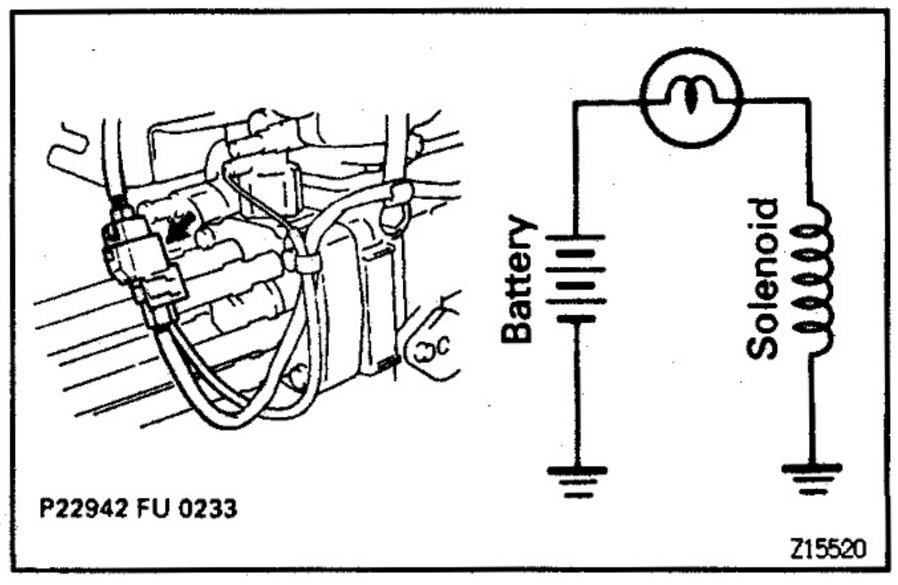


(h) Install an overflow hose with 2 gaskets and union bolt.
HINT: Always use the overflow screw installed on the pump to be adjusted.



(i) Using a 5 mm hexagon wrench, remove the 2 bolts and RH timer cover.
(j) Install the inner pressure gauge with the timer measuring device.
Part No. 95095–10231 and 95095–10480 (NIPPONDENSO)
HINT: Bleed the air by the air bleed screw.
(k) Connect SST (turbocharger pressure gauge) to the boost compensator.
SST 09992–00241





(l) Apply about 6 volts of DC power to the fuel cut solenoid.

NOTICE:

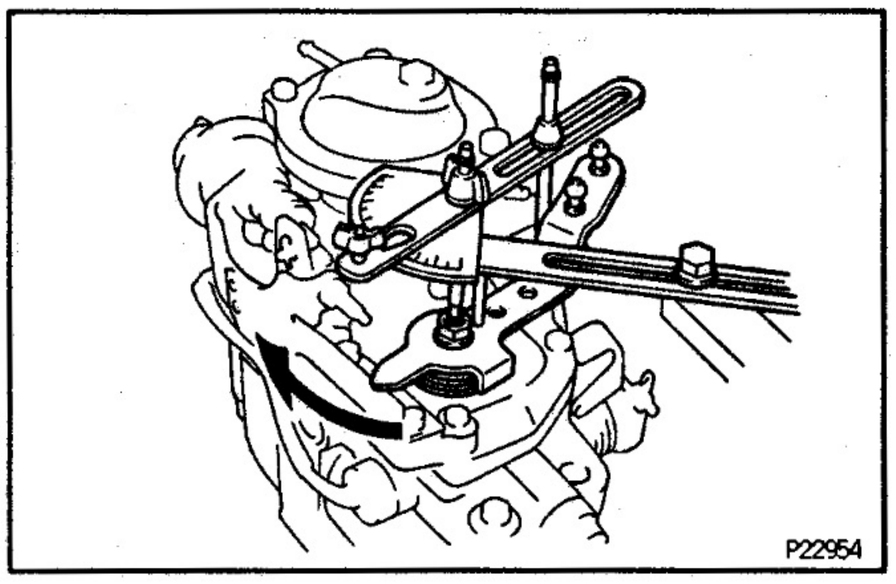
- **When applying voltage to the solenoid, position the battery as far away from the solenoid as possible so that a spark does not occur.**
- **When connecting the battery cable, connect the solenoid side first.**

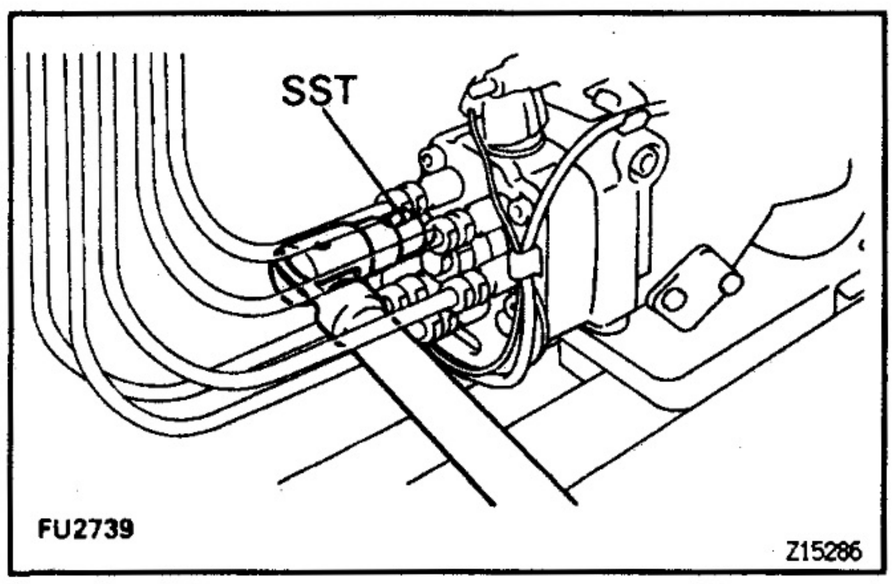
(m) The pressure for feeding fuel to the injection pump should be 20 kPa (0.2 kgf/cm², 2.8 psi). The fuel temperature for pump testing should be 40 – 45°C (104 – 113°F).

(n) Install an angle gauge to the stand and set it to the adjusting lever.

Part No. 95095–10360 (Stand w/ angle gauge)

(o) Secure the adjusting lever fully on the maximum speed side.

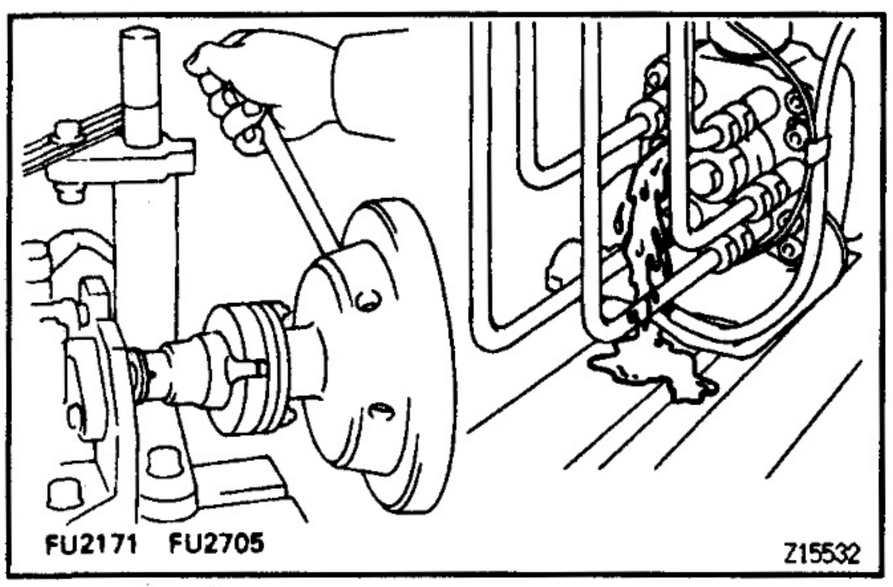




(p) Check the installation direction of the camplate as follows:

- Disconnect the injection pipe from the position marked "C" on the distributive head.
- Using SST, remove the delivery valve holder assembly and gasket.

SST 09260–54012 (09269–54020)

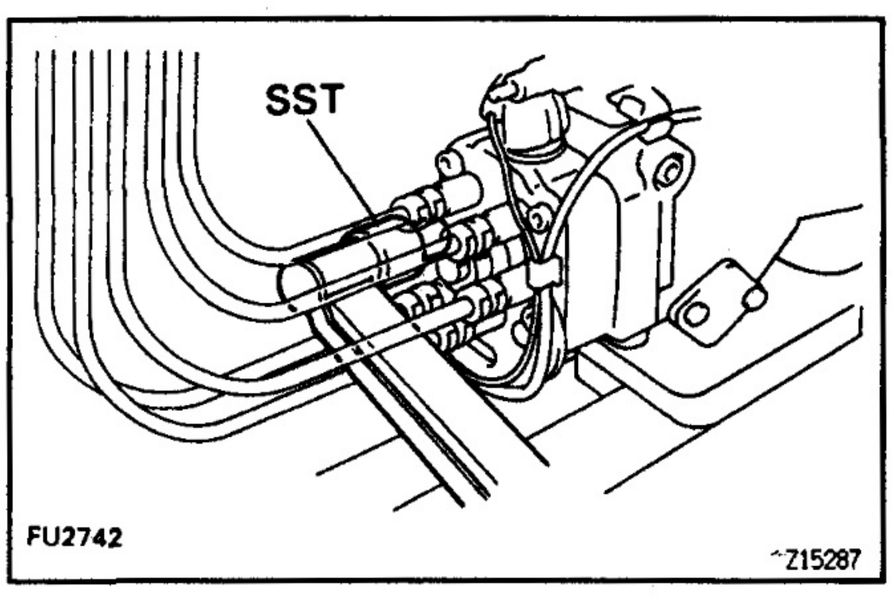


- Check that fuel is flowing out when the mark is in the position shown in the illustration.

If not, it is improperly assembled.

- Disassemble and change the camplate position 180° in the opposite direction.

HINT: At this time, disconnect the fuel cut solenoid wire harness.

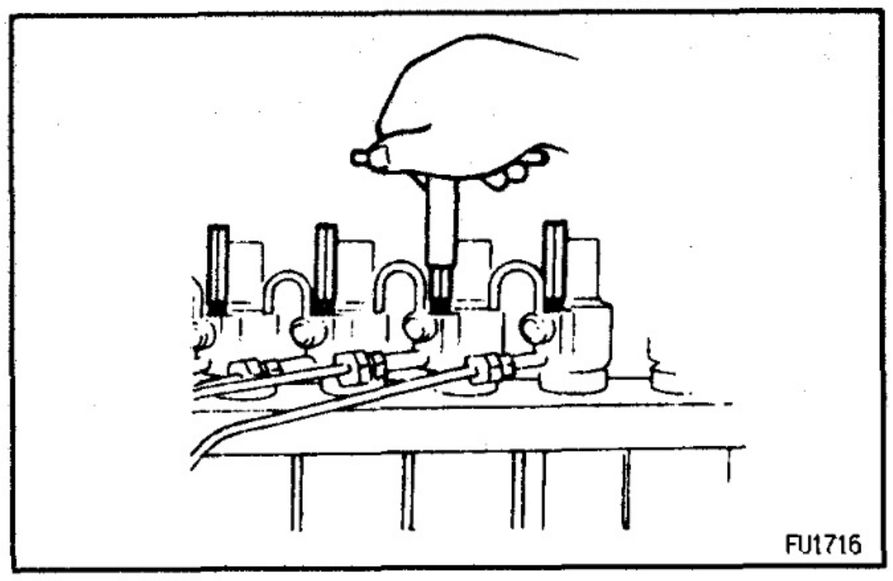


- Using SST, install a new gasket and the delivery valve holder assembly.

SST 09260–54012 (09269–54020)

Torque: 59 N·m (600 kgf·cm, 43 ft·lbf)

- Connect the injection pipe.


FU1716

(q) Bleed the air from the injection pipes.

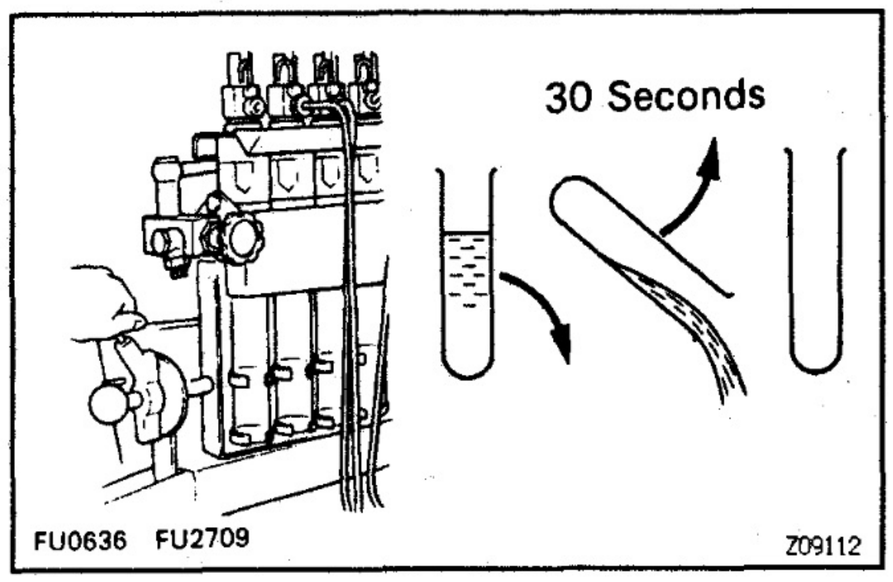
(r) Measure the injection volume.

Pump rpm	No. of measuring strokes	Each injection volume cc (cu in.)
1,080	200	14.92 – 16.52 (0.91 – 1.01)

(s) Race the injection pump for 5 minutes at 1,200 rpm.
NOTICE: Check that there is no fuel leakage or abnormal noise.

HINT:

- Measure the volume of each injection cylinder with a measuring cylinder.
- Before measuring the injection volume, first hold the cylinder tilted for at least 30 seconds to discard all the fuel.



FU0636 FU2709 Z09112

2. PRE–SET FULL LOAD INJECTION VOLUME

(a) Set the adjusting lever to maximum position.

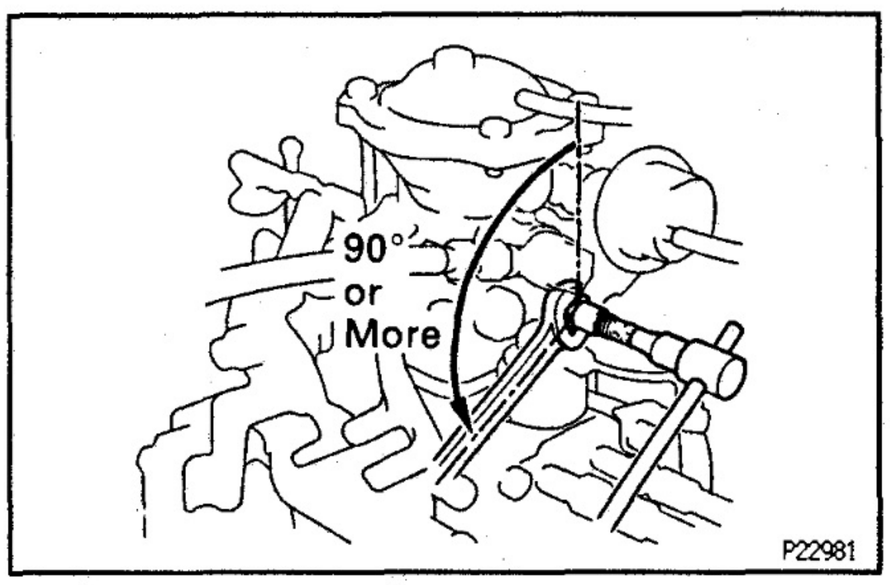
(b) Apply 67.2 kPa (503.7 mmHg, 19.83 in.Hg) of vacuum to the SICS actuator.

(c) w/o BACS:
Apply 79 kPa (0.81 kgf/cm², 11.5 psi) of pressure to the boost compensator.

(d) w/ BACS:
Apply 121.9 kPa (1.24 kgf/cm², 17.7 psi) of pressure to the boost compensator.

(e) Measure the injection volume.

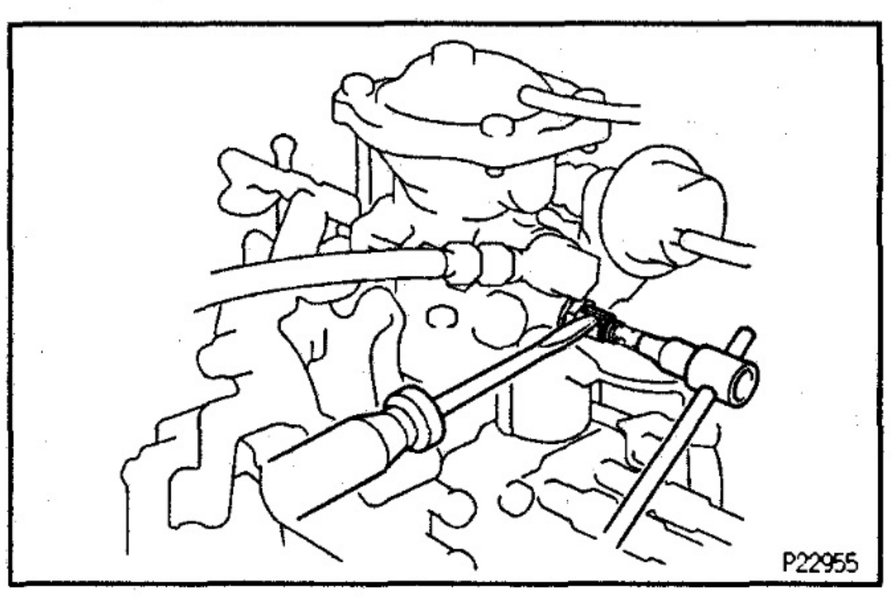
Pump rpm	No. of measuring strokes	Each injection volume cc (cu in.)
1,080	200	14.92 – 16.52 (0.91 – 1.01)



P22981

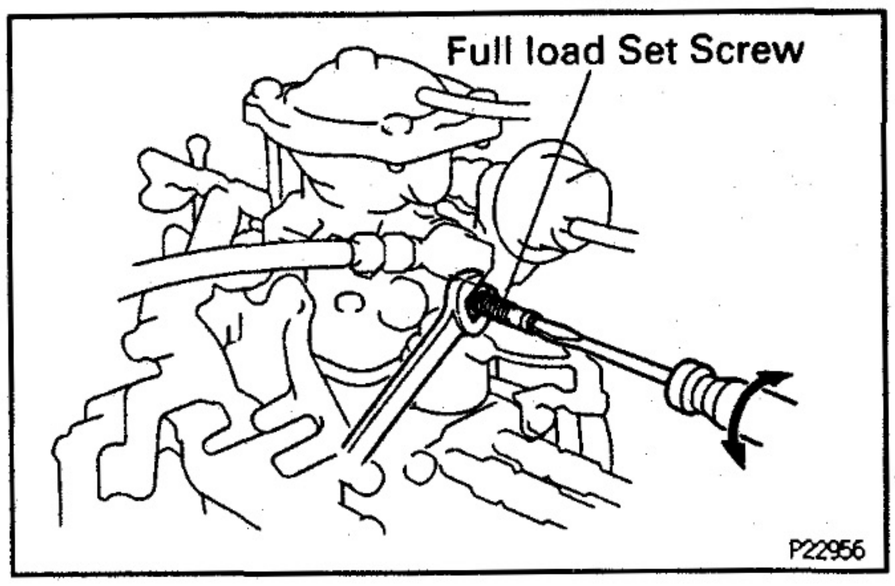
(f) Remove the collar seal as follows:

- Hold the full load set screw, and release the collar seal from the spot weld by turning the lock nut counterclockwise by 90° or more.

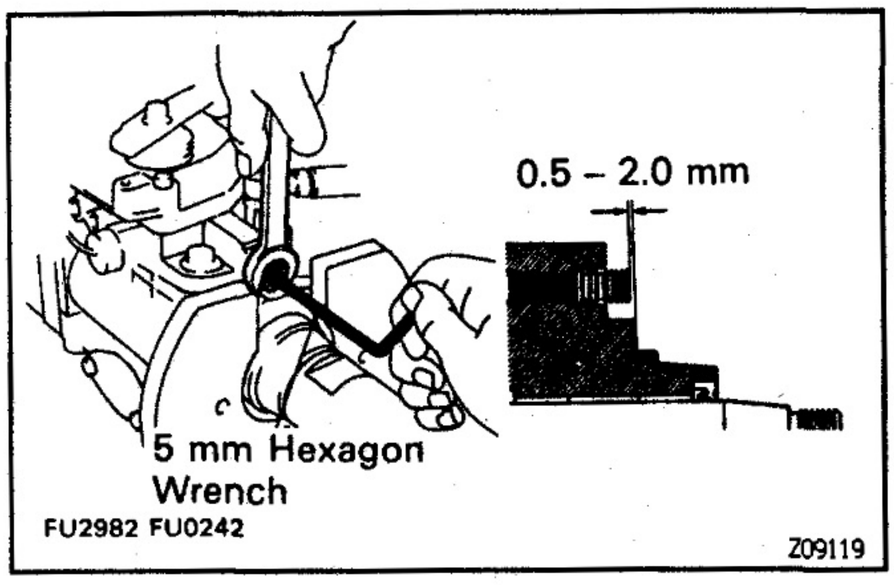

P22955

- Using a screwdriver, pry out the collar seal.

EG



(g) Adjust by turning the full load set screw.
HINT: The injection volume will increase about 3 cc (0.18 cu in.) with each 1/2 turn of the screw.



3. w/o BACS:
PRE–SETTING OF LOAD SENSING TIMER
Using a 5 mm hexagon wrench, adjust the protrusion of the governor shaft.
Protrusion:
0.5 – 2.0 mm (0.020 – 0.079 in.)

4. **PRE–SET MAXIMUM SPEED**

(a) Set the adjusting lever to maximum position.

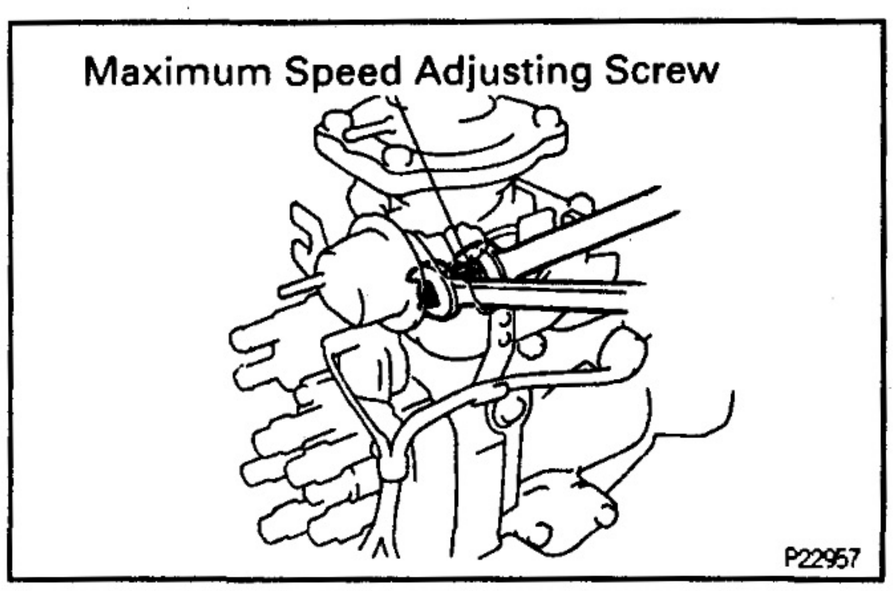
(b) Apply 67.2 kPa (503.7 mmHg, 19.83 in.Hg) of vacuum to the SICS actuator.

(c) w/o BACS:
Apply 79 kPa (0.81 kgf/cm², 11.5 psi) of pressure to the boost compensator.

(d) w/ BACS:
Apply 121.9 kPa (1.24 kgf/cm², 17.7 psi) of pressure to the boost compensator.

(e) Measure the injection volume.

Pump rpm	No. of measuring strokes	Each injection volume cc (cu in.)
2,200	200	4.0–6.0 (0.24–0.37)



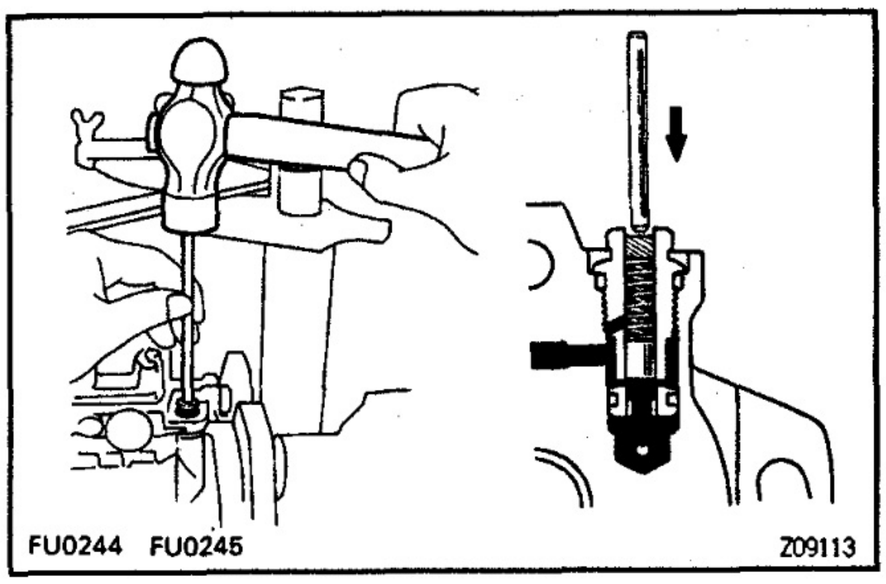
(f) Remove the lock plate.

(g) Adjust the injection volume with the maximum speed adjusting screw.

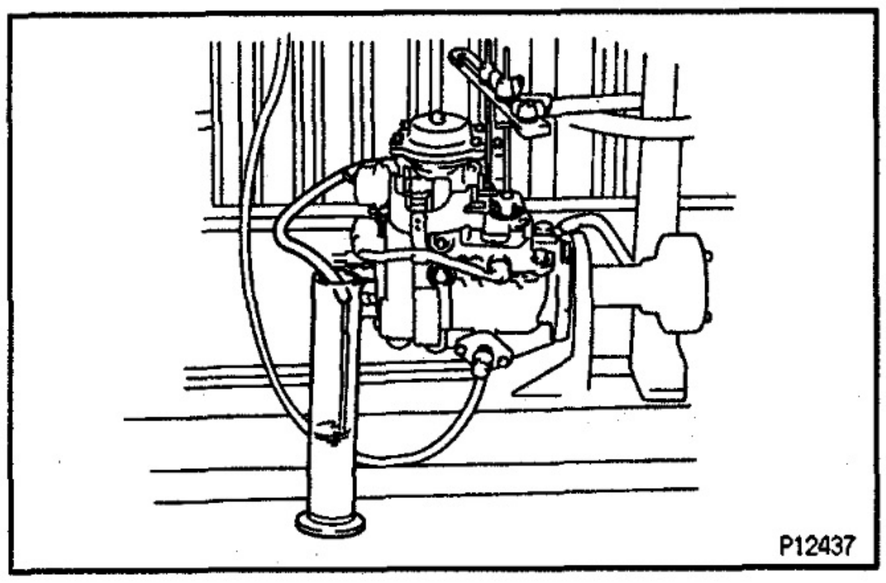
5. **ADJUST PUMP INNER PRESSURE**

(a) Measure the pump inner pressure at the below listed rpm.

Pump rpm	Inner pressure kPa (kgf/cm², psi)
1,080	402.1 – 460.9 (4.1 – 4.7, 58.3 – 66.8)
1,800	813.9 – 872.8 (8.3 – 8.9, 118.3 – 126.8)


FU0244 FU0245 Z09113

(b) If the pressure is low, adjust by lightly tapping the regulator valve piston while watching the pressure gauge.
HINT: If the pressure is too high or if the regulator valve was tapped in too far, the regulator valve must be replaced.

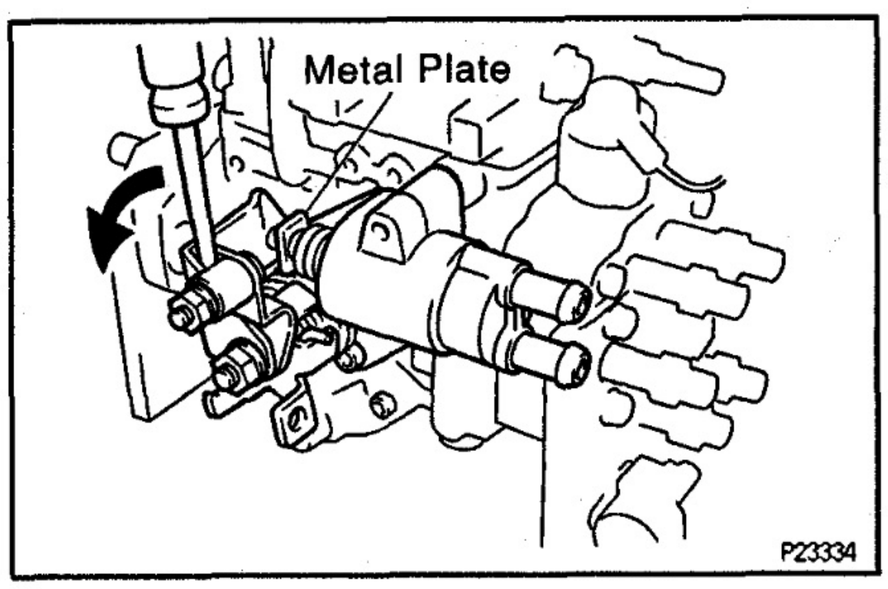

P12437

6. CHECK OVERFLOW VOLUME

Measure the overflow volume at the below listed rpm.

Pump rpm	Overflow volume cc/min. (cu in./min.)
1,800	1,292 – 1,942 (78.8 – 118.5)

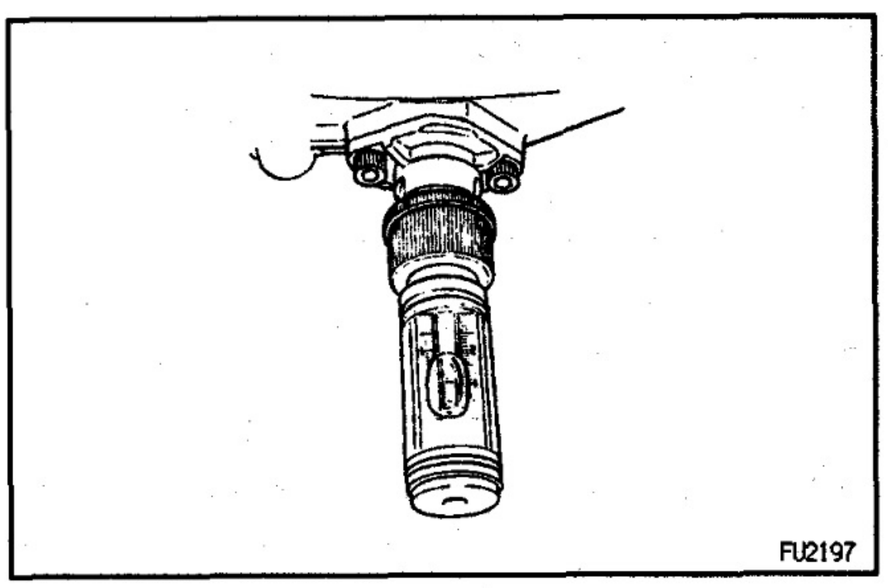
HINT: Always use the overflow screw installed on the pump to be adjusted.



P23334

7. RELEASE COLD STARTING SYSTEM FOR NEXT INSPECTIONS

(a) Using a screwdriver, turn the cold starting lever counterclockwise approx. 20°.
(b) Put a metal plate (thickness of 5.0 – 8.0 mm (0.20 – 0.31 in.)) between the cold starting lever and thermo wax plunger.
HINT: Keep the cold starting system released until all measurements and adjustments are finished.

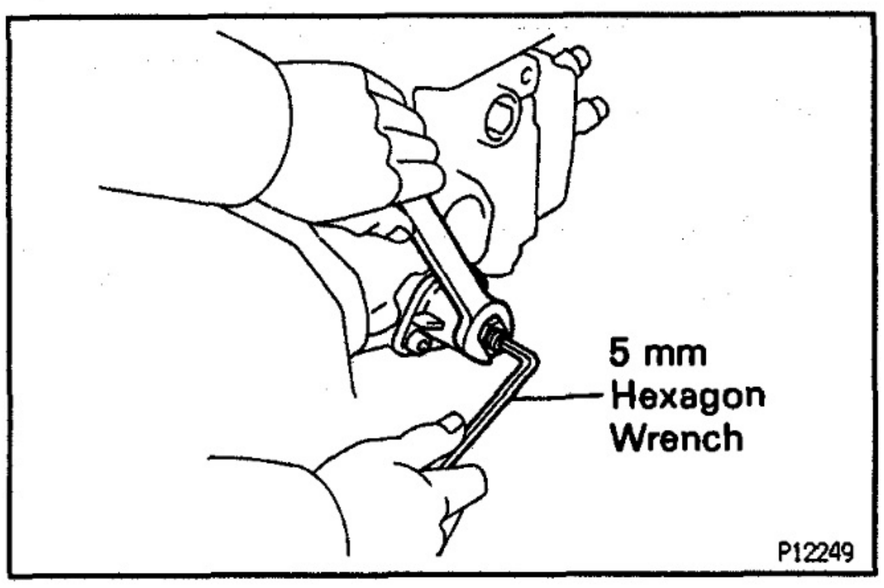

FU2197

8. ADJUST TIMER

(a) Set the timer measuring device at zero.
(b) Measure the timer piston stroke at the below listed rpm.

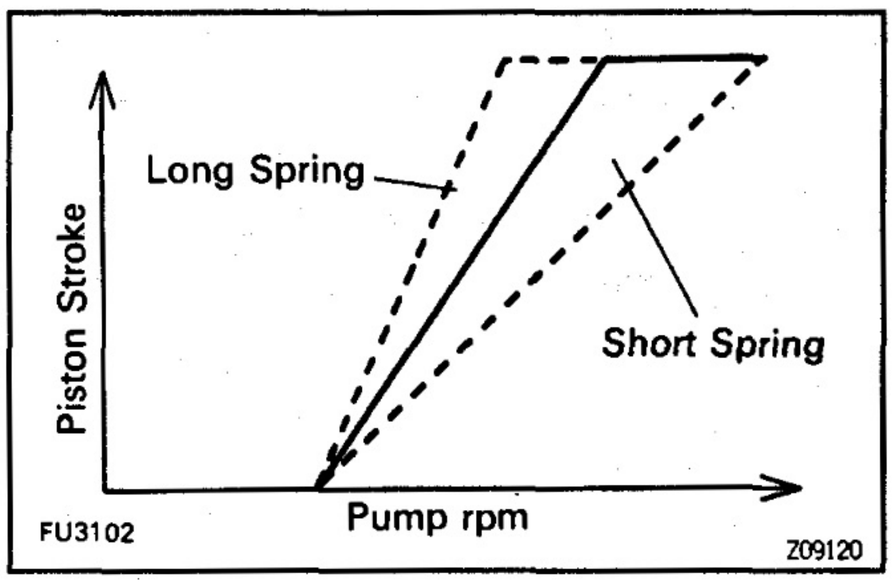
Item	Pump rpm	Piston strokes mm (in.)
w/o BACS	1,080	0.63 – 1.63 (0.025 – 0.064)
	1,440	3,24 – 4,24 (0.128 – 0.167)
	1,800	5.85 – 6.85 (0.230 – 0.270)
	2,000	7.7 – 8.7 (0.303 – 0.343)
w/ BACS	1,080	0.22 – 1.22 (0.009 – 0.048)
	1,440	2.83 – 3.83 (0.111 – 0.151)
	1,800	5.44 – 6.44 (0.214 – 0.254)
	2,000	7.7 – 8.7 (0.303 – 0.343)

V06645



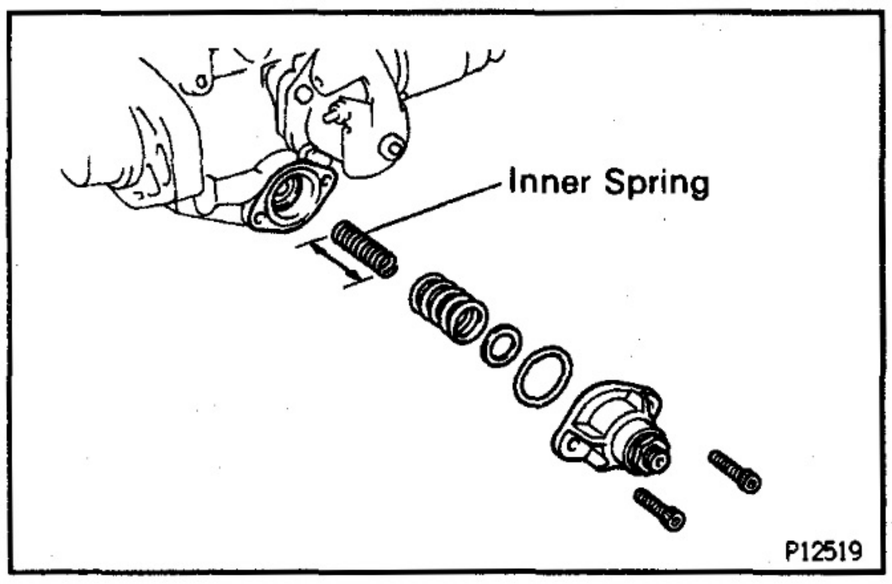
P12249

HINT: Check that the hysteresis is within 0.3 mm (0.012 in.).
(c) Using a 5 mm hexagon wrench, adjust by turning the timer adjusting screw.



HINT: Turn clockwise to reduce the stroke, turn counterclockwise to increase the stroke.

(d) Check the timer stroke for characteristic tendency.

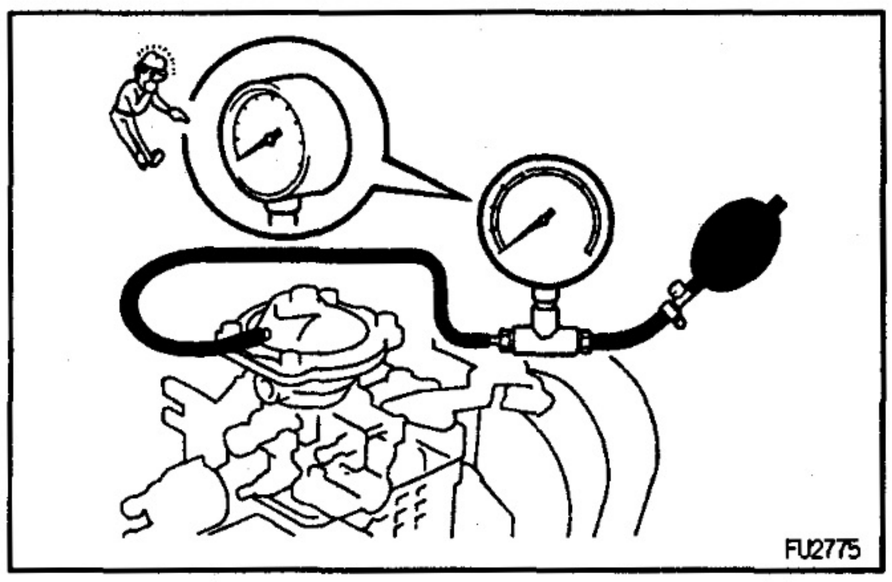


If tendency is not as specified, select and replace the inner spring.

Timer spring free length:

34.4 mm (1.35 in.)
34.0 mm (1.34 in.)
33.6 mm (1.32 in.)

HINT: The timer stroke will increase with a long spring and decrease with a short spring.



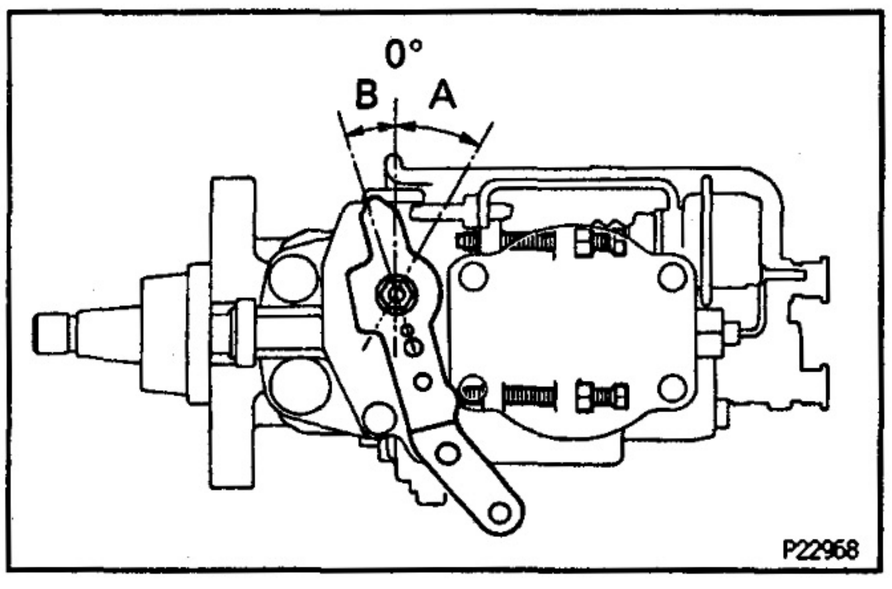
9. CHECK BOOST COMPENSATOR FOR AIR TIGHTNESS

(a) Apply 98 kPa (1.00 kgf/cm², 14.2 psi) of pressure to the boost compensator.

(b) Measure the time it takes for pressure to drop to 95 kPa (0.97 kgf/cm², 13.8 psi).

Pressure drop:

10 seconds or more



10. ADJUST FULL LOAD INJECTION VOLUME

(a) The adjusting lever angle for the adjustment below should be as shown in the illustration.

Adjusting lever angle:

A (Maximum speed side)	B (Idle speed side)
Plus 21 – 31°	Minus 12 – 22°

(b) Apply 67.2 kPa (503.7 mmHg, 19.83 in.Hg) of vacuum to the SICS actuator.

(c) w/o BACS:

Apply 79 kPa (0.81 kgf/cm², 11.5 psi) of pressure to the boost compensator.

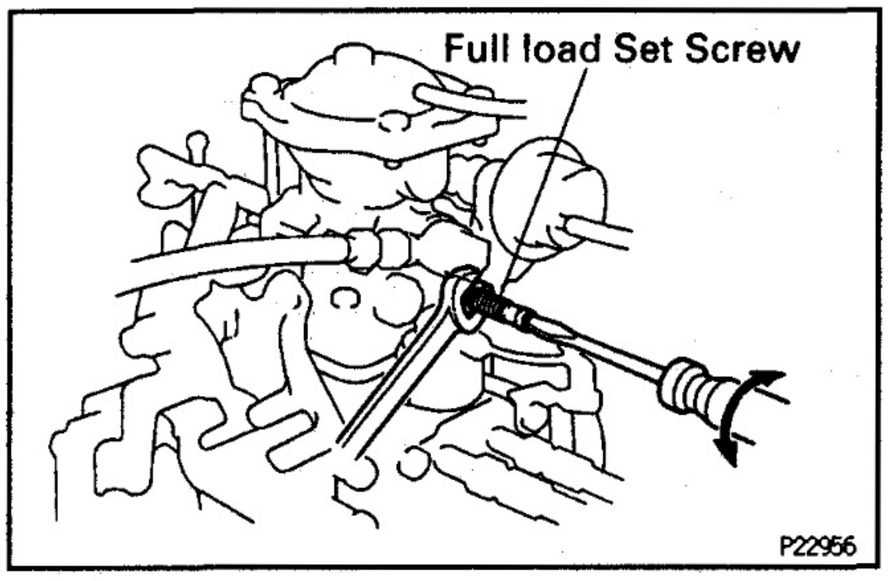
(d) w/ BACS:

Apply 121.9 kPa (1.24 kgf/cm², 17.7 psi) of pressure to the boost compensator.

(e) Measure the full load injection volume.

Adjusting lever angle	Pump rpm	No. of messuring strokes	Injection volume of each cylinder cc (cu in.)
Plus 21 – 31°	1,080	200	14.92 – 16.52 (0.91 – 1.01)

V06637

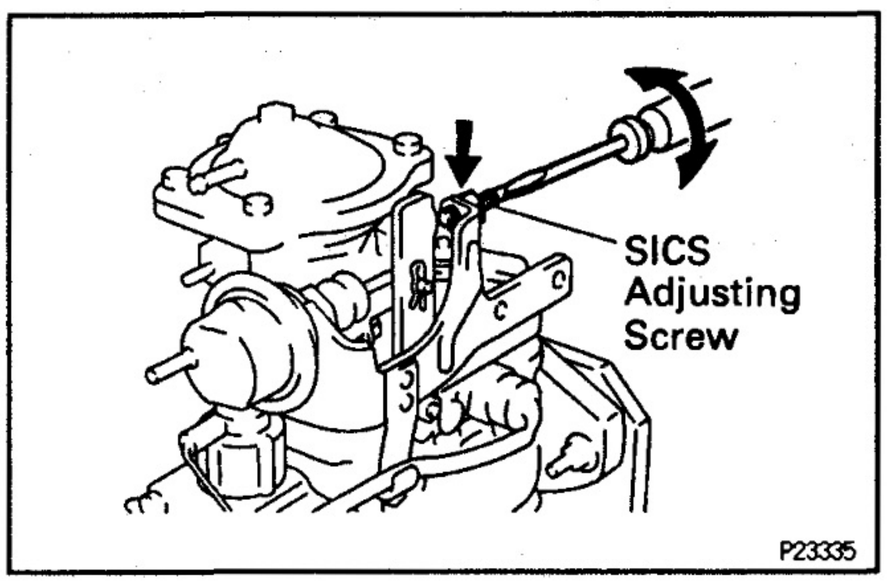


(f) Adjust by turning the full load set screw.
HINT: The injection volume will increase about 3 cc (0.18 cu in.) with each 1/2 turn of the screw.

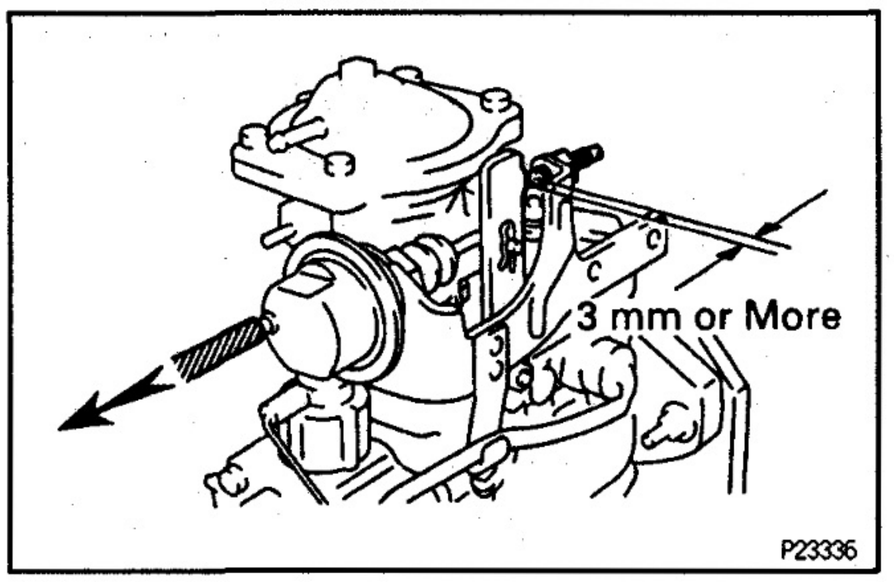
(g) Release the vacuum from the SICS actuator.

(h) Measure the injection volume.

Pump rpm	No. of measuring strokes	Each injection volume cc (cu in.)
100	200	11.3 – 12.7 (0.69 – 0.77)



(i) Adjust by turning the SICS adjusting screw.
HINT: By screwing in the adjusting screw, the injection volume is increased; unscrewing the adjusting screw decreases the injection volume.



(j) Check that when the actuator rod for SICS is withdrawn the most, the gap between SICS lever and SICS adjusting screw is 3 mm or more. If it less than 3 mm, add 1 adjusting washer on the nut side and check that the gap is 3 mm or more.

(k) Check that when the actuator is not operating, the gap between SICS lever and SICS adjusting screw is 0 mm.

11. ADJUST MAXIMUM SPEED

(a) w/o BACS:
Apply 79 kPa (0.81 kgf/cm², 11.5 psi) of pressure to the boost compensator.

(b) w/ BACS:
Apply 121.9 kPa (1.24 kgf/cm², 17.7 psi) of pressure to the boost compensator.

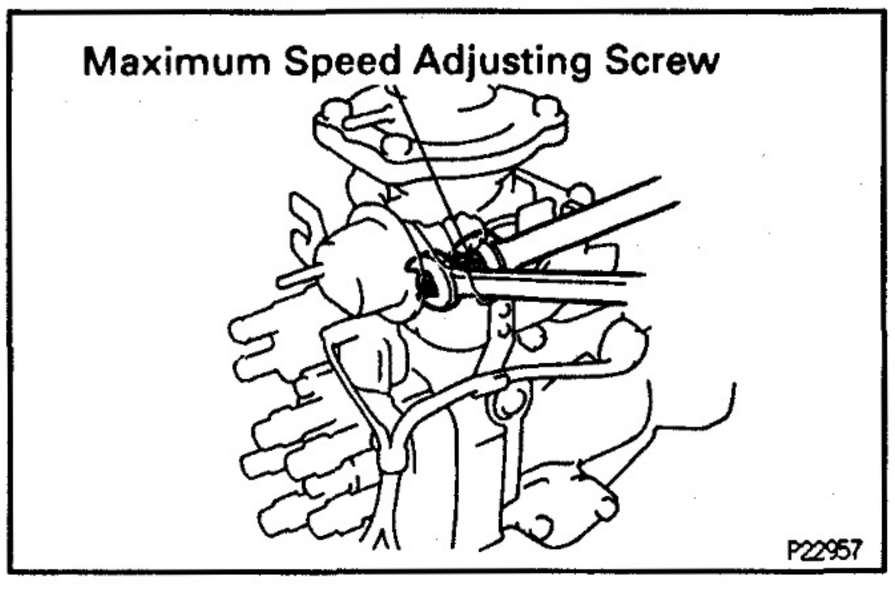
(c) Apply 67.2 kPa (503.8 mmHg, 19.83 in.Hg) of vacuum to the SICS actuator.

(d) Measure the injection volume at each pump rpm.

Adjusting lever angle	Pump rmp	No. of measuring strokes	Injection volume of each cylinder cc (cu in.)	Remarks
Plus 21 – 31°	2,200	200	4.0 – 6.0 (0.24 – 0.37)	Adjust
Minus 12 – 22°	2,200		1.0 (0.06) or less	–

V06638

EG



(e) Adjust by turning the maximum speed adjusting screw.

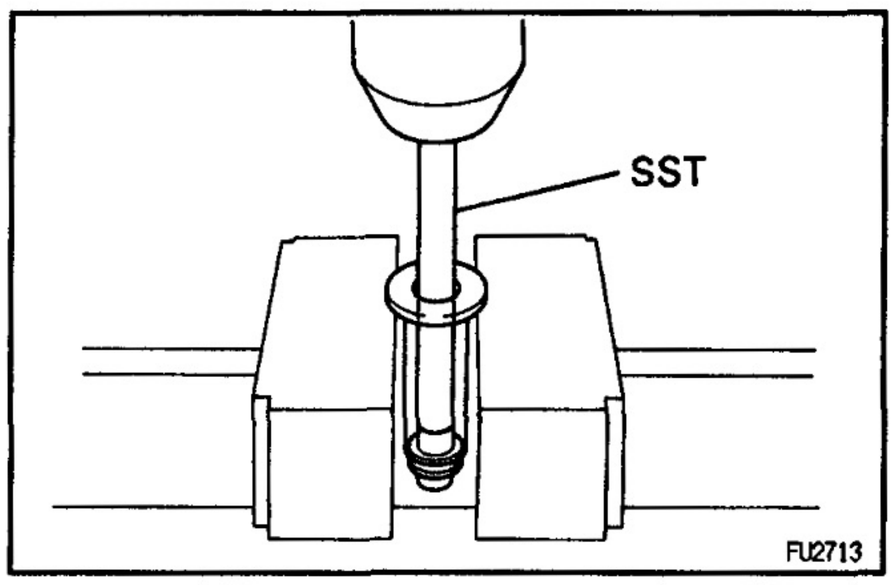
12. CHECK INJECTION VOLUME

(a) Apply 67.2 kPa (503.7 mmHg, 19.83 in.Hg) of vacuum to the SICS actuator.

(b) Measure the injection volume at each pump rpm and boost pressure.

Item	Adjusting lever angle	Pump rpm	Boost pressure kPa (kg/cm², psi)	No. of measuring Strokes	Each injection volume cc (cu in.)	Variation limit cc (cu in.)	Remarks
w/BACS	Plus 21 – 31°	1,080	121.9 (1.24, 17.7)	200	14.92 – 16.52 (0.91 – 1.01)	1.6 (0.10)	Basic full-load injection volume
		100	41.2 (0.42, 6.0)		15.60 – 19.60 (0.95 – 1.20)	–	Volume during starting
		720	0 (0, 0)		7.14 – 8.34 (0.44 – 0.51)	–	–
		1,800	121.9 (1.24, 17.7)		17.74 (1.08)	–	–
w/o BACS	Plus 21 – 31°	1,080	79 (0.81, 11.5)	200	14.92 – 16.52 (0.91 – 1.01)	1.6 (0.10)	Basic full-load injection volume
		100	0 (0, 0)		14.00 – 15.00 (0.85 – 0.92)	–	Volume during Starting
		720	0 (0, 0)		8.02 – 9.22 (0.49 – 0.56)	–	–
		1,800	79 (0.81, 11.5)		17.74 (1.08)	–	–

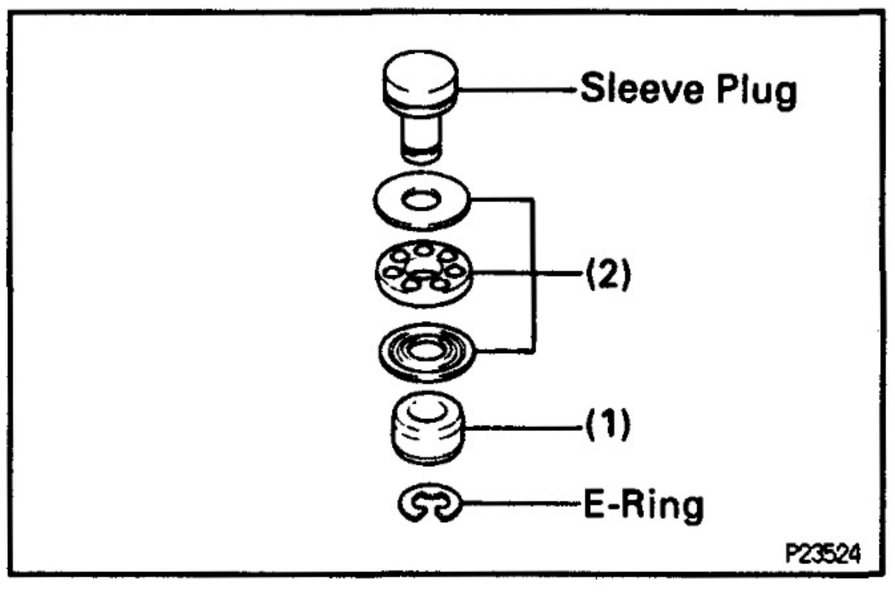
V06639



If the injection volume at 100 rpm is not as specified, replace the governor sleeve plug as follows:

- Using SST and a press, press out the sleeve plug assembly from the governor sleeve.

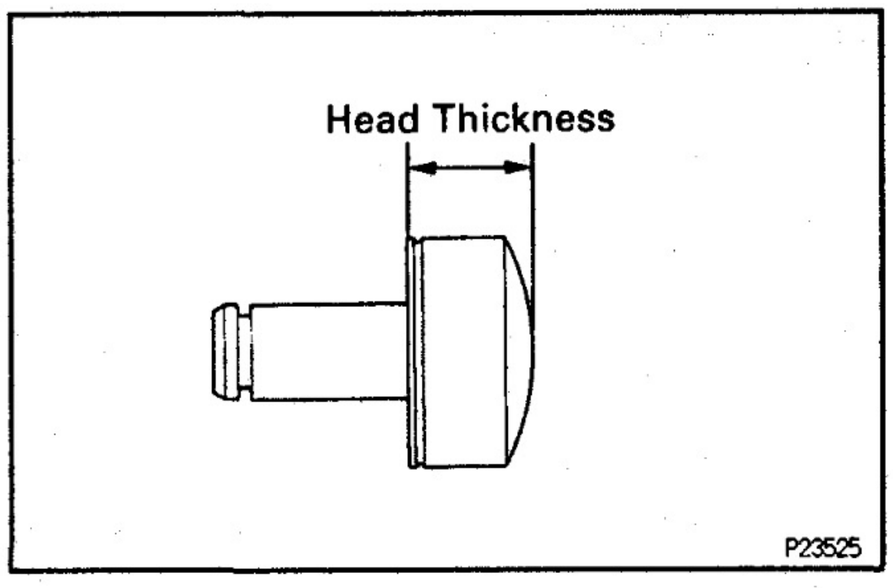
SST 09236–00101 (09237–00070)



- Remove the E–ring and following parts from the sleeve plug:

(1) Stop ring

(2) Bearing and 2 bearing retainers



- Measure the head thickness of the sleeve plug, and select a new sleeve plug.

Governor sleeve plug head thickness: mm (in.)

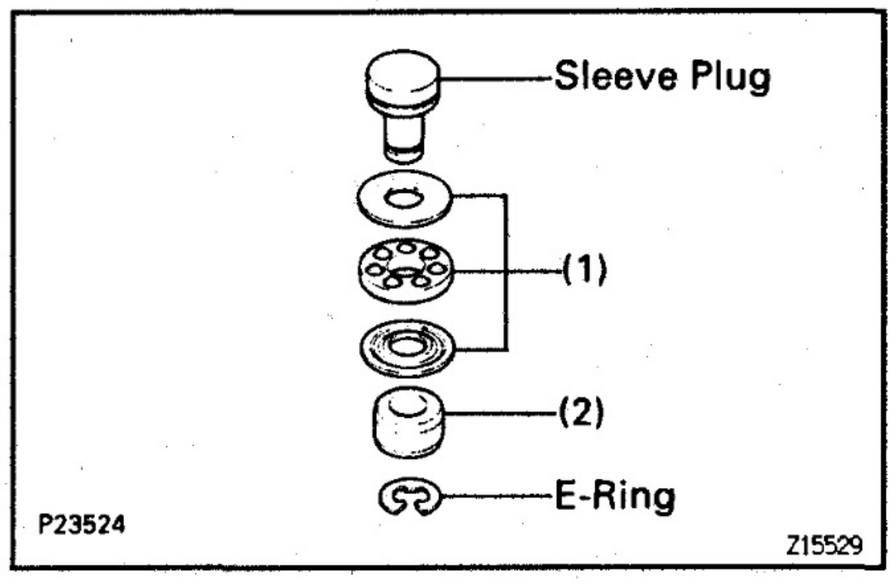
1.3 (0.051)	1.7 (0.067)	2.1 (0.083)
2.5 (0.098)	2.9 (0.114)	3.3 (0.130)
3.7 (0.146)	4.1 (0.161)	4.5 (0.177)
4.9 (0.193)	–	–

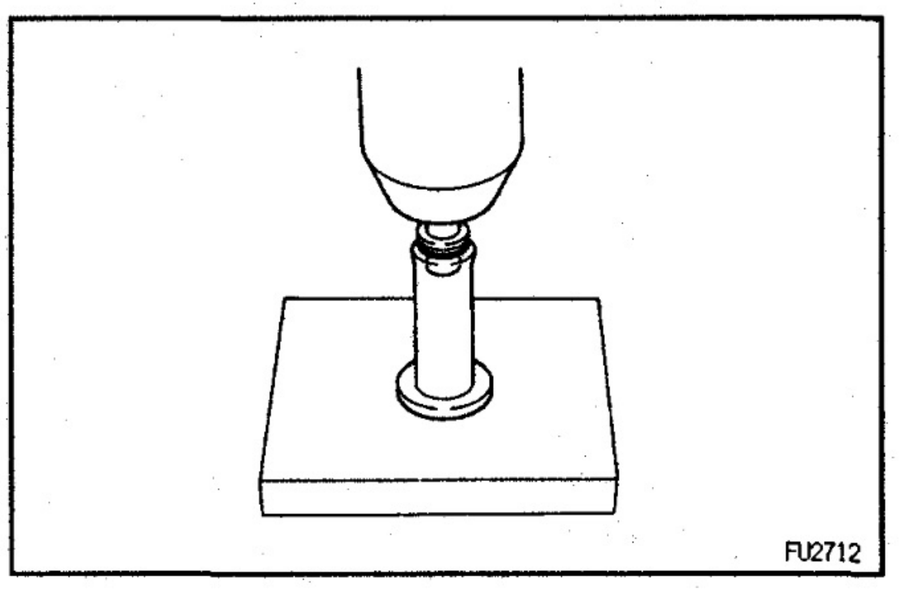
HINT: Lengthening the plug by 0.1 mm (0.004 in.) will decrease injection volume by 0.6 cc (0.04 cu in.).

If the variation limit is greater than specified, replace the delivery valve.

- Install these parts to the new sleeve plug with a new E–ring:

(1) Bearing and 2 retainers
(2) Stop ring





- Using a press, press in the sleeve plug assembly to the governor sleeve.

13. ADJUST FULL LOAD MINIMUM INJECTION VOLUME

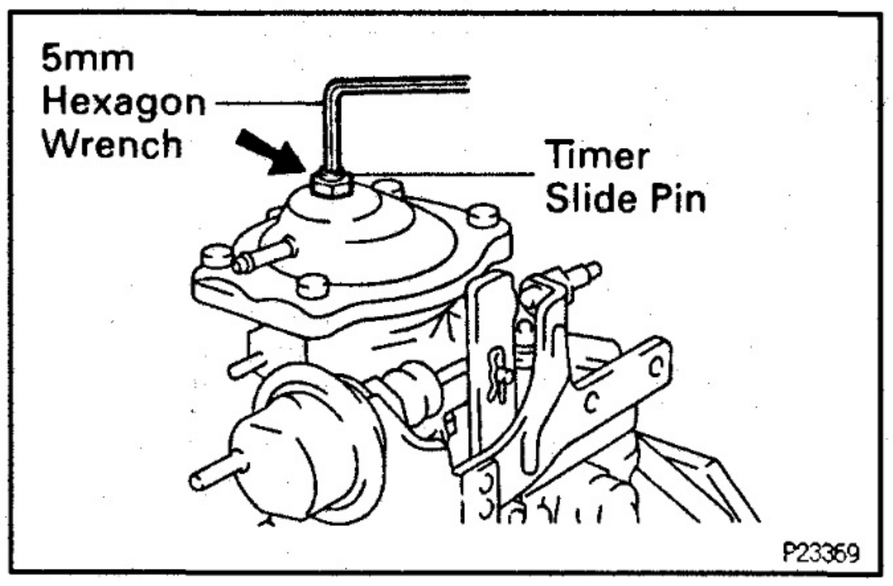
(a) Set the adjusting lever to maximum position.
(b) Apply 67.2 kPa (503.7 mmHg, 19.83 in.Hg) of vacuum to the SICS actuator.
(c) w/o BACS:
Release the pressure from the boost compensator.
(d) w/ BACS:
Apply 49 kPa (0.50 kgf/cm², 7.1 psi) of pressure to the boost compensator.
(e) Measure the injection volume.

w/ BACS:

Pump rpm	No. of measuring strokes	Each injection volume cc (cu in.)
720	200	7.14 – 8.34 (0.44 – 0.51)

w/o BACS:

Pump rpm	No. of measuring strokes	Each injection volume cc (cu in.)
720	200	8.02 – 9.22 (0.49 – 0.56)



(f) Using a 5 mm hexagon wrench, adjust by turning the timer slide pin.

14. ADJUST BOOST COMPENSATOR CHARACTERISTIC

(a) Apply 67.2 kPa (503.7 mmHg, 19.83 in.Hg) of vacuum to the SICS actuator.

(b) w/o BACS:
Apply 40 kPa (0.41 kgf/cm², 5.8 psi) of pressure to the boost compensator.

(c) w/ BACS:
Apply 79 kPa (0.81 kgf/cm², 11.5 psi) of pressure to the boost compensator.

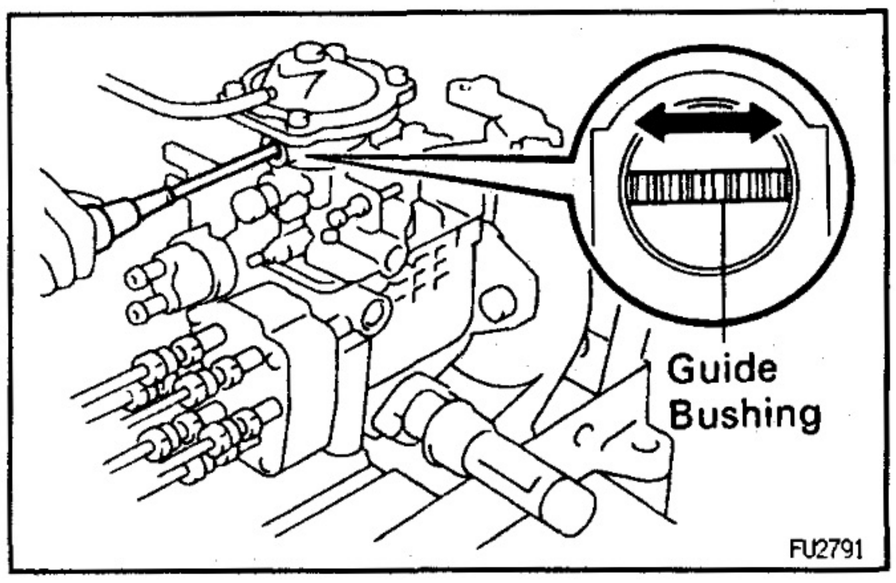
(d) Measure the injection volume.

w/ BACS:

Pump rpm	No. of measuring strokes	Each injection volume cc (cu in.)
720	200	12.56 – 14.16 (0.76 – 0.86)

w/o BACS:

Pump rpm	No. of measuring strokes	Each injection volume cc (cu in.)
720	200	12.70 – 14.30 (0.77 – 0.87)



(e) Using a screwdriver, adjust the injection volume by the guide bushing.
HINT: When the guide bushing is turned clockwise, as seen from above, the injection volume will increase.

15. CHECK FOR CHARACTERISTIC TENDENCY

(a) Apply 67.2 kPa (503.7 mmHg, 19.83 in.Hg) of vacuum to the SICS actuator.

(b) w/o BACS:
Apply 15.7 kPa (0.16 kgf/cm², 2.3 psi) of pressure to the boost compensator.

(c) w/ BACS:
Apply 41.2 kPa (0.42 kgf/cm², 6.0 psi) of pressure to the boost compensator.

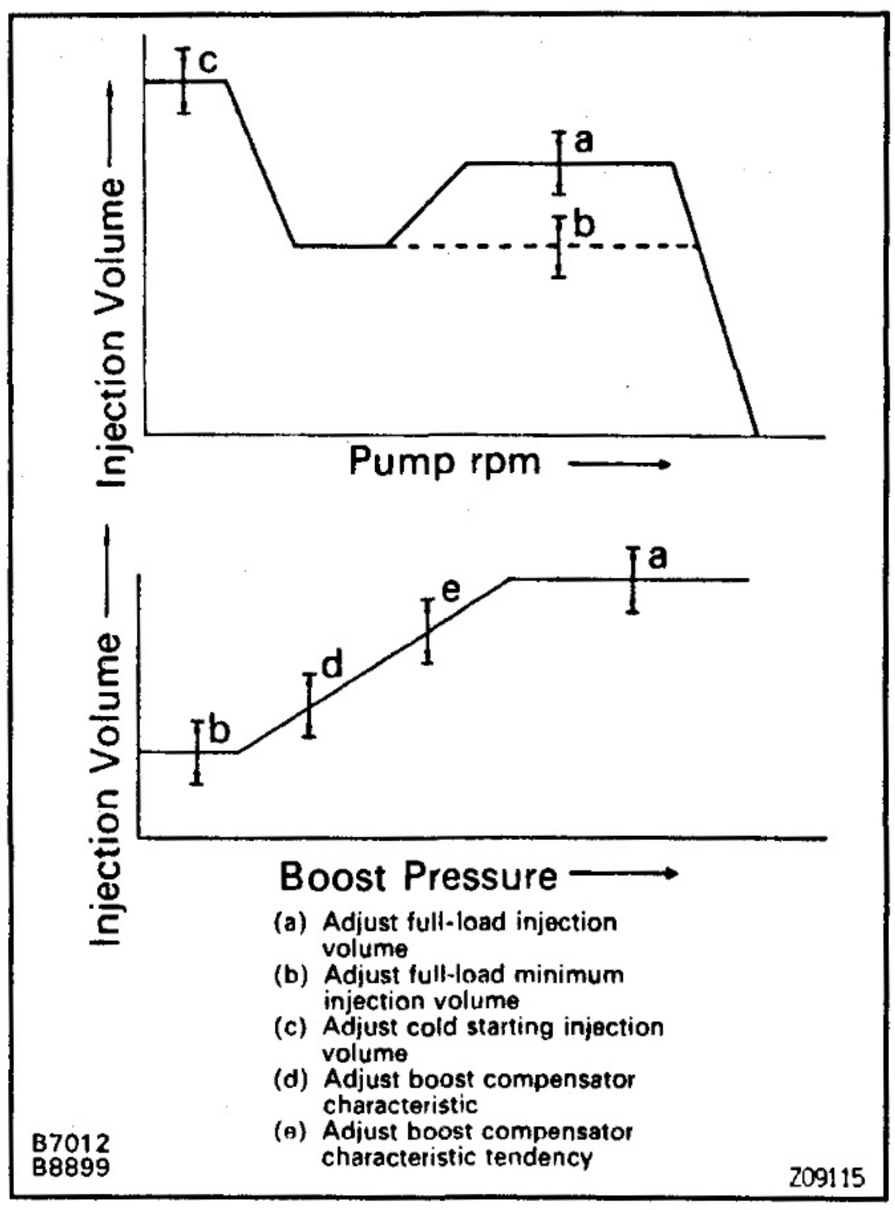
(d) Measure the injection volume.

w/ BACS:

Pump rpm	No. of measuring strokes	Each injection volume cc (cu in.)
720	200	8.02 – 9.22 (0.49 – 0.56)

w/o BACS:

Pump rpm	No. of measuring strokes	Each injection volume cc (cu in.)
720	200	8.80 – 10.00 (0.54 – 0.61)



16. CHECK HYSTERESIS

(a) w/o BACS:
Compare the injection volume when the boost compensator pressure is lowered from 79 kPa (0.81 kgf/cm², 11.5 psi) to 0 kPa (0 kgf/cm², 0 psi) and, conversely, when it is raised from zero.

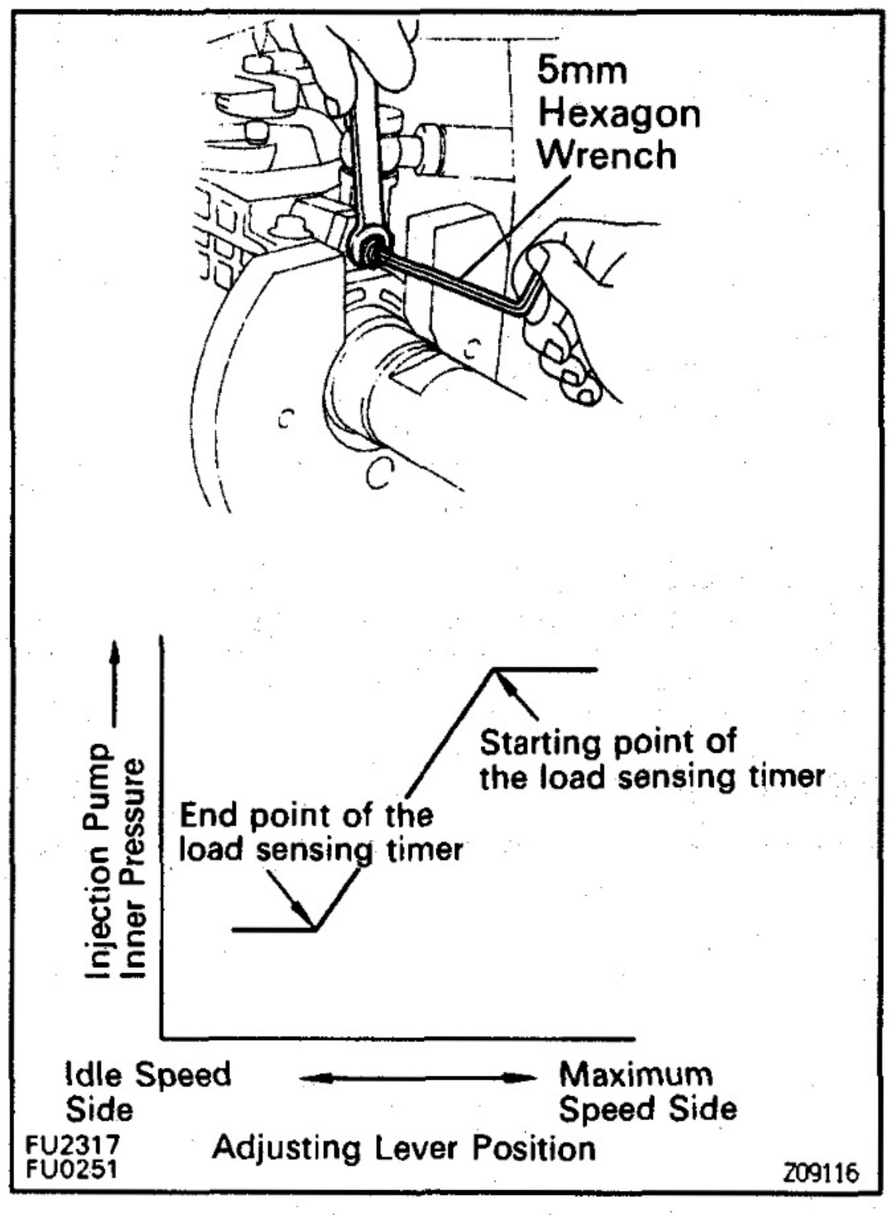
(b) w/ BACS:
Compare the injection volume when the boost compensator pressure is lowered from 127 kPa (1.25 kgf/cm², 18.3 psi) to 0 kPa (0 kgf/cm², 0 psi) and, conversely, when it is raised from zero.

HINT: Make measurements after moving the adjusting lever between idle and maximum 3 times for each lowering of the pressure.

Item	Pump rpm	Boost pressure kPa (kgf/cm², psi)	No. of measuring strokes	Injection volume of each cylinder cc (cu in.)	Hysteresis cc (cu in.)
w/ BACS	720	121.9 (1.24, 17.7)	200	14.04 – 15.64 (0.86 – 0.95)	–
		79 (0.81, 11.5)		12.56 – 14.16 (0.76 – 0.86)	–
		41.2 (0.42, 6.0)		8.02 – 9.22 (0.49 – 0.56)	0.6 (0.10) or less
		0 (0, 0)		7.14 – 8.34 (0.44 – 0.51)	–
w/o BACS	720	79 (0.81, 11.5)	200	14.04 – 15.64 (0.86 – 0.95)	–
		40 (0.41, 5.8)		12.70 – 14.30 (0.77 – 0.87)	–
		15.7 (0.16, 2.3)		8.80 – 10.00 (0.54 – 0.61)	0.6 (0.10) or less
		0 (0, 0)		8.02 – 9.22 (0.49 – 0.56)	–

V06640

If not within standard value, check each sliding part of the boost compensator and check whether or not there is any oil.



17. ADJUST LOAD SENSING TIMER

(a) Using a 5 mm hexagon wrench, adjust the starting and end points of the load sensing timer by turning the governor shaft.

(b) Set the adjusting lever to maximum position.

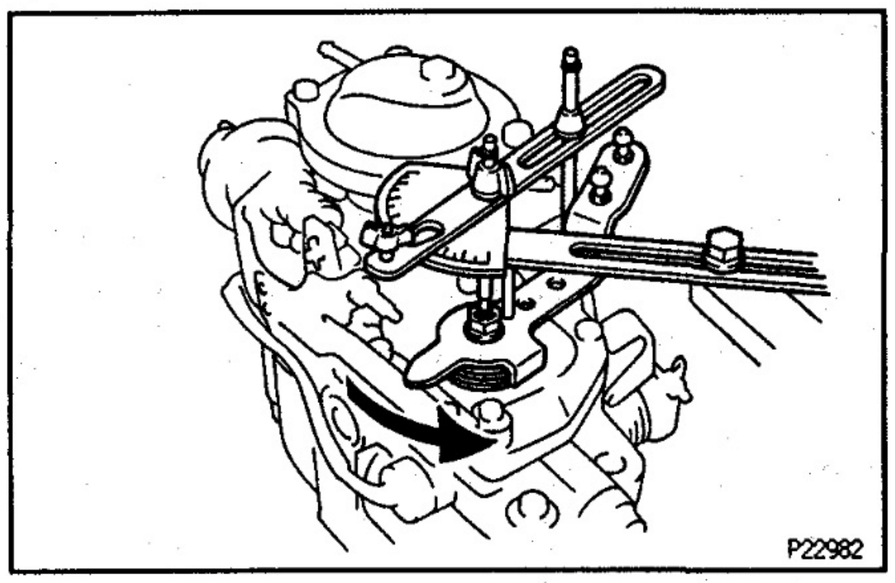
(c) Apply 67.2 kPa (503.7 mmHg, 19.83 in.Hg) of vacuum to the SICS actuator.

(d) w/o BACS:
Apply 79 kPa (0.81 kgf/cm², 11.5 psi) of pressure to the boost compensator.

(e) w/ BACS:
Apply 121.9 kPa (1.24 kgf/cm², 17.7 psi) of pressure to the boost compensator.

(f) Measure the injection volume.

Adjusting lever position	Pump rpm	No. of measuring strokes
Maximum speed side	1,440 1,800	200



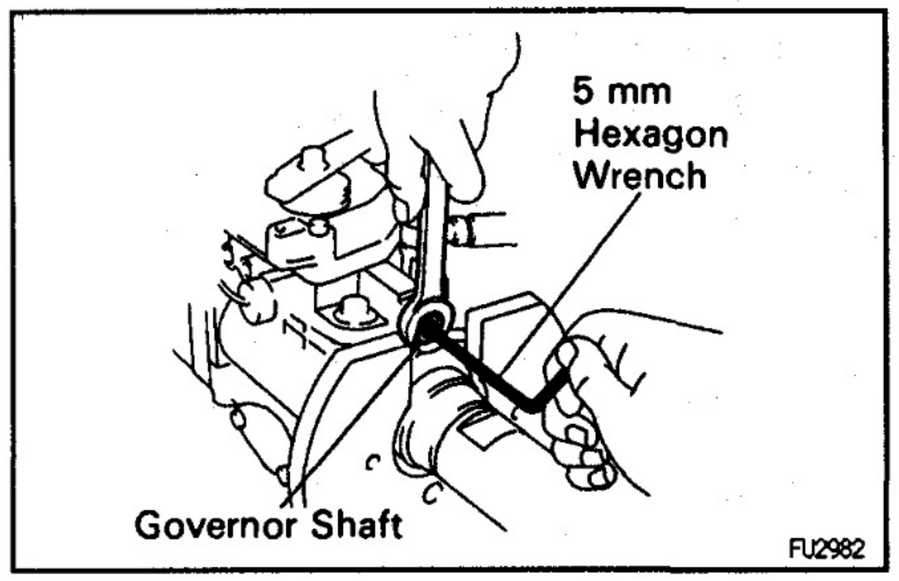
P22982

(g) Slowly move the adjusting lever from the maximum speed side to the idle speed side, and secure it at the point where the pump inner pressure begins to drop.

(h) Measure the injection volume at the drop point (starting point).

Pump rpm	No. of measuring strokes	Injection volums of each cylinder cc (cu in.)
1,800	200	Measured value at step (f) minus 1.0 (0.06) ± 0.3 (0.02)

V06641



FU2982

(i) Using a 5 mm hexagon wrench, adjust the load sensing timer by turning the governor shaft, and do the measurement again as specified.
HINT: The injection volume will increase approx. 3 cc (0.2 cu in.) with each 1/2 turn of the governor shaft.

Item	Pump rpm	No. of mesuring strokes	Injection volume of each cylinder cc (cu in.)	Timer piston stroke mm (in.)
w/ BACS	1,440	200	Measured value at step (f) minus 3.8 (0.23) ± 1.0 (0.06)	1.56 – 2.56 (0.061 – 0.101)
w/o BACS	1,440	200	Measured value at step (f) minus 3.8 (0.23) ± 1.0 (0.06)	1.29 – 2.29 (0.051 – 0.090)

V06642

HINT: The end point is hard to identify, so use the methods used in the chart above.

(k) When the adjusting lever is moved slowly from the maximum speed side to the idle speed side.

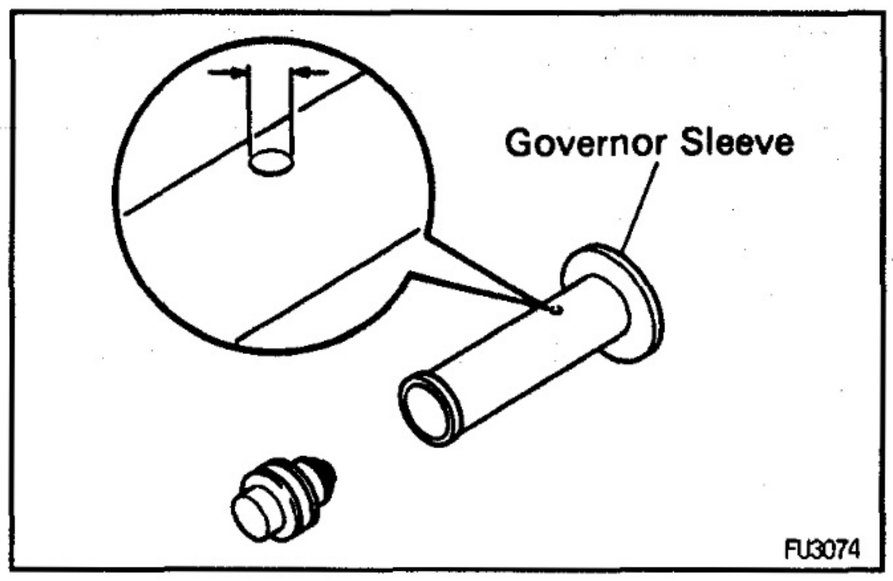
w/ BACS:

Pump rpm	Timer piston stroke mm (in.)
1,440	0.77 – 1.77 (0.030 – 0.069)

w/o BACS:

Pump rpm	Timer piston stroke mm (in.)
1,440	1.45 – 2.45 (0.057 – 0.096)

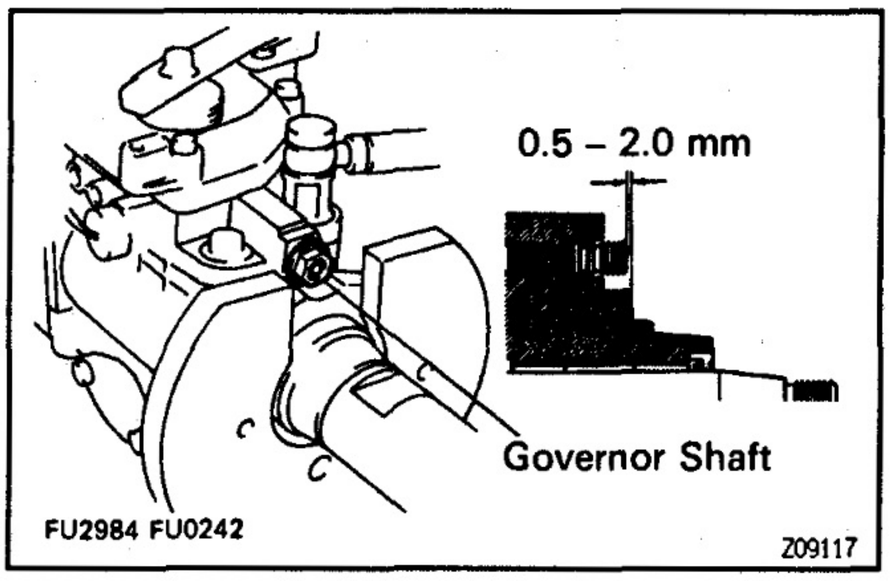
If the timer stroke is not as specified when the load sensing is at maximum retard angle, select a new governor sleeve.



Governor sleeve hole diameter:

Item	Diameter mm (in)	Item	Diameter mm (in)
Europe	0.45 (0.0177) 0.50 (0.0197) 0.55 (0.0217)	Australia	0.55 (0.0217) 0.60 (0.0236) 0.625 (0.0246) 0.65 (0.0256)

V06636



HINT: A large hole diameter decreases the timer stroke and a smaller hole diameter increases the timer stroke.

(l) Check the protrusion of the governor shaft.

Protrusion:

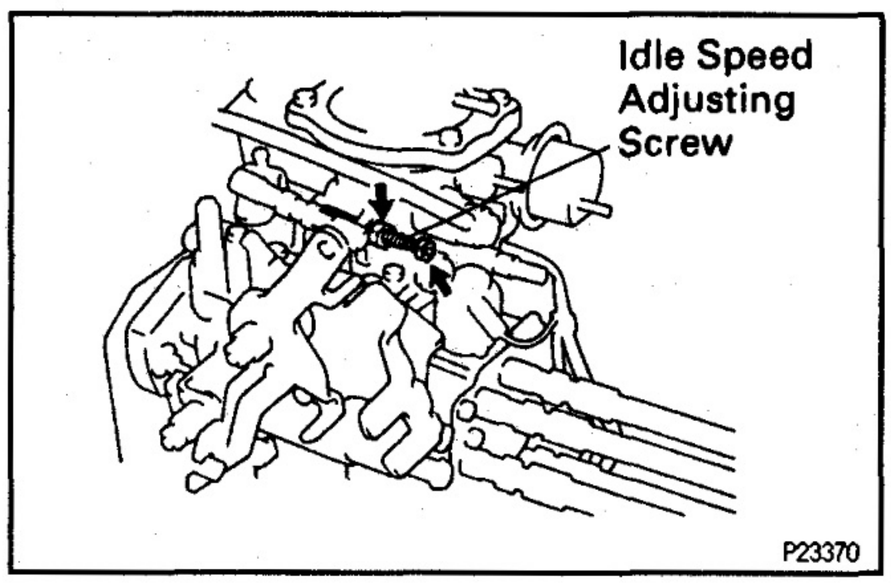
0.5 – 2.0 mm (0.020 – 0.079 in.)

18. ADJUST IDLE SPEED

(a) Measure the injection volume for each pump rpm.

Item	Adjusting lever angle	Pump rpm	No. of measuring strokes	Injection volume of each cylinder cc (cu in.)	Variation limit cc (cu in.)	Remarks
Europe	Full position	400	200	7.86 ~ 10.66 (0.48 ~ 0.65)	–	–
	Minus 12 – 22°	350		q = 0.70 ~ 1.10 (0.04 ~ 0.07)	0.5 (0.03)	Adjust
Australia M/T	Full position	400	200	7.86 ~ 10.66 (0.48 ~ 0.65)	–	–
	Minus 12 – 22°	350		q = 0.70 ~ 1.10 (0.04 ~ 0.07)	0.5 (0.03)	Adjust
Australia A/T	Full position	400	200	7.86 ~ 10.66 (0.48 ~ 0.65)	–	–
	Minus 12 – 22°	400		q = 0.70 ~ 1.10 (0.04 ~ 0.07)	0.5 (0.03)	Adjust

V06643



(b) Adjust injection volume by turning the idle speed adjusting screw.

19. ADJUST COLD STARTING SYSTEM

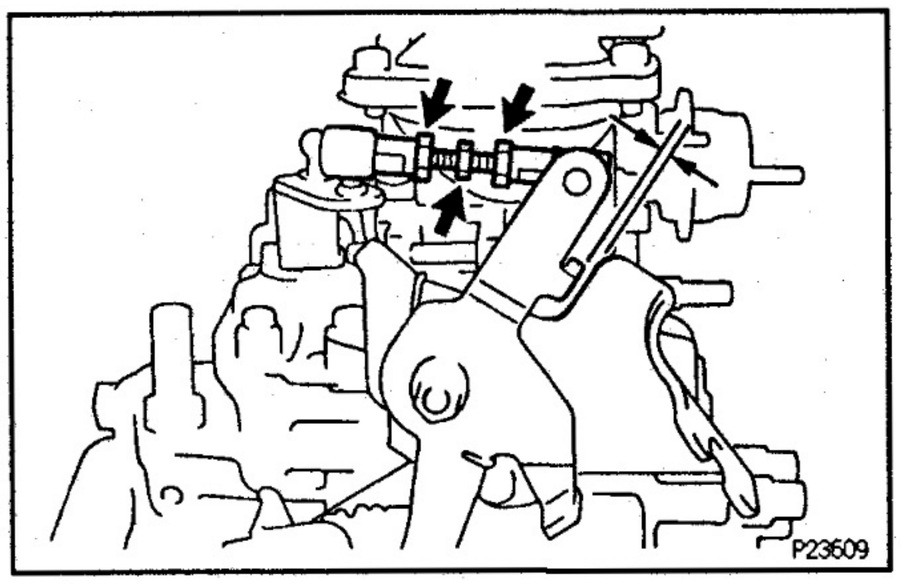
(a) Remove the overflow screw and check the fuel temperature in the fuel pump.

Fuel temperature:

15 – 35°C (59 – 95°F)

(b) Check that the cam part of the camplate is not on top of the roller ring.

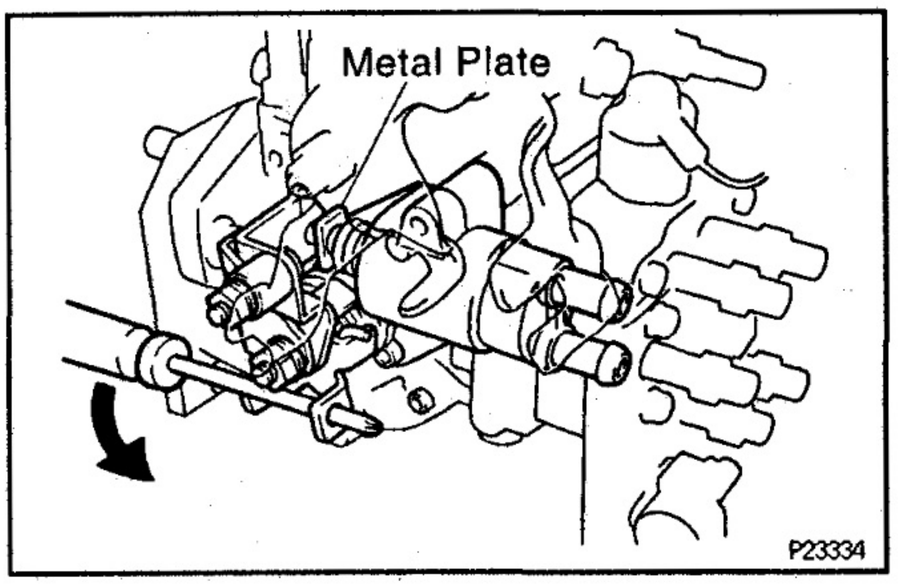
(c) Set the scale of the timer measuring device to zero.



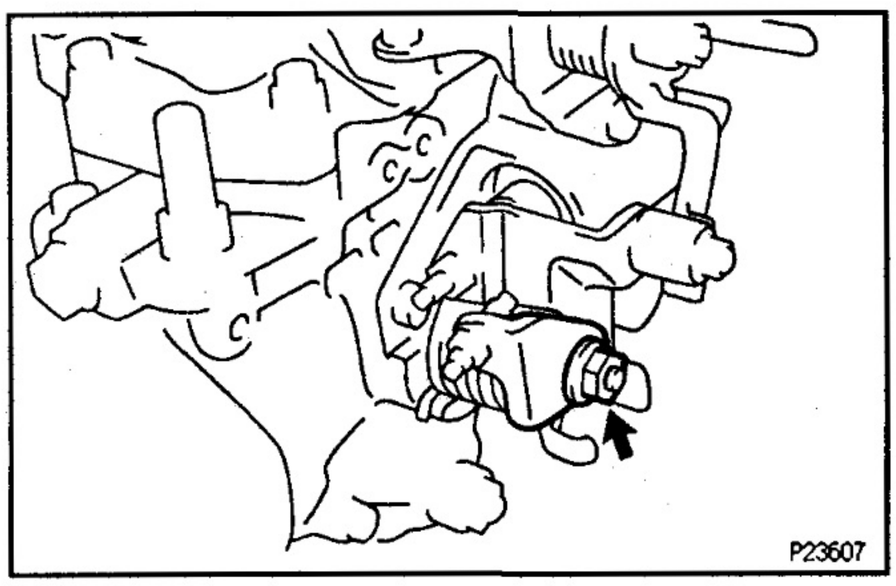
(d) Check the adjustng lever opening angle and consider this angle as zero.

(e) Measure the clearance between the idle–up lever and idle–up lever bracket.
Clearance: 1.95 – 2.05 mm (0.077 – 0.0.081 in.)

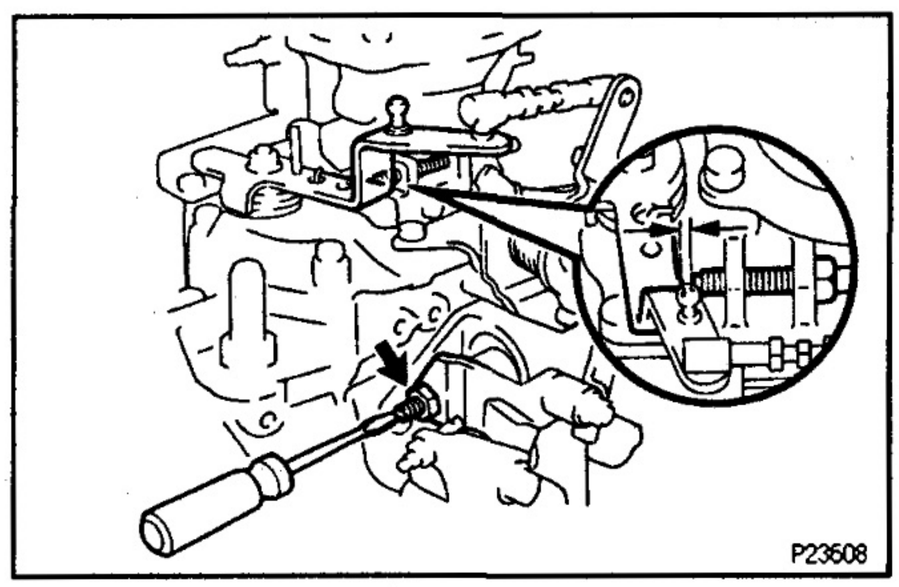
(f) Adjust by turning the fast idle adjusting screw.



(g) Remove the metal plate between the cold starting lever and thermo wax plunger.



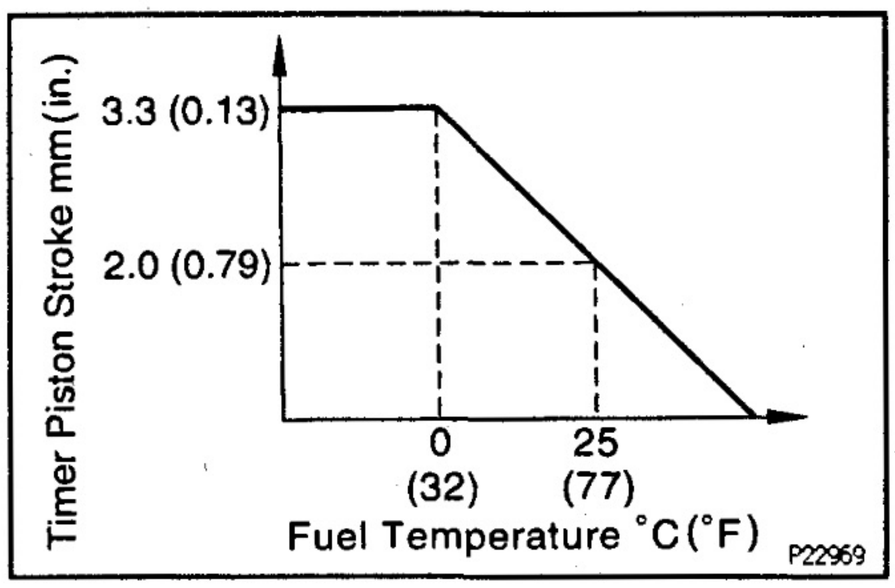
(h) Loosen the nut from the cold starting lever.



(i) Measure the clearance between the adjusting lever and idle speed adjusting screw.

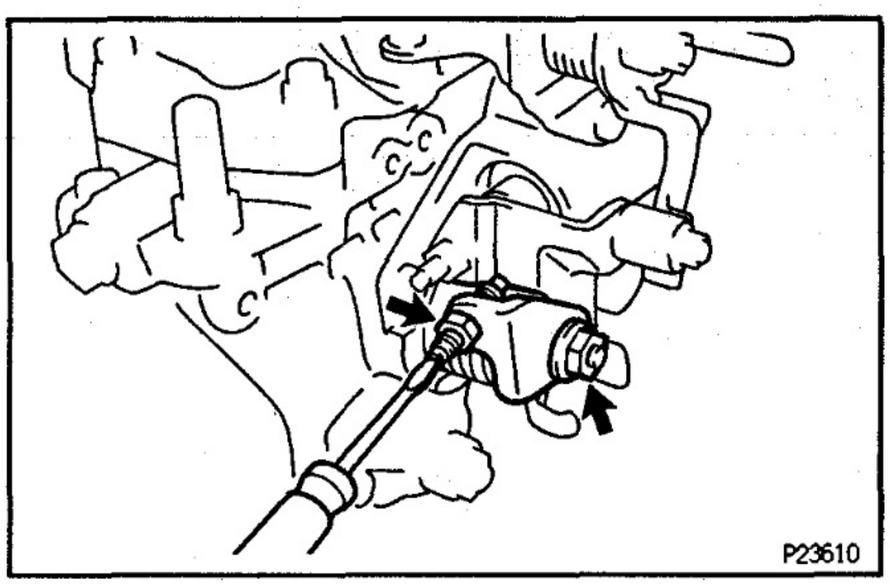
Fuel temperature	Clearance
25°C (68°F)	0.95 mm (0.037 in.)
50°C (122°F)	0 mm (0 in.)

(j) Adjust by turning the cold starting adjusting screw.



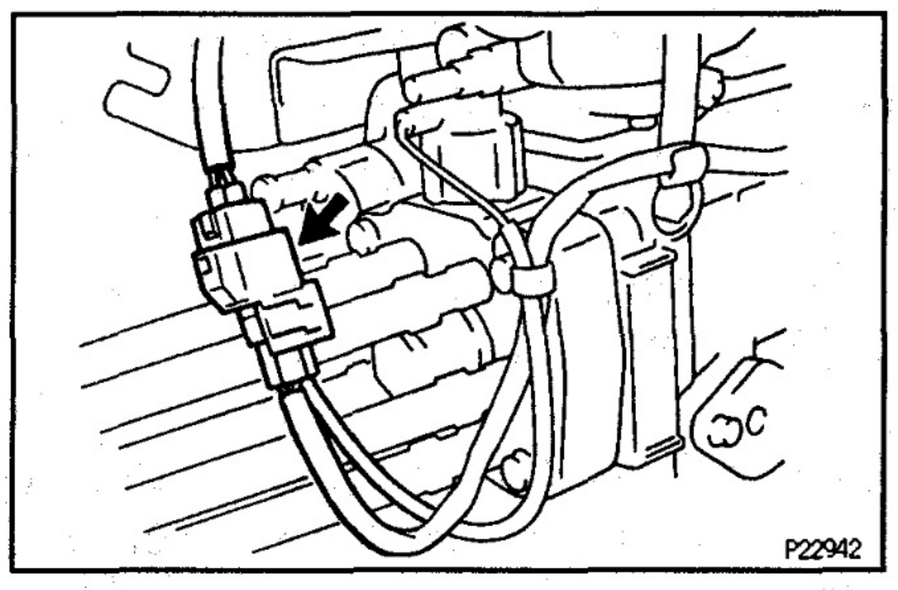
(k) Measure the timer piston stroke.

Fuel temperature	Timer piston stroke mm (in.)
25°C (77°F)	1.9 – 2.1 (0.075 – 0.083)



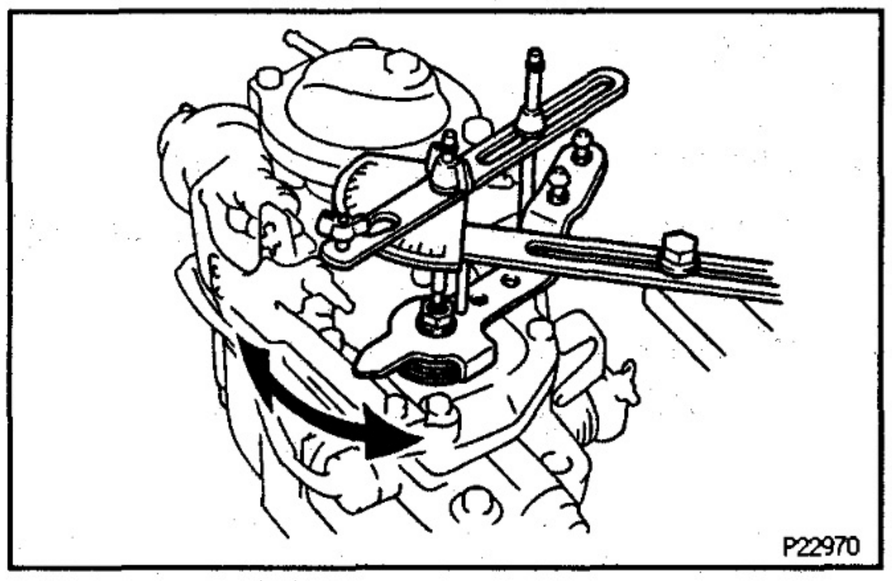
(l) Adjust by turning the timer adjusting screw.
HINT: Screw in for stroke decrease.

(m) Torque the nut to the cold starting lever.
Torque: 27 N·m (275 kgf·cm, 20 ft·lbf)

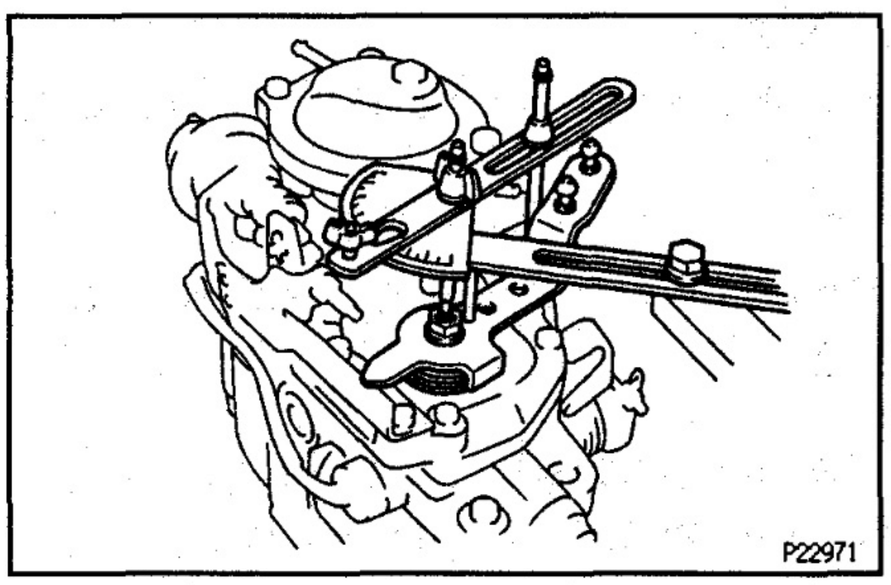


20. POST ADJUSTMENT CHECK

(a) Check that injection stops when the fuel cut solenoid harness is removed.
Pump revolution:
150 rpm
q = 3.1 cc (0.19 cu in.) or less



(b) Check the adjusting lever movement.
Adjusting lever angle:
38 – 48°

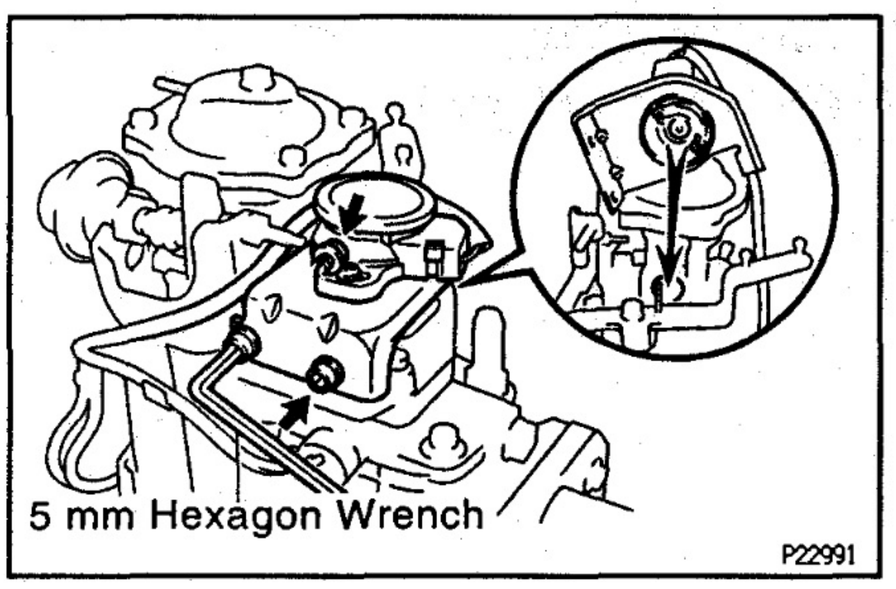


21. w/o Australia M/T:
INSTALL THROTTLE POSITION SENSOR AND BRACKET

(a) Europe:
Set the adjusting lever to the angle for the injection volume shown below.

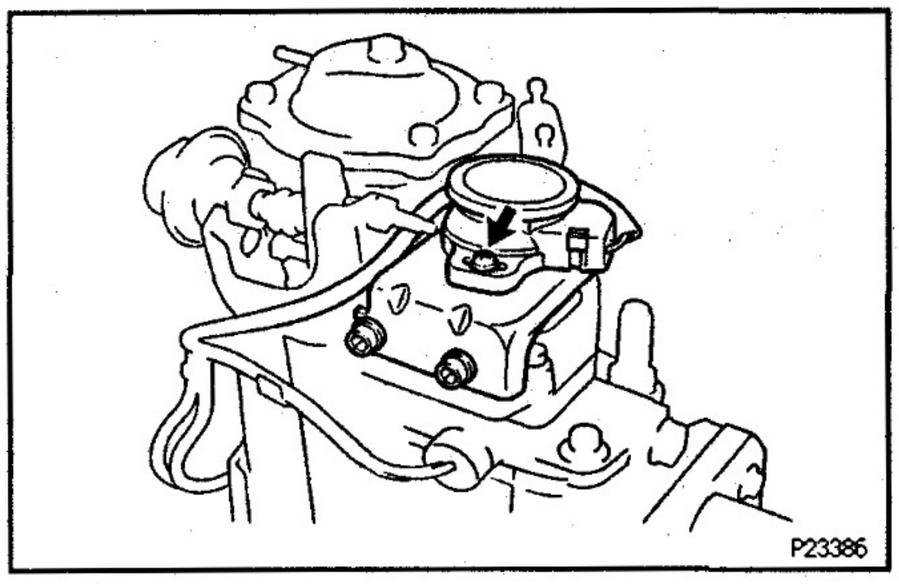
Pump	No. of measuring strokes	Injection volume of each cylinder cc (cu in.)
1,000	200	6.66 (0.406)

V06644

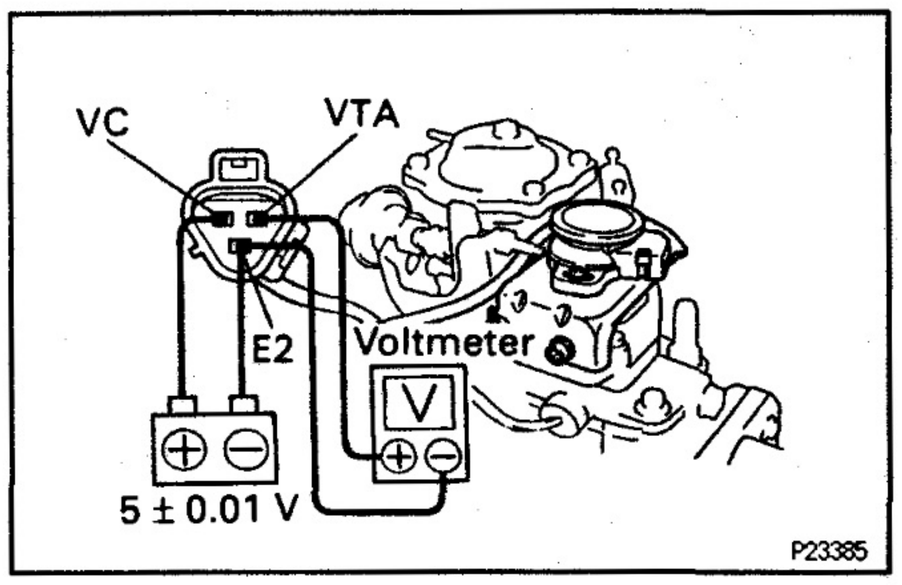


(b) Attach the portions of the throttle position sensor and adjusting lever.

(c) Using a 5 mm hexagon wrench, install the throttle position sensor with the 3 bolts.



(d) Loosen the 2 screws holding the throttle position sensor to the bracket.



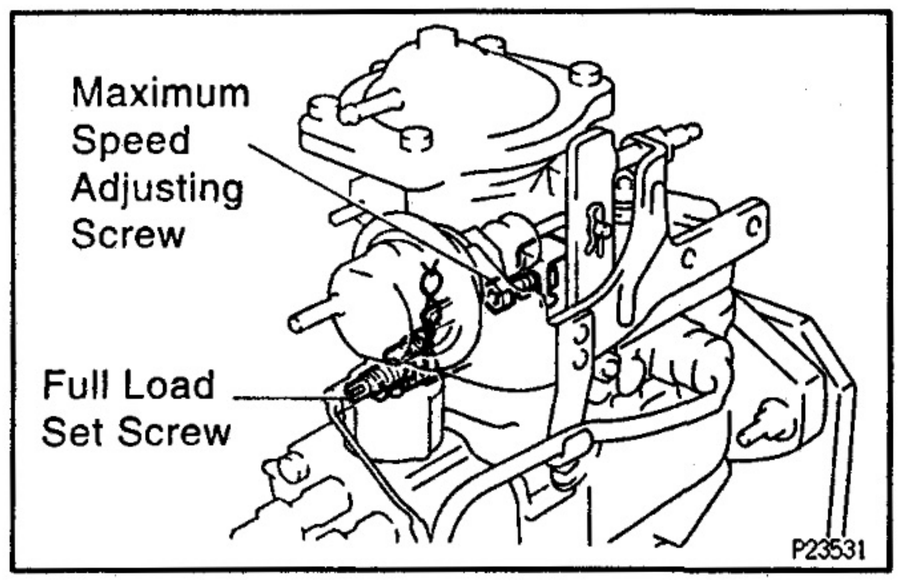
(e) Apply 5 ± 0.01 V across terminals VC and E2.
(f) Connect the tester probes of a voltmeter to terminals VTA and E2 of the throttle position sensor.
(g) Europe:
Gradually turn the throttle position sensor, so that its output will be 2.754 ± 0.025 V.
(h) Australia:
Secure the adjusting lever fully on the maximum speed side so that its output will be 0.6 ± 0.025 V.
(i) Tighten the 2 screws holding the throttle position sensor to the bracket.

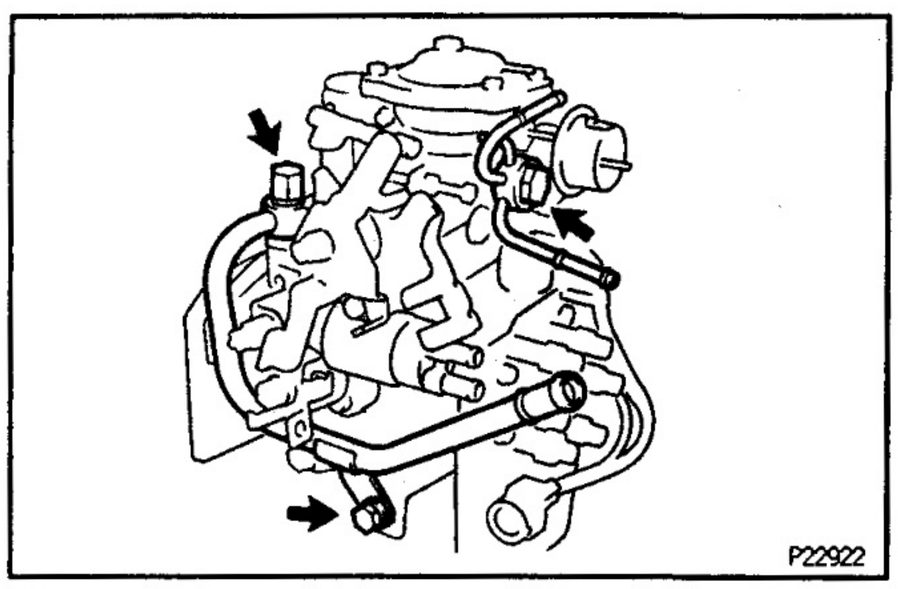
22. SEAL PARTS

(a) Seal the full load set screw with new lead seal.
(b) Install the lock plate to the maximum speed adjusting screw.

23. INSTALL FUEL PIPE BRACKET

Install the fuel pipe bracket with a bolt.



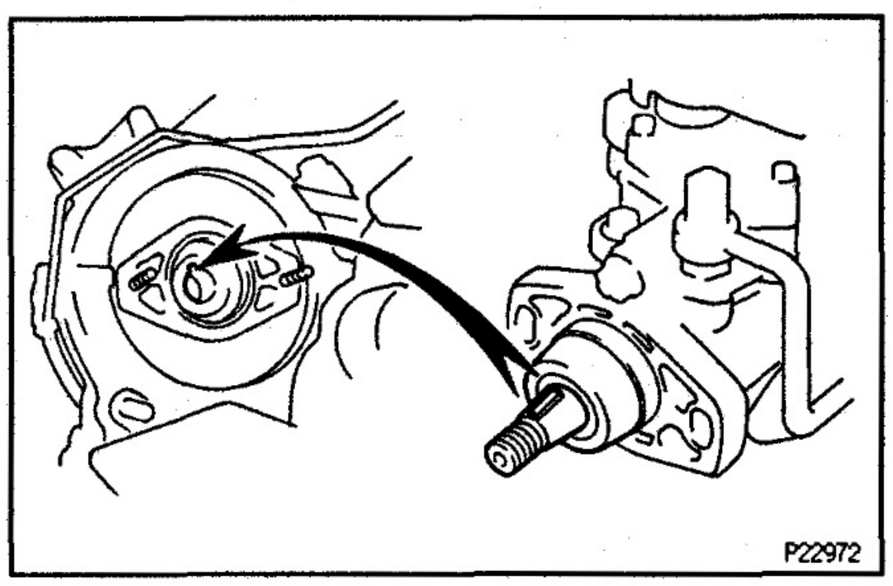


24. INSTALL FUEL PIPES

(a) Install the nozzle leakage pipe No.2 and 2 new gaskets with the union bolt.
Torque: 24.55 N·m (250 kgf·cm, 18 ft·lbf)
(b) Install the fuel inlet pipe and 2 new gaskets with the cap nut and bolt.
Torque:
Cap nut: 24.55 N·m (250 kgf·cm, 18 ft·lbf)
Bolt: 19.6 N·m (200 kgf·cm, 15 ft·lbf)

25. w/ A/C:

INSTALL IDLE–UP ACTUATOR
Torque: 9.35 N·m (95 kgf·cm, 83 in.·lbf)



INJECTION PUMP INSTALLATION

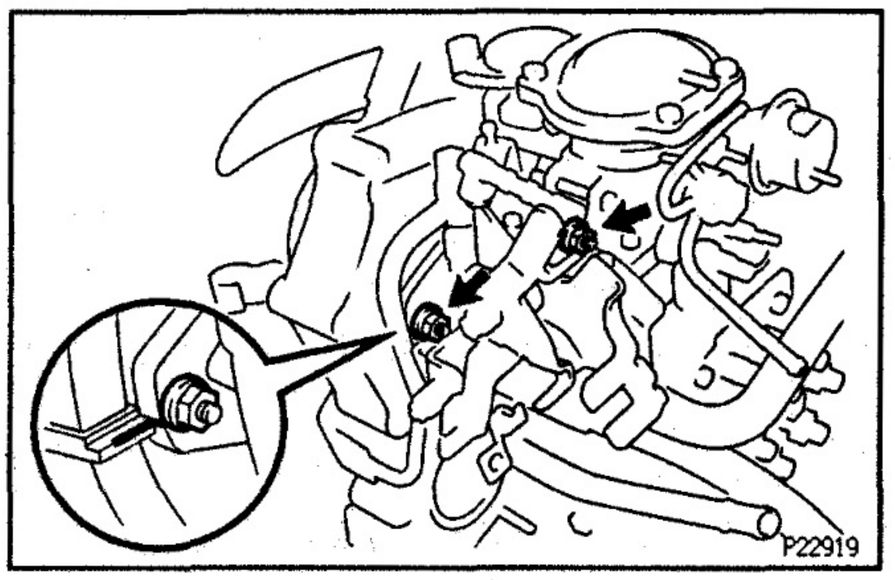
1. **INSTALL INJECTION PUMP**

NOTICE: Do not put the injection pump at an angle more than 45° from the horizontal.

(a) Install a new O–ring to the pump.

(b) Apply a light coat of engine oil on the O–ring.

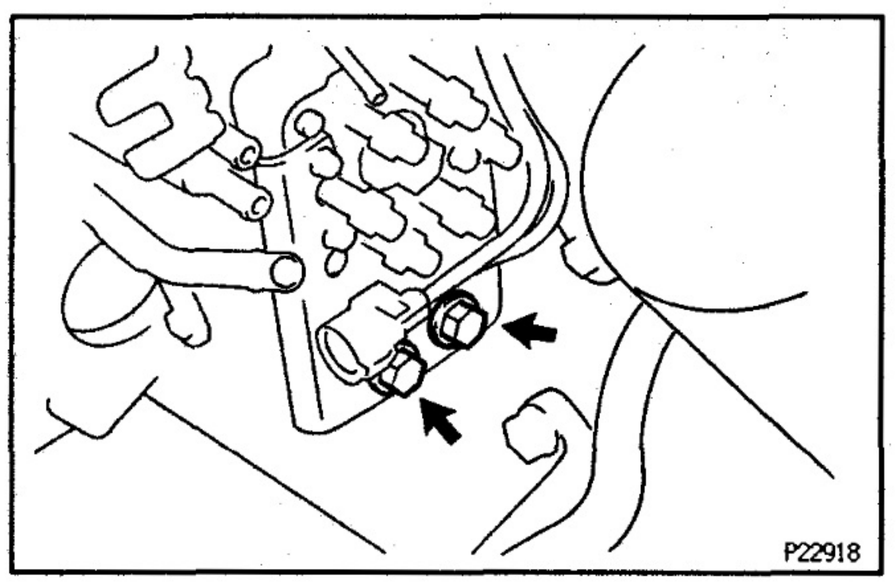
(c) Align the set key on the drive shaft and groove of the injection pump drive gear.



(d) Align the period lines (or matchmarks) of the injection pump and timing belt case.

(e) Install the 2 nuts holding the injection pump to the timing gear case.

Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)



(f) Install the injection pump stay with the 2 bolts.

Torque:

69 N·m (700 kgf·cm, 51 ft·lbf)

NOTICE: Before tightening to the standard torque, check whether the pump stay is up against the injection pump. If there is a gap, loosen the bolts joining the pump stay to the cylinder block and set the pump stay against the injection pump.

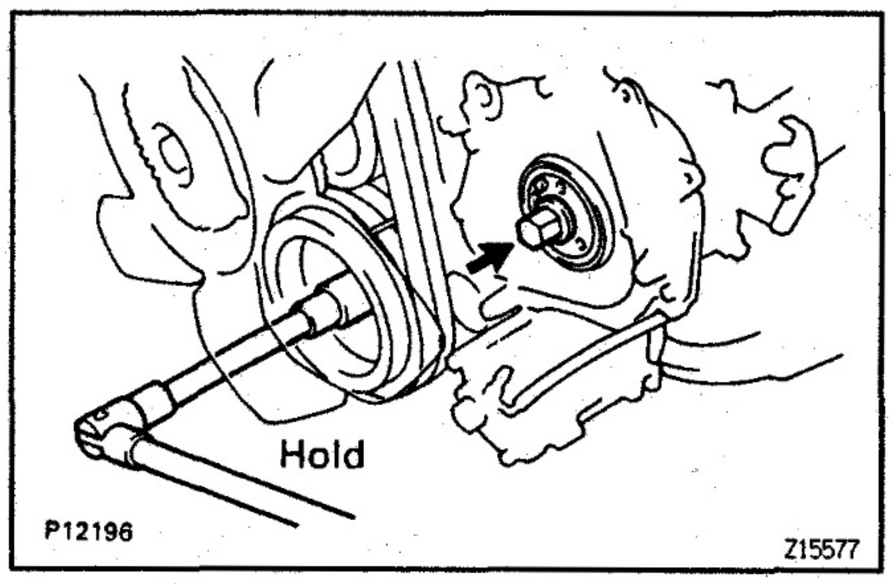
(g) Install a new O–ring to the injection pump drive gear.

(h) Install the injection pump drive gear set nut.

(i) Hold the crankshaft pulley, and torque the set nut.

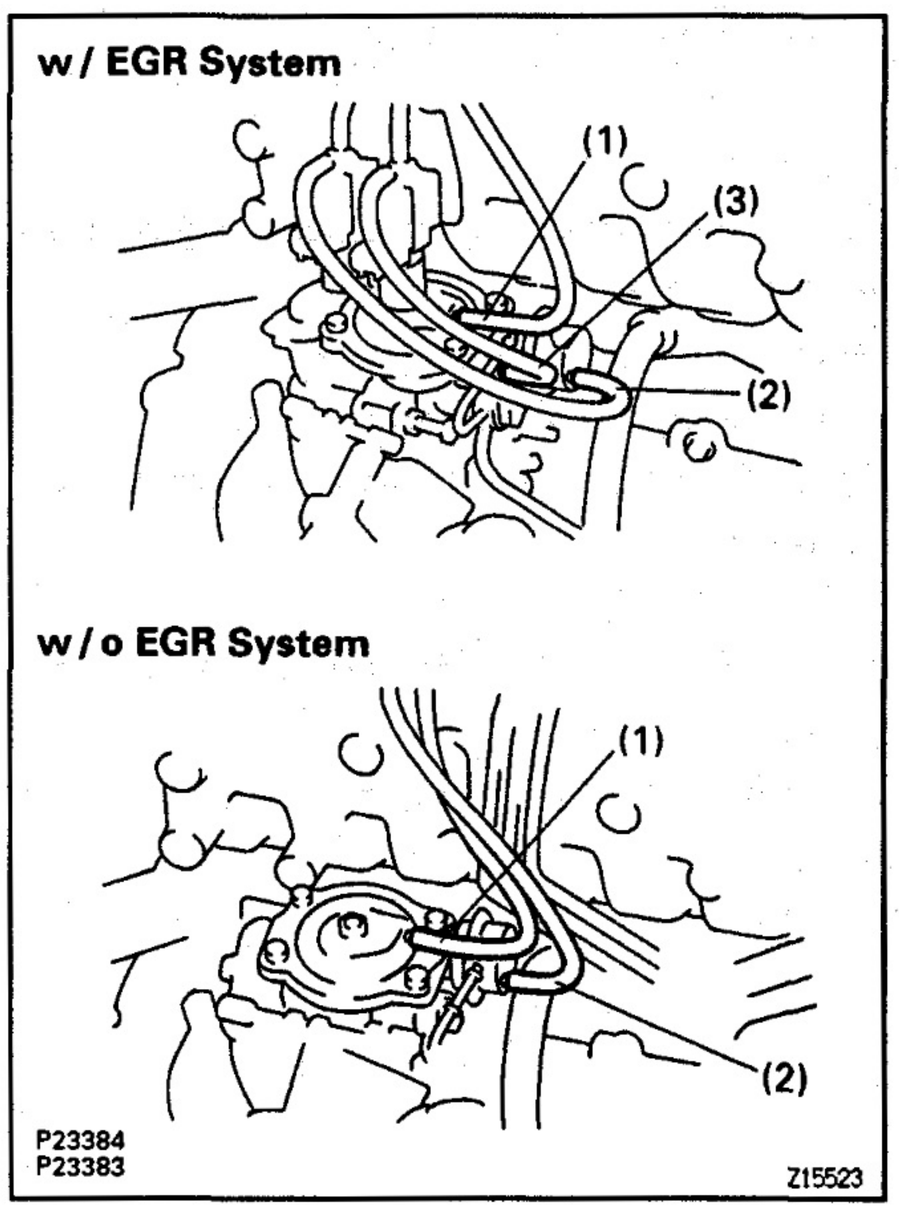
Torque: 103 N·m (1050 kgf·cm, 76 ft·lbf)

NOTICE: Do not turn the cranckshaft pulley. The valve heads will hit against the piston top.



(j) Check the thrust clearance of the injection pump drive shaft.

(See injection timing inspection and adjustment in Engine Mechanical)



2. CONNECT HOSES

Connect these hoses to the injection pump.

(1) Boost compensator hose
(2) SICS vacuum hose
(3) w/ BACS:
BACS vacuum hose

3. CONNECT WATER BYPASS HOSES TO THERMO WAX

4. INSTALL NO.2 CAMSHAFT TIMING PULLEY

(See step 3 in timing belt installation in Engine Mechanical)

5. INSTALL TIMING BELT

(See steps 5 to 10 in timing belt installation in Engine Mechanical)

6. CHECK INJECTION TIMING

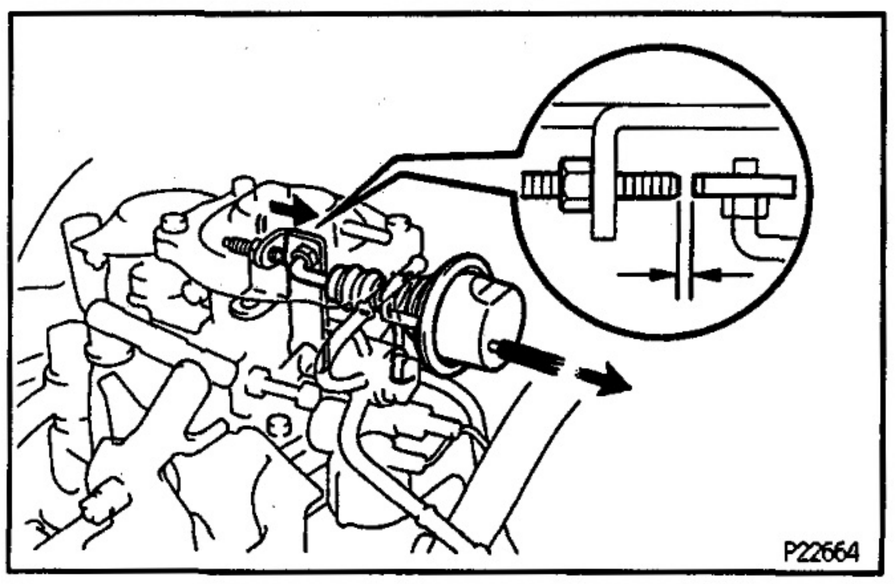
(See injection timing adjustment and inspection in Engine Mechanical)

7. INSTALL INJECTION PIPES

(See steps 3, 5 and 7 in injection nozzle installation)

8. FILL WITH ENGINE COOLANT

9. START ENGINE AND CHECK FOR FUEL LEAKAGE



STARTING INJECTION CONTROL SYSTEM (SICS)

ON–VEHICLE INSPECTION

E0344C-02

INSPECT SICS

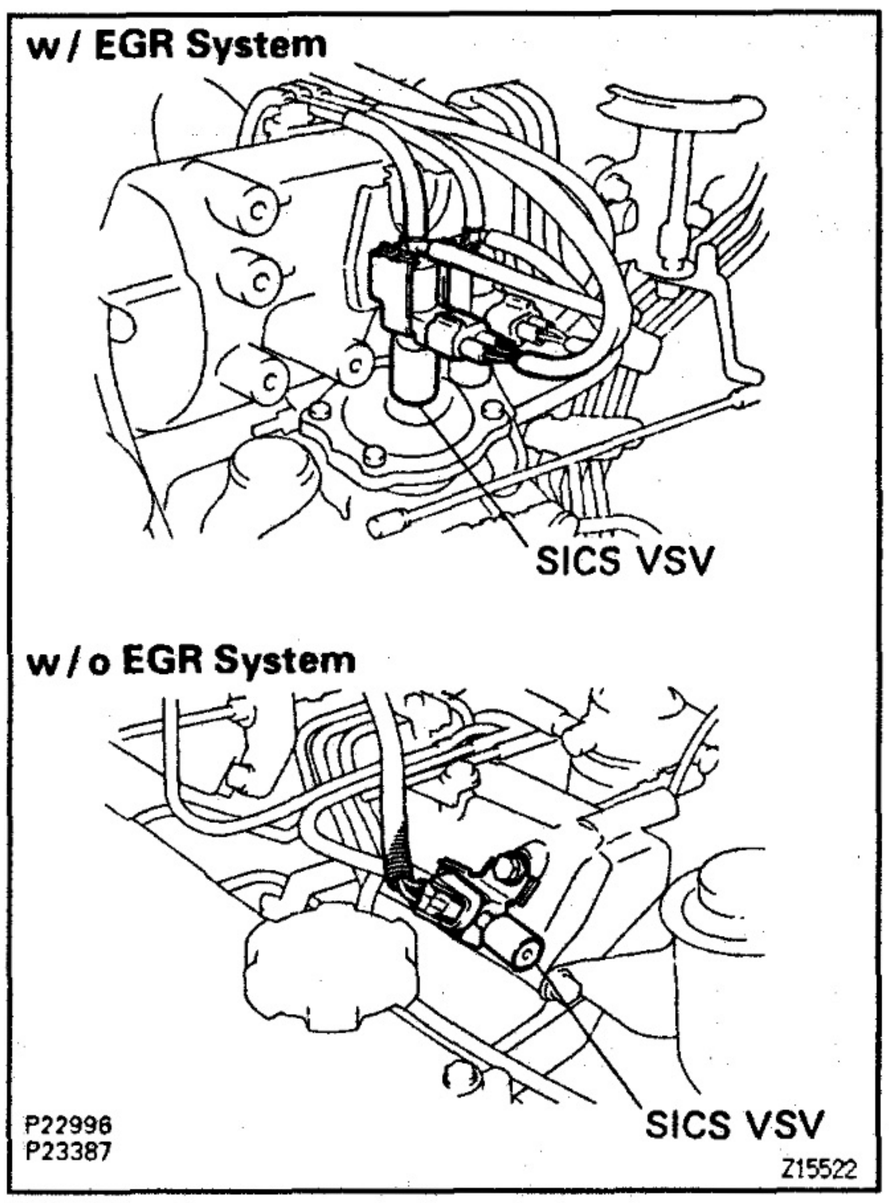
(a) With the engine stopped after it is warmed up, check tha the SICS lever and SICS adjusting screw are in contact with each other.

(b) After restarting the engine, check that the SICS lever and SICS adjusting screw are apart from each other.

SICS COMPONENTS INSPECTION

2034D-02

1. REMOVE SICS VSV



2. INSPECT SICS VSV

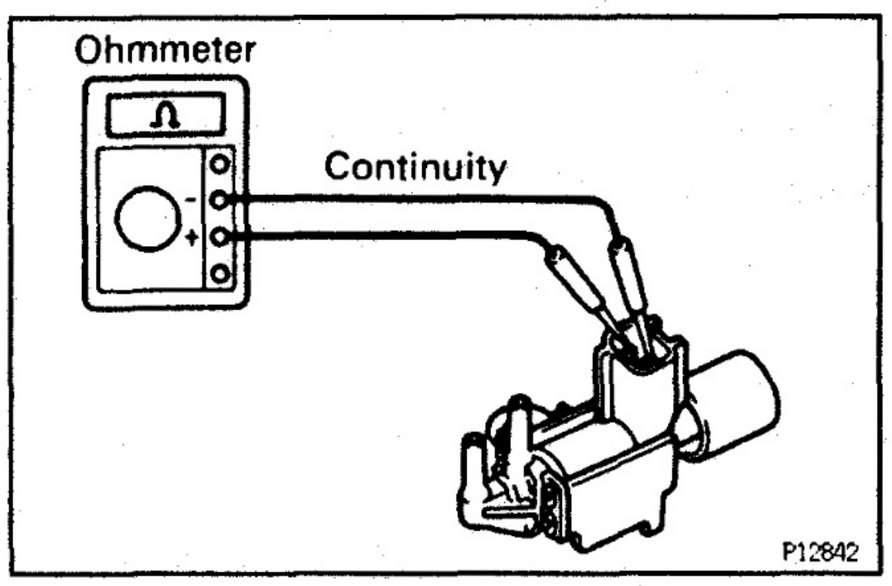
A. Inspect VSV for open circuit

Using an ohmmeter, check that there is continuity between the terminals.

Resistance:

At 20°C (68°F): 38.5 — 44.5 Ω

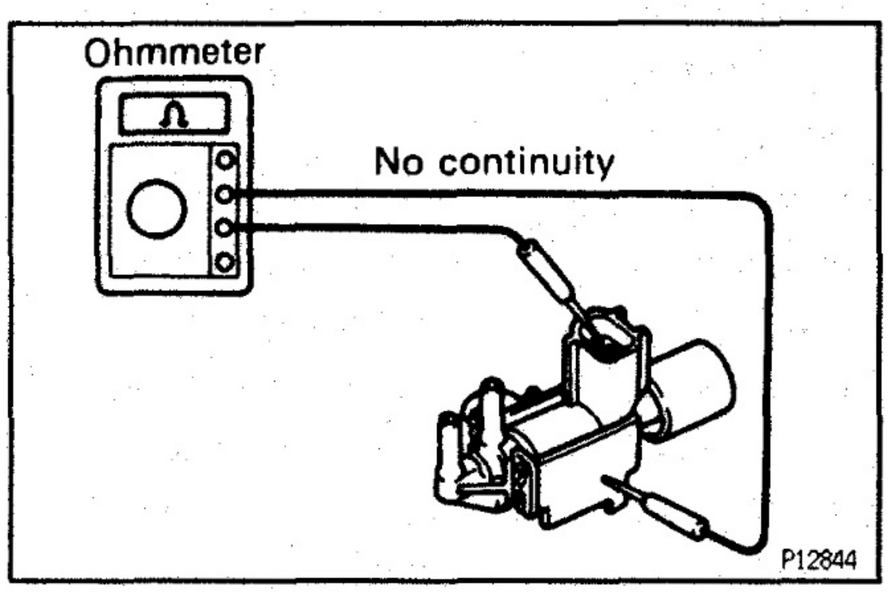
If there is no continuity, replace the VSV.



B. Inspect VSV for ground

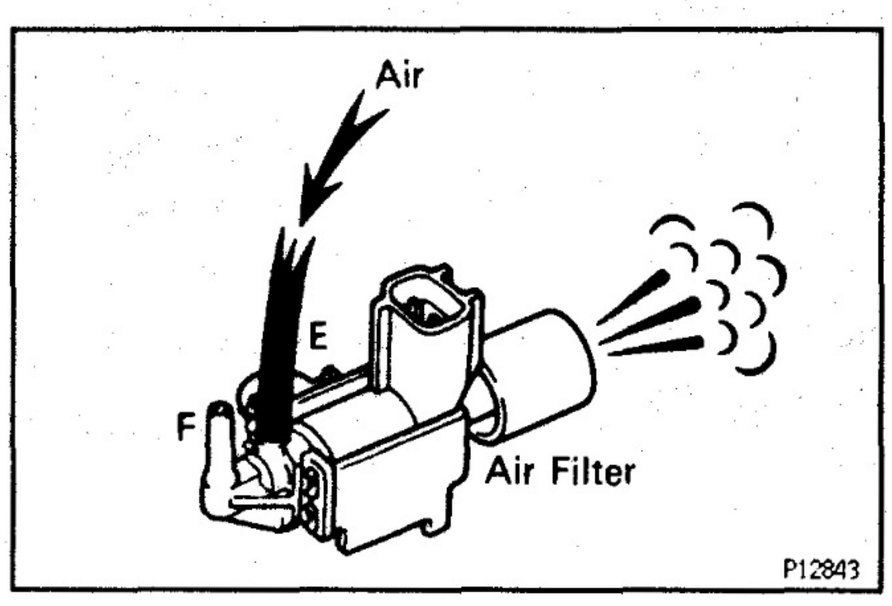
Using an ohmmeter, check that there is no continuity between each terminal and the body.

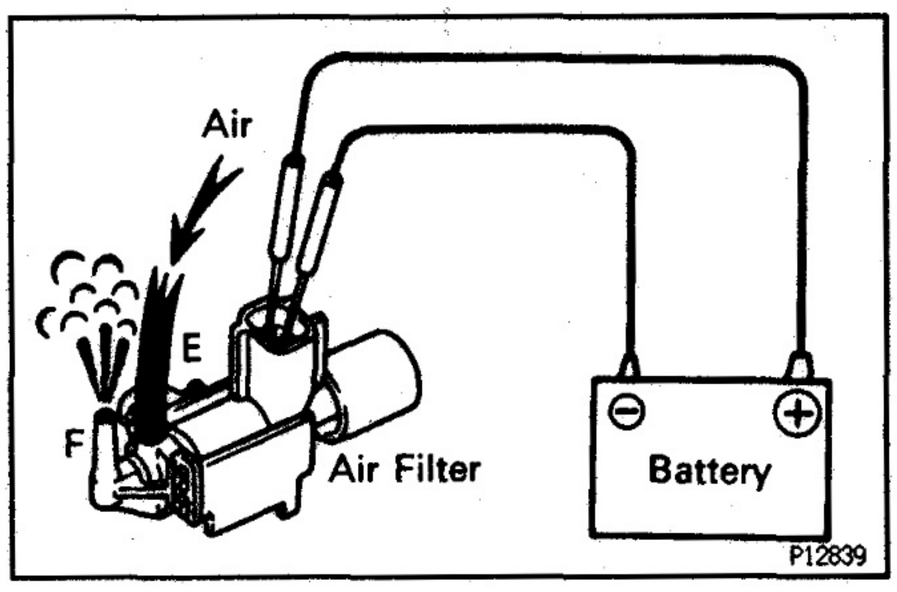
If there is continuity, replace the VSV.



C. Inspect VSV operation

(a) Check that air flows from pipe E to the filter.





(b) Apply battery voltage across the terminals.
(c) Check that air flows from pipe E to F.
If operation is not as specified, replace the VSV.

3. REINSTALL SICS VSV

EG

SERVICE SPECIFICATIONS

E0STA-01

SERVICE DATA

Fuel heater	Resistance	at 20°C (68°F)	0.5 – 2.0 Ω
Injection nozzles	Nozzle type		DLLA145P639
	Nozzle opening pressure	No.1	17,652 – 18,633 kPa (180 – 190 kgf/cm², 2,560 – 2,702 psi)
		No.2	23,144 – 24,124 kPa (236 – 246 kgf/cm², 3,356 – 3,498 psi)
	Needle–lift		0.23 – 0.28 mm (0.0091 – 0.0119 in.)
	Adjusting shim thickness		1.900 mm (0.0748 in.) 1.925 mm (0.0758 in.) 1.950 mm (0.0768 in.) 1.975 mm (0.0778 in.) 2.000 mm (0.0787 in.)
	Pre–lift		0.085 – 0.0105 mm (0.00335 – 0.00413 in.)
	Adjusting No.2 pressure spring seat thickness		3.09 mm (0.1217 in.) 3.12 mm (0.1228 in.) 3.15 mm (0.1240 in.) 3.18 mm (0.1252 in.) 3.21 mm (0.1264 in.) 3.24 mm (0.1276 in.) 3.27 mm (0.1287 in.)
	No.2 opening pressure adjusting shim thickness		0.700 mm (0.0276 in.) 0.850 mm (0.0335 in.) 1.000 mm (0.0394 in.) 1.025 mm (0.0404 in.) 1.150 mm (0.0453 in.) 1.175 mm (0.0463 in.) 1.275 mm (0.0502 in.) 1.300 mm (0.0512 in.) 1.425 mm (0.0561 in.) 1.450 mm (0.0571 in.) 1.575 mm (0.0620 in.) 1.600 mm (0.0630 in.) 1.725 mm (0.0679 in.) 1.750 mm (0.0689 in.) 1.900 mm (0.0748 in.) 2.050 mm (0.0807 in.)
	No.1 opening pressure adjusting shim thickness		0.825 mm (0.0325 in.) 0.900 mm (0.0354 in.) 0.975 mm (0.0384 in.) 1.050 mm (0.0413 in.) 1.125 mm (0.0443 in.) 1.200 mm (0.0472 in.) 1.275 mm (0.0502 in.) 1.350 mm (0.0532 in.) 1.425 mm (0.0561 in.) 1.500 mm (0.0591 in.) 1.575 mm (0.0620 in.) 1.650 mm (0.0650 in.) 1.725 mm (0.0679 in.) 1.800 mm (0.0709 in.) 1.875 mm (0.0738 in.) 1.950 mm (0.0768 in.) 2.000 mm (0.0787 in.) 2.100 mm (0.0827 in.) 2.175 mm (0.0856 in.)

Injection pump	Part No.	Europe	22100–17880
		Australia M/T	22100–17890
		A/T	22100–1B010
	Direction of rotation		Clockwise as seen from drive side
	Injection order		1 – 4 – 2 – 6 – 3 – 5 (A – B – C – D – E – F)
	Coupling spring protrusion		0.10 – 0.14 mm (0.0394 – 0.0551 in.)
	Delivery valve opening pressure		7,350 – 8,330 kPa
			(75 – 85 kgf/cm², 1,067 – 1,209 psi)
	Plunger spring deviation		2.0 mm (0.079 in.)
	Spring free length		
	Delivery valve spring		12.6 mm (0.496 in.)
	Plunger spring		34.09 mm (1.342 in.)
	Boost compensator spring		19.4 mm (0.764 in.)
	Roller height variation		0.02 mm (0.0008 in.)
	Pickup sensor resistance		650 – 970 Ω
	Timer adjusting screw protrusion pre–setting		7.5 – 8.0 mm (0.295 – 0.315 in.)
	Plunger spring shim thickness		0.5 mm (0.020 in.) 0.8 mm (0.031 in.)
			1.0 mm (0.039 in.) 1.2 mm (0.047 in.)
			1.5 mm (0.059 in.) 1.8 mm (0.071 in.)
			2.0 mm (0.079 in.)
	Flyweight holder thrust clearance		0.15 – 0.35 mm (0.0059 – 0.0138 in.)
	Governor gear adjusting washer thickness		1.05 mm (0.0413 in.) 1.25 mm (0.0492 in.)
			1.45 mm (0.0571 in.) 1.65 mm (0.0650 in.)
			1.85 mm (0.0728 in.)
	Governor shaft protrusion		0.5 – 2.0 mm (0.020 – 0.079 in.)
	Plunger pre–strokes		0.48 – 0.52 mm (0.0189 – 0.0205 in.)
	Adjusting shim thickness		Shim are available in 131 sized in increments
			0.01 mm (0.004 in.), from 1.90 mm (0.0748 in.)
			to 3.20 mm (0.1260 in.)
	Boost compensator diaphragm adjusting shim thickness		Shim are available in 12 sized in increments
			0.2 mm (0.008 in.), from 1.1 mm (0.043 in.)
			to 3.3 mm (0.130 in.)

EG

EG0EE–1E

TORQUE SPECIFICATIONS

Part tightened	N·m	kgf·cm	ft·lbf
Fuel filter x Fuel filter bracket	18	185	13
Fuel hose clamp x Fuel filter bracket	12	120	9
Nozzle holder body x Nozzle holder retaining nut	30	300	22
Injection nozzle x Cylinder head	25	255	18
Injection pipe x Injection nozzle, Injection pump	24.5	250	25
Injection pipe clamp x Intake manifold, Injection pipe clamp	6.4	65	56 in.·lbf
No.3 nozzle leakage pipe x Intake manifold	19.6	200	14
No.1 nozzle leakage pipe x Injection nozzle	18	176	13
No.1 nozzle leakage pipe x Cylinder head	19	186	14
Accelerator link assembly x intake manifold	19.6	200	14
Delivery valve holder x Distributive head	59	600	43
Fuel inlet hollow screw x Injection pump body	37	375	27
Regulator valve x Injection pump body	8.8	90	78 in.·lbf
Feed pump cover x Injection pump body	3.0	31	27 in.·lbf

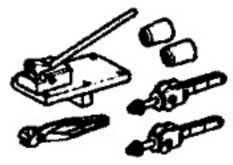
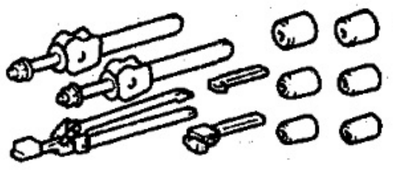
Timer cover, Injection pump stay, Thermo wax x Injection pump body	8.35	85	74 in.·lbf
Timer adjusting screw x Timer cover	14.2	145	11
Governor link support x Injection pump body	14	140	10
Distributive head x Injection pump body	12	120	9
Governor shaft x Injection pump body	27	275	20
Overflow screw x Governor cover	24.55	250	18
Control lever x Governor cover	6.85	70	61 in.·lbf
Governor cover x Injection pump body	8.3	85	74 in.·lbf
Idle speed adjusting screw, No.1 SICS lever x Governor cover	6.9	70.4	61 in.·lbf
Adjusting lever x Governor cover	8.35	85	74 in.·lbf
Pickup sensor x Injection pump body	22.1	225	15.6
Distributive head plug x Distributive head	88	900	65
Diaphragm x Push rod	7.35	75	65 in.·lbf
Diaphragm cover x Governor cover	7.35	75	65 in.·lbf
Lever control spring x Governor cover	11.3	115	8
Fuel cut solenoid x Distributive head	22	225	16
Lead wire x Fuel cut solenoid	1.7	17	15 in.·lbf
Cap x Injection pump	11	115	8
SICS actuator bracket x Governor cover	9.3	95	82 in.·lbf
SICS actuator x SICS actuator bracket	9.35	95	83 in.·lbf
SICS adjusting screw x SICS actuator bracket	6.9	70	61 in.·lbf
Idle–up lever x Injection pump body Short bolt	8.35	85	74 in.·lbf
Long bolt	11.75	120	9
No.2 nozzle leakage pipe, Fuel inlet pipe x Injection pump	24.55	250	18
Fuel inlet pipe x Bracket	19.6	200	15
Idle–up actuator x Idle–up lever	9.35	95	83 in.·lbf
Injection pump x Timing gear case	18	185	13
Pump stay x Injection pump	69	700	51
Injection pump drive gear x Injection pump	103	1050	76

COOLING SYSTEM

PREPARATION

SST (SPECIAL SERVICE TOOLS)

EG12S-0A

	09230-00010 Radiator Service Tool Set	
	09230-01010 Radiator Service Tool Set	
	(09231-00060) No.3 Plug	For inspection water leakage

EQUIPMENT

EG12W-0B

Heater	
Radiator cap tester	
Thermometer	
Torque wrench	

COOLANT

EG12X-0F

Item		Capacity	Classification
Engine coolant			Ethylene-glycol base
w/ Front and rear heaters	M/T	12.0 liters (12.7 US qts, 10.7 Imp. qts)	
	A/T	11.8 liters (12.5 US qts, 10.4 Imp. qts)	
w/ Front heater	M/T	11.1 liters (11.7 US qts, 9.8 Imp. qts)	
	A/T	10.9 liters (11.5 US qts, 9.6 Imp. qts)	
w/o Heater	M/T	10.4 liters (11.0 US qts, 9.2 Imp. qts)	
	A/T	10.2 liters (11.1 US qts, 9.0 Imp. qts)	

SSM (SERVICE SPECIAL MATERIALS)

EG12S-0B

08826-00100	Seal Packing 1282B, THREE BOND 1282B or equivalent (FIPG)	Engine drain plug on oil cooler cover

EG

COOLANT CHECK

EG55P-01

1. **CHECK ENGINE COOLANT LEVEL AT RADIATOR RESERVOIR**

The engine coolant level should be between the "LOW" and "FULL" lines.

If low, check for leaks and add engine coolant up to the "FULL" line.

2. **CHECK ENGINE COOLANT QUALITY**

(a) Remove the radiator cap.

CAUTION: To avoid the danger of being burned, do not remove the radiator cap while the engine and radiator are still hot, as fluid and steam can be blown out under pressure.

(b) There should not be any excessive deposits of rust or scale around the radiator cap or water filler hole, and the coolant should be free from oil.

If excessively dirty, replace the coolant.

(c) Reinstall the radiator cap.

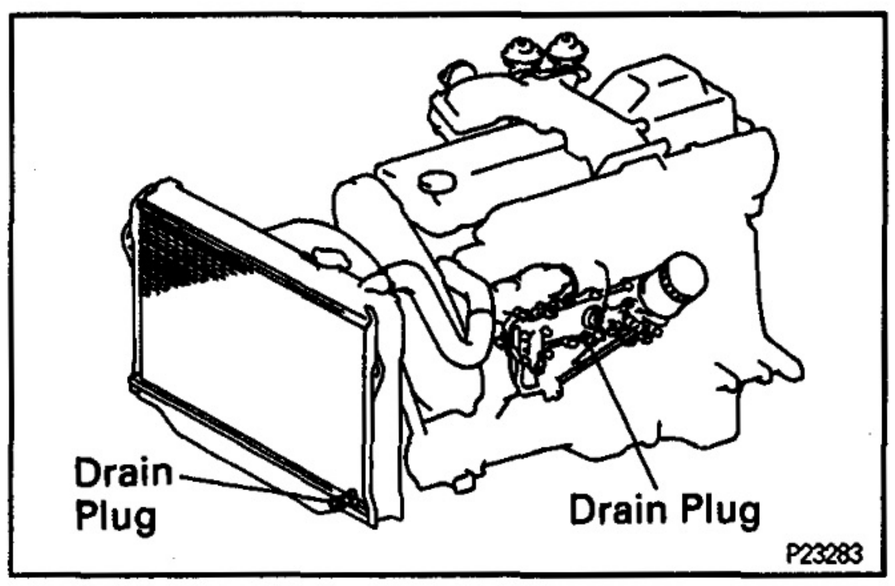
COOLANT REPLACEMENT

EG56Q-01

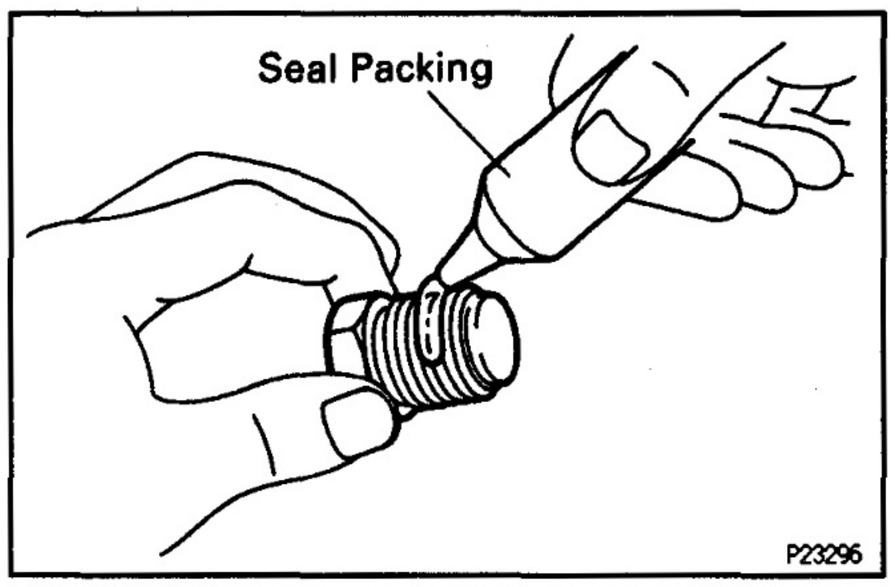
1. **DRAIN ENGINE COOLANT**

(a) Remove the radiator cap.

CAUTION: To avoid the danger of being burned, do not remove the radiator cap while the engine and radiator are still hot, as fluid and steam can be blown out under pressure.



(b) Loosen the radiator drain plug (on the left side of the radiator lower tank) and engine drain plug (on the oil cooler cover), and drain the coolant.



(c) Apply seal packing to 2 or 3 threads of the engine drain plug.

Seal packing:

Part No. 08826—00100 or equivalent

(d) Close the drain plugs.

Torque (Engine): 29.4 N·m (300 kgf·cm, 22 ft·lbf)

2. FILL ENGINE COOLANT

(a) Slowly fill the system with coolant.

- Use a good brand of ethylene–glycol base coolant and mix it according to the manufacturer's directions.
- Using coolant which includes more than 50 % ethylene–glycol (but not more than 70 %) is recommended.

NOTICE:

- **Do not use an alcohol type coolant.**
- **The coolant should be mixed with demineralized water or distilled water.**

Capacity:

w/ Front and rear heaters

M/T

12.0 liters (12.7 US qts, 10.7 Imp. qts)

A/T

11.8 liters (12.5 US qts, 10.4 Imp. qts)

w/ Front heater

M/T

11.1 liters (11.7 US qts, 9.8 Imp. qts)

A/T

10.9 liters (11.5 US qts, 9.6 Imp. qts)

w/o Heater

M/T

10.4 liters (11.0 US qts, 9.2 Imp. qts)

A/T

10.2 liters (11.1 US qts, 9.0 Imp. qts)

(b) Install the radiator cap.

(c) Start the engine, and bleed the cooling system.

(d) Refill the radiator reservoir with coolant until it reaches the "FULL" line.

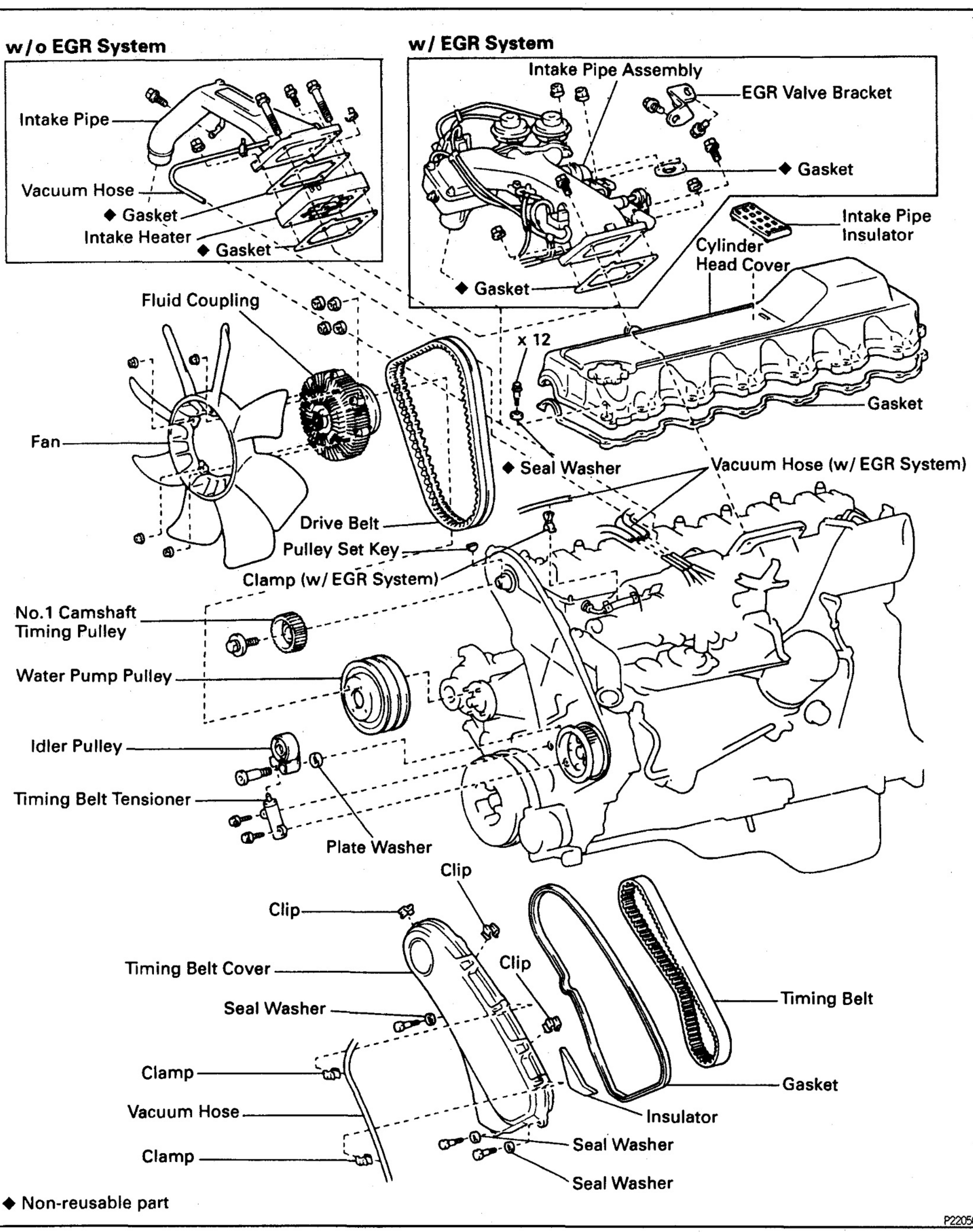
3. CHECK ENGINE COOLANT FOR LEAKS

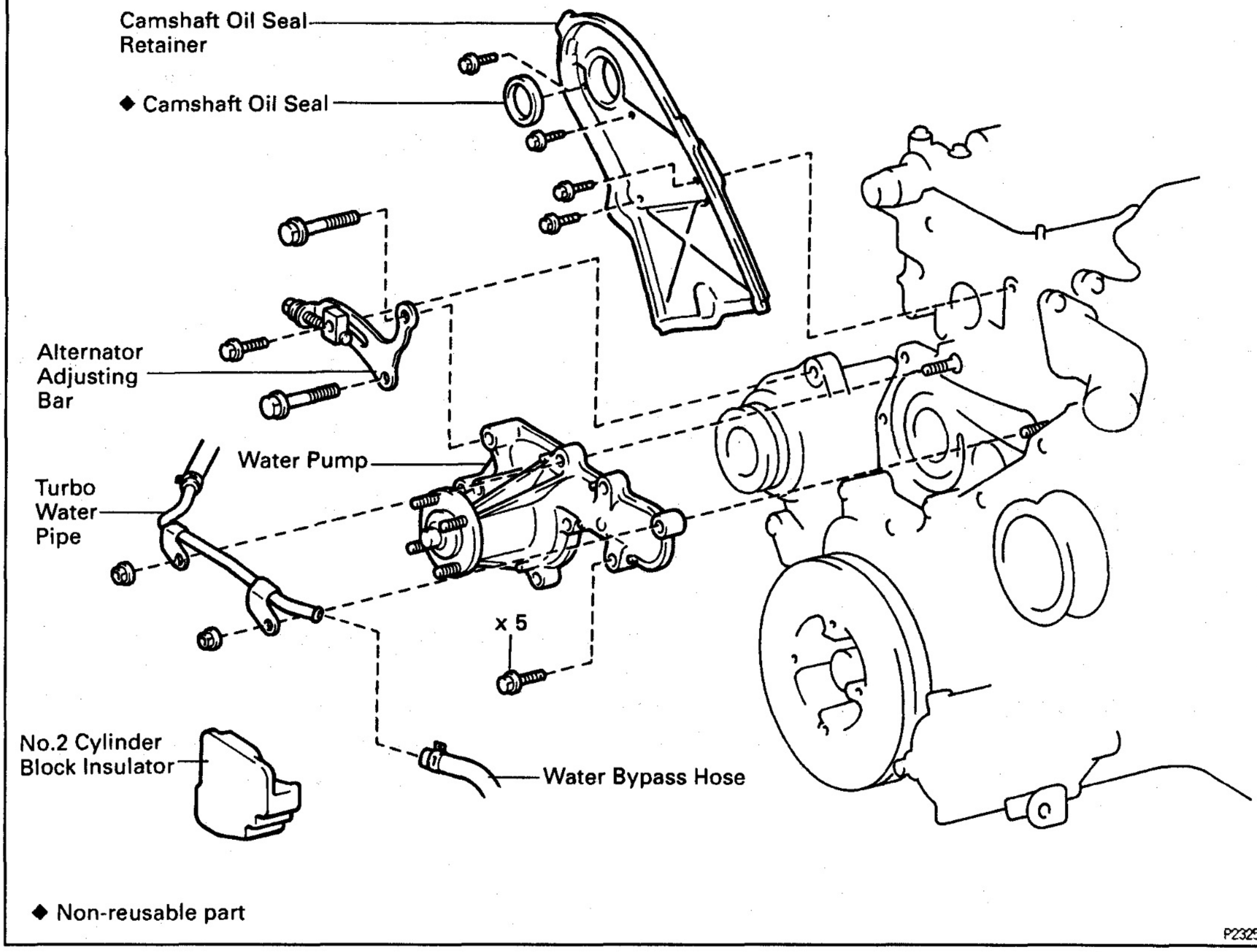
WATER PUMP

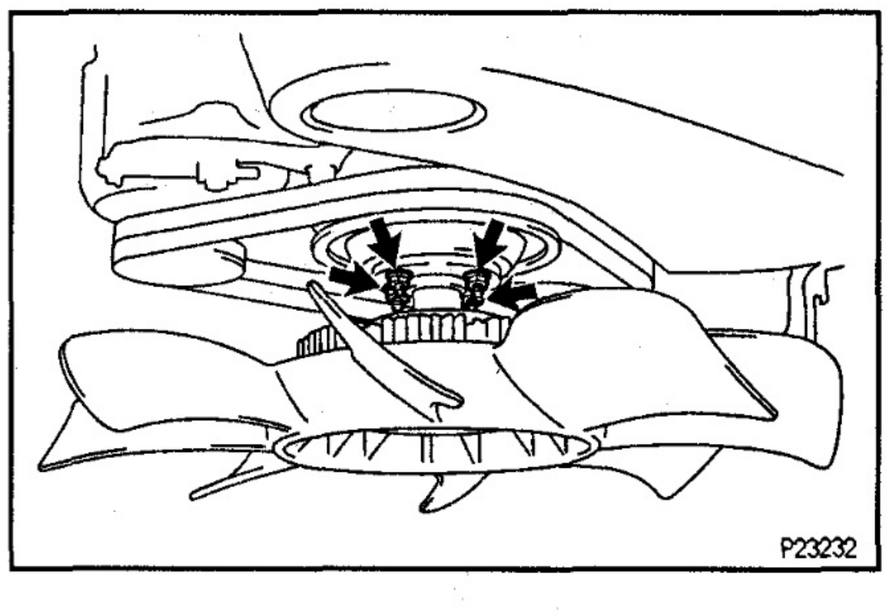
COMPONENTS FOR REMOVAL AND INSTALLATION

E05MR-01

EG







EG568-01

WATER PUMP REMOVAL

1. **DRAIN ENGINE COOLANT**
2. **REMOVE DRIVE BELTS, FAN, FLUID COUPLING AND WATER PUMP PULLEY**

(a) Loosen the 4 water pump pulley nuts.

(b) Loosen the alternator pivot bolt and adjusting lock bolt.

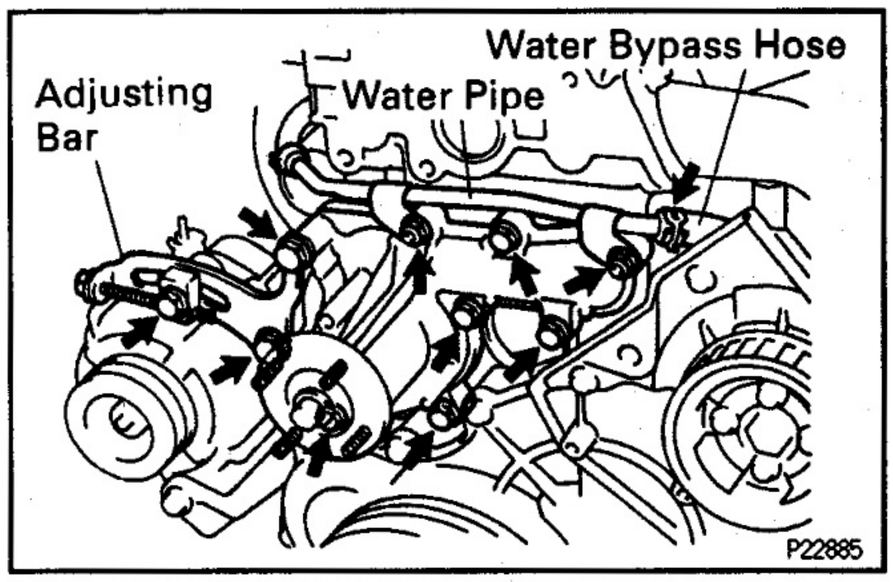
(c) Loosen the adjusting bolt, and remove the 2 drive belts.

(d) Remove the 4 nuts, the fan, fluid coupling assembly and pulley.

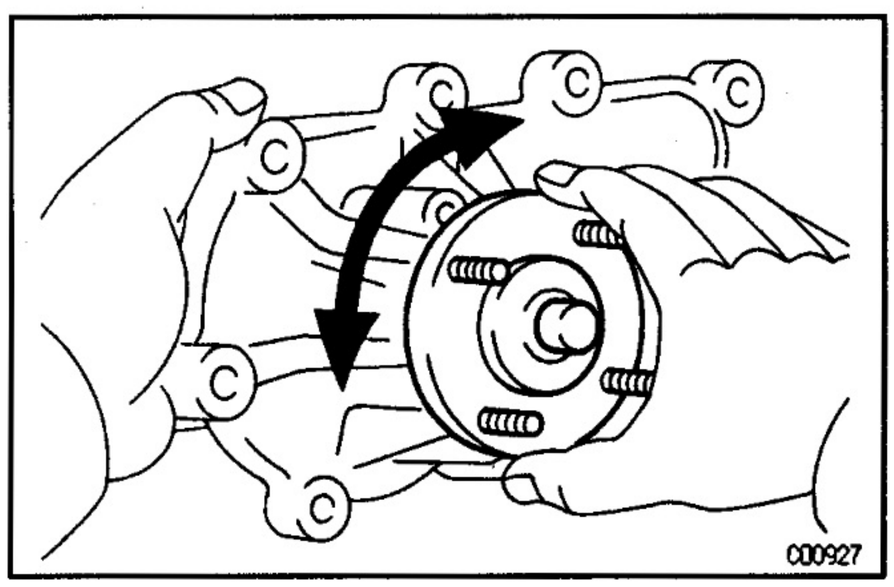
(e) Remove the 4 nuts and fan from the fluid coupling.

3. **REMOVE TIMING BELT**
   (See steps 1 to 3 in timing belt removal in Engine Mechanical)
4. **REMOVE IDLER PULLEY**
   (See step 4 in timing belt removal in Engine Mechanical)

5. **REMOVE NO.1 CAMSHAFT TIMING PULLEY**
(See steps 6 and 7 in timing belt removal in Engine Mechanical)
6. **REMOVE CAMSHAFT OIL SEAL RETAINER**
(See step 14 in cylinder head removal in Engine Mechanical)
7. **REMOVE NO.2 CYLINDER BLOCK INSULATOR**



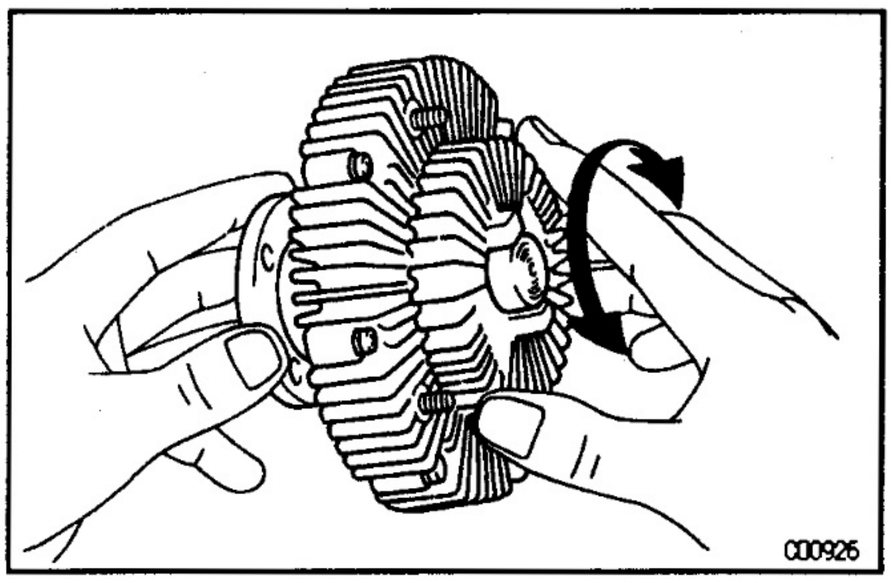
8. **REMOVE WATER PUMP**
(a) Remove the 3 bolts and alternator adjusting bar.
(b) Remove the 2 nuts, and disconnect the turbo water pipe from the water pump.
(c) Disconnect the turbo water pipe from the water bypass hose.
(d) Remove the 5 bolts, water pump and gasket.



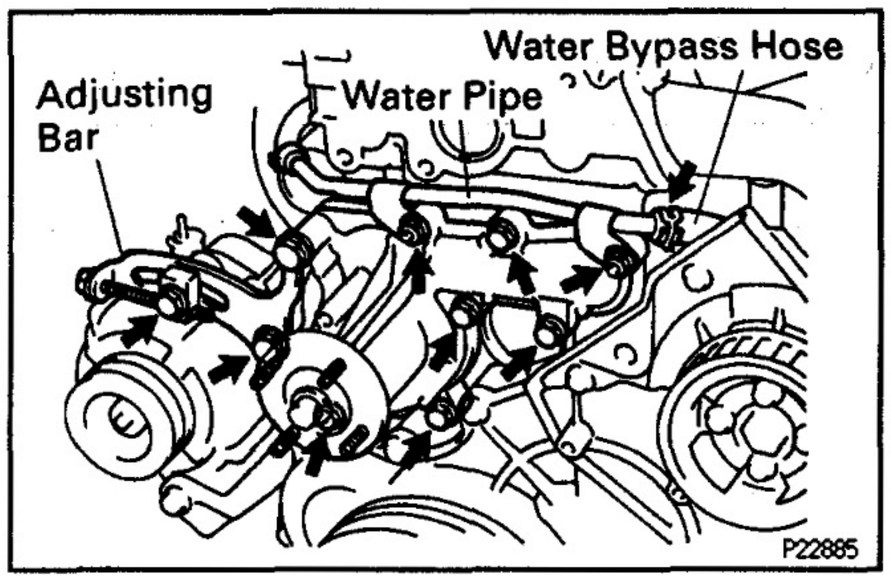
WATER PUMP INSPECTION

EG3S5-02

1. **INSPECT WATER PUMP**
Turn the pulley and check that the water pump bearing moves smoothly and quietly.
If necessary, replace the water pump.



2. **INSPECT FLUID COUPLING**
Check the fluid coupling for damage and silicon oil leakage.
If necessary, replace the fiuid coupling.



EGSGT-01

WATER PUMP INSTALLATION

1. INSTALL WATER PUMP

(a) Temporarily install a new gasket and the water pump with the 5 bolts.

(b) Connect the turbo water pipe to the water bypass hose.

(c) Temporarily install the turbo water pipe with the 2 nuts.

(d) Temporarily install the alternator with the 3 bolts.

(e) Uniformly tighten the 7 bolts and 2 nuts holding the water pump to the cylinder block.

Torque:

12 mm head

19.6 N·m (200 kgf·cm, 14 ft·lbf)

14 mm head

39.2 N·m (400 kgf·cm, 29 ft·lbf)

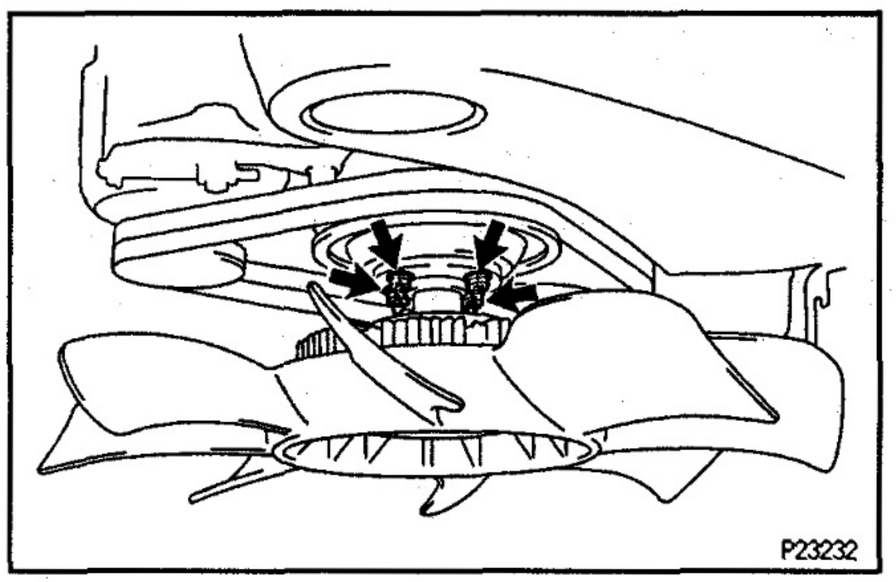
2. INSTALL NO.2 CYLINDER BLOCK INSULATOR

3. INSTALL CAMSHAFT OIL SEAL RETAINER
(See step 6 in cylinder head installation in Engine Mechanical)

4. INSTALL NO.1 CAMSHAFT TIMING PULLEY
(See steps 1 and 2 in timing belt installation in Engine Mechanical)

5. INSTALL IDLER PULLEY
(See step 4 in timing belt installation in Engine Mechanical)

6. INSTALL TIMING BELT
(See steps 5 to 10 in timing belt installation in Engine Mechanical)



7. INSTALL WATER PUMP PULLEY, FLUID COUPLING, FAN AND DRIVE BELTS

(a) Install the fan to the fluid coupling with 4 new nuts.
Torque: 6.4 N·m (65 kgf·cm, 57 in.·lbf)

(b) Temporarily install the pump pulley, the fluid fan and coupling assembly with the 4 nuts.

(c) Install and adjust the drive belt.
(See step 3 in on—vehicle inspection in Charging System)

(d) Tighten the 4 water pump pulley nuts.
Torque: 19.6 N·m (200 kgf·cm, 14 ft·lbf)

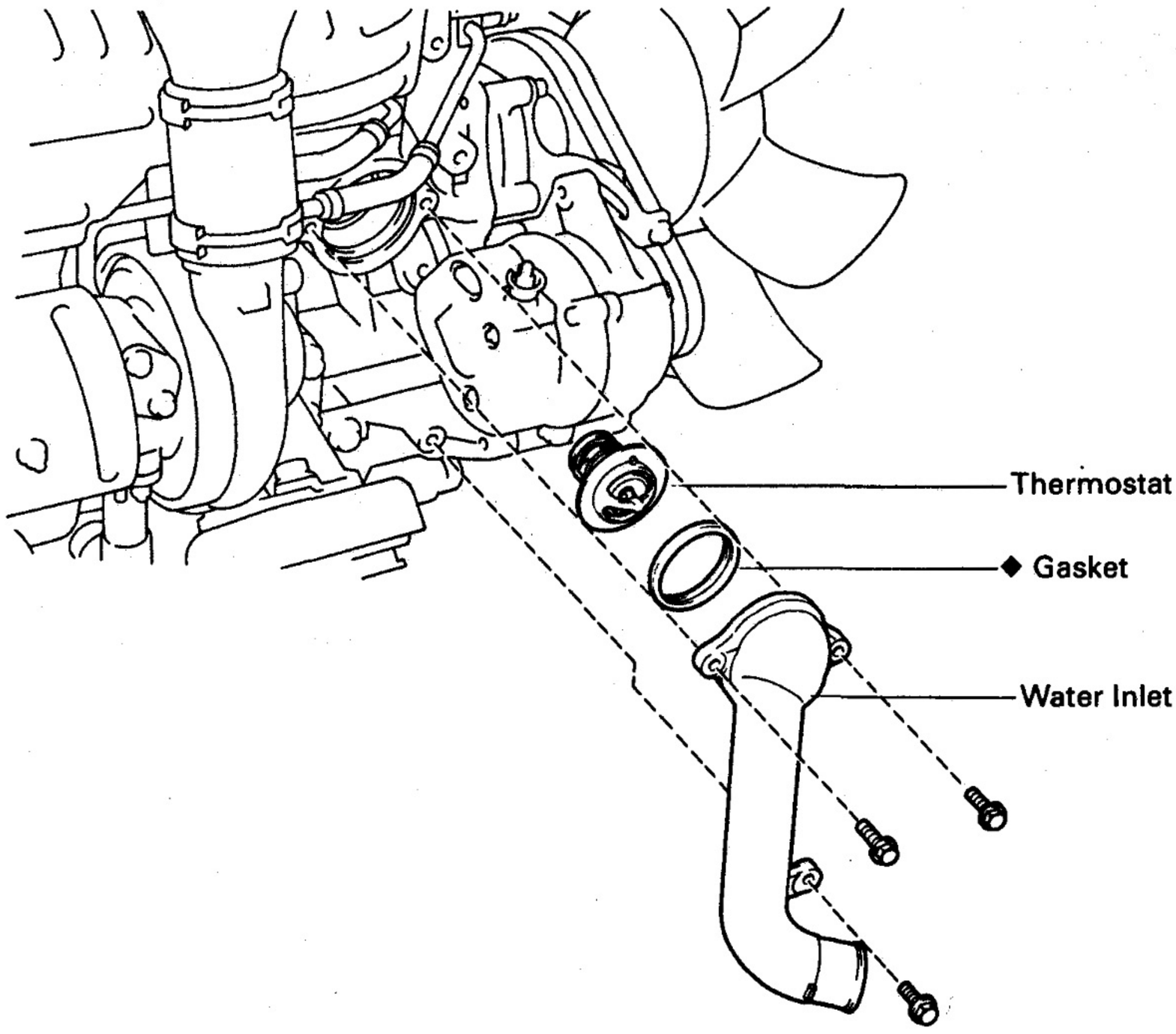
8. FILL WITH ENGINE COOLANT

9. START ENGINE, AND CHECK FOR COOLANT LEAKS

THERMOSTAT

COMPONENTS FOR REMOVAL AND INSTALLATION

E0130-02



◆ Non-reusable part

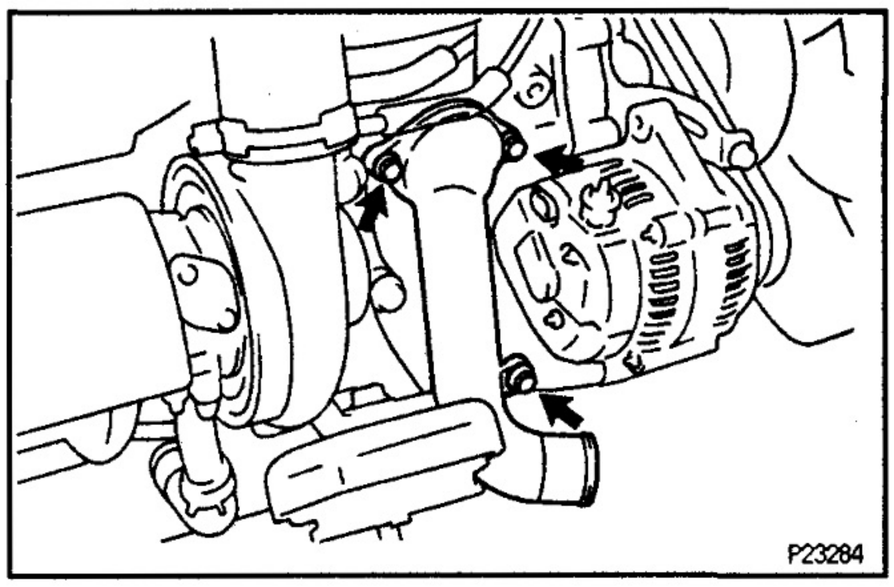
P22033

E0580-01

THERMOSTAT REMOVAL

HINT: Removal of the thermostat would have an adverse effect, causing a lowering of cooling efficiency. Do not remove the thermostat, even if the engine tends to overheat.

1. **DRAIN ENGINE COOLANT**



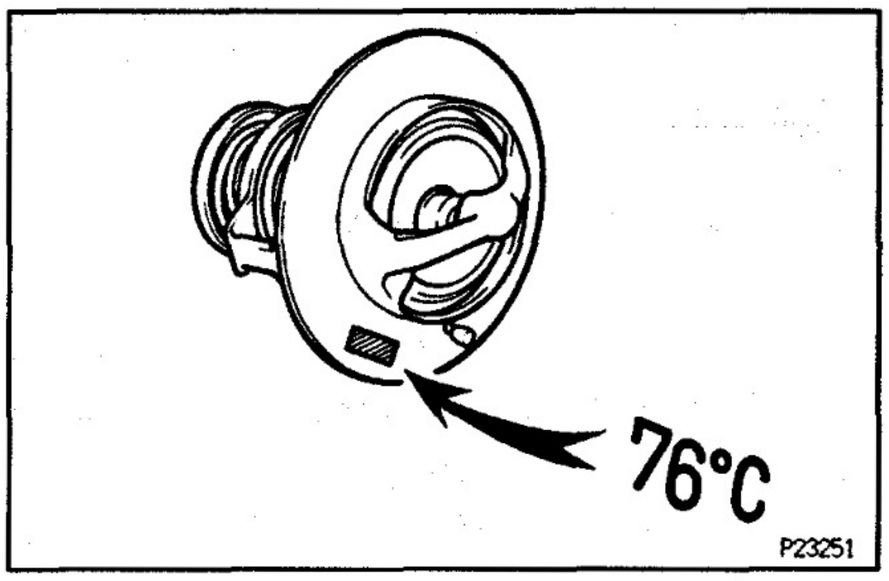
P23284

2. **REMOVE WATER INLET AND THERMOSTAT**

(a) Remove the 3 bolts and water inlet.

(b) Remove the thermostat.

(c) Remove the gasket from the thermostat.

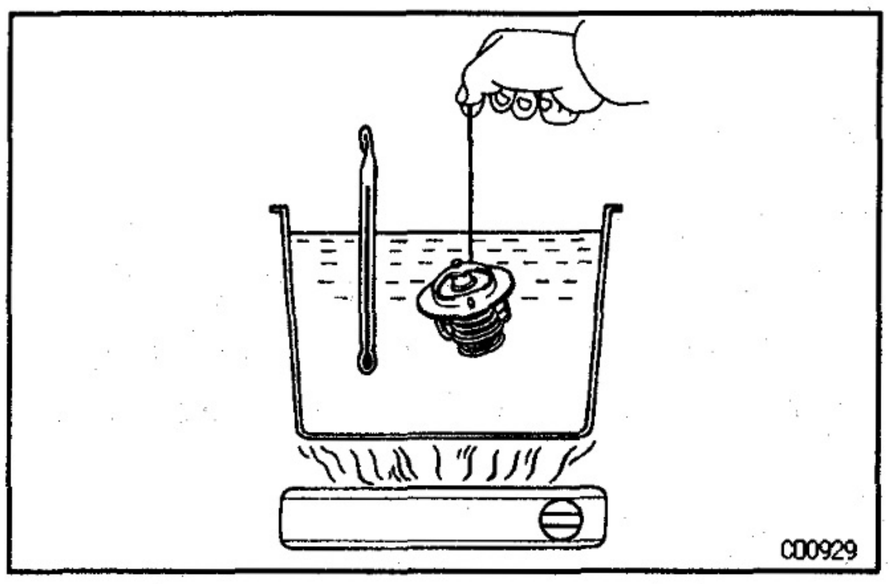


EG13H–0C

THERMOSTAT INSPECTION

INSPECT THERMOSTAT

HINT: The thermostat is numbered with the valve opening temperature.



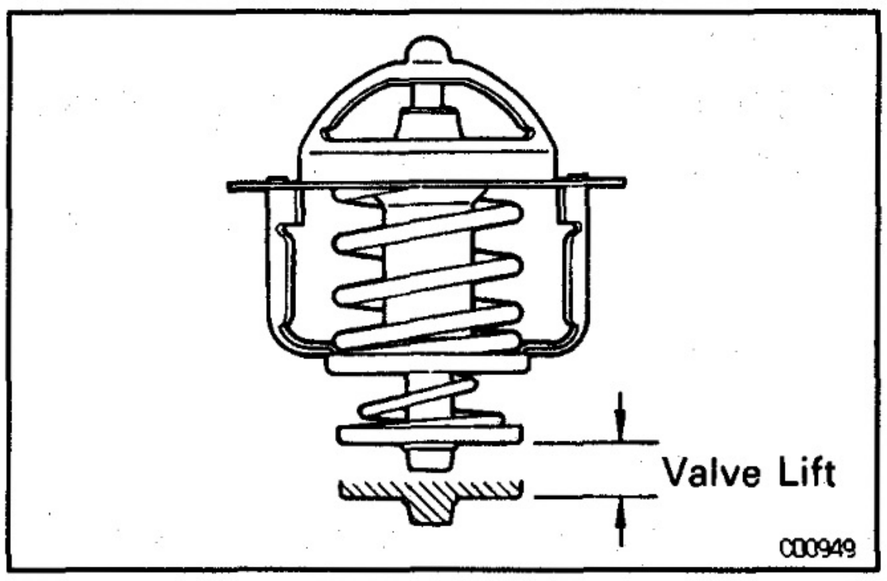
(a) Immerse the thermostat in water and gradually heat the water.

(b) Check the valve opening temperature.

Valve opening temperature:

74 – 78°C (165 – 172°F)

If the valve opening temperature is not as specified, replace the thermostat.



(c) Check the valve lift.

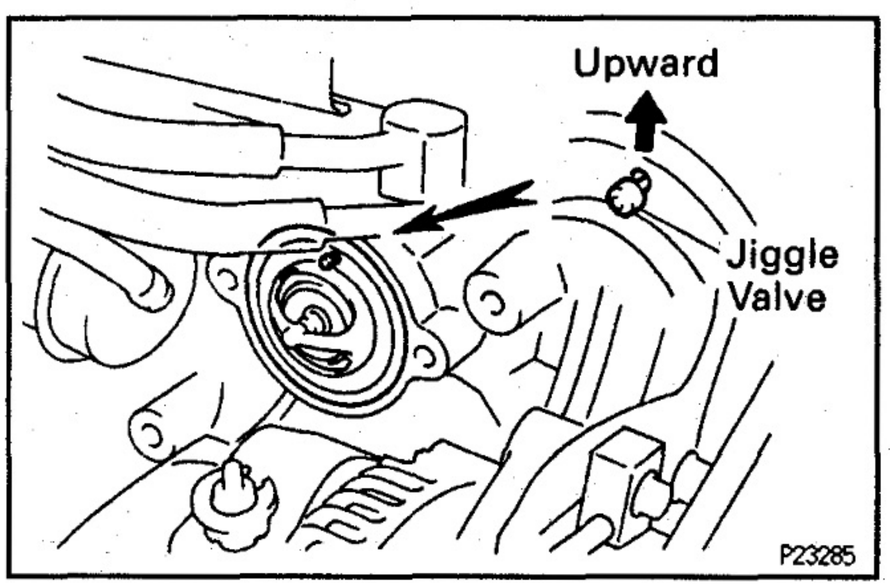
Valve lift:

10 mm (0.39 in.) or more at 90°C (194°F)

If the valve lift is not as specified, replace the thermostat.

(d) Check that the valve spring is tight when the thermostat is fully closed.

If not closed, replace the thermostat.



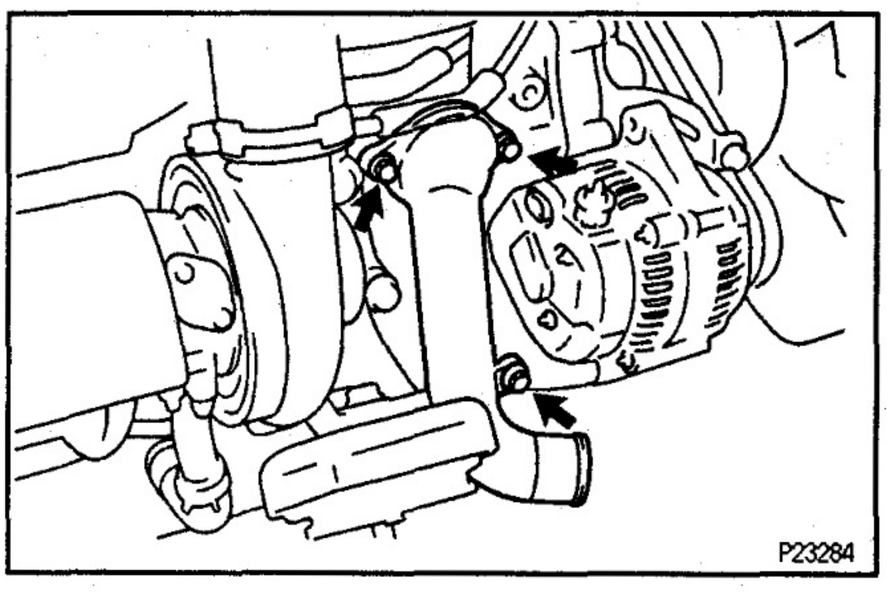
EG35E–02

THERMOSTAT INSTALLATION

1. PLACE THERMOSTAT IN CYLINDER BLOCK

(a) Install a new gasket to the thermostat.

(b) Install the thermostat with the jiggle valve upward.



2. INSTALL WATER INLET

(a) Temporarily install the water inlet with the 3 bolts.

(b) Alternately tighten the 3 bolts in several passes.

Torque: 19.6 N·m (200 kgf·cm, 14 ft·lbf)

3. FILL WITH ENGINE COOLANT

4. START ENGINE, AND CHECK FOR COOLANT LEAKS

RADIATOR

RADIATOR CLEANING

B0STL-01

Using water or a steam cleaner, remove any mud and dirt from the radiator core.

NOTICE: If using a high pressure type cleaner, be careful not to deform the fins of the radiator core. If the cleaner nozzle pressure is 2,942 — 3,432 kPa (30 — 35 kgf/cm², 427 — 498 psi), keep a distance of at least 40 — 50 cm (15.75 — 19.69 in.) between the radiator core and cleaner nozzle.

RADIATOR INSPECTION

1. REMOVE RADIATOR CAP

CAUTION: To avoid the danger of being burned, do not remove the radiator cap while the engine and radiator are still hot, as fluid and steam can be blown out under pressure.

2. INSPECT RADIATOR CAP

NOTICE: If the radiator cap contains water or foreign subtances, always rinse it with water.

Using a radiator cap tester, pump the tester and measure the relief valve opening pressure.

Standard opening pressure:

74 — 103 kPa

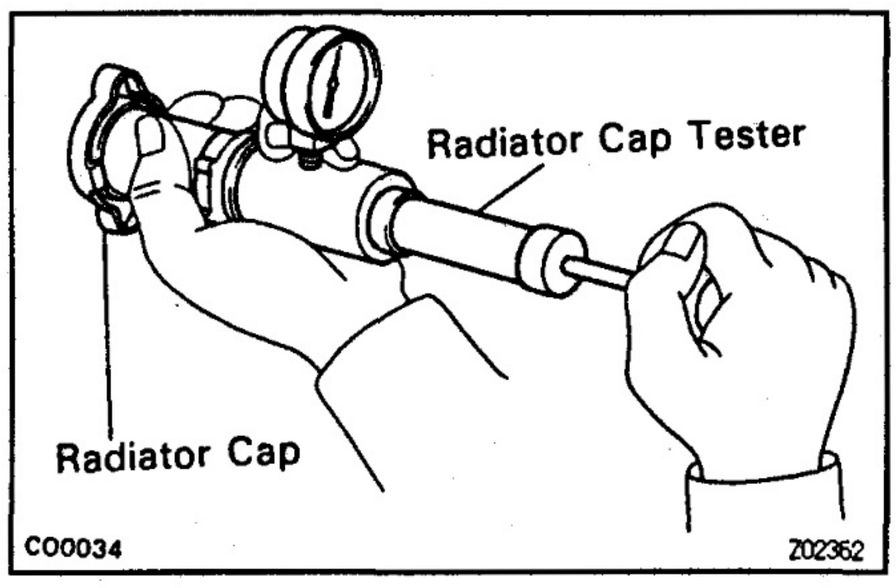
(0.75 — 1.05 kgf/cm², 10.7 — 14.9 psi)

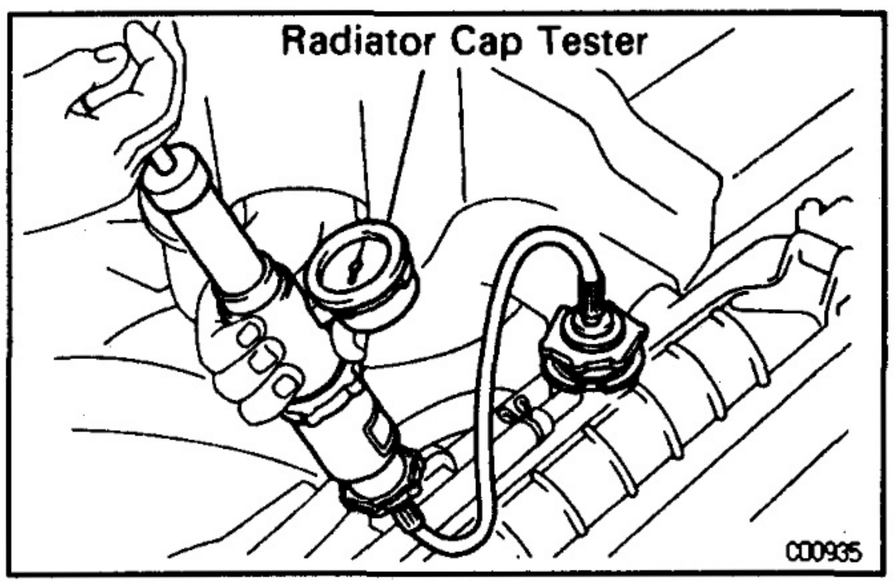
Minimum opening pressure:

59 kPa (0.6 kgf/cm², 8.5 psi)

HINT: Use the tester's maximum reading as the opening pressure.

If the opening pressure is less than minimum, replace the radiator cap.





3. INSPECT COOLING SYSTEM FOR LEAKS

(a) Fill the radiator and engine with coolant, and attach a radiator cap tester to the water filler.

(b) Warm up the engine.

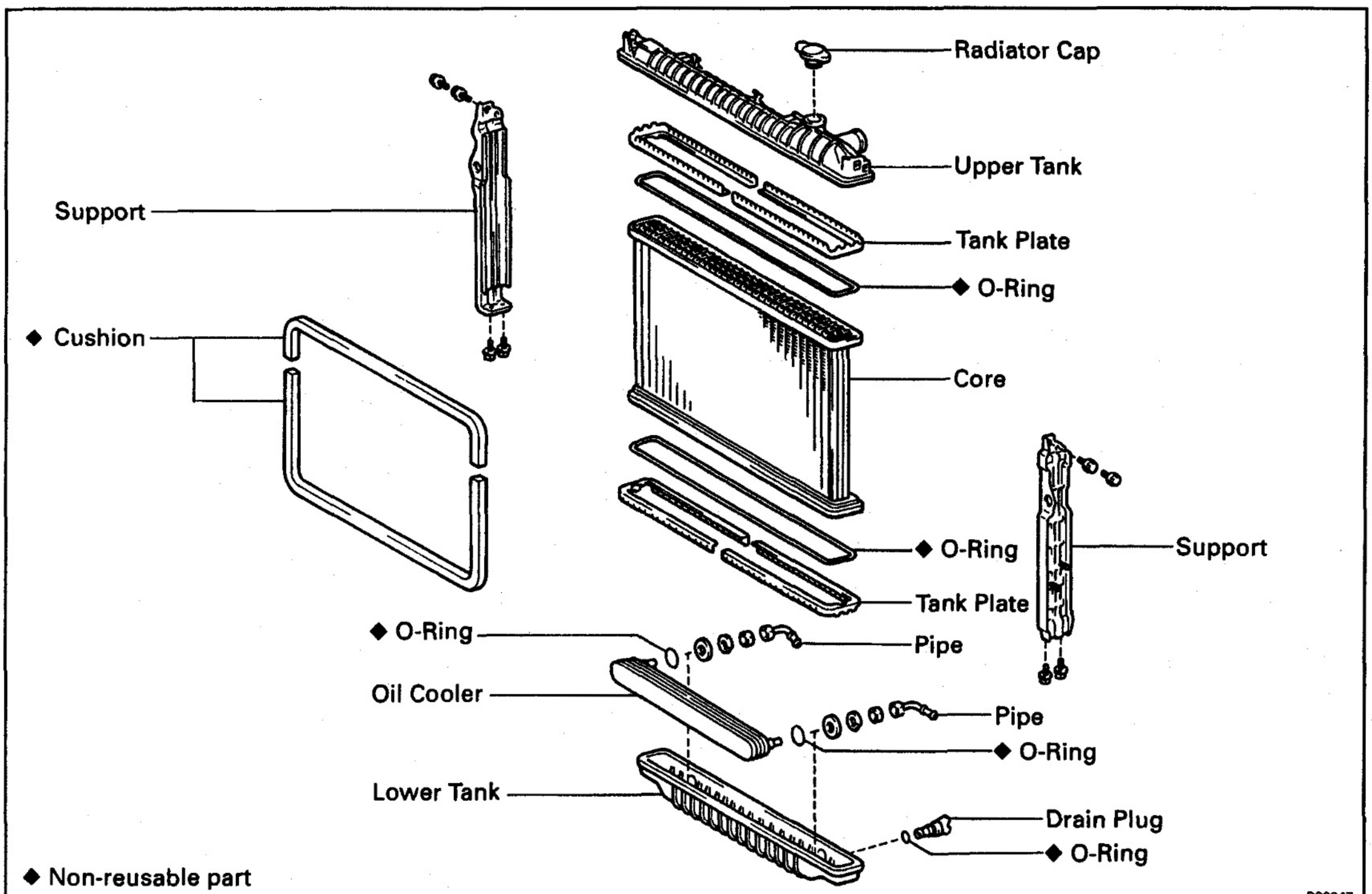
(c) Pump it to 118 kPa (1.2 kgf/cm², 17.1 psi), and check that the pressure does not drop.

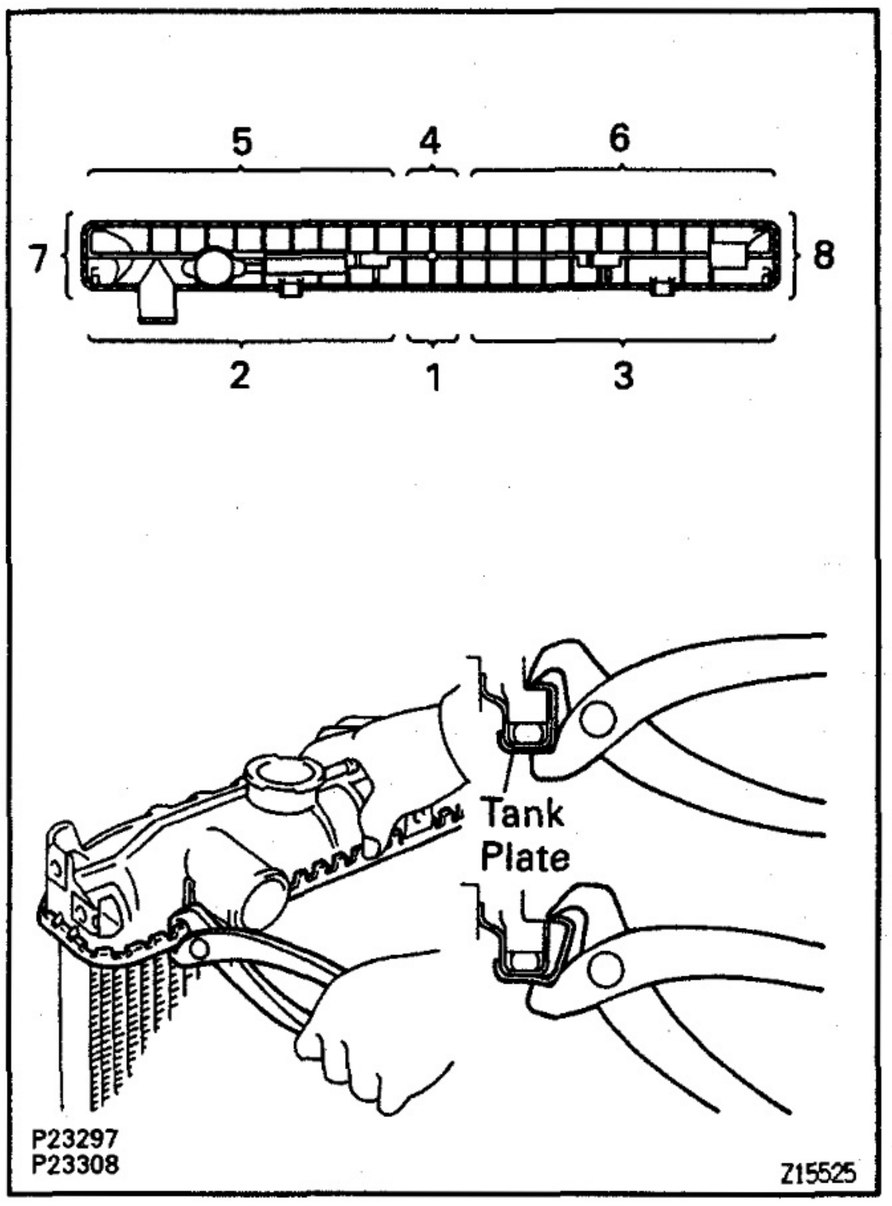
If the pressure drops, check the hoses, radiator or water pump for leaks. If no external leaks are found, check the heater core, cylinder block and cylinder head.

4. REINSTALL RADIATOR CAP

COMPONENTS FOR DISASSEMBLY AND ASSEMBLY

EG1J6-08





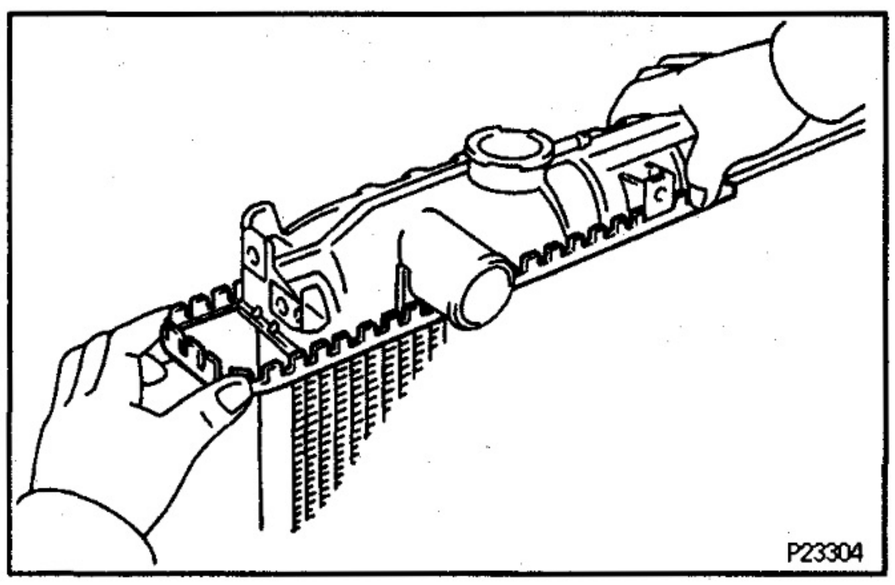
SDSSW-01

RADIATOR DISASSEMBLY

1. **REMOVE CUSHIONS**
2. **REMOVE SUPPORTS**
3. **REMOVE DRAIN PLUG**
4. **REMOVE TANK PLATE**

(a) Raise the claws of the tank plates with SST in the numerical order shown in the illustration.
SST 09230−00010

NOTICE: Be careful not to damage the core plate.



(b) Pull the tank plates outward.

5. REMOVE TANK

(a) Pull the tank upward.

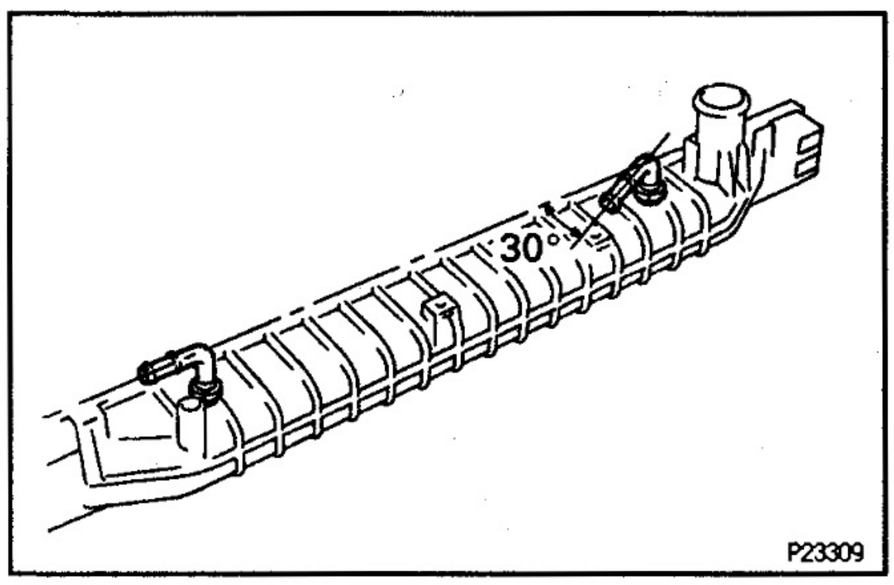
(b) Remove the O–ring.

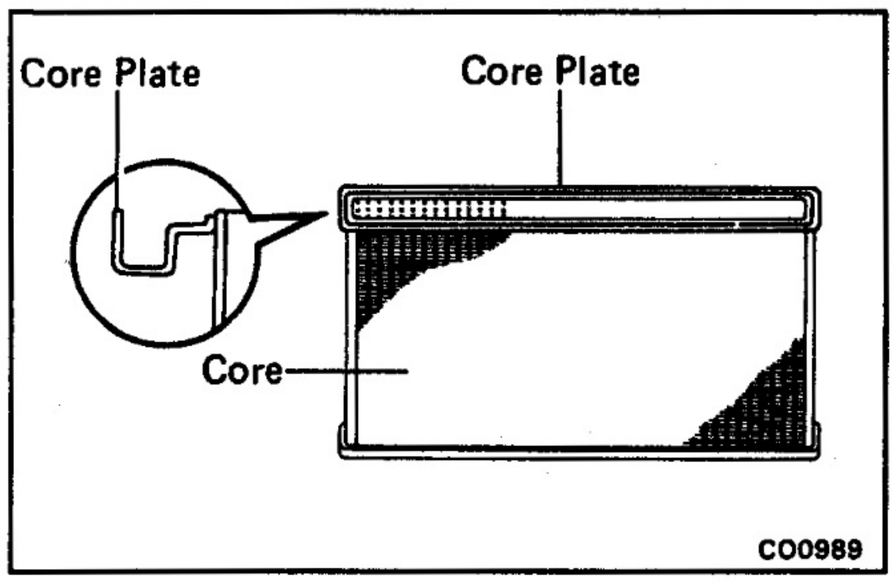
6. REMOVE OIL COOLER FROM LOWER TANK

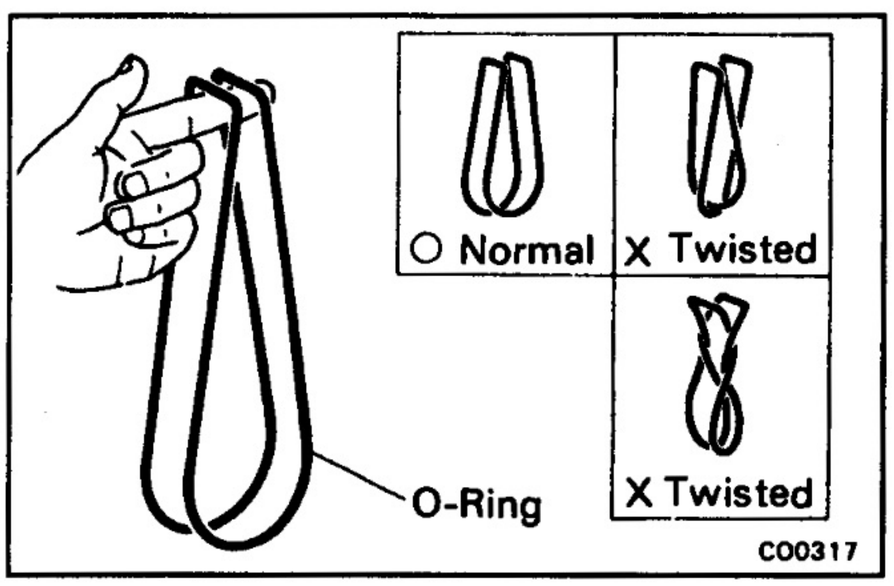
(a) Remove the 2 pipes.

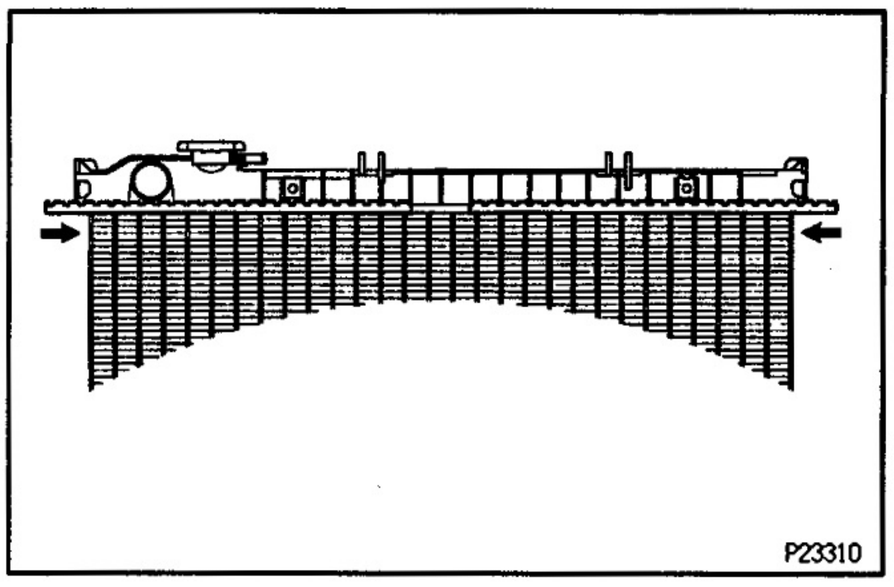
(b) Remove the 2 nuts, 2 spring washers, 2 plate washers and oil cooler.

(c) Remove the 2 O–rings from the oil cooler.









EG58X–01

RADIATOR ASSEMBLY

1. INSTALL OIL COOLER TO LOWER TANK

(a) Install 2 new O–rings to the oil cooler.

(b) Install the oil cooler to the lower tank.

(c) Install the 2 plate washers, 2 spring washers and 2 nuts.

Torque: 10 N·m (100 kgf·cm, 7 ft·lbf)

(d) Install the 2 pipes.

Torque: 15 N·m (150 kgf·cm, 11 ft·lbf)

HINT: Face the pipes in the direction shown in the illustration.

2. CHECK CORE PLATE FOR DAMAGE

HINT:

- If the sides of the core plate groove are deformed, reassembly of the tank will be impossible. Therefore, first correct any deformation with pliers.
- Water leakage will result if the bottom of the core plate groove is damaged or dented. Therefore, repair or replace if necessary.

3. INSTALL TANK

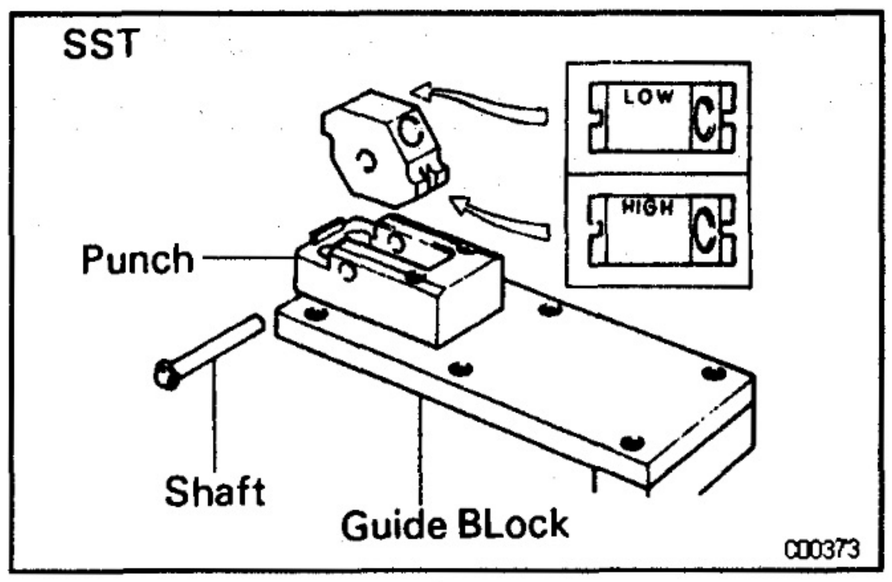
Install a new O–ring and the tank.

HINT:

- Clean the tank and core plate.
- Take out any twists.

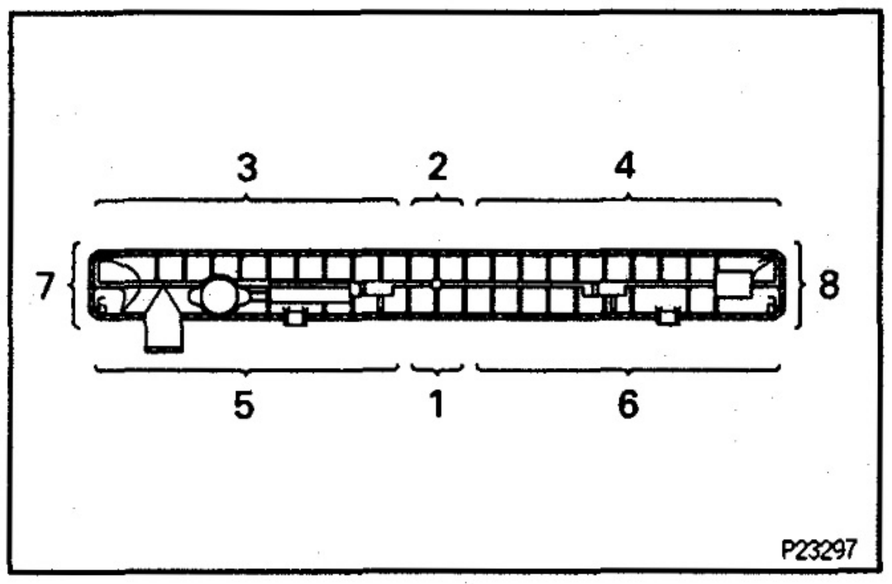
4. INSTALL TANK PLATE

Insert new tank plates from both ends in the direction of the arrows. Firmly set the tank plates in the core plate.

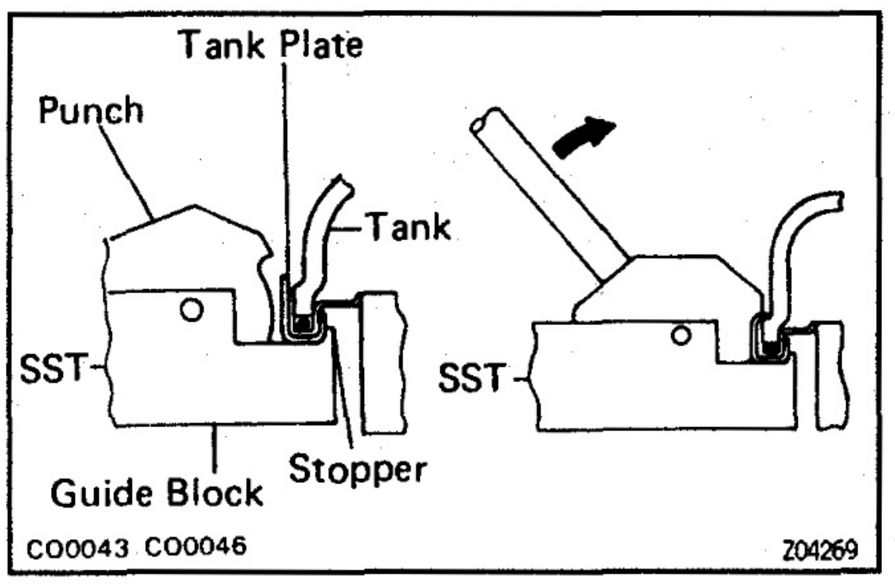


5. STAKE CLAWS OF TANK PLATES

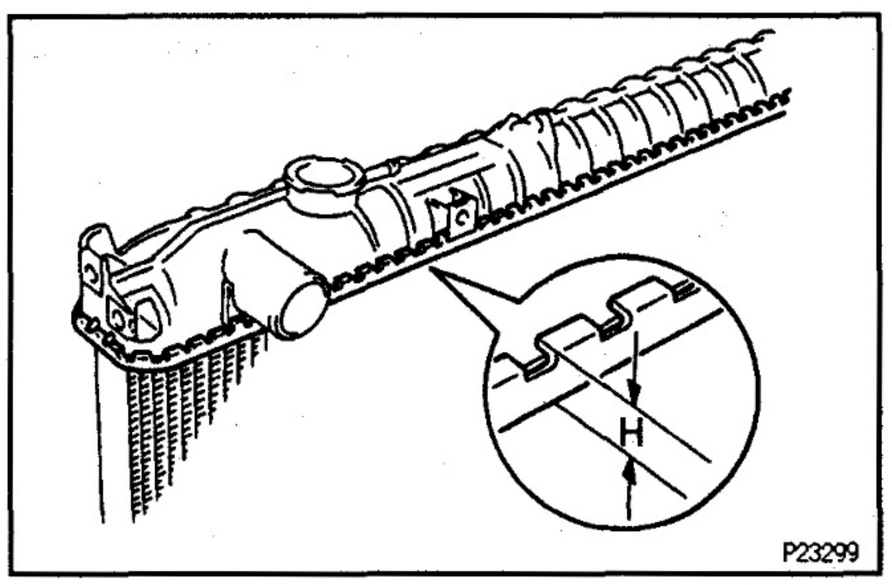
(a) Set the punch of SST to "LOW".
SST 09230–00010



(b) Stake the claws of the tank plates with SST in the numerical order shown in the illustration.



NOTICE: If the bottom of the core plate is staked with the SST on the guide block stopper, it may result in water leakage.

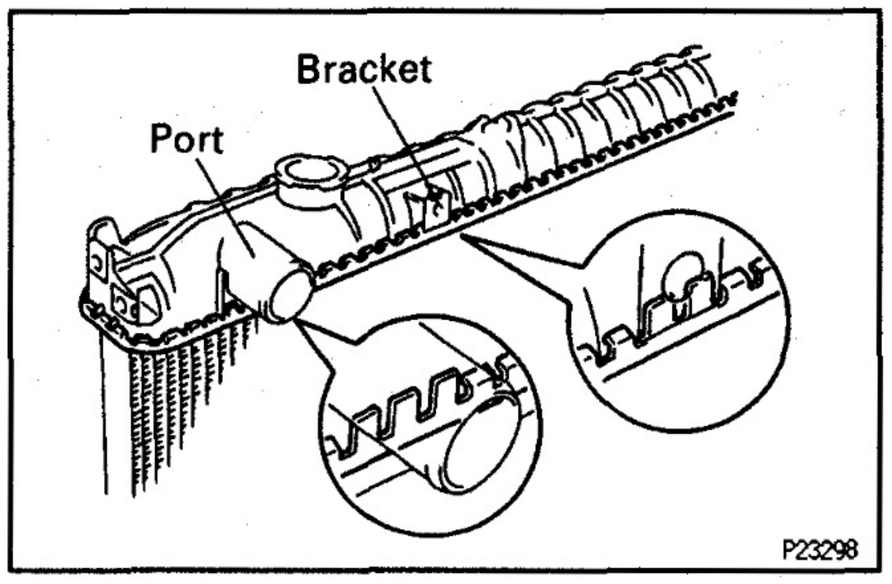


HINT:

- Stake with just enough pressure to leave a mark on the claw. The staked plate height (H) should be as follows:

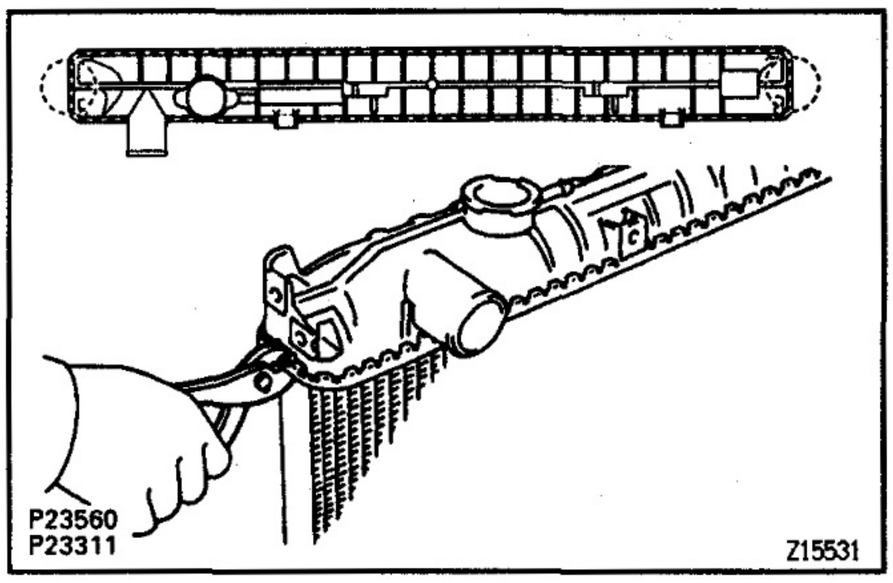
Plate height (H):

9.2 – 9.6 mm (0.362 – 0.378 in.)



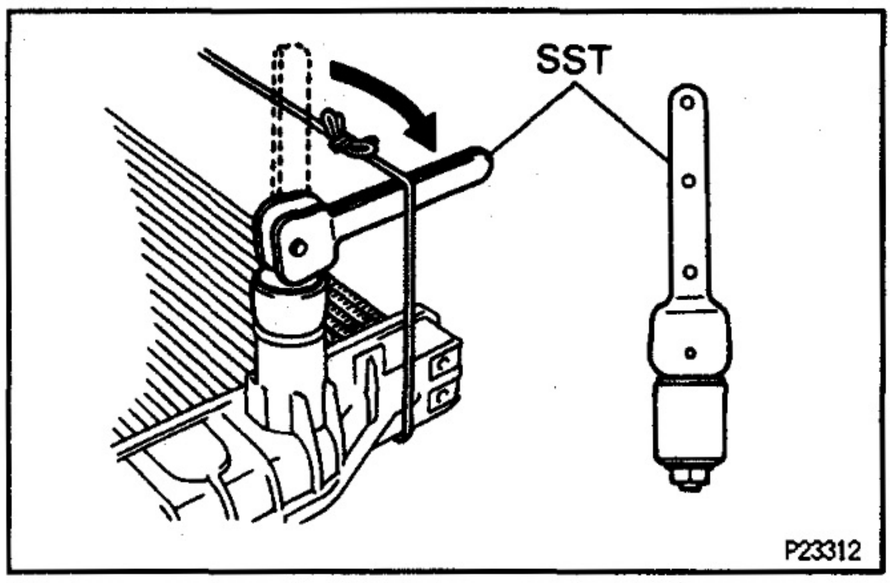
- Do not stake the areas protruding around the ports or brackets.

EG



- The points shown in the illustration cannot be staked with the SST. Use pliers and be careful not to damage the core plates.

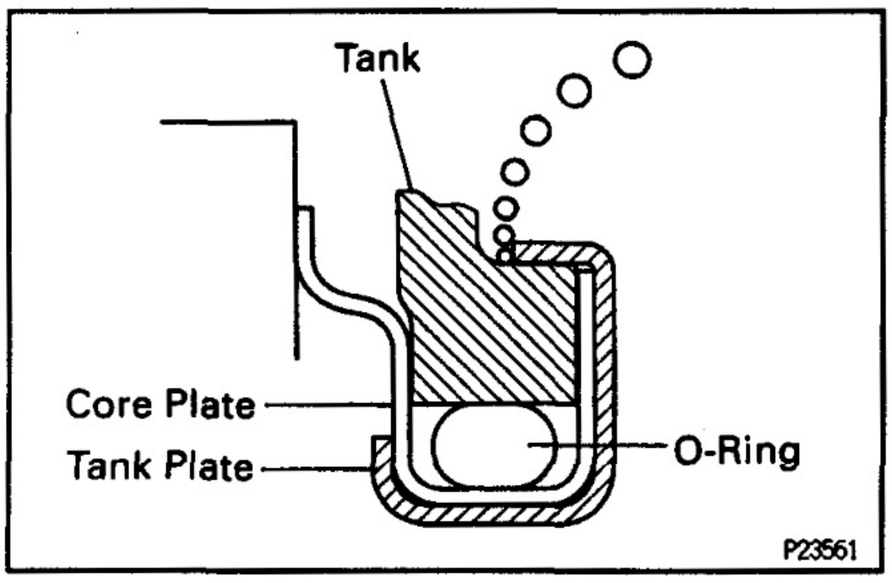
6. INSTALL DRAIN PLUG



7. CHECK FOR WATER LEAKS

(a) Plug the inlet and outlet pipes of the radiator with SST.
SST 09230–01010 (09231–00060)

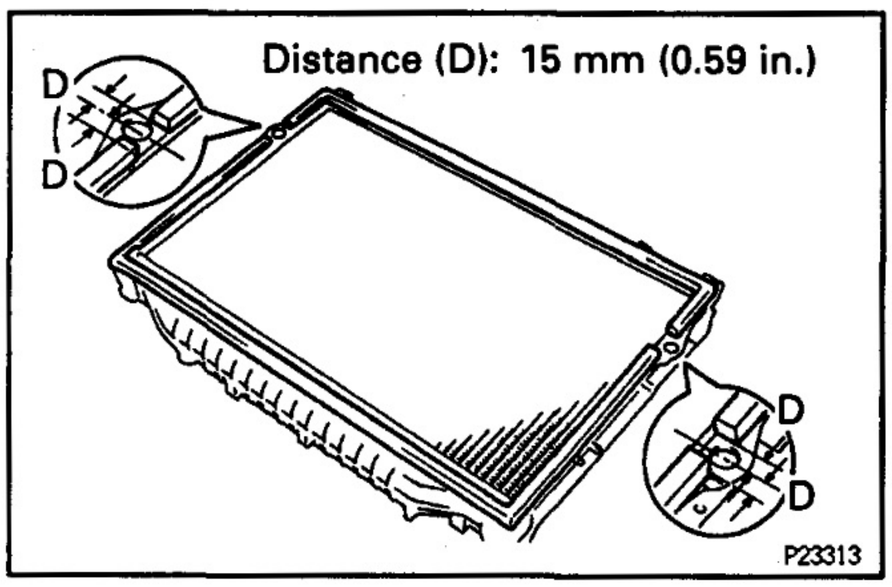
(b) Using a radiator cap tester, apply pressure to the radiator.
Test pressure:
147 kPa (1.5 kgf/cm², 21 psi)



(c) Check for water leaks.
HINT: On radiators with resin tanks, there is a clearance between the core plate and tank plate where a minute amount of air will remain, giving the appearance of an air leak when the radiator is submerged in water. Therefore, before performing the water leak test, first swirl the radiator around in the water until all air bubbles disappear.

8. PAINT TANK PLATE
HINT: If the water leak test checks out okay, allow the radiator to dry completely and then paint the tank plate.

9. INSTALL SUPPORTS
Torque: 12.7 N·m (130 kgf·cm, 9 ft·lbf)



10. INSTALL CUSHIONS
Install the 2 cushions as shown in the illustration.

SERVICE SPECIFICATIONS

SERVICE DATA

EG07L-1A

Thermostat	Valve opening temperature		74 — 78°C (165 — 172°F)
	Valve lift	at 90°C (194°F)	10 mm (0.39 in.) or more
Radiator cap	Relief valve opening pressure	STD	74 — 103 kPa (0.75 — 1.05 kgf/cm², 10.7 — 14.9 psi)
		Minimum	59 kPa (0.6 kgf/cm², 8.5 psi)

EG

TORQUE SPECIFICATIONS

EG07M-1A

Part tightened		N·m	kgf·cm	ft·lbf
Drain plug x Oil cooler cover		29.4	300	22
Water pump x Cylinder block	12 mm head	19.6	200	14
	14 mm head	39.2	400	29
Fan x Fluid coupling		6.4	65	57 in.·lbf
Fluid coupling x Water pump pulley		19.6	200	14
Water inlet x Cylinder block		19.6	200	14
Water inlet x Alternator bracket		19.6	200	14
Oil cooler x Lower tank		10	100	7
Oil cooler pipe x Oil cooler		15	150	11
Support x Tank on radiator		12.7	130	9

LUBRICATION SYSTEM

PREPARATION

SST (SPECIAL SERVICE TOOLS)

EG14U-0J

EG

	09032-00100 Oil Pan Seal Cutter	
	09228-10002 Oil Filter Wrench	

RECOMMENDED TOOLS

EG14V-0H

	09200-00010 Engine Adjust Kit .	

EQUIPMENT

EG14W-0G

Oil pressure gauge	
Precision straight edge	
Torque wrench	

LUBRICANT

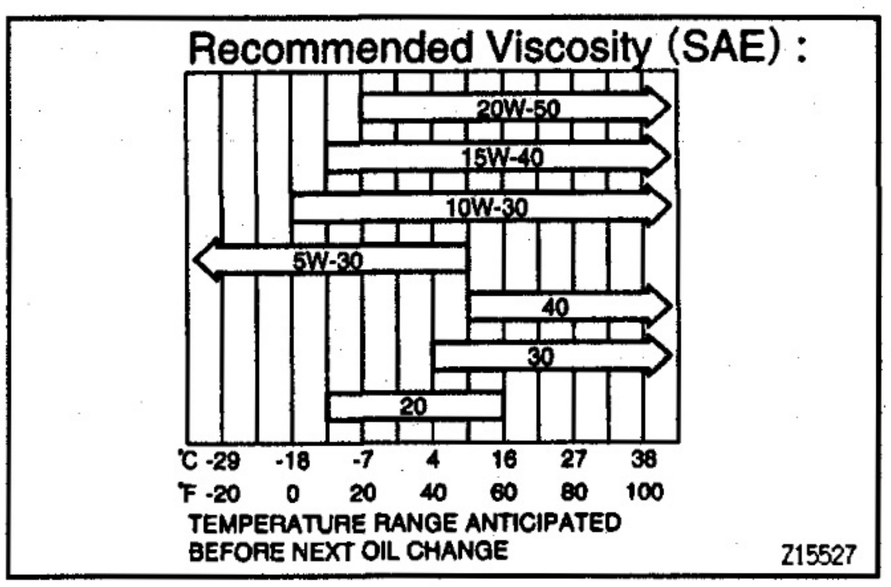
EG14X-0Z

Item	Capacity	Classification
Engine oil		API grade CD or better
Dry fill	10.0 liters (10.6 US qts, 8.8 Imp. qts)	
Drain and refill		
w/ Oil filter change	9.7 liters (10.3 US qts, 8.5 Imp. qts)	
w/o Oil filter change	8.4 liters (8.9 US qts, 7.4 Imp. qts)	

SSM (SPECIAL SERVICE MATERIALS)

EG14Y-0J

08826-00080	Seal Packing Black or equivalent (FIPG)	Oil pump Oil pan
08833-00080	Adhesive 1344, THREE BOND 1344, LOCTITE 242 or equivalent	Oil pressure sender gauge Taper screw plug on timing gear case



OIL PRESSURE CHECK

EQ56Y–01

1. CHECK ENGINE OIL QUALITY

Check the oil for deterioration, entry of water, discoloring or

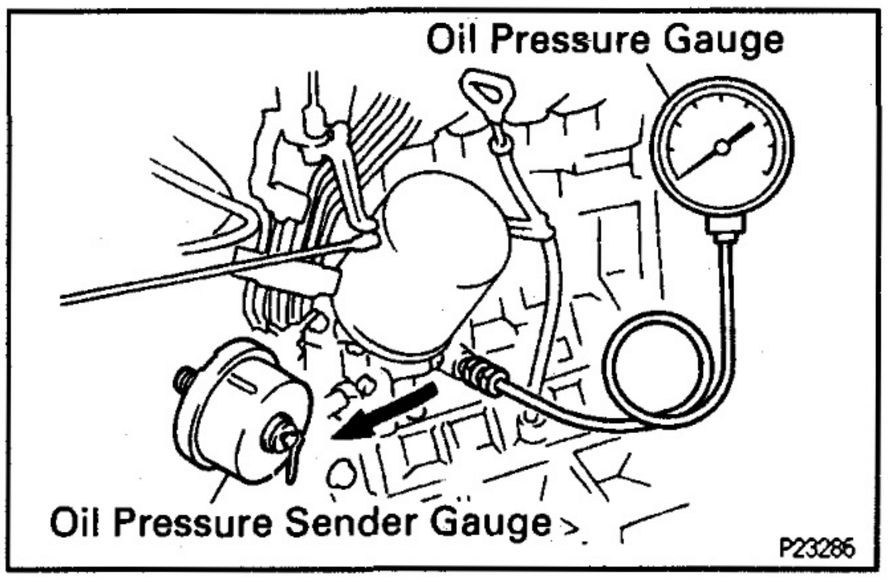
If the quality is visibly poor, replace the oil.

Oil grade:

API grade CD or better

Recommended viscosity:

Refer to illustration



2. CHECK ENGINE OIL LEVEL

The oil level should be between the "L" and "F" marks on the dipstick.

If low, check for leakage and add oil up to "F" mark.

3. REMOVE OIL PRESSURE SENDER GAUGE

4. INSTALL OIL PRESSURE GAUGE

5. WARM UP ENGINE

Allow the engine to warm up to normal operating temperature.

6. CHECK OIL PRESSURE

Oil pressure:

At idle

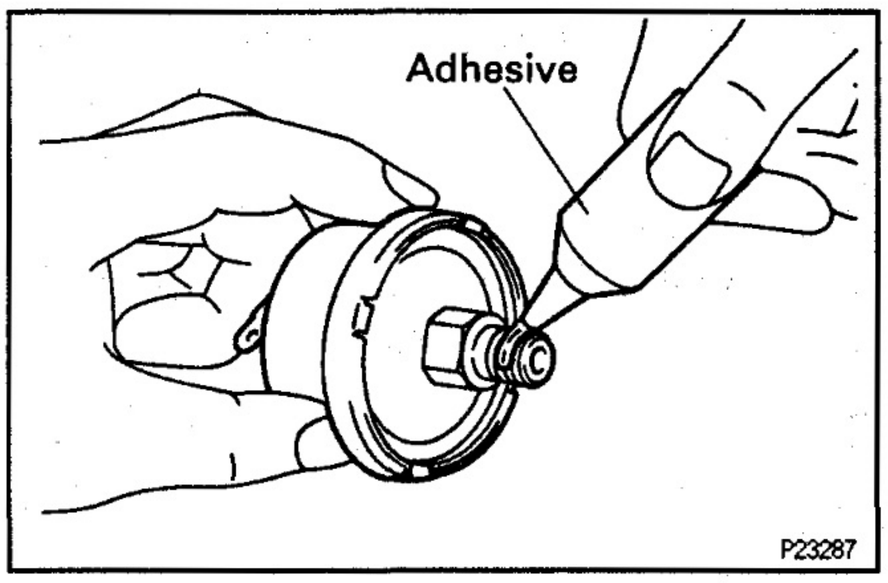
29 kPa (0.3 kgf/cm², 4.3 psi) or more

At 3,000 rpm

250 — 600 kPa

(2.5 — 6.1 kgf/cm², 36 — 87 psi)

7. REMOVE OIL PRESSURE GAUGE



8. REINSTALL OIL PRESSURE SENDER GAUGE

(a) Apply adhesive to 2 or 3 threads of the oil pressure sender gauge.

Adhesive:

Part No. 08833—00080, THREE BOND 1344, LOCTITE 242 or equivalent

(b) Install the oil pressure sender gauge.

9. START ENGINE, AND CHECK FOR OIL LEAKS

OIL AND FILTER REPLACEMENT

EQ58Z–01

CAUTION:

- **Prolonged and repeated contact with mineral oil will result in the removal of natural fats from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer.**

EG

- **Care should be taken, therefore, when changing engine oil to minimize the frequency and length of time your skin is exposed to used engine oil. Protective clothing and gloves that cannot be penetrated by oil should be worn. The skin should be thoroughly washed with soap and water, or use water—less hand cleaner, to remove any used engine oil. Do not use gasoline, thinners, or solvents.**
- **In order to preserve the environment, used oil and used oil filters must be disposed of only at designated disposal sites.**

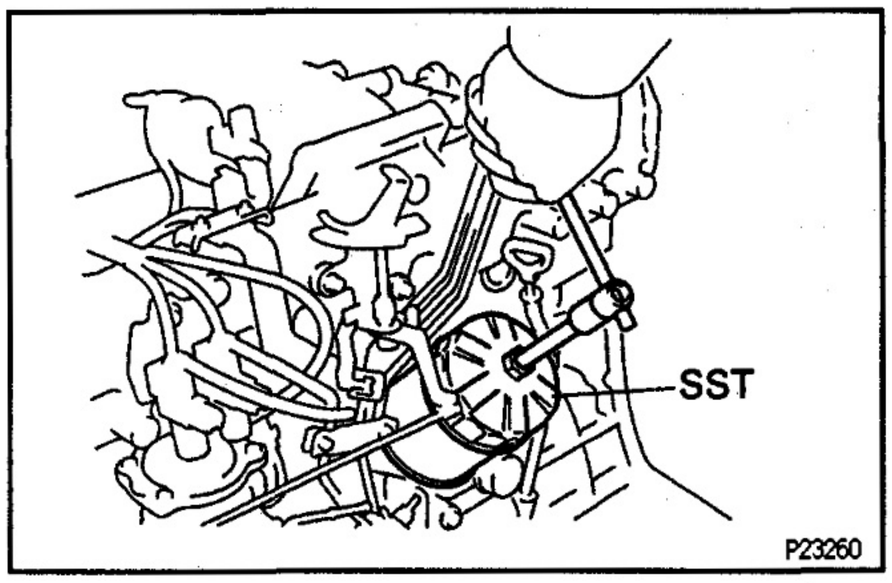
1. DRAIN ENGINE OIL

(a) Remove the oil filler cap.

(b) Remove the oil drain plug, and drain the oil into a container.

2. REPLACE OIL FILTER

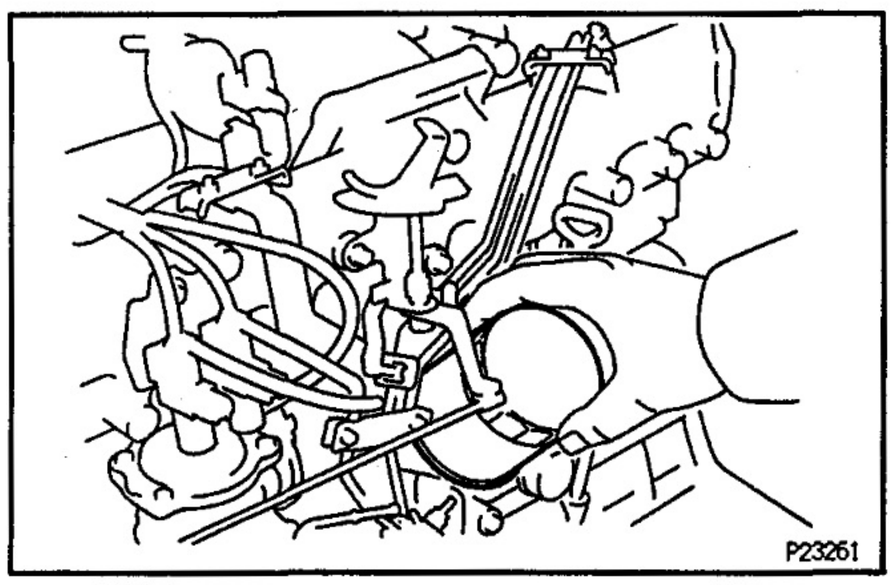
(a) Using SST, remove the oil filter.
SST 09228—10002

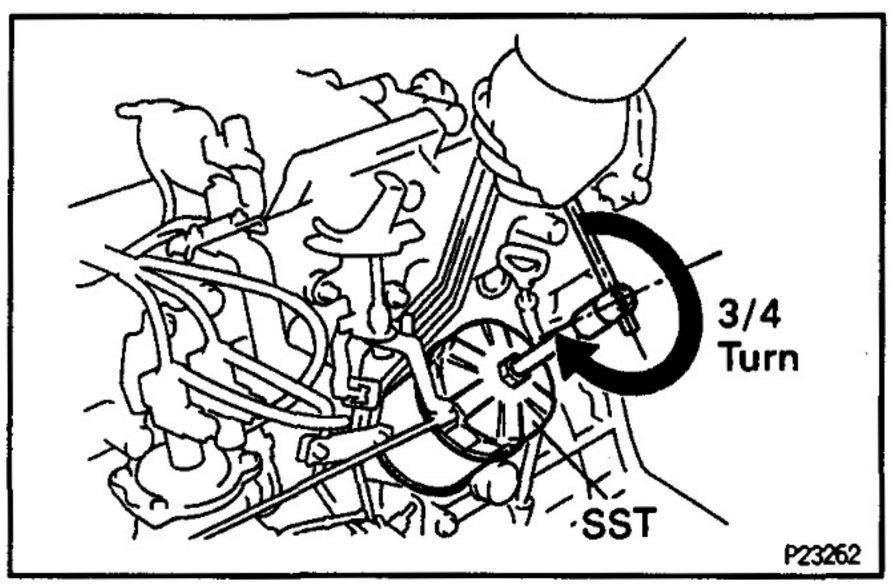


(b) Clean the oil filter contact surface on the oil filter mounting.

(c) Lubricate the filter rubber gasket with clean engine oil.

(d) Tighten the oil filter by hand until the rubber gasket contacts the seat of the filter mounting.





(e) Using SST, give it an additional 3/4 turn to seat the filter.
SST 09228—10002

3. REFILL WITH ENGINE OIL

(a) Clean the drain plug, and install a new gasket and it.
Torque: 34.3 N·m (350 kgf·cm, 25 ft·lbf)

(b) Fill with new engine oil.
Capacity:

Drain and refill

w/ Oil filter change

9.7 liters (10.3 US qts, 8.5 Imp. qts)

w/o Oil filter change

8.4 liters (8.9 US qts, 7.4 Imp. qts)

Dry fill

10.0 liters (10.6 US qts, 8.8 Imp. qts)

(c) Reinstall the oil filler cap.

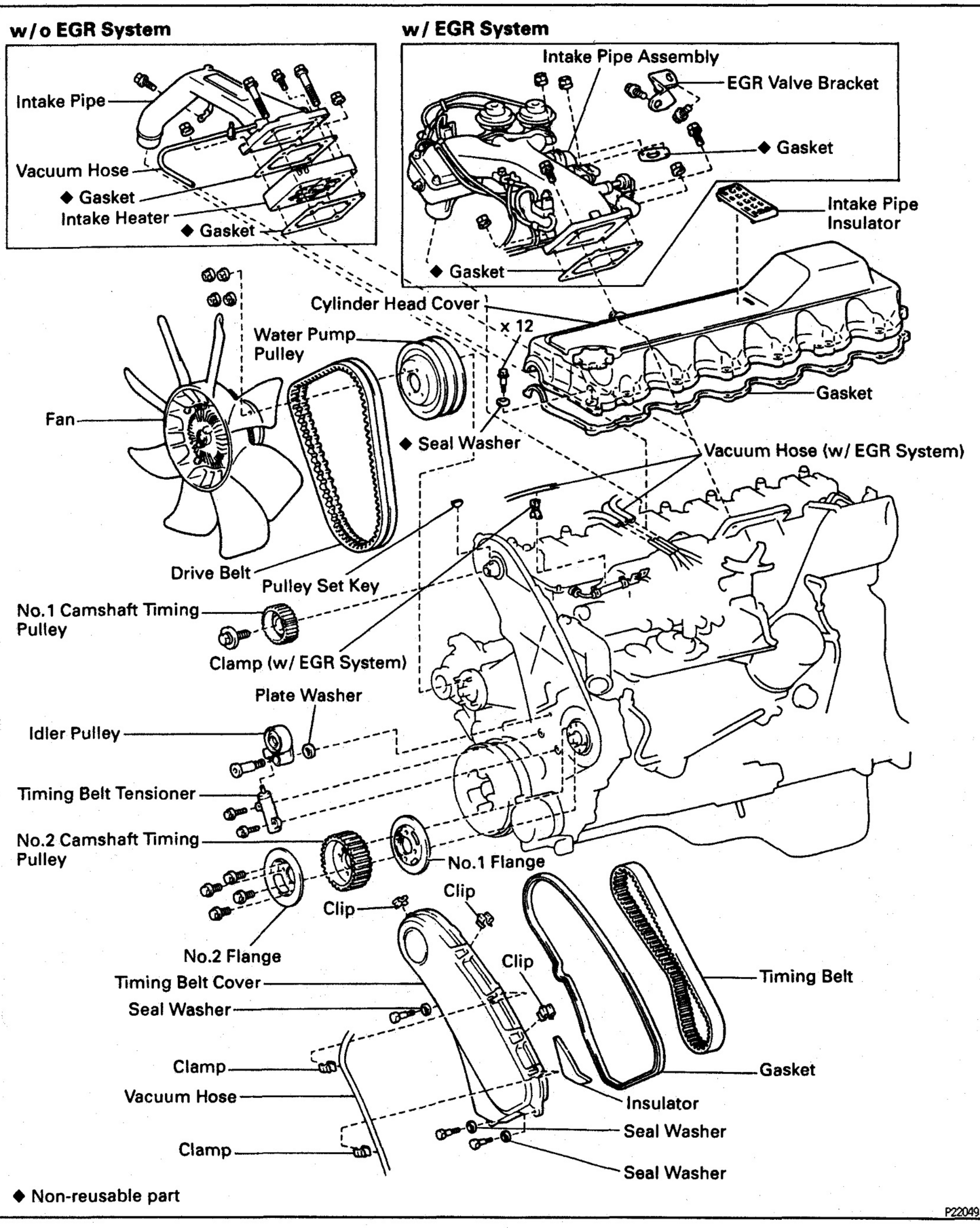
4. START ENGINE AND CHECK FOR OIL LEAKS

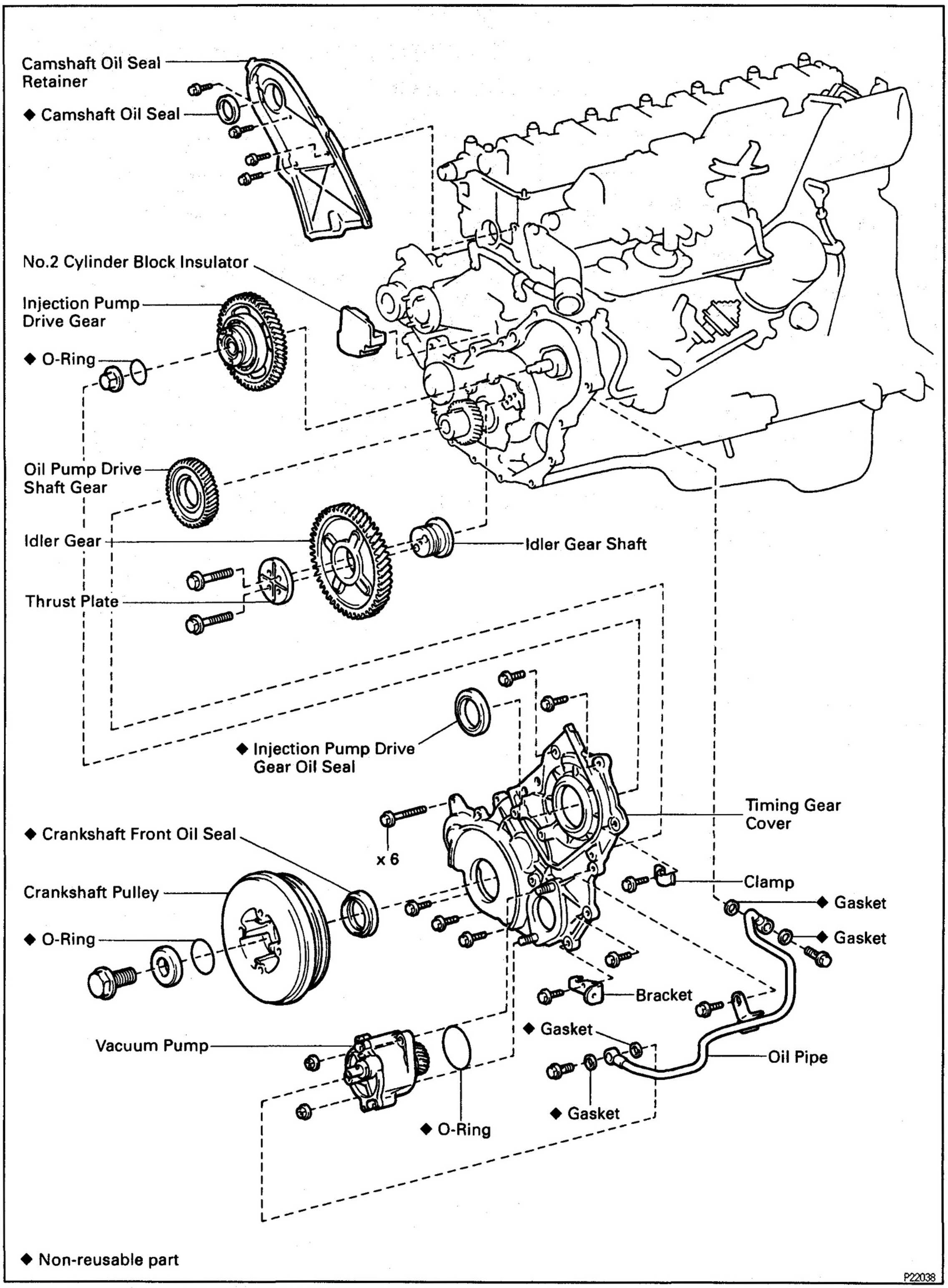
5. RECHECK ENGINE OIL LEVEL

OIL PUMP

COMPONENTS FOR REMOVAL AND INSTALLATION

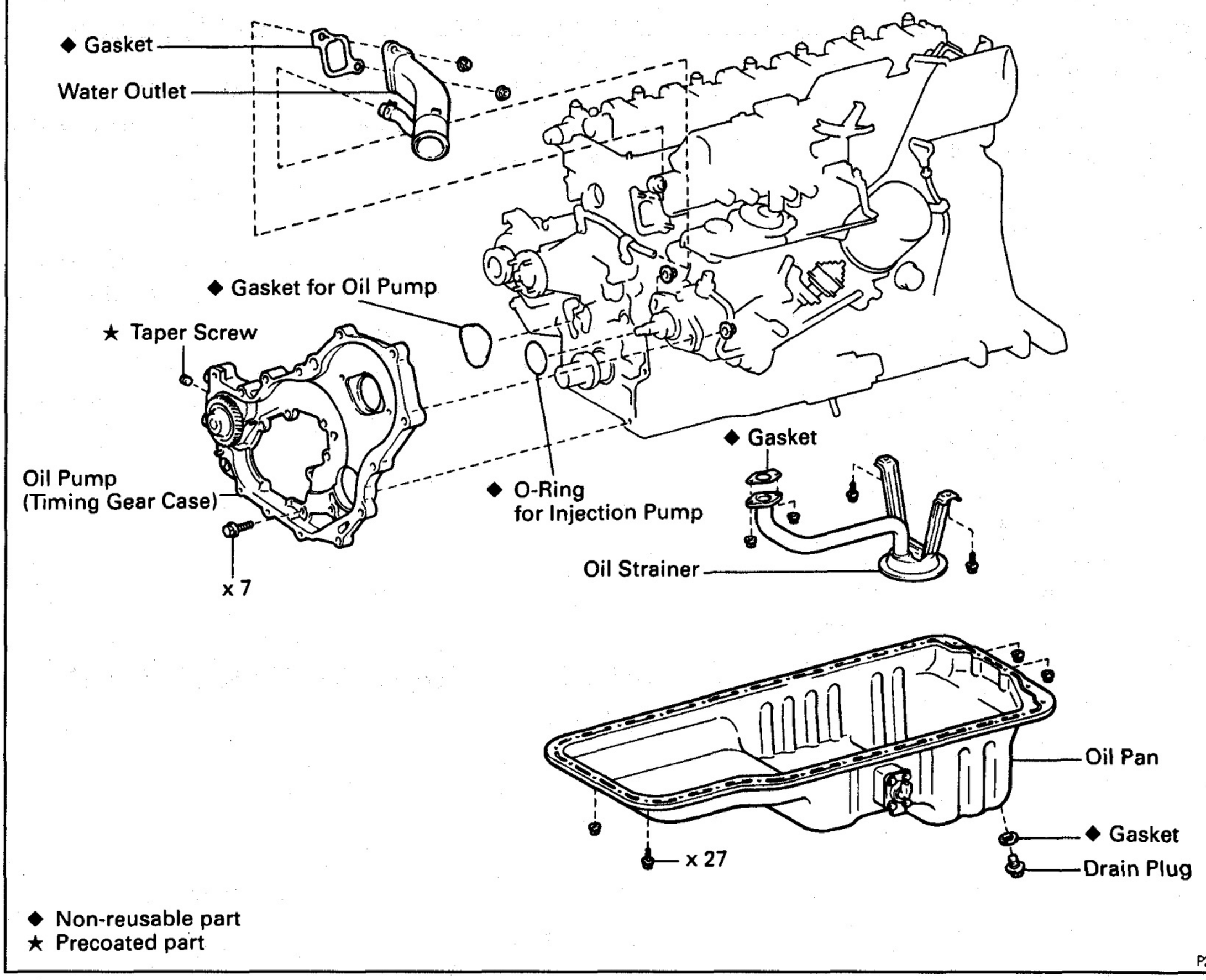
EGSTC-01





◆ Non-reusable part

P22038



EG5T1-01

OIL PUMP REMOVAL

HINT: When repairing the oil pump, the oil pan and strainer should be removed and cleaned.

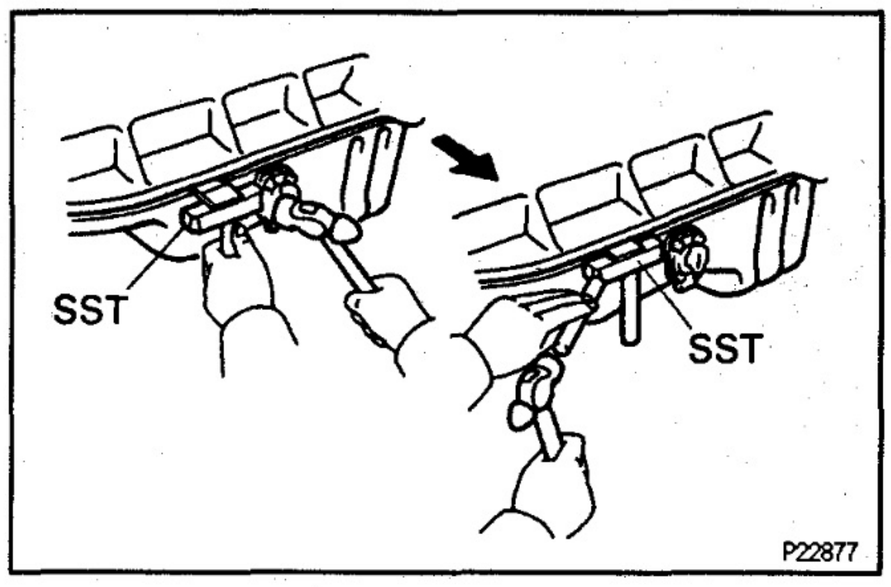
1. **DRAIN ENGINE COOLANT**
2. **DRAIN ENGINE OIL**
3. **REMOVE TIMING GEARS**
   (See steps 1 to 3 in timing gears removal in Engine Mechanical)
4. **REMOVE OIL PAN**

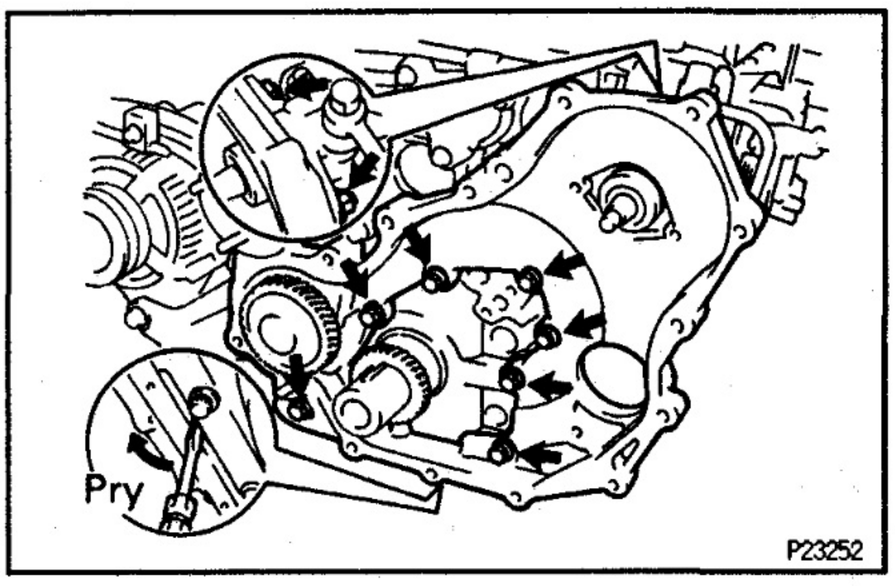
(a) Remove the 27 bolts and 3 nuts.

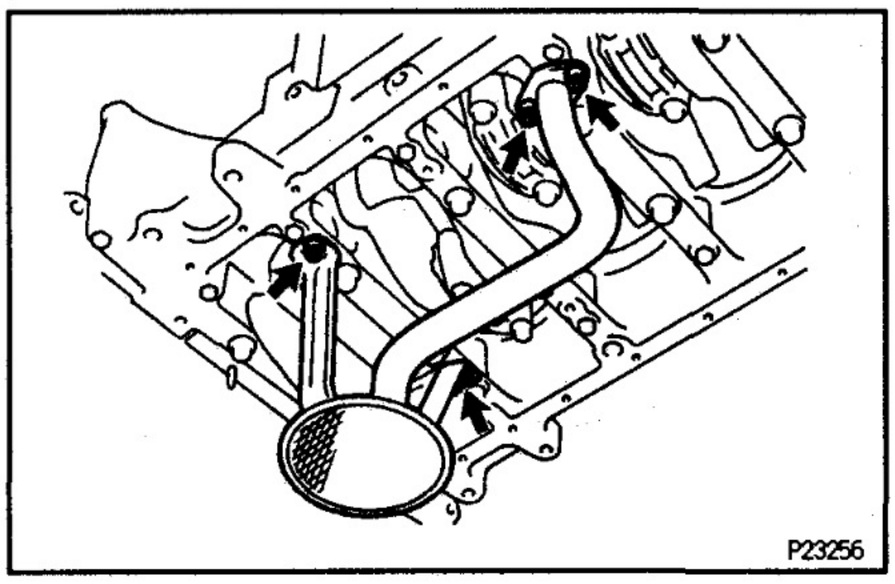
(b) Insert the blade of SST between the cylinder block and oil pan, and cut off applied sealer and remove the oil pan.
SST 09032—00100

NOTICE:

- **Do not use SST for the oil pump body side and rear oil seal retainer.**
- **Be careful not to damage the oil pan flange.**







5. REMOVE WATER OUTLET
(See step 6 in cylinder head removal in Engine Mechanical)

6. REMOVE OIL PUMP (TIMING GEAR CASE)

(a) Remove the 2 nuts holding the injection pump to the timing gear case.

(b) Remove the 7 bolts holding the timing gear case to the cylinder block.

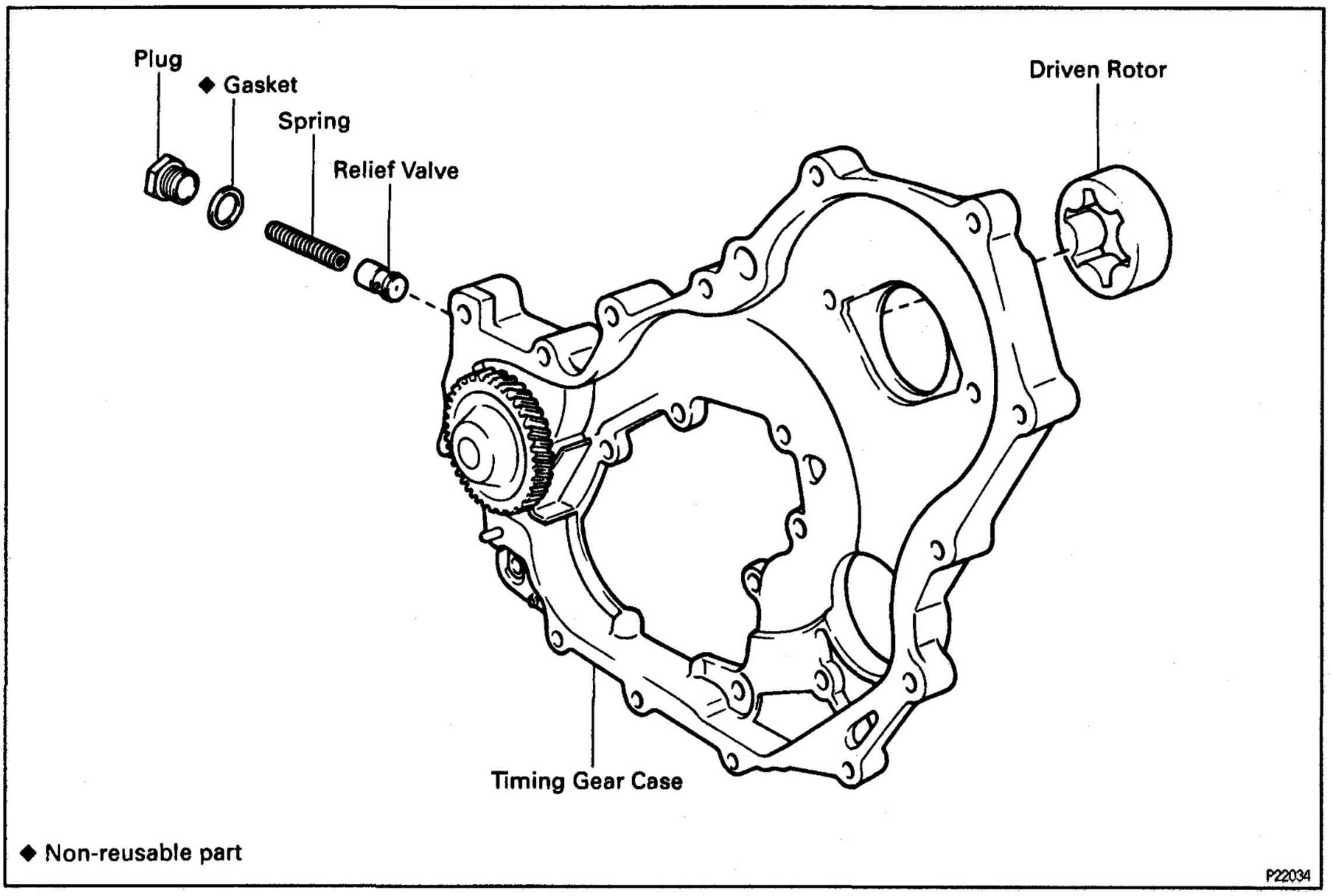
(c) Using a screwdriver, remove the oil pump by prying the portions between the oil pump and cylinder block.

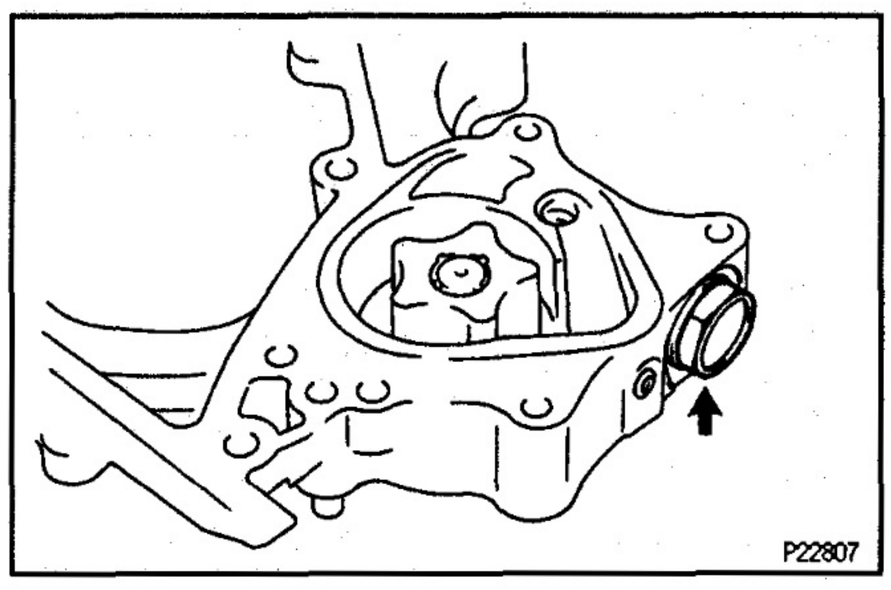
(d) Remove the gasket and O–ring.

7. REMOVE OIL STRAINER

Remove the 2 bolts, 2 nuts, oil strainer and gasket.

COMPONENTS FOR DISASSEMBLY AND ASSEMBLY

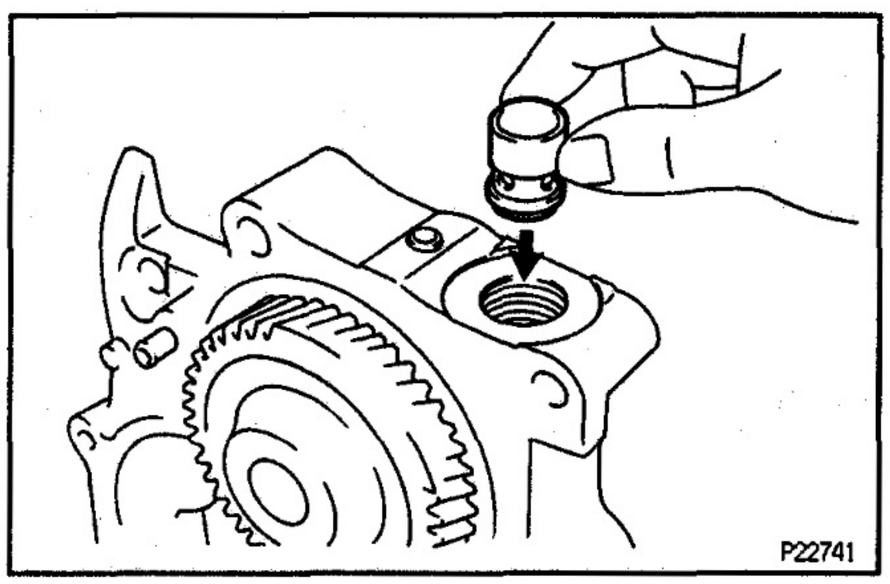




EGST2-01

OIL PUMP DISASSEMBLY

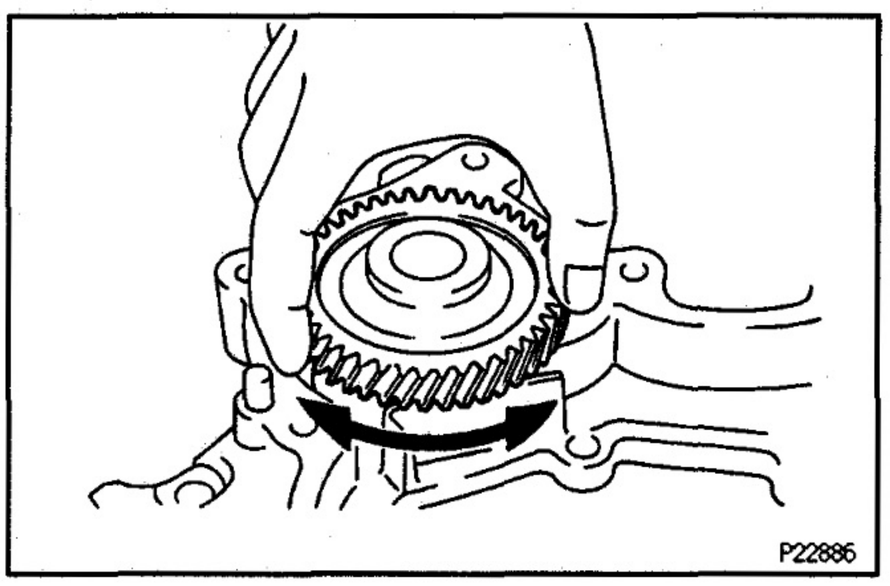
1. **REMOVE DRIVEN ROTOR**
2. **REMOVE RELIEF VALVE**
   Remove the plug, gasket, spring and relief valve.



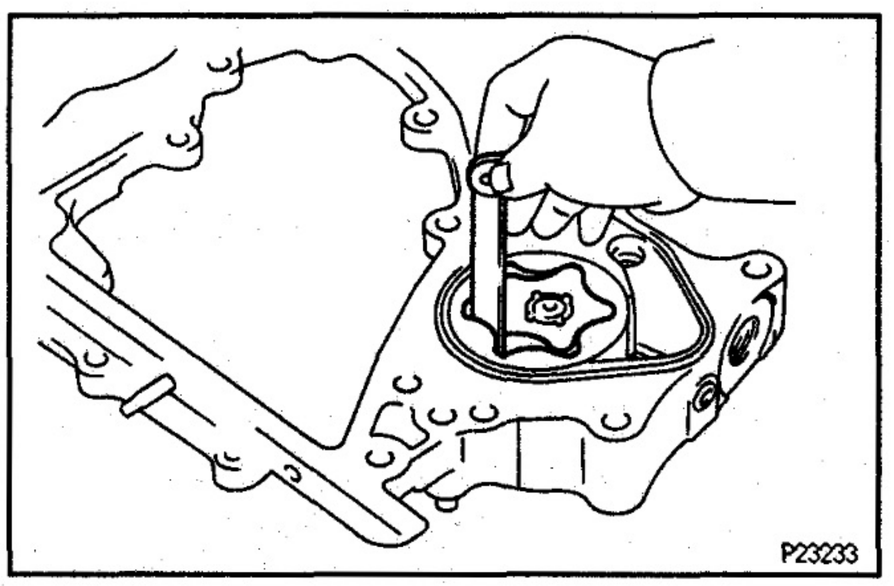
EG573-01

OIL PUMP INSPECTION

1. **INSPECT RELIEF VALVE**
   Coat the valve with engine oil and check that it falls smoothly into the valve hole by its own weight.
   If it doesn't, replace the relief valve. If necessary, replace the oil pump assembly.

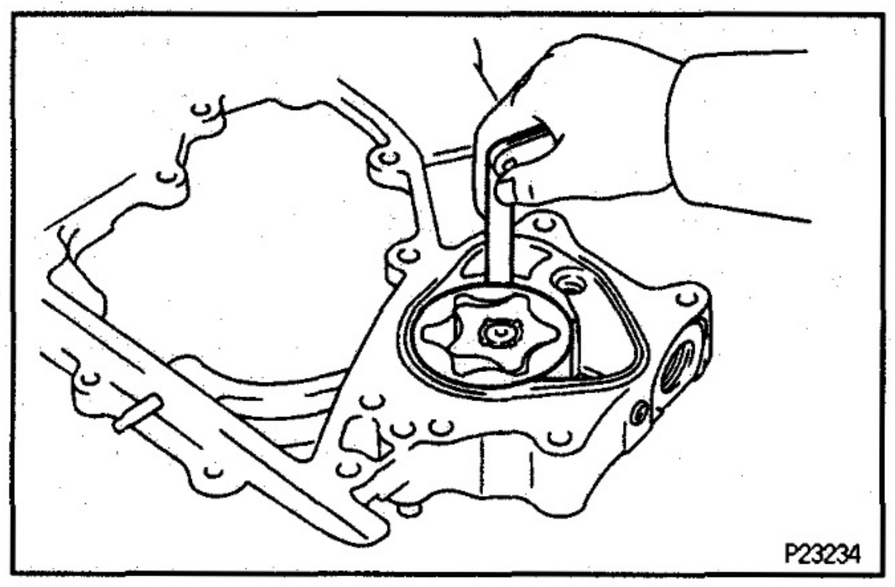


2. **INSPECT DRIVE SHAFT**
   Turn the gear, and check that the drive shaft moves smoothly and quietly.
   If necessary, replace the oil pump assembly.

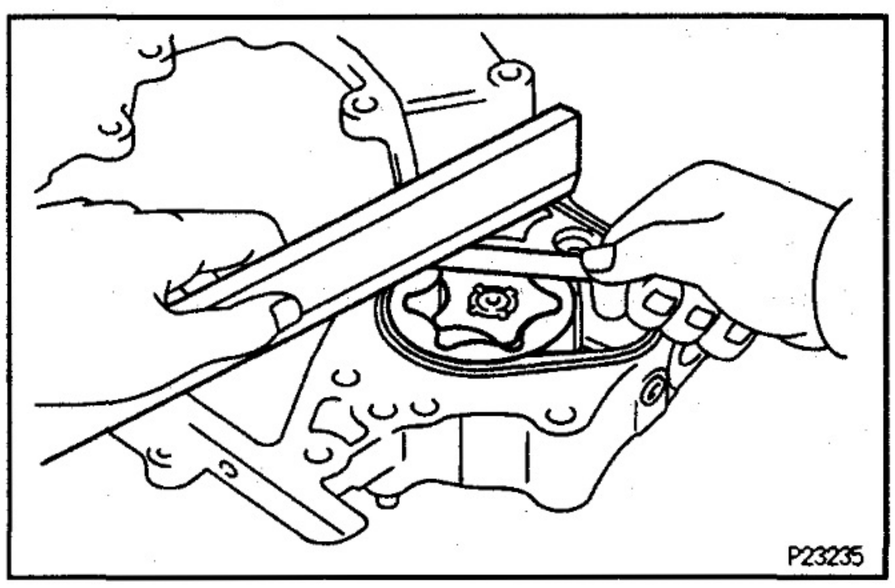


3. **INSPECT DRIVE AND DRIVEN ROTORS**

A. **Inspect rotor tip clearance**
   Using a feeler gauge, measure the clearance between the drive and driven rotor tips.
   Standard tip clearance:
   0.080 — 0.160 mm (0.0031 — 0.0063 in.)
   Maximum tip clearance:
   0.21 mm (0.0083 in.)
   If the tip clearance is greater than maximum, replace the oil pump assembly.



B. **Inspect rotor body clearance**
   Using a feeler gauge, measure the clearance between the driven rotor and body.
   Standard body clearance:
   0.100 — 0.170 mm (0.0039 — 0.0067 in.)
   Maximum body clearance:
   0.20 mm (0.0079 in.)
   If the body clearance is greater than maximum, replace the oil pump assembly.



C. Inspect rotor side clearance

Using a feeler gauge and precision straight edge, measure the clearance between the rotors and precision straight edge.

Standard side clearance:

0.030 – 0.090 mm (0.0012 – 0.0035 in.)

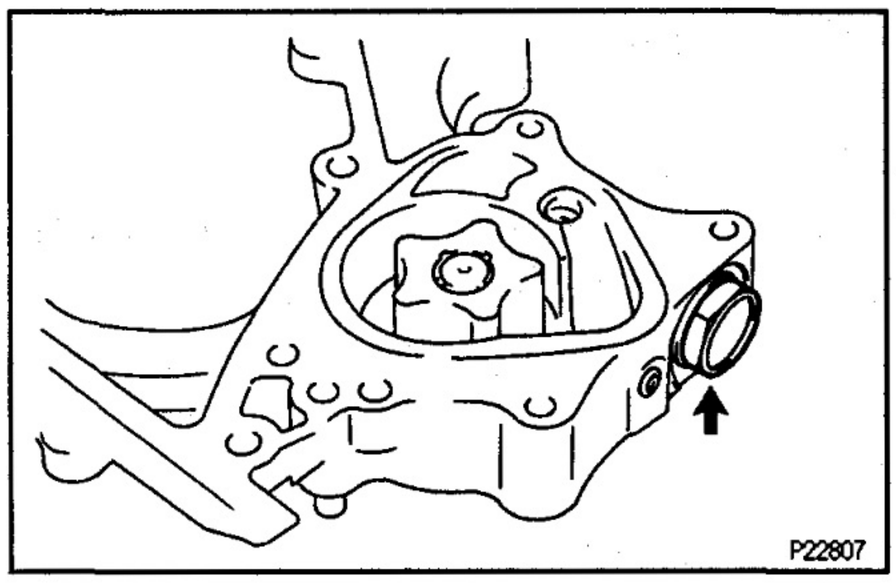
Maximum side clearance:

0.15 mm (0.0059 in.)

If the side clearance is greater than maximum, replace the oil pump assembly.

EG35C–02

OIL PUMP ASSEMBLY

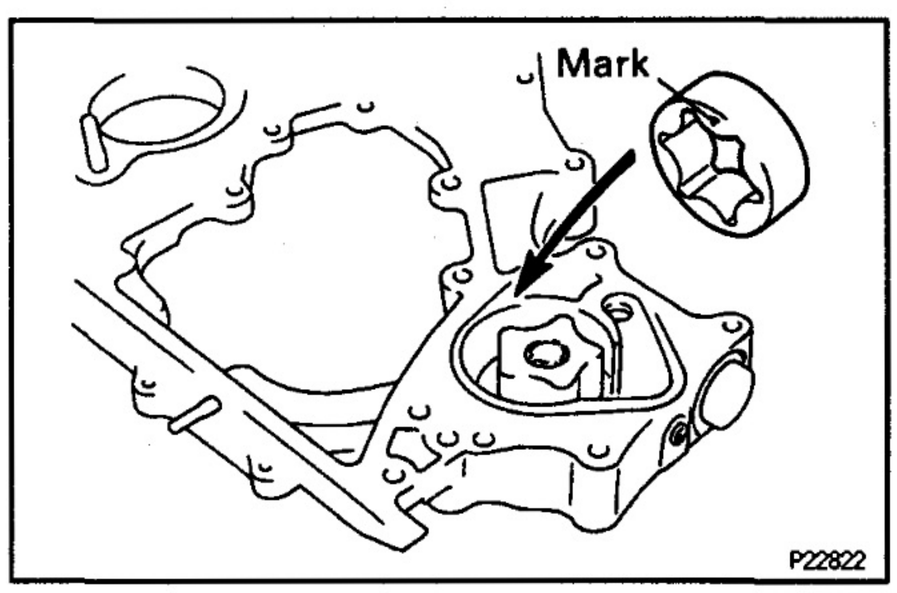


1. INSTALL RELIEF VALVE

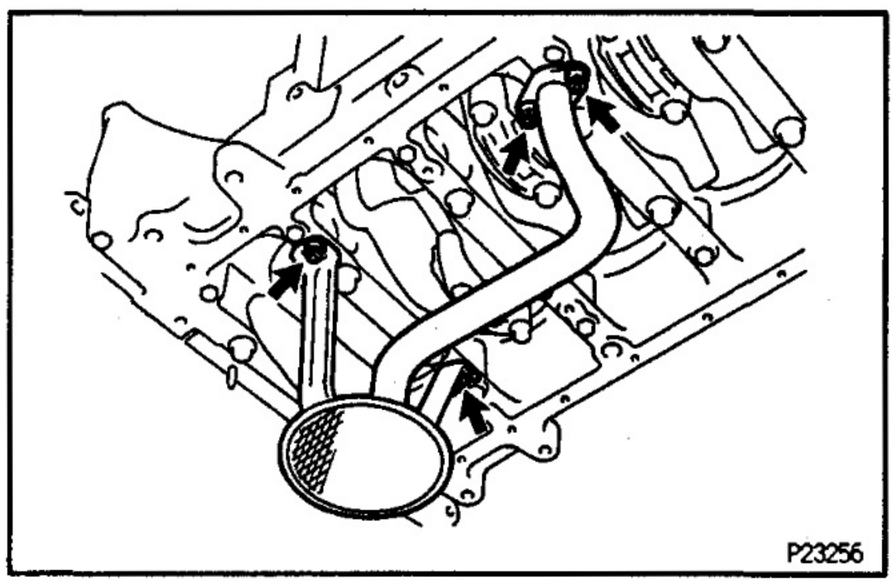
(a) Insert the relief valve and spring into the installation hole of the timing gear case.

(b) Install a new gasket and the plug.

Torque: 42 N·m (425 kgf·cm, 31 ft·lbf)



2. INSTALL DRIVE AND DRIVEN ROTOR



EG5T4–01

OIL PUMP INSTALLATION

1. INSTALL OIL STRAINER

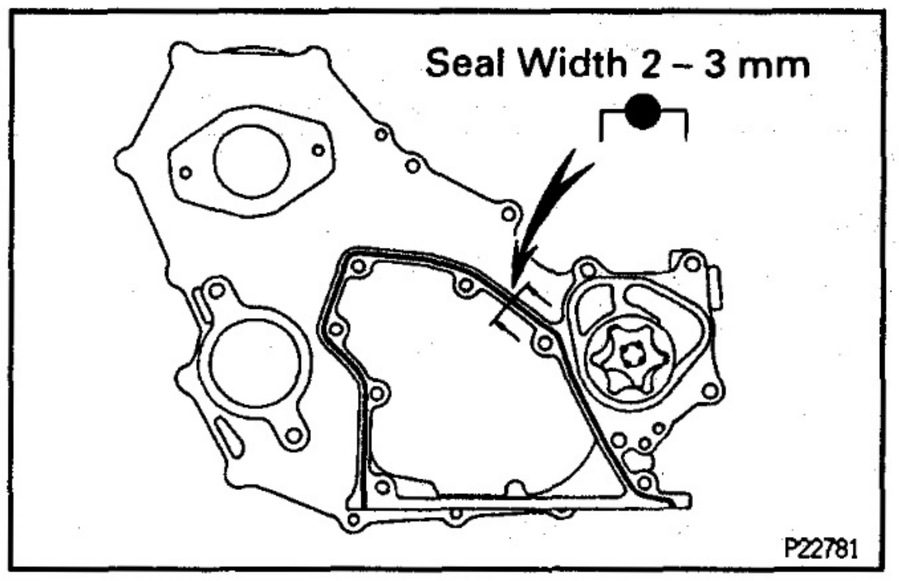
Install a new gasket and the oil strainer with the 2 bolts and 2 nuts.

Torque: 8.8 N·m (90 kgf·cm, 78 in.·lbf)

2. INSTALL OIL PUMP (TIMING GEAR CASE)

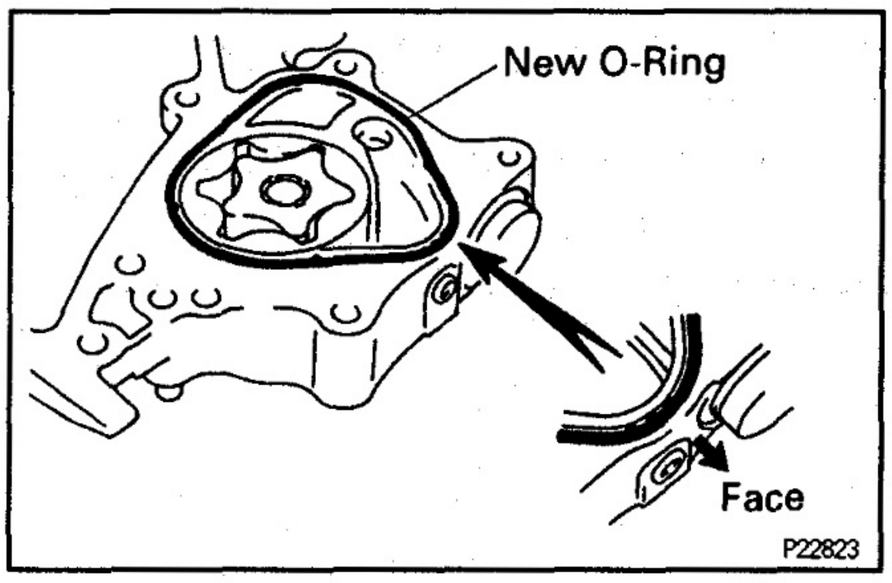
(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the timing gear case and cylinder block.

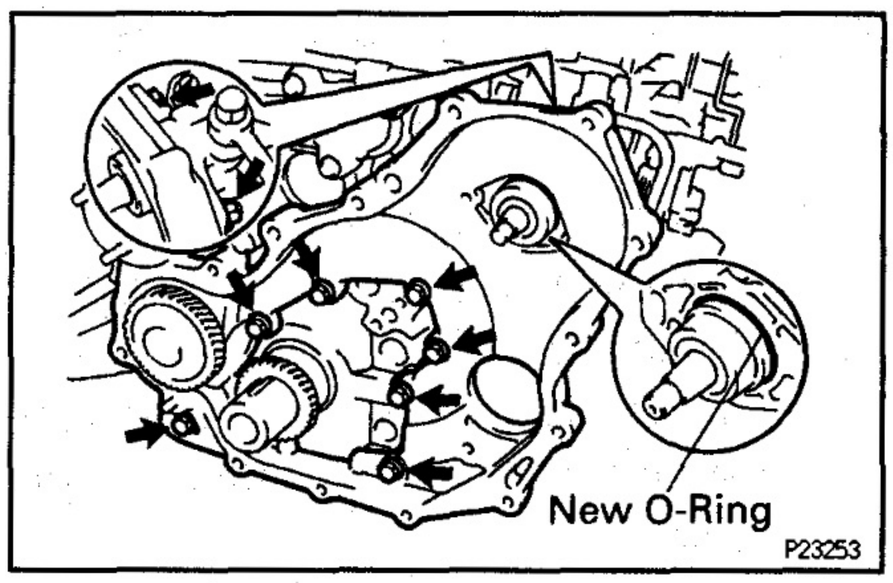
- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Using a non–residue solvent, clean both sealing surfaces.



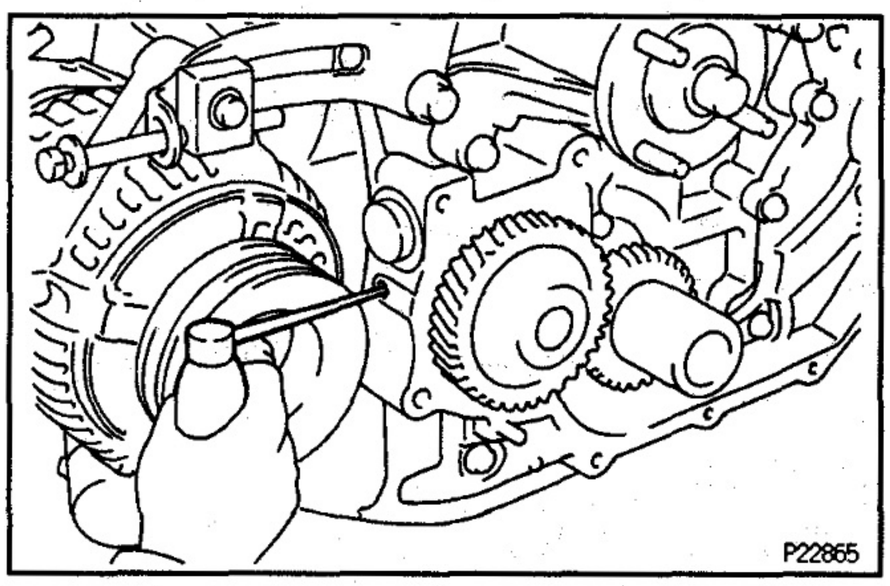
(b) Apply seal packing to the timing gear case as shown in the illustration.
Seal packing:
Part No. 08826—00080 or equivalent
- Install a nozzle that has been cut to a 2 — 3 mm (0.08 — 0.12 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

(c) Place a new gasket into the groove of the timing gear case as shown in the illustration.

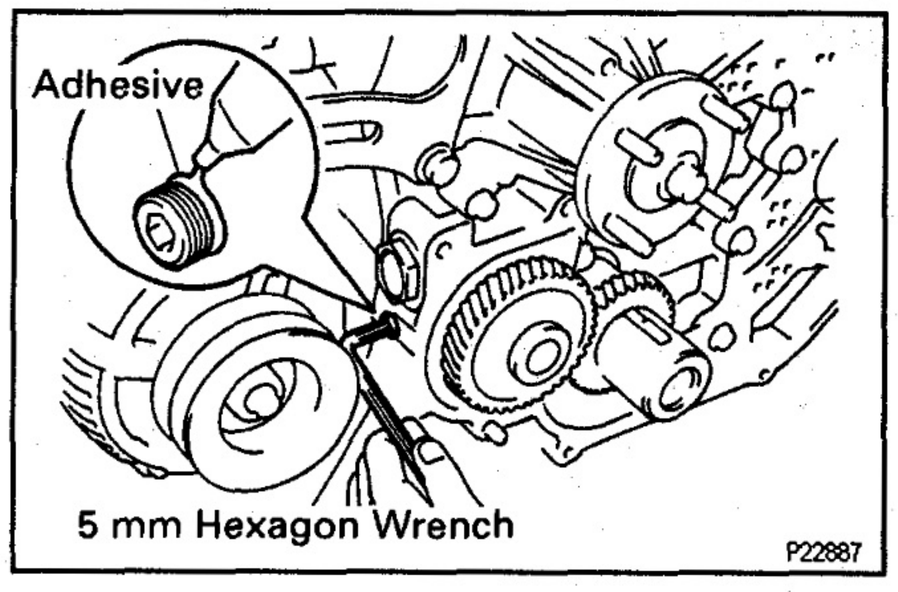




(d) install a new O—ring to the injection pump.
(e) Install the timing gear case to the cylinder block with the 7 bolts. Uniformly tighten the bolts in several passes.
Torque: 19.6 N·m (200 kgf·cm, 14 ft·lbf)
(f) Install the 2 nuts holding the injection pump to the timing gear case.
Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)



3. POUR ENGINE OIL INTO OIL PUMP
(a) Using a 5 mm hexagon wrench, remove the taper screw plug.
(b) Pour in approx. 10 cc (0.6 cu in.) of engine oil into the oil pump.



(c) Apply adhesive to 2 or 3 threads of the taper screw plug.
Adhesive:
Part No. 08833—00080, THREE BOND 1344, LOCTITE 242 or equivalent
(d) Using a 5 mm hexagon wrench, install the taper screw plug.

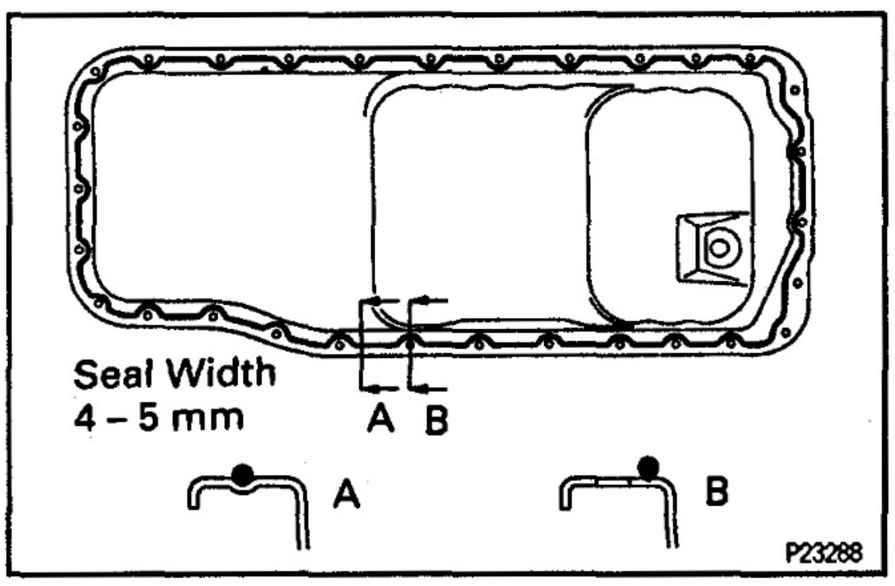
4. INSTALL WATER OUTLET
(See step 15 in cylinder head installation in Engine Mechanical)

5. INSTALL OIL PAN

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the oil pan and cylinder block.

- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Using a non—residue solvent, clean both sealing surfaces.

NOTICE: Do not use a solvent which will affect the painted surfaces.



(b) Apply seal packing to the oil pan as shown in the illustration.

Seal packing:

Part No. 08826—00080 or equivalent

- Install a nozzle that has been cut to a 4 — 5 mm (0.16 — 0.20 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

(c) Install the oil pan with the 27 bolts and 3 nuts. Uniformly tighten the bolts and nuts in several passes.

Torque: 9.8 N·m (100 kgf·cm, 87 in.·lbf)

6. INSTALL TIMING GEARS
(See steps 2 to 13 in timing gears installation in Engine Mechanical)

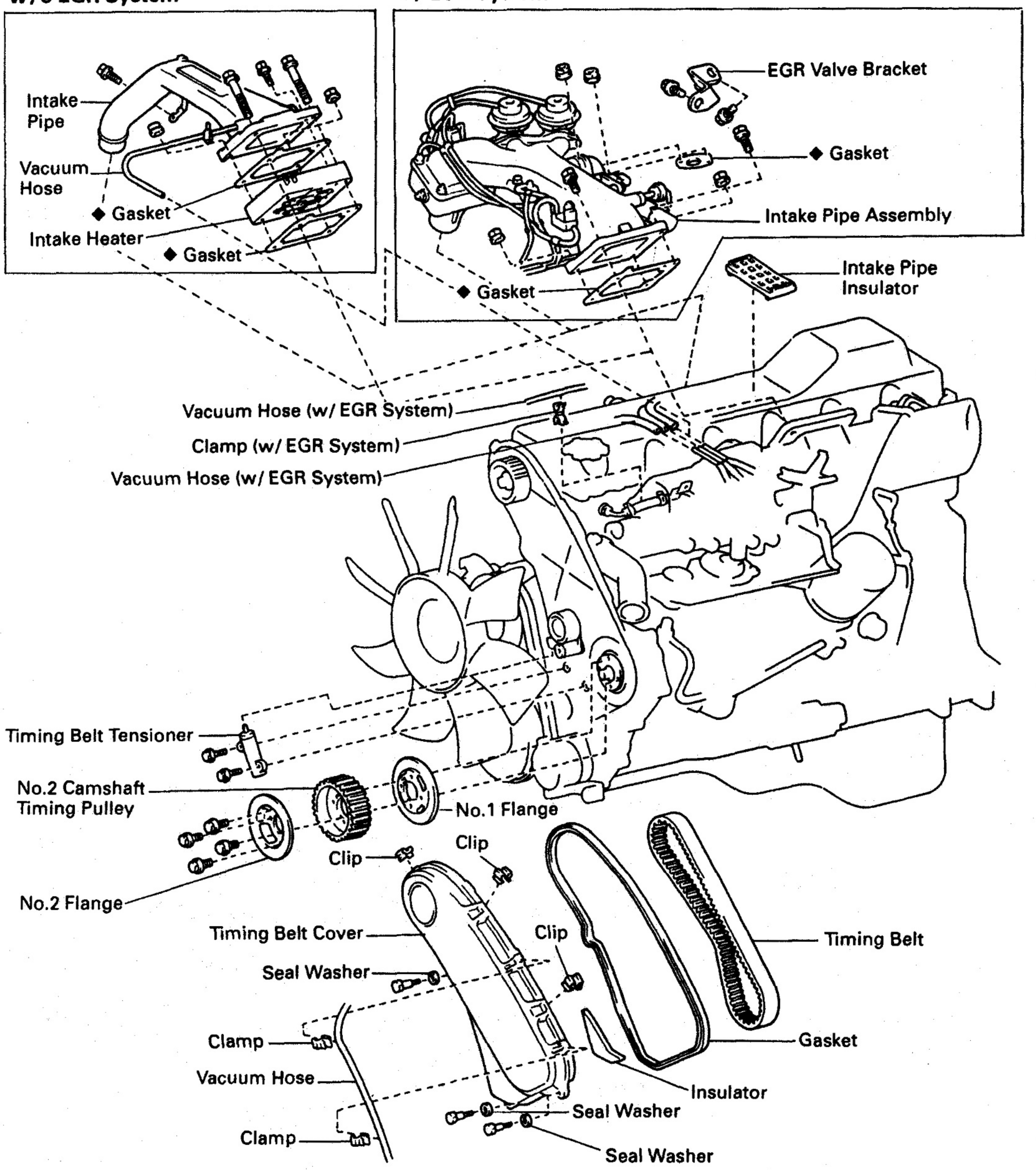
7. FILL WITH ENGINE OIL

8. FILL WITH ENGINE COOLANT

9. START ENGINE AND CHECK FOR OIL LEAKS

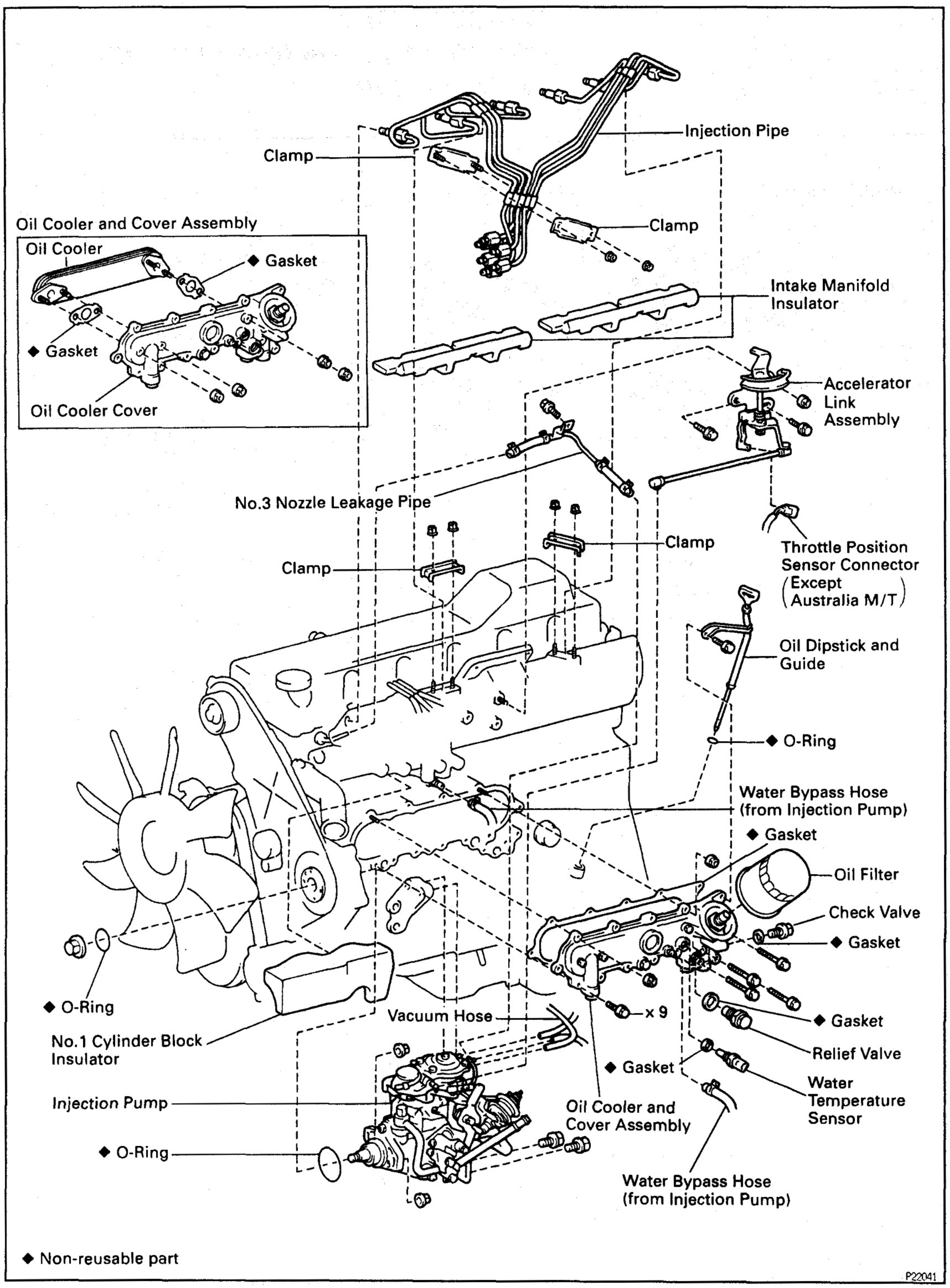
10. RECHECK ENGINE OIL LEVEL

OIL COOLER
COMPONENTS FOR REMOVAL AND INSTALLATION



◆ Non-reusable part

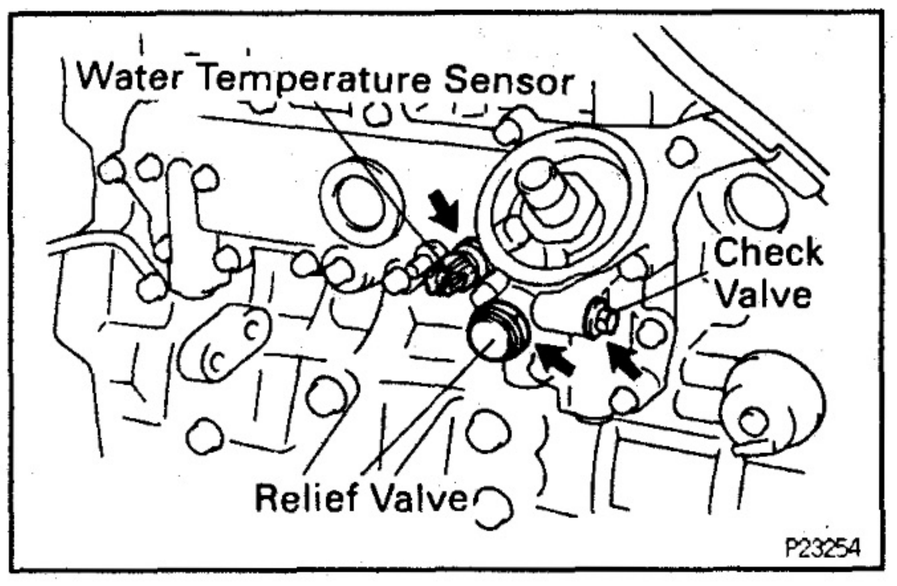
P22051


Injection Pipe
Clamp
Clamp
Oil Cooler and Cover Assembly
Oil Cooler
◆ Gasket
◆ Gasket
Oil Cooler Cover
Intake Manifold Insulator
Accelerator Link Assembly
No.3 Nozzle Leakage Pipe
Clamp
Clamp
Throttle Position Sensor Connector (Except Australia M/T)
Oil Dipstick and Guide
◆ O-Ring
Water Bypass Hose (from Injection Pump)
◆ Gasket
Oil Filter
Check Valve
◆ Gasket
x 9
◆ Gasket
Relief Valve
Water Temperature Sensor
◆ Gasket
Oil Cooler and Cover Assembly
Water Bypass Hose (from Injection Pump)
◆ O-Ring
Vacuum Hose
No.1 Cylinder Block Insulator
Injection Pump
◆ O-Ring
◆ Non-reusable part
P22041

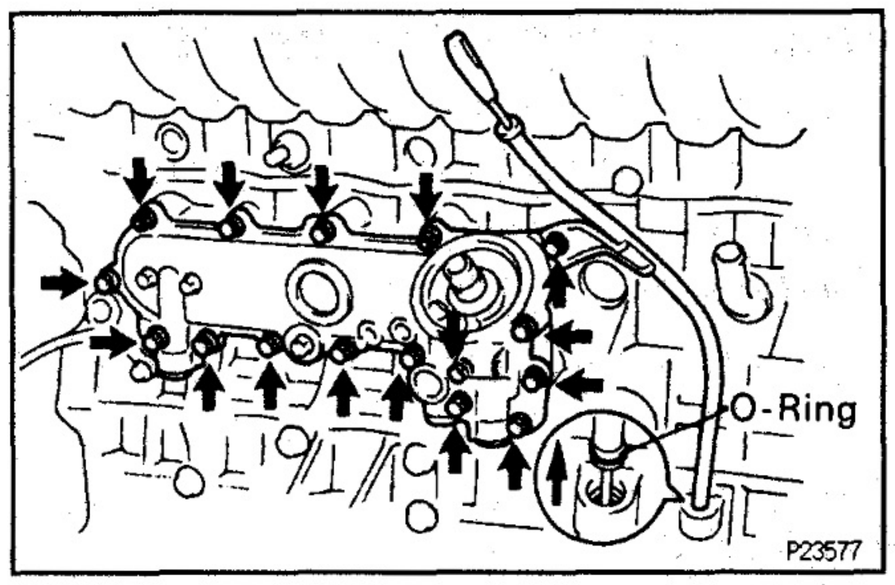
EG5T6-01

OIL COOLER REMOVAL

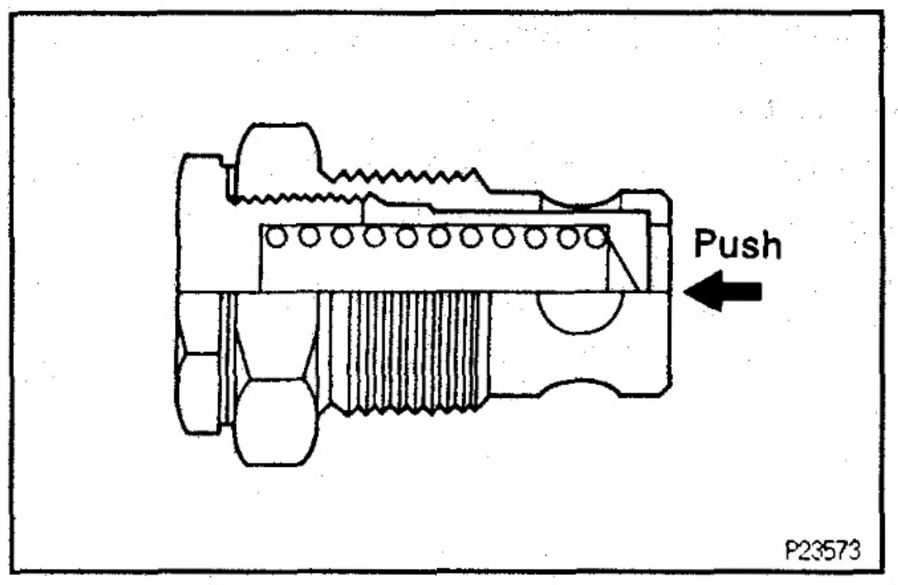
1. **DRAIN ENGINE COOLANT**
2. **REMOVE TIMING BELT**
   (See steps 1 to 3 in timing belt removal in Engine Mechanical)
3. **REMOVE NO.2 CAMSHAFT TIMING PULLEY**
   (See step 5 in timing belt removal in Engine Mechanical)
4. **REMOVE INJECTION PIPES**
   (See steps 3 and 5 in injection nozzles removal in Fuel System)
5. **REMOVE INJECTION PUMP**
   (See steps 5 to 7 in injection pump removal in Fuel System)
6. **REMOVE OIL FILTER**
   (See step 2 in oil and filter replacement)



7. **REMOVE RELIEF VALVE**
   Remove the relief valve and gasket.
8. **REMOVE CHECK VALVE**
   Remove the check valve and gasket.
9. **REMOVE WATER TEMPERATURE SENSOR**
   Remove the sensor and gasket.



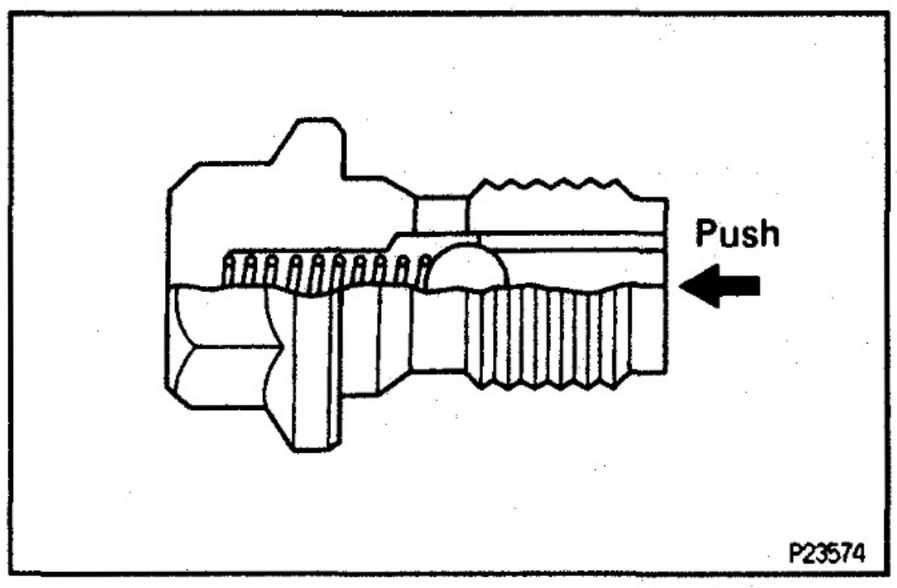
10. **REMOVE OIL DIPSTICK AND GUIDE**
    (a) Remove the bolt, and pull out the dipstick guide together with the dipstick from the oil pan.
    (b) Remove the O—ring from the dipstick guide.
11. **REMOVE OIL COOLER AND COVER ASSEMBLY**
    Remove the 13 bolts, 2 nuts, the oil cooler, cover assembly and gasket.
12. **REMOVE OIL COOLER FROM OIL COOLER COVER**



EG5T6-01

OIL COOLER AND RELIEF VALVE INSPECTION

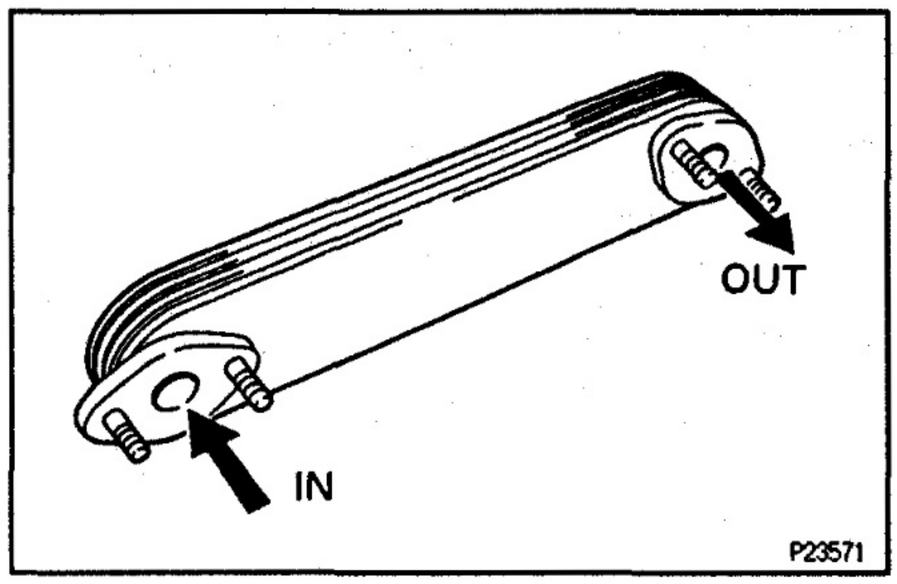
1. **INSPECT RELIEF VALVE**
   Push the valve with a wooden stick to check if it is stuck.
   If stuck, replace the relief valve.



2. INSPECT CHECK VALVE

Push the valve with a wooden stick to check if it is stuck.

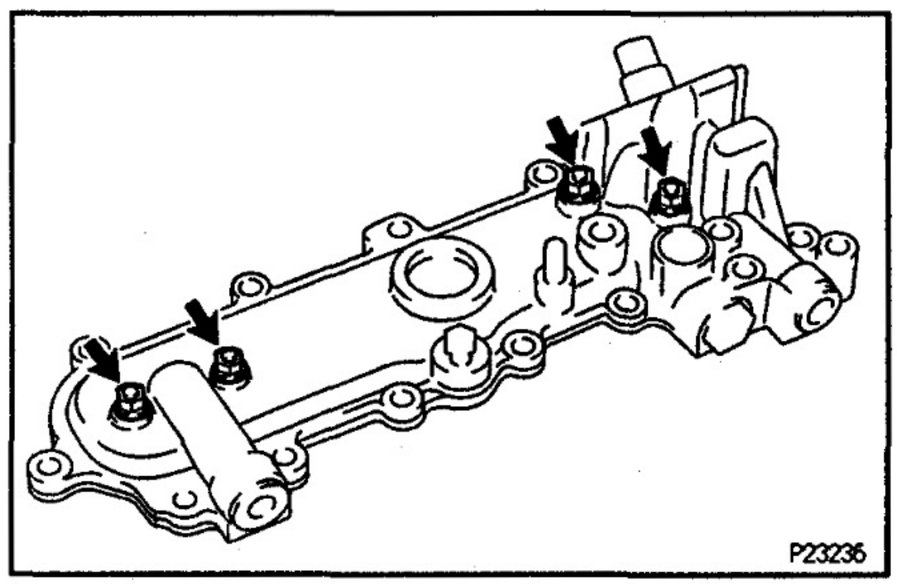
If stuck, replace the check valve.



3. INSPECT OIL COOLER

Check the oil cooler for damage or clogging.

If necessary, replace the oil cooler.



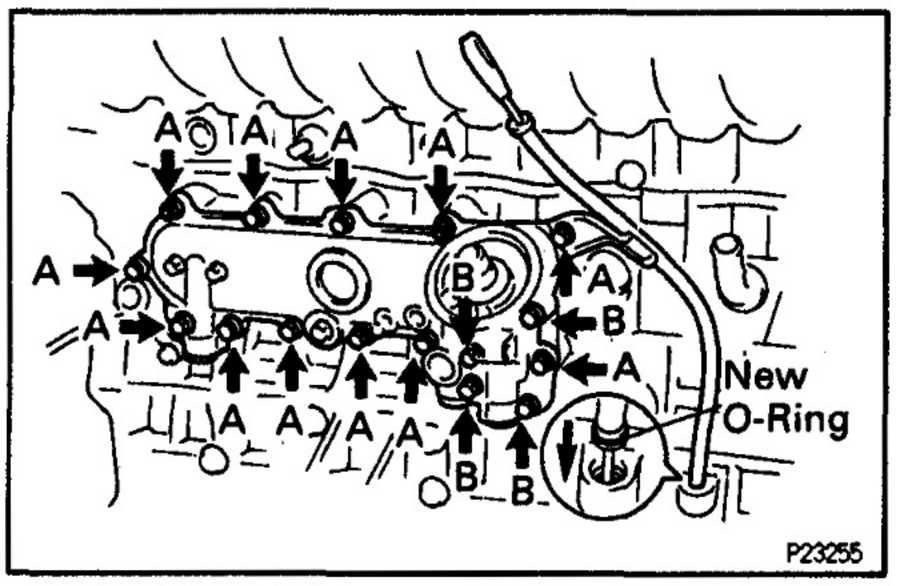
OIL COOLER INSTALLATION

E0577-01

1. INSTALL OIL COOLER TO OIL COOLER COVER

Install 2 new gaskets and the oil cooler to the oil cooler cover with the 4 nuts.

Torque: 15.7 N·m (160 kgf·cm, 12 ft·lbf)



2. INSTALL OIL COOLER AND COVER ASSEMBLY

Install a new gasket, the oil cooler and cover assembly with the 13 bolts and 2 nuts. Uniformly tighten the bolts and nuts in several passes.

Torque: 19.6 N·m (200 kgf·cm, 14 ft·lbf)

HINT: Each bolt length is indicated in the illustration.

Bolt length:

A 20 mm (0.78 in.)

B 40 mm (1.57 in.)

3. INSTALL OIL DIPSTICK GUIDE AND OIL DIPSTICK

(a) Install a new O–ring to the dipstick guide.

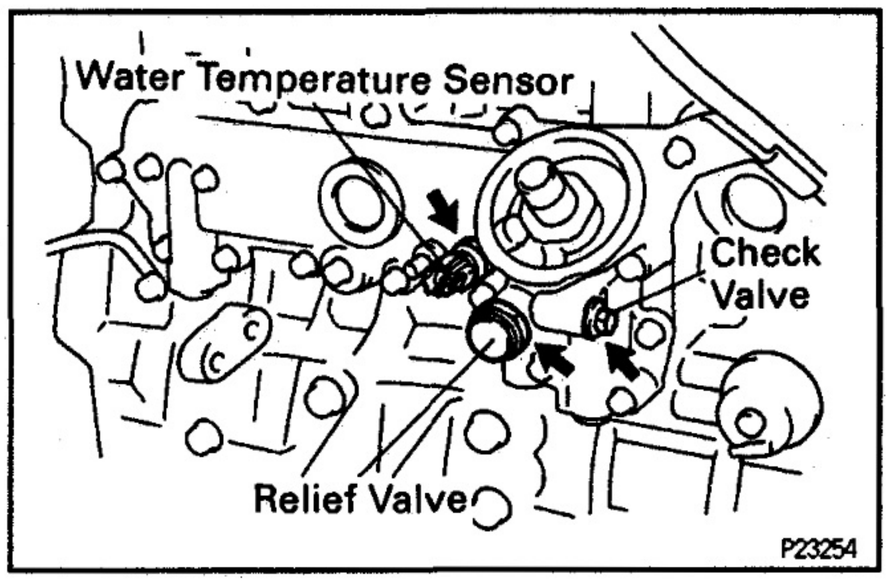
(b) Apply soapy water to the O–ring.

(c) Push in the dipstick guide end into the guide hole of the cylinder block.

(d) Install the oil dipstick guide with the bolt.

Torque: 19.6 N·m (200 kgf·cm, 14 ft·lbf)

(e) Install the dipstick.

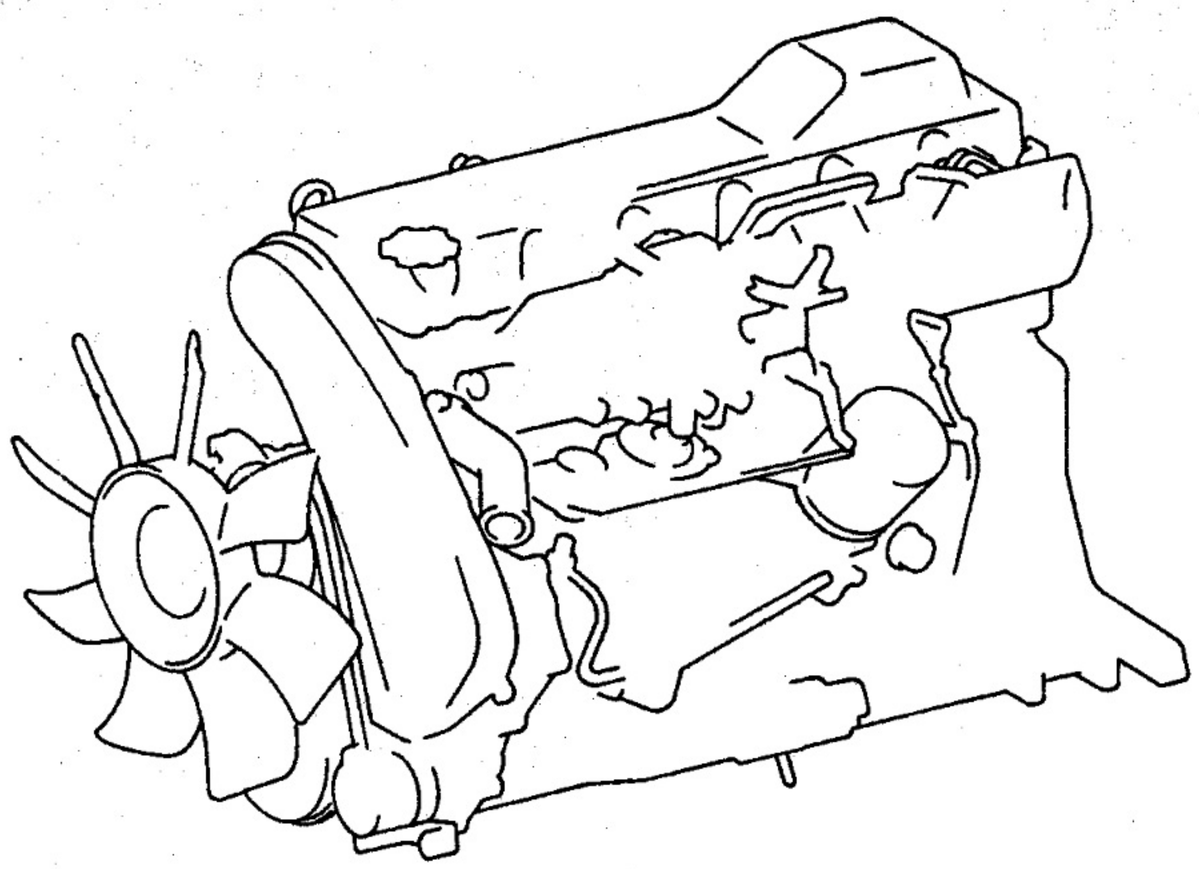


4. **INSTALL RELIEF VALVE**
   Install a new gasket and the relief valve.
   Torque: 39 N·m (400 kgf·cm, 29 ft·lbf)
5. **INSTALL CHECK VALVE**
   Install a new gasket and the check valve.
   Torque: 27 N·m (275 kgf·cm, 20 ft·lbf)
6. **INSTALL WATER TEMPERATURE SENSOR**
   Install a new gasket and the sensor.
   Torque: 19.6 N·m (200 kgf·cm, 14 ft·lbf)
7. **INSTALL OIL FILTER**
   (See step 2 in oil and filter replacement)
8. **INSTALL INJECTION PUMP**
   (See steps 1 to 3 in injection pump installation in Fuel System)
9. **INSTALL INJECTION PIPES**
   (See steps 3 and 5 in injection nozzle installation in Fuel System)
10. **INSTALL NO.2 CAMSHAFT TIMING PULLEY**
    (See step 3 in timing belt installation in Engine Mechanical)
11. **INSTALL TIMING BELT**
    (See steps 5 to 10 in timing belt installation in Engine Mechanical)
12. **FILL WITH ENGINE COOLANT**
13. **START ENGINE AND CHECK FOR LEAKS**
14. **CHECK ENGINE OIL LEVEL**

OIL NOZZLE

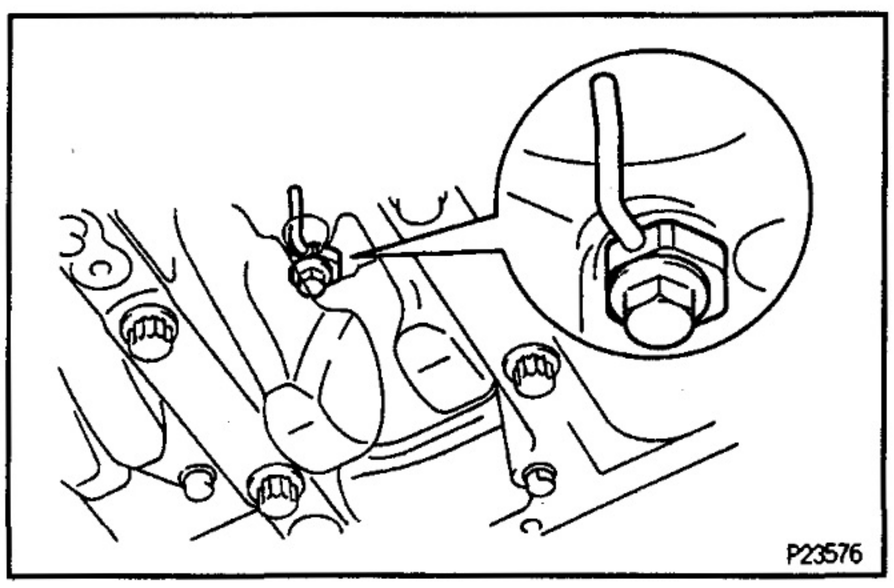
COMPONENTS FOR REMOVAL AND INSTALLATION

E02K2-06



E02K3-07

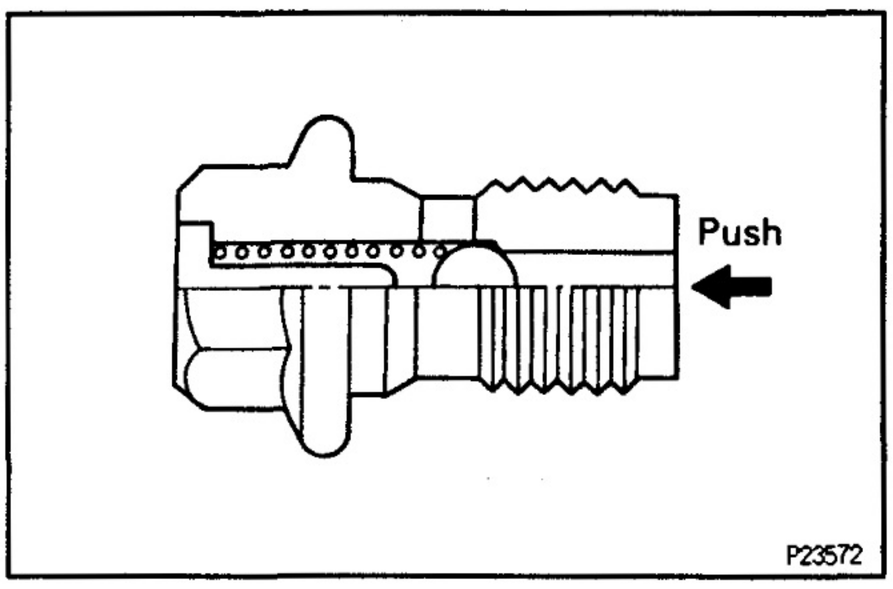
OIL NOZZLES REMOVAL



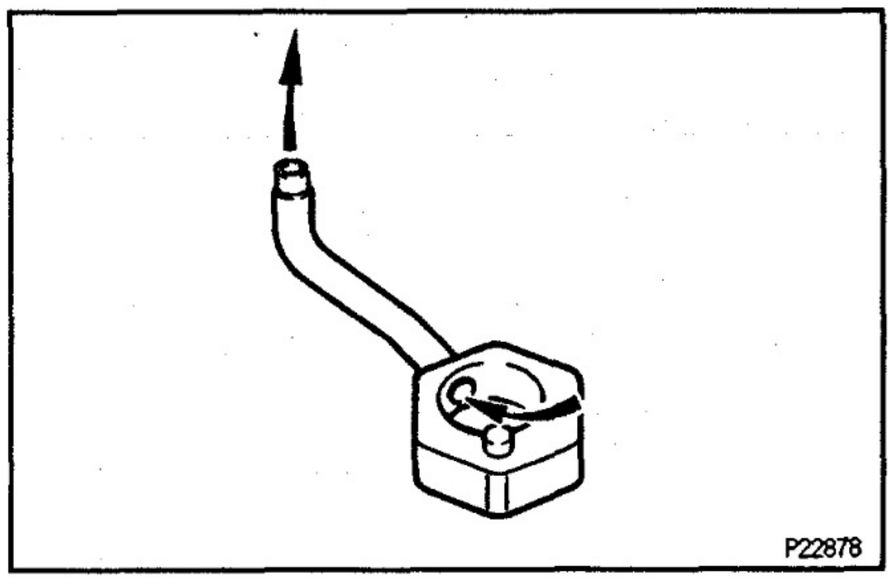
1. **REMOVE OIL PAN**
   (See steps 1 and 4 in oil pump removal)
2. **REMOVE CHECK VALVE AND OIL NOZZLES**
   Remove the 6 check valves and 6 oil nozzles.

E02SG-02

OIL NOZZLES INSPECTION

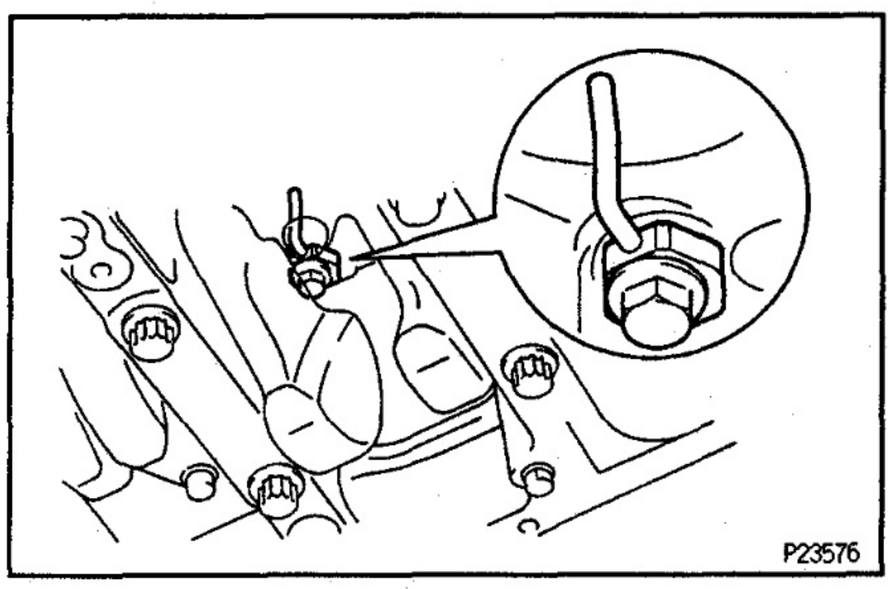


1. **INSPECT CHECK VALVES**
   Push the valve with a wooden stick to check if it is stuck.
   If stuck, replace the check valve.



2. INSPECT OIL NOZZLES

Check the oil nozzles for damage or clogging.
If necessary, replace the oil nozzle.



EG9T9-01

OIL NOZZLES INSTALLATION

1. INSTALL OIL NOZZLES AND CHECK VALVES

(a) Align the pin of the oil nozzle with the pin hole of the cylinder block.

(b) Install the oil nozzle with the check valve. Install the 6 oil nozzles and 6 check valves.
Torque: 27 N·m (275 kgf·cm, 20 ft·lbf)

2. INSTALL OIL PAN

(See steps 5, 7, 9 and 10 in oil pump installation)

SERVICE SPECIFICATIONS

SERVICE DATA

EG15A-0K

Oil pressure		at idle speed	29 kPa (0.3 kgf/cm², 43 psi) or more
		at 3,000 rpm	250 – 600 kPa (2.5 – 6.1 kgf/cm², 36 – 87 psi)
Oil pump	Tip clearance	STD	0.080 – 0.160 mm (0.0031 – 0.0063 in.)
		Maximum	0.21 mm (0.0083 in.)
	Body clearance	STD	0.100 – 0.170 mm (0.0039 – 0.0067 in.)
		Maximum	0.20 mm (0.0079 in.)
	Side clearance	STD	0.030 – 0.090 mm (0.0012 – 0.0035 in.)
		Maximum	0.15 mm (0.0059 in.)

TORQUE SPECIFICATIONS

EG15C-0R

Part tightened	N·m	kgf·cm	ft·lbf
Drain plug x Oil pan	34.3	350	25
Relief valve x Timing gear case	42	425	31
Oil strainer x Main bearing cap	8.8	90	78 in.·lbf
Timing gear case x Cylinder block, Main bearing cap	19.6	200	14
Injection pump x Timing gear case	18	185	13
Oil pan x Main bearing cap, Timing gear case, Rear oil seal retainer	9.8	100	87 in.·lbf
Oil cooler cover x Oil cooler	15.7	160	12
Oil cooler cover, Oil dipstick guide x Cylinder block	19.6	200	14
Relief valve x Oil cooler cover	39	400	29
Check valve x Oil cooler cover	27	275	20
Water temperature sensor x Oil cooler cover	19.6	200	14
Oil nozzle x Cylinder block	27	275	20

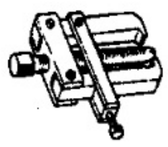
STARTING SYSTEM

PREPARATION ..... ST– 2
PRE–HEATING SYSTEM ..... ST– 3
STARTER ..... ST– 8
STARTER RELAY ..... ST– 18
VOLTAGE CONVERTER TIMER ..... ST– 19
(w/ 24 V Starter)
VOLTAGE CONVERTER RELAY ..... ST– 20
(w/ 24 V Starter)
24 V HOLD WARNING RELAY ..... ST– 21
(w/ 24 V Starter)
SERVICE SPECIFICATIONS ..... ST– 22

PREPARATION

SST (SPECIAL SERVICE TOOLS)

ST00S-0M

	09286-46011	Injection Pump Spline Shaft Puller	
	09820-00030	Alternator Rear Bearing Replacer	Armature rear bearing

ST

RECOMMENDED TOOLS

ST00T-0H

	09082-00050	TOYOTA Electrical Tester Set.	

EQUIPMENT

ST00U-0D

Dial indicator	Commutator
Magnetic finger	
Pull scale	Brush spring
Sandpaper	Commutator
Torque wrench	
V-block	
Vernier calipers	Commutator, Brush

PRE—HEATING SYSTEM

ON—VEHICLE INSPECTION

ST08Q—02

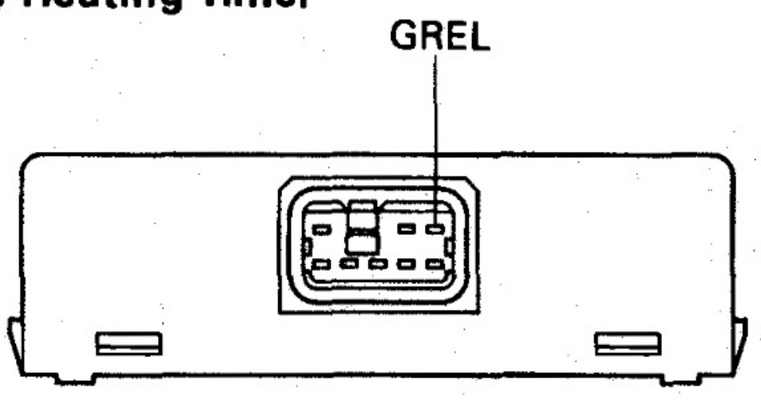
HINT: Refer to Diesel Electrical System Diagnosis for inspection procedures.
(See troubleshooting in Engine Mechanical)

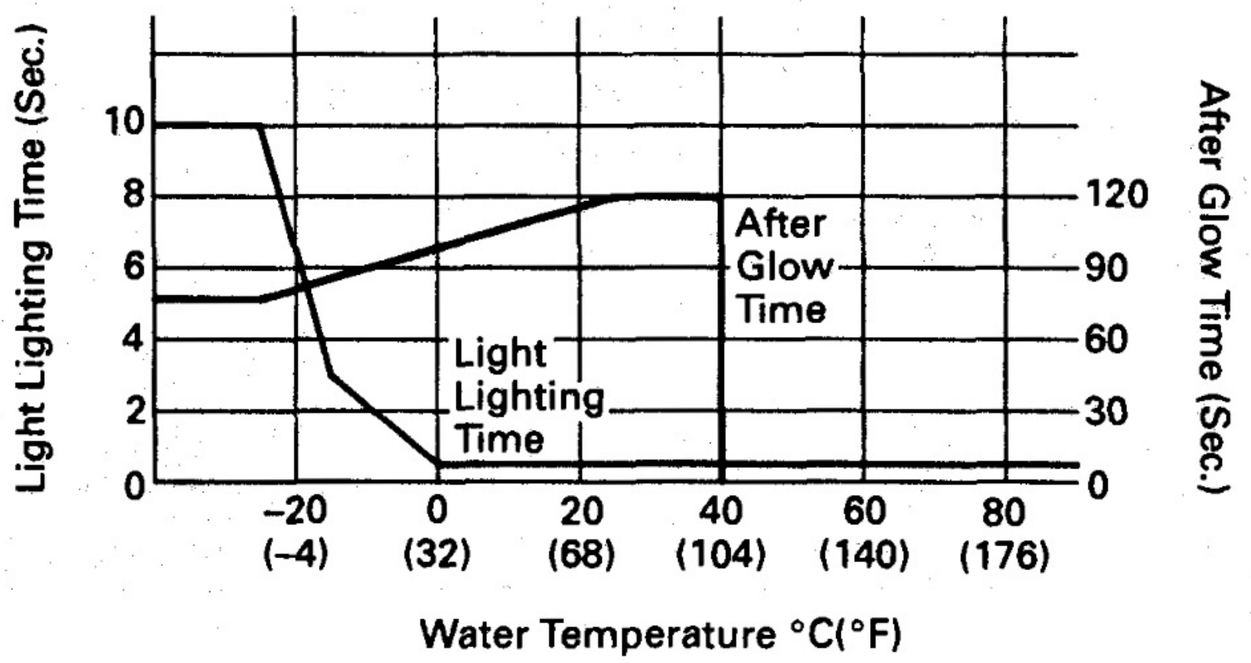
1. **INSPECT LIGHTING TIME OF INTAKE HEATER INDICATOR LIGHT**
   Turn the ignition switch "ON", measure the lighting time.
   Light lighting time: Refer to the chart graph

2. **INSPECT AFTER GLOW**
   Turn the ignition switch "ON", measure the time battery voltage is applied to terminal GREL of the pre—heating timer or emission ECU.
   After glow time: Refer to the chart graph

w/ EGR System
Emission ECU

w/o EGR System
Pre-Heating Timer





P23526
P22973 P22974

Z15322

PRE—HEATING TIMER OR EMISSION ECU INSPECITON

ST08R—02

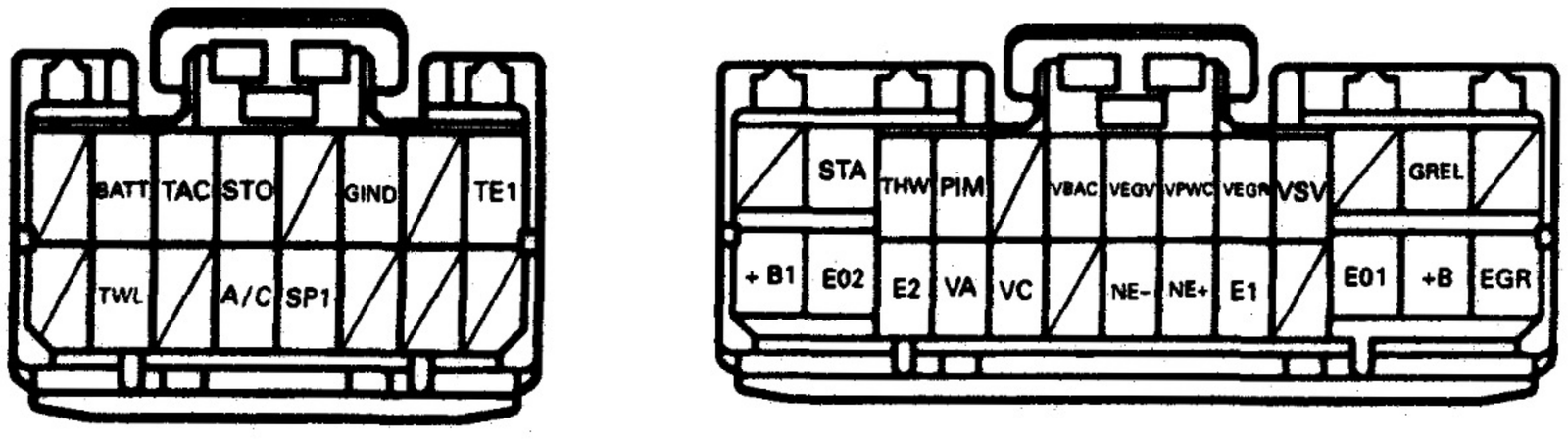
1. **DISCONNECT PRE—HEATING TIMER OR EMISSION ECU CONNECTOR(S)**
   LOCATION: Under the instrument panel on the passenger seat.

2. INSPECT PRE–HEATING TIMER OR EMISSION ECU CIRCUIT

Check the connector on the wire harness side as shown in these chart:

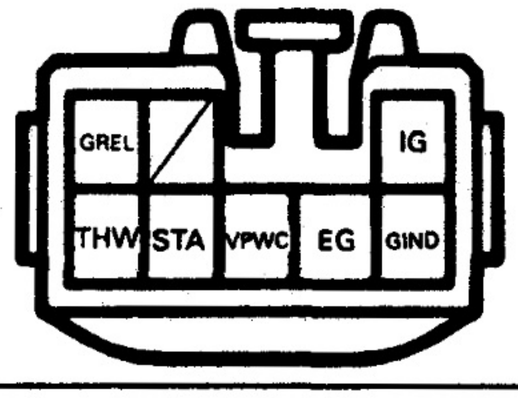
Check for	Tester connection	Condition	Specified value
Voltage*1	BATT – Ground	–	Battery voltage
Voltage	GIND – Ground	Ignition switch OFF	No voltage
		Ignition switch ON	Battery voltage
Voltage*1	+B, +B1 – Ground	Ignition switch OFF	No voltage
		Ignition switch ON	Battery voltage
Voltage*2	IG – Ground	Ignition switch OFF	No voltage
		Ignition switch ON	Battery voltage
Voltage	STA – Ground	Ignition switch OFF	No voltage
		Ignition switch START	Battery voltage
Voltage	VPWC – Ground	Ignition switch OFF	No voltage
		Ignition switch ON	Battery voltage
Continuity	GREL – Ground	–	Continuity
Continuity*1	THW – E2	–	Continuity
Continuity*2	THW – EG	–	Continuity
Continuity*1	E1, E01, E02 – Ground	–	Continuity

w/ EGR System
Wire Harness Side of Emission ECU



n-16-1-A mn-26-1

w/o EGR System
Wire Harness Side of Pre-Heating Timer

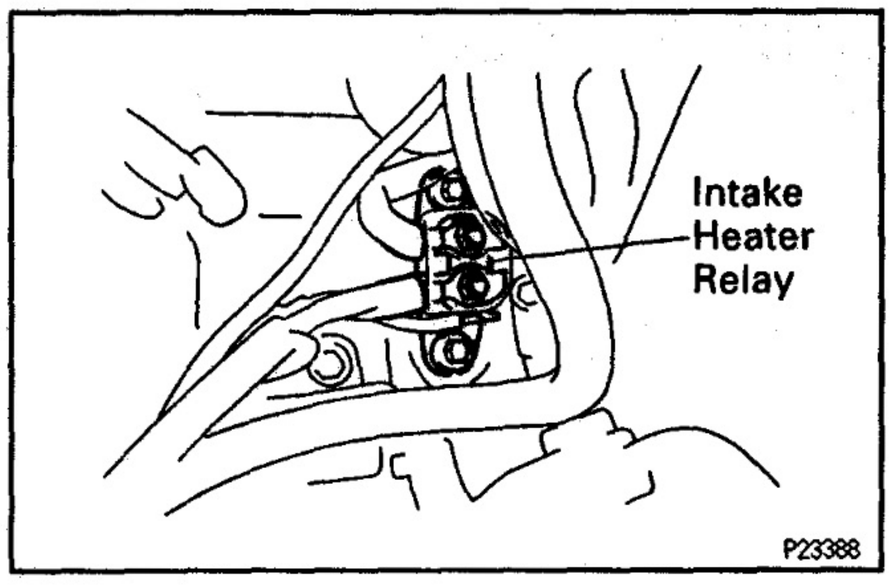


e-8-1

*1: w/ EGR System
*2: w/o EGR System

V06504

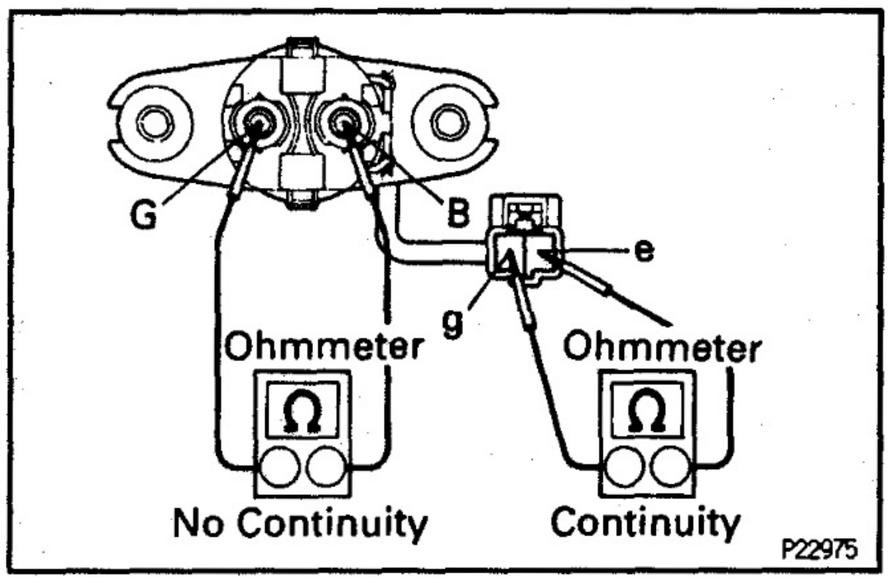
3. RECONNECT PRE–HEATING TIMER OR EMISSION ECU CONNECTOR(S)



INTAKE HEATER RELAY INSPECTION

ST0A6–01

1. REMOVE INTAKE HEATER RELAY



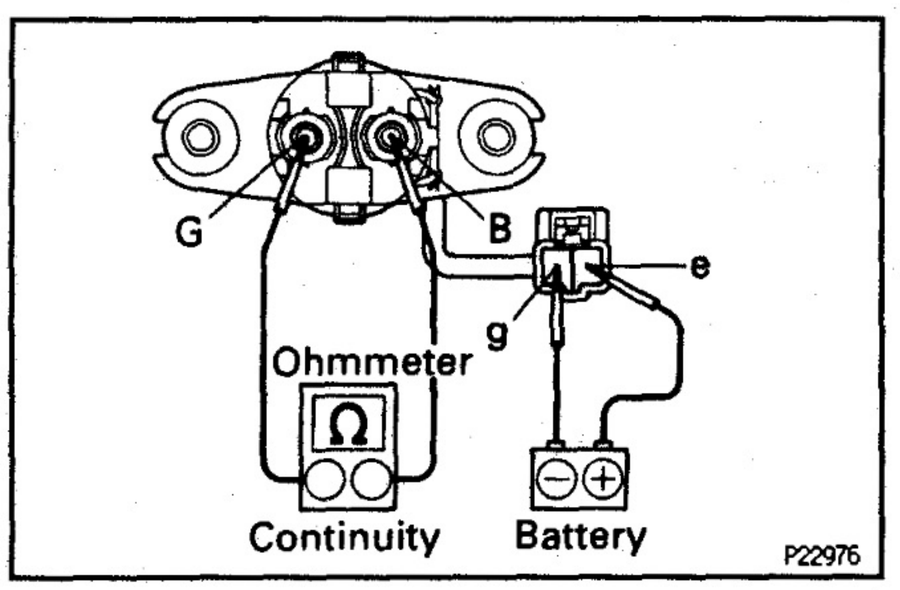
2. INSPECT INTAKE HEATER RELAY

A. Inspect relay continuity

(a) Using an ohmmeter, check that there is continuity between terminals e and g.

(b) Check that there is no continuity between terminals B and G.

If continuity is not as specified, replace the relay.



B. Inspect relay operation

(a) Apply battery voltage across terminals e and g.

(b) Using an ohmmeter, check that there is continuity between terminals B and G.

If operation is not as specified, replace the relay.

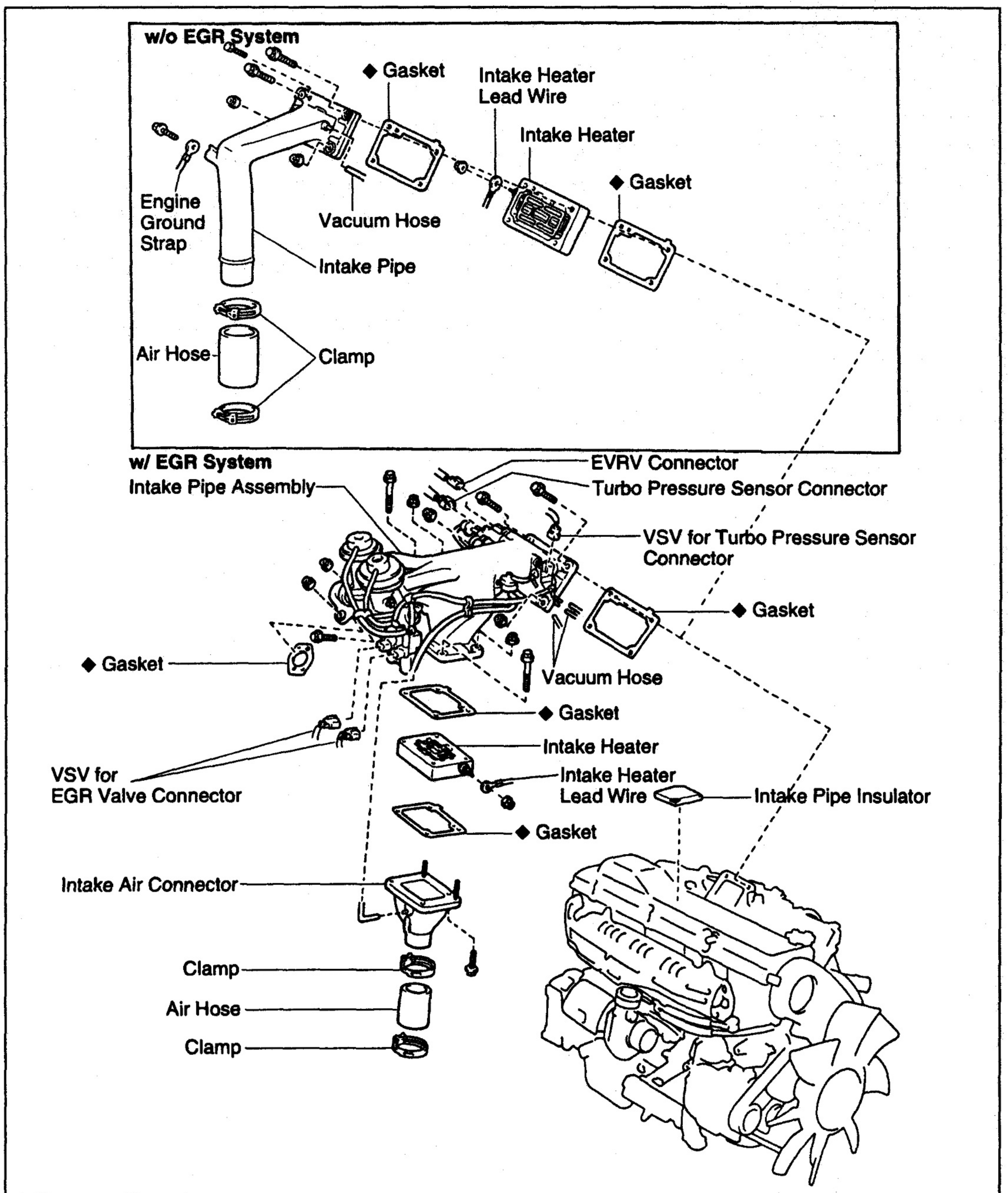
3. REINSTALL INTAKE HEATER RELAY

ST

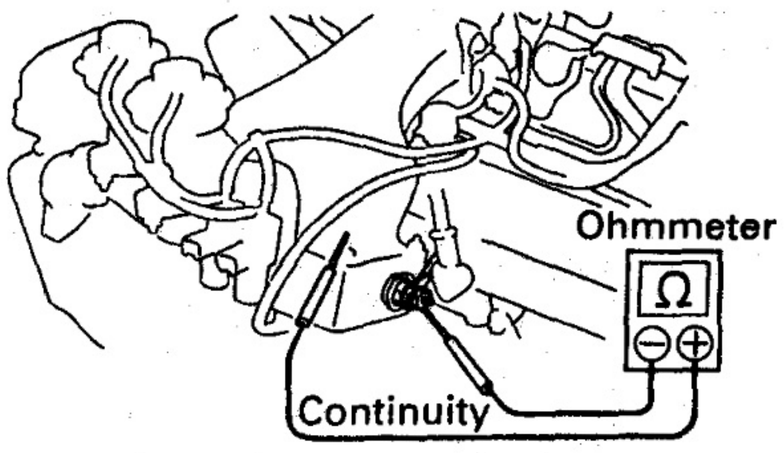
ST

INTAKE HEATER INSPECTION

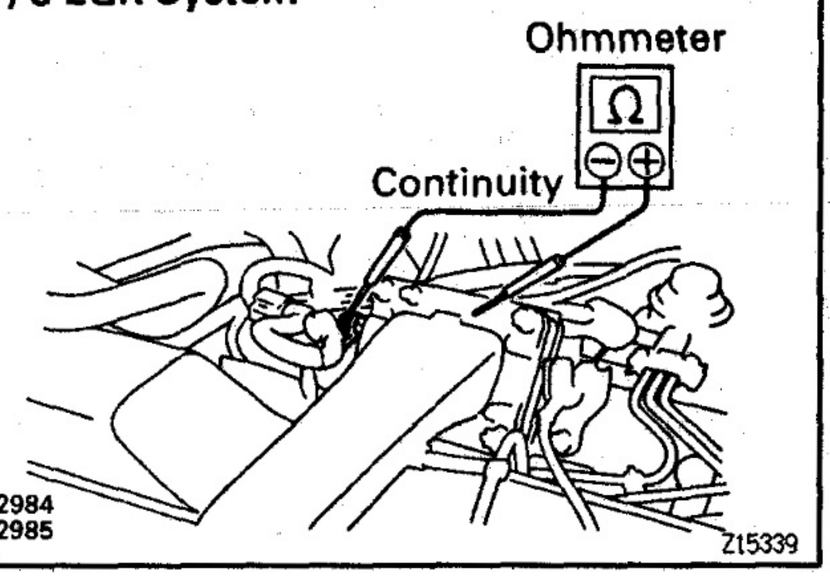
Components



w/ EGR System



w/o EGR System

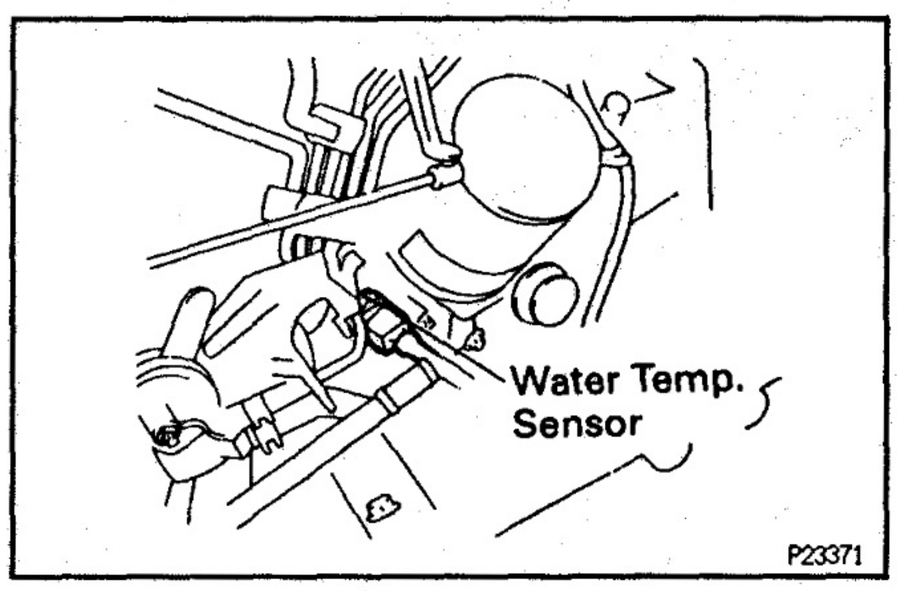


Inspection

INSPECT INTAKE HEATER

Using an ohmmeter, check that there is continuity between terminal of the intake heater and ground.
If there is no continuity, replace the intake heater.

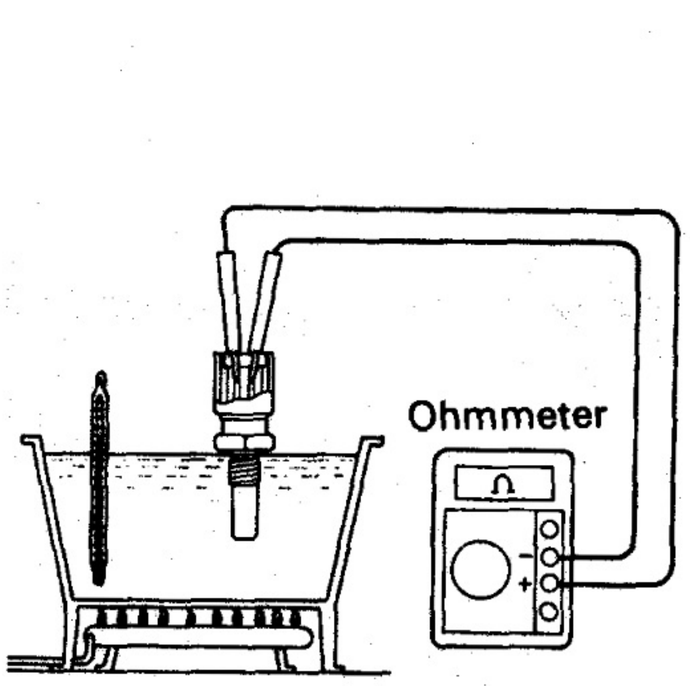
ST

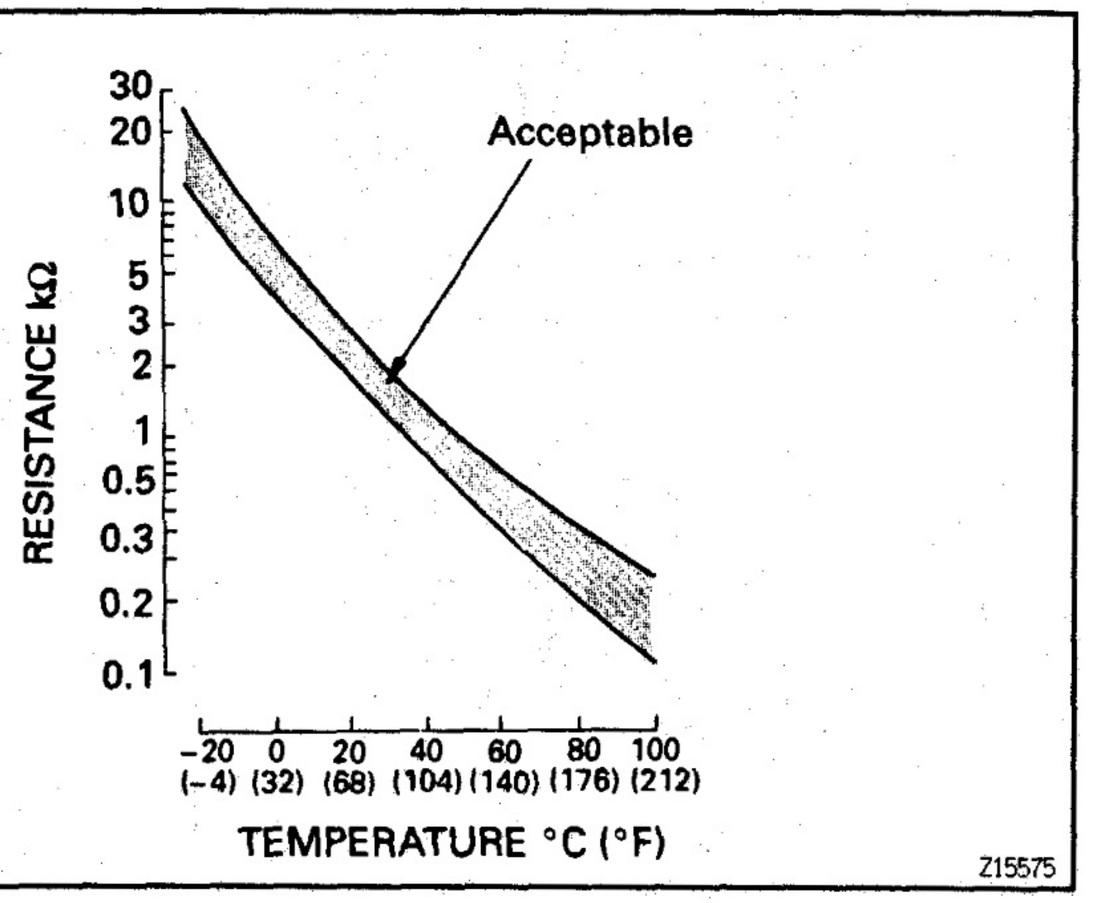


ST0A8-01

WATER TEMPERATURE SENSOR INSPECTION

1. **REMOVE WATER TEMPERATURE SENSOR**
2. **INSPECT WATER TEMPERATURE SENSOR**
   Using an ohmmeter, measure the resistance between the terminals.
   Resistance:
   Refer to the chart graph
   If the resistance is not as specified, replace the water temperature sensor.
3. **REINSTALL WATER TEMPERATURE SENSOR**



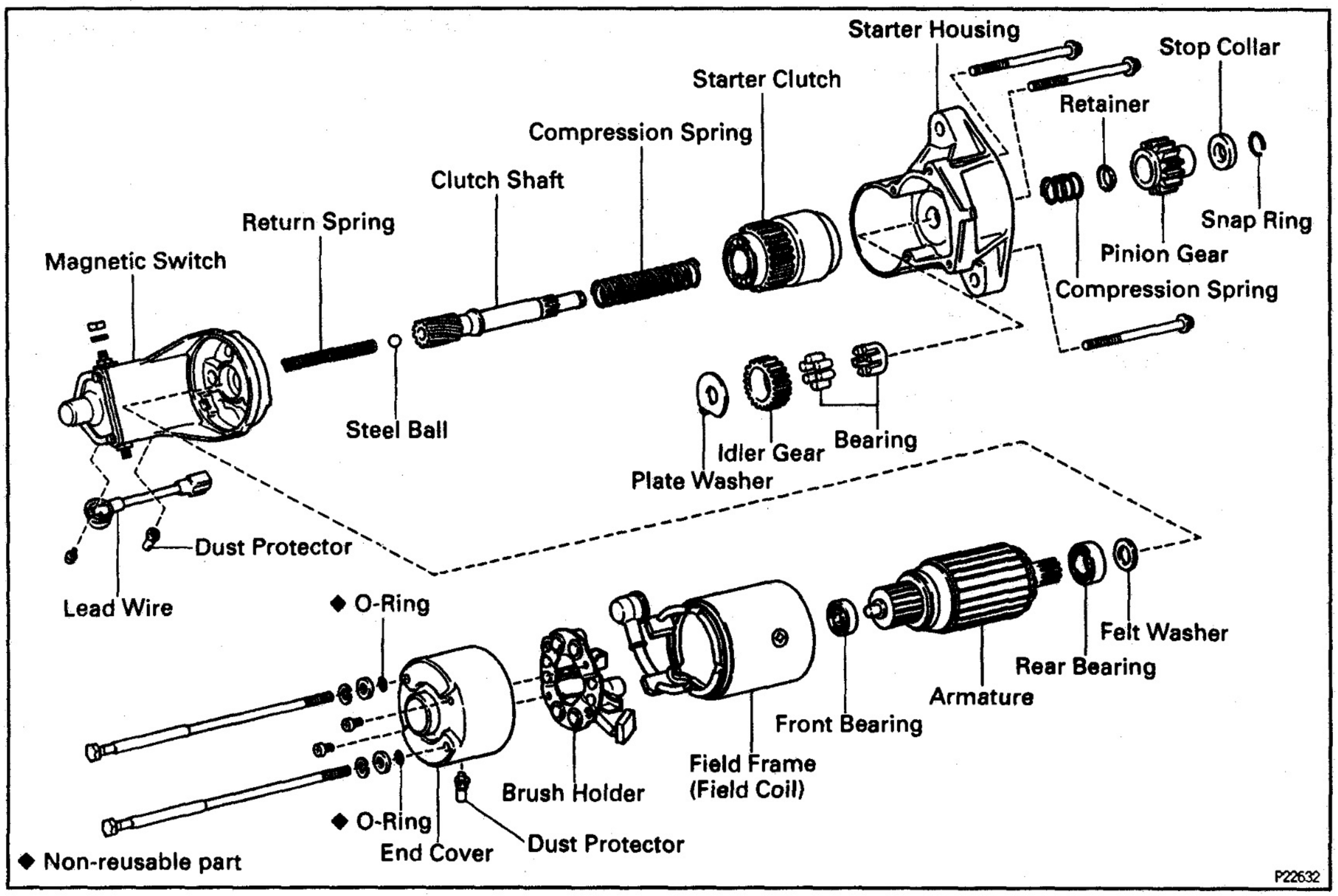


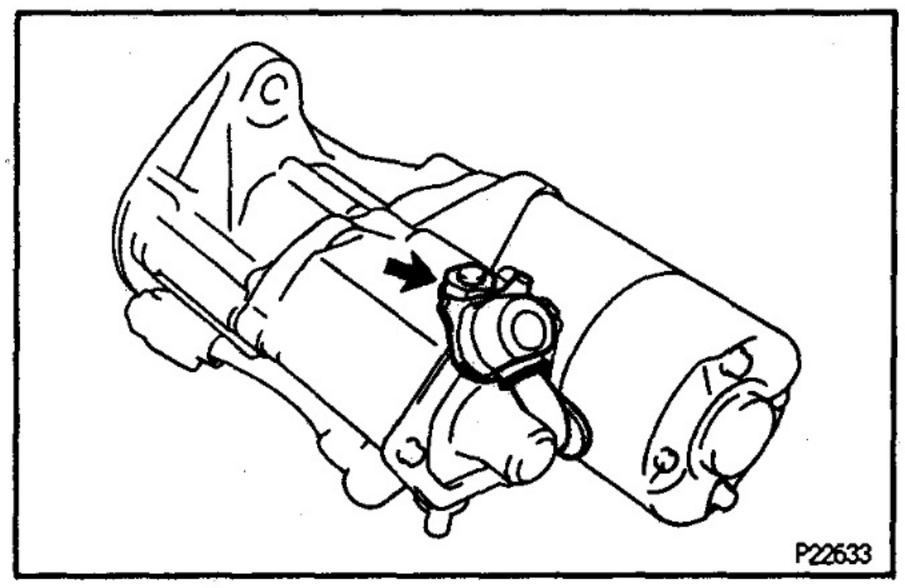
ST

STARTER

COMPONENTS FOR DISASSEMBLY AND ASSEMBLY

ST00W-10



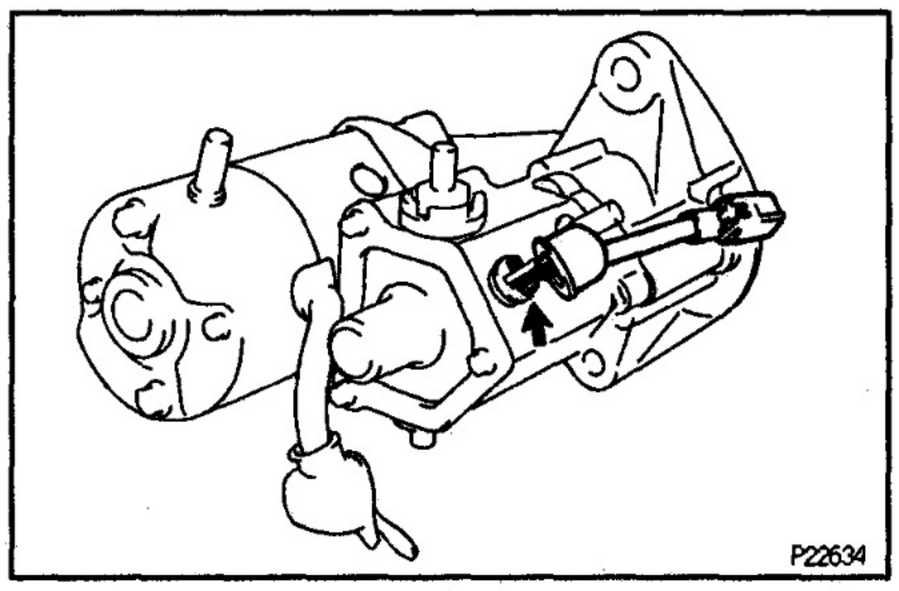


ST00V-02

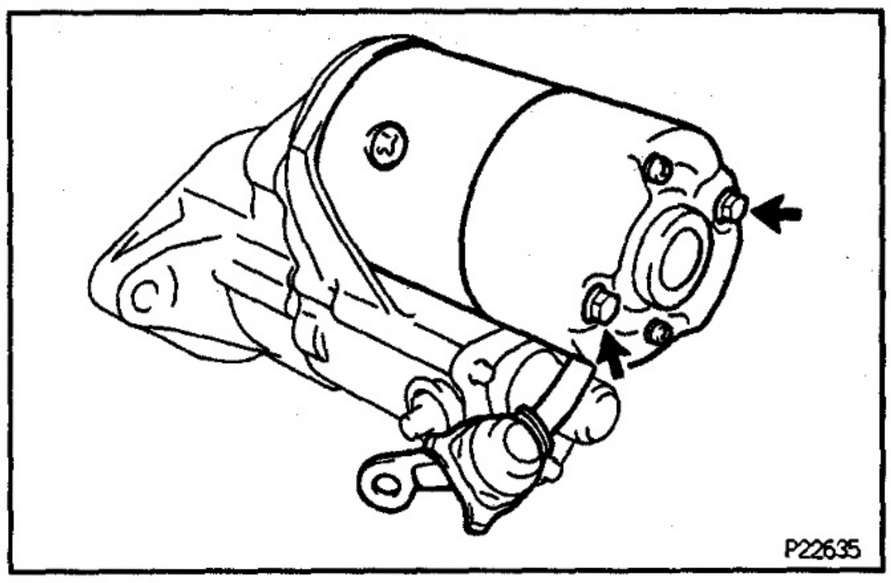
STARTER DISASSEMBLY

1. REMOVE FIELD FRAME WITH ARMATURE AND LEAD WIRE FROM MAGNETIC SWITCH

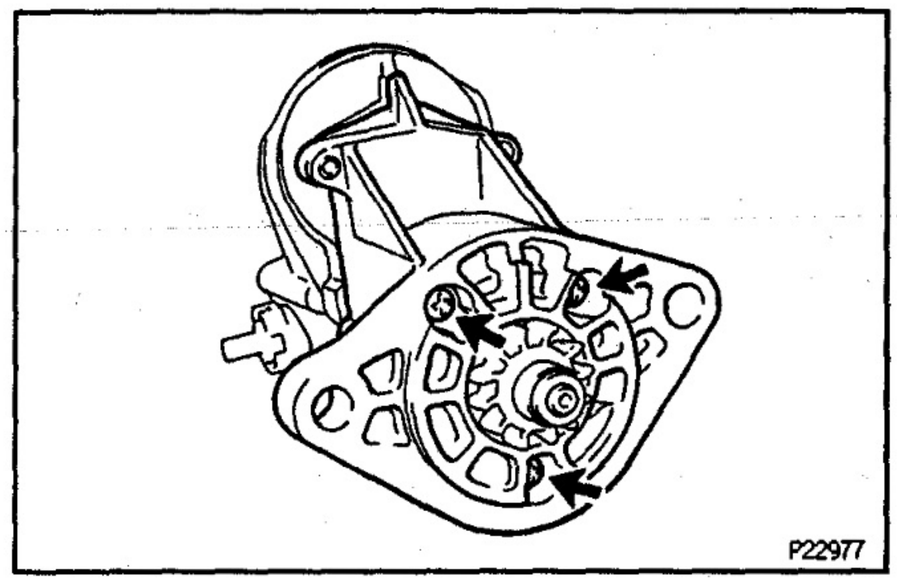
(a) Remove the nut, and disconnect lead wire from the magnetic switch terminal.



(b) Remove the screw, washer and the lead wire from the terminal 50.

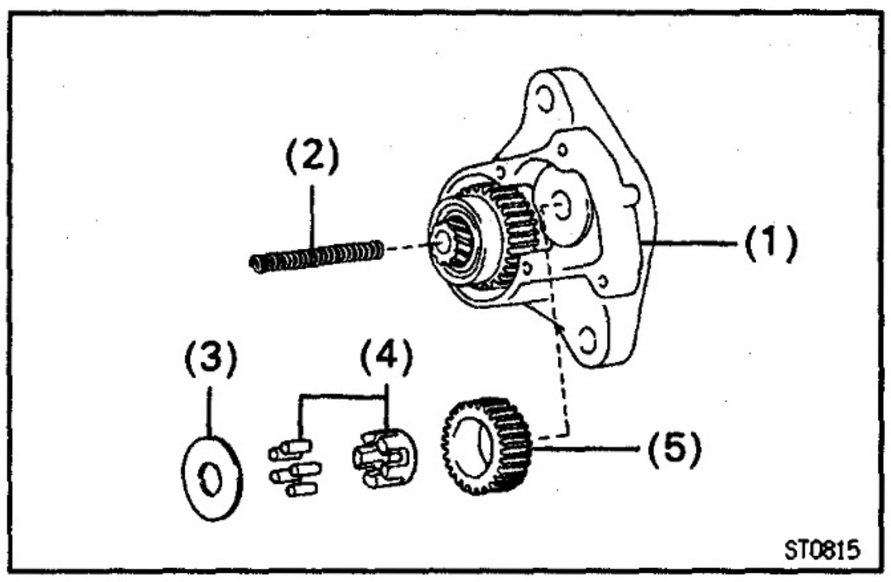


(c) Remove the 2 through bolts and spring washers.
(d) Pull out the field frame with the armature from the magnetic switch assembly.
(e) Remove the felt washer from the rear bearing.

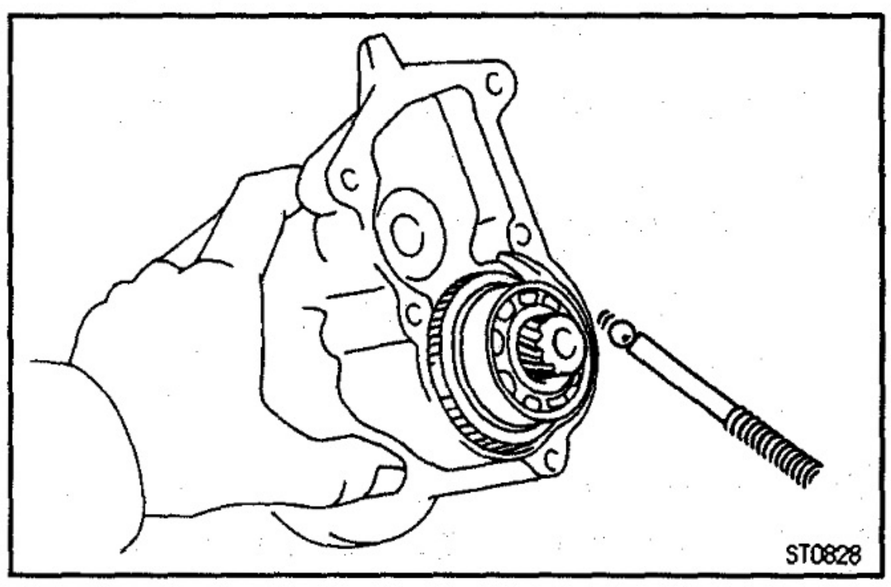


2. REMOVE STARTER HOUSING, CLUTCH ASSEMBLY AND GEARS

(a) Remove the 3 screws.

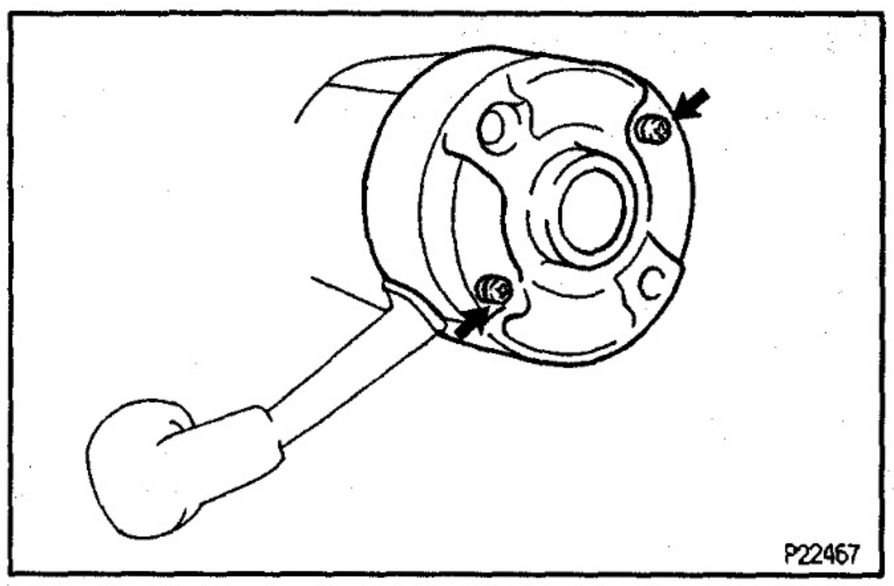


(b) Remove these parts from the magnetic switch assembly:
(1) Starter housing and clutch assembly
(2) Return spring
(3) Plate washer
(4) Idler gear
(5) Bearing



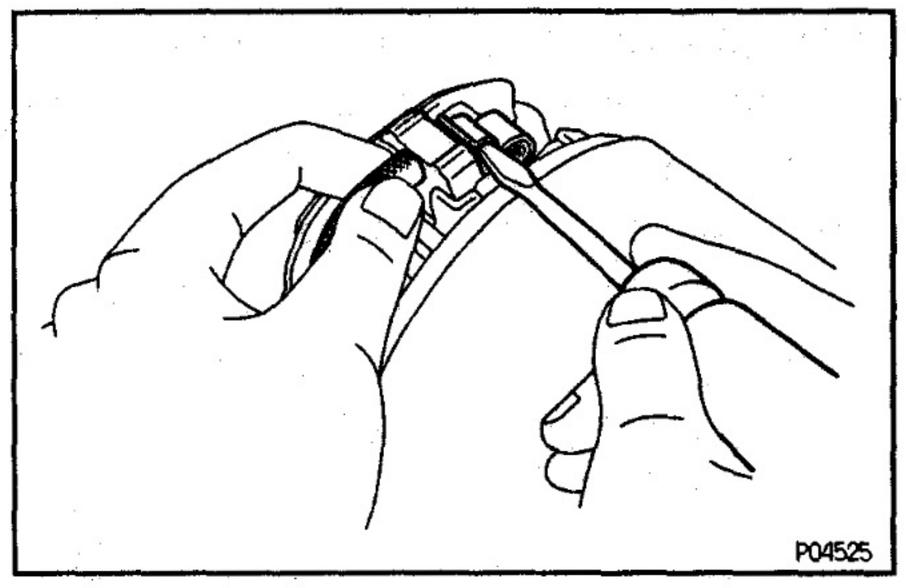
3. REMOVE STEEL BALL

Using a magnetic finger, remove the steel ball from the clutch shaft hole.



4. REMOVE BRUSH HOLDER

(a) Remove the 2 screws and end cover from the field frame.



(b) Using a screwdriver, hold the spring tank back and disconnect the brush from the brush holder.
(c) Disconnect the 4 brushes and remove the brush holder.

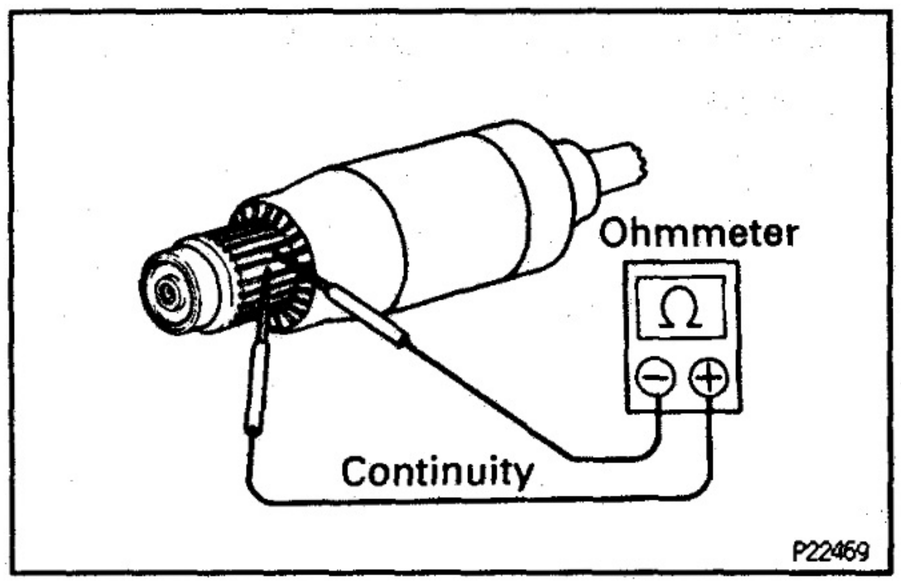
5. REMOVE ARMATURE FROM FIELD FRAME

ST

ST0A0-01

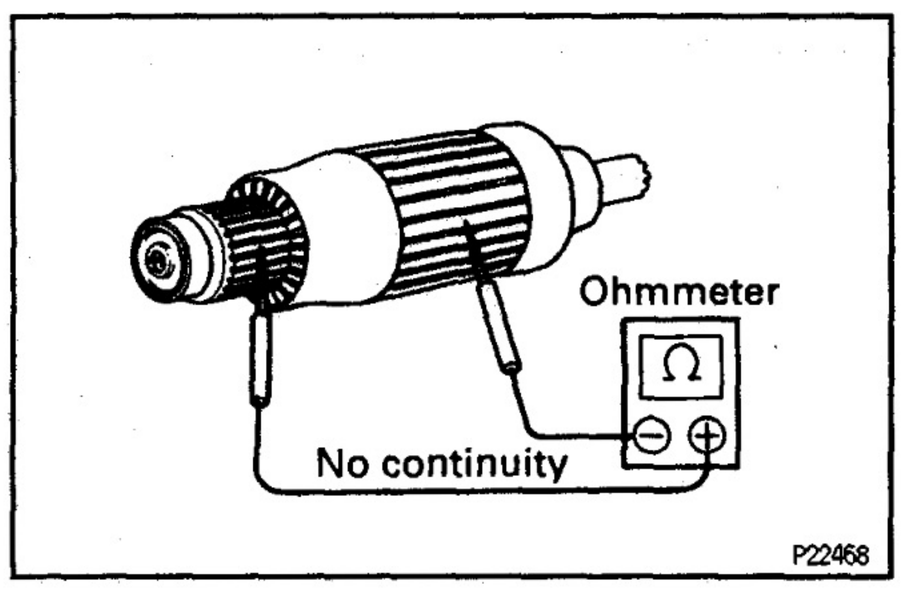
STARTER INSPECTION AND REPAIR

Armature Coil



1. INSPECT COMMUTATOR FOR OPEN CIRCUIT

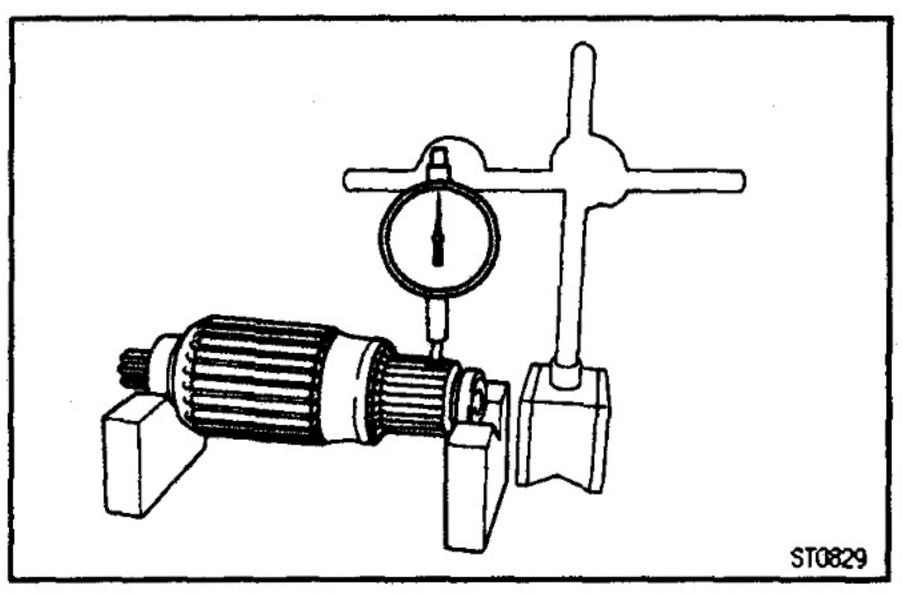
Using an ohmmeter, check that there is continuity between the segments of the commutator.
If there is no continuity between any segment, replace the armature.



2. INSPECT COMMUTATOR FOR GROUND

Using an ohmmeter, check that there is no continuity between the commutator and armature coil core.
If there is continuity, replace the armature.

Commutator



1. INSPECT COMMUTATOR FOR DIRTY AND BURNT SURFACES

If the surface is dirty or burnt, correct it with sandpaper (No. 400) or on a lathe.

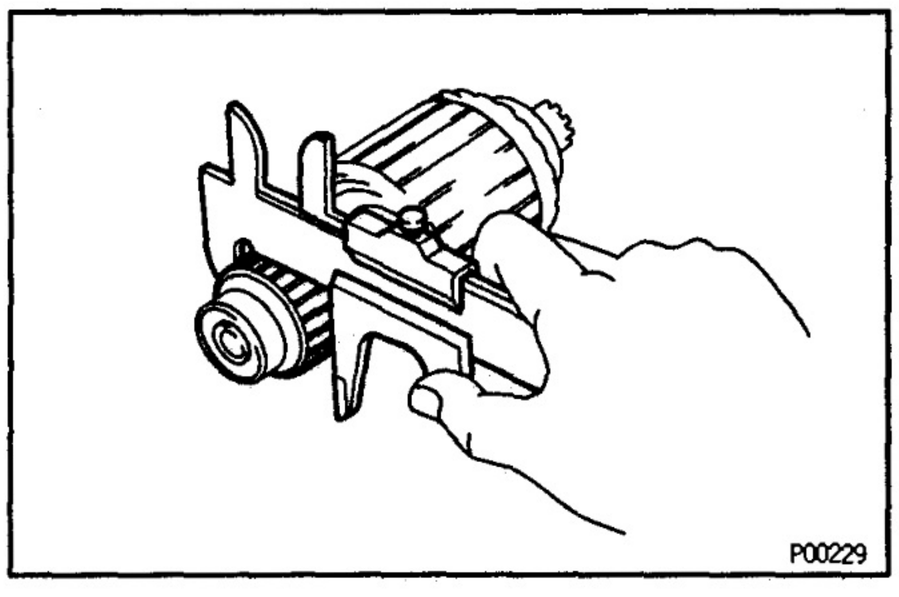
2. INSPECT COMMUTATOR CIRCLE RUNOUT

(a) Place the commutator on V—blocks.
(b) Using a dial gauge, measure the circle runout.

Maximum circle runout:

0.05 mm (0.0020 in.)

If the circle runout is greater than maximum, correct it on a lathe.



3. INSPECT COMMUTATOR DIAMETER

Using vernier calipers, measure the commutator diameter.

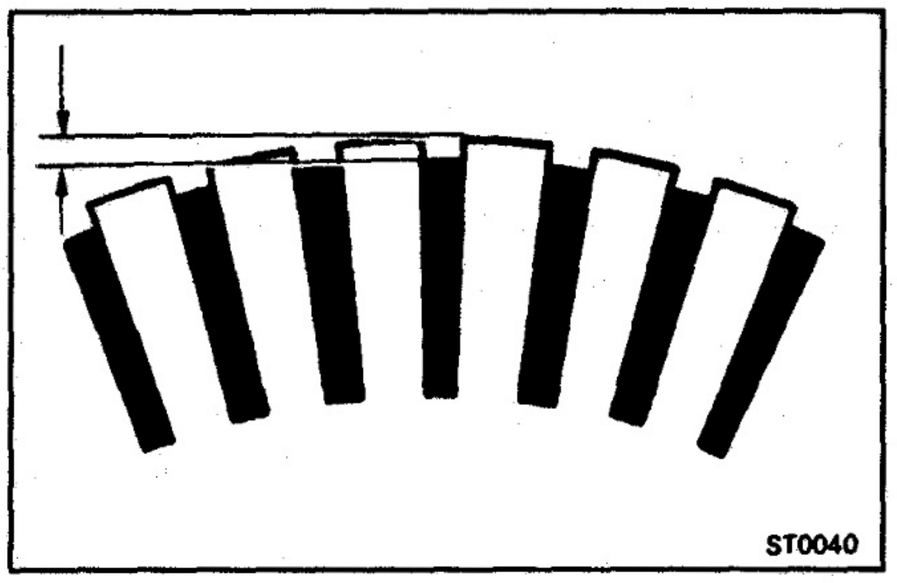
Standard diameter:

36.0 mm (1.417 in.)

Minimum diameter:

35.0 mm (1.378 in.)

If the diameter is less than minimum, replace the armature.



4. INSPECT UNDERCUT DEPTH

Check that the undercut depth is clean and free of foreign materials. Smooth out the edge.

Standard undercut depth:

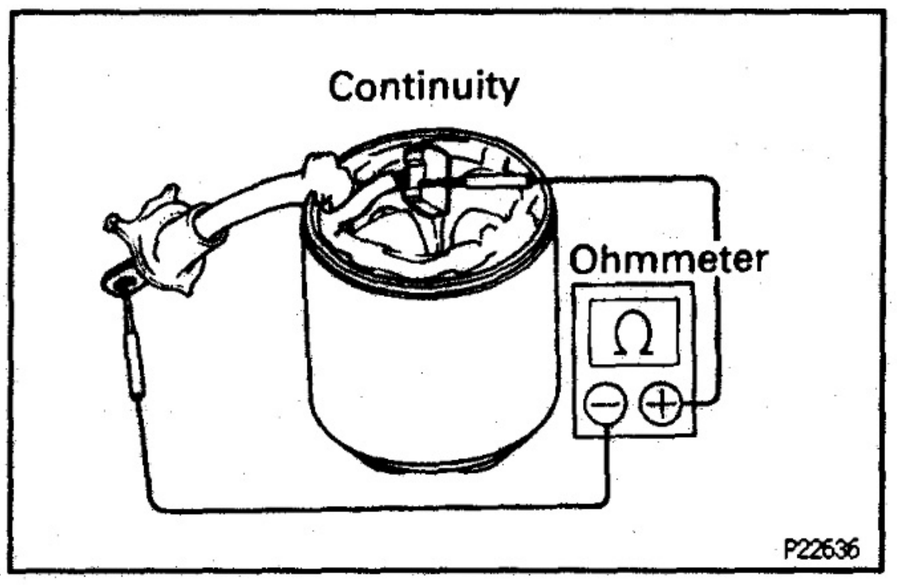
0.7 – 0.9 mm (0.028 – 0.035 in.)

Minimum undercut depth:

0.2 mm (0.008 in.)

If the undercut depth is less than minimum, correct it with a hacksaw blade.

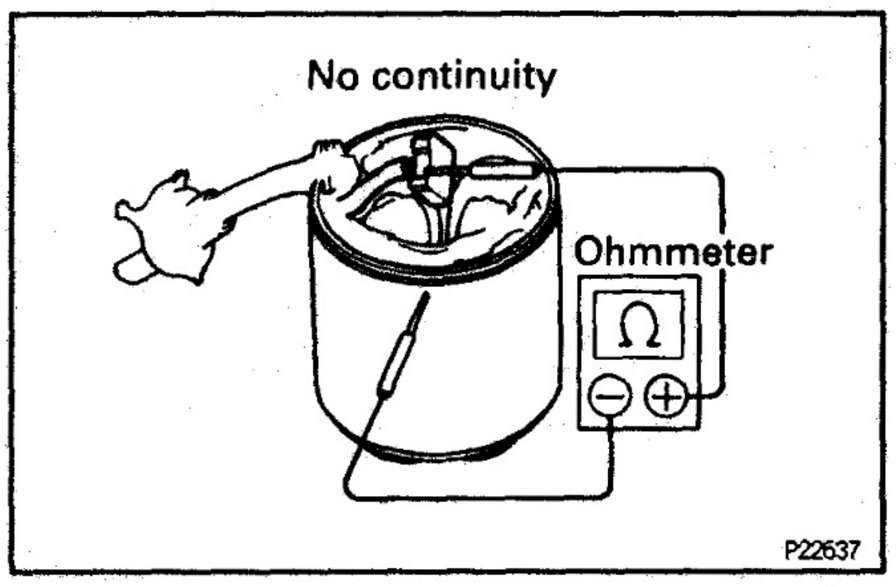
Field Frame (Field Coil)



1. INSPECT FIELD COIL FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between the lead wire and field coil brush lead.

If there is no continuity, replace the field frame.

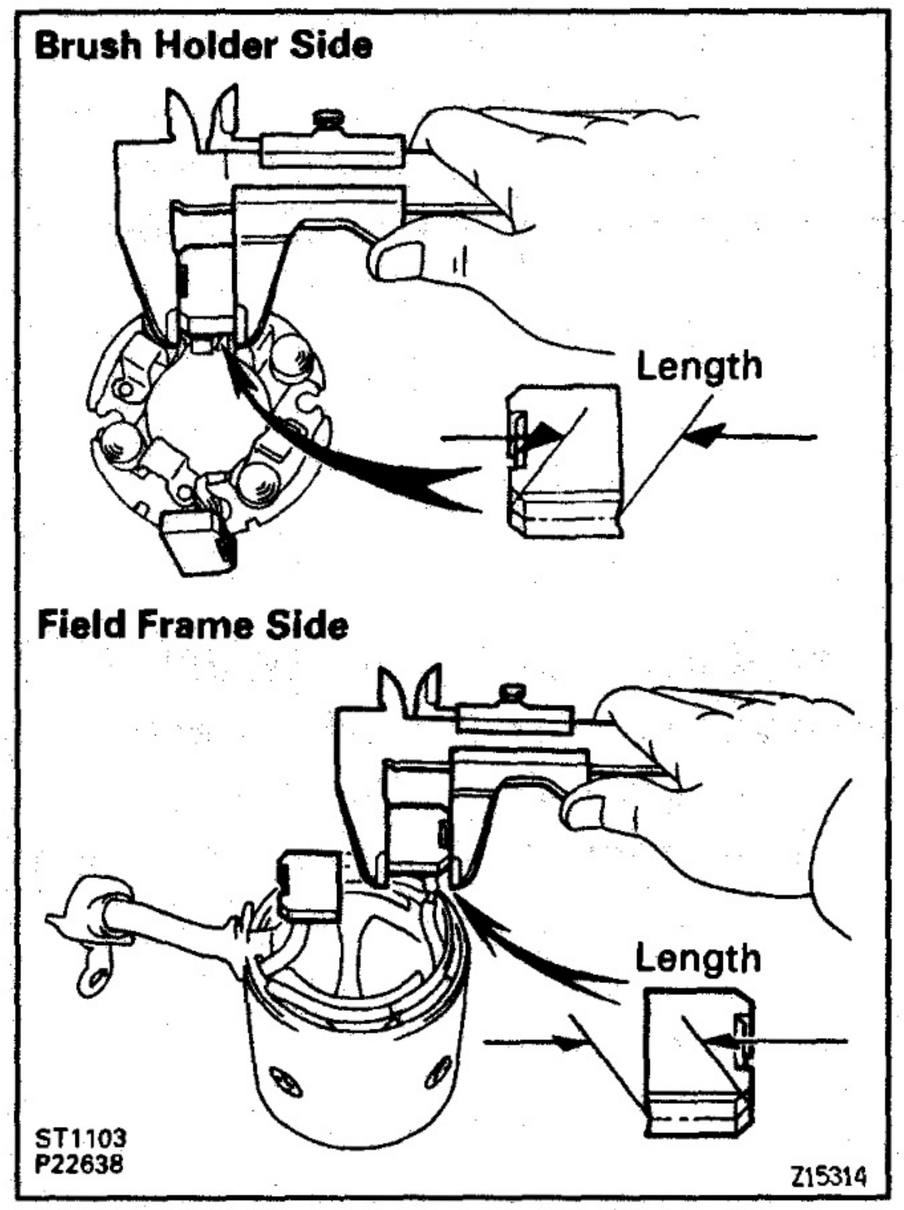


2. INSPECT FIELD COIL FOR GROUND

Using an ohmmeter, check that there is no continuity between the field coil end and field frame.

If there is continuity, repair or replace the field frame.

Brushes



INSPECT BRUSH LENGTH

Using vernier calipers, measure the brush length.

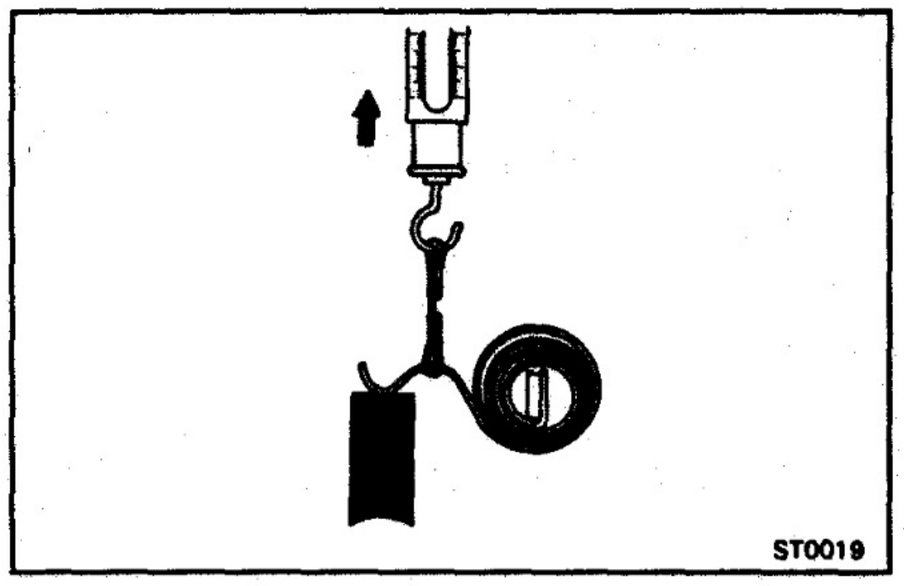
Standard length:

20.5 – 21.0 mm (0.807 – 0.827 in.)

Minimum length:

13.0 mm (0.512 in.)

If the length is less than minimum, replace the brush holder and field frame.



Brush Springs

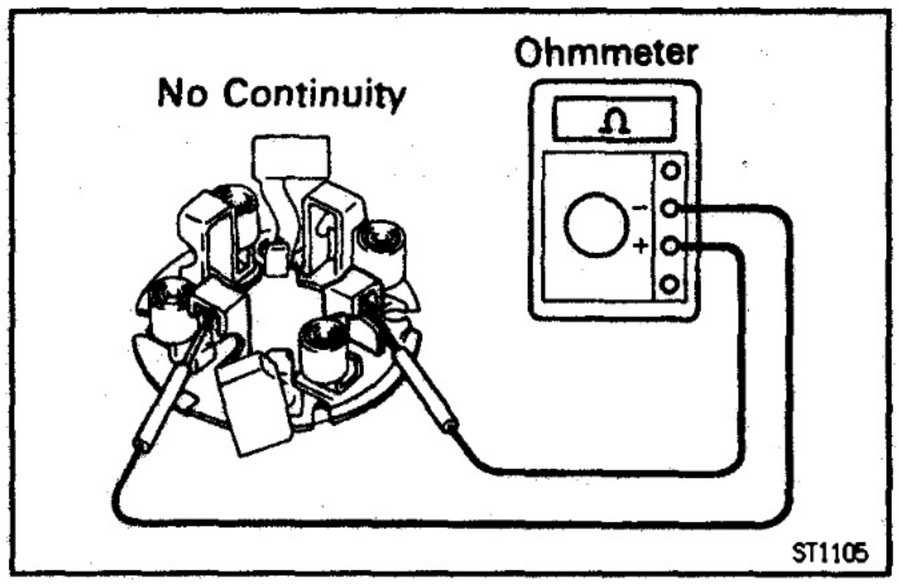
INSPECT BRUSH SPRING LOAD

Take the pull scale reading the instant the brush spring separates from the brush.

Spring installed load:

18.6 – 35.3 N (1.9 – 3.6 kgf, 4.2 – 7.9 lbf)

If the installed load is not within specification, replace the brush springs.



Brush Holder

INSPECT BRUSH HOLDER INSULATION

Using an ohmmeter, check that there is no continuity between the positive (+) and negative (–) brush holders.

If there is continuity, repair or replace the brush holder.

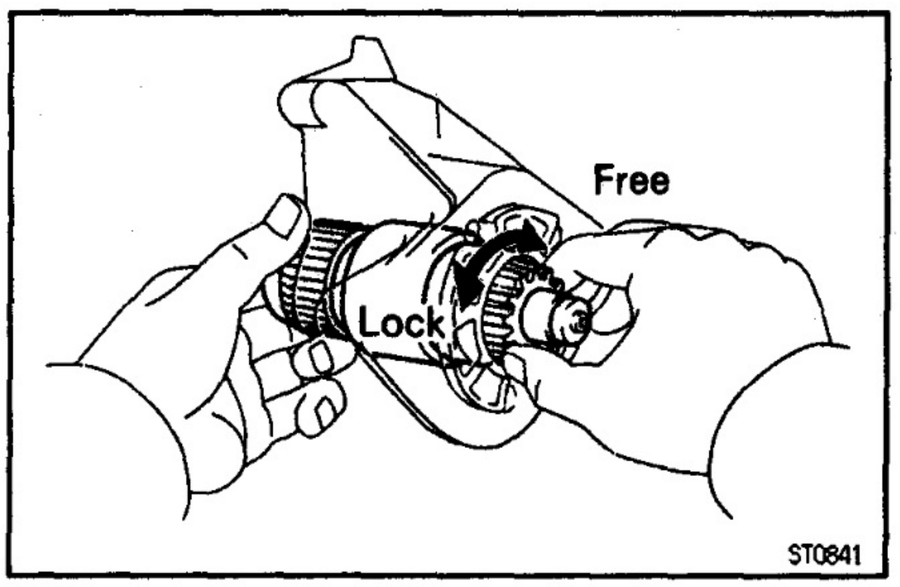
Clutch and Gears

1. **INSPECT GEAR TEETH**

Check the gear teeth on the pinion gear, idle gear and clutch assembly for wear or damage.

If damaged, replace the gear or clutch assembly.

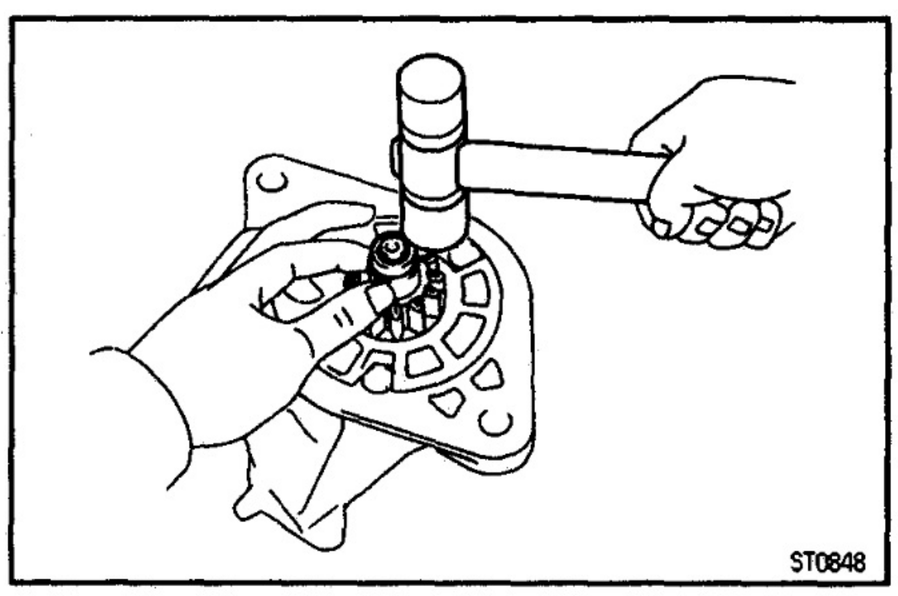
If damaged, also check the drive plate ring gear for wear or damage.



2. **INSPECT CLUTCH PINION GEAR**

Hold the starter clutch and rotate the pinion gear clockwise, and check that it turns freely. Try to rotate the pinion gear counterclockwise and check that it locks.

If necessary, replace the clutch assembly.

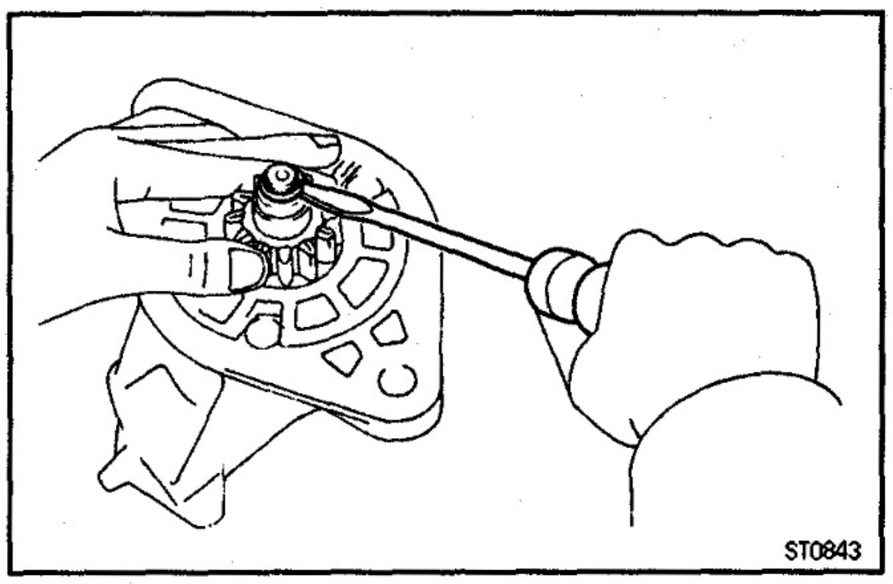


3. **IF NECESSARY, REPLACE CLUTCH ASSEMBLY**

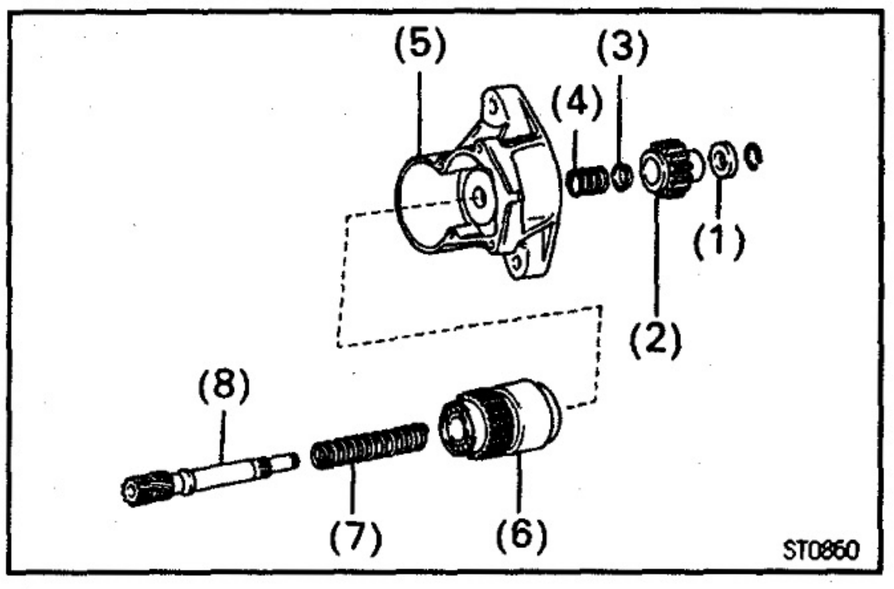
A. Disassemble starter housing and clutch assembly

(a) Push down the pinion gear and starter housing.

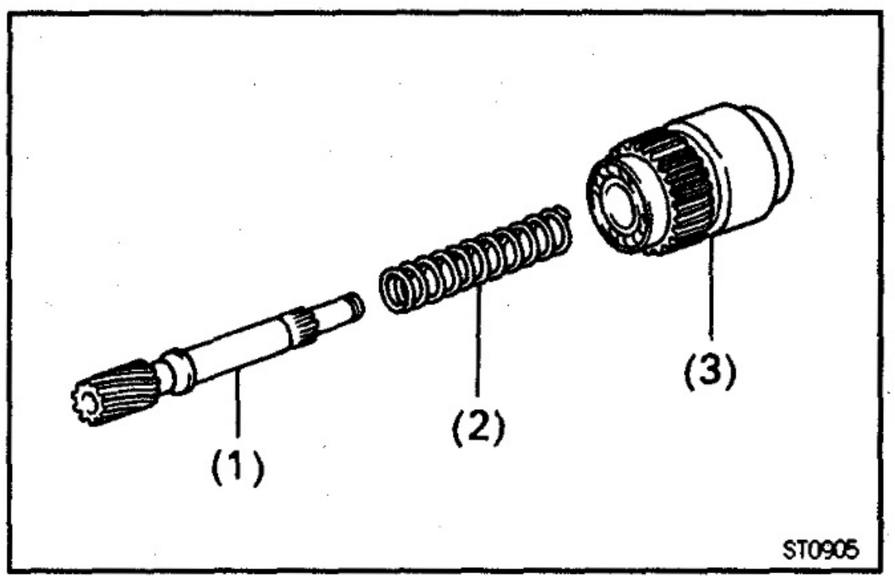
(b) Using a plastic–faced hammer, tap down the stop collar.



(c) Using a screwdriver, pry out the snap ring.

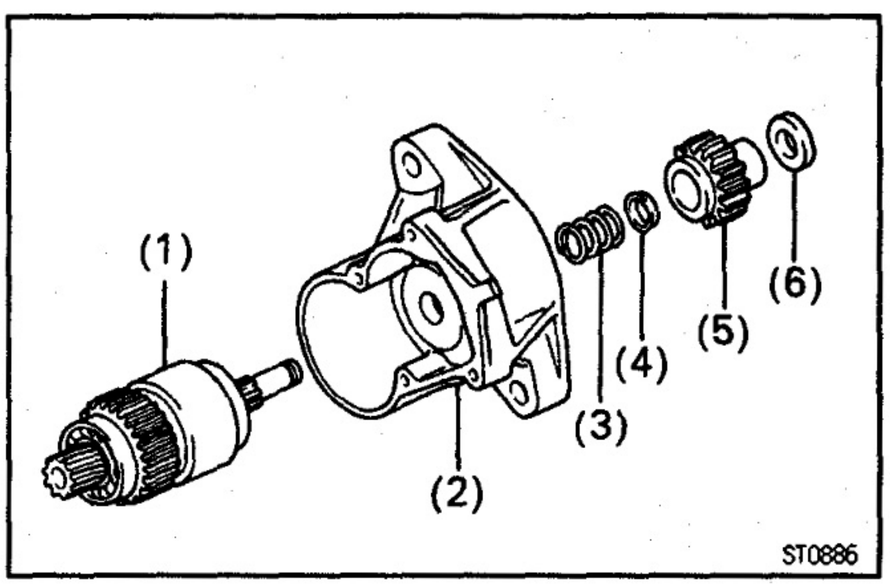


(d) Disassemble these parts:
(1) Stop collar
(2) Pinion gear
(3) Retainer
(4) Compression spring
(5) Starter housing
(6) Starter clutch
(7) Compression spring
(8) Clutch shaft

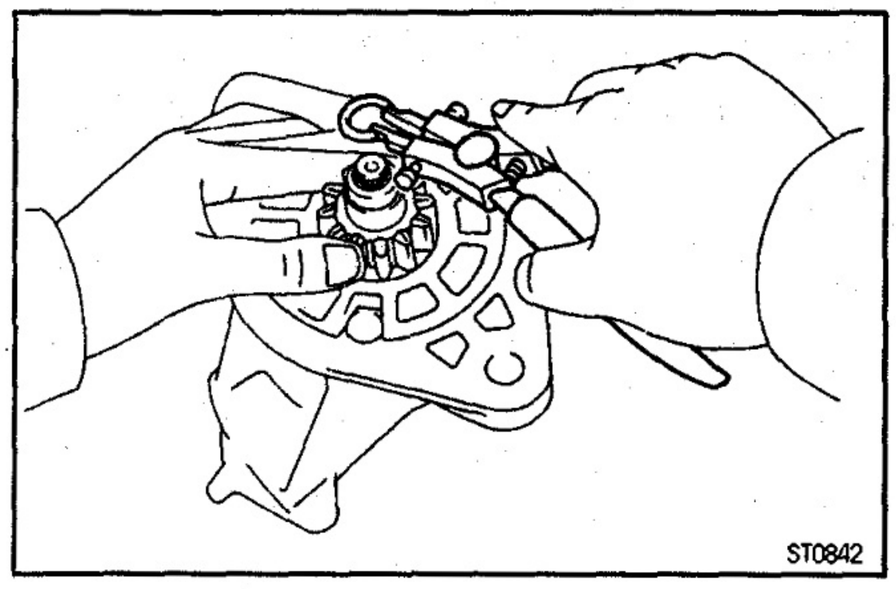


B. Assemble starter housing and clutch assembly

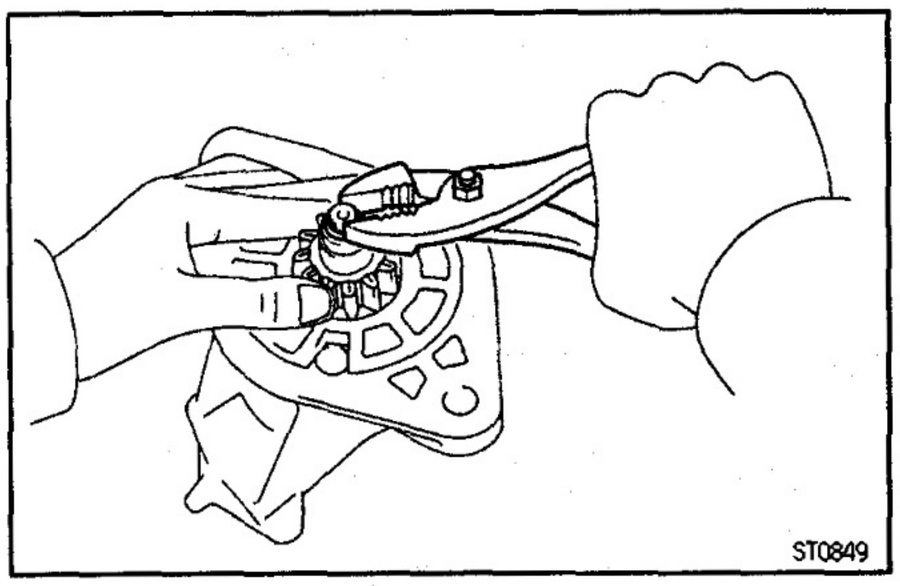
(a) 1st, assemble these parts:
(1) Clutch shaft
(2) Compression spring
(3) Starter clutch



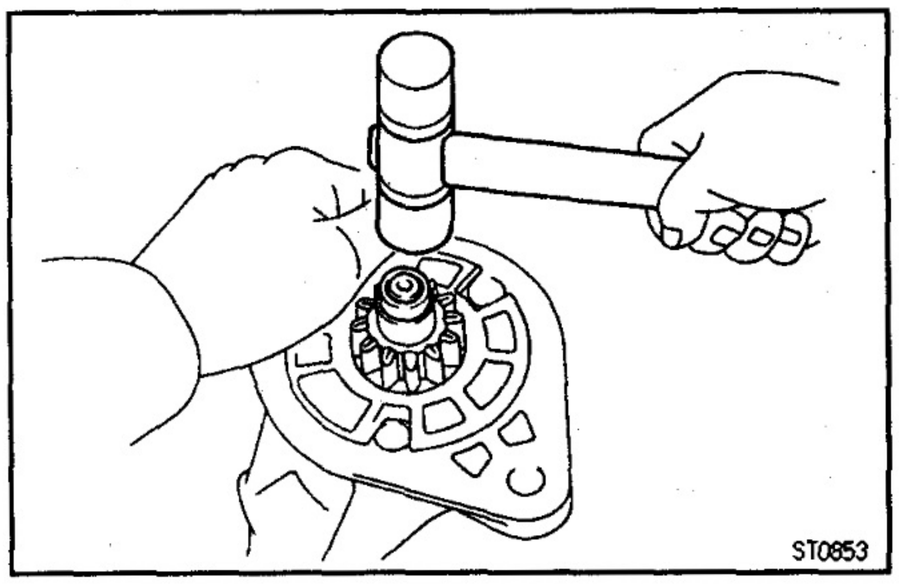
(b) 2nd, assemble these parts:
(1) Clutch shaft and starter shaft assembly
(2) Starter housing
(3) Compression spring
(4) Retainer
(5) Pinion gear
(6) Stop collar



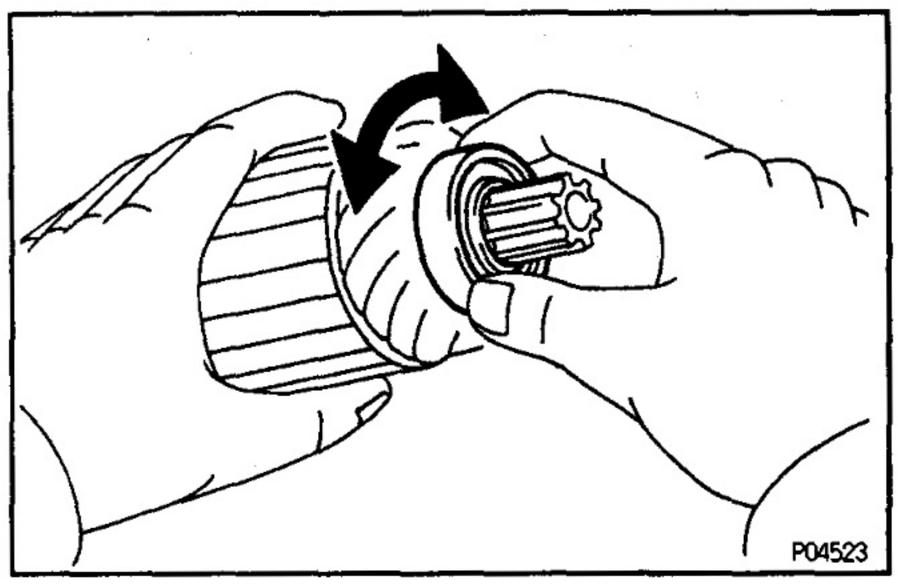
(c) Push down the pinion gear and starter housing.
(e) Using snap ring pliers, install a new snap ring.



(d) Using pliers, compress the snap ring.
(e) Check that the snap ring fits correctly.



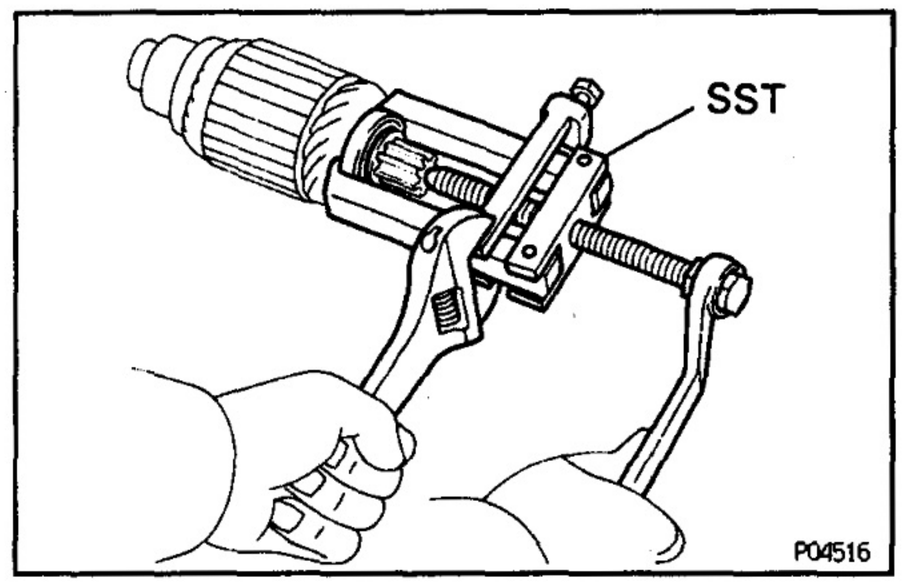
(f) Using a plastic–faced hammer, tap the clutch shaft and install the stop collar onto the snap ring.



Bearings

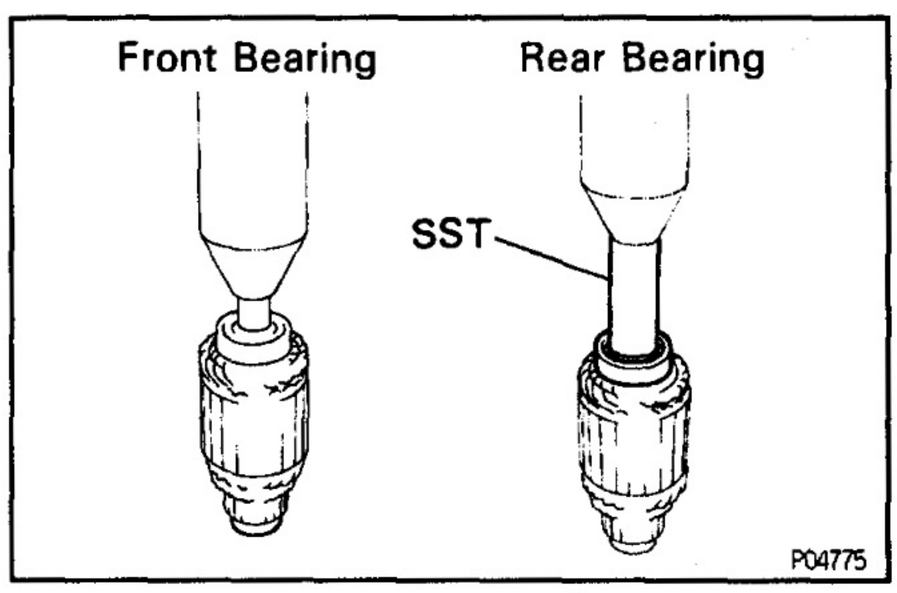
1. INSPECT BEARINGS

Turn the bearing by hand while applying inward force. If resistance is felt or the bearing sticks, replace the bearing.

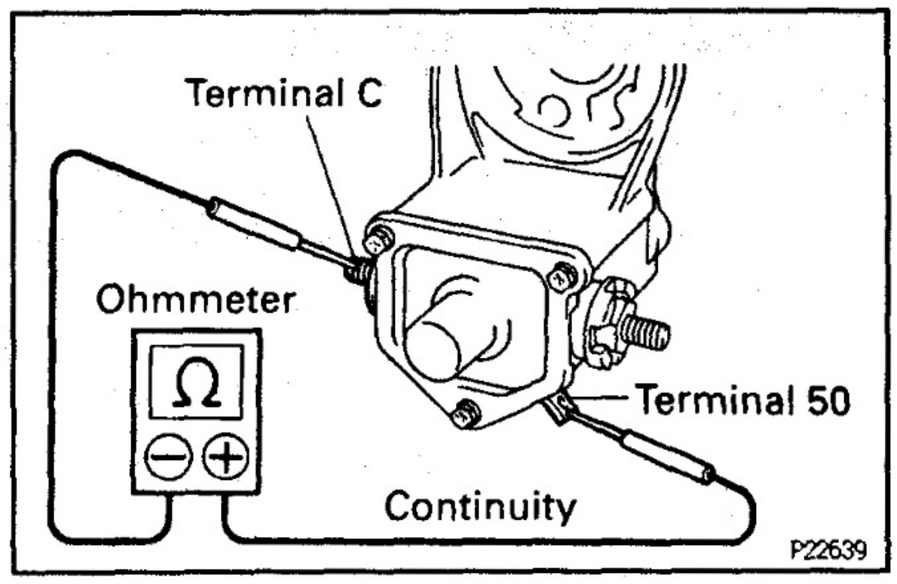


2. IF NECESSARY, REPLACE BEARINGS

(a) Using SST, remove the bearing.
SST 09286–46011

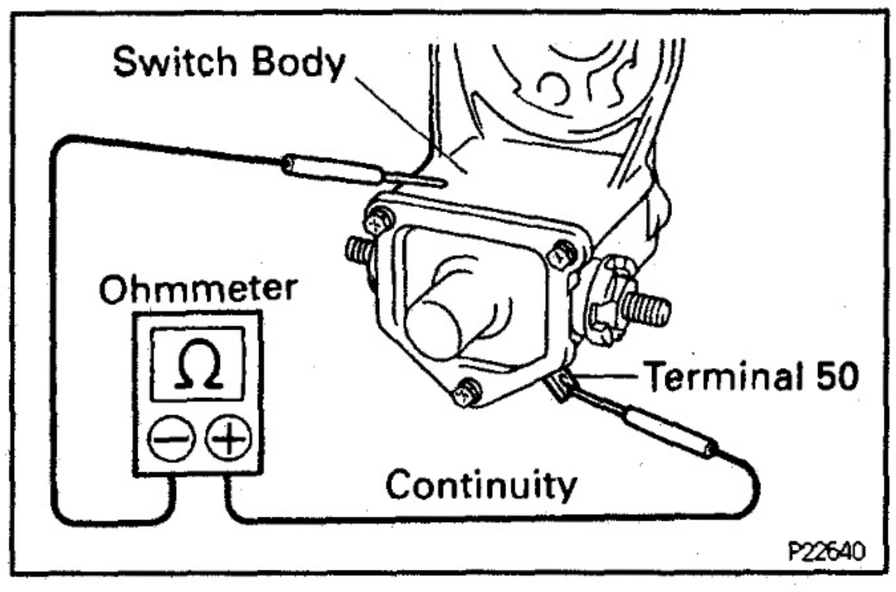


(b) Using a press, press in a new front bearing.
(c) Using SST and a press, press in a new rear bearing.
SST 09820–00030

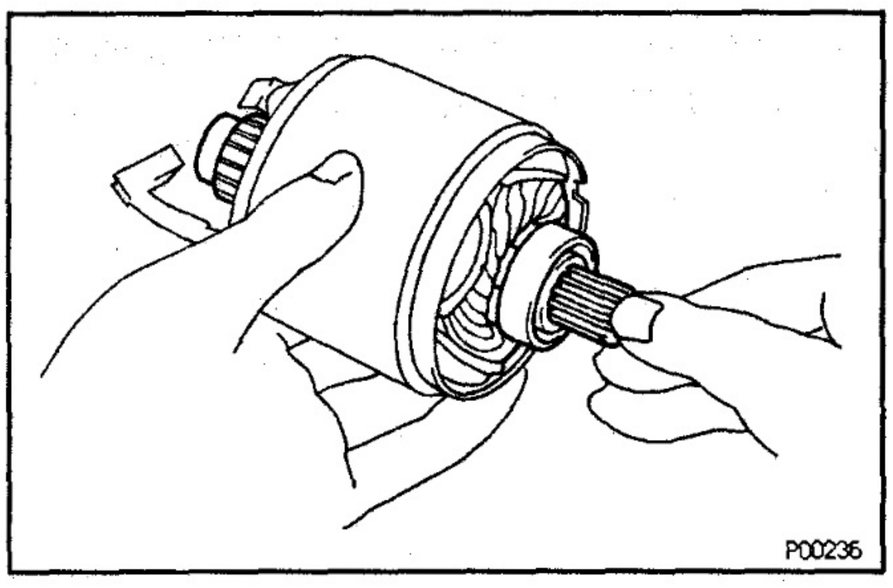


Magnetic Switch

1. **PERFORM PULL—IN COIL OPEN CIRCUIT TEST**
Using an ohmmeter, check that there is continuity between terminals 50 and C.
If there is no continuity, replace the magnetic switch.



2. **PERFORM HOLD—IN COIL OPEN CIRCUIT TEST**
Using an ohmmeter, check that there is continuity between terminal 50 and the switch body.
If there is no continuity, replace the magnetic switch.

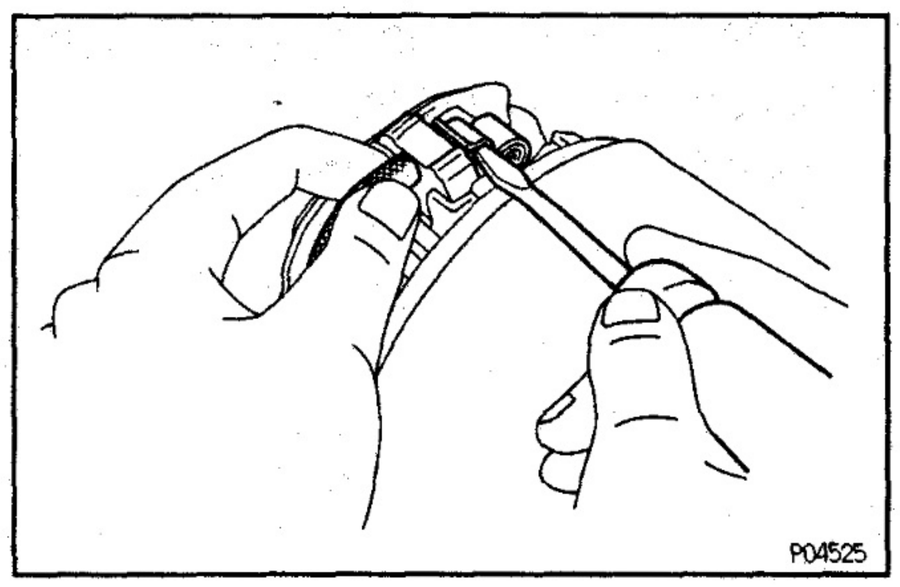


STARTER ASSEMBLY

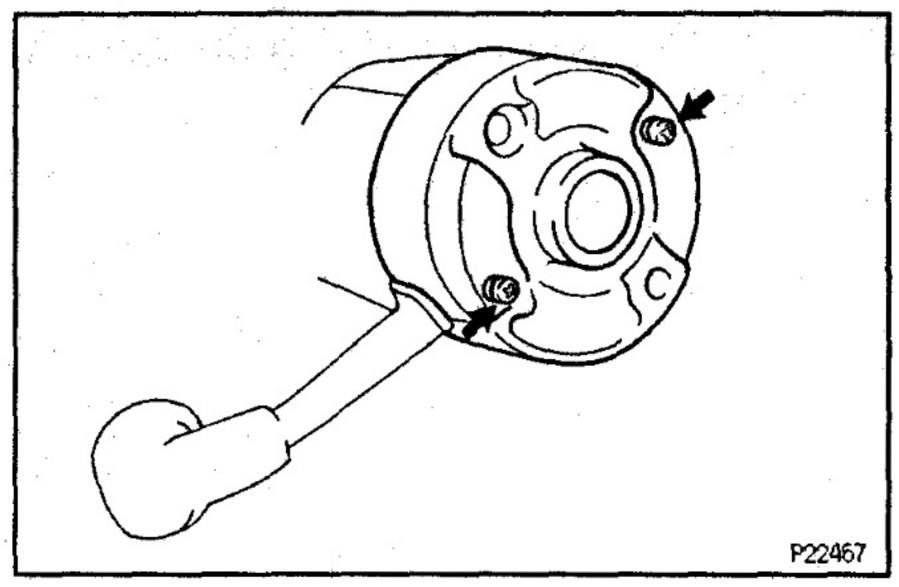
ST0A1-01

HINT: Use high—temperature grease to lubricate the bearings and gears when assembling the starter.

1. **PLACE ARMATURE INTO FIELD FRAME**
Apply grease to the armature bearings, and insert the armature into the field frame.

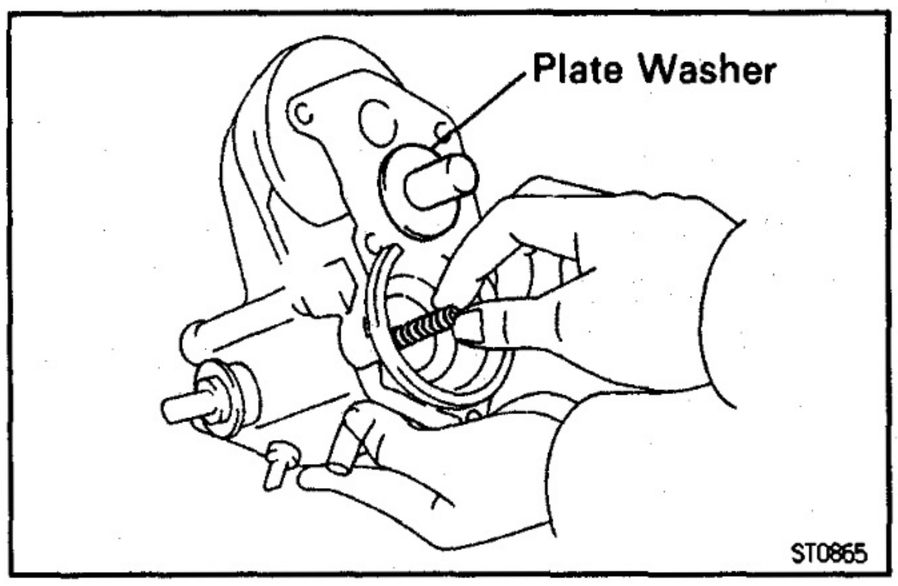


2. **INSTALL BRUSH HOLDER**
(a) Place the brush holder on the armature.
(b) Using a screwdriver, hold the brush spring back, and connect the brush into the brush holder. Connect the four brushes.
NOTICE: Check that the positive (+) lead wires are not grounded.



(c) Install the end cover to the field frame with the 2 screws.

3. **INSERT STEEL BALL INTO CLUTCH SHAFT HOLE**
(a) Apply grease to the steel ball.
(b) Insert the steel ball into the clutch shaft hole.

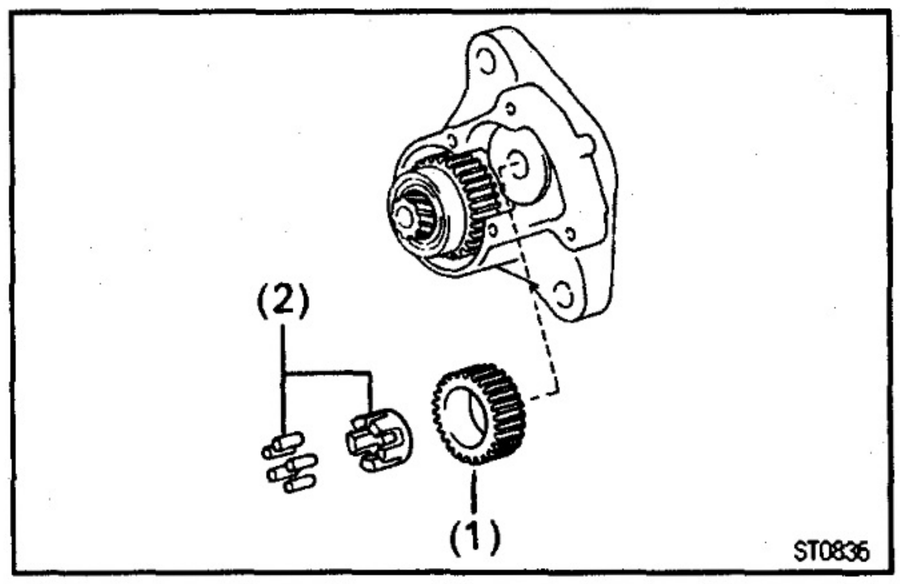


4. INSTALL STARTER HOUSING, CLUTCH ASSEMBLY AND GEAR

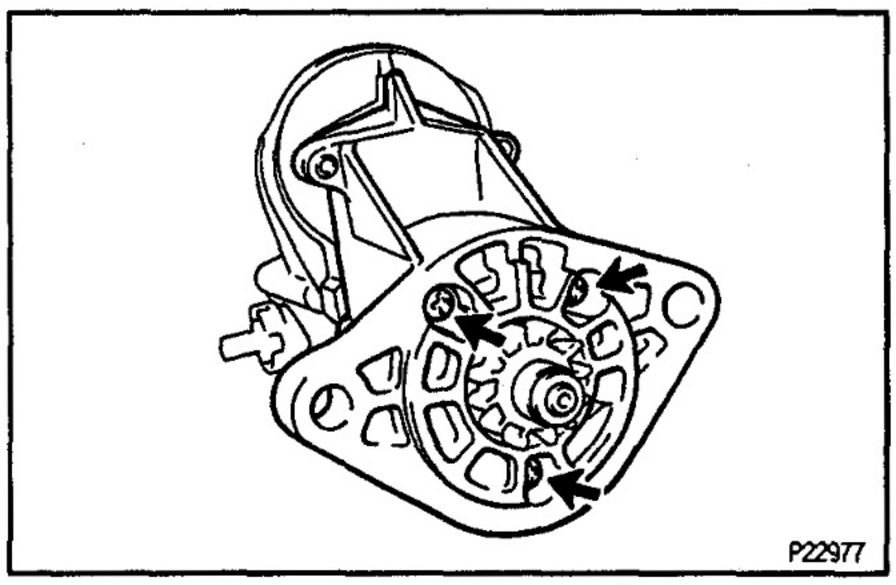
(a) Apply grease to the return spring.

(b) Insert the return spring into the magnetic switch hole.

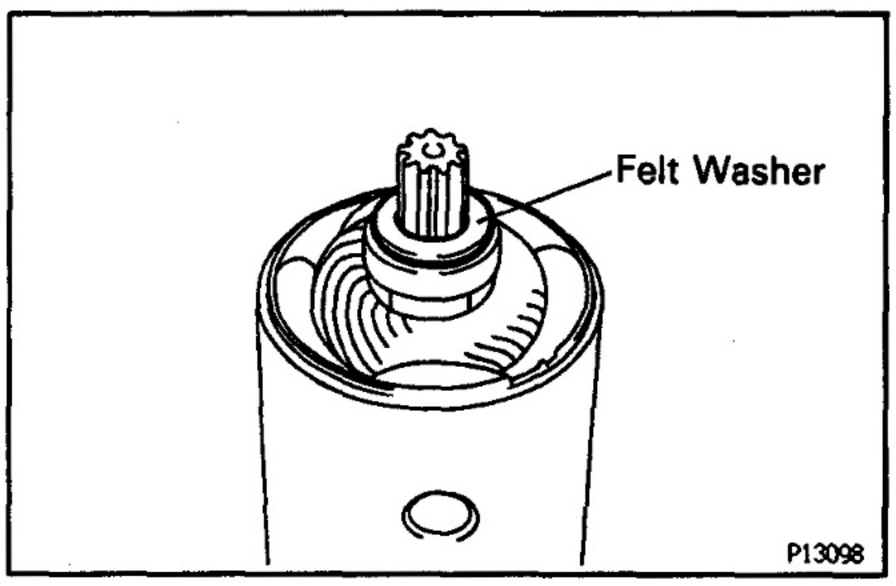
(c) Install the plate washer to the magnetic switch.



(c) Place these parts to the starter housing:
  (1) Idler gear
  (2) Bearing

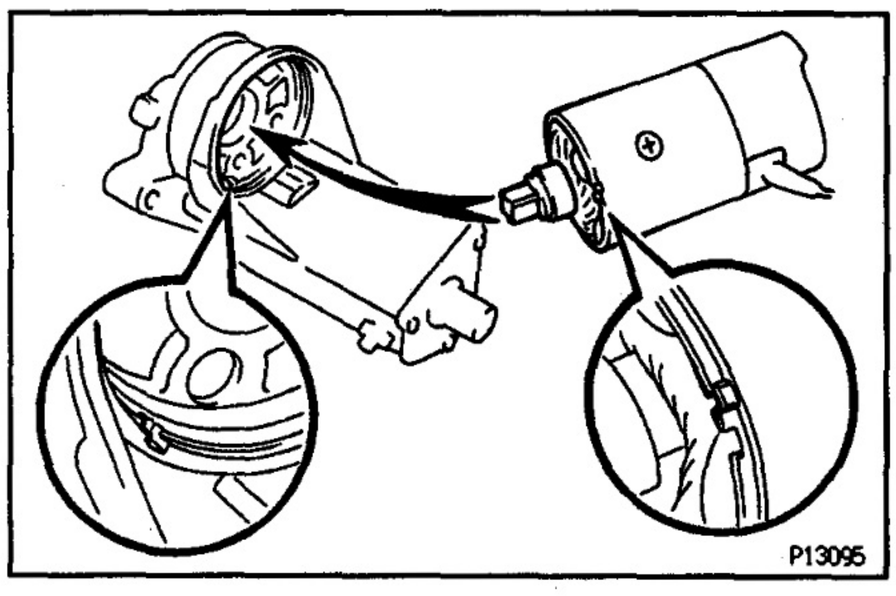


(d) Assemble the starter housing and magnetic switch assembly and install the 3 screws.

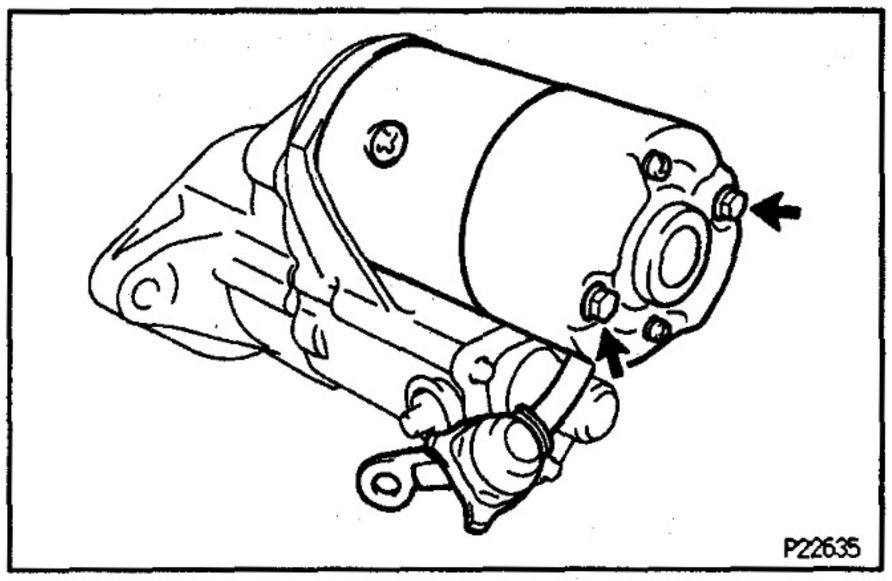


5. INSTALL FIELD FRAME WITH ARMATURE AND LEAD WIRE TO MAGNETIC SWITCH

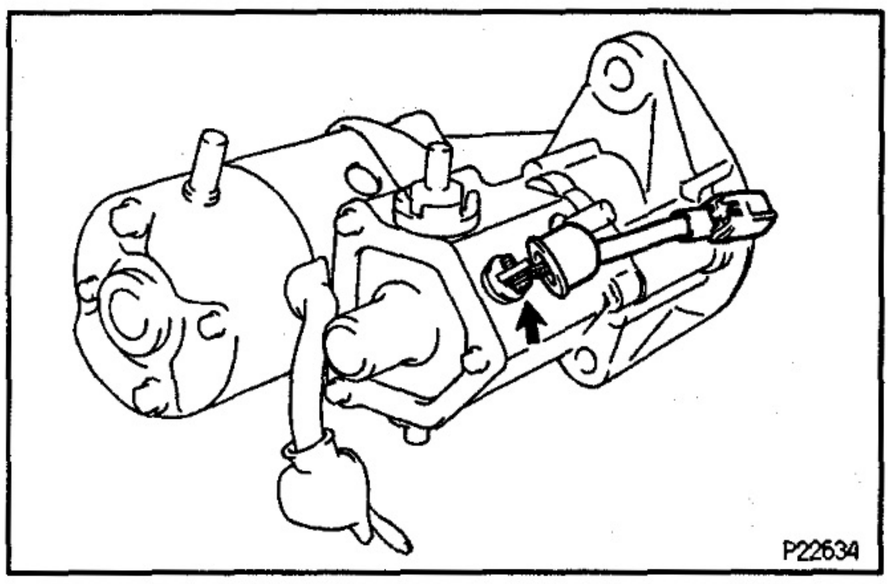
(a) Install a new felt washer to the armature.



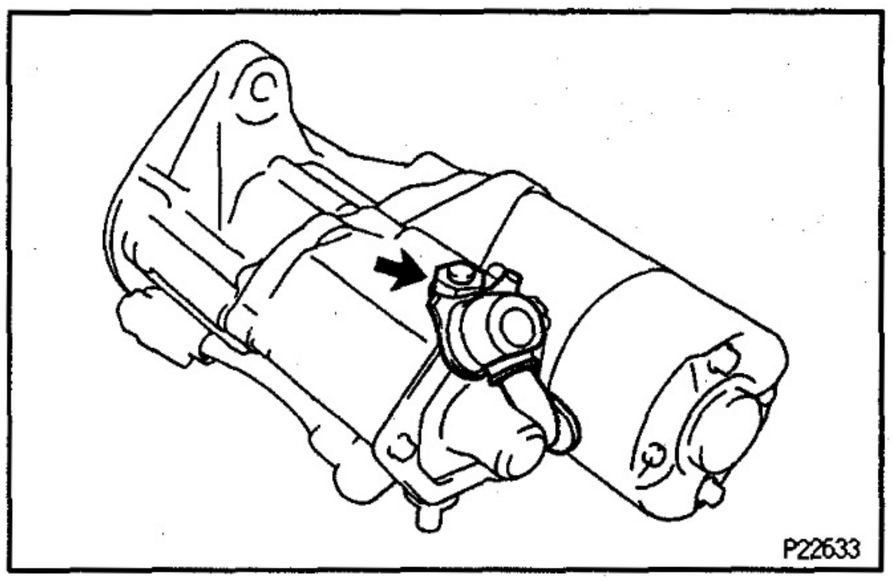
(b) Align the protrusion of the field frame with the cutout of the magnetic switch.



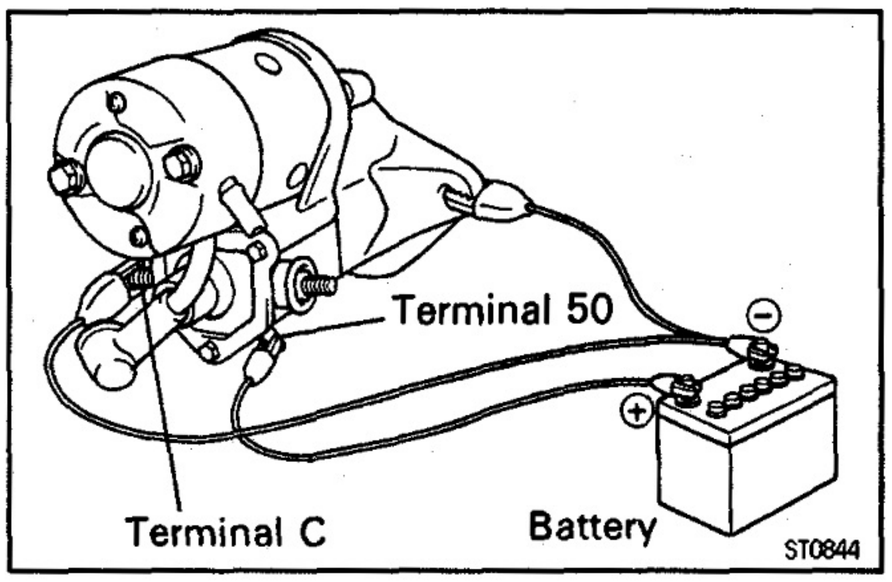
(c) Install the field frame and armature assembly with the 2 through bolts.
Torque: 9.3 N·m (95 kgf·cm, 82 in.·lbf)

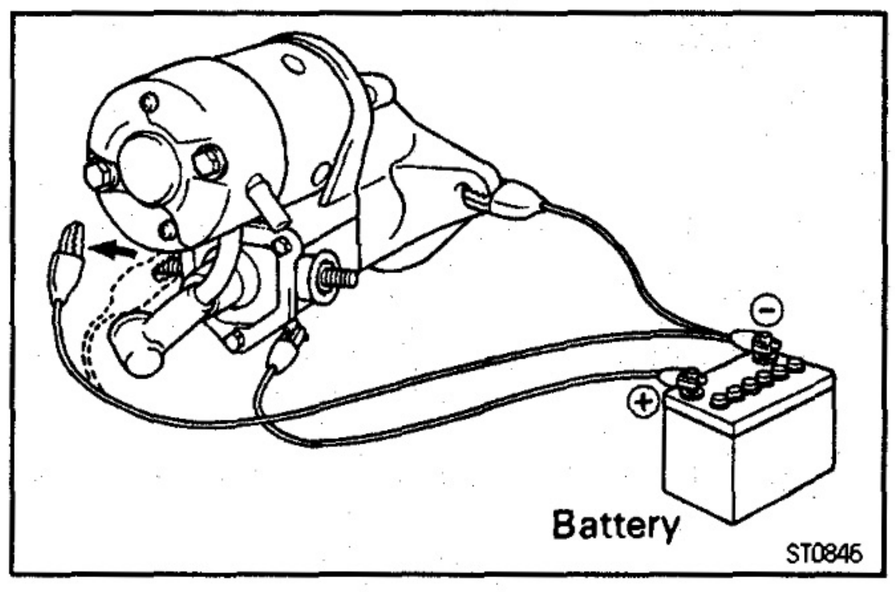


(d) Install the lead wire to terminal 50 with the screw and washer.
Torque: 3.6 N·m (41 kgf·cm, 32 in.·lbf)



(e) Connect the lead wire to terminal C, and install the nut.
Torque: 21.1 N·m (215 kgf·cm, 16 ft·lbf)





STARTER PERFORMANCE TEST

ST010-0X

NOTICE: These tests must be performed within 3 to 5 seconds to avoid burning out the coil.

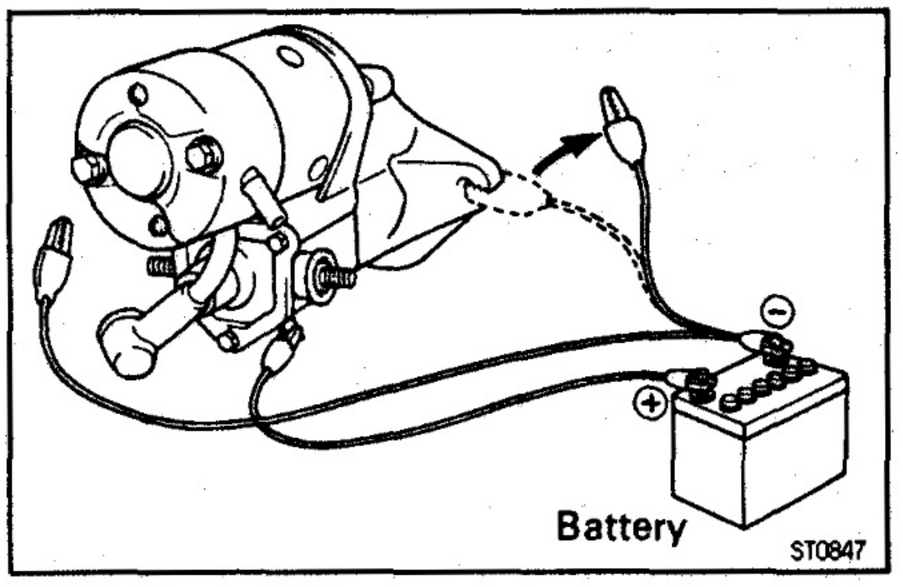
1. DO PULL–IN TEST

(a) Disconnect the field coil lead wire from terminal C.

(b) Connect the battery to the magnetic switch as shown. Check that the clutch pinion gear moves outward.
If the clutch pinion gear does not move, replace the magnetic switch assembly.

2. DO HOLD–IN TEST

With battery connected as above with the clutch pinion gear out, disconnect the negative (–) lead from terminal C. Check that the pinion gear remains out.
If the clutch pinion gear returns inward, replace the magnetic switch assembly.



3. INSPECT CLUTCH PINION GEAR RETURN

Disconnect the negative (–) lead from the switch body.

Check that the clutch pinion gear returns inward.

If the clutch pinion gear does not return, replace the magnetic switch assembly.

4. DO NO–LOAD PERFORMANCE TEST

(a) Connect the battery and ammeter to the starter as shown.

(b) Check that the starter rotates smoothly and steadily with the pinion gear moving out. Check that the ammeter shows the specified current.

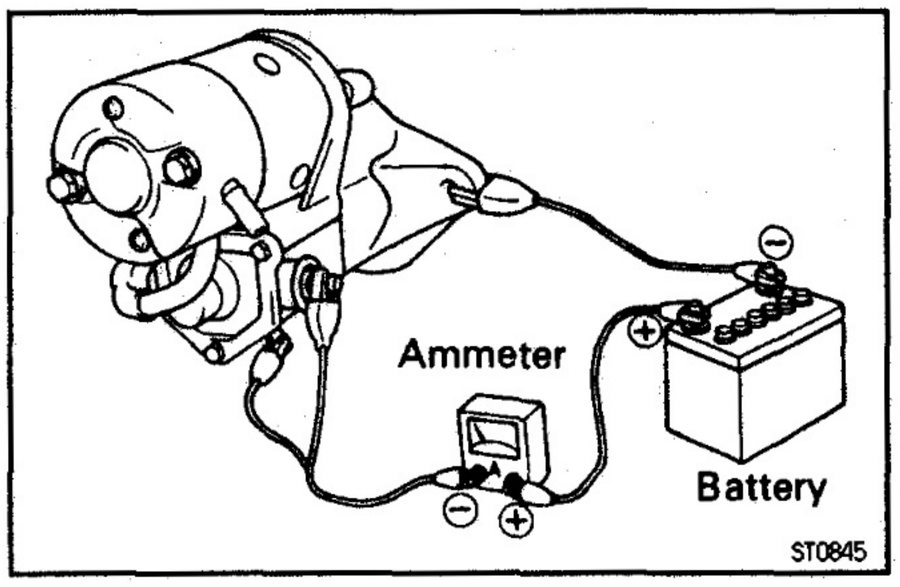
Specified current:

12 V type:

At 11.0 V: 180 A or less

24 V type:

At 23.0 V: 90 A or less

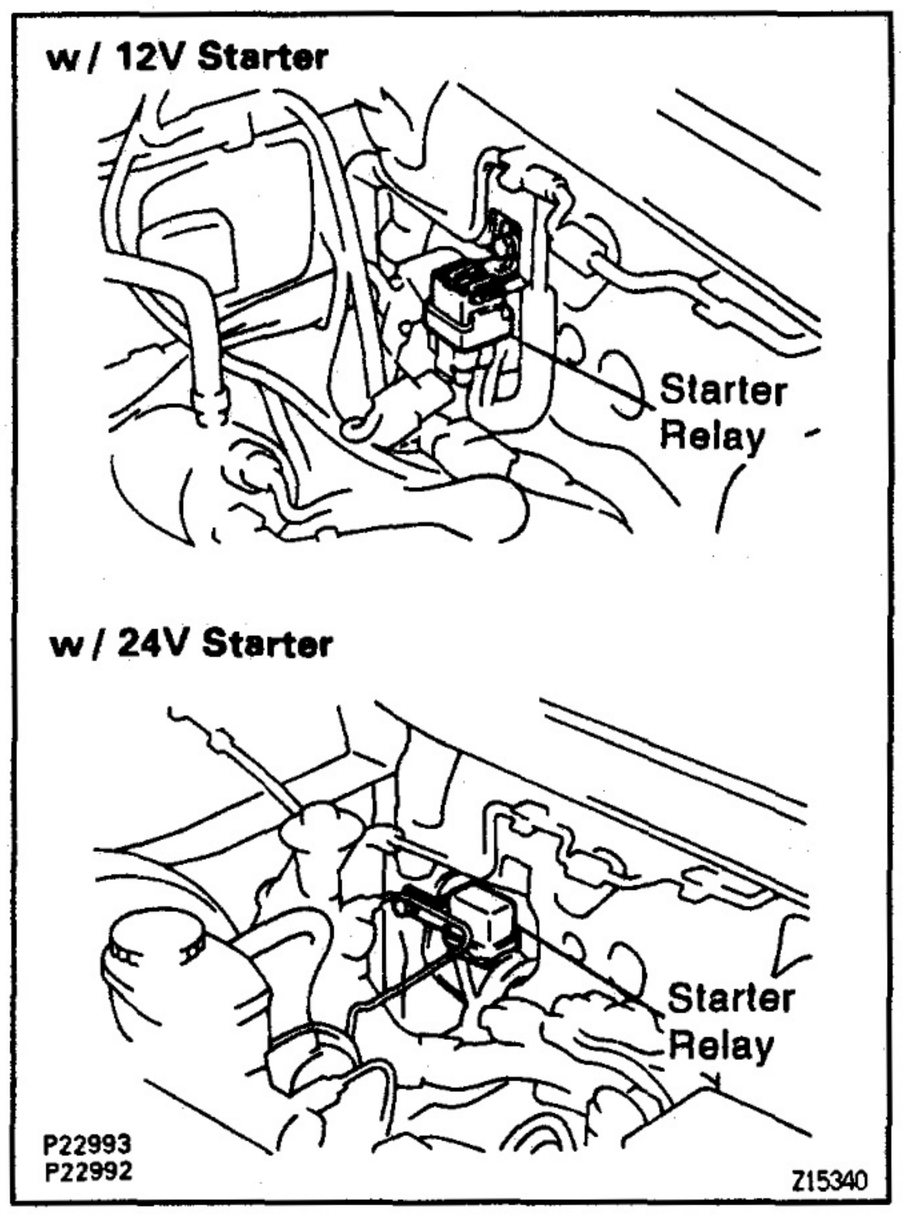


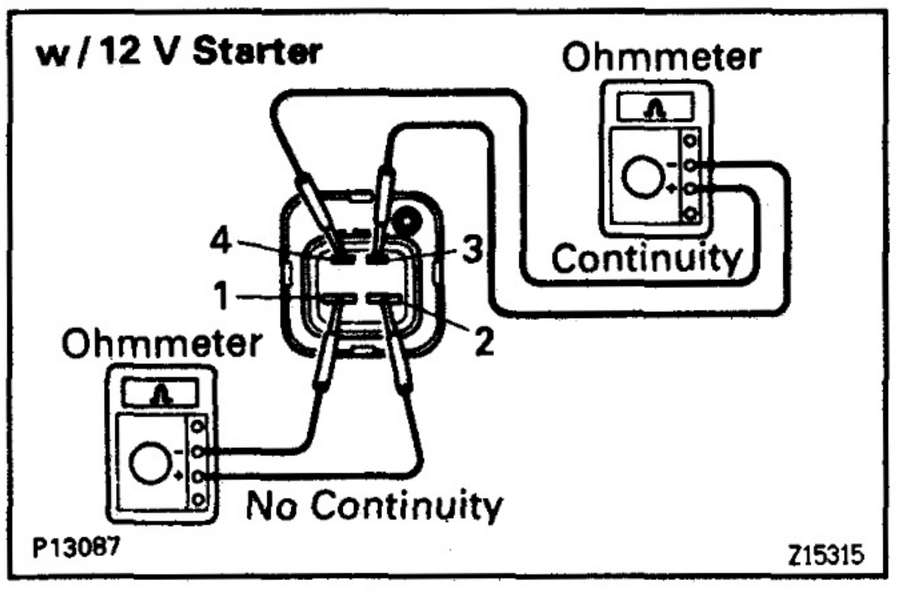
STARTER RELAY

STARTER RELAY INSPECTION

ST0A3–01

1. REMOVE STARTER RELAY





2. INSPECT STARTER RELAY

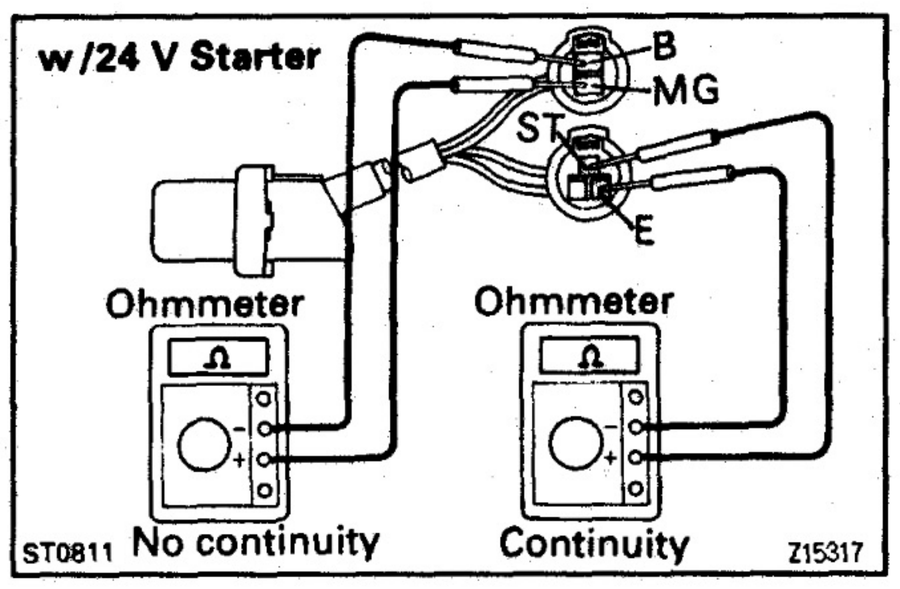
A. Inspect relay continuity

w/ 12 V Starter:

(a) Using an ohmmeter, check that there is continuity between terminals 3 and 4.

(b) Check that there is no continuity between terminals 1 and 2.

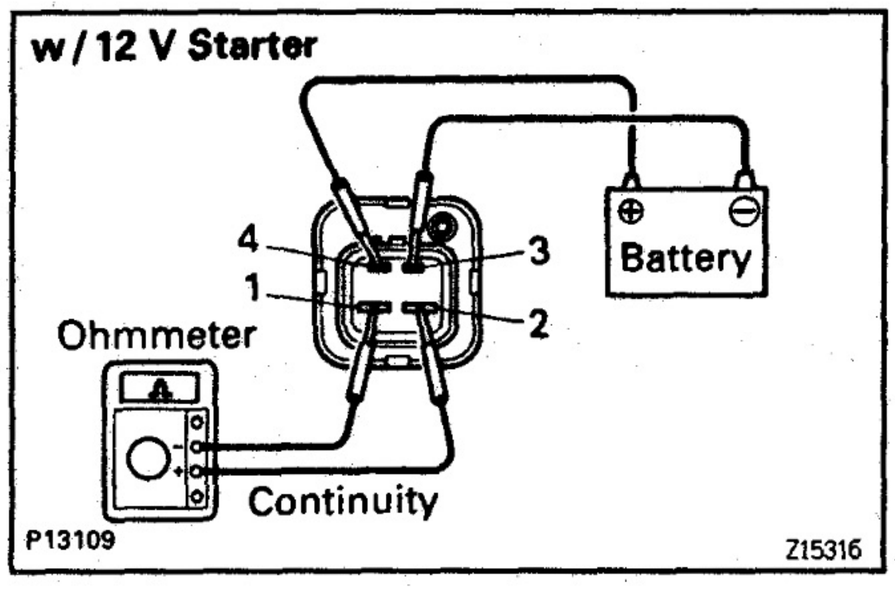
If continuity is not as specified, replace the relay.



w/ 24 V Starter:

(a) Using an ohmmeter, check that there is continuity between terminals E and ST.

(b) Check that there is no continuity between terminals B and MG.
If continuity is not as specified, replace the relay.

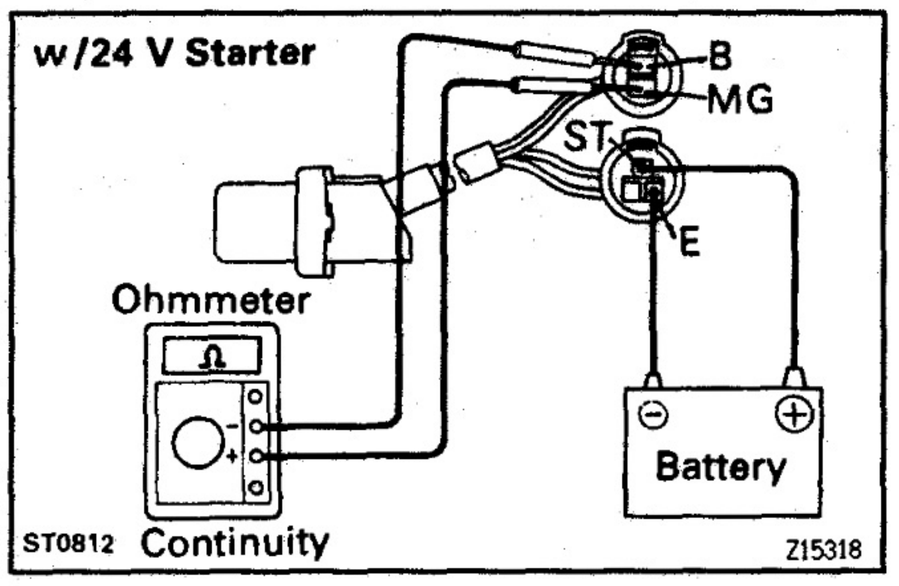


B. Inspect relay operation

w/ 12 V Starter:

(a) Apply battery voltage across terminals 3 and 4.

(b) Using an ohmmeter, check that there is continuity between terminals 1 and 2.
If operation is not as specified, replace the relay.

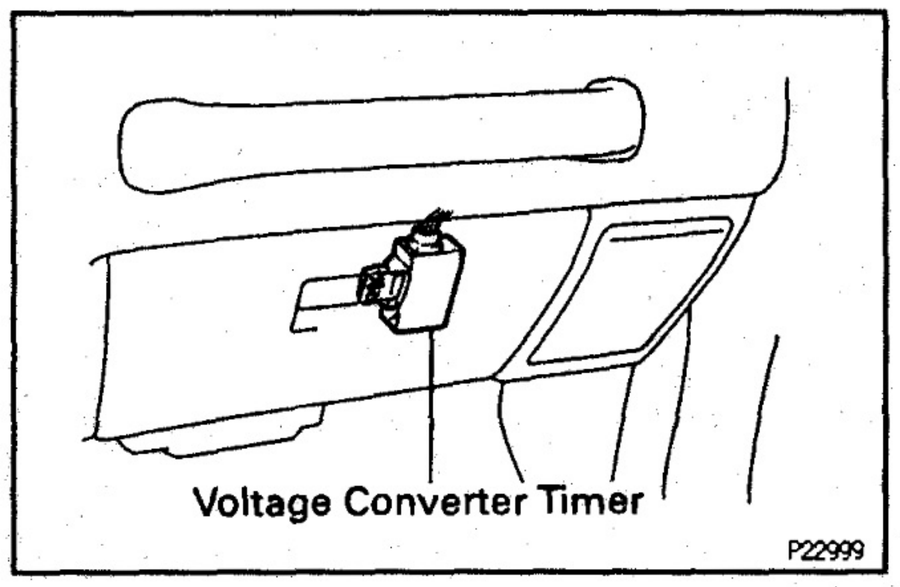


w/ 24 V Starter:

(a) Apply battery voltage across terminals E and ST.
NOTICE: If the vehicle has a voltage converter, do the check using a 12 V battery.

(b) Using an ohmmeter, check that there is continuity between terminals B and MG.
If operation is not as specified, replace the relay.

3. REINSTALL STARTER RELAY



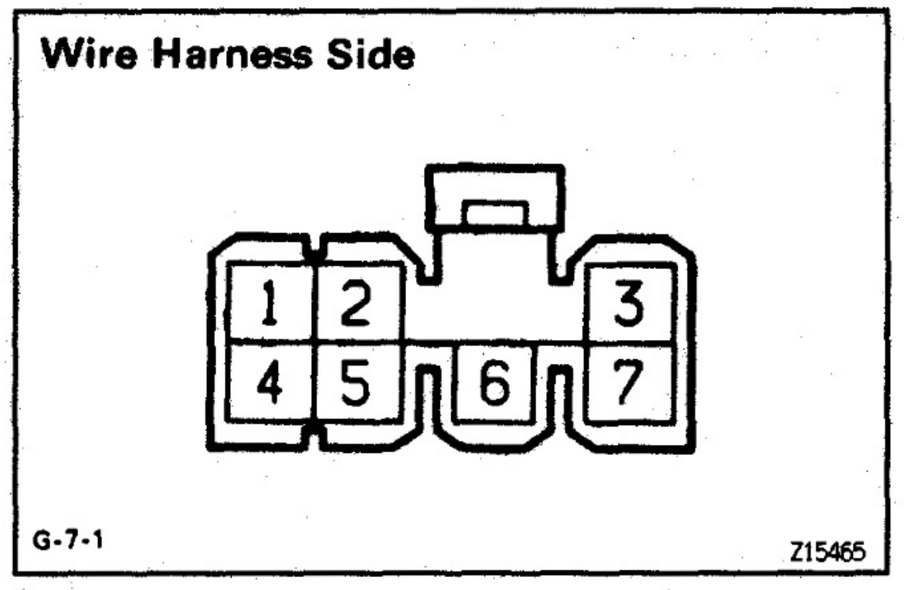
VOLTAGE CONVERTER TIMER (w/ 24 V Starter)

ST0A3-01

VOLTAGE CONVERTER TIMER

INSPECTION

1. DISCONNECT VOLTAGE CONVERTER TIMER CONNECTOR



2. INSPECT VOLTAGE CONVERTER TIMER

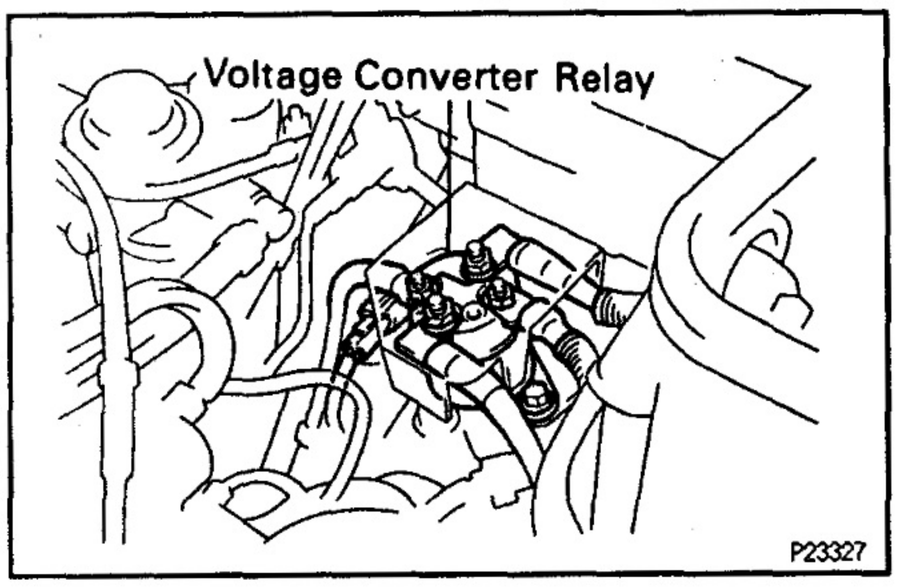
Check the connector on the wire harness side as shown in these chart:

ST

Check for	Tester connection	Condition	Specified value
Voltage	1 – Ground	Turn starter switch OFF	No voltage
		Turn starter switch START	Battery voltage
Voltage	2 – Ground	Turn starter switch OFF	No voltage
		Turn starter switch ON	Battery voltage
Voltage	3 – Ground	Turn starter switch OFF	No voltage
		Turn starter switch START	Battery voltage
Continuity	4 – Ground	–	Continuity
Continuity	5 – 6	–	Continuity
Continuity	7 – Ground	–	Continuity

V06503

3. RECONNECT VOLTAGE CONVERTER TIMER CONNECTOR

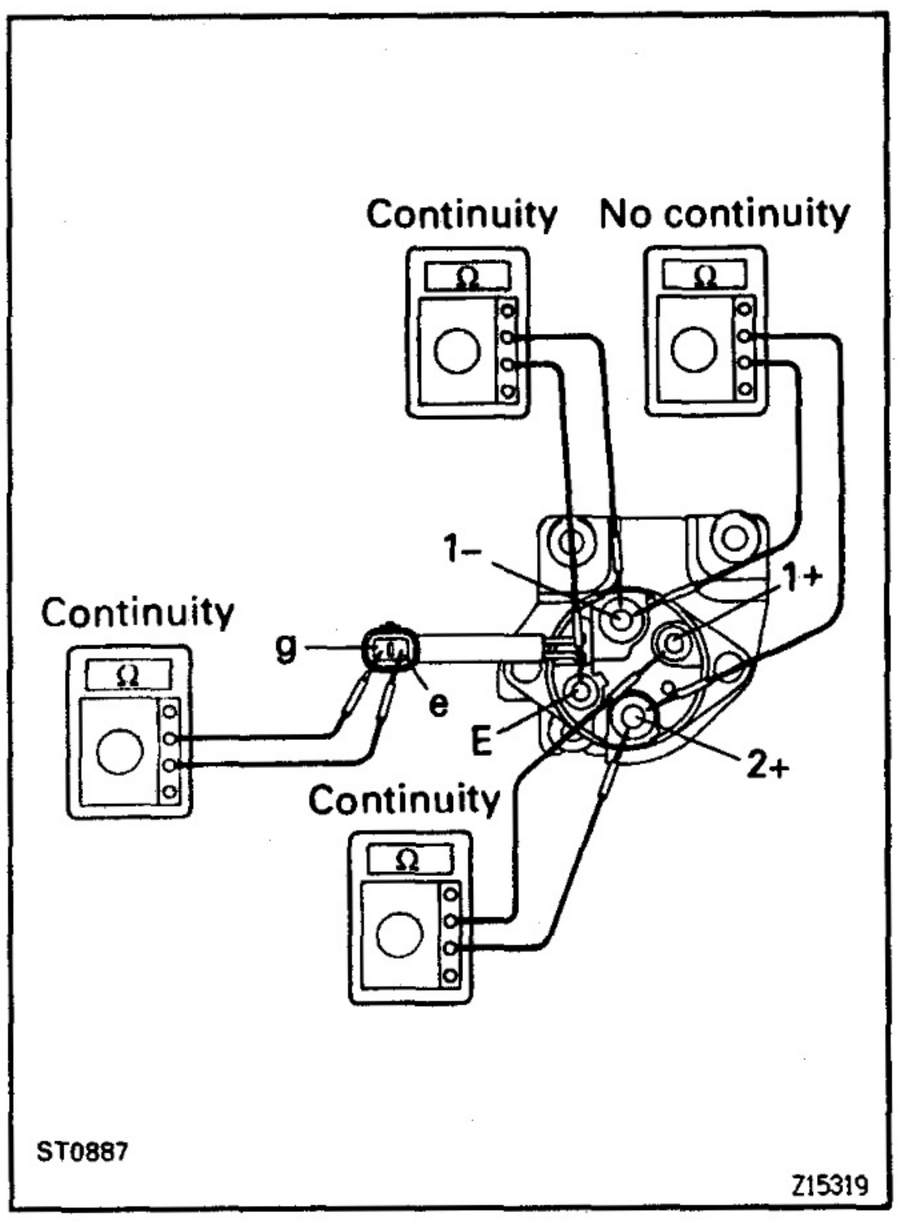


VOLTAGE CONVERTER RELAY (w/ 24 V Starter)

ST0A4-01

VOLTAGE CONVERTER RELAY INSPECTION

1. REMOVE VOLTAGE CONVERTER RELAY



2. INSPECT VOLTAGE CONVERTER RELAY

A. Inspect relay continuity

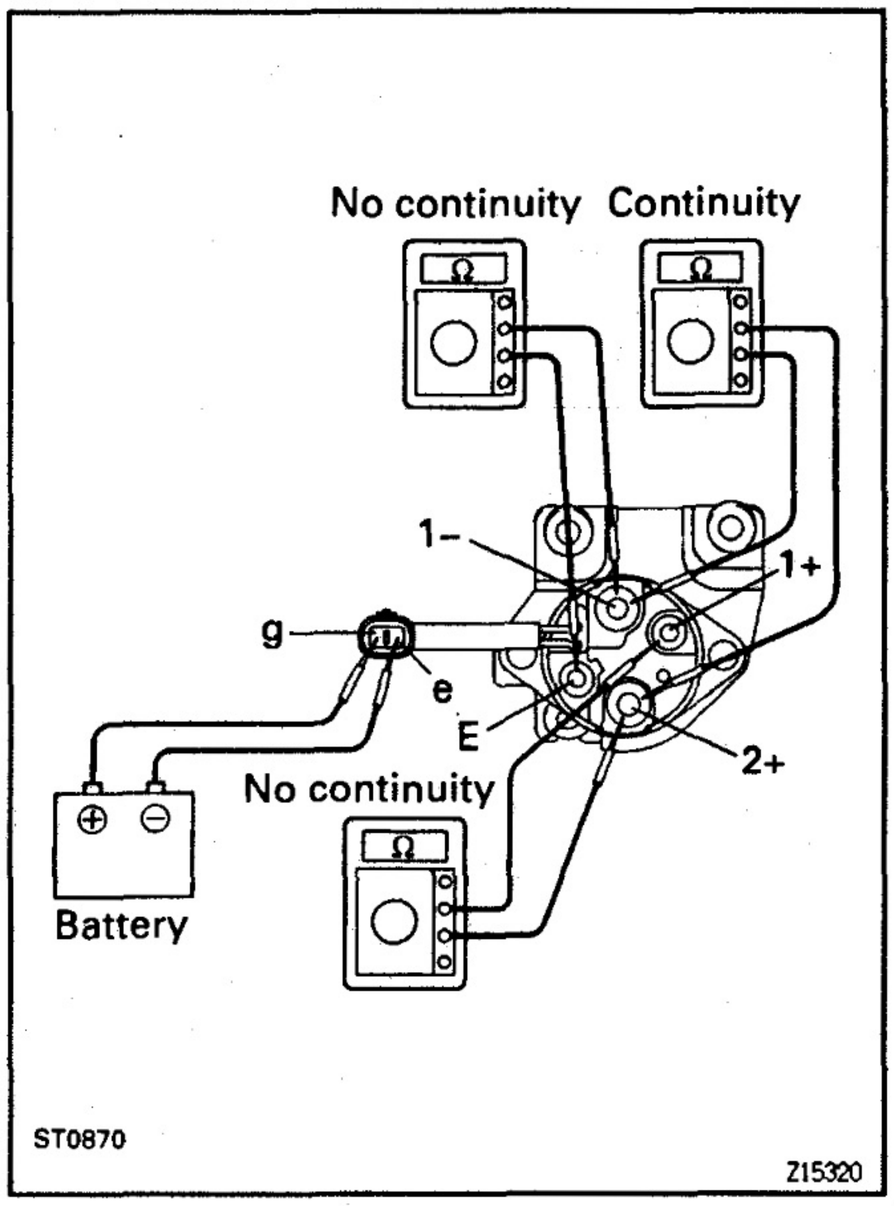
(a) Using an ohmmeter, check that there is continuity between terminals e and g.

(b) Using an ohmmeter, check that there is continuity between terminals 1 – and E.

(c) Using an ohmmeter, check that there is continuity between terminals 1 + and 2+.

(d) Using an ohmmeter, check that there is no continuity between terminals 1 – and 2+.

If continuity is not as specified, replace the relay.



B. Inspect relay operation

(a) Apply battery voltage across terminals e and g.

(b) Using an ohmmeter, check that there is continuity between terminals 1 — and 2+.

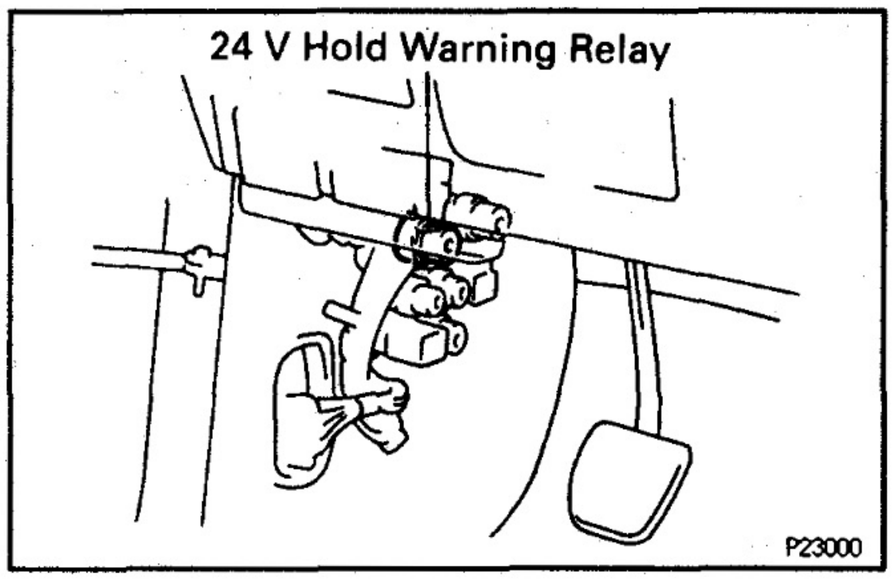
(c) Using an ohmmeter, check that there is no continuity between terminals 1+ and 2+.

(d) Using an ohmmeter, check that there is no continuity terminals 1 — and E.

If continuity is not as specified, replace the relay.

3. REINSTALL VOLTAGE CONVERTER RELAY

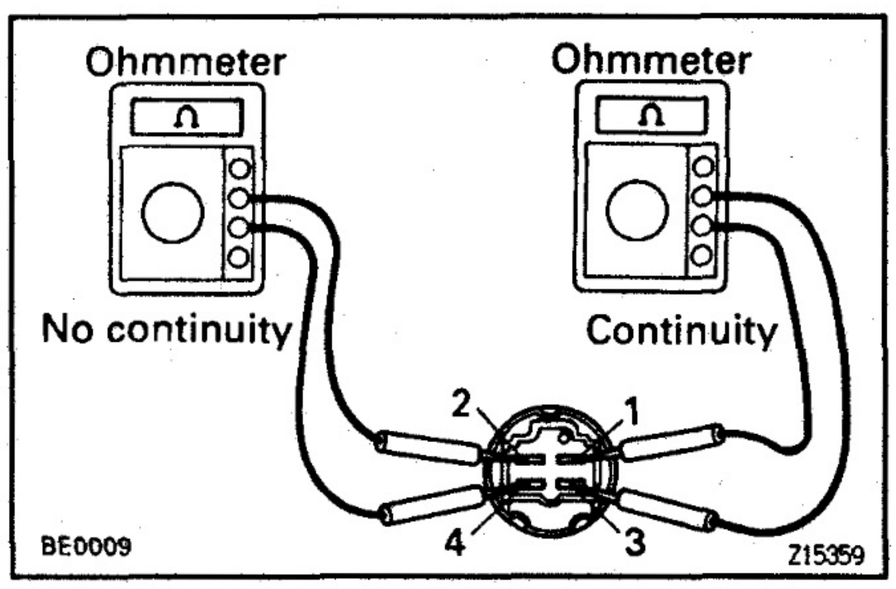
ST



24 V HOLD WARNING RELAY (w/ 24 V Starter)

24 V HOLD WARNING RELAY INSPECTION ST0AS-01

1. REMOVE 24 V HOLD WARNING RELAY



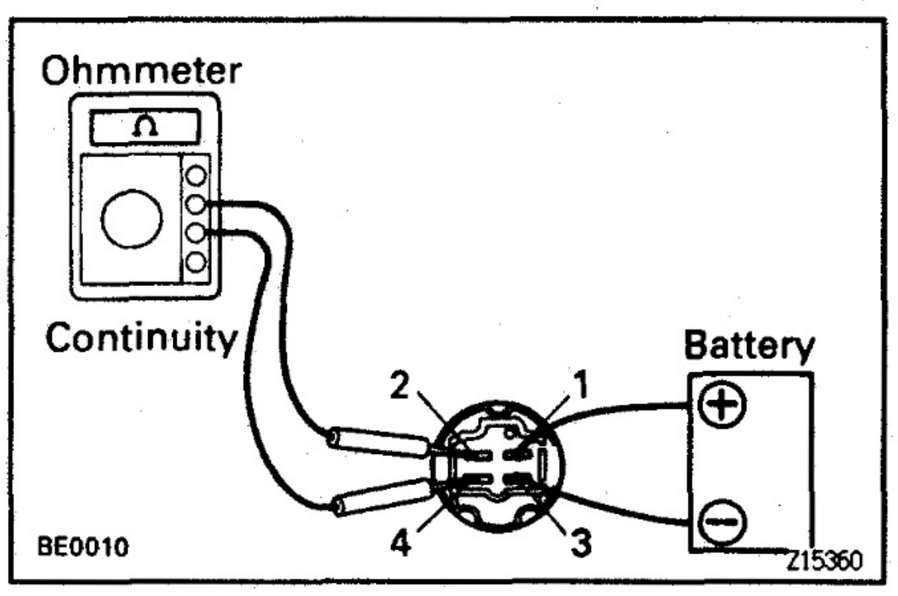
2. INSPECT 24 V HOLD WARNING RELAY

A. Inspect relay continuity

(a) Using an ohmmeter, check that there is continuity between terminals 1 and 3.

(b) Using an ohmmeter, check that there is continuity between terminals 2 and 4.

If continuity is not as specified, replace the relay.



B. Inspect relay operation

(a) Apply battery voltage across terminals 1 and 3.

(b) Using an ohmmeter, check that there is continuity between terminals 2 and 4.

If continuity is not as specified, replace the relay.

3. REINSTALL 24 V HOLD WARNING RELAY

SERVICE SPECIFICATIONS

SERVICE DATA

ST015-0W

Starter	Rated voltage and output power			12 V 2.5 kW, 24 V 4.5 kW
	No-load characteristics	Current	12 V type	180 A or less at 11.0 V
			24 V type	90 A or less at 23.0 V
			rpm	3,500 rpm or more
	Brush length		STD	20.5 — 21.0 mm (0.807 — 0.827 in.)
			Minimum	13.0 mm (0.512 in.)
	Spring installed load			18.6 — 35.3 N (1.9 — 3.6 kgf, 4.2 — 7.9 lbf)
	Commutator			
	Diameter		STD	36.0 mm (1.417 in.)
			Minimum	35.0 mm (1.378 in.)
	Undercut depth		STD	0.7 — 0.9 mm (0.028 — 0.035 in.)
			Minimum	0.2 mm (0.008 in.)
	Circle runout		Maximum	0.05 mm (0.0020 in.)

TORQUE SPECIFICATIONS

ST01Q-0L

Part tightened	N·m	kgf·cm	ft·lbf
Starter housing x Magnetic switch	9.3	95	82 in.·lbf
End cover x Starter housing	9.3	95	82 in.·lbf
Lead wire x Terminal 50	3.6	41	32 in.·lbf
Lead wire x Terminal C	21.1	215	16

CHARGING SYSTEM

PRECAUTION ..... CH– 2
PREPARATION ..... CH– 2
ON–VEHICLE INSPECTION ..... CH– 3
ALTERNATOR ..... CH– 5
SERVICE SPECIFICATIONS ..... CH– 14

PRECAUTION

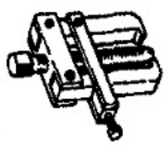
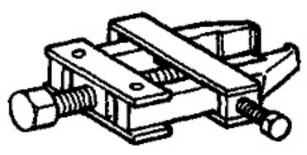
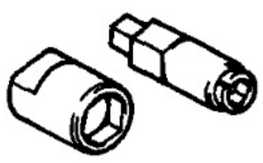
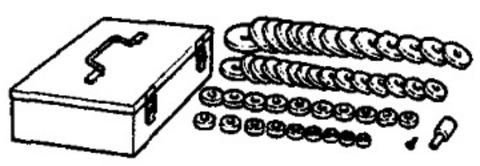
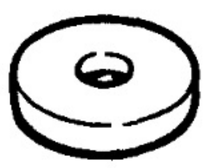
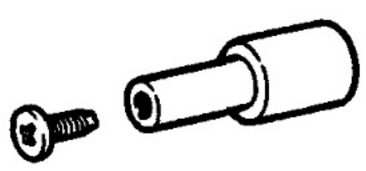
CH00K–0E

1. Check that the battery cables are connected to the correct terminals.
2. Disconnect the battery cables when the battery is given a quick charge.
3. Do not perform tests with a high voltage insulation resistance tester.
4. Never disconnect the battery while the engine is running.

PREPARATION

CH00R–0D

SST (SPECIAL SERVICE TOOLS)

	09285–76010	Injection Pump Camshaft Bearing Cone Replacer	Rotor rear bearing cover
	09286–46011	Injection Pump Spline Shaft Puller	Rectifier end frame
	09820–00021	Alternator Rear Bearing Puller	
	09820–00030	Alternator Rear Bearing Replacer	
	09820–63010	Alternator Pulley Set Nut Wrench Set	
	09950–60010	Replacer Set	Rotor front bearing
	(09951–00260)	Replacer 26	
	(09951–00500)	Replacer 50	
	(09952–06010)	Adapter	

RECOMMENDED TOOLS

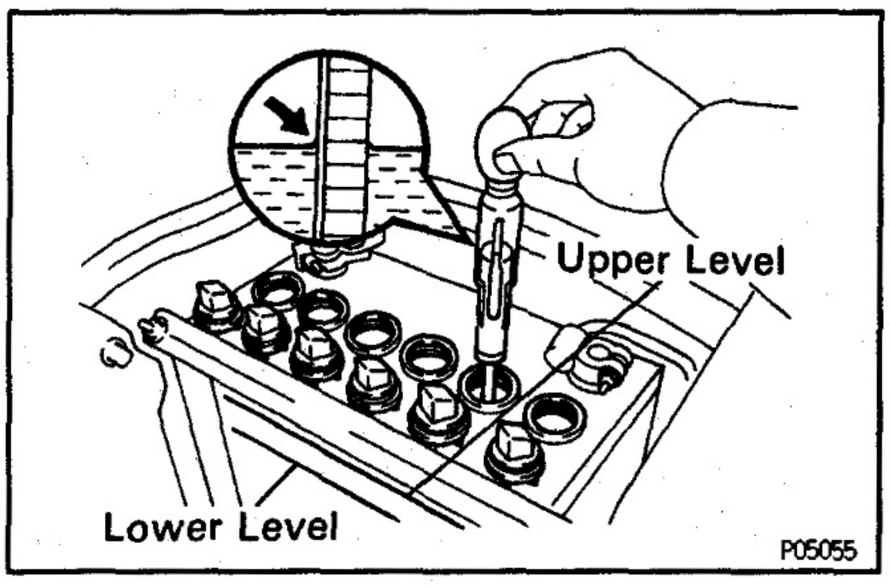
CH00T–0K

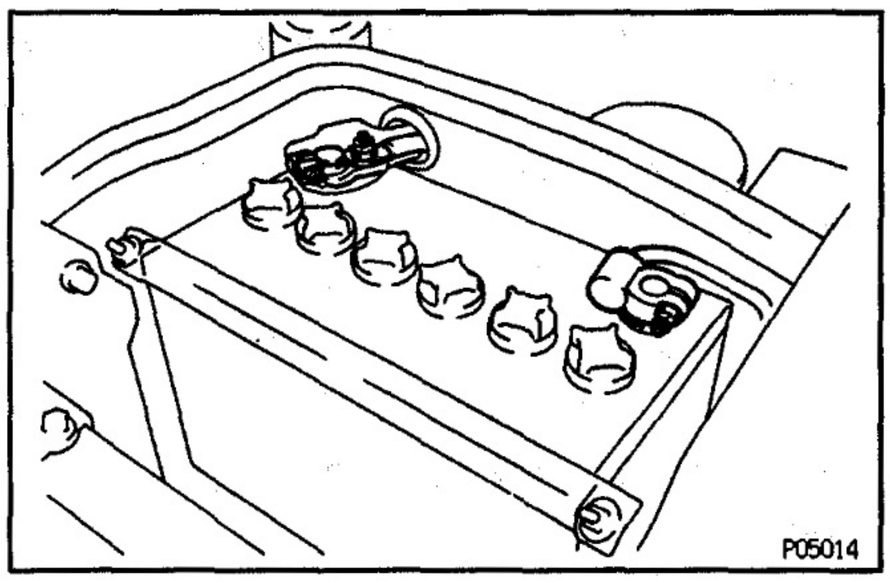
	09082–00050 TOYOTA Electrical Tester Set.	

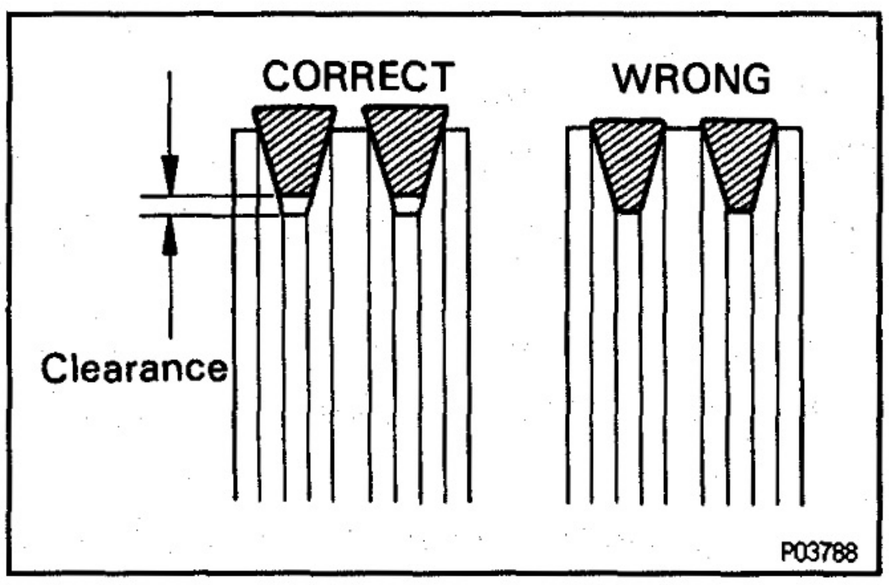
CH00V–0L

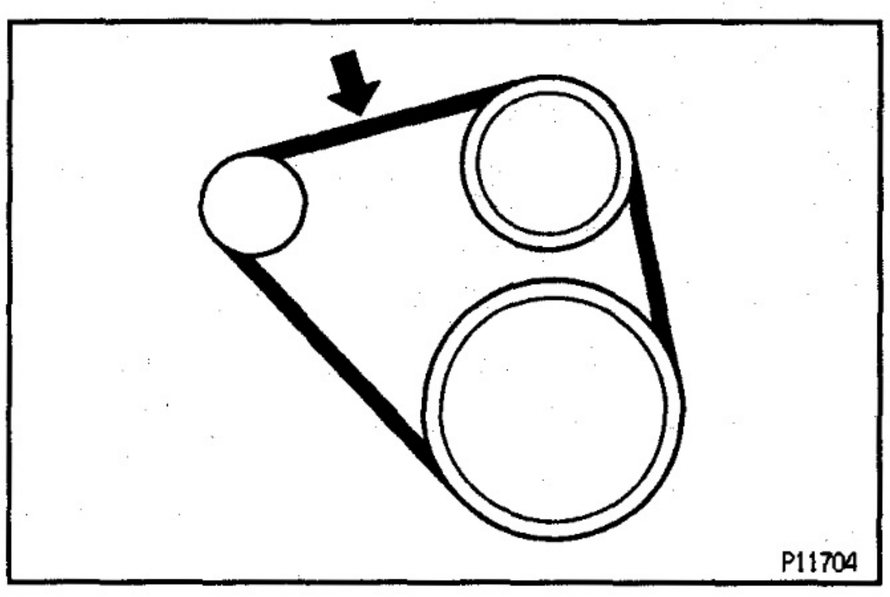
EQUIPMENT

Ammeter(A)	
Battery specific gravity gauge	
Torque wrench	
Vernier calipers	Rotor (Slip ring)









ON–VEHICLE INSPECTION

CH

CH0AD–01

1. CHECK BATTERY SPECIFIC GRAVITY AND ELECTROLYTE LEVEL

(a) Check the electrolyte quantity of each cell.
If insufficient, refill with distilled (or purified) water.

(b) Check the specific gravity of each cell.

Standard specific gravity:

At 20°C (68°F):

105D31L and 105D31R: 1.27 – 1.29

Others: 1.25 – 1.27

If the gravity is less than specification, charge the battery.

2. CHECK BATTERY TERMINALS, FUSIBLE LINK AND FUSES

(a) Check that the battery terminals are not loose or corroded.

(b) Check the fusible link and fuses for continuity.

3. INSPECT DRIVE BELTS

(a) Visually check the drive belt for cracks, oiliness or wear. Check that the belt does not touch the bottom of the pulley groove.
If necessary, replace the drive belts as a set.

(b) Check the drive belt deflection by pressing on the belt at the points indicated in the illustration with 98 N (10 kgf, 22 lbf) of pressure.

Drive belt deflection:

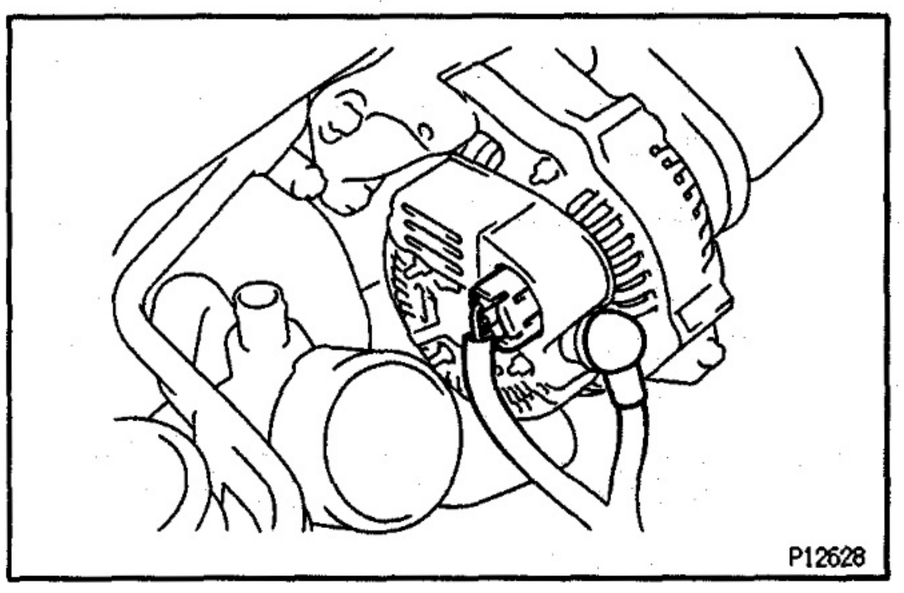
New belt: 6 – 8 mm (0.24 – 0.31 in.)

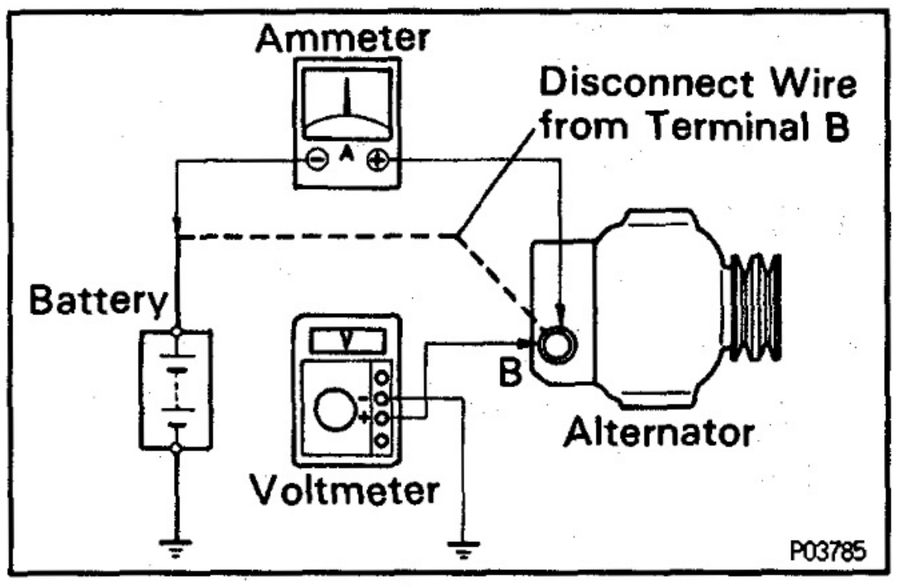
Used belt: 8 – 11 mm (0.31 – 0.43 in.)

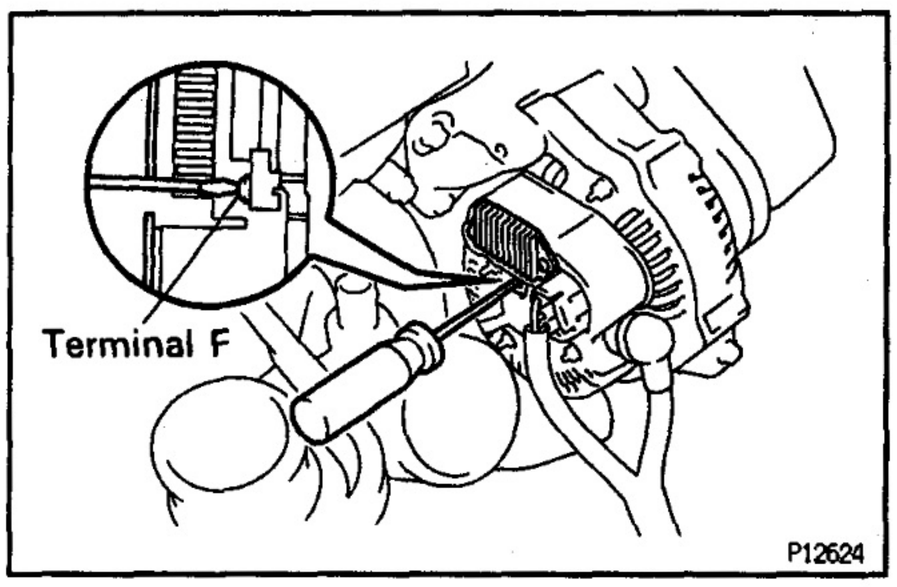
If necessary, adjust the drive belt deflection.

HINT:

- "New belt" refers to a belt which has been used less than 5 minutes on a running engine.
- "Used belt" refers to a belt which has been used on a running engine for 5 minutes or more.
- After installing a new belt, run the engine for about 5 minutes and recheck the deflection.







4. VISUALLY CHECK ALTERNATOR WIRING AND LISTEN FOR ABNORMAL NOISES

(a) Check that the wiring is in good condition.

(b) Check that there is no abnormal noise from the alternator while the engine is running.

5. INSPECT DISCHARGE WARNING LIGHT CIRCUIT

(a) Turn the ignition switch "ON". Check that the discharge warning light comes on.

(b) Start the engine. Check that the light goes off.
If the light does not operate as specified, troubleshoot the discharge warning light circuit.

6. INSPECT CHARGING CIRCUIT WITHOUT LOAD

HINT: If a battery/alternator tester is available, connect the tester to the charging circuit as per the manufacturer's instructions.

(a) If a tester is not available, connect a voltmeter and ammeter the charging circuit as follows:

- Disconnect the wire from terminal B of the alternator and connect it to the negative (–) lead of the ammeter.
- Connect the positive (+) lead of the ammeter to terminal B of the alternator.
- Connect the positive (+) lead of the voltmeter to terminal B of the alternator.
- Ground the negative (–) lead of the voltmeter.

(b) Check the charging circuit as follows:
With the engine running from idle to 2,000 rpm, check the reading on the ammeter and voltmeter.

Standard amperage:

10 A or less

Standard voltage:

At 25°C (77°F): 14.0 – 15.0 V

At 115°C (239°F): 13.5 – 14.3 V

If the voltmeter reading is more than standard voltage, replace the IC regulator.

If the voltmeter reading is less than the standard voltage, check the IC regulator and alternator as follows:

- With terminal F grounded, start the engine and check the voltmeter reading of terminal B.
- If the voltmeter reading is more than standard voltage, replace the IC regulator.
- If the voltmeter reading is less than standard voltage, check the alternator.

7. INSPECT CHARGING CIRCUIT WITH LOAD

(a) With the engine running at 2,000 rpm, turn on the high beam headlights and place the heater blower switch at "HI".

(b) Check the reading on the ammeter.

Standard amperage:

12 V 80 A type: 30 A or more

12 V 100 A type: 40 A or more

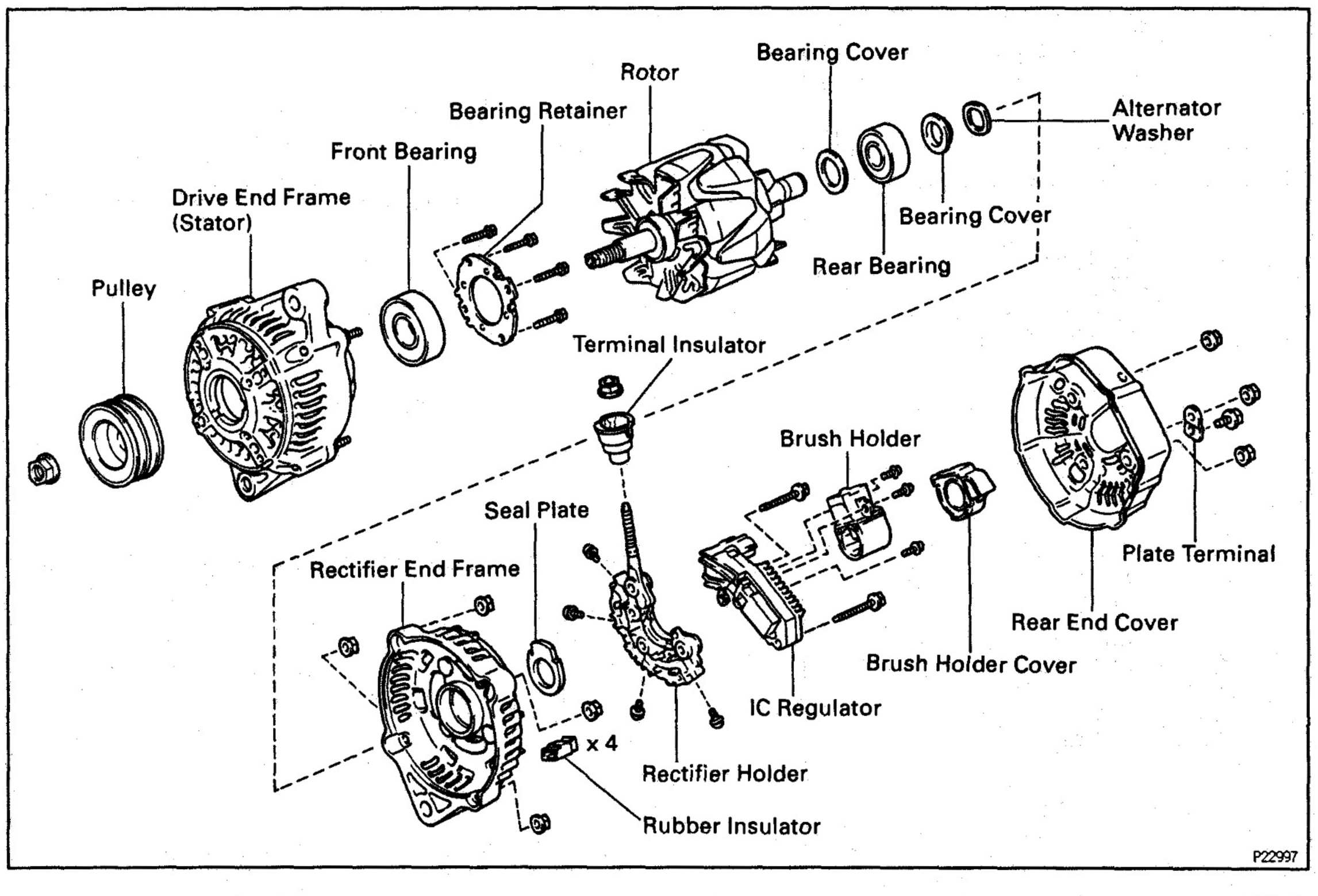
If the ammeter reading is less than standard amperage, repair the alternator.

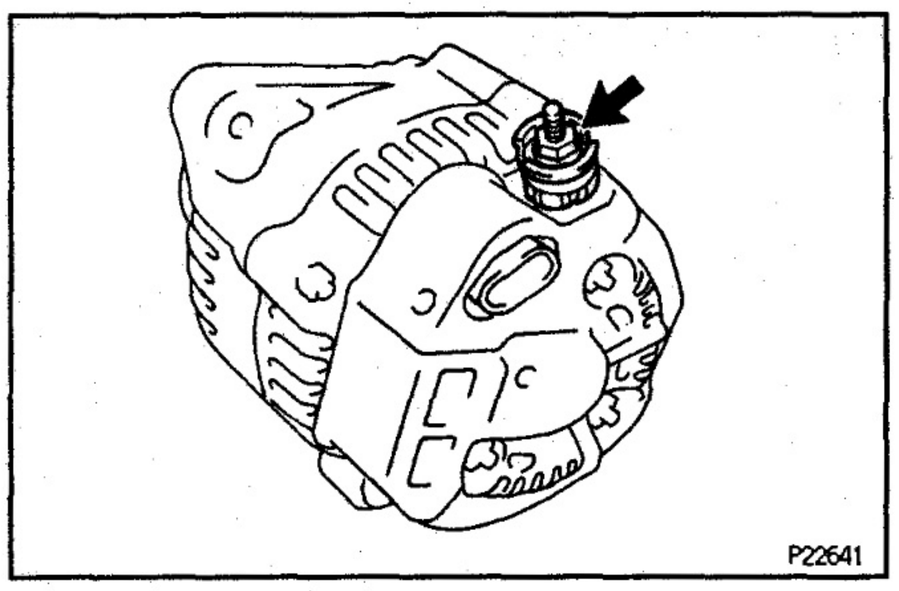
HINT: If the battery is fully charged, the indication will sometimes be less than standard amperage.

ALTERNATOR

COMPONENTS FOR DISASSEMBLY AND ASSEMBLY

CH0SR-0D



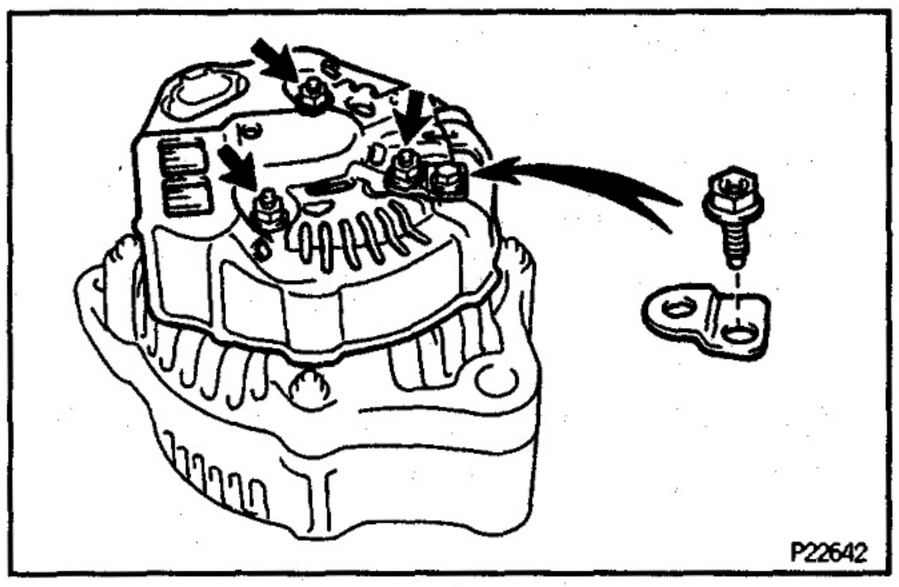


CH0AE-01

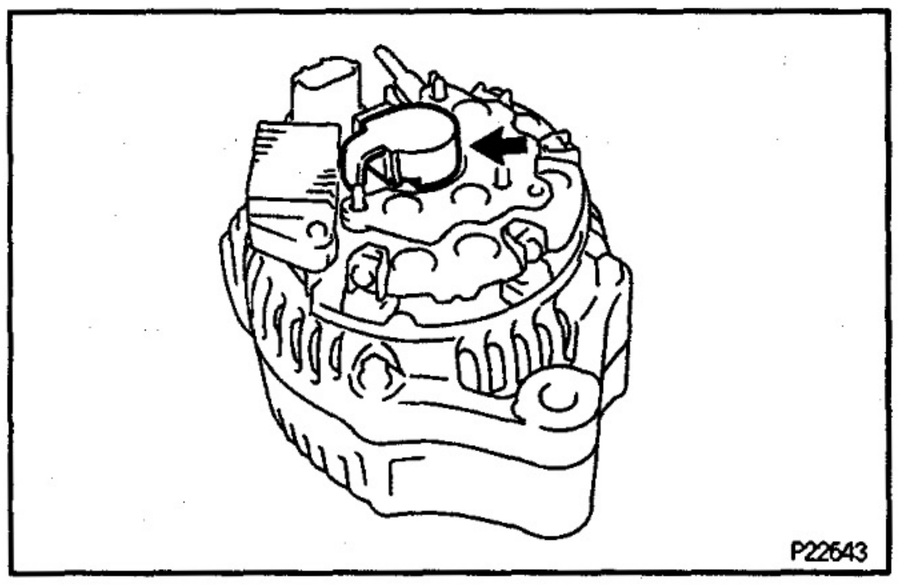
ALTERNATOR DISASSEMBLY

1. REMOVE REAR END COVER

(a) Remove the nut and terminal insulator.

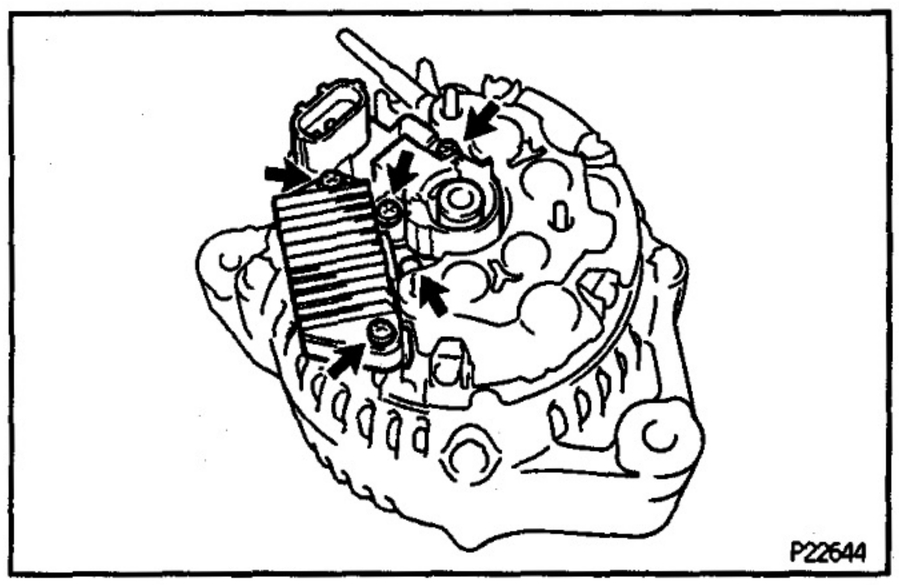


(b) Remove the 3 nuts, bolt and plate terminal.
(c) Remove the rear end cover.

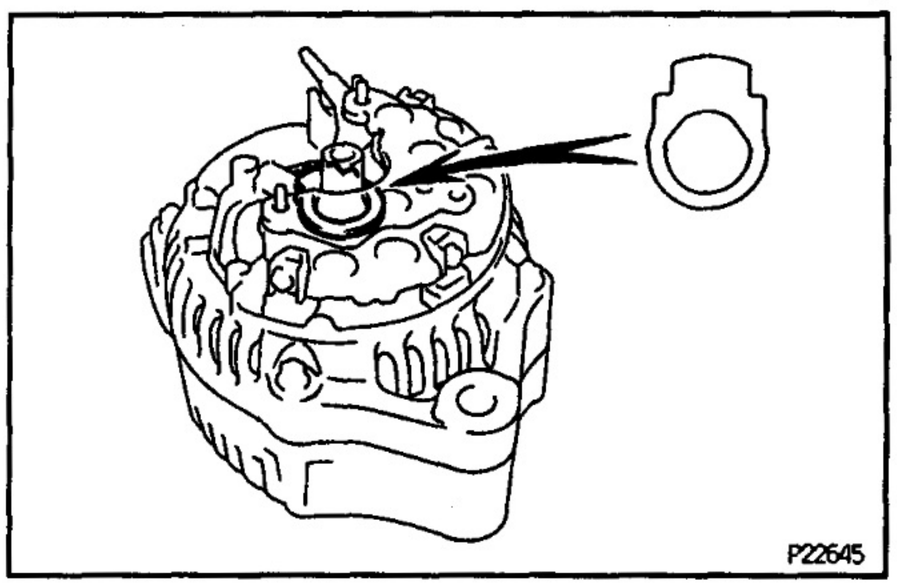


2. REMOVE BRUSH HOLDER AND IC REGULATOR

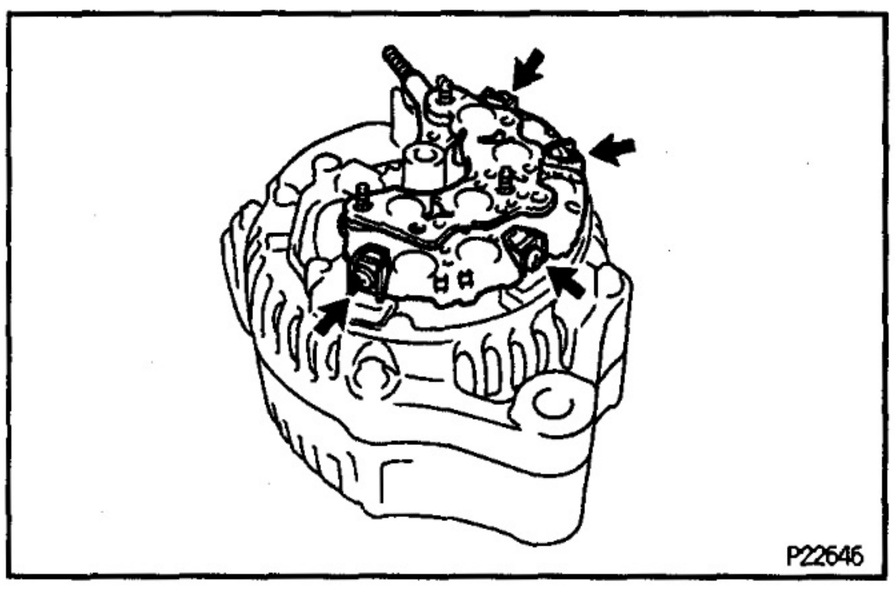
(a) Remove the brush holder cover from the brush holder.



(b) Remove the 5 screws, brush holder and IC regulator.

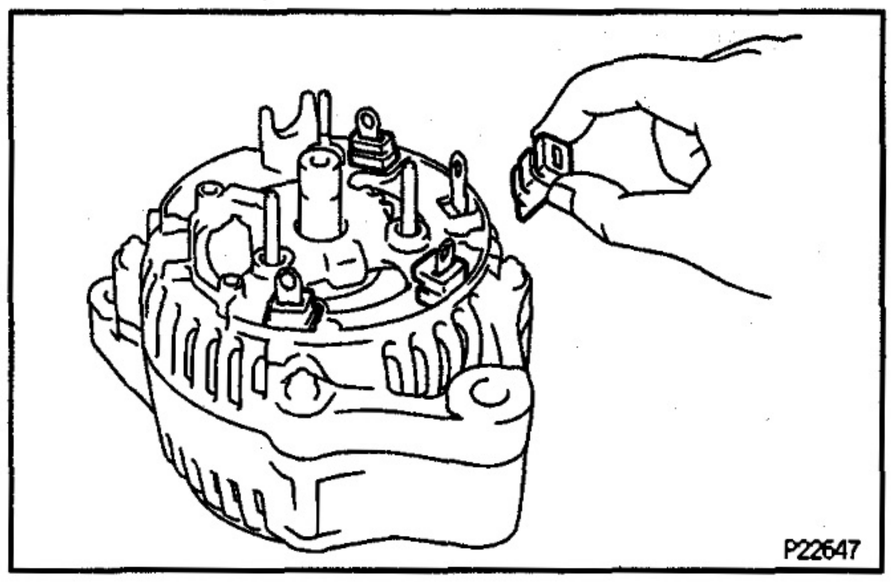


(c) Remove the seal plate from the rectifier end frame.

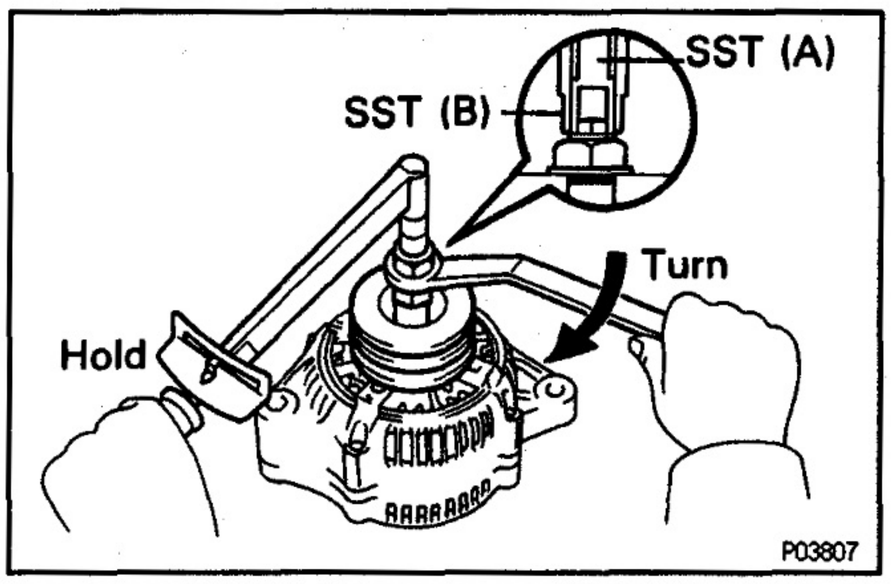


3. REMOVE RECTIFIER HOLDER

(a) Remove the 4 screws and rectifier holder.



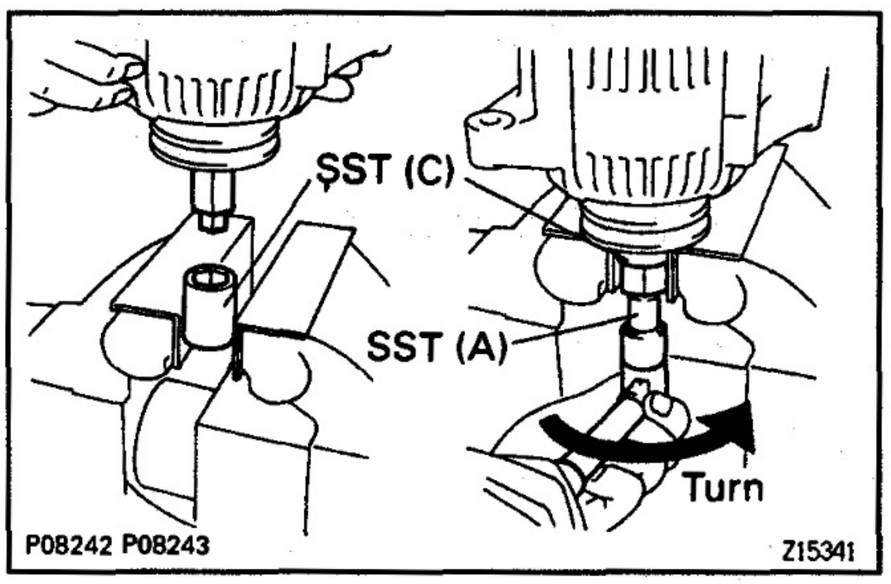
(b) Remove the 4 rubber insulators.



4. REMOVE PULLEY

(a) Hold SST (A) with a torque wrench, and tighten SST (B) clockwise to the specified torque.
SST 09820–63010
Torque: 39 N·m (400 kgf·cm, 29 ft·lbf)

(b) Check that SST (A) is secured to the rotor shaft.



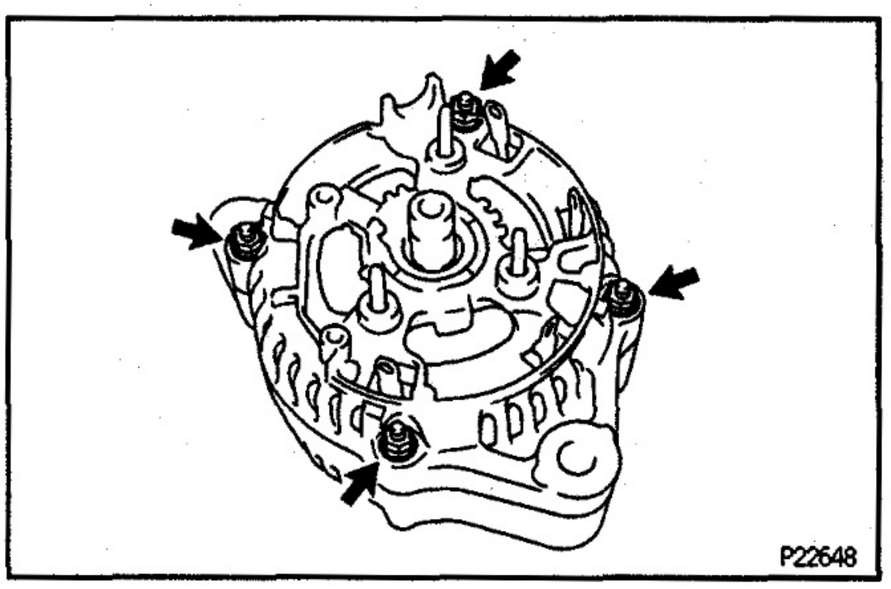
(c) As shown in the illustration, mount SST (C) in a vise, and install the alternator to SST (C).

(d) To loosen the pulley nut, turn SST (A) in the direction shown in the illustration.
NOTICE: To prevent damage to the rotor shaft, do not loosen the pulley nut more than one–half of a turn.

(e) Remove the alternator from SST (C).

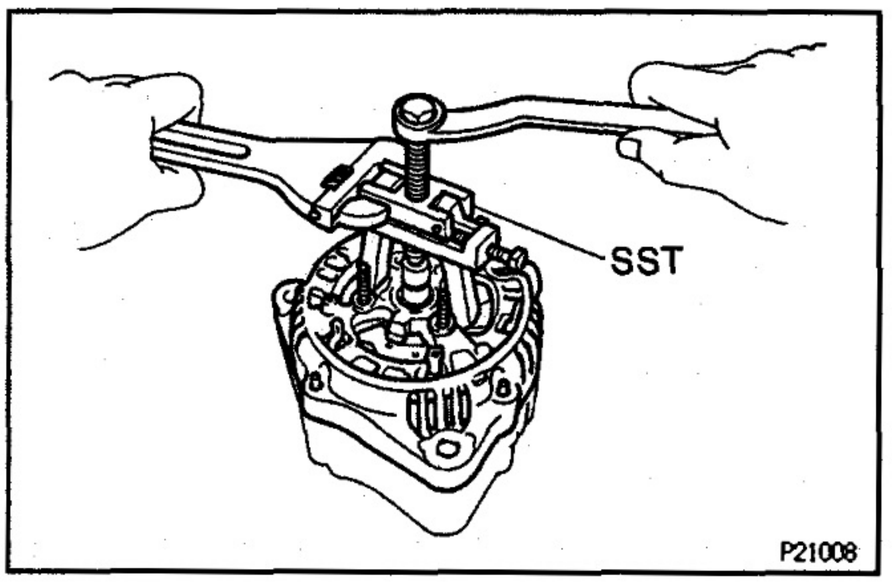
(f) Turn SST (B) and remove SST (A and B).

(g) Remove the pulley nut and pulley.

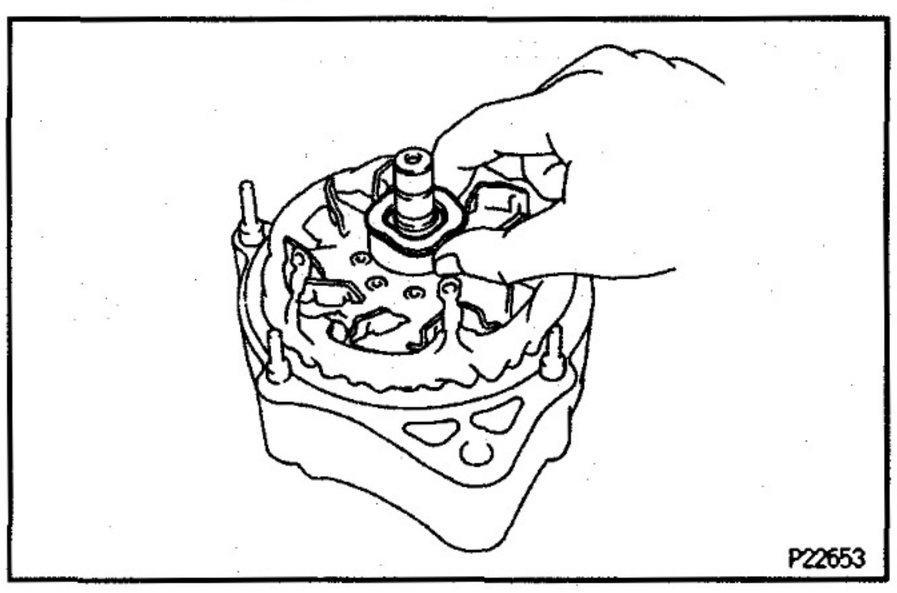


5. REMOVE RECTIFIER END FRAME

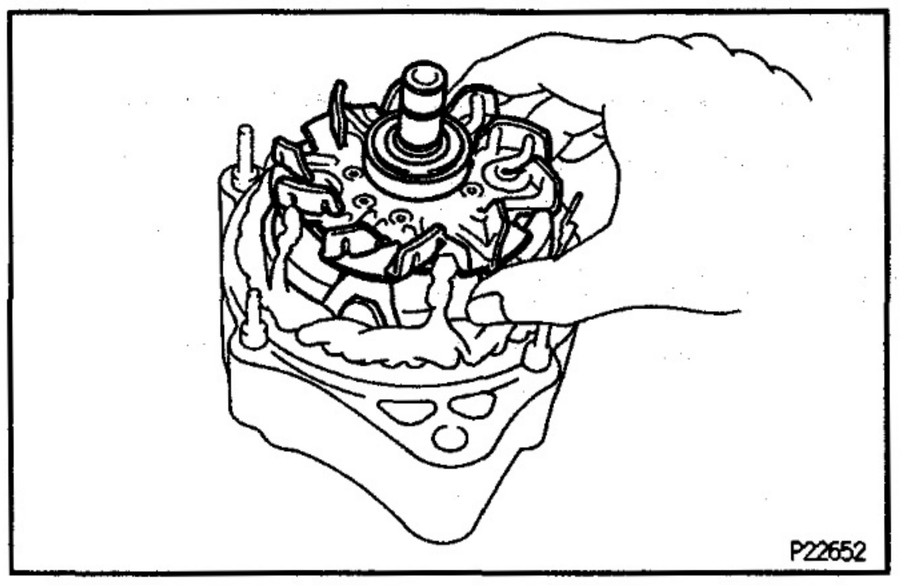
(a) Remove the 4 nuts.



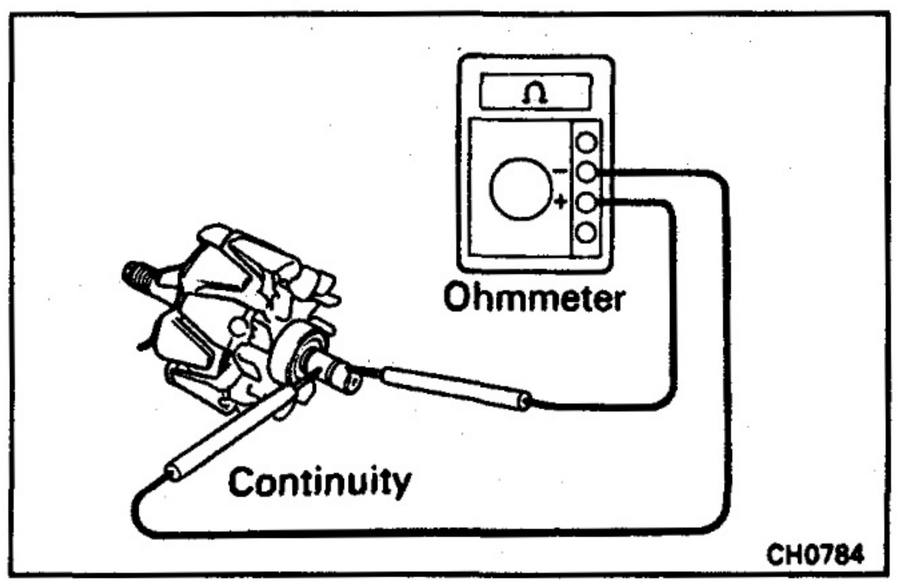
(b) Using SST, remove the rectifier end frame.
SST 09286–46011



(c) Remove the alternator washer.



6. REMOVE ROTOR FROM DRIVE END FRAME



ALTERNATOR INSPECTION AND REPAIR CH015-0D

Rotor

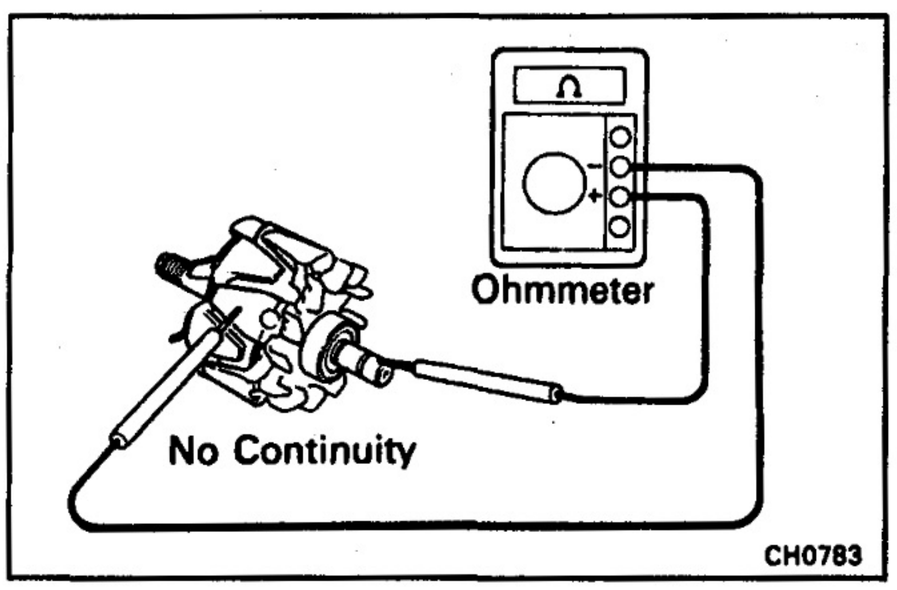
1. INSPECT ROTOR FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between the slip rings.

Standard resistance:

At 20°C (68°F): 2.9 Ω

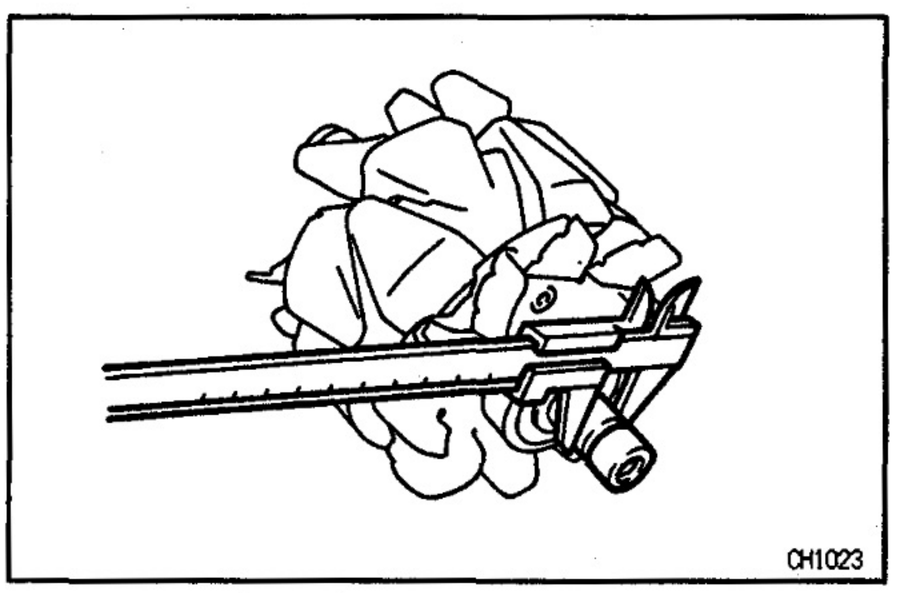
If there is no continuity, replace the rotor.



2. INSPECT ROTOR FOR GROUND

Using an ohmmeter, check that there is no continuity between the slip ring and rotor.

If there is continuity, replace the rotor.



3. INSPECT SLIP RINGS

(a) Check that the slip rings are not rough or scored.

If rough or scored, replace the rotor.

(b) Using vernier calipers, measure the slip ring diameter.

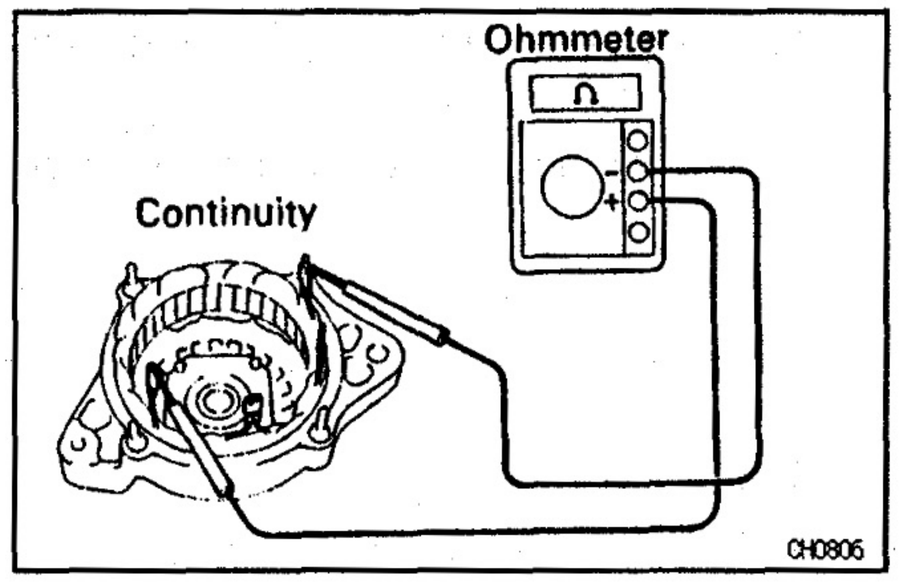
Standard diameter:

14.2–14.4 mm (0.559–0.567 in.)

Minimum diameter:

12.8 mm (0.504 in.)

If the diameter is less than minimum, replace the rotor.

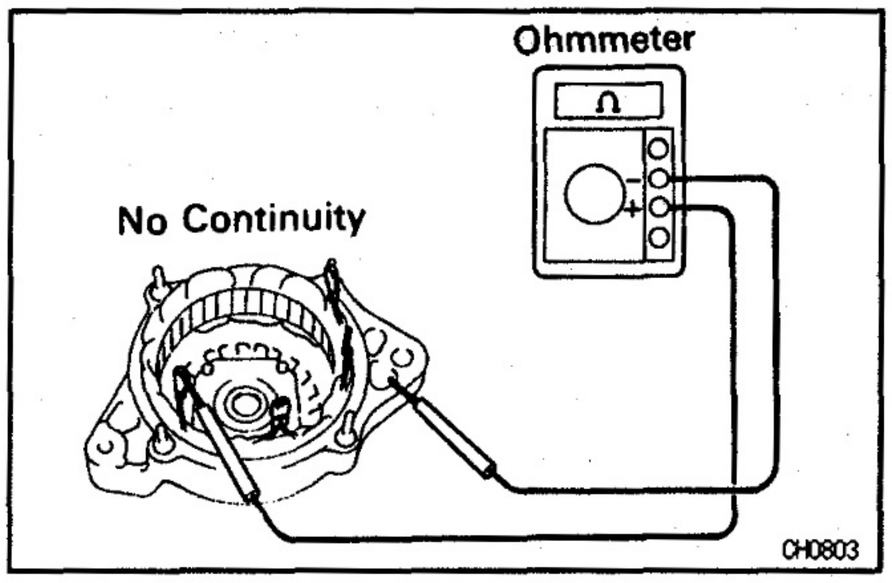


Stator (Drive End Frame)

1. **INSPECT STATOR FOR OPEN CIRCUIT**

Using an ohmmeter, check that there is continuity between the coil leads.

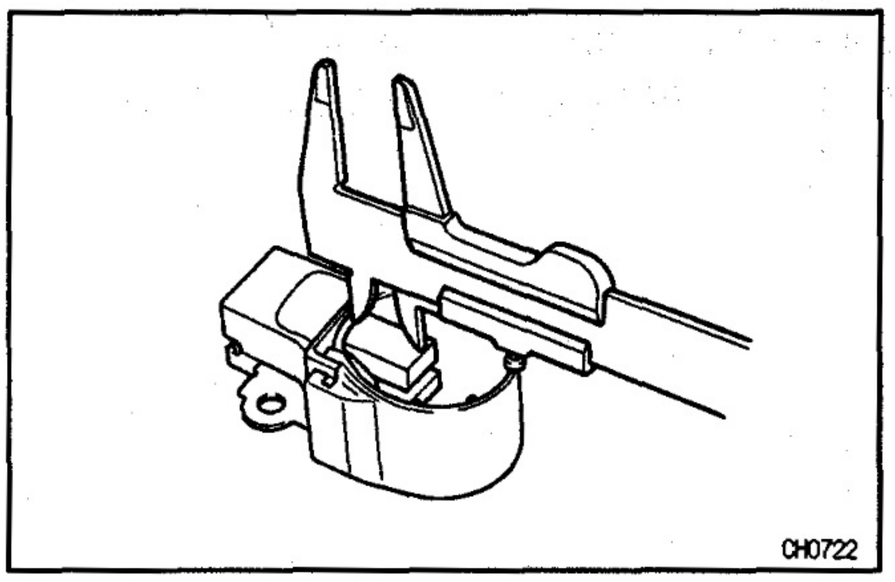
If there is no continuity, replace the drive end frame assembly.



2. **INSPECT STATOR FOR GROUND**

Using an ohmmeter, check that there is no continuity between the coil lead and drive end frame.

If there is continuity, replace the drive end frame assembly.



Brushes

INSPECT EXPOSED BRUSH LENGTH

Using vernier calipers, measure the exposed brush length.

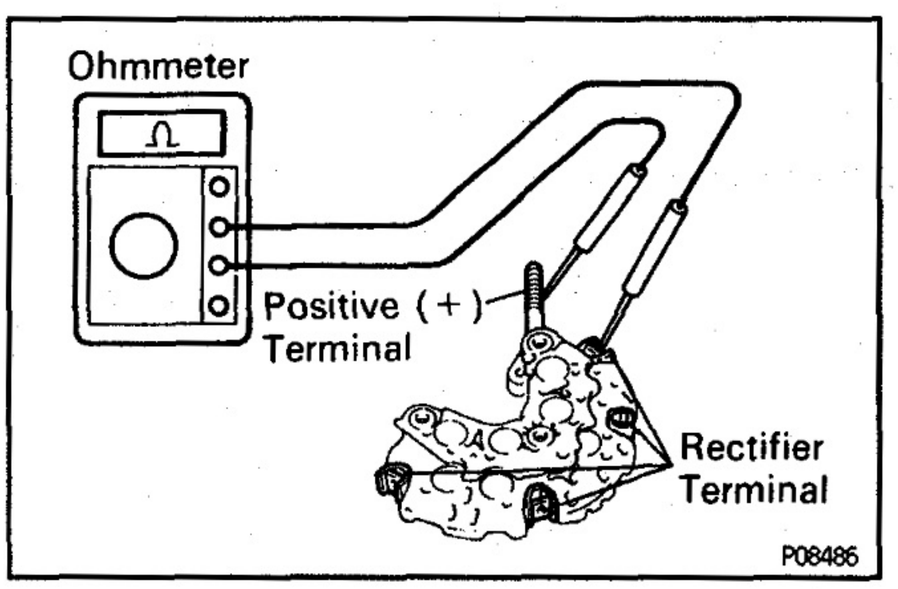
Standard exposed length:

10.5 mm (0.413 in.)

Minimum exposed length:

1.5 mm (0.059 in.)

If the exposed length is less than minimum, replace the brush holder.



Rectifiers (Rectifier Holder)

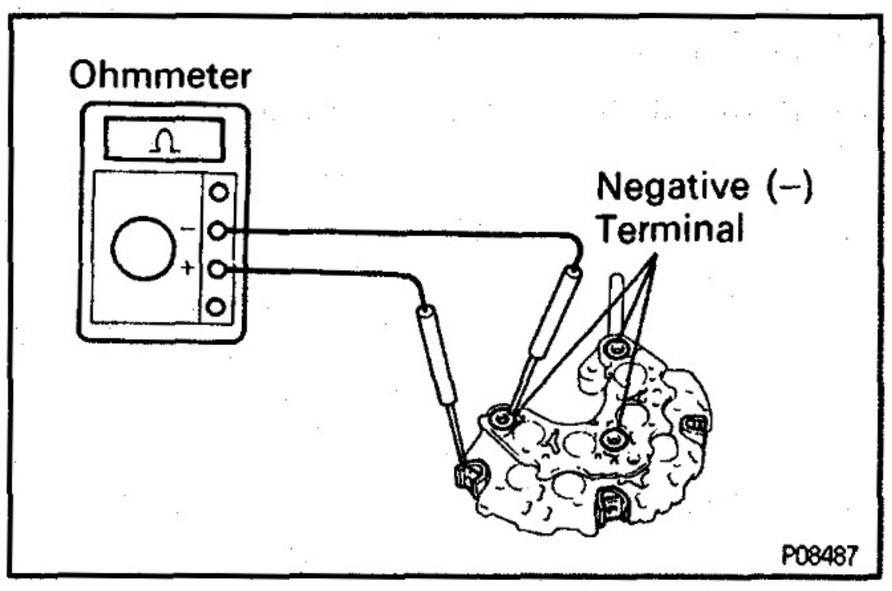
1. **INSPECT POSITIVE RECTIFIER**

(a) Using an ohmmeter, connect one tester probe to the positive (+) terminal and the other to each rectifier terminal.

(b) Reverse the polarity of the tester probes and repeat step (a).

(c) Check that one shows continuity and the other shows no continuity.

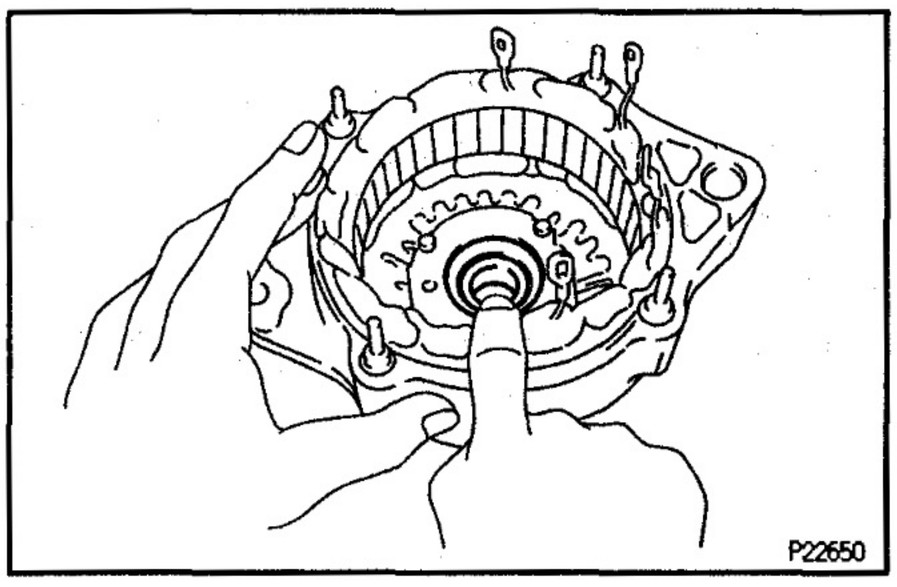
If continuity is not as specified, replace the rectifier holder.



2. **INSPECT NEGATIVE RECTIFIER**

(a) Using an ohmmeter, connect one tester probe to each negative (–) terminal and the other to each rectifier terminal.

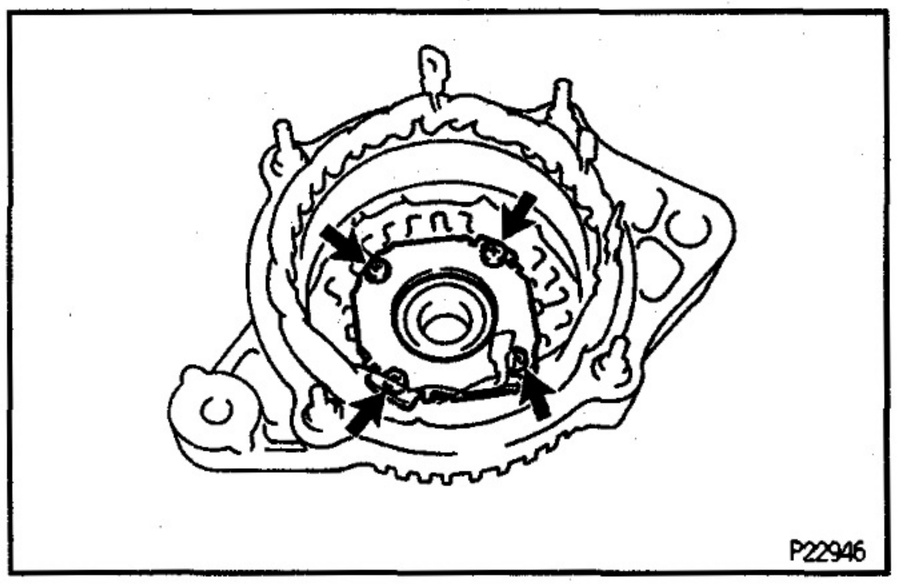
(b) Reverse the polarity of the tester probes and repeat step (a).



(c) Check that one shows continuity and the other shows no continuity.
If continuity is not as specified, replace the rectifier holder.

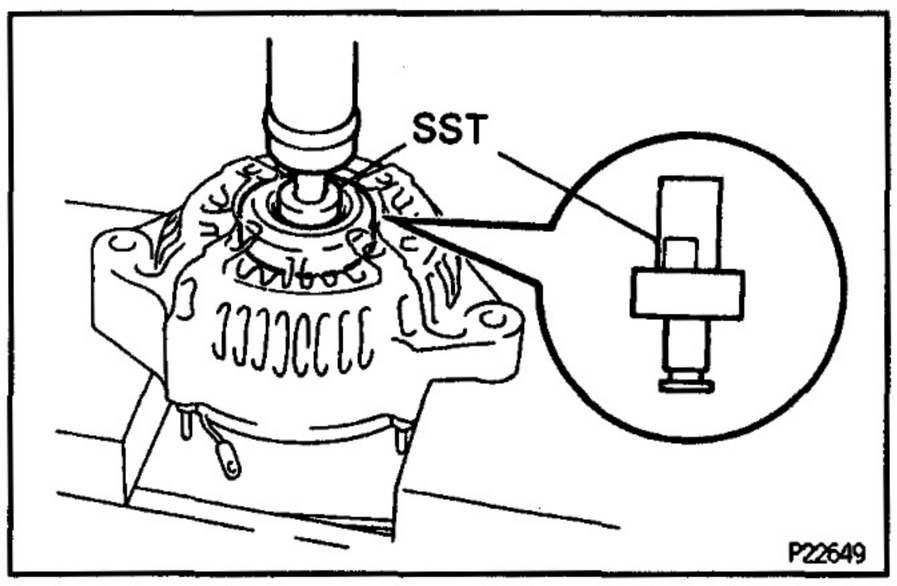
Bearings

1. INSPECT FRONT BEARING
Check that the bearing is not rough or worn.

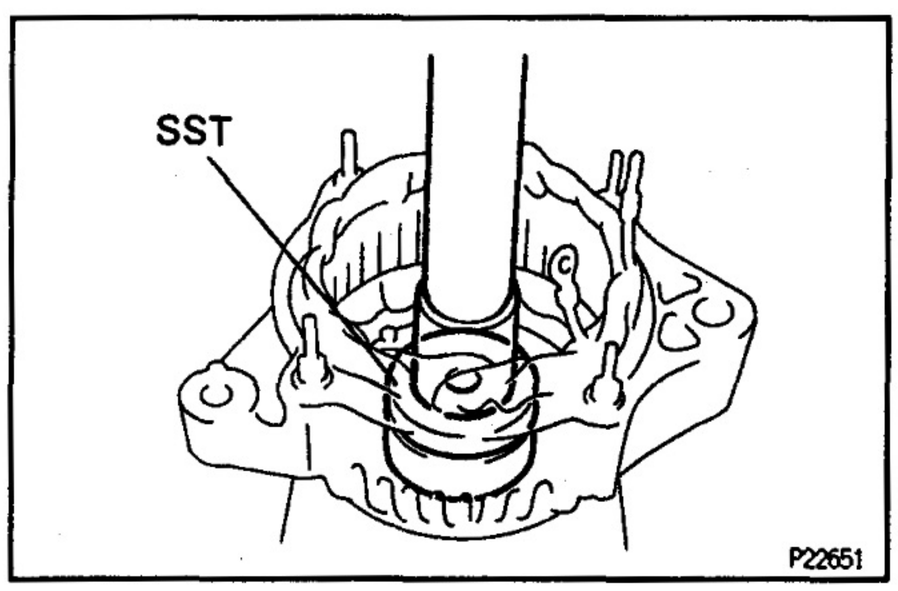


2. IF NECESSARY, REPLACE FRONT BEARING

(a) Remove the 4 screws, bearing retainer and bearing.

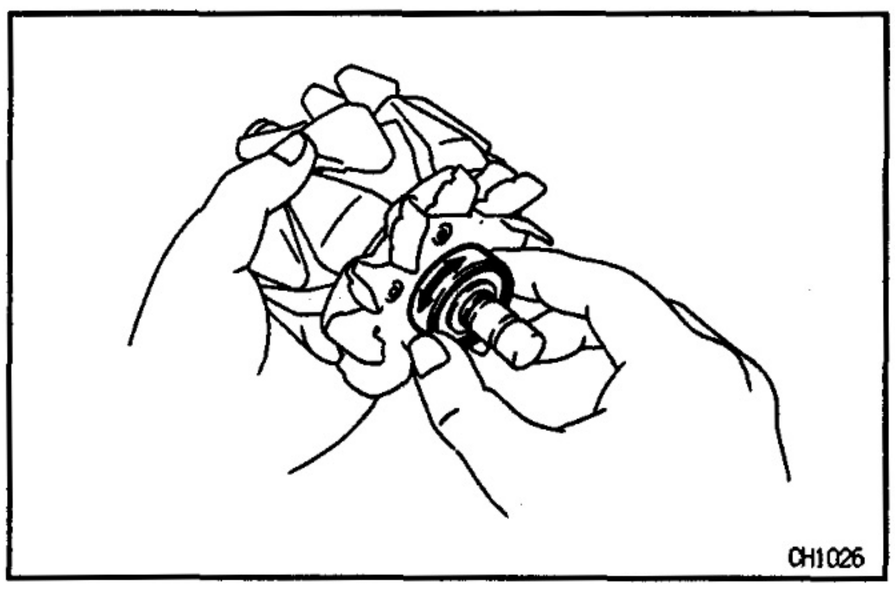


(b) Using SST and a press, press out the bearing.
SST 09950–60010 (09951–00260, 09952–06010)

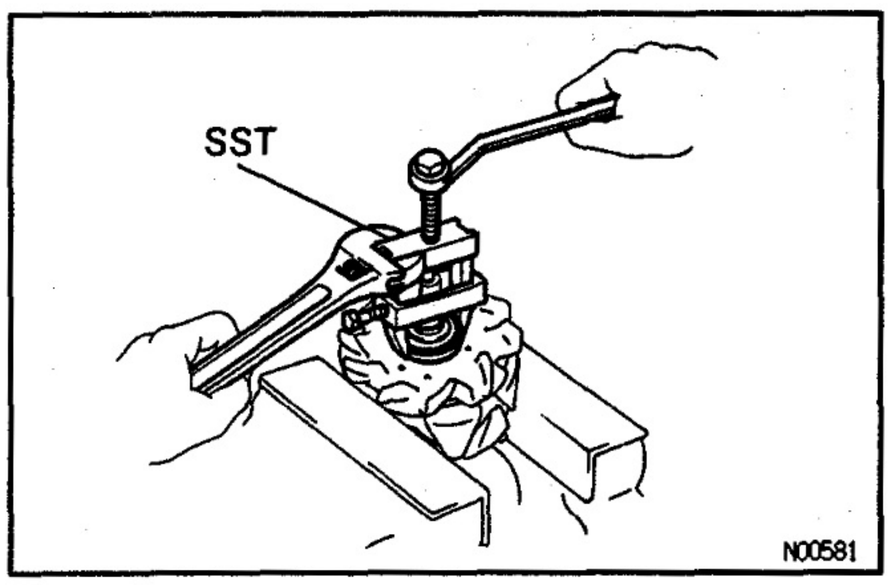


(c) Using SST and a press, press in a new bearing.
SST 09950–60010 (09951–00500)

(d) Install the bearing retainer with the 4 screws.

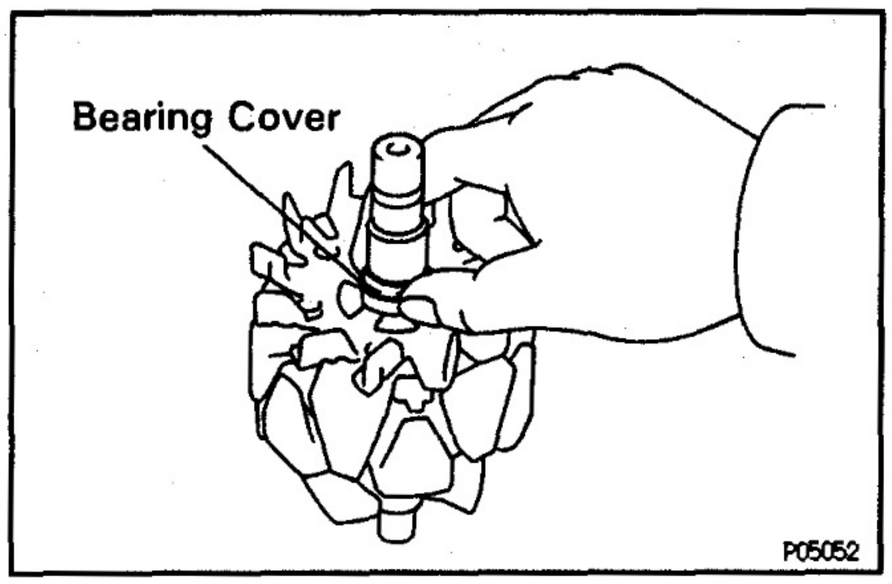


3. INSPECT REAR BEARING
Check that the bearing is not rough or worn.

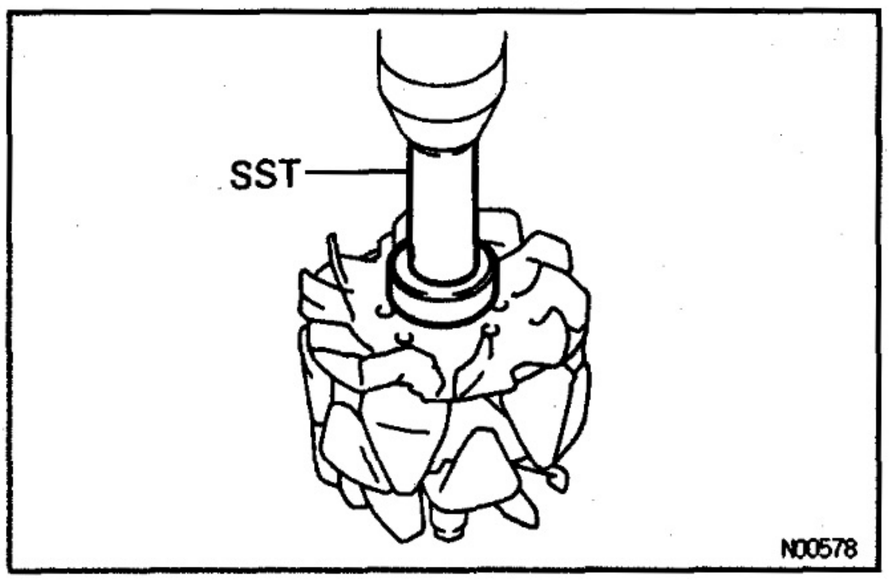


4. IF NECESSARY, REPLACE REAR BEARING

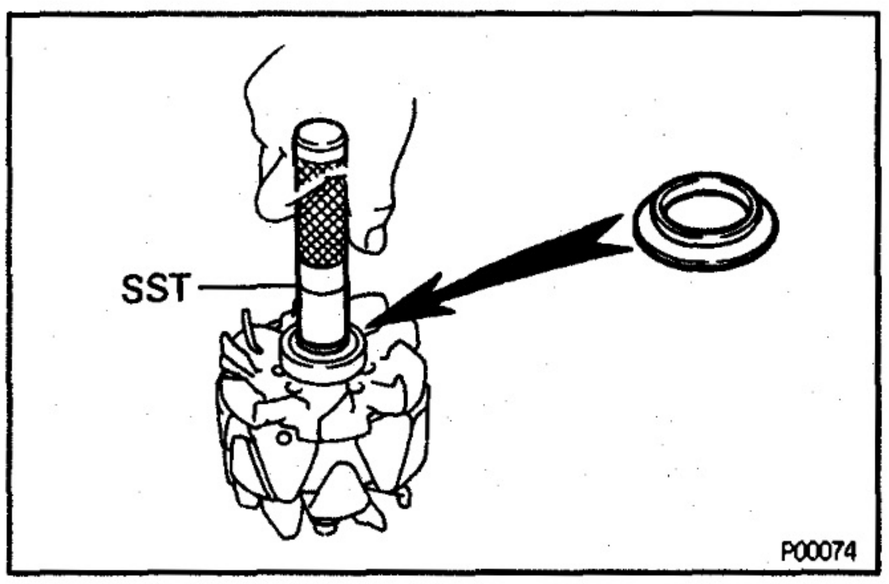
(a) Using SST, remove the bearing cover, bearing and bearing cover.
SST 09820–00021
NOTICE: Be careful not to damage the fan.



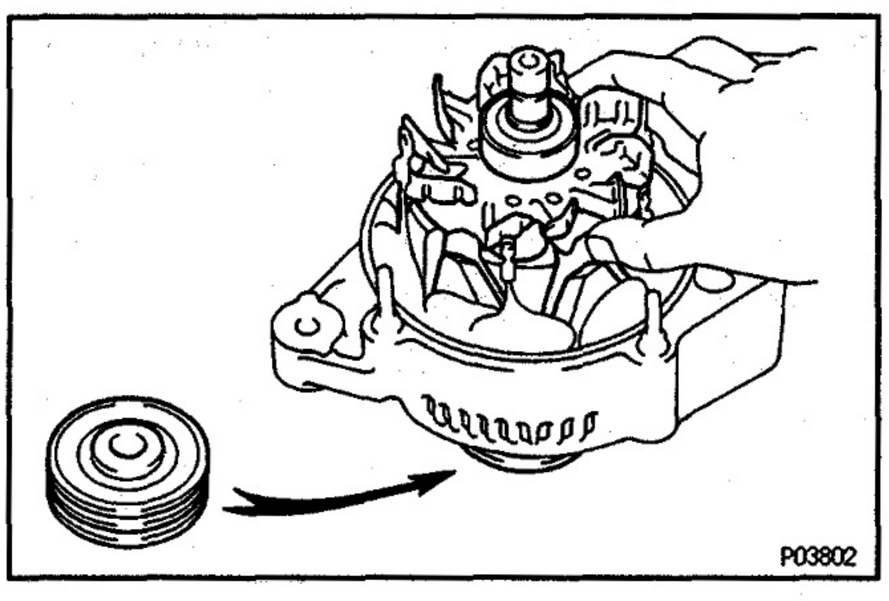
(b) Place the bearing cover on the rotor.



(c) Using SST and a press, press in a new bearing.
SST 09820–00030



(d) Using SST, push in the bearing cover.
SST 09285–76010

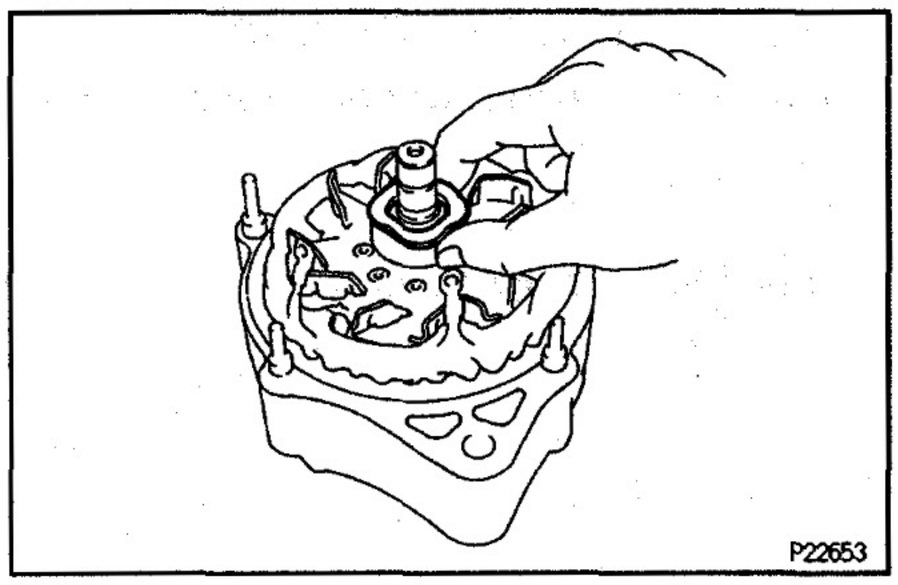


CH0AF–01

ALTERNATOR ASSEMBLY

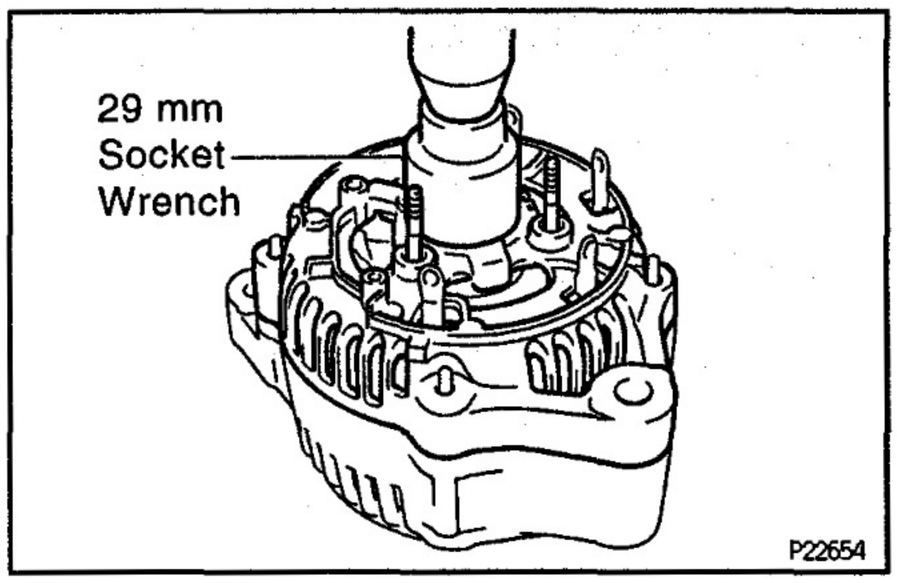
1. PLACE RECTIFIER END FRAME ON PULLEY

2. INSTALL ROTOR TO RECTIFIER END FRAME

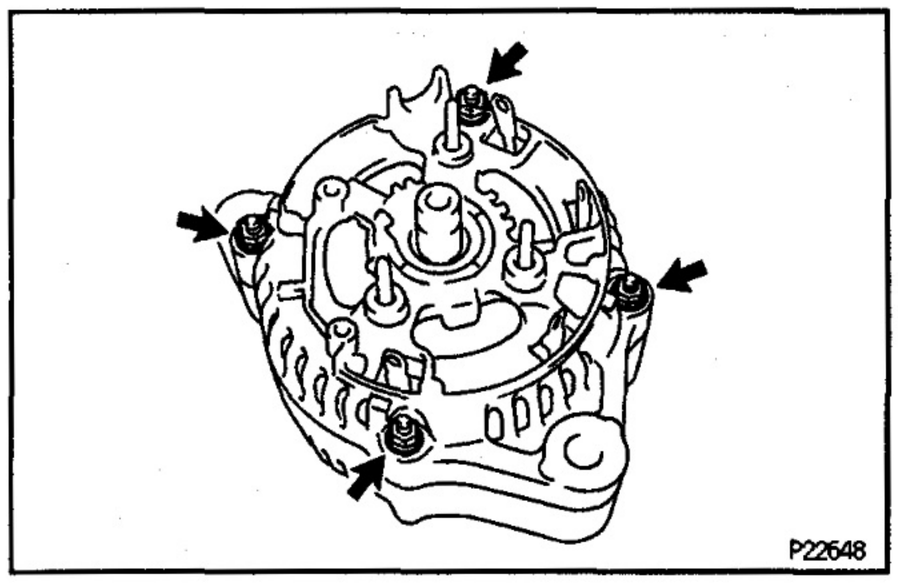


3. INSTALL RECTIFIER END FRAME

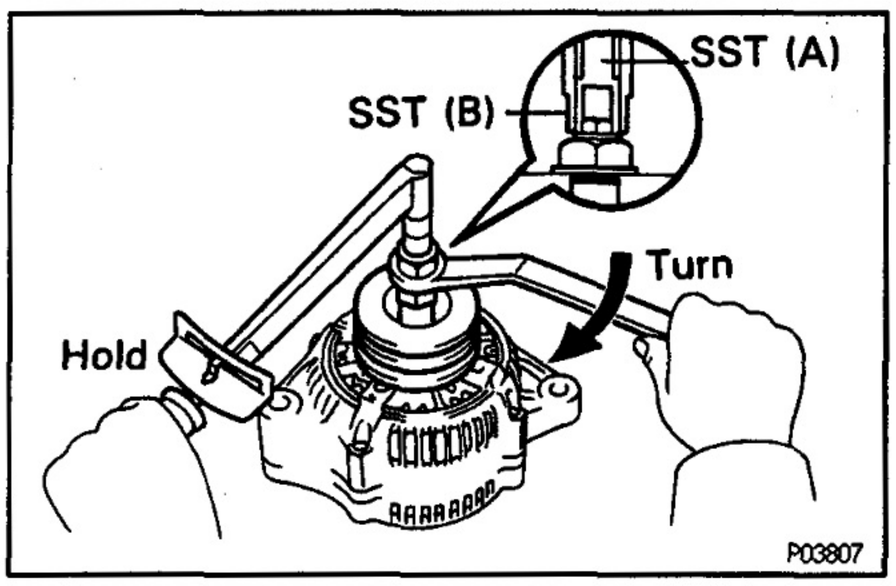
(a) Place the alternator washer on the rotor.



(b) Using a 29 mm socket wrench and press, slowly press in the rectifier end frame.



(c) Install the 4 nuts.
Torque: 4.5 N·m (46 kgf·cm, 40 in.·lbf)

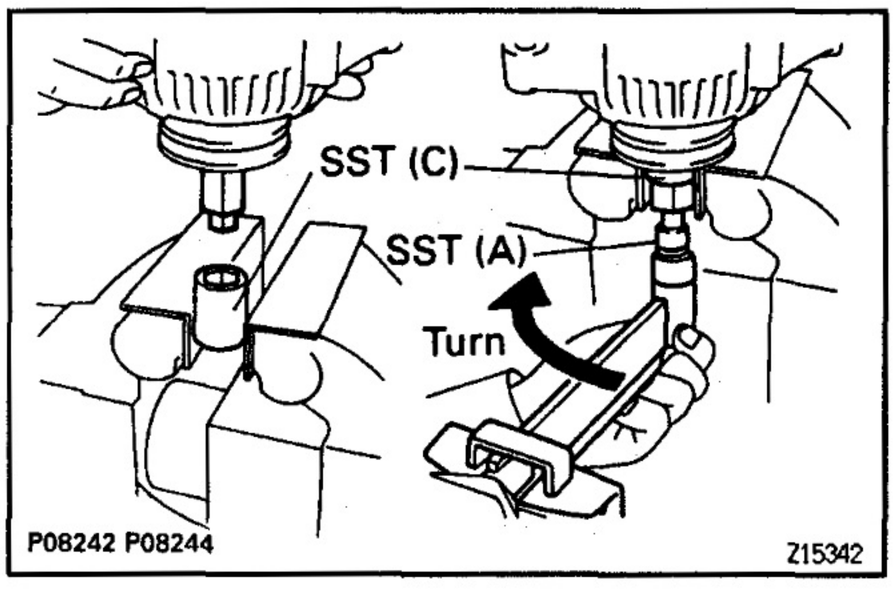


4. INSTALL PULLEY

(a) Install the pulley to the rotor shaft by tightening the pulley nut by hand.

(b) Hold SST (A) with a torque wrench, and tighten SST (B) clockwise to the specified torque.
SST 09820–63010
Torque: 39 N·m (400 kgf·cm, 29 ft·lbf)

(c) Check that SST (A) is secured to the pulley shaft.

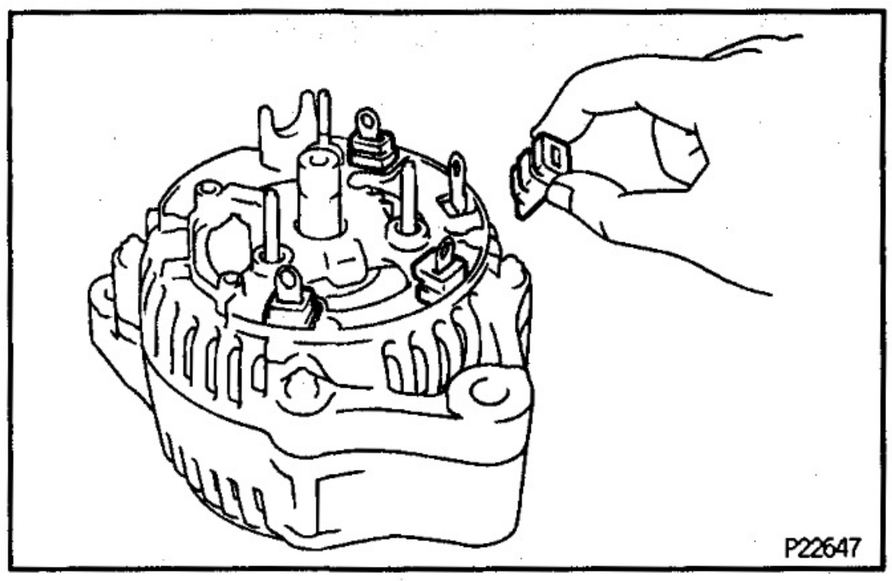


(d) As shown in the illustration, mount SST (C) in a vise, and install the alternator to SST (C).

(e) To torque the pulley nut, turn SST (A) in the direction shown in the illustration.
Torque: 110 N·m (1,125 kgf·cm, 81 ft·lbf)

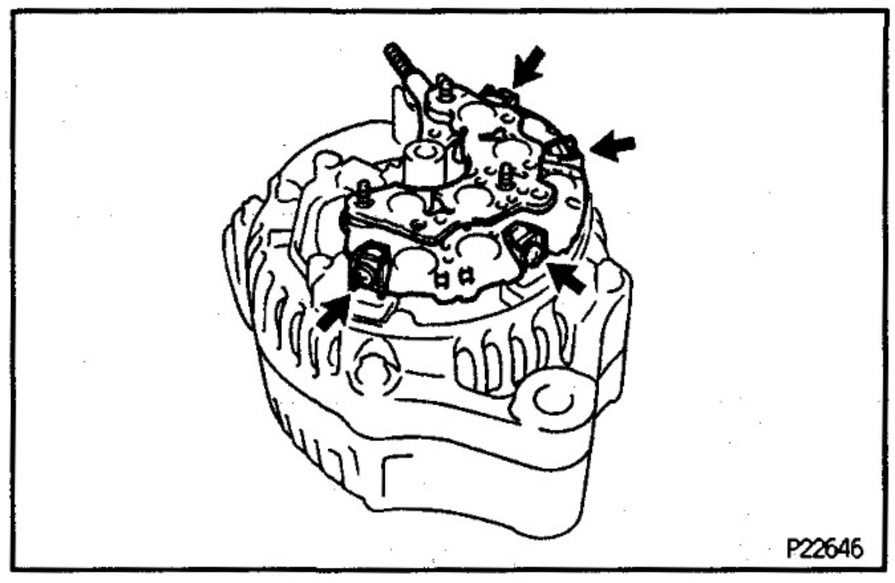
(f) Remove the alternator from SST (C).

(g) Turn SST (B) and remove SST (A and B).



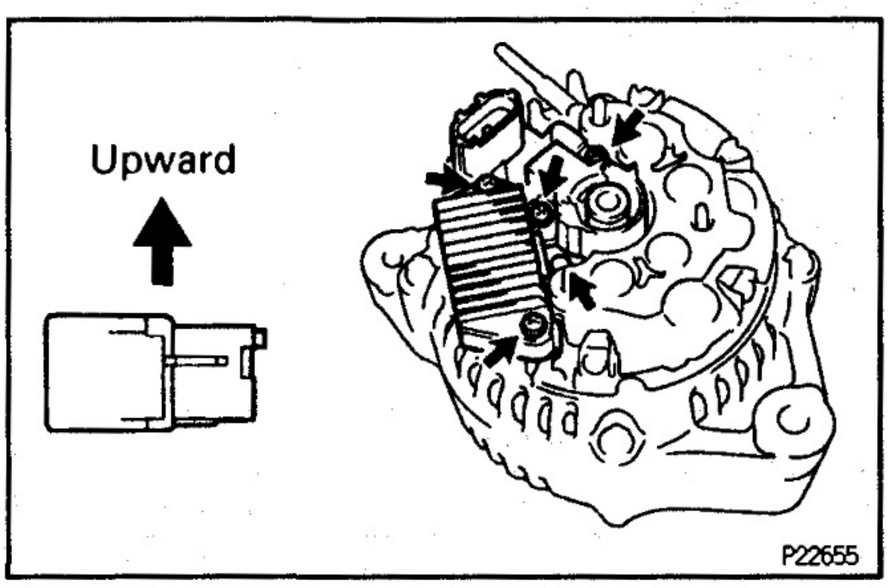
5. INSTALL RECTIFIER HOLDER

(a) Install the 4 rubber insulators on the lead wires.



(b) Install the rectifier holder while pushing it with the 4 screws.

Torque: 2.9 N·m (30 kgf·cm, 26 in.·lbf)



6. INSTALL IC REGULATOR AND BRUSH HOLDER

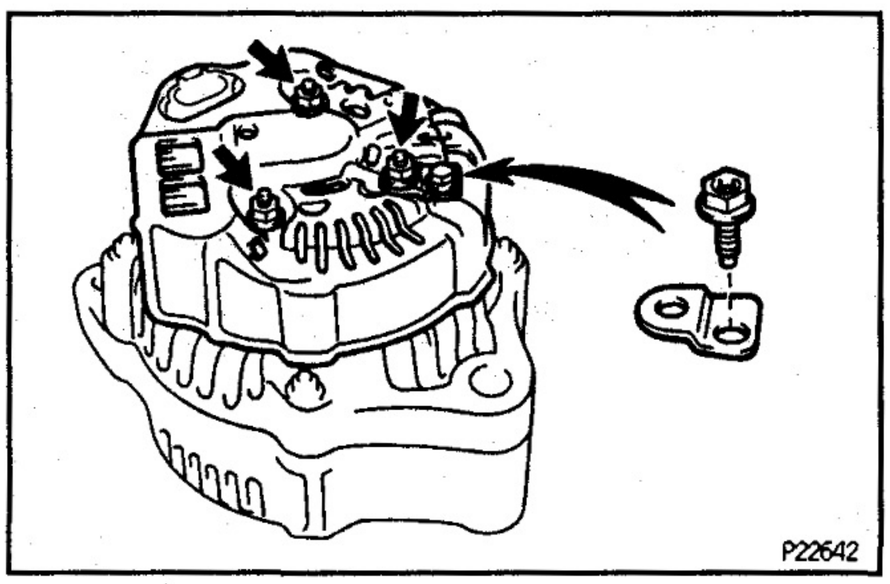
(a) Place the seal plate on the rectifier end frame.

(b) Place the IC regulator and brush holder on the rectifier end frame.

NOTICE: Be careful of the holder installation direction.

(c) Install the 5 screws.

(d) Place the brush holder cover on the brush holder.



7. INSTALL REAR END COVER

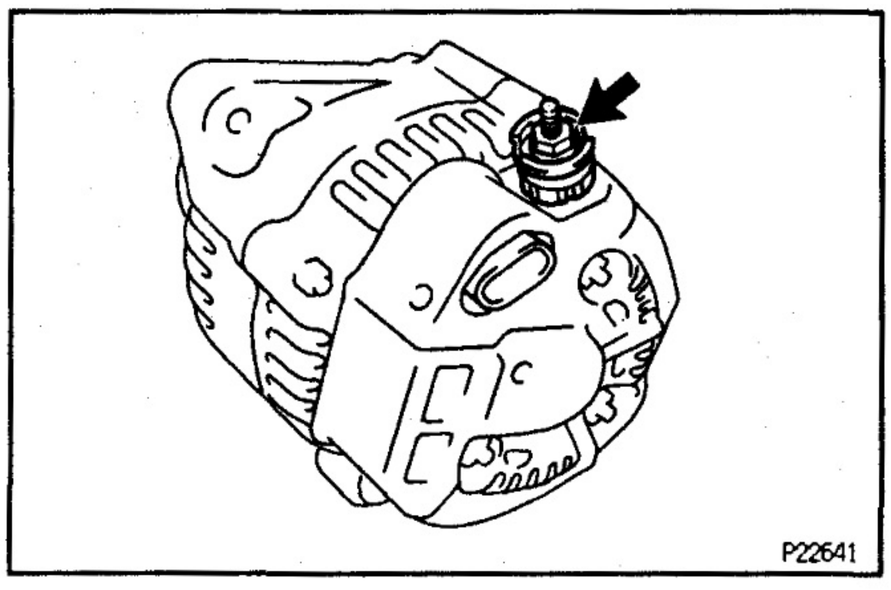
(a) Install the end cover and plate terminal with the 3 nuts and bolt.

Torque:

Bolt: 3.8 N·m (39 kgf·cm, 34 in.·lbf)

Nut 80 A: 4.4 N·m (45 kgf·cm, 39 in.·lbf)

100 A: 4.5 N·m (46 kgf·cm, 40 in.·lbf)

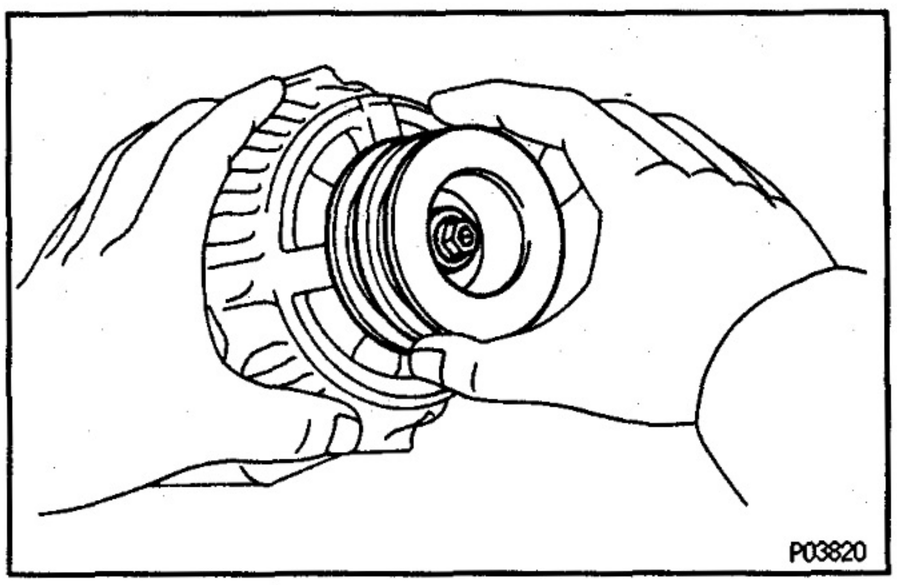


(b) Install the terminal insulator with the nut.

Torque:

80 A: 4.1 N·m (41.5 kgf·cm, 36 in.·lbf)

100 A: 6.5 N·m (66 kgf·cm, 58 in.·lbf)



8. CHECK THAT ROTOR ROTATES SMOOTHLY

CH

SERVICE SPECIFICATIONS

SERVICE DATA

CH01B–0W

Battery	Specific gravity		
	at 20°C (68°F)	105D31L and 105D31R	1.27 – 1.29
		Others	1.25 – 1.27
Alternator	Rated output		12 V 80 A, 100 A
	Rotor coil resistance		2.9 Ω
	Slip ring diameter	STD	14.2 mm – 14.4 mm (0.559 – 0.567 in.)
		Minimum	12.8 mm (0.504 in.)
	Brush exposed length	STD	10.5 mm (0.413 in.)
		Minimum	1.5 mm (0.059 in.)
IC Regulator	Regulating voltage	at 25°C (77°F)	14.0 – 15.0 V
		at 115°C (239°F)	13.5 – 14.3 V

CH01D–0N

TORQUE SPECIFICATIONS

Part tightened		N·m	kgf·cm	ft·lbf
Rectifier end frame x Drive end frame		4.5	46	40 in.·lbf
Alternator pulley x Rotor		110	1,125	81
Rectifier holder x Coil lead on rectifier end frame		2.9	30	26 in.·lbf
Plate terminal x Rectifier holder		3.8	39	34 in.·lbf
Rear end cover x Rectifier holder	80 A	4.4	45	39 in.·lbf
	100 A	4.5	46	40 in.·lbf
Terminal insulator x Rectifier holder	80 A	4.1	41.5	36 in.·lbf
	100 A	6.5	66	58 in.·lbf

TOYOTA

1HD-FT Engine

Supplement for engine repair manual (RM437E)

January 1995

Toyota Motor Corporation Australia Limited A.C.N. 004 384 338

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(c) Subtract the valve stem diameter measurement from the guide bushing inside diameter measurement.

Standard oil clearance:

Intake

0.025 – 0.060 mm (0.0010 – 0.0024 in.)

Exhaust

0.035 – 0.070 mm (0.0014 – 0.0028 in.)

Maximum oil clearance:

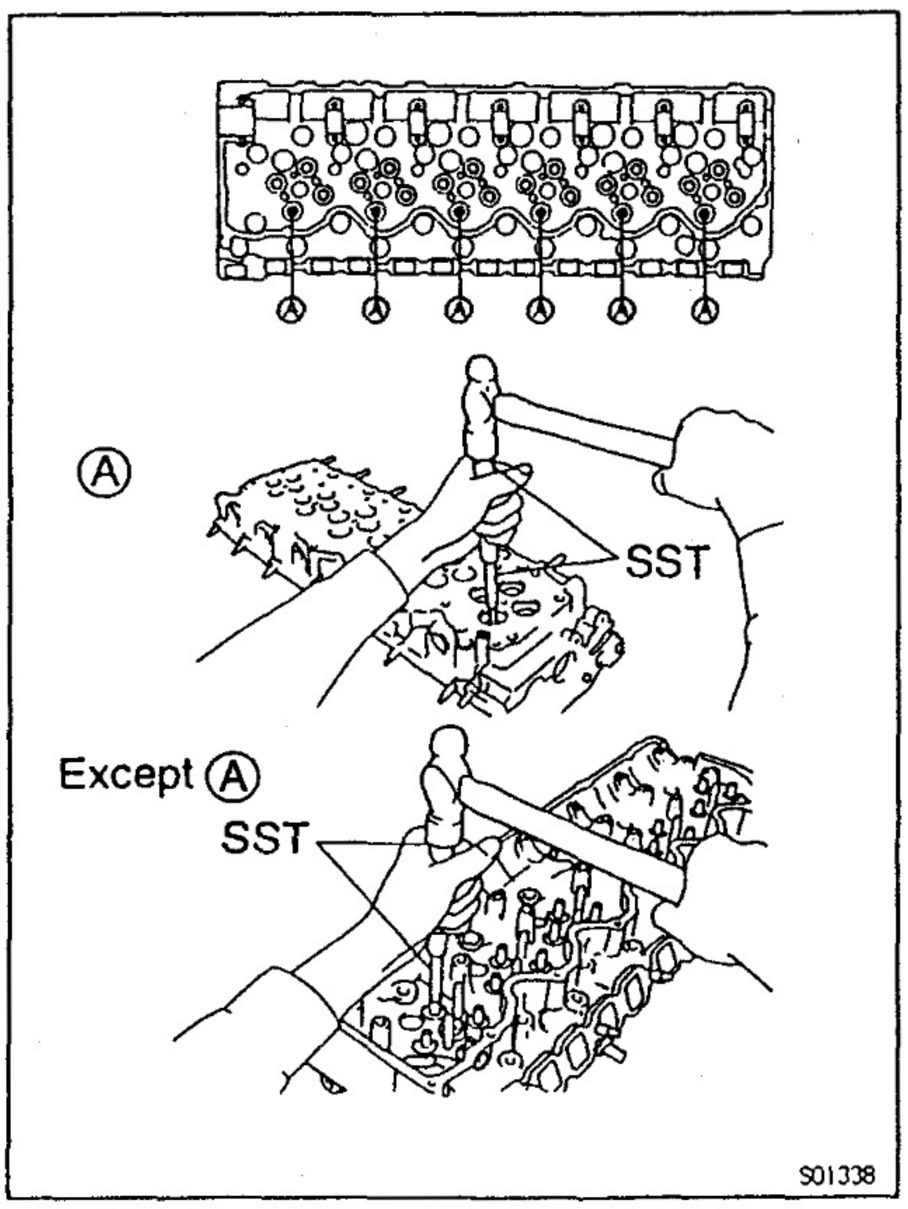
Intake

0.08 mm (0.0031 in.)

Exhaust

0.10 mm (0.0039 in.)

If the clearance is greater than maximum, replace the valve and guide bushing.



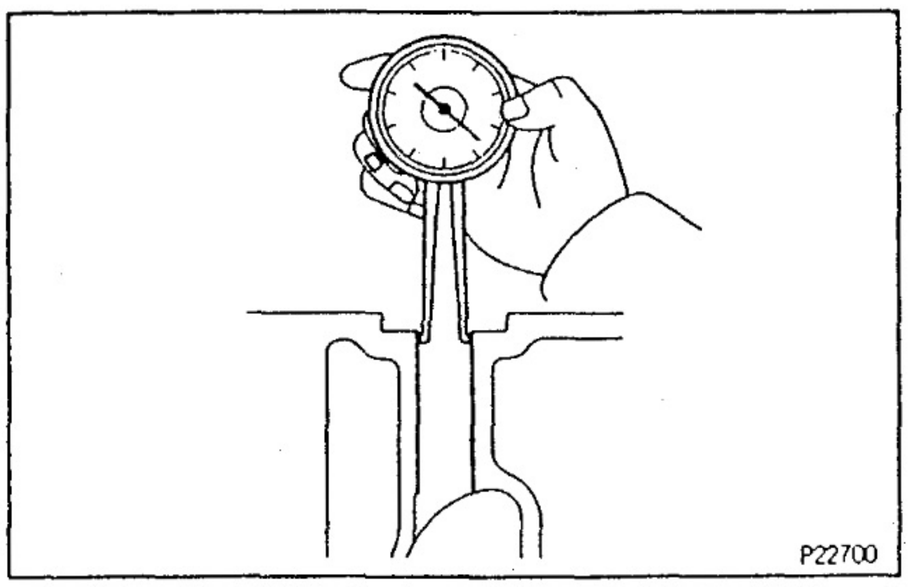
6. IF NECESSARY, REPLACE VALVE GUIDE BUSHINGS

(a) Using SST and a hammer, tap out the guide bushings (at position Ⓐ in the illustration) from the combustion chamber side.

SST 09201 – 10000 (09201 – 01080),
09950 – 70010 (09951 – 07100)

(b) Using SST and a hammer, tap out the guide bushings (at the positions other than Ⓐ) toward the combustion chamber side.

SST 09201 – 10000 (09201 – 01070),
09950 – 70010 (09951 – 07100)

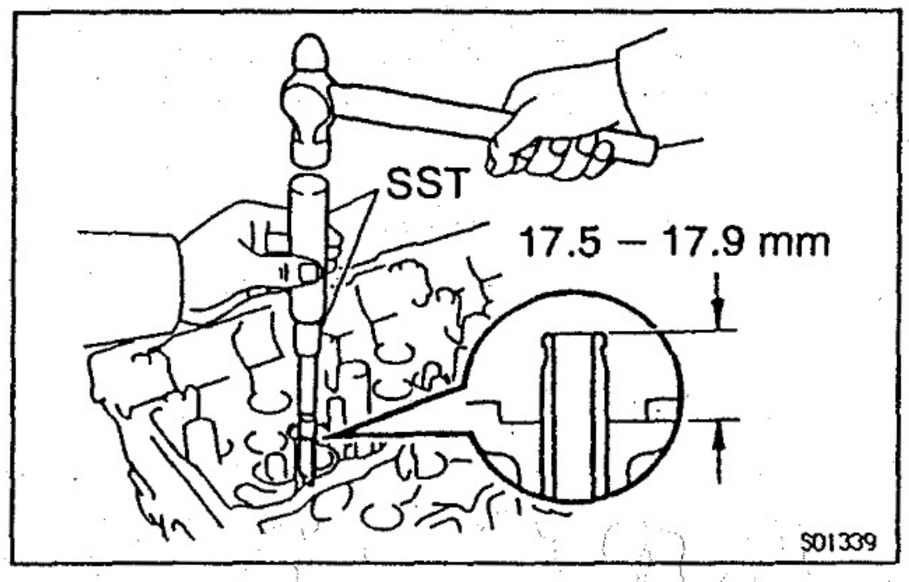


(c) Using a caliper gauge, measure the bushing bore diameter of the cylinder head.

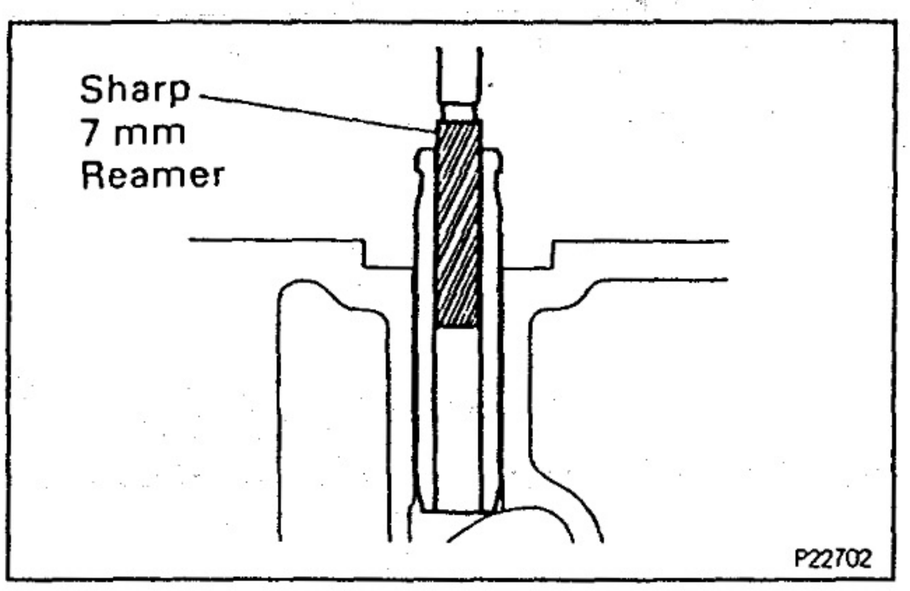
Bushing bore diameter mm (in.)	Bushing size
11.504 – 11.525 (0.4529 – 0.4537)	Use STD
11.554 – 11.575 (0.4549 – 0.4557)	Use O/S 0.05

V06580

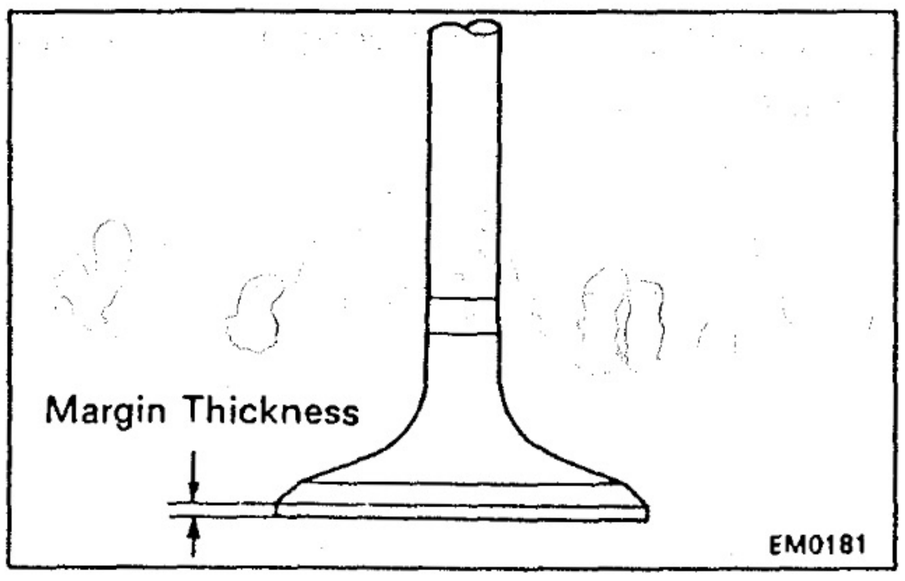
(d) Select a new guide bushing (STD or O/S 0.05).
If the bushing bore diameter of the cylinder head is greater than 11.525 mm (0.4537 in.), machine the bushing bore to the following dimension:
Rebored cylinder head bushing bore dimension:
11.554 – 11.575 mm (0.4549 – 0.4557 in.)
If the bushing bore diameter of the cylinder head is greater than 11.575 mm (0.4557 in.), replace the cylinder head.



(e) Using SST and a hammer, tap in a new guide bushing until there is 17.5 – 17.9 mm (0.689 – 0.705 in.) protruding from the cylinder head.
SST 09201–10000 (09201–01070),
09950–70010 (09951–07100)



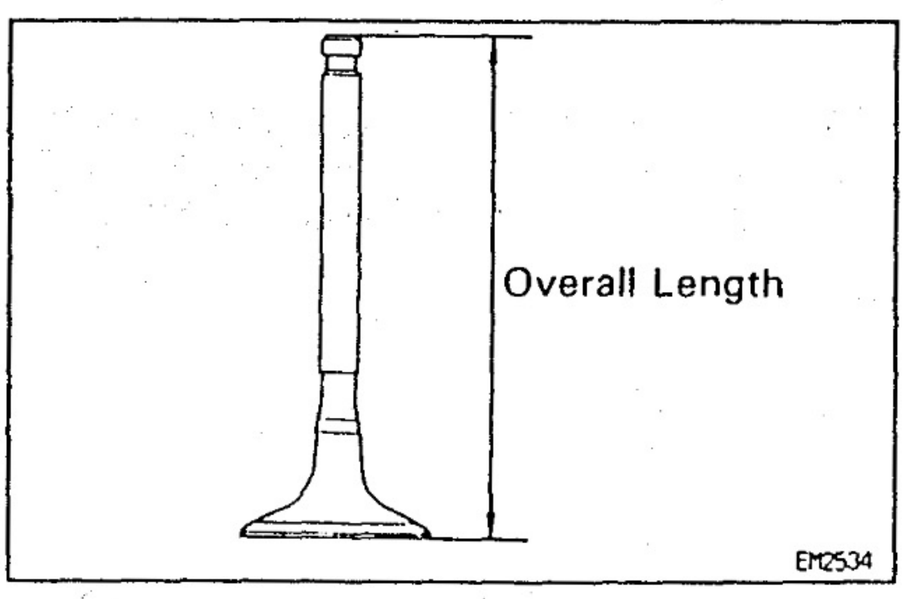
(f) Using a sharp 7 mm reamer, ream the guide bushing to obtain the standard specified clearance (See step 5 above) between the guide bushing and valve stem.



7. INSPECT AND GRIND VALVES

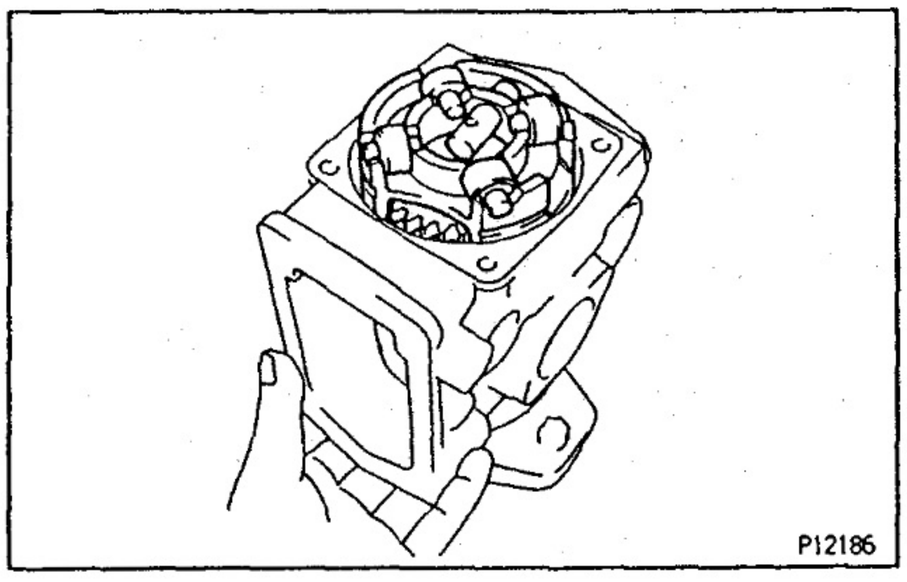
(a) Check the valve face for wear.
If the valve face is worn, replace the valve.

(b) Check the valve head margin thickness.
Standard margin thickness:
1.00 mm (0.0394 in.)
Minimum margin thickness:
0.83 mm (0.0327 in.)
If the margin thickness is less than minimum, replace the valve.

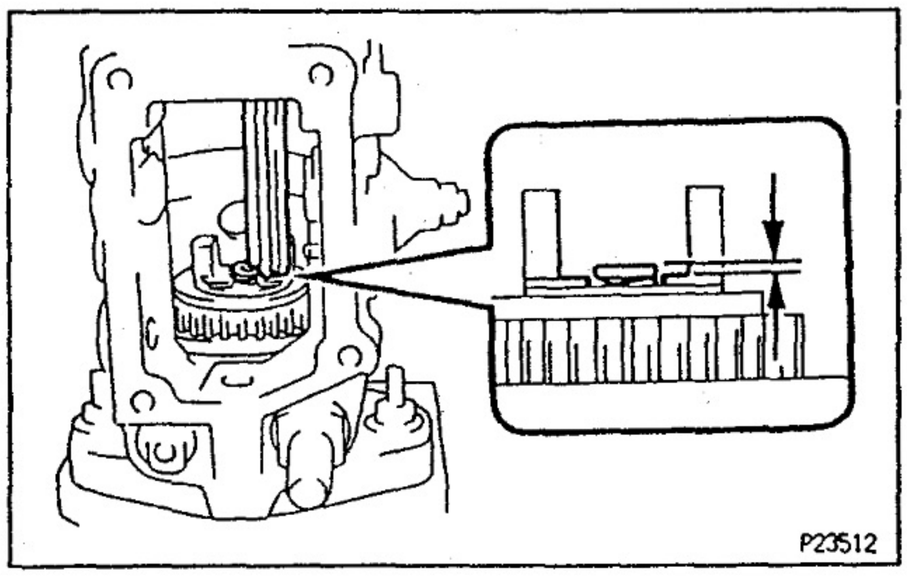


(c) Check the valve overall length.
Standard overall length:
Intake
126.85 – 127.45 mm (4.9941 – 5.0177 in.)
Exhaust
126.43 – 127.03 mm (4.9775 – 5.0012 in.)

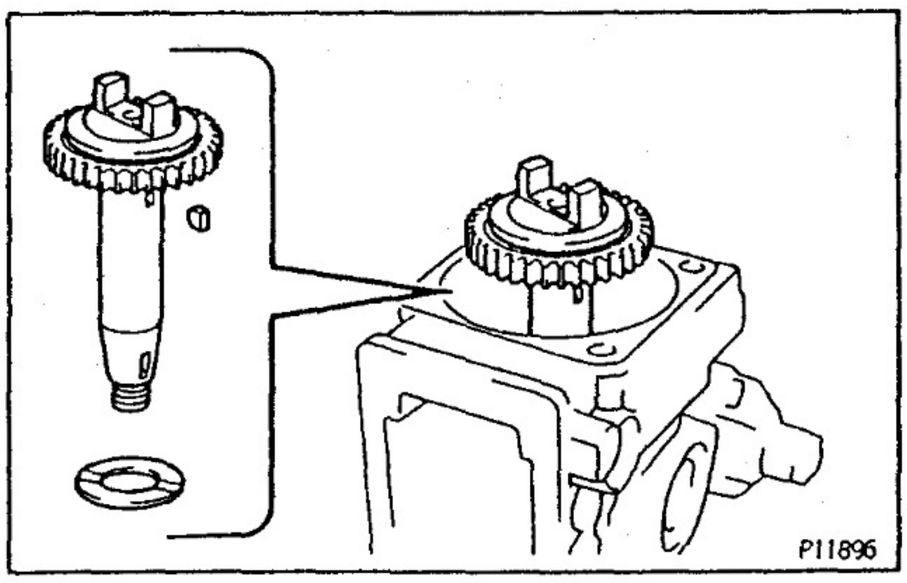
continued overleaf



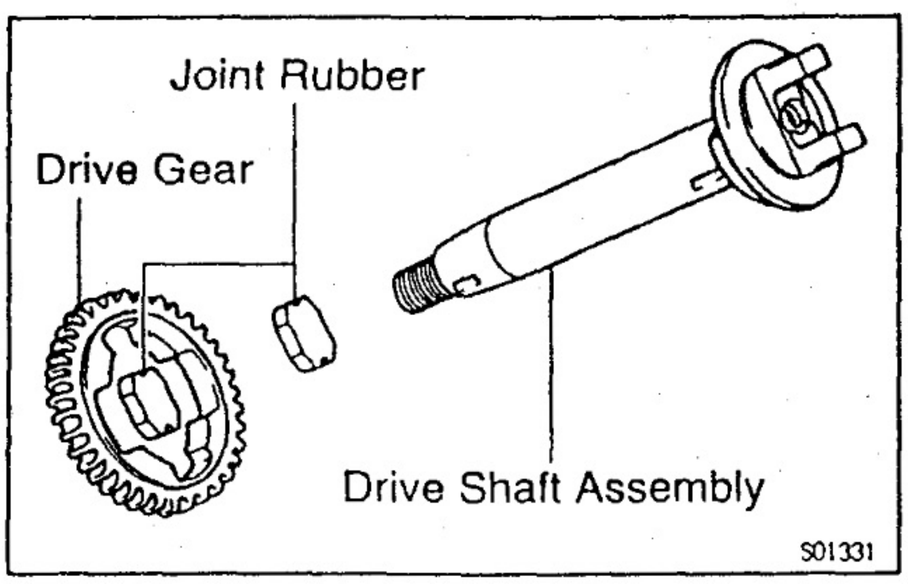
(c) Push the drive shaft, and remove the roller ring, 4 rollers and shims assembly.
NOTICE:
- **Be careful not to drop the rollers.**
- **Do not alter the position or assembly of the rollers.**



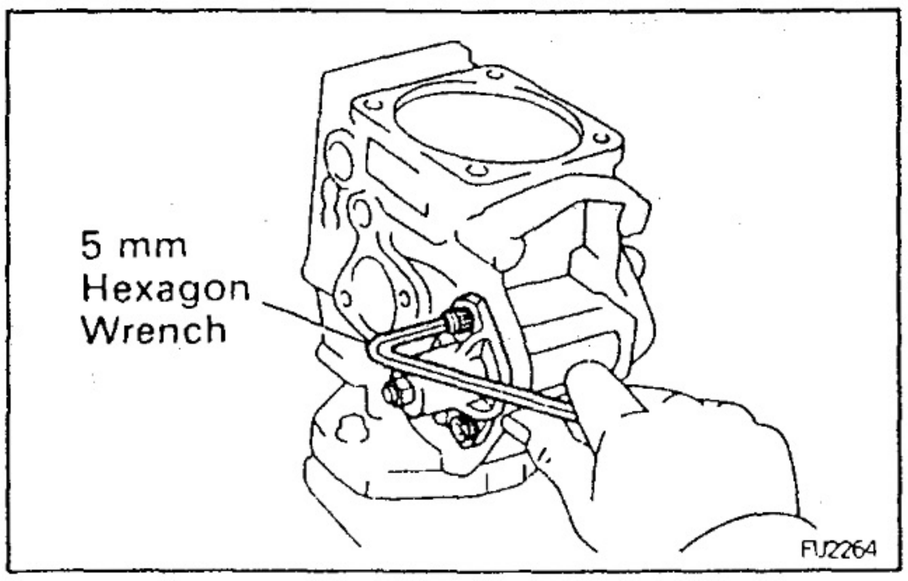
(d) Using vernier calipers, measure the protrusion of the coupling spring.
Protrusion:
1.0 – 1.4 mm (0.03937 – 0.05512 in.)
If the protrusion is not as specified, replace the coupling spring.
NOTICE: Do not remove the coupling spring unless necessary. If you remove the coupling spring, replace it with a new one.



(e) Remove the drive shaft, governor drive gear, 2 joint rubbers assembly, set key and drive shaft washer.

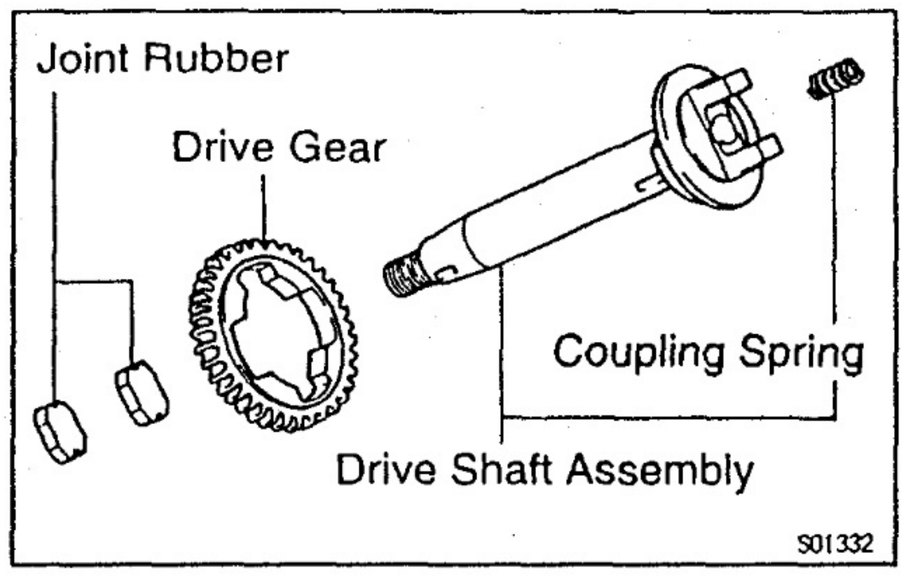


(f) Remove the drive gear and 2 joint rubbers from the drive shaft assembly.



26. REMOVE TIMER

(a) Using a 5 mm hexagon wrench, remove the 4 bolts.

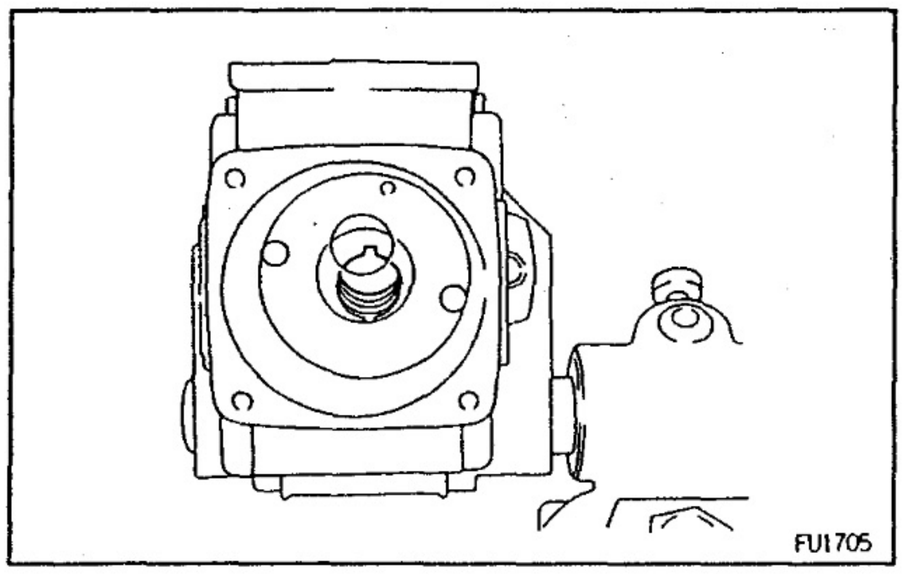


4. INSTALL DRIVE SHAFT

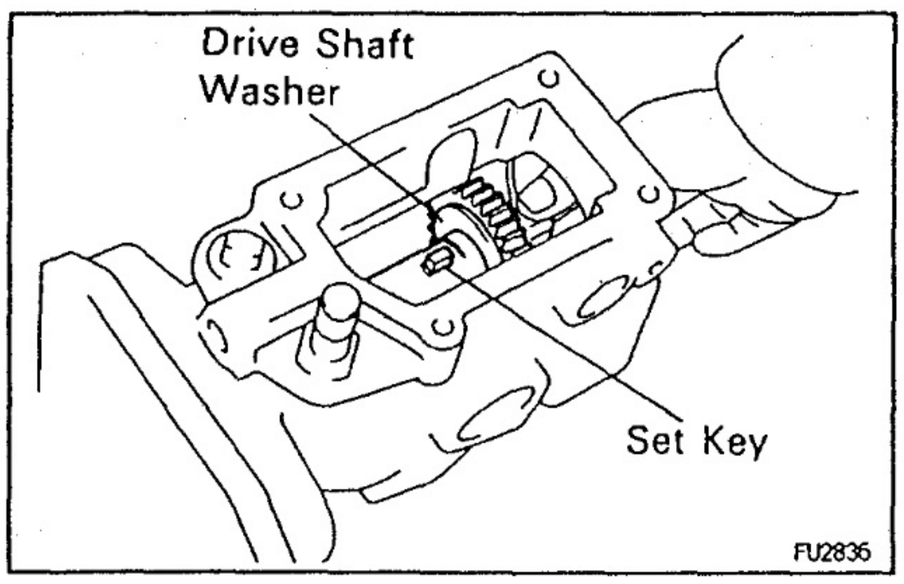
(a) Install the drive gear on the drive shaft assembly as shown.

NOTICE: If the coupling spring is removed from the drive shaft, install a new coupling spring.

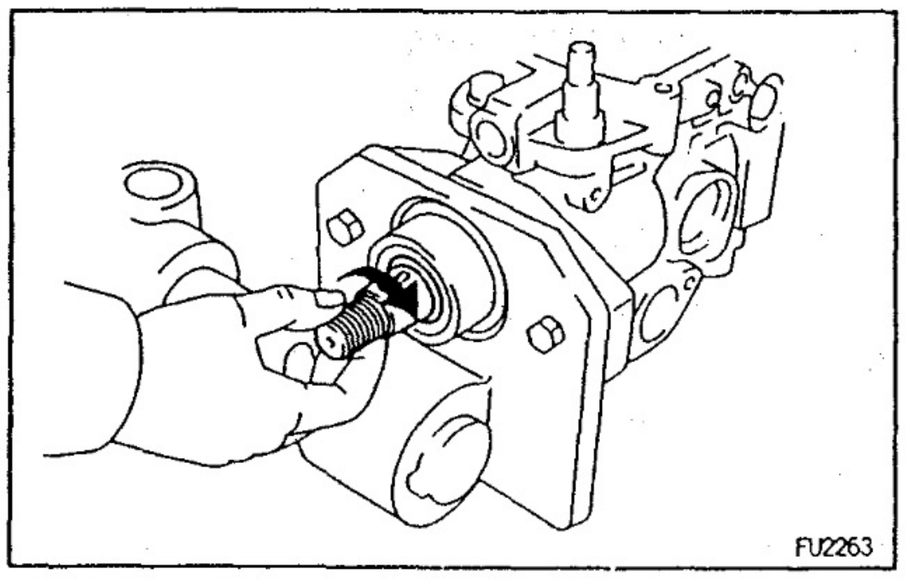
(b) Install 2 new joint rubbers into the drive gear.



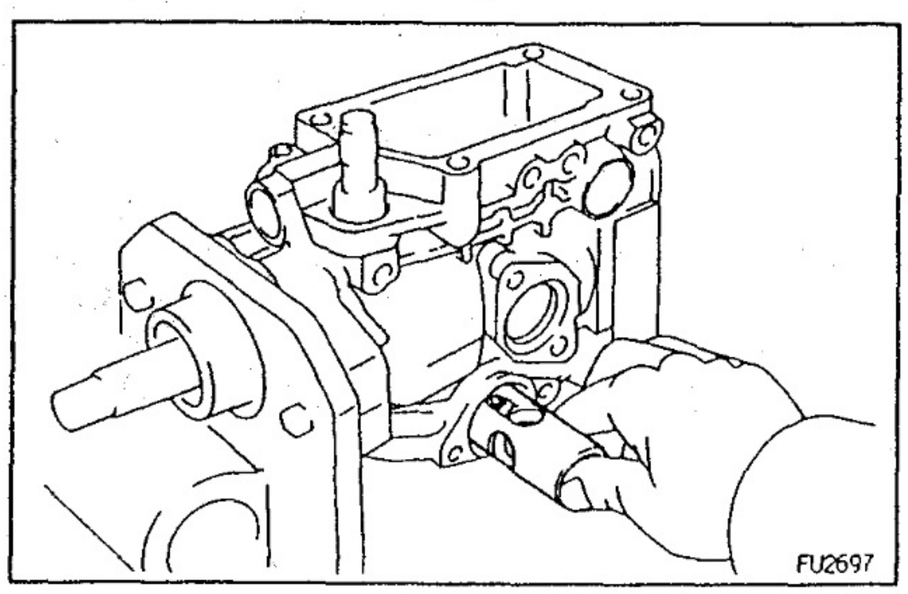
(c) Position the key groove of the feed pump rotor upward.



(d) Install the drive shaft washer and set key on the drive shaft and insert the drive shaft assembly into the pump housing.



(e) Check that the drive shaft turns without catching.



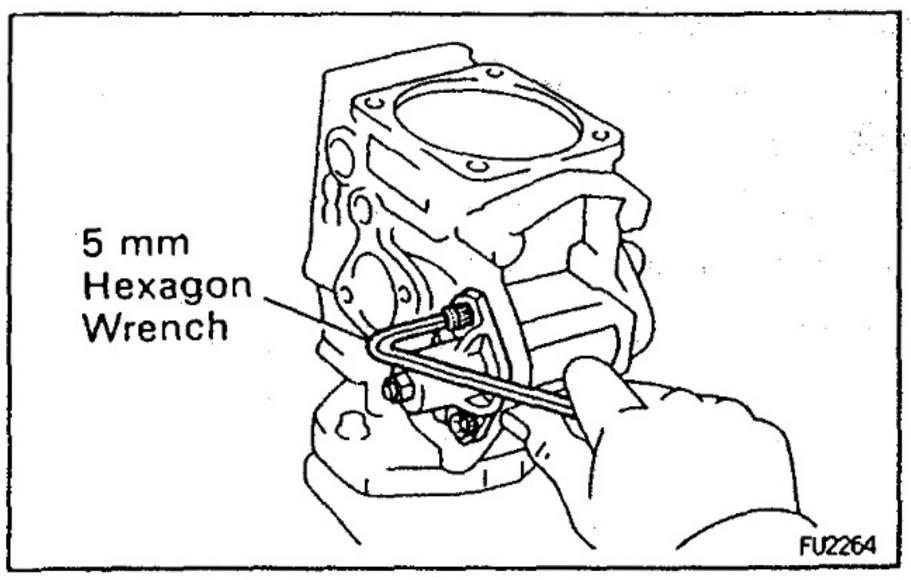
5. INSTALL TIMER PISTON

(a) Apply grease to the timer piston.

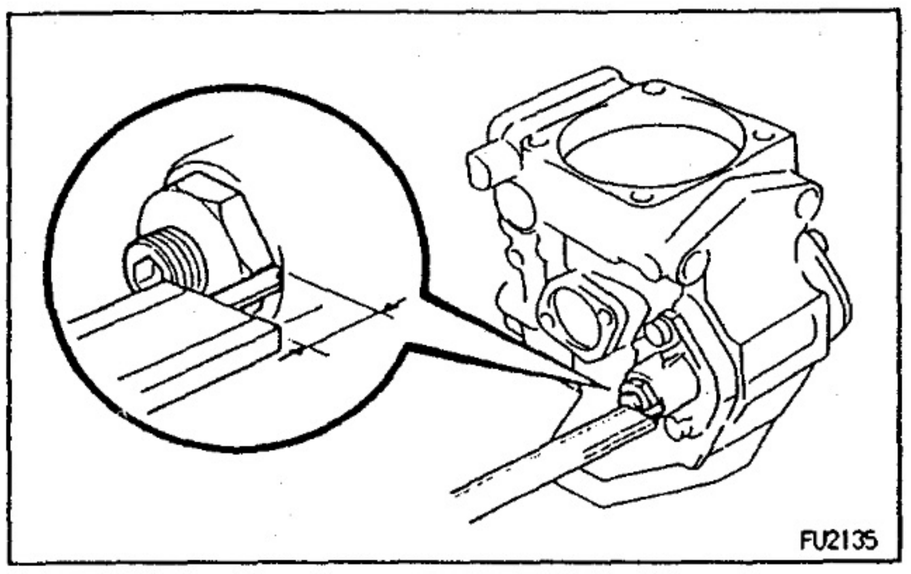
(b) Install the sub-piston into the timer piston.

(c) Insert the timer piston into the pump housing.

continued overleaf

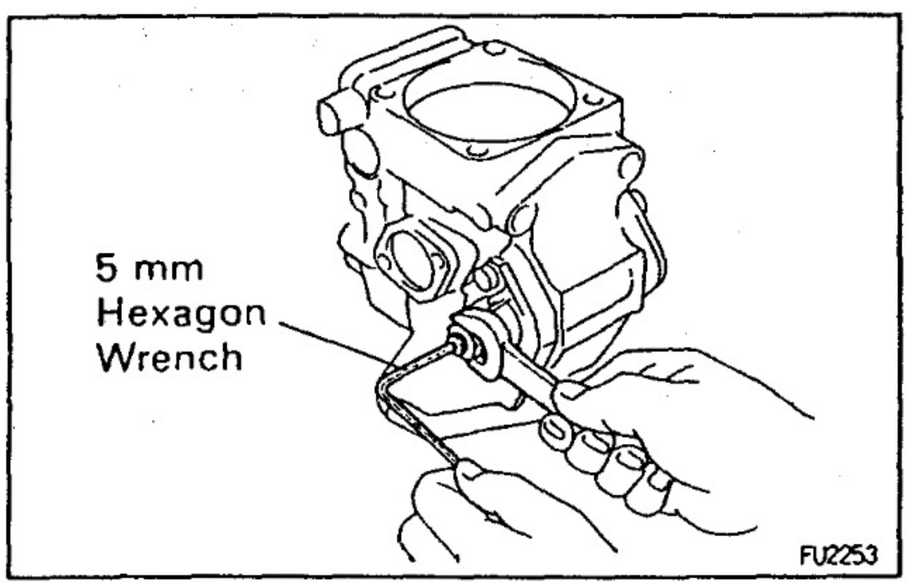


(d) Using a 5 mm hexagon wrench, install the 4 bolts.
Torque: 8.4 N·m (85 kgf·cm, 74 in.·lbf)

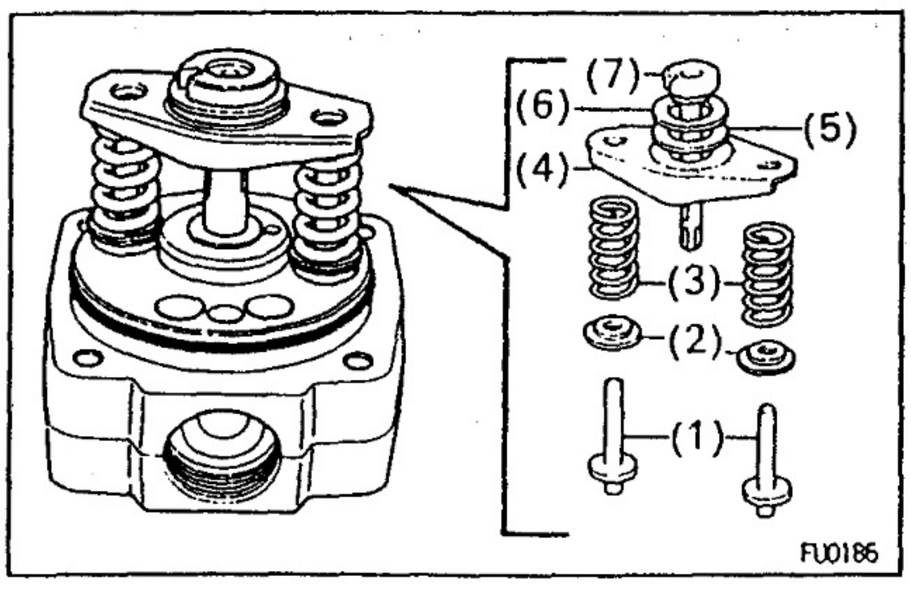


8. PRESET TIMER ADJUSTING SCREW

(a) Using vernier calipers, measure the protrusion of the adjusting screw from the timer cover.
Protrusion:
7.5 – 8.0 mm (0.295 – 0.315 in.)

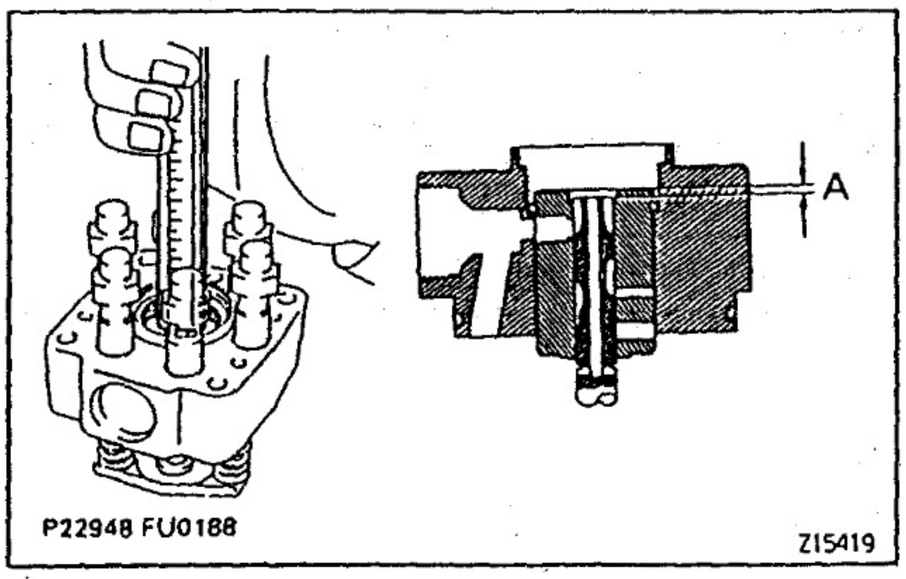


(b) Using a 5 mm hexagon wrench, adjust the protrusion of the adjusting screw from the timer cover.
(c) Tighten the nut.
Torque: 14 N·m (145 kgf·cm, 11 ft·lbf)



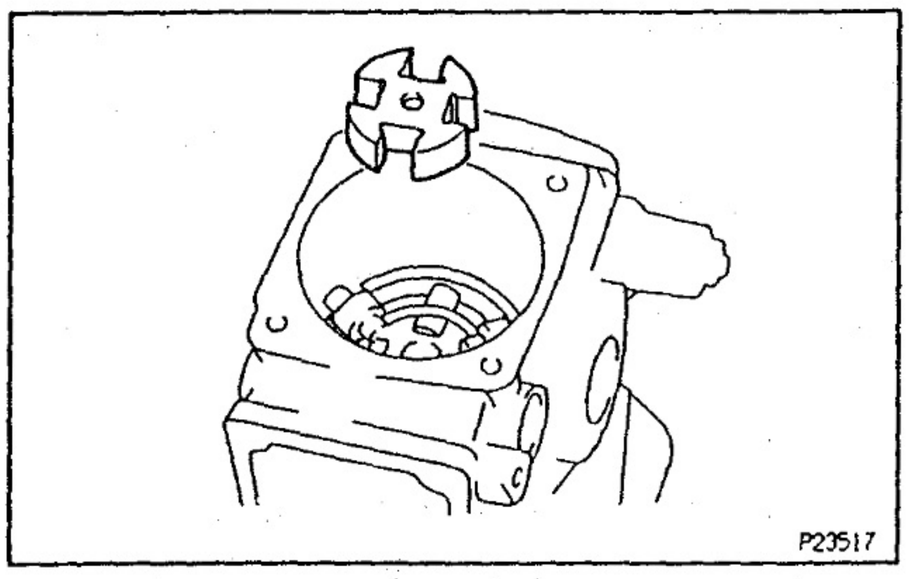
9. ADJUST PLUNGER SPRING SHIM

(a) Install these parts to the distributive head:
(1) 2 plunger spring guides
(2) 2 upper spring seats
(3) 2 plunger springs
(4) Lower spring seat
(5) Upper plunger plate
(6) Lower plunger plate
(7) Pump plunger
HINT: Do not assemble the plunger spring shims at this time.
(b) Using vernier calipers, measure clearance A indicated in the illustration.
(c) Determine the plunger spring shim size by using these formula and chart.
New plunger spring shim thickness = 7.1 – A
A ... Measured plunger position



Plunger spring shim selection chart: mm (in.)

Measured clearance	Shim thickness
More than 6.6 (0.256)	0.5 (0.020)
6.3 – 6.5 (0.248 – 0.252)	0.8 (0.031)
6.1 – 6.2 (0.236 – 0.240)	1.0 (0.039)
5.9 – 6.0 (0.228 – 0.232)	1.2 (0.047)
5.6 – 5.8 (0.217 – 0.224)	1.5 (0.059)
5.3 – 5.5 (0.205 – 0.213)	1.8 (0.071)
Less than 5.1 (0.197)	2.0 (0.079)

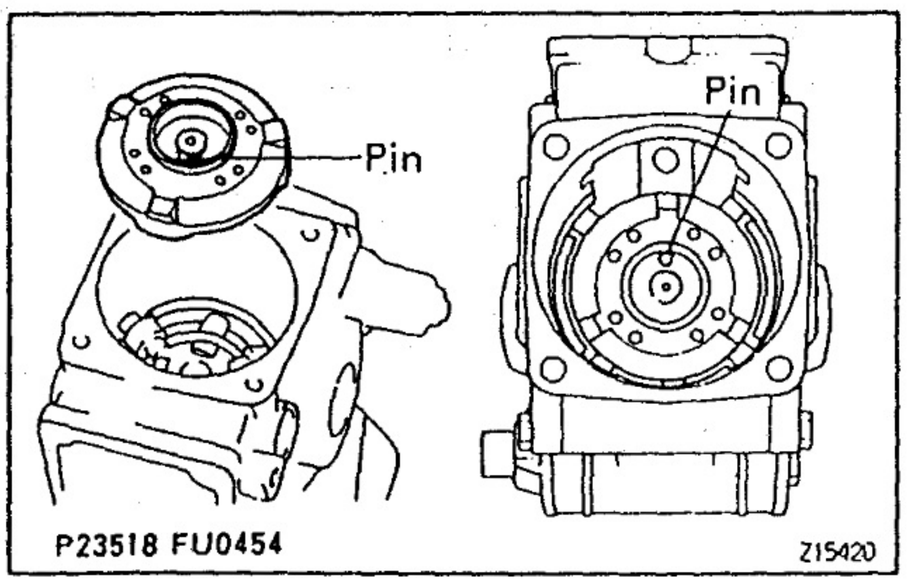


HINT:

- For a measurement between listed sizes, use the next larger size.For example, if thickness is 1.1 mm (0.043 in.) by calculation, use a 1.2 mm (0.047 in.) shim.
- Select 2 shims which have the same thickness.

10. INSTALL COUPLING

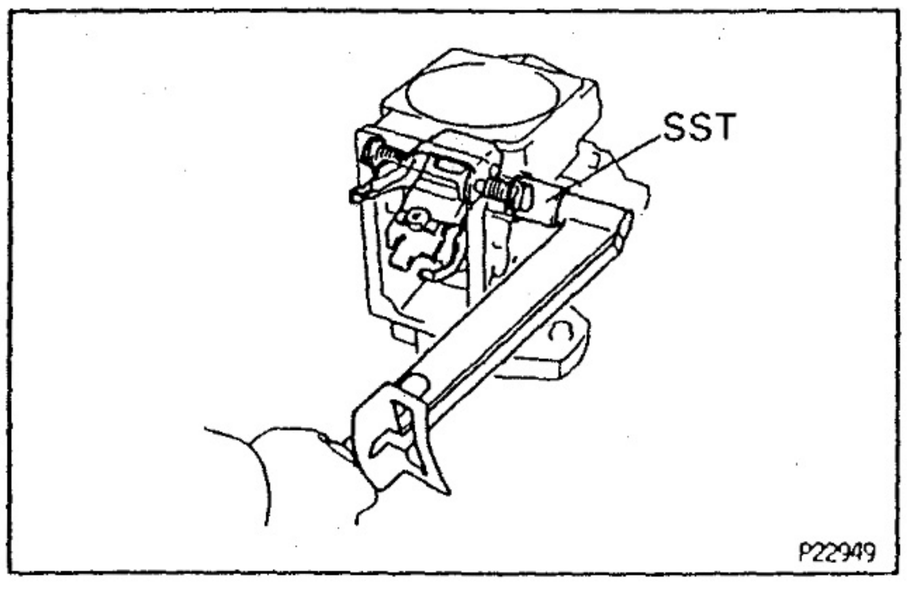
Install the coupling.



11. INSTALL FACE CAMPLATE

(a) Face the drive shaft with the key groove facing upward.

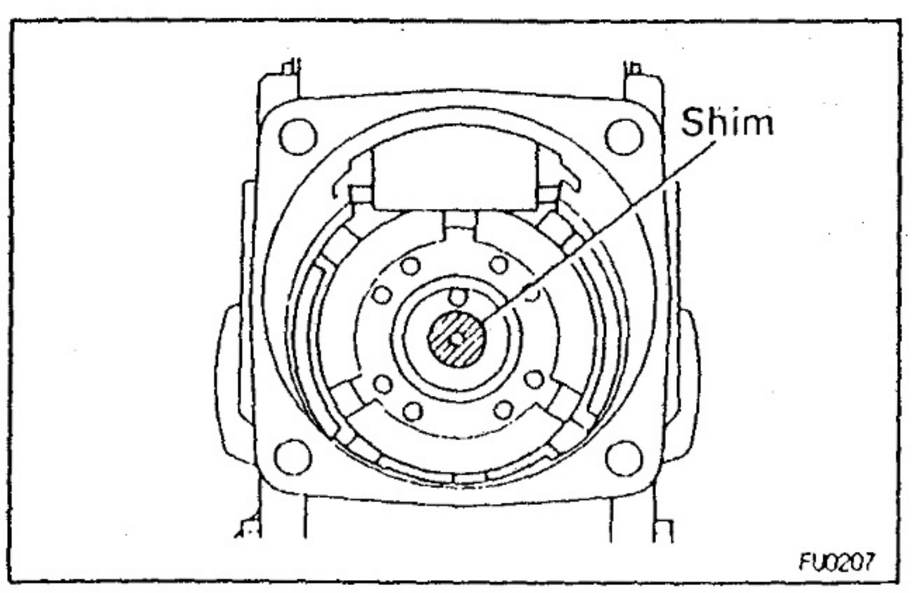
(b) Install the camplate with the camplate pin facing the governor cover side.



12. INSTALL GOVERNOR LINK

(a) Using SST, install the governor link with 2 new gaskets and the 2 support bolts.
Torque: 14 N·m (140 kgf·cm, 10 ft·lbf)
SST 09260–54012 (09269–54040)

(b) Check that the governor link moves smoothly.



13. INSTALL PUMP PLUNGER

(a) Place the previously used plunger adjusting shim on the center of the camplate.
NOTICE: Do not apply grease to the shim.

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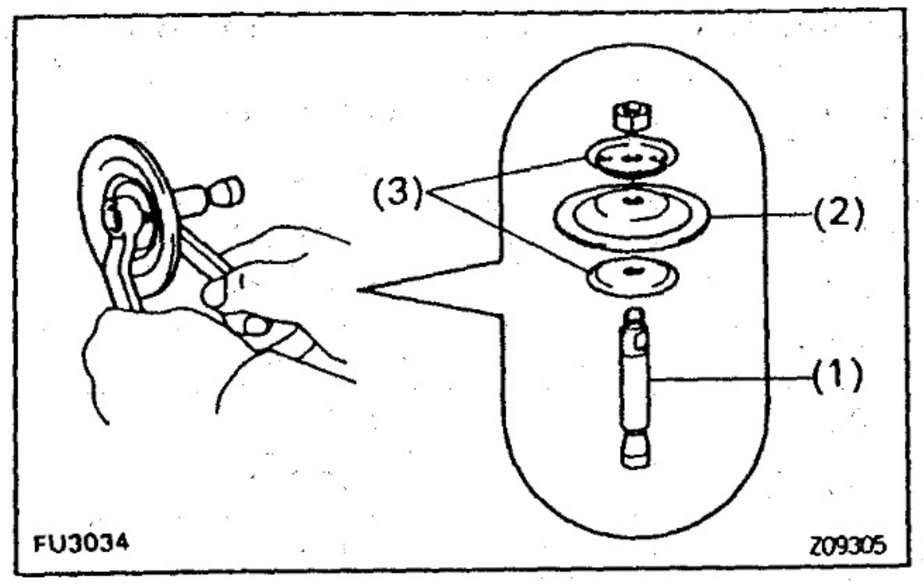
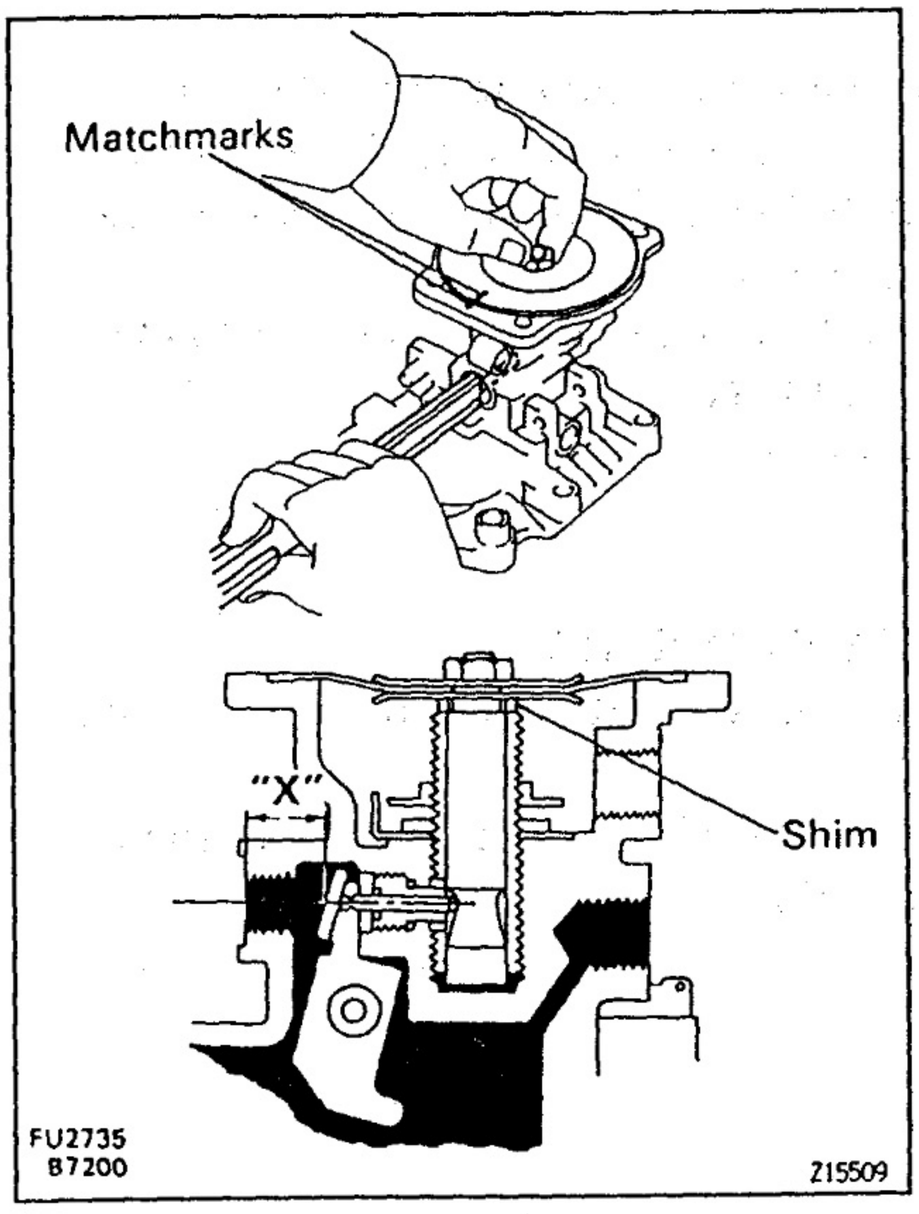


(b) Apply sealant to the push rod threads.
Sealant:
Part No.08833—00080, THREE BOND 1344, LOCTITE 242 or equivalent

(c) Assemble these parts with the nut.
Torque: 7.4 N·m (75 kgf·cm, 65 in.·lbf)
(1) Push rod
(2) Diaphragm
(3) 2 spring seats

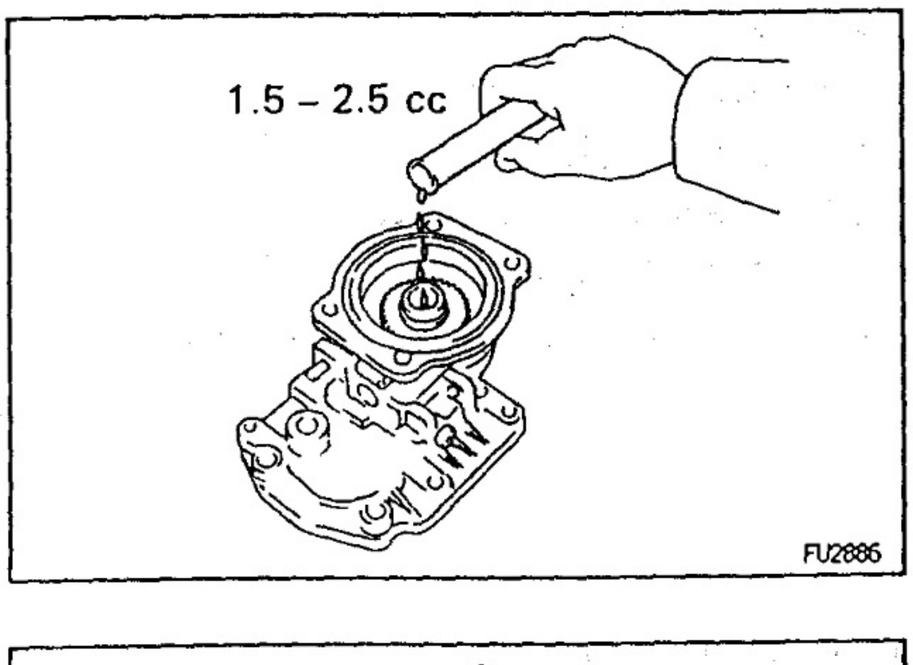


(d) Adjust the installation direction of boost compensator diaphragm assembly.
- Install the shim and diaphragm assembly.

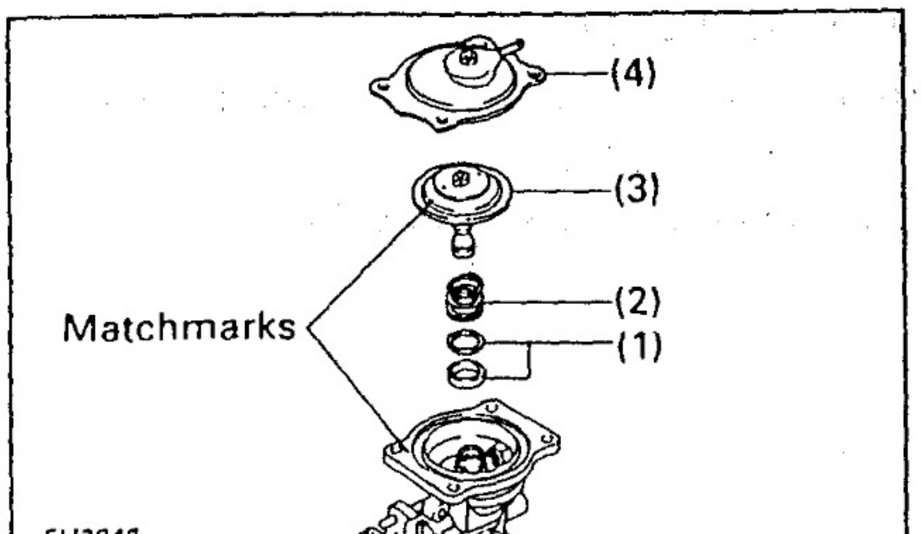
HINT: Do not assemble the spring.
- Using vernier calipers, while pushing on the diaphragm assembly dimension "X" with vernier calipers as shown.

Dimension "X":
w/ BACS: 8.8 — 9.0 mm (0.346 — 0.354 in.)
w/o BACS: 8.5 — 8.7 mm (0.335 — 0.343 in.)

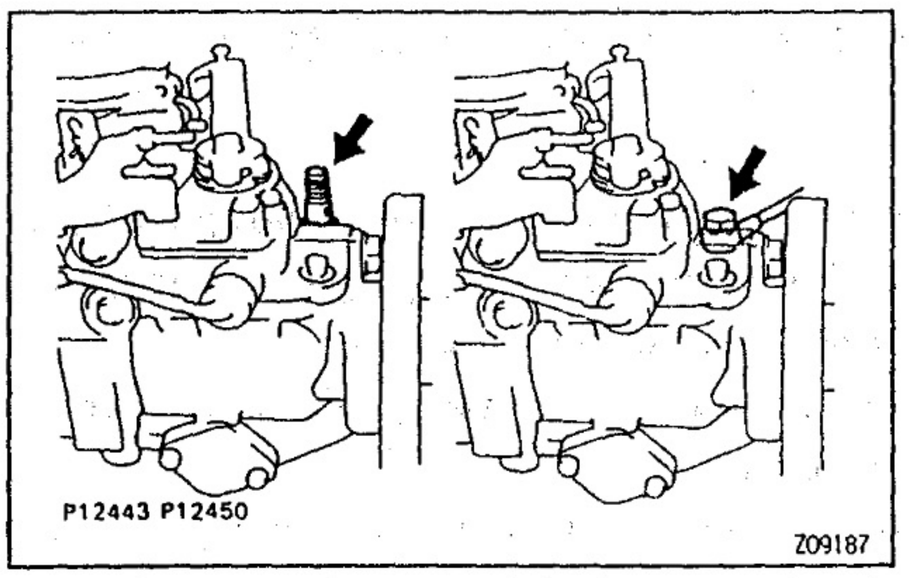
HINT: Measure at the center of the hole.
- Place matchmarks on the diaphragm assembly and governor cover.
- Remove the diaphragm assembly.



(e) Insert 1.5 — 2.5 cc (0.09 — 0.15 cu in.) of engine oil into the bushing hole.

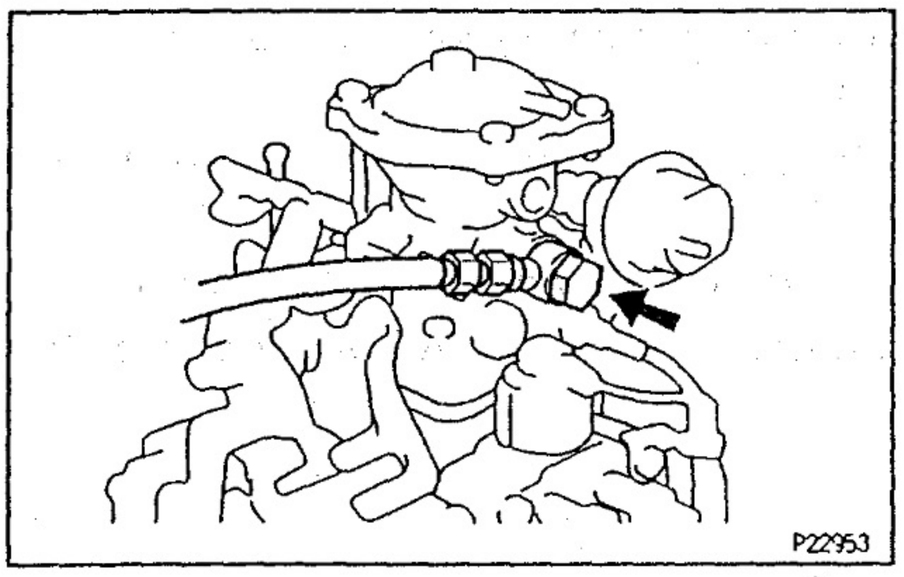


(f) Install these parts to the governor cover.
(1) Boost compensator shim
(2) Spring
(3) Diaphragm assembly
(4) Diaphragm cover

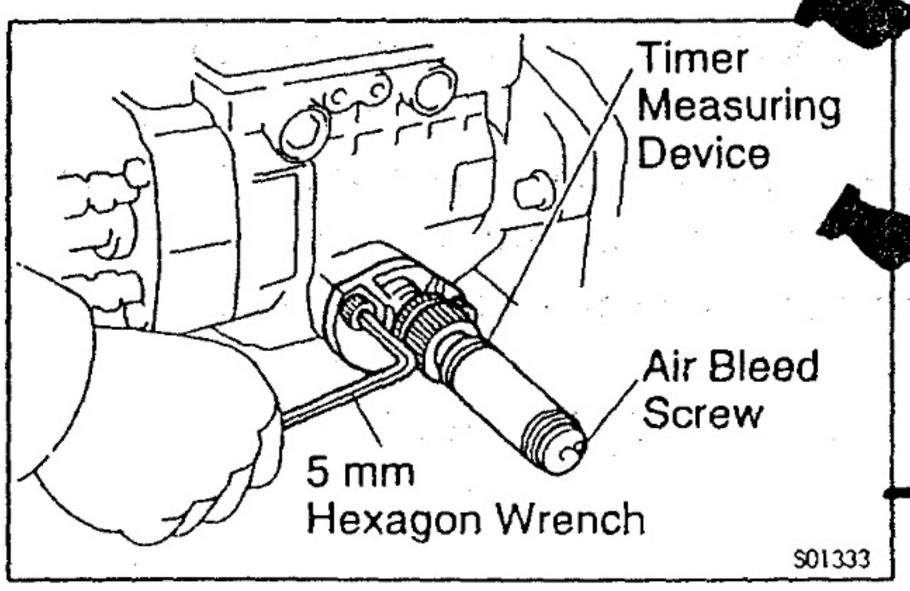


(f) Remove the fuel inlet hollow screw.

(g) Connect the fuel inlet pipe with an adapter.



(h) Install the inner pressure gauge with 2 gaskets and union bolt.
Part No.95095−10480 (NIPPONDENSO)
HINT:Use the union bolt from the pressure gauge.

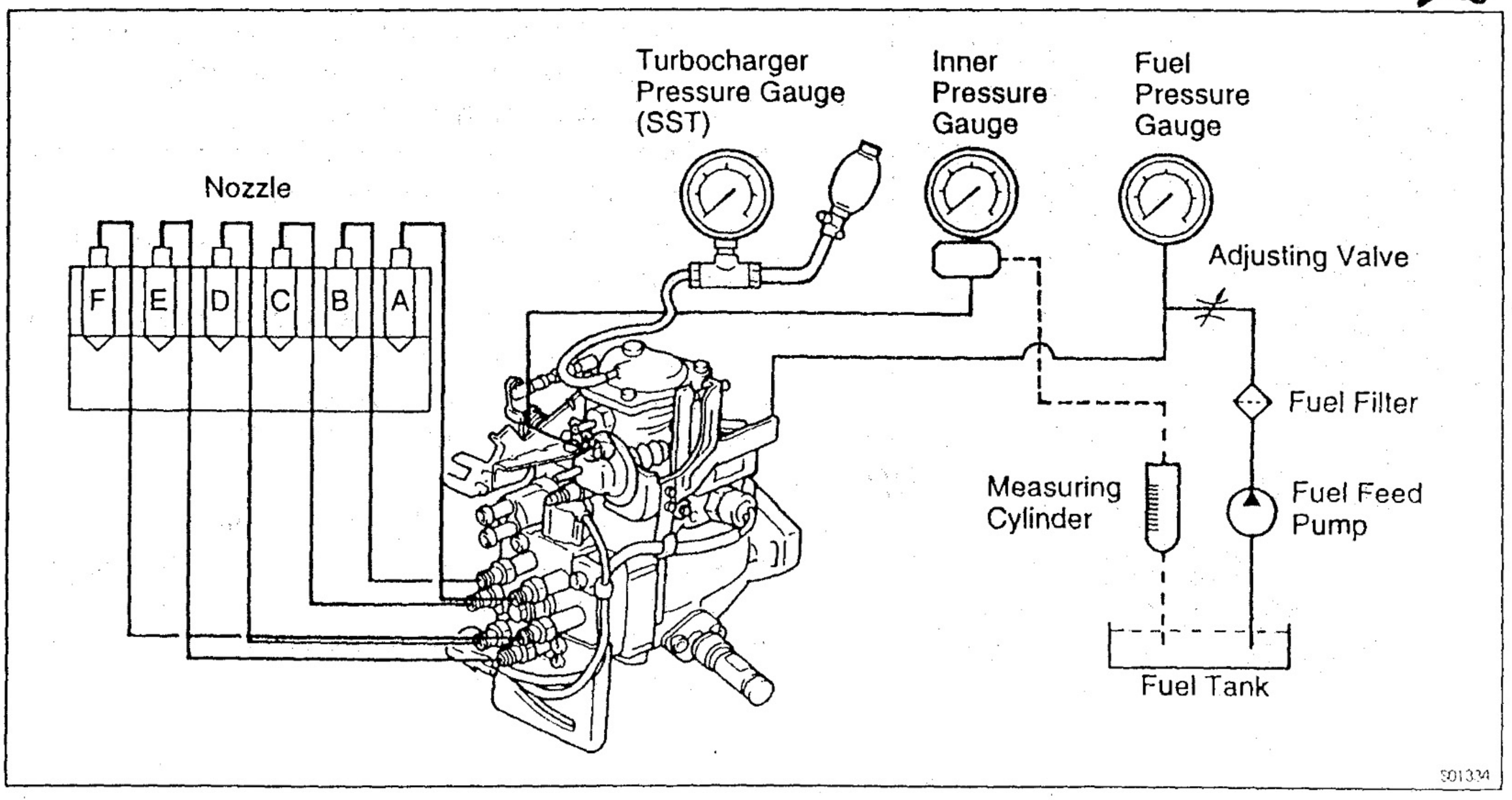


(i) Using a 5 mm hexagon wrench, remove the 2 bolts and RH timer cover.

(j) Replace the timer measure rod and timer measure spring of the timer measuring device.
Parts No. 95095−40060 and 95913−10090 (NIPPONDENSO)

(k) Install the timer measuring device.
Part No. 95095−10222 (NIPPONDENSO)

(l) Connect SST (turbocharger pressure gauge) to the boost compensator.
SST 09992−00241



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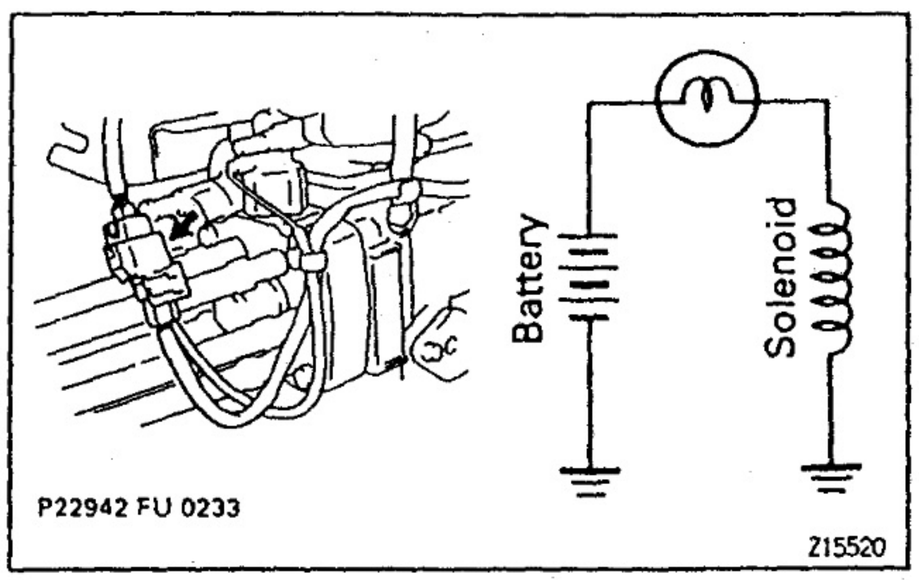
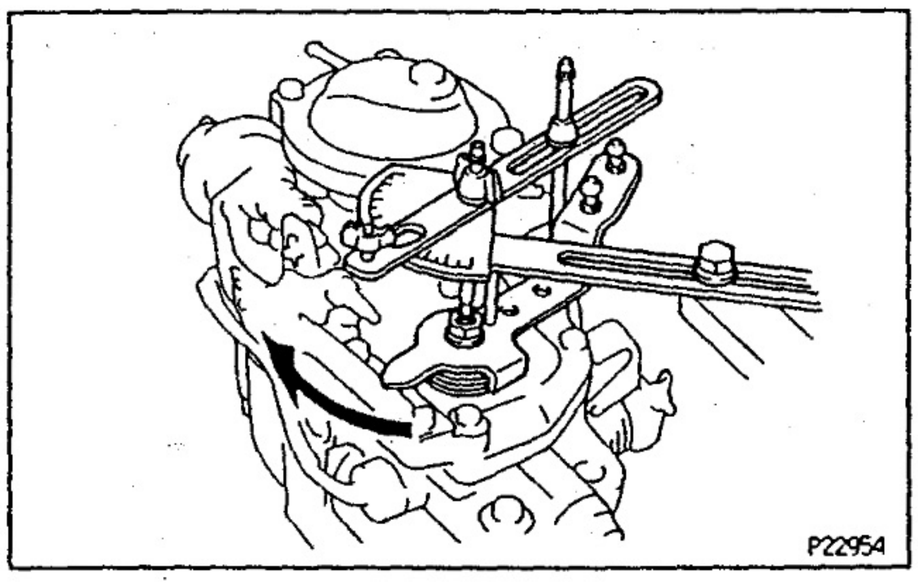


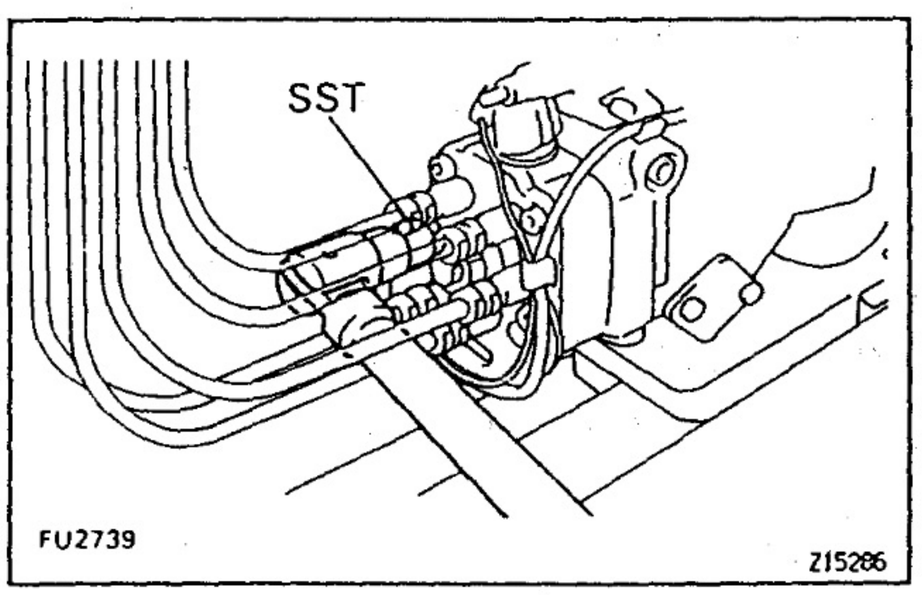
(m) Apply about 6 volts of DC power to the fuel cut solenoid.
NOTICE:
- **When applying voltage to the solenoid, position the battery as far away from the solenoid as possible so that a spark does not occur.**
- **When connecting the battery cable, connect the solenoid side first.**

(n) The pressure for feeding fuel to the injection pump should be 20 kPa (0.2 kgf/cm², 2.8 psi). The fuel temperature for pump testing should be 40 — 45°C (104 — 113°F).

(o) Install an angle gauge to the stand and set it to the adjusting lever.
Part No. 95095—10360 (Stand w/ angle gauge)

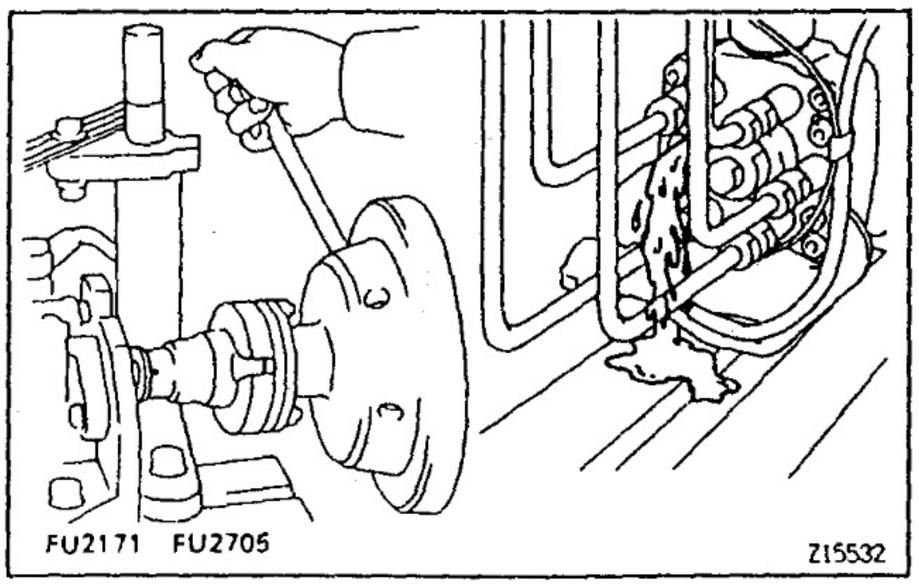
(p) Secure the adjusting lever fully on the maximum speed side.





(q) Check the installation direction of the camplate as follows:
- Disconnect the injection pipe from the position marked "C" on the distributive head.
- Using SST, remove the delivery valve holder assembly and gasket.

SST 09260—54012 (09269—54020)

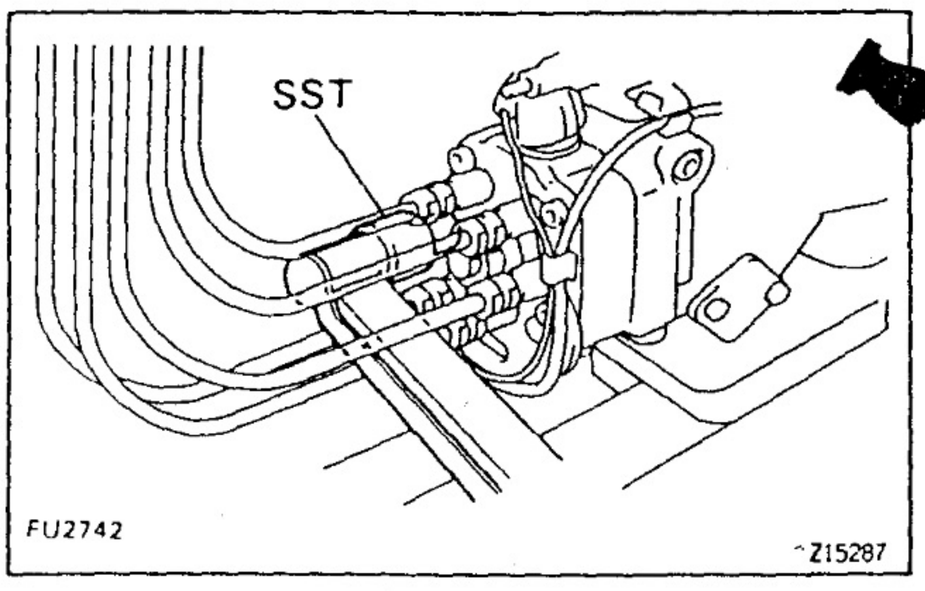


- Check that fuel is flowing out when the mark is in the position shown in the illustration.

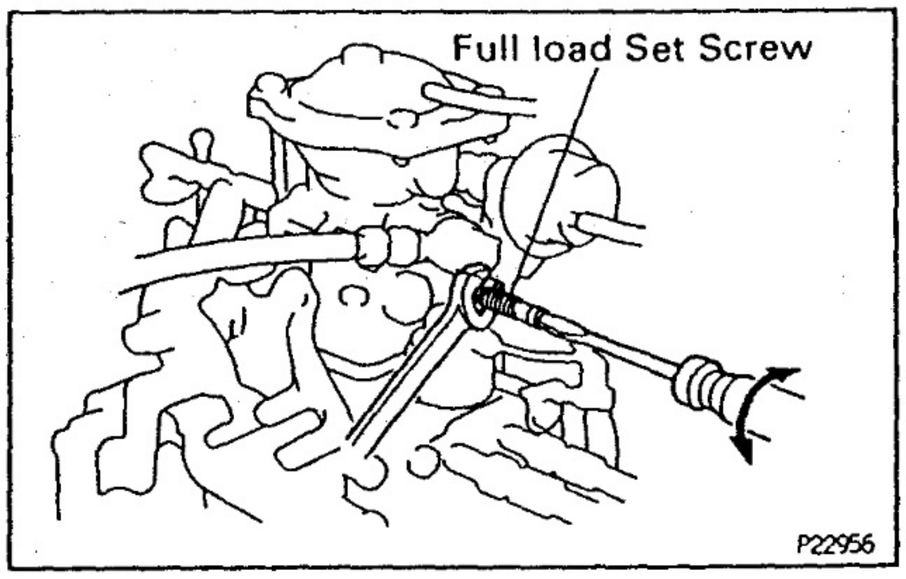
If not, it is improperly assembled.
- Disassemble and change the camplate position 180° in the opposite direction.

HINT: At this time, disconnect the fuel cut solenoid wire harness.
- Using SST, install a new gasket and the delivery valve holder assembly.

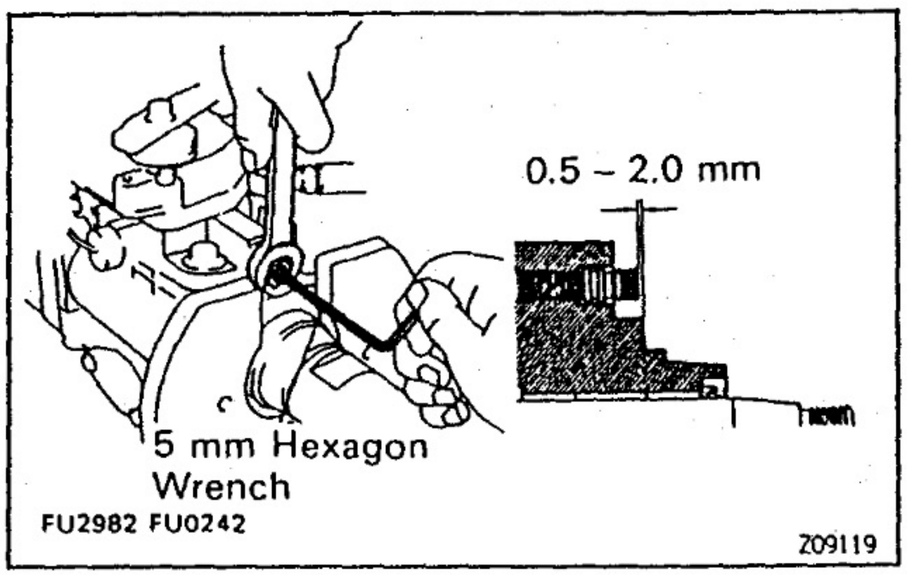
SST 09260—54012 (09269—54020)
Torque: 59 N·m (600 kgf·cm, 43 ft·lbf)
- Connect the injection pipe.



(r) Bleed the air from the distributive head plug bolt.
HINT: Make sure the air is completely bled out of the timer measuring device.
NOTICE: Do not let the pump exceed 800 rpm until the air is completely bled out.



(g) Adjust by turning the full load set screw.
HINT: The injection volume will increase about 3 cc (0.18 cu in.) with each 1/2 turn of the screw.



3. w/o BACS:

PRE–SETTING OF LOAD SENSING TIMER

Using a 5 mm hexagon wrench, adjust the protrusion of the governor shaft.

Protrusion:

0.5 – 2.0 mm (0.020 – 0.079 in.)

4. PRE–SET MAXIMUM SPEED

(a) Set the adjusting lever to maximum position.

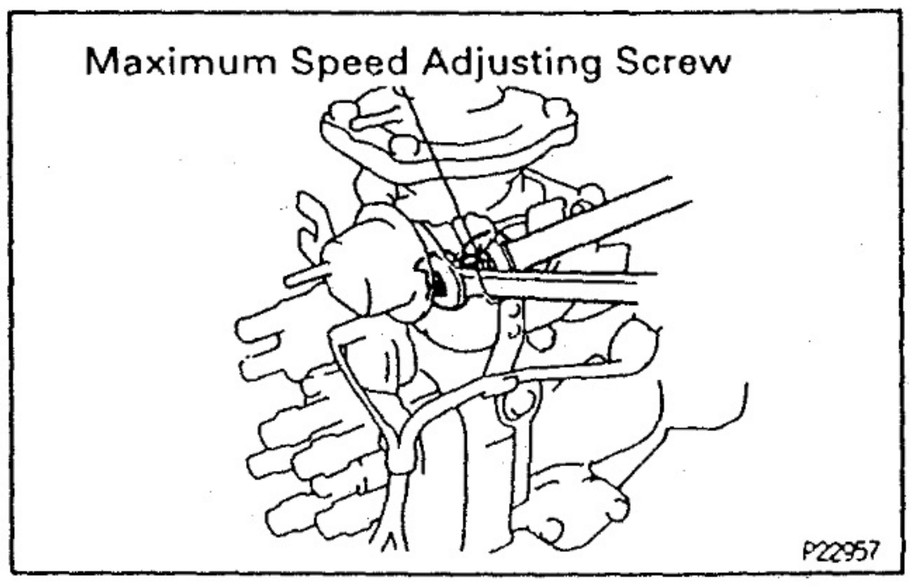
(b) Apply 67.2 kPa (503.7 mmHg, 19.83 in.Hg) of vacuum to the SICS actuator.

(c) w/o BACS:
Apply 79 kPa (0.81 kgf/cm², 11.5 psi) of pressure to the boost compensator.

(d) w/ BACS:
Apply 121.9 kPa (1.24 kgf/cm², 17.7 psi) of pressure to the boost compensator.

(e) Measure the injection volume.

Pump rpm	No. of measuring strokes	Each injection volume cc (cu in.)
2,200	200	4.0–6.0 (0.24–0.37)



(f) Remove the lock plate.

(g) Adjust the injection volume with the maximum speed adjusting screw.

5. ADJUST PUMP INNER PRESSURE

(a) The adjusting lever at idle position.

(b) Measure the pump inner pressure at the below listed rpm.
HINT: Check that the adjusting lever at idle position.

Pump rpm	Inner pressure kPa (kgf/cm², psi)
1,080	402.1 – 460.9 (4.1 – 4.7, 58.3 – 66.8)
1,800	813.9 – 872.8 (8.3 – 8.9, 118.3 – 126.8)

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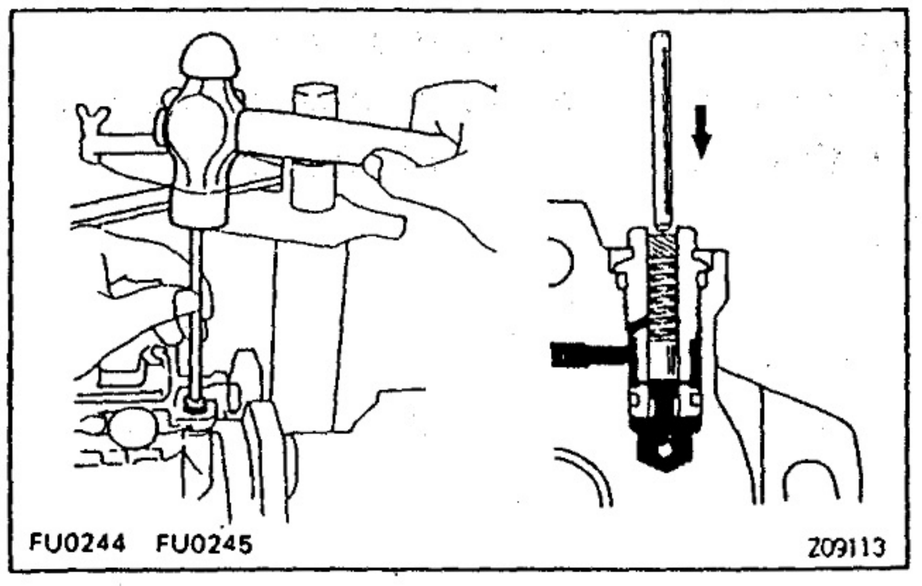
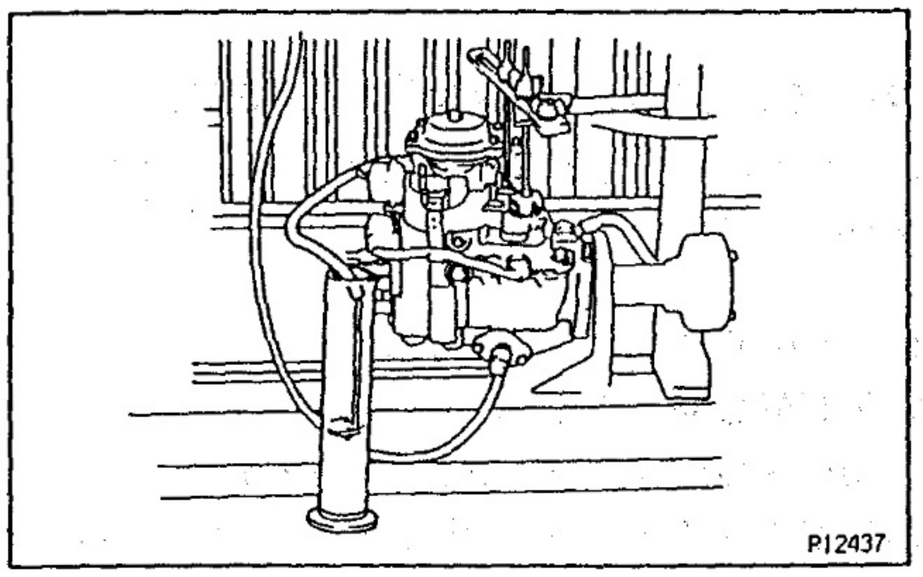


(c) If the pressure is low, adjust by lightly tapping the regulator valve piston while watching the pressure gauge.
HINT: If the pressure is too high or if the regulator valve was tapped in too far, the regulator valve must be replaced.

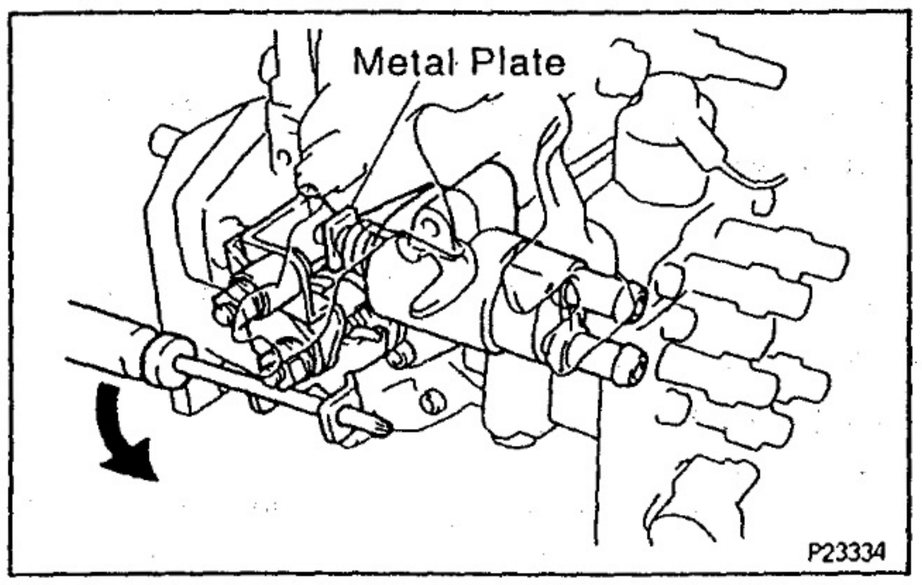


6. CHECK OVERFLOW VOLUME

Measure the overflow volume at the below listed rpm.

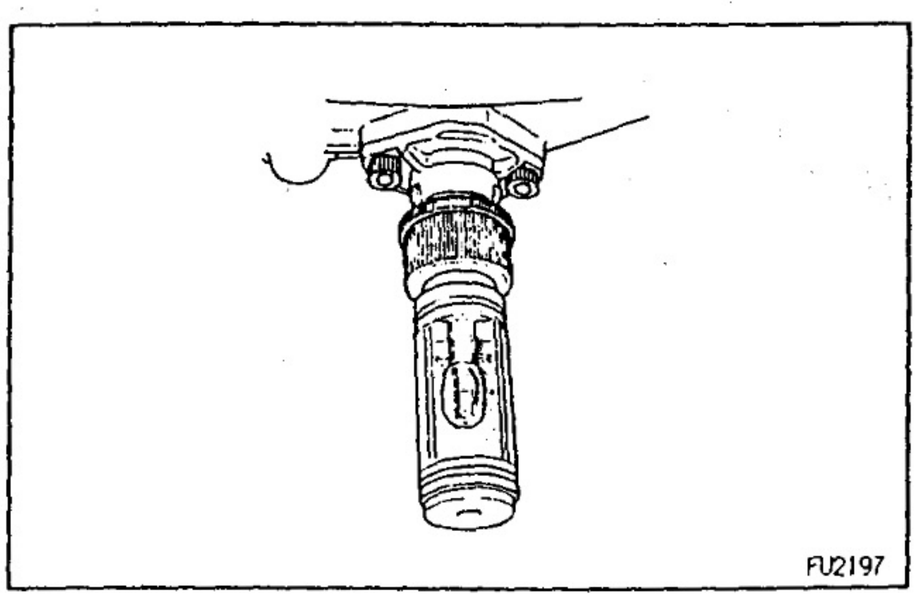
Pump rpm	Overflow volume cc/min. (cu in./min.)
1,800	1,292 – 1,942 (78.8 – 118.5)

HINT: Always use the overflow screw installed on the pump to be adjusted.



7. RELEASE COLD STARTING SYSTEM FOR NEXT INSPECTIONS

(a) Using a screwdriver, turn the cold starting lever counterclockwise approx. 20°.
(b) Put a metal plate (thickness of 5.0 – 8.0 mm (0.20 – 0.31 in.)) between the cold starting lever and thermo wax plunger.
HINT: Keep the cold starting system released until all measurements and adjustments are finished.



8. ADJUST TIMER

(a) Set the timer measuring device at zero.
(b) Measure the timer piston stroke at the below listed rpm.

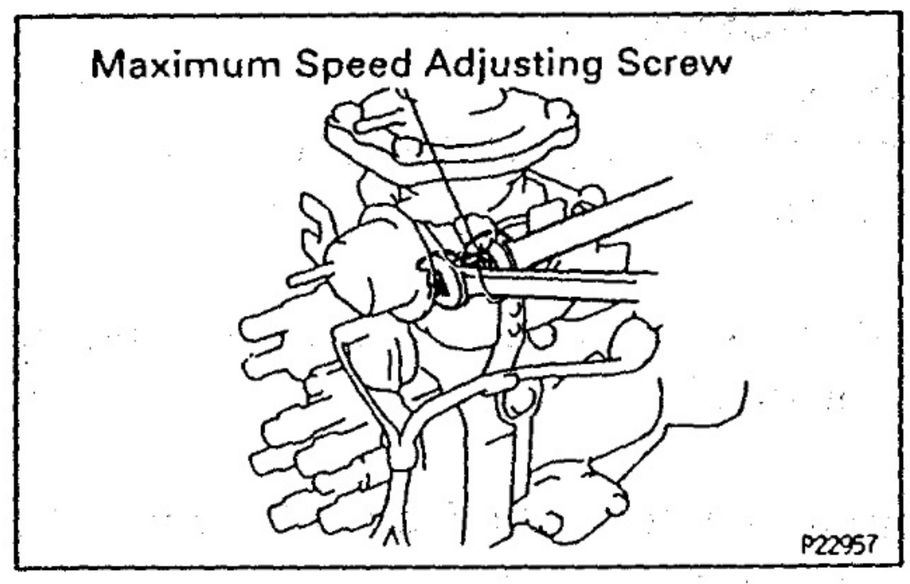
HINT: Check that the hysteresis is within 0.3 mm (0.012 in.).

Item	Pump rpm	Piston strokes mm (in.)	Procedure	Adjusting lever
w/o BACS	1,440	4.13 (0.163)	Set	Full load
	1,080	0.73 – 1.53 (0.029 – 0.060)	Verify	Full load
	2,000	7.8 – 8.6 (0.307 – 0.339)	Verify	Idle
w/ BACS	1,440	3.71 (0.146)	Set	Full load
	1,080	0.31 – 1.11 (0.012 – 0.044)	Verify	Full load
	2,000	7.8 – 8.6 (0.307 – 0.339)	Verify	Idle

(c) Apply 67.2 kPa (503.8 mmHg, 19.83 in.Hg) of vacuum to the SICS actuator.
(d) Measure the injection volume at each pump rpm.

Adjusting lever angle	Pump rmp	No. of measuring strokes	Injection volume of each cylinder cc (cu in.)	Remarks
Plus 21 – 31°	2,200	200	4.0 – 6.0 (0.24 – 0.37)	Adjust
Minus 12 – 22°	2,200		1.0 (0.06) or less	–

V06638



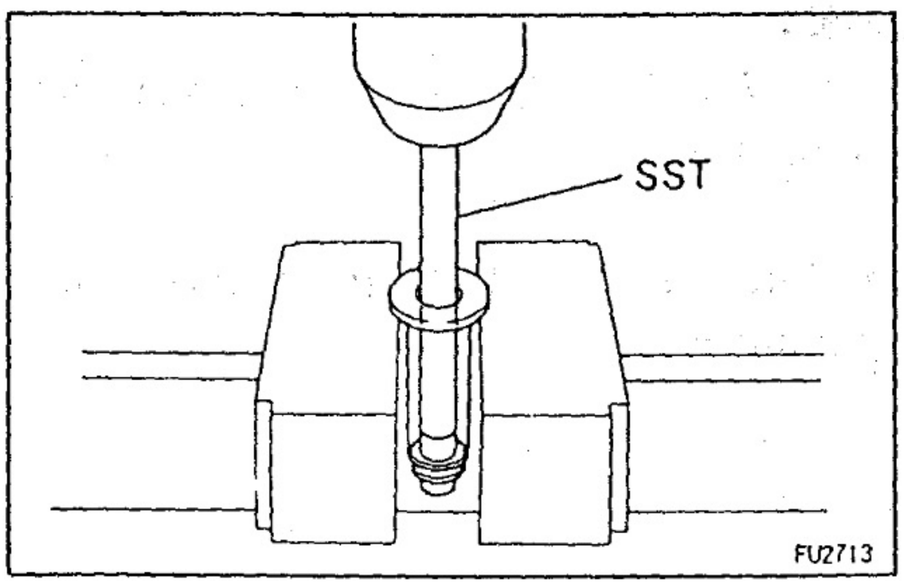
(e) Adjust by turning the maximum speed adjusting screw.

12. CHECK INJECTION VOLUME

(a) Apply 67.2 kPa (503.7 mmHg, 19.83 in.Hg) of vacuum to the SICS actuator.
(b) Measure the injection volume at each pump rpm and boost pressure.

Item	Adjusting lever angle	Pump rpm	Boost pressure kPa (kgf/cm², psi)	No. of measuring strokes	Each injection volume cc (cu in.)	Variation limit cc (cu in.)	Remarks
w/BACS	Plus 21 – 31°	1,080	121.9 (1.24, 17.7)	200	14.92 – 16.52 (0.91 – 1.01)	1.6 (0.10)	Basic full-load injection volume
		100	41.2 (0.42, 6.0)		15.60 – 19.60 (0.95 – 1.20)	–	Volume during starting
		720	0 (0, 0)		7.14 – 8.34 (0.44 – 0.51)	–	–
		1,800	121.9 (1.24, 17.7)		17.74 (1.08)	–	–
w/o BACS	Plus 21 – 31°	1,080	79 (0.81, 11.5)	200	14.92 – 16.52 (0.91 – 1.01)	1.6 (0.10)	Basic full-load injection volume
		100	0 (0, 0)		14.00 – 18.00 (0.85 – 1.10)	–	Volume during starting
		720	0 (0, 0)		8.02 – 9.22 (0.49 – 0.56)	–	–
		1,800	79 (0.81, 11.5)		17.74 (1.08)	–	–

V07367

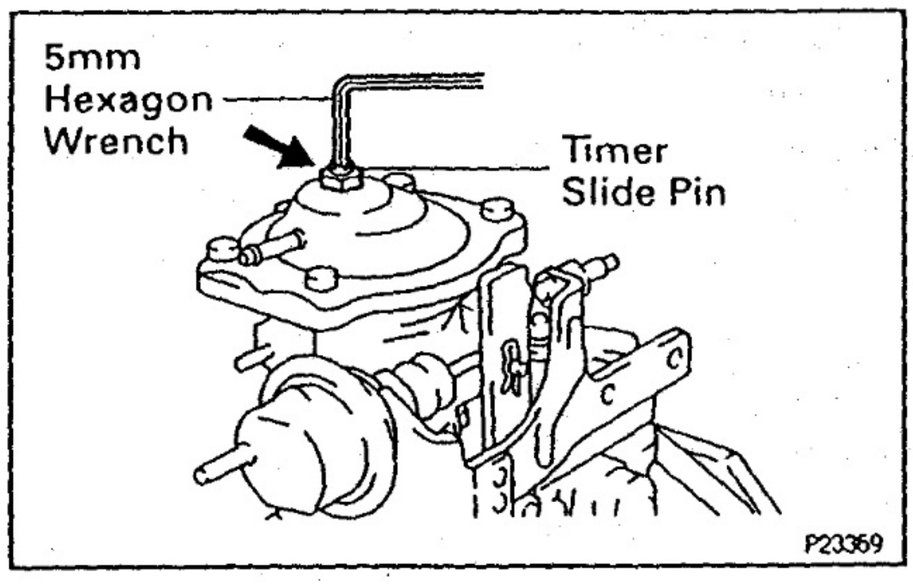


If the injection volume at 100 rpm is not as specified, replace the governor sleeve plug as follows:

- Using SST and a press, press out the sleeve plug assembly from the governor sleeve.

SST 09236–00101 (09237–00070)

continued overleaf



w/o BACS:

Pump rpm	No. of measuring strokes	Each injection volume cc (cu in.)
720	200	8.02 – 9.22 (0.49 – 0.56)

(f) Using a 5 mm hexagon wrench, adjust by turning the timer slide pin.

14. ADJUST BOOST COMPENSATOR CHARACTERISTIC

(a) Apply 67.2 kPa (503.7 mmHg, 19.83 in.Hg) of vacuum to the SICS actuator.

(b) w/o BACS:
Apply 40 kPa (0.41 kgf/cm², 5.8 psi) of pressure to the boost compensator.

(c) w/ BACS:
Apply 79 kPa (0.81 kgf/cm², 11.5 psi) of pressure to the boost compensator.

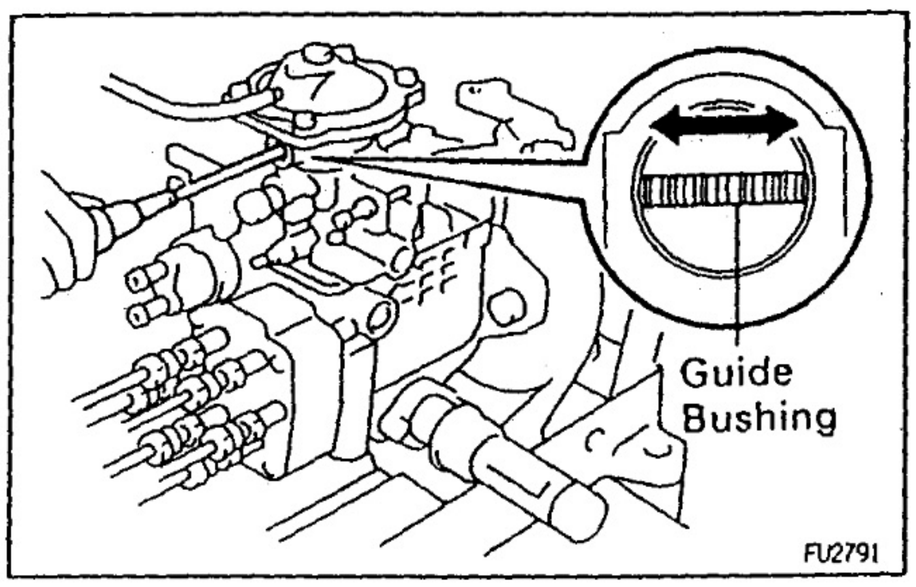
(d) Measure the injection volume.

w/ BACS:

Pump rpm	No. of measuring strokes	Each injection volume cc (cu in.)
720	200	12.46 – 14.26 (0.76 – 0.87)

w/o BACS:

Pump rpm	No. of measuring strokes	Each injection volume cc (cu in.)
720	200	12.60 – 14.40 (0.77 – 0.88)



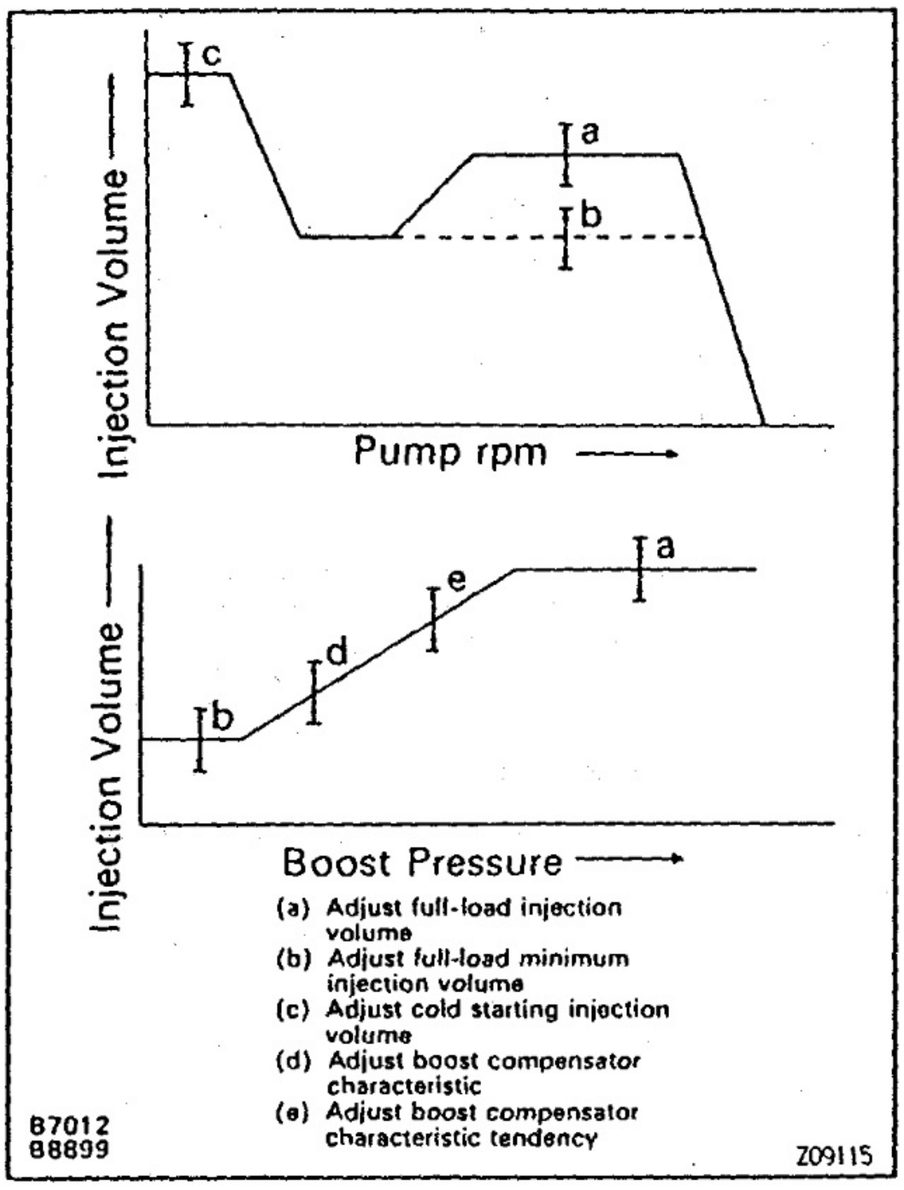
(e) Using a screwdriver, adjust the injection volume by the guide bushing.
HINT: When the guide bushing is turned clockwise, as seen from above, the injection volume will increase.

15. CHECK FOR CHARACTERISTIC TENDENCY

(a) Apply 67.2 kPa (503.7 mmHg, 19.83 in.Hg) of vacuum to the SICS actuator.

(b) w/o BACS:
Apply 16.0 kPa (0.16 kgf/cm², 2.3 psi) of pressure to the boost compensator.

(c) w/ BACS:
Apply 41.2 kPa (0.42 kgf/cm², 6.0 psi) of pressure to the boost compensator.



(d) Measure the injection volume.

w/ BACS:

Pump rpm	No. of measuring strokes	Each injection volume cc (cu in.)
720	200	8.02 – 9.22 (0.49 – 0.56)

w/o BACS:

Pump rpm	No. of measuring strokes	Each injection volume cc (cu in.)
720	200	8.80 – 10.00 (0.54 – 0.61)

16. CHECK HYSTERESIS

(a) w/o BACS:

Compare the injection volume when the boost compensator pressure is lowered from 79 kPa (0.81 kgf/cm², 11.5 psi) to 0 kPa (0 kgf/cm², 0 psi) and, conversely, when it is raised from zero.

(b) w/ BACS:

Compare the injection volume when the boost compensator pressure is lowered from 127 kPa (1.25 kgf/cm², 18.3 psi) to 0 kPa (0 kgf/cm², 0 psi) and, conversely, when it is raised from zero.

HINT: Make measurements after moving the adjusting lever between idle and maximum 3 times for each lowering of the pressure.

Item	Pump rpm	Boost pressure kPa (kgf/cm², psi)	No. of measuring strokes	Injection volume of each cylinder cc (cu in.)	Hysteresis cc (cu in.)
w/BACS	720	121.9 (1.24, 17.7)	200	14.04 – 15.64 (0.86 – 0.95)	–
		79 (0.81, 11.5)		12.46 – 14.26 (0.76 – 0.87)	–
		41.2 (0.42, 6.0)		8.02 – 9.22 (0.49 – 0.56)	0.6 (0.10) or less
		0 (0, 0)		7.14 – 8.34 (0.44 – 0.51)	–
w/o BACS	720	79 (0.81, 11.5)	200	14.04 – 15.64 (0.86 – 0.95)	–
		40 (0.41, 5.8)		12.60 – 14.40 (0.77 – 0.88)	–
		16.0 (0.16, 2.3)		8.80 – 10.00 (0.54 – 0.61)	0.6 (0.10) or less
		0 (0, 0)		8.02 – 9.22 (0.49 – 0.56)	–

V07364

If not within standard value, check each sliding part of the boost compensator and check whether or not there is any oil.

continued overleaf

HINT: The end point is hard to identify, so use the methods used in the chart above.

(j) When the adjusting lever is moved slowly from the maximum speed side to the idle speed side.

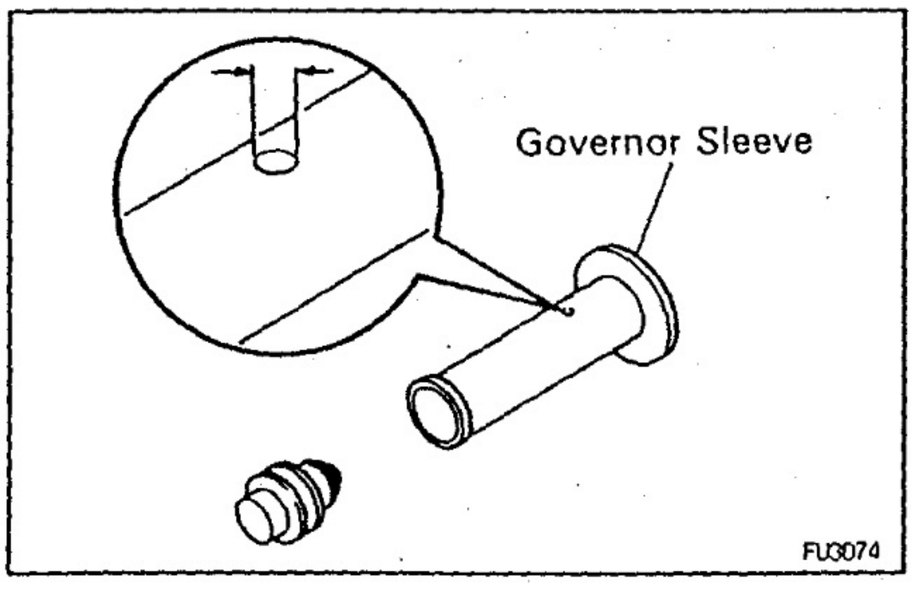
w/ BACS:

Pump rpm	Timer piston stroke mm (in.)
1,440	1.56 – 2.56 (0.061 – 0.101)

w/o BACS:

Pump rpm	Timer piston stroke mm (in.)
1,440	1.29 – 2.29 (0.051 – 0.090)

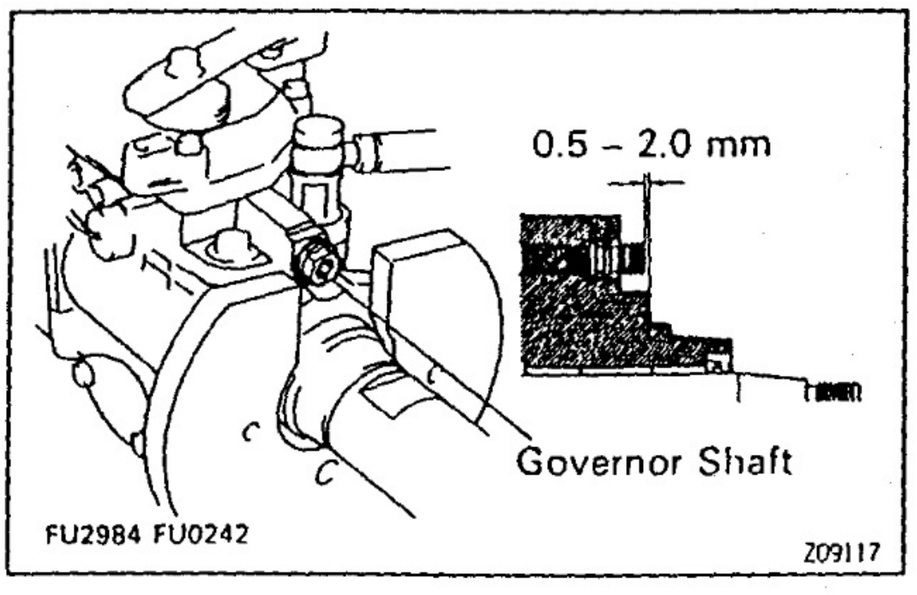
If the timer stroke is not as specified when the load sensing is at maximum retard angle, select a new governor sleeve.



Governor sleeve hole diameter:

Item	Diameter mm (in)	Item	Diameter mm (in)
Europe	0.45 (0.0177) 0.50 (0.0197) 0.55 (0.0217)	Australia	0.55 (0.0217) 0.60 (0.0236) 0.625 (0.0246) 0.65 (0.0256)

V06636



HINT: A large hole diameter decreases the timer stroke and a smaller hole diameter increases the timer stroke.

(k) Check the protrusion of the governor shaft.

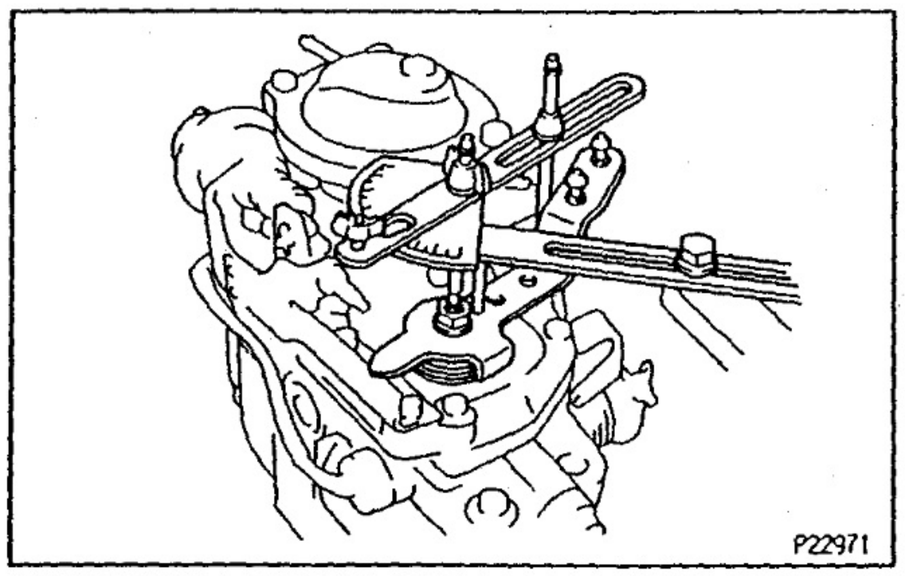
Protrusion:

0.5 – 2.0 mm (0.020 – 0.079 in.)

18. ADJUST IDLE SPEED

(a) Measure the injection volume for each pump rpm.

Item	Adjusting lever angle	Pump rpm	No. of measuring strokes	Injection volume of each cylinder cc (cu in.)	Variation limit cc (cu in.)	Remarks
Europe	Full position	400	200	7.86 ~ 10.66 (0.48 ~ 0.65)	–	–
	Minus 12 – 22°	350		q = 0.70 ~ 1.10 (0.04 ~ 0.07)	0.5 (0.03)	Adjust
Australia M/T	Full position	400	200	7.86 ~ 10.66 (0.48 ~ 0.65)	–	–
	Minus 12 – 22°	350		q = 0.70 ~ 1.10 (0.04 ~ 0.07)	0.5 (0.03)	Adjust
Australia A/T	Full position	400	200	7.86 ~ 10.66 (0.48 ~ 0.65)	–	–
	Minus 12 – 22°	400		q = 0.70 ~ 1.10 (0.04 ~ 0.07)	0.5 (0.03)	Adjust

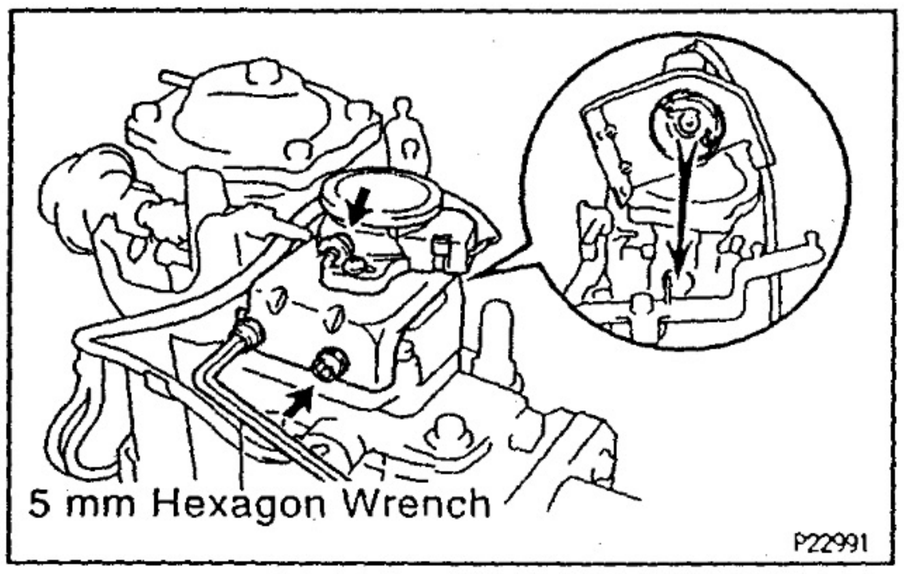


21. w/o Australia M/T:
INSTALL THROTTLE POSITION SENSOR AND BRACKET

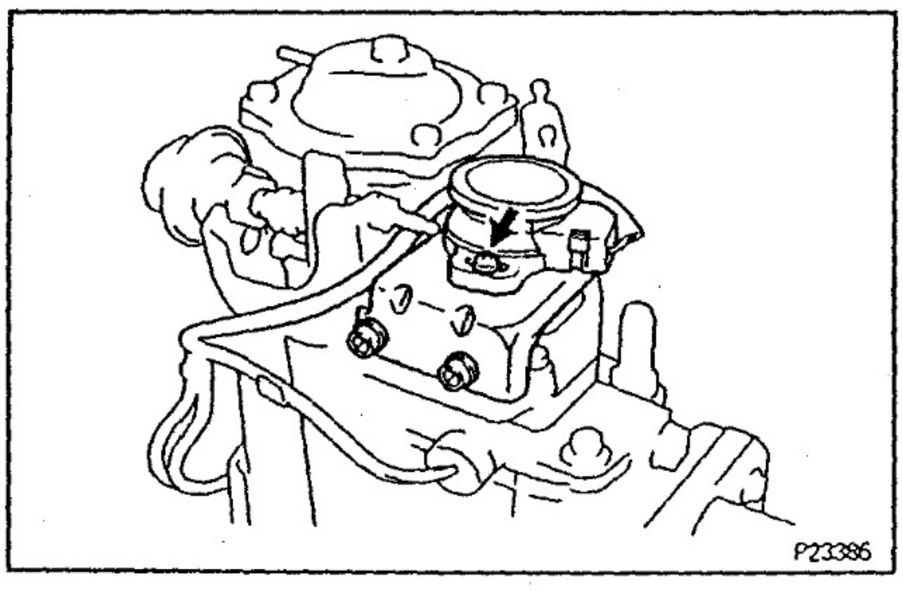
(a) Europe:
Set the adjusting lever to the angle for the injection volume shown below.

Pump	No. of measuring strokes	Injection volume of each cylinder cc (cu in.)
1,000	200	6.66 (0.406)

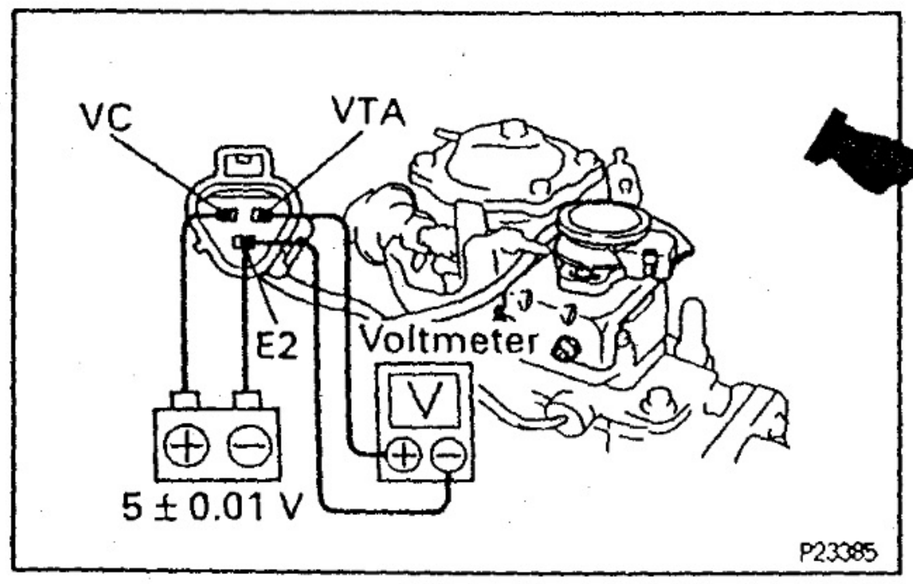
V06644



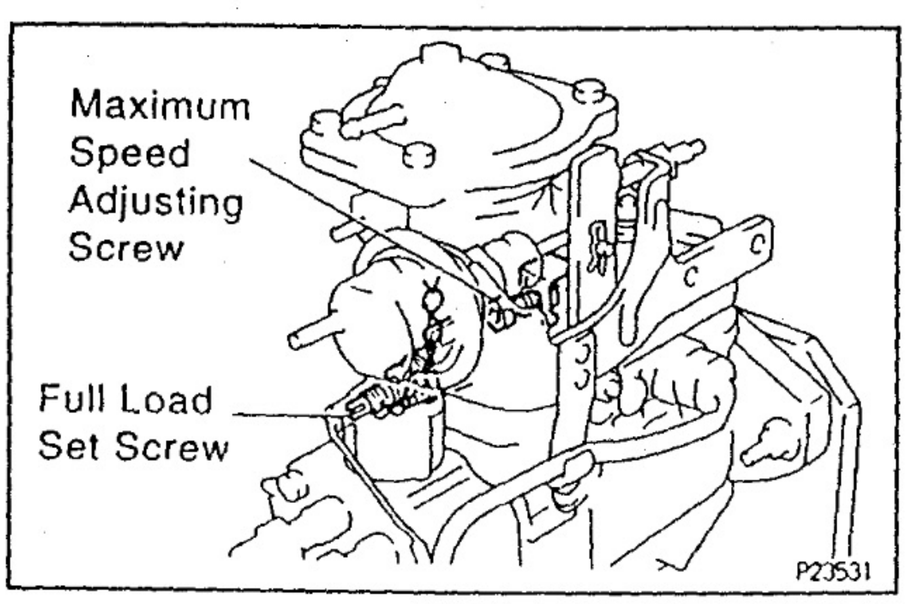
(b) Attach the portions of the throttle position sensor and adjusting lever.
(c) Using a 5 mm hexagon wrench, install the throttle position sensor with the 3 bolts.



(d) Loosen the 2 screws holding the throttle position sensor to the bracket.



(e) Apply 5 ± 0.01 V across terminals VC and E2.
(f) Connect the tester probes of a voltmeter to terminals VTA and E2 of the throttle position sensor.
(g) Europe:
With the adjusting lever set in the position required in (a) above, gradually turn the throttle position sensor so that its output will be 2.754 ± 0.025 V.
(h) Australia:
Secure the adjusting lever fully on the maximum speed side so that its output will be 0.6 ± 0.025 V.
(i) Tighten the 2 screws holding the throttle position sensor to the bracket.



22. SEAL PARTS
(a) Seal the full load set screw with new lead seal.
(b) Install the lock plate to the maximum speed adjusting screw.

23. INSTALL FUEL PIPE BRACKET
Install the fuel pipe bracket with a bolt.