

NISSAN

# NISSAN

**MODEL RD SERIES  
DIESEL ENGINES**

**SERVICE MANUAL**

## QUICK REFERENCE INDEX

### INTRODUCTION

The purpose of this Workshop Manual, is to help the Service personnel to carry out the repair and maintenance works on the new models RD28 and RD28T.

Throughout the Manual, the model or models of engine are only indicated when the information is specific for one of them; if not, it shall be understood that the said information is common to both engines.

All information contained in this Manual is that currently in use at the time of printing. Nissan Motor Iberica, reserves the right to modify the specifications and equipment of its products, at any time and without prior notice.

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<b>MAINTENANCE</b> _____	<b>MA</b>
<b>ENGINE MECHANICAL</b> _____	<b>EM</b>
<b>ENGINE LUBRICATION &amp; COOLING SYSTEMS</b> —	<b>LC</b>
<b>ENGINE FUEL SYSTEM</b> _____	<b>EF</b>

EDITED BY THE  
TECHNICAL ASSISTANCE DIRECTION

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**NISSAN MOTOR IBERICA, S.A.**

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# GENERAL INFORMATION

## SECTION **GI**

**GI**

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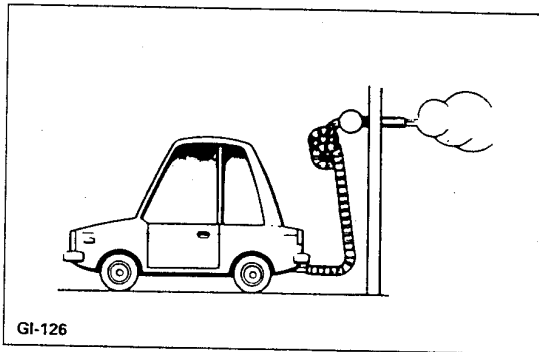


## PRECAUTIONS

### GENERAL

The following precautions must be taken to guarantee the safety and suitability of the repair and maintenance operations carried out on the vehicle.

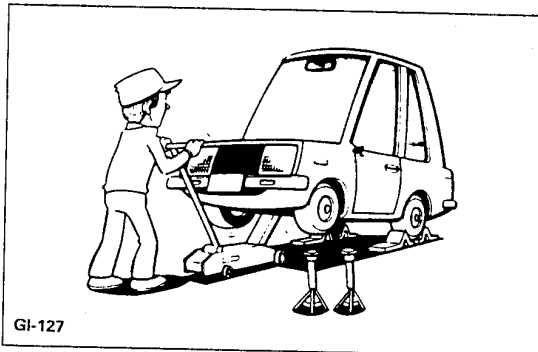
These warnings will not be repeated in each Chapter.



1. Never leave the engine running in a closed space where the exhaust gases cannot be easily extracted.

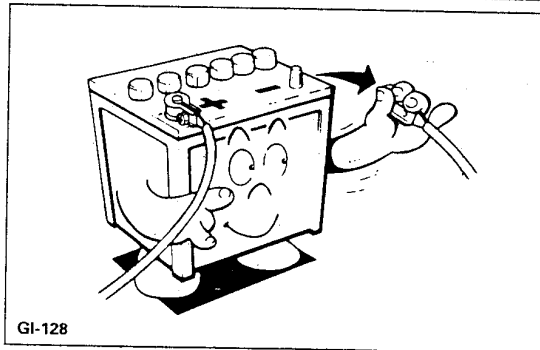
Check that the place of work is always well ventilated and does not contain flammable materials. Use extreme care when handling flammable or toxic substances such as gasoline, refrigerant gas, etc. When working in a pit or in any enclosed area, make sure suitable ventilation is provided before handling dangerous materials.

Never smoke when working on the vehicle.



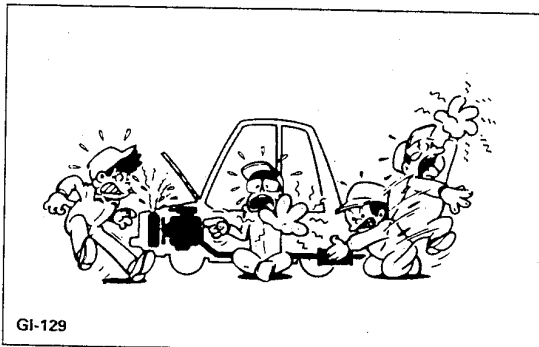
2. Before jacking up the vehicle, chock the wheels so as to prevent any possible movement. When the vehicle is raised, and before working on it, support it at the rest and towing points.

All these operations should be carried out with the vehicle standing on a flat surface.



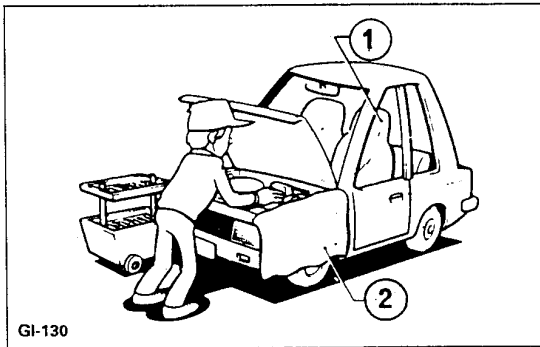
3. When a heavy component such as the engine, differential or transmission is removed, take the necessary precautions to ensure that the said component does not drop and cause a sudden out of balance in the vehicle. Likewise ensure that the component does not strike against adjacent parts, especially brake pipes, brake booster, etc.

4. Before starting any repair in which battery current is not used, disconnect the ignition switch and the battery ground cables, so as to prevent any short-circuit.



5. Avoid all contact with hot metal elements, such as the radiator, exhaust manifold, exhaust pipe and muffler.

Never remove the radiator cap whilst the engine is hot.

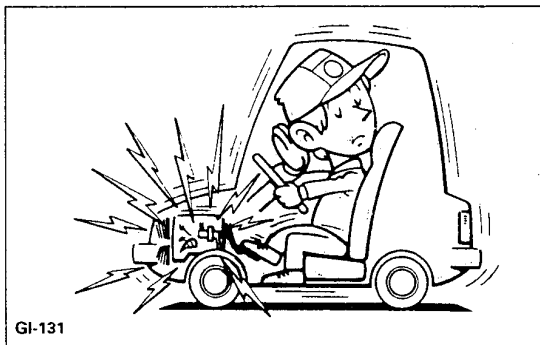


1. Seat protection cover
2. Mudguard protection

6. Before starting work on the vehicle, protect the mudguards, upholstery and carpeting, so as to prevent scratches and stains.

Take care not to scratch the paintwork with the keys, or buckles and buttons of work clothes.

7. Clean all disassembled parts with the indicated liquid or solvent before their inspection or installation.
8. Replace all oil seals, sealing gaskets, packings, O rings, lockwashers, split pins, self-locking nuts and other parts as applicable.
9. Place the disassembled parts in the sequence and position in which they are installed.
10. Do not touch the terminals of electrical components that use microprocessors, such as electronic control devices, since the static electricity from one's body could damage the internal electronic components.
11. When disconnecting vacuum or pressure air lines, mark them so that they can be reinstalled in their correct position.
12. Use the lubricants specified in the Sub-Section "Recommended Lubricants", of Section MA.
13. Always use the recommended glues and sealers, or their equivalent.
14. The correct standard and special recommended tools shall be used to ensure a safe and effective repair.
15. After carrying out repairs on the fuel, oil, water, air or exhaust systems, check that there are no leaks.
16. Suitably remove the oil or solvent used for cleaning the parts.



## TURBOCHARGER

The turbocharger system uses engine oil and coolant for the lubrication and cooling of its rotating parts. When the engine is running at maximum speed, the turbine turns at speeds above 100,000 r.p.m., and its temperature can reach 870 °C (1,598 °F). It is therefore essential to maintain a constant flow of oil and coolant to the turbocharger. A sudden interruption in the supply can produce serious damage in the turbocharger.

To ensure correct operation of the system, pay special attention to the procedure stated below.

1. Always use the recommended oil and coolant.
2. Never accelerate the engine to high revolutions immediately after starting it.
3. If the engine has been running at high speed for a prolonged period of time, leave it to run at idling speed for a few minutes before stopping it.

## SYMBOLOLOGY

1. The following SYMBOLS are used:



: Tightening torque. Nm (kgm) (ft-lb).



: Unless otherwise specified, apply multi-purpose grease.



: Lubricate with oil.



: Apply sealant.



: Check.



: Replace after each removal.

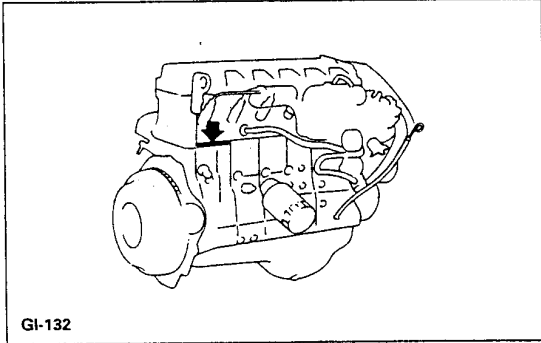
2. The precautions to be taken to avoid personal injury, and damage to engine components, are included in the NOTES and WARNINGS.

## ENGINE APPLICATIONS

MODEL	VEHICLE
RD28	— HARDTOP
	— HIGH-ROOF HARDTOP
	— VAN
	— STATION WAGON
RD28T	— HARDTOP
	— VAN
	— STATION WAGON

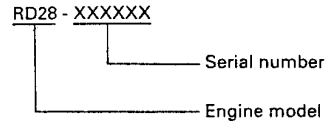
**NOTE:** In the operations, figures, notes, etc., in which a particular model or models of vehicle is not specified, it shall be understood that they are common to all of them.

## ENGINE SERIAL NUMBER



GI-132

The engine serial number is stamped on the right rear side of the engine block.





## SPECIFICATIONS

APPLICATION		HARDTOP HIGH-ROOF HARDTOP VAN STATION WAGON	HARDTOP VAN STATION WAGON
Engine model		RD28	RD28T
Operating principle		Diesel cycle	
Cylinders	Number	6	
	Bore mm (in)	85 (3.35)	
	Stroke	83 (3.27)	
	Arrangement	Vertical, in-line	
	Stroke/bore ratio	0.97	
Cubic capacity cm <sup>3</sup> (in <sup>3</sup> )		2,826 (172.44)	
Cycle		4 stroke	
Injection order		1-5-3-6-2-4	
Compression ratio		21.2 ± 1.2:1	
Compression pressure kg/cm <sup>2</sup> (rpm)		25-31 (200)	
Number of piston rings	Compression	2	
	Oil scraper	1	
Number of main bearings		7	
Idling speed rpm		650 <sup>+50</sup> / <sub>-0</sub>	
Maximum engine speed		5,000 ± 100	4,600 ± 100
Static injection advance mm (in)		0.75 ± 0.03 (0.0295 ± 0.0012)	0.86 ± 0.05 (0.0339 ± 0.0020)
Valve setting	Inlet	(self-adjusting hydraulic tappets)	
	Exhaust		
Dynamic injection advance APMS degrees (rpm)		6° (650 + 50)	8° (650 + 50)

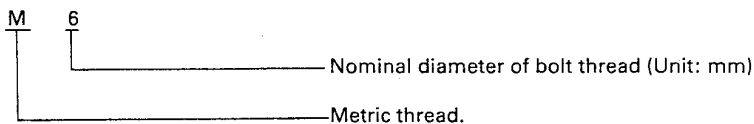
## TIGHTENING TORQUES OF STANDARD BOLTS

GRADE	NOMINAL SIZE	DIAMETER (mm)*	PITCH (mm)	TIGHTENING TORQUE		
				Nm	kgm	ft-lb
4T	M6	6.0	1.0	3-4	0.3-0.4	2.2-2.9
	M8	8.0	1.25	8-11	0.8-1.1	5.8-8.0
			1.0	8-11	0.8-1.1	5.8-8.0
	M10	10.0	1.5	16-22	1.6-2.2	12-16
			1.25	16-22	1.6-2.2	12-16
	M12	12.0	1.75	26-36	2.7-3.7	20-27
1.25			30-40	3.1-4.1	22-30	
M14	14.0	1.5	46-62	4.7-6.3	34-46	
7T	M6	6.0	1.0	6-7	0.6-0.7	4.3-5.1
	M8	8.0	1.25	14-18	1.4-1.8	10-13
			1.0	14-18	1.4-1.8	10-13
	M10	10.0	1.5	25-35	2.6-3.6	19-26
			1.25	26-36	2.7-3.7	20-27
	M12	12.0	1.75	45-61	4.6-6.2	33-45
1.25			50-68	5.1-6.9	37-50	
M14	14.0	1.5	76-103	7.7-10.5	56-76	
9T	M6	6.0	1.0	8-11	0.8-1.1	5.8-8.0
	M8	8.0	1.25	19-25	1.9-2.5	14-18
			1.0	20-27	2.0-2.8	14-20
	M10	10.0	1.5	36-50	3.7-5.1	27-37
			1.25	39-51	4.0-5.2	29-38
	M12	12.0	1.75	65-88	6.6-9.0	48-65
1.25			72-97	7.3-9.9	53-72	
M14	14.0	1.5	109-147	11.1-15.0	80-108	

1. The special parts are excluded.
2. These values are only applicable to bolts that have the following marks on the head.

Grade	Mark
4T .....	4
7T .....	7
9T .....	9

\*Nominal diameter



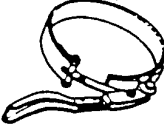
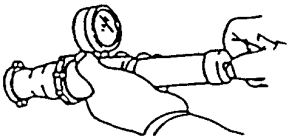
**SECTION MA**



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**SPECIAL SERVICE TOOLS**

PART N.º	DENOMINATION
ST-193-20000	Wrench for extracting engine oil filter. 
EG-176-50301	Radiator cap and cooling system pressure tester. 

## HEALTH AND ENVIRONMENTAL PROTECTION PRECAUTIONS

### ENGINE OILS

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. Adequate means of skin protection and washing facilities should be provided.

#### Health Protection

- a) Avoid prolonged and repeated contact with oils, particularly used engine oils.
- b) Wear protective clothing, including impervious gloves where practicable.
- c) Do not put oily rags in pockets.
- d) Avoid contaminating clothes, particularly underpants, with oil.
- e) Overalls must be cleaned regularly. Discard unwashable clothing and oil impregnated footwear.
- f) First Aid treatment should be obtained immediately for open cuts and wounds.
- g) Use barrier creams, applying before each work period, to help the removal of oil from the skin.
- h) Wash with soap and water to ensure all oil is removed (skin cleansers and nail brushes will help). Preparations containing lanolin replace the natural skin oils which have been removed.
- i) Do not use petrol, kerosine, diesel fuel, gas oil, thinners or solvents for washing skin.
- j) If skin disorders develop, obtain medical advice.
- k) Where practicable, degrease components prior to handling.
- l) Where there is a risk of eye contact, eye protection should be worn, for example, chemical goggles or face shields; in addition an eye wash facility should be provided.

#### Environmental Protection

It is illegal to pour used oil on to the ground, down sewers or drains, or into water courses.

The burning of used engine oil in small space heaters or boilers is not recommended unless emission control equipment is fitted; in cases of doubt check with the Local Authority.

Dispose of used oil through authorised waste disposal contractors to licensed waste disposal sites, or to the waste oil reclamation trade. If in doubt, contact the Local Authority for advice on disposal facilities.

## RECOMMENDED LUBRICANTS

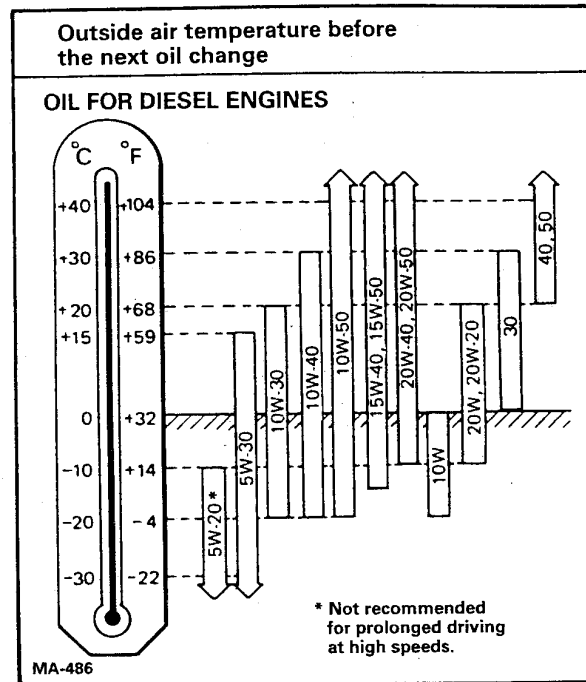
### LUBRICANTS

LUBRICANT	SPECIFICATION	REMARKS
Diesel engines		
Naturally aspirated	MIL-L-2104D CCMC D2-PD1 API CDII	For further details, see the Table of Recommended Viscosities (SAE)
Turbocharged	CCMC D3-PD1 API CE	
Anti-freeze	—	Ethyl-glycol base

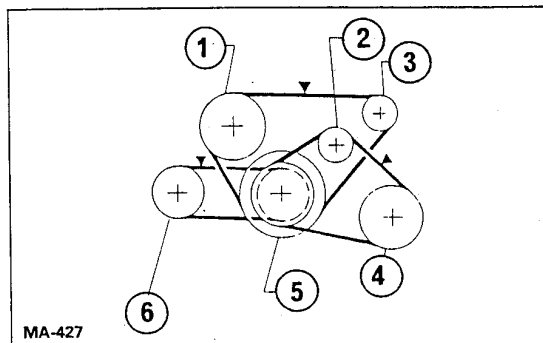
The oil specification for Diesel engines is compulsory.

ENGINE	RD28 and RD28T
Capacity	
With filter and cooler	6.7
Without filter or cooler	6.0

### SAE VISCOSITY INDEX



## ENGINE MAINTENANCE



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### COMPONENTS

1. Water pump
2. Tensioner pulley
3. Alternator
4. Air compressor
5. Crankshaft pulley
6. Power steering pump

## DRIVE BELTS

### CHECKING THE DRIVE BELTS

1. Check that the belts are not cracked, cut, worn or stained with oil. Replace where necessary. The belts should not rub on the bottom of the pulley groove. The water pump has two belts. Where necessary, replace both belts.
2. Check the flexure by applying pressure at a point halfway between each pulley.

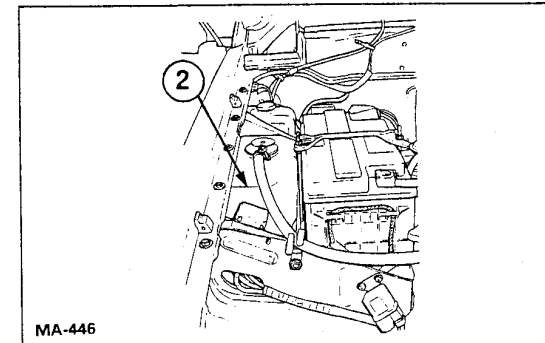
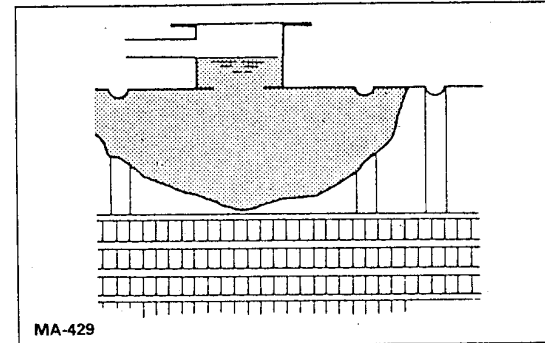
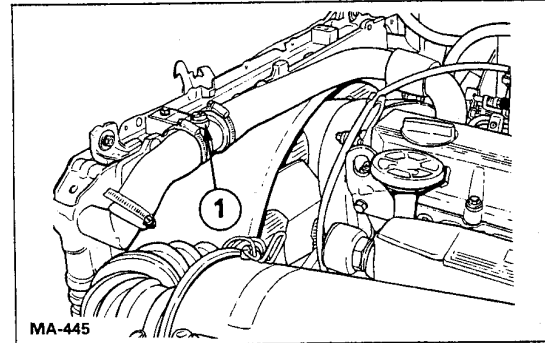
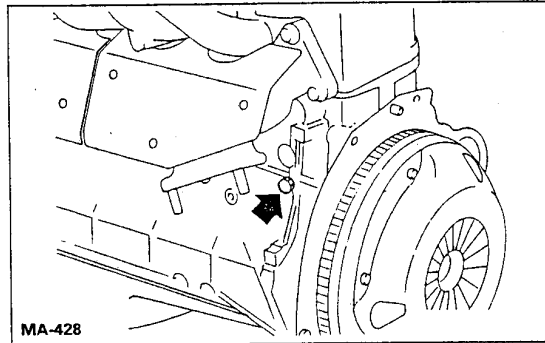
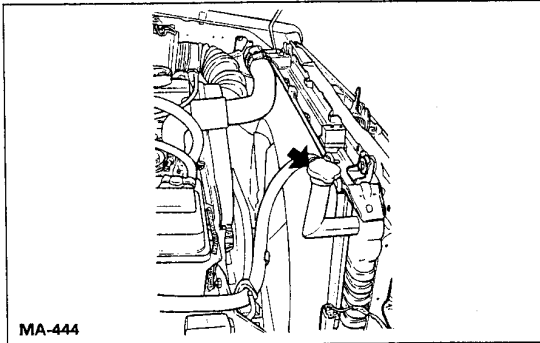
Adjust the tension if the flexure is greater than the specified value.

Unit: mm (in)

	USED BELT FLEXURE		ADJUSTMENT FLEXURE OF THE NEW BELT
	Limit	Corrected flexure	
Alternator	25* (0.98) 17 (0.67)	14-16* (0.55-0.63) 12-14 (0.47-0.55)	12-14* (0.47-0.55) 9-11 (0.35-0.43)
Air conditioning compressor	10* (0.39) 11 (0.43)	5-7* (0.20-0.28) 7-9 (0.28-0.35)	4-6* (0.16-0.24) 6-8 (0.24-0.31)
Power steering pump	15* (0.59) 14 (0.55)	8-10* (0.31-0.39) 10-12 (0.39-0.47)	6-8* (0.24-0.31) 9-11 (0.35-0.43)
Applied thrust force	98 N (10 kg, 22 lb)		

\* RD28 ENGINE

Check the belt flexure with the engine cold.  
If it is still hot, wait at least 30 minutes.



## COOLING SYSTEM

### CHANGING THE ENGINE COOLANT

**WARNING:**

Never attempt to change the coolant whilst the engine is hot, because there is a risk of burning yourself.

Whenever the coolant is changed, set the heating control at the end of its travel, e.g. at the "HOT" position.

1. Drain the coolant.
  - (a) Open the drain plug, located at the bottom of the radiator, and remove the plug.
  - (b) Remove the engine block drain plug and allow all the water to flow out.
2. Fill the radiator and engine with new coolant.
  - (a) Make sure that the radiator and engine block drain plugs are correctly tightened.
    - 🔧 **Engine block drain plug**  
(Use an appropriate sealant)  
20-29 Nm (2.0-3.0 kgm) (14-22 ft-lb)
  - (b) Open the air vent plug (1).
  - (c) Fill the radiator and engine block with new coolant up to the filler orifice. Use the proportion of water-antifreeze mixture indicated on the antifreeze container.

**Slowly pour the coolant through the filler mouth so that any air in the system can escape.**

- (d) Tighten the air vent plug (1).
- (e) Fill the reserve tank (2) up to the "MAX" level and tighten the radiator cap.
- (f) Run the engine at idling speed until the thermostat opens (after about 10 minutes).

**Carefully watch the water temperature gauge.**

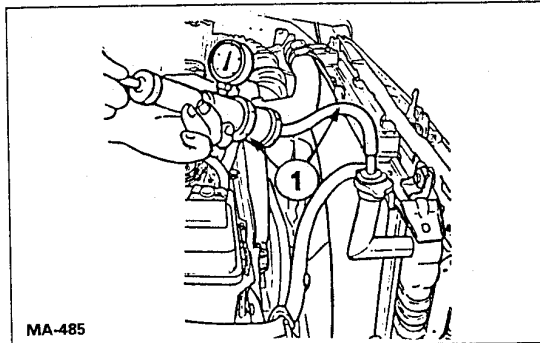
- (g) Stop the engine and, when it has cooled down, add more coolant to the radiator and engine block until it flows out of the filler orifice. Pour coolant in the reserve tank until arriving to the "MAX" level.
- (h) Repeat operations (6) and (7) until the coolant level ceases to drop after the engine has been operated.

### CHECKING THE COOLING SYSTEM

#### INSPECTING THE HOSES

Check that the hoses are not loose, do not show signs of leaks, cracks, rubbing or wear, and that the connections are tight.



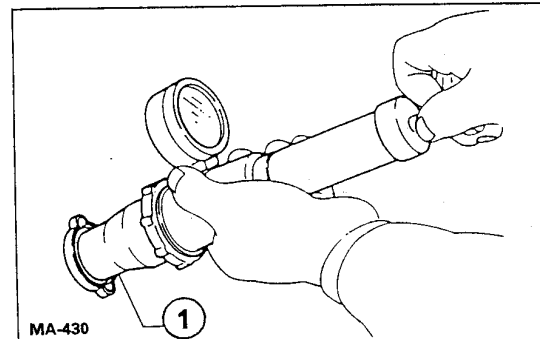


**CHECKING FOR LEAKS IN THE COOLING SYSTEM**

Apply pressure to the cooling system, using the tool (1) EG-176-50301 to check for leaks.

**Test pressure:**  
157 kPa (1.57 bar) (1.6 kg/cm<sup>2</sup>) (23 lb/in<sup>2</sup>)

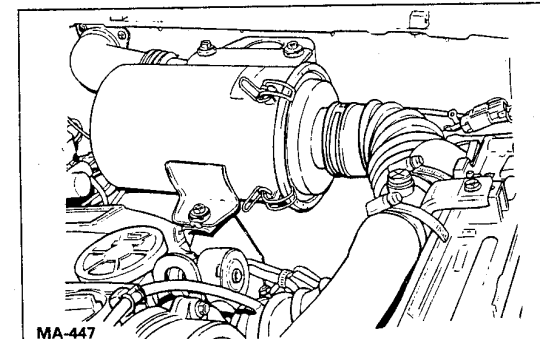
**WARNING:**  
If a pressure greater than the specified value is applied, it can damage the radiator.



**CHECKING THE RADIATOR CAP**

Check the condition of the radiator cap by applying pressure with the cap checking tool (1) EG-176-50301.

**Radiator cap safety pressure:**  
79-98 kPa (0.78-0.98 bar)  
(0.8-1.0 kg/cm<sup>2</sup>) (11-14 lb/in<sup>2</sup>)



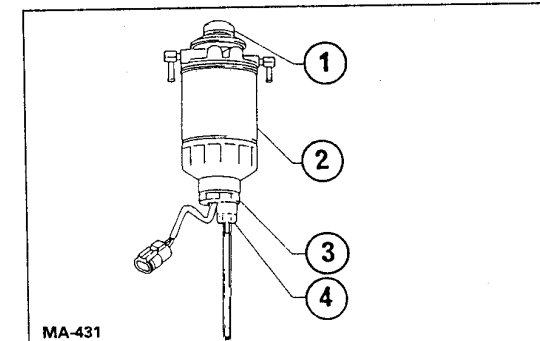
**FUEL SYSTEM**

**CHECKING THE FUEL SYSTEM**

Check the fuel lines to make sure there are no loose connections, cracks or defects. Tighten any loose connections and replace defective parts.

**REPLACING THE AIR CLEANER (VISCIOUS PAPER)**

Under no circumstance shall the filter element be cleaned and used again. When the element is replaced, clean the inside of the bowl and cover with a damp cloth.

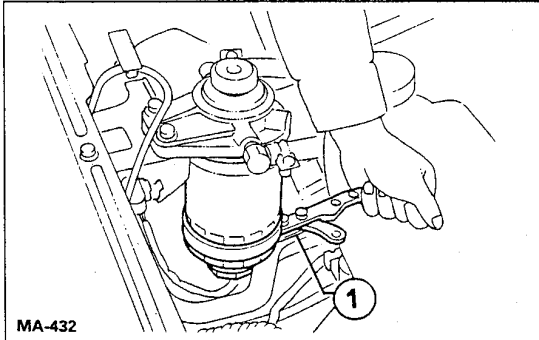


**CHECKING THE FUEL FILTER, DRAINING THE WATER AND REPLACING THE FILTER**

This filter incorporates the priming pump and the fuel filter sensor.

The fuel filter sensor can be used again after these operations.

- 1. Priming pump
- 2. Fuel filter
- 3. Sensor
- 4. Drain connection

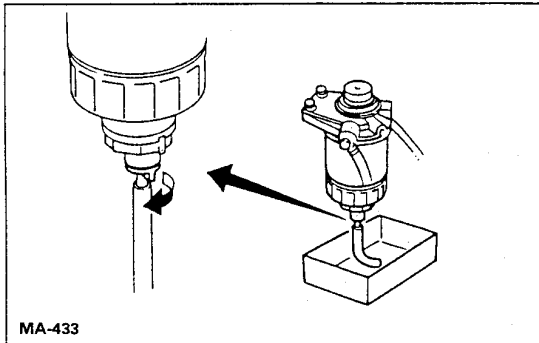


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**REPLACING THE FUEL FILTER**

1. Remove the fuel filter sensor and take out the fuel filter.
2. Remove the fuel filter, using the correct tool (1).
3. Install the sensor in the new filter.
4. Connect the fuel filter to the priming pump.
5. Bleed the air.  
See Section «EF» for instructions for bleeding the fuel system.

**Start the engine and check for leaks.**



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**DRAINING THE WATER**

1. Place a container under the fuel filter.
2. Loosen the connection and drain the water.

**The water will start to come out when the connection has been unscrewed 4 or 5 turns.**

3. Bleed the air.  
See Section «EF» for instructions for bleeding the fuel system.

**LUBRICATION SYSTEM**

**CHANGING THE ENGINE OIL**

**WARNING:**


**Be careful not to burn yourself, since the engine oil may still be hot.**

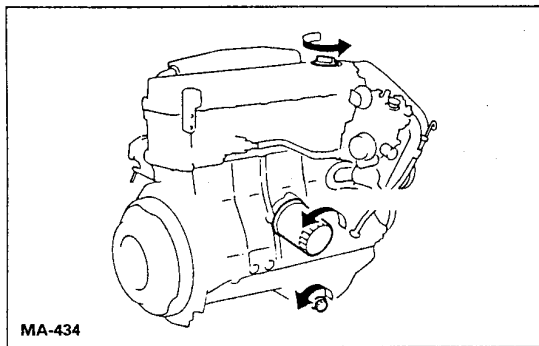
1. Once the engine has reached its normal operating temperature, check that there are no oil leaks.
2. Stop the engine.
3. Remove the oil filler and drain plugs.
4. Drain all the oil and refill with fresh oil.

**Oil capacity (approx.):**  
**Changing the oil filter: 6.7 (5.89 qt)**  
**Without changing the oil filter: 6.0 (5.27 qt)**

**WARNING:**

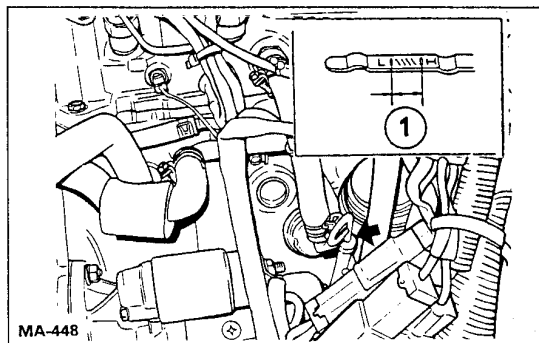
- Clean the draining plug and fit a new washer.

 **Draining plug**  
**29-39 Nm**  
**(3.0-4.0 kgm) (22-29 ft-lb)**

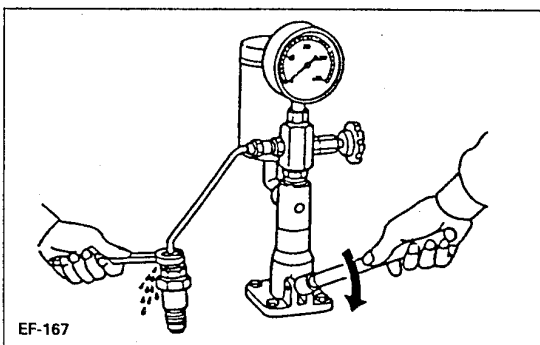
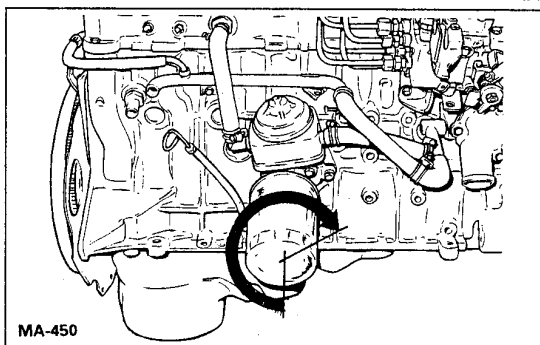
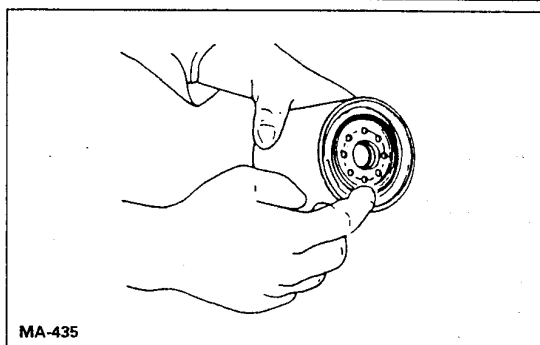
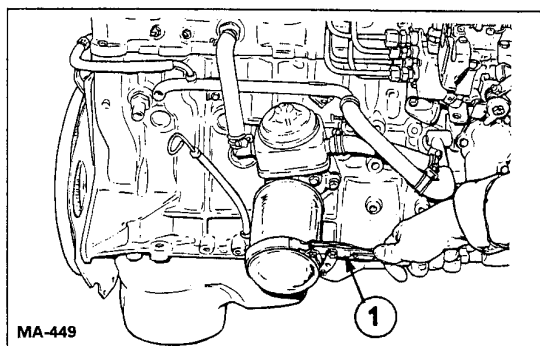


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- Use the recommended engine oil.
  - Fill up to the level "H".
  - Do not overfill.
5. Check that the oil level is maintained between the limits (1).
  6. Start the engine. Check that there is no oil leak around the drain plug and the oil filter.
  7. Run the engine for a few minutes and then stop it. Re-check the oil level.



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**CHANGING THE OIL FILTER**

1. Remove the filter, using the tool (1), ST-193-20000.

**NOTE:** Be careful not to burn yourself, since the oil may still be hot.

2. Before installing the new oil filter, clean the mating surface of the head and apply a thin film of engine oil to the rubber sealing ring.

3. Fit the filter on the head and screw it in until a slight resistance is felt, then tighten it an additional 2/3 rds of a turn.

4. Check the oil level and add more oil if necessary. See the Section "Changing the Engine Oil".

**INJECTION SYSTEM**

**CHECKING THE INJECTORS**

**WARNING:**

When using the injector checking tool, special care must be taken to ensure that the fuel atomized by the nozzle does not come into contact with the hands or body, and it is recommended to wear protection goggles.

1. Clean and check the nozzles.
2. Install the injector on the checking tool and bleed the air through the flared nut.
3. Check the initial injection pressure by pumping with the lever of the checking tool at a rate of once per second.

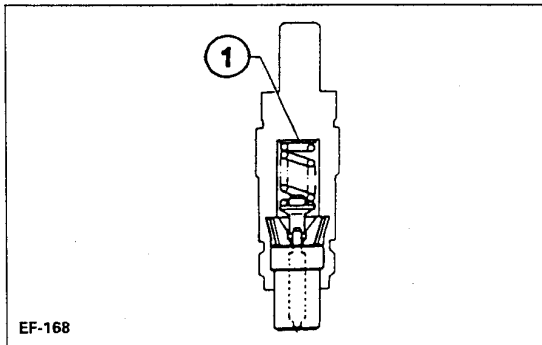
**Initial injection pressure:**

12,259-13,239 kPa  
(122.6-132.4 bar) (125-135 kg/cm<sup>2</sup>) (1,778-1,920 lb/in<sup>2</sup>)

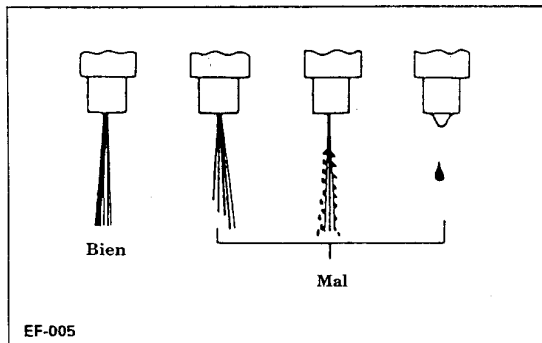
**Initial injection pressure at the new injector:**

13,329-14,024 kPa  
(132.4-140.2 bar) (135-143 kg/cm<sup>2</sup>) (1,920-2,033 lb/in<sup>2</sup>)

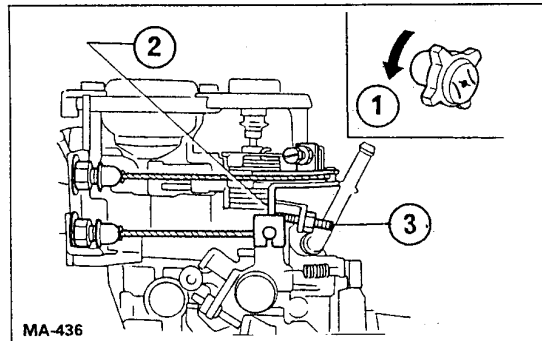
The initial injection pressure must be checked whenever a new injector is installed.



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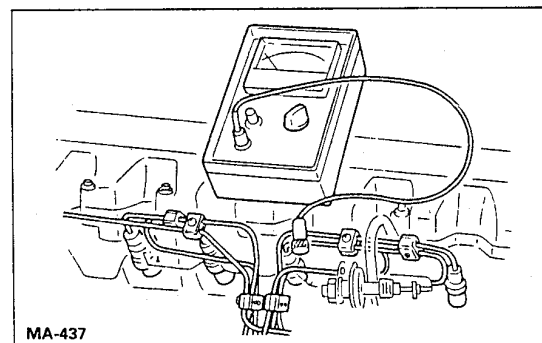


EF-005



MA-436

1. Idling control knob
2. Accelerator control lever
3. Idling control lever adjustment screw



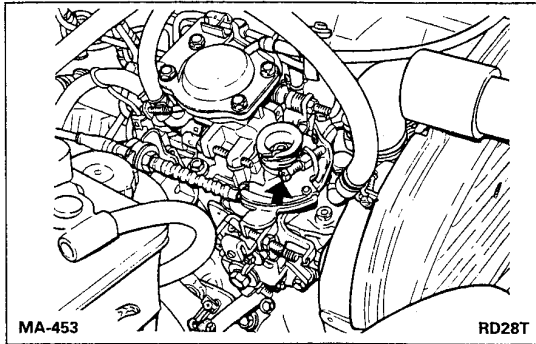
MA-437

4. To adjust the injection pressure, it is necessary to change the adjustment shims (1).
  - a. The initial injection pressure increases when the thickness of the shims is increased. The initial injection pressure is reduced when the thickness of the shims is reduced.
  - b. A shim thickness of 0.04 mm (0.0016 in) corresponds to a difference of approximately 471 kPa (4.71 bar) (4.8 kg/cm<sup>2</sup>) (68 lb/in<sup>2</sup>) in the initial injection pressure.
5. Check the shape of the atomized spray by pumping the handle of the checking tool at a rate of once per second.
6. The incorrect shapes of the atomized spray or the appearance of drops at the nozzle are often due to incorrect contact between the needle and its seating. If this problem is produced, the injector must be repaired. For this, see the Sub-Section "Replacing the Injector" in Section EF.

### CHECKING THE IDLING SPEED

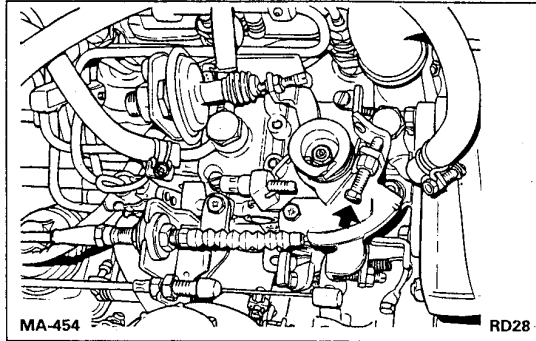
#### PREPARATION

1. Make sure that the injection advance setting is correct.
2. Check that the injectors are in perfect condition.
3. Check:
  - That the air cleaner is not obstructed.
  - Engine oil and coolant levels.
  - Air intake system.
  - Oil filler plug, dipstick, etc.
4. Move the gear shift lever to the neutral position. Apply the parking brake and chock the front and rear wheels.
5. Turn off the air conditioner, lights and accessories.
6. Make sure that the idling speed control knob is turned fully in a counterclockwise direction, and that the idling adjustment screw does not come into contact with the accelerator control lever.



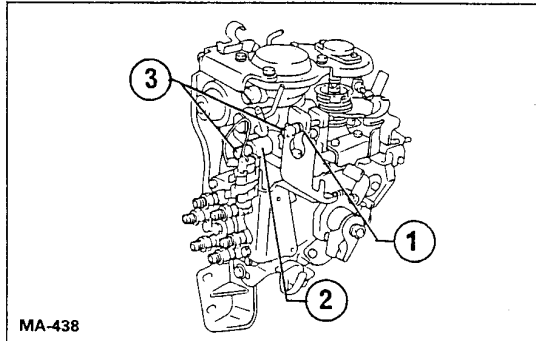
MA-453

RD28T



MA-454

RD28



MA-438

1. Maximum speed adjustment screw
2. Full power adjustment screw
3. Seals

**ADJUSTING THE IDLING SPEED**

1. Start the engine and run it until arriving to the normal operating temperature.
2. Connect the tachometer measuring unit to N.º 1 fuel injection pipe.

**In order to obtain a correct reading of the engine speed, remove the clamp that holds N.º 1 fuel injection pipe.**

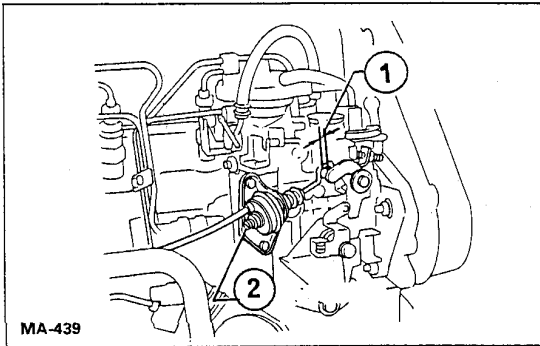
3. With the engine running, check the idling speed.

**Idling speed (rpm): 650  $\pm$ <sup>50</sup><sub>0</sub>**

4. If the speed is not within the specified values, proceed as follows:
  - a) Slacken the locknut of the idling speed adjustment screw.
  - b) Turn the adjustment screw in the corresponding direction until obtaining the specified idling speed.
  - c) Tighten the locknut.

**CAUTION:**

- Do not remove the wire locks unless absolutely necessary.
- If the position of the full power adjustment screw and the diaphragm screw is altered, the fuel flow specifications will be changed and the engine will be incorrectly adjusted. To adjust the fuel injection pump, a suitable checking tool must be used.
- If the maximum speed adjustment screw is turned in the direction that increases the angle of the control lever, the engine could suffer serious damage.



1. Gap 1 mm (0.04 in)
2. Adjustment screw

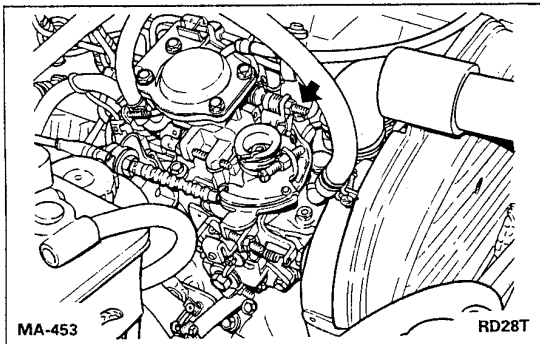
**MODEL EQUIPPED WITH AIR CONDITIONER**

1. Check that the gap between the needle of the idling speed control lever and the fuel injection pump control lever is within the specified limits.
2. With the air conditioner turned off, adjust the idling speed to the specified rpm.
3. Next, with the air conditioner operating, check that the idling speed is still correct.

Unit: rpm

Idling speed (air conditioner operating)	850 ± 50
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If the idling speed is not correct, set it by means of the Fuel Injection Control Device adjustment screw.

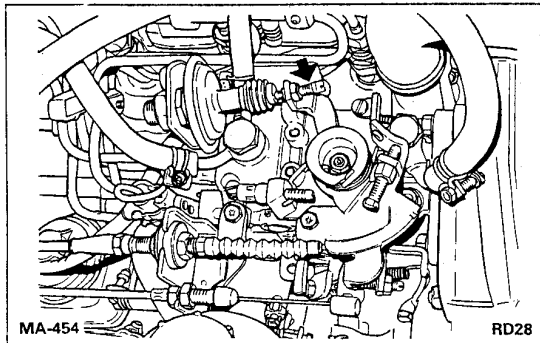


**ADJUSTING THE DAMPER**

Unit: rpm

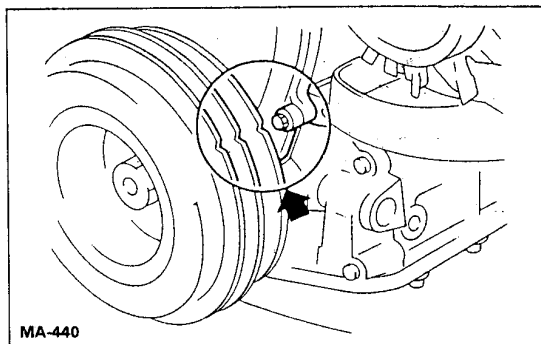
1,300 ± 200
-------------

Insert a gauge block of 2.7 + 0.05 mm (0.1063-0.0020 in) RD28 engine or 3.8 + 0.05 mm (0.1496-0.0020 in) RD28T engine between the idling speed adjusting screw and the retainer, and turn the damper adjusting screw until it makes contact with the rod.

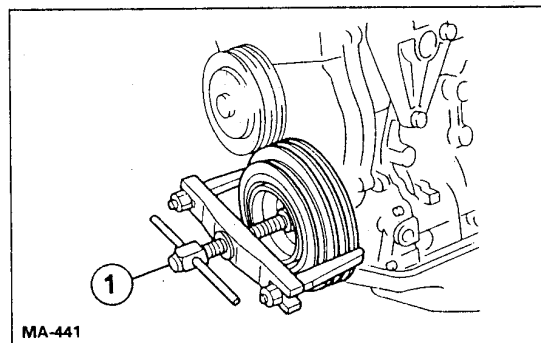


## REPLACING THE TIMING BELT

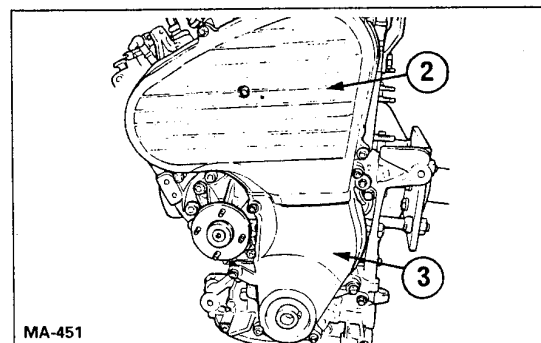
1. Remove the connection pipe between the inlet manifold and the air cleaner.
2. Drain the coolant from the system and take off the top radiator hose.
3. Remove the radiator shroud.
4. Remove the fan and the viscous coupling.
5. Remove the belts from the: Power steering pump, water pump, alternator, and air conditioning compressor if fitted.
6. Set the N.º 1 cylinder piston at the B.D.C. of its expansion stroke, as shown in the figure.



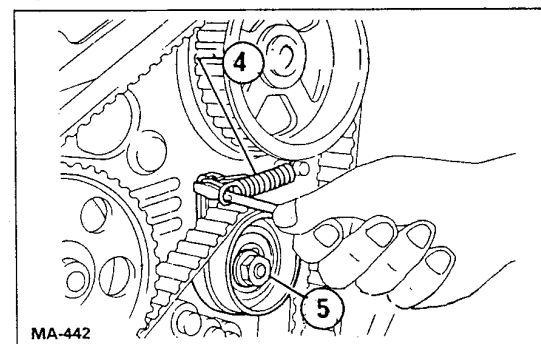
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MA-451



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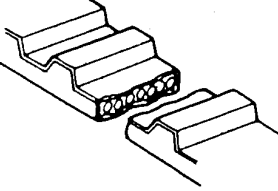
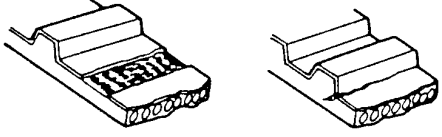
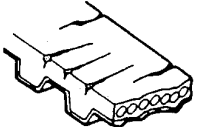
7. Using a universal extractor (1), remove the crankshaft pulley.
8. Remove the water pump pulley.
9. Take out the bolts and remove the upper and lower covers (2) and (3).
10. Remove the tensioner spring (4) and slacken the lock-nut (5) of the pulley tensioner.
11. Remove the timing belt.

**Once the belt is removed, do not turn the crankshaft or the camshaft separately, because the valves would strike against the piston crowns.**

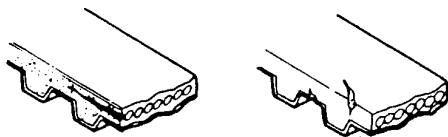
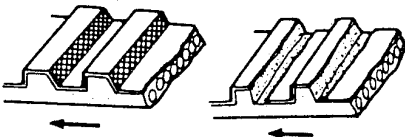
**WARNING:**

- Do not bend nor twist the timing belt excessively.
- Once the belt is removed, do not turn the crankshaft or camshaft separately, because the valves would strike against the piston crowns.
- Check that the timing belt, camshaft gear, crankshaft gear, tensioner pulley, fuel injection pump gear and the pulley tensioner are clean.

12. Visually inspect the condition of the belt.

SYMPTOM	FAULT	PROBABLE CAUSE
<p><b>Broken belt.</b></p>		<ul style="list-style-type: none"> <li>• Incorrect handling.</li> <li>• Defective sealing of the belt cover.</li> <li>• Coolant leaks through the water pump.</li> </ul>
<p><b>Broken tooth/it is stuck to the base of the tooth.</b></p>		<ul style="list-style-type: none"> <li>• Camshaft sticking.</li> <li>• Fuel injection pump sticking.</li> <li>• Oil leaks through camshaft/crankshaft oil seal.</li> </ul>
<p><b>The upper face of the belt is cracked or worn.</b></p>	 <p>MA-312</p>	<ul style="list-style-type: none"> <li>• Tensioner sticking.</li> <li>• Engine overheating.</li> <li>• Rubbing against the belt cover.</li> </ul>



SYMPTOM	FAULT	PROBABLE CAUSE
<p>The side face is worn.</p>	 <p>MA-312</p> <ul style="list-style-type: none"> <li>• The side face of the belt is so worn that it has lost its original shape.</li> <li>• The edges of the belt are worn and rounded.</li> <li>• The reinforcement cords are worn.</li> </ul>	<ul style="list-style-type: none"> <li>• Incorrect belt installation.</li> <li>• Defective operation of crankshaft pulley plates or the timing belt.</li> </ul>
<p>The teeth are worn.</p>	 <p>MA-312</p> <ul style="list-style-type: none"> <li>• The flank area of the teeth is worn.</li> <li>• The tooth area has become frayed, the rubber layer is worn and has a whitish aspect, or the reinforcement has irregularities.</li> </ul>	<ul style="list-style-type: none"> <li>• Defective sealing of the belt cover.</li> <li>• Coolant leaks through the water pump.</li> <li>• Defective operation of the camshaft.</li> <li>• Defective operation of the fuel injection pump.</li> <li>• Belt excessively tight.</li> </ul>
<p>Oil, coolant or water on the belt.</p>		<ul style="list-style-type: none"> <li>• Leaks through the oil seals.</li> <li>• Coolant leaks through the water pump.</li> <li>• Defective sealing of the belt cover.</li> </ul>

13. Check that the N.º 1 cylinder piston is at the B.D.C. of its expansion stroke, as shown below.

**Make sure that the crankshaft key (1) is facing downwards.**

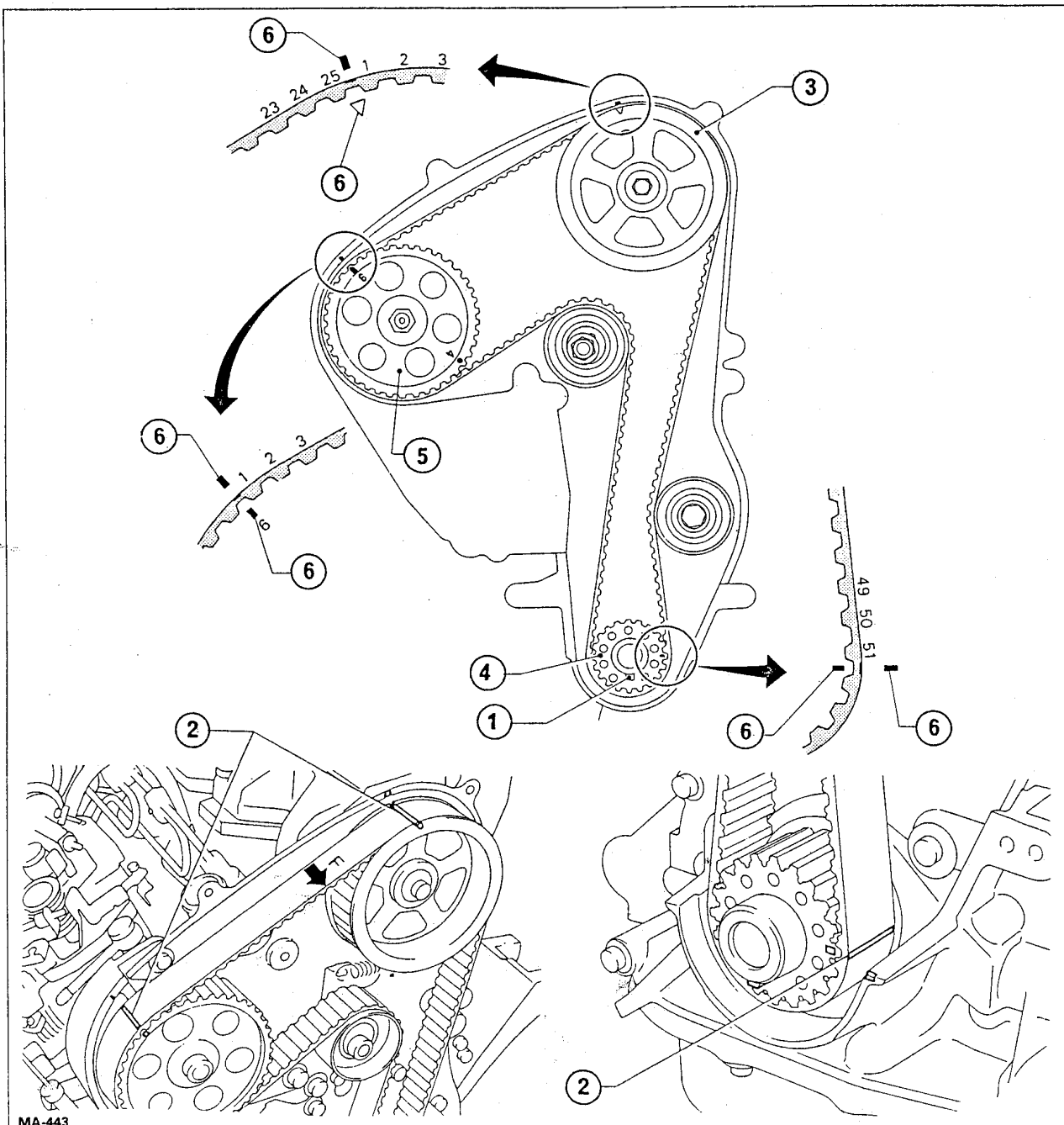
14. Install the belt.

a. **Make sure that the belt, gears and pulleys are clean and free of oil or water. Remember not to bend nor twist the belt excessively.**

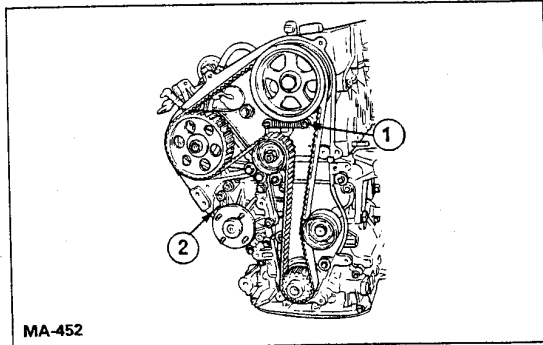
b. **Align the white lines (2) of the belt with the corresponding marks on the gears of the camshaft (3), crankshaft (4) and fuel injection pump (5).**

c. **The arrow on the belt must face towards the front.**


d. **Alignment marks (6).**

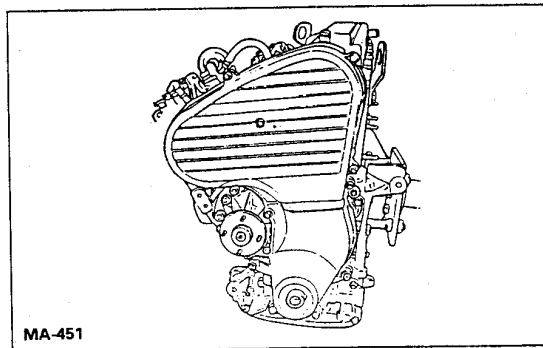


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15. Fit the tensioner spring (1). Turn the crankshaft twice in a clockwise direction and tighten the belt tensioner locknut (2).


 **32-40 Nm**  
(3.3-4.1 kgm) (24-30 ft-lb)




16. Fit the upper and lower covers and secure them with the bolts.

 **Cover bolts:**  
3.5 Nm (0.3-0.5 kgm) (2.2-3.6 ft-lb)

17. Install the crankshaft pulley and tighten the retaining bolt to the specified torque.

 **Pulley bolt:**  
142-152 Nm (14.5-15.5 kgm) (105-112 ft-lb)

18. Install the water pump pulley, viscous coupling and the fan.

 **Pulley and fan nuts and bolts:**  
7-8 Nm (0.7-0.8 kgm) (5.1-5.8 ft-lb)

19. Fit the drive belts and check their tension by applying pressure halfway between the pulleys (see Page 5 of this Section).

20. For the rest of the components, proceed in reverse order of removal.

**Check the belt flexure when the engine is cold. If it is still hot, wait for at least 30 minutes.**

## TECHNICAL DATA AND SPECIFICATIONS

**BELT FLEXURE**

Unit: mm (in)

	FLEXURE OF THE USED BELT		FLEXURE ADJUSTMENT OF THE NEW BELT
	Limit	Corrected flexure	
Alternator	17 (0.67) 25 (0.98)*	12-14 (0.47-0.55) 14-16 (0.55-0.63)*	9-11 (0.35-0.43) 12-14 (0.47-0.55)*
Air conditioning compressor	11 (0.43) 10 (0.39)*	7-9 (0.28-0.35) 5-7 (0.20-0.28)*	6-8 (0.24-0.31) 4-6 (0.16-0.24)*
Power steering pump	14 (0.55) 15 (0.59)*	10-12 (0.39-0.47) 8-10 (0.31-0.39)*	9-11 (0.35-0.43) 6-8 (0.24-0.31)*
Applied thrust force	98 N (10 kg, 22 lb)		

**\* RD28 ENGINE**

Check the belt flexure whilst the engine is cold.

If the engine is still not, wait at least 30 minutes.

**INJECTOR**

Initial injection pressure	
New	13,239-14,024 (132.4-140.2) (135-143) (1,920-2,033)
Used	12,259-13,239 (122.6-132.4) (125-135) (1,778-1,920)

**INJECTION ADVANCE AND IDLING SPEED ADJUSTMENT**

Injection advance (piston rise)	(Equivalent to A.P.M.S. 6.° RD28 and 8.° RD28T) 0.75 ± 0.03 mm (0.0295 ± 0.0012 in)* 0.86 ± 0.05 mm (0.0339 ± 0.0020 in)
Idling speed	rpm 650 ± <sub>0</sub> <sup>50</sup>

**\* RD28 ENGINE**

**OIL CAPACITY (top up)**

Unit: l (qt)

Changing the oil filter	6.7 (5.89)
Without changing the oil filter	6.0 (5.27)

**COOLING SYSTEM**

Radiator cap relief pressure	78-98 (0.78-0.98) (0.8-1.0) (11-14)
Cooling system leak test pressure	98 (0.98) (1.0) (14) 157 (1.57) (1.6) (23)*

\*RD28 ENGINE

**TIGHTENING TORQUES**

COMPONENTS	Nm	kgm	ft-lb
Alternator-bracket	63-77 43-58*	6.4-7.9 4.4-5.9	46-57 32-43
Alternator-adjusting rod	16-21	1.6-2.1	12-15
Adjustment bolt, power steering pump	16-21	1.6-2.1	12-15
Bolt, air conditioning compressor bracket	43-58	4.4-5.9	32-43
Retaining nut, fuel injection pump	16-21	1.6-2.1	12-15
Injection pipe	22-25	2.2-2.5	16-18
Leakoff pipe	39-49	4.0-5.0	29-36
Injector	59-69	6.0-7.0	43-51
Drain plug, oil pan	29-39	3.0-4.0	22-29
Bolt, tensioner pulley	32-40	3.3-4.1	24-30
Bolt, pulley-guide	32-40	3.4-4.1	24-30
Bolt, front cover	3-5	0.3-0.5	2.2-3.6
Bolt, crankshaft pulley	142-152	14.5-15.5	105-112

\*RD28 ENGINE



# ENGINE MECHANICAL

## SECTION **EM**

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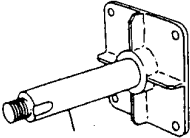
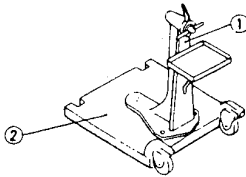
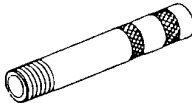
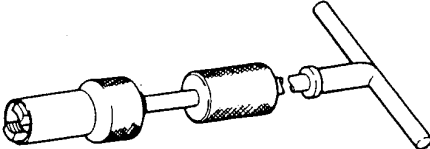
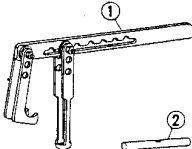
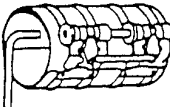

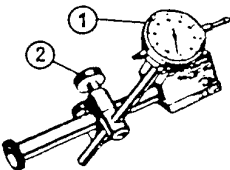
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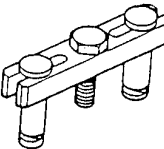
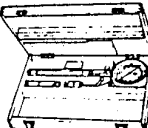
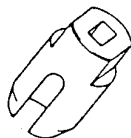
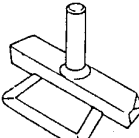
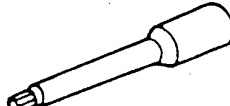
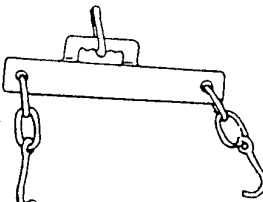






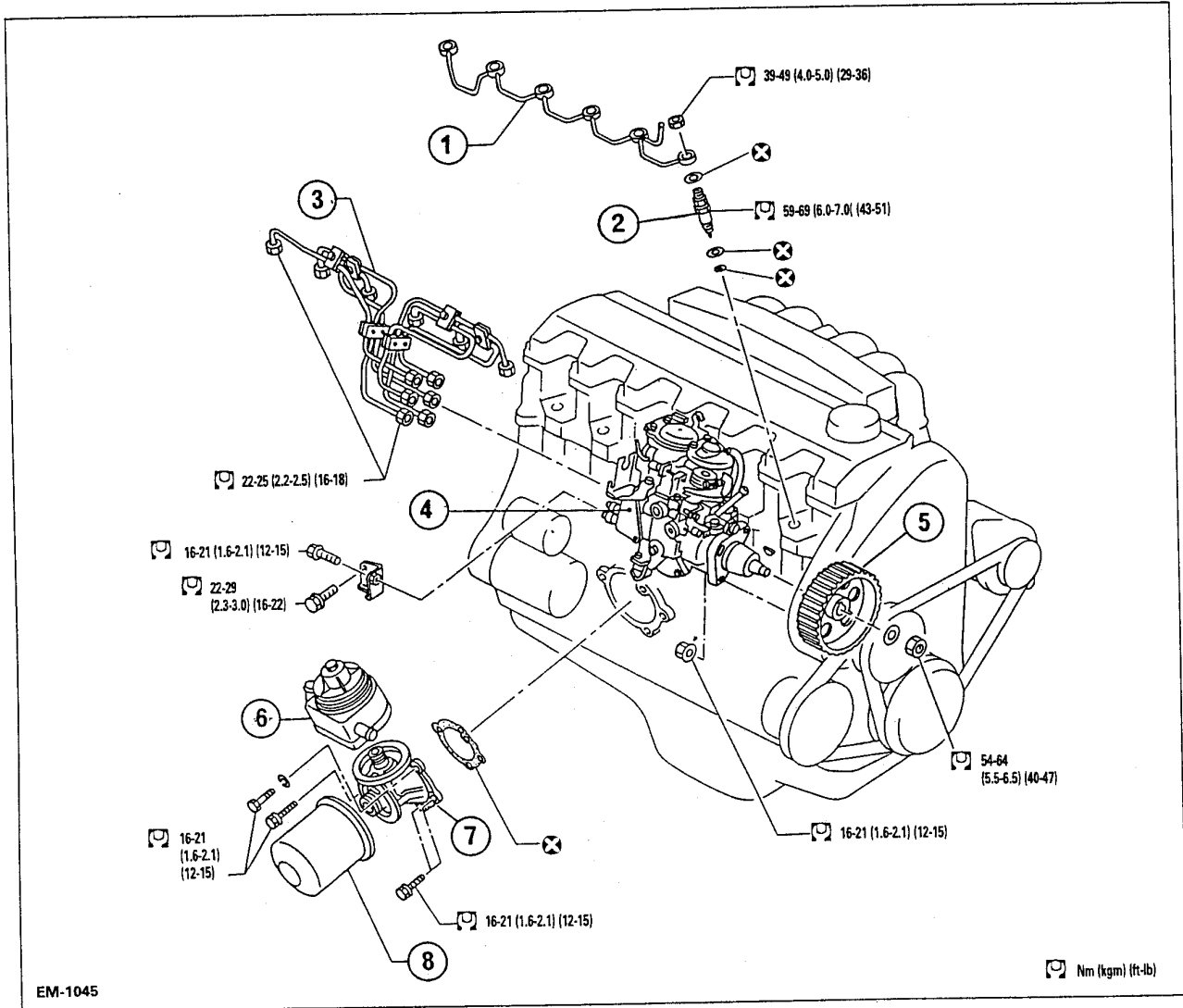
## SPECIAL SERVICE TOOLS

PART N.º	DENOMINATION	APPLICATION	
		RD28	RD28T
KV-101-06500	Engine support accessory (Universal Clamp)  Used with ST-050-1S000 	X	X
ST-050-1S000 ① ST-050-11000 ② ST-050-12000	Engine support (Stand)  Engine stand  Base 	X	X
KV-101-07501	Valve guide oil seal inserter 	X	X
KV-101-07900	Valve guide oil seal extractor 	X	X
KV-101-092S0 ① KV-101-09210 ② KV-101-09220	Valve spring compressor  Compressor  Adapter 	X	X
EH-034-70000	Piston ring compressor 	X	X
ST-166-10001	Guide bush extractor 	X	X
Shop tool	① Dial indicator ② Magnetic base 	X	X

PART N.º	DENOMINATION	APPLICATION	
		RD28	RD28T
KV-111-02900	Fuel injection pump gear extractor 	X	X
ED-196-00000	Diesel compression pressure tester, 10-60 bar 	X	X
KV-111-00300	Injector wrench 	X	X
KV-101-11100	Tool for sump sealer 	X	X
ST-101-20000	Cylinder head bolt adapter 	X	X
Shop manufactured tool	Engine lifting tool. To remove and install the engine in the vehicle 	X	X

# ENGINE COMPONENTS

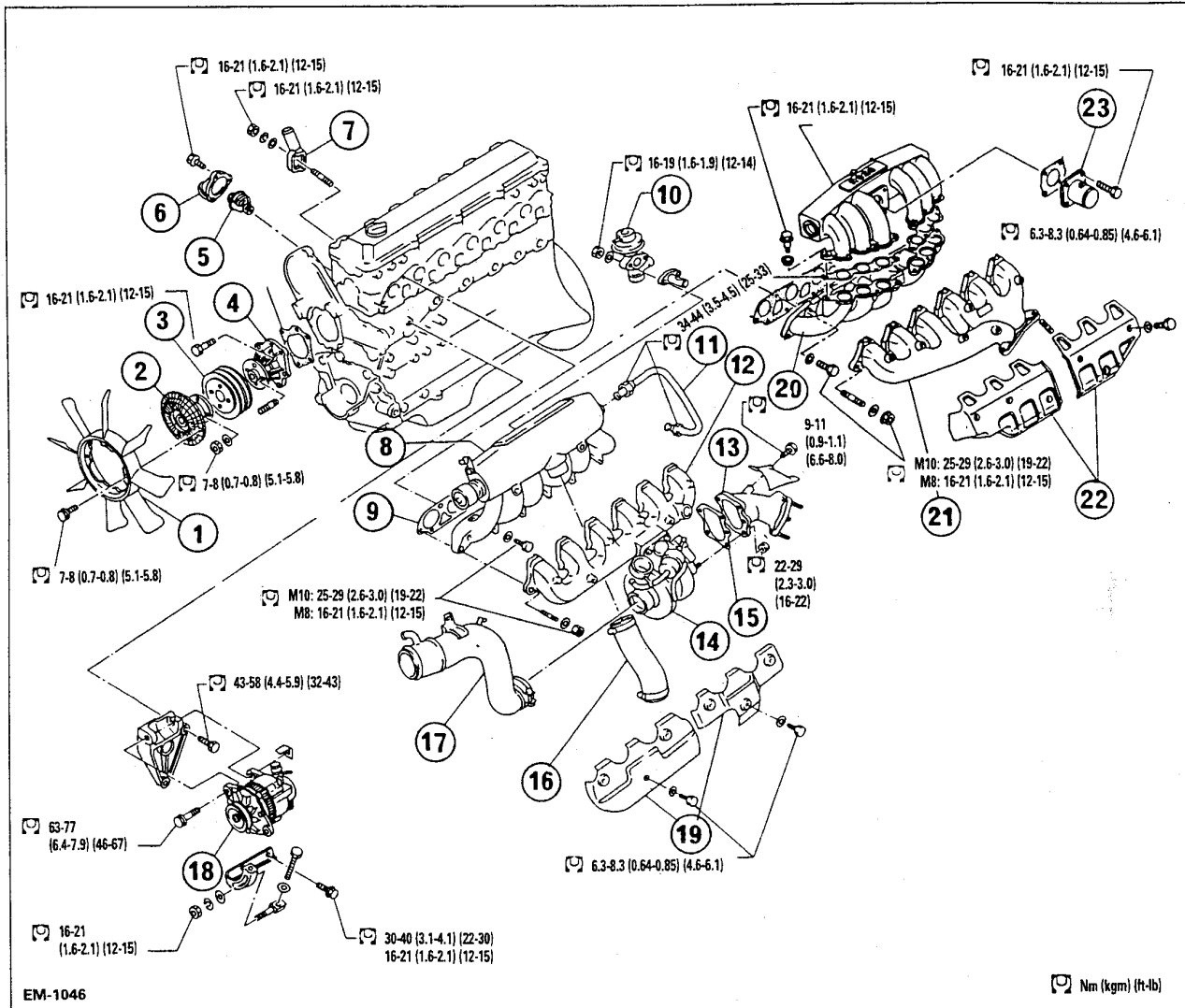
RIGHT HAND SIDE



## COMPONENTS

- |                        |                                   |
|------------------------|-----------------------------------|
| 1. Leakoff pipe        | 5. Fuel injection pump drive gear |
| 2. Injector            | 6. Oil cooler                     |
| 3. Injection pipes     | 7. Head                           |
| 4. Fuel injection pump | 8. Oil filter                     |

LEFT HAND SIDE

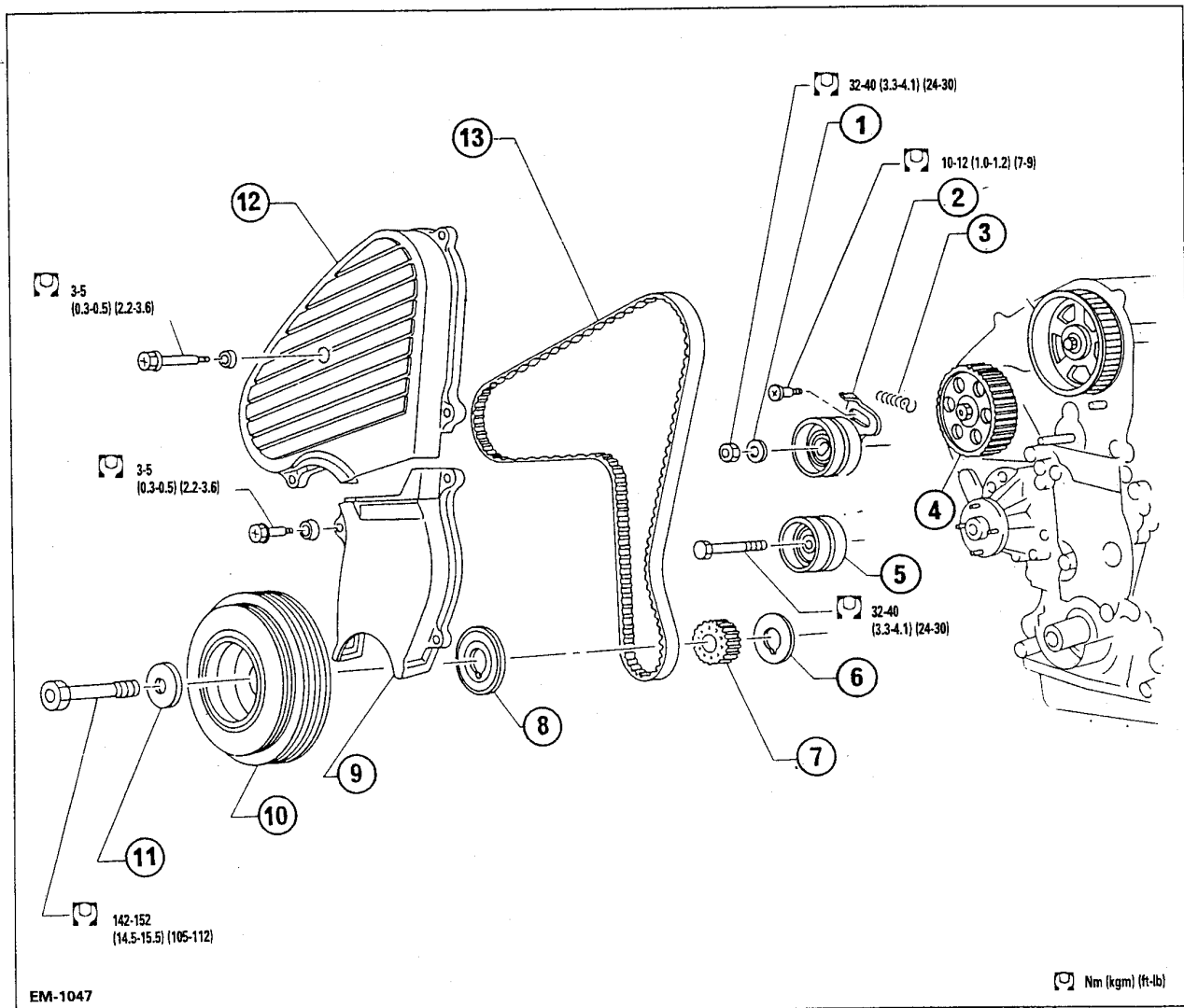


COMPONENTS

- |                              |                                    |
|------------------------------|------------------------------------|
| 1. Fan                       | 13. Outlet elbow to exhaust pipe   |
| 2. Viscous coupling          | 14. Turbocharger                   |
| 3. Water pump pulley         | 15. Gasket                         |
| 4. Water pump                | 16. Turbocharger connection hose   |
| 5. Thermostat                | 17. Air cleaner connection hose    |
| 6. Thermostat housing        | 18. Alternator                     |
| 7. Cooling connection        | 19. Exhaust pipe protection        |
| 8. Inlet manifold (RD28T)    | 20. Inlet manifold assembly (RD28) |
| 9. Manifold gasket           | 21. Exhaust manifold (RD28)        |
| 10. E.G.R. control valve     | 22. Exhaust pipe protector         |
| 11. E.G.R. connection pipe   | 23. Inlet manifold adapter         |
| 12. Exhaust manifold (RD28T) |                                    |

**FRONT**

**TIMING GEARS**

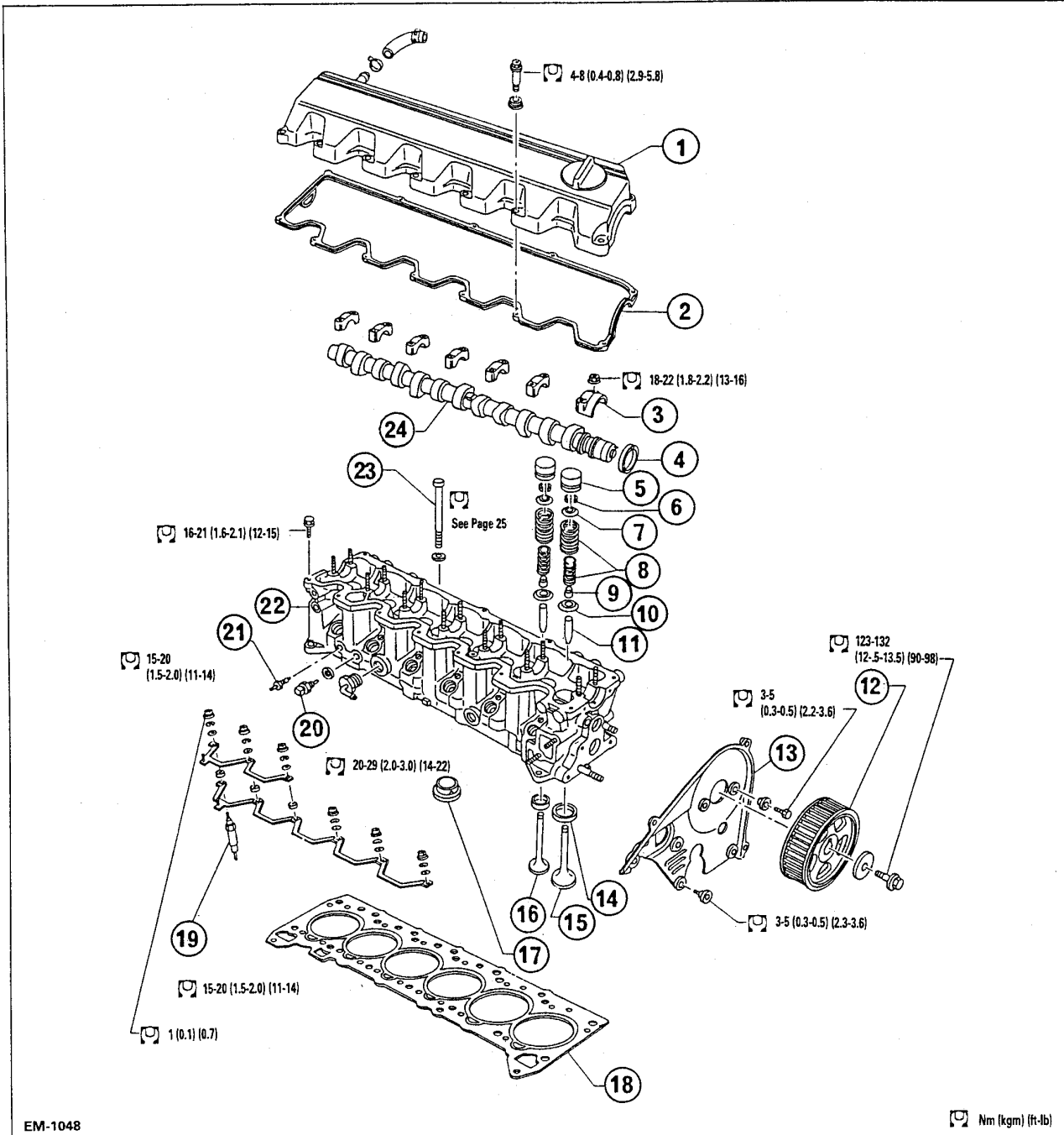


**COMPONENTS**

- |                                   |                             |
|-----------------------------------|-----------------------------|
| 1. Washer                         | 8. Crankshaft pulley washer |
| 2. Tensioner pulley               | 9. Lower timing gear cover  |
| 3. Tensioner spring               | 10. Crankshaft pulley       |
| 4. Fuel injection pump drive gear | 11. Washer                  |
| 5. Idler pulley                   | 12. Upper timing gear cover |
| 6. Crankshaft gear washer         | 13. Timing belt             |
| 7. Crankshaft gear                |                             |

INTERNAL PARTS

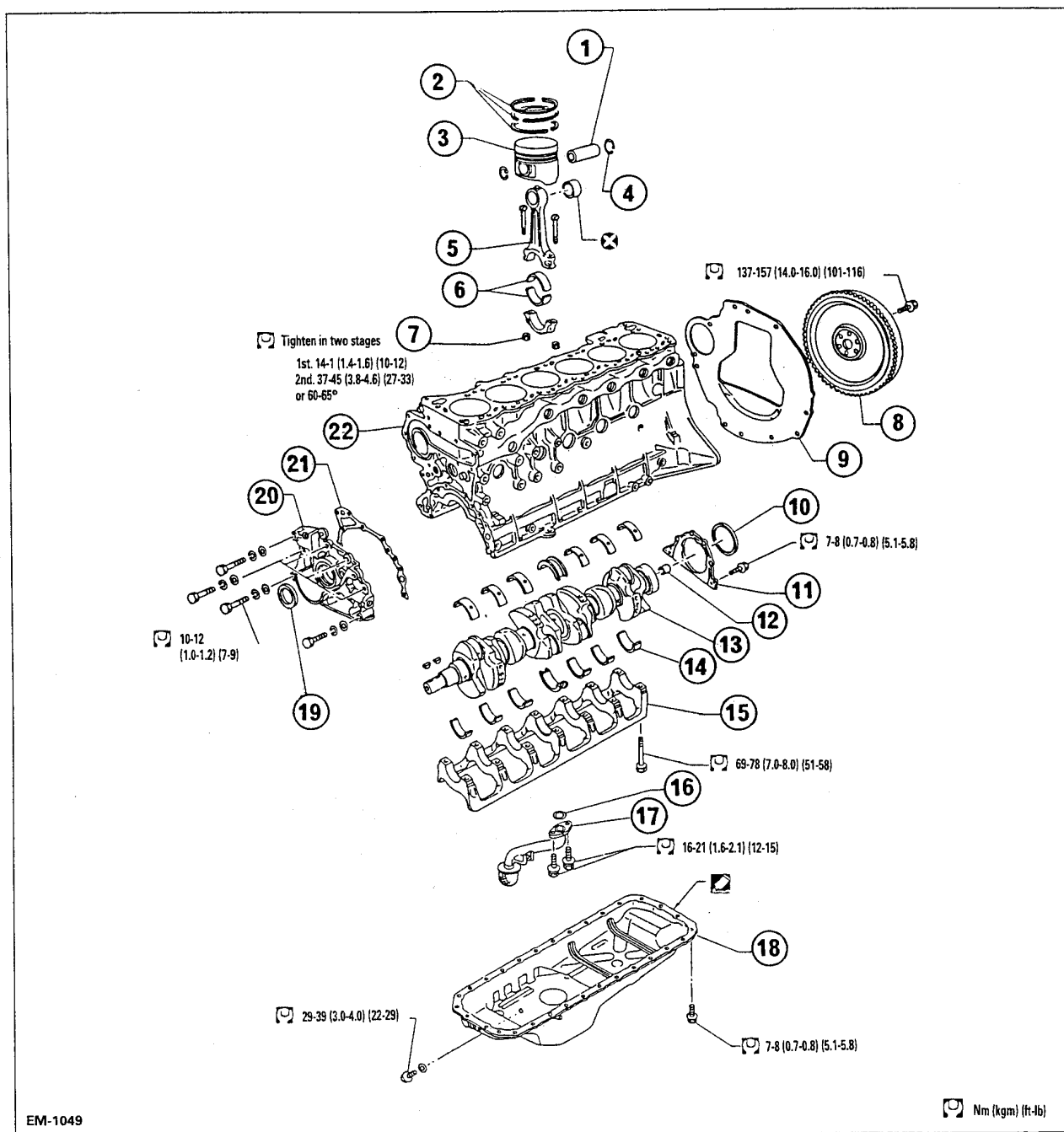
CYLINDER HEAD



COMPONENTS

- |                          |                           |                                   |
|--------------------------|---------------------------|-----------------------------------|
| 1. Rocker cover          | 9. Valve retainer         | 17. Combustion chamber            |
| 2. Gasket                | 10. Spring seating washer | 18. Cylinder head gasket          |
| 3. Camshaft bearing caps | 11. Valve guide           | 19. Incandescent plug             |
| 4. Oil seal              | 12. Camshaft gear         | 20. Water temperature sensor      |
| 5. Hydraulic tappets     | 13. Timing gear backplate | 21. Thermal transmitter           |
| 6. Split cones           | 14. Valve seat            | 22. Cylinder head                 |
| 7. Valve spring retainer | 15. Inlet valve           | 23. Cylinder head retaining bolts |
| 8. Valve springs         | 16. Exhaust valve         | 24. Camshaft                      |

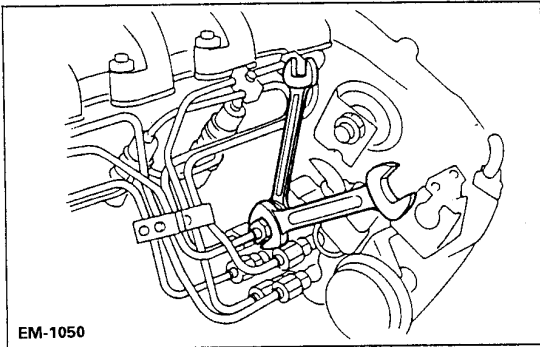
## ENGINE BLOCK, CRANKSHAFT, PISTON AND OIL PUMP



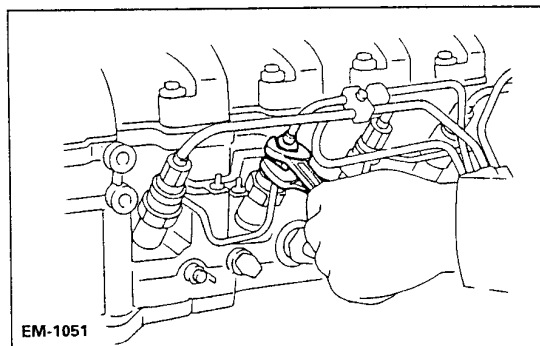
## COMPONENTS

- |                            |                              |
|----------------------------|------------------------------|
| 1. Gudgeon pin             | 12. Guide bush               |
| 2. Piston rings            | 13. Crankshaft               |
| 3. Piston                  | 14. Main bearings            |
| 4. Circlip                 | 15. Bearing housing assembly |
| 5. Connecting rod          | 16. O ring                   |
| 6. Connecting rod bearings | 17. Suction pipe             |
| 7. Connecting rod nuts     | 18. Oil pan                  |
| 8. Flywheel                | 19. Front oil seal           |
| 9. Rear plate              | 20. Oil pump                 |
| 10. Rear oil seal          | 21. Oil pump gasket          |
| 11. Rear oil seal retainer | 22. Engine block             |

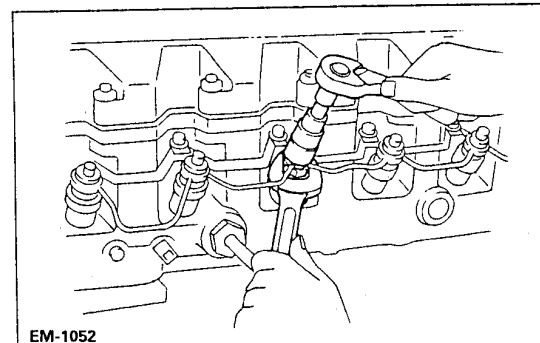
## CHECKING THE CYLINDER COMPRESSION



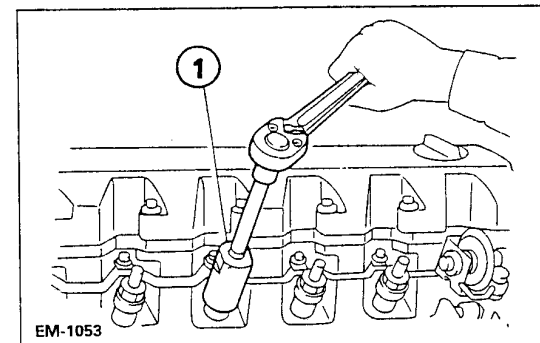
EM-1050



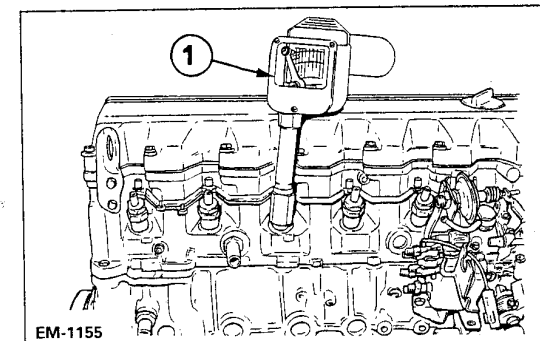
EM-1051



EM-1052



EM-1053



EM-1155

1. Allow the engine to warm up sufficiently.

2. Disconnect the injection pipe at the nozzle side and slacken it at the pump side.

Use two wrenches so that the discharge nozzle bracket on the pump side is not loosened.

3. Remove the leakoff pipe assembly.

So that the leakoff pipe is not broken, withdraw it whilst holding the nozzle body assembly.

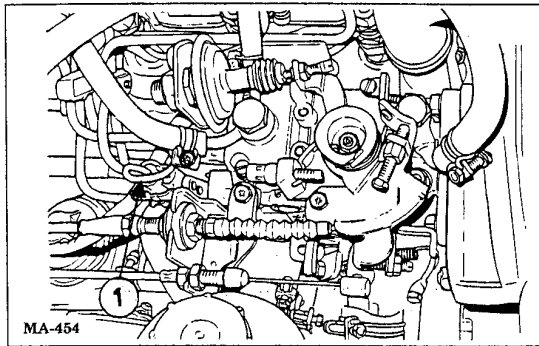
4. Remove all the injectors, using the special tool or another suitable tool.

1. KV-111-00300

5. Place the adapter and the compression tester (1) in the cylinder.

1. ED-196-00000





MA-454

1. Fuel shut-off solenoid valve connector

6. Disconnect the fuel shut-off solenoid valve connector.

7. Turn the engine over with the starter motor and check the reading on the compression tester.

Turning speed: 200 rpm

Compression pressure:

Normal:

3,040 kPa (30.4 bar) (31 kg/cm<sup>2</sup>) (441 lb/in<sup>2</sup>)

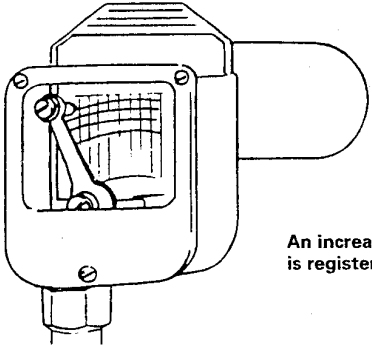
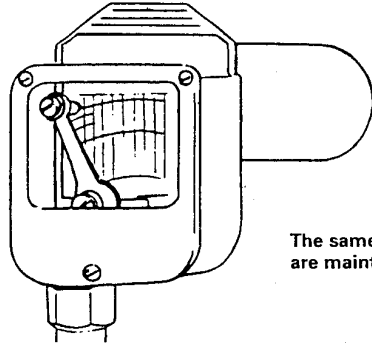
Limit:

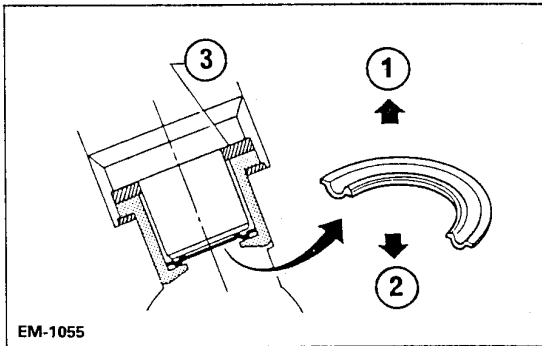
2,452 kPa (24.5 bar) (25 kg/cm<sup>2</sup>) (356 lb/in<sup>2</sup>)

Difference limit between cylinders:

490 kPa (4.9 bar) (5 kg/cm<sup>2</sup>) (71 lb/in<sup>2</sup>)

8. If the pressure is low, pour approximately 3 ml (0.11 ounces) of engine oil in the cylinders, via the injector orifice, and repeat the test.

VALUES REGISTERED BY THE COMPRESSION TESTER	CAUSE
 <p data-bbox="618 1333 732 1375">An increase is registered</p> <p data-bbox="217 1430 285 1451">EM-1239</p>	<ul data-bbox="846 1262 1247 1283" style="list-style-type: none"> <li>• The piston rings are worn or damaged.</li> </ul>
 <p data-bbox="618 1696 776 1738">The same values are maintained</p> <p data-bbox="217 1797 285 1818">EM-1054</p>	<ul data-bbox="846 1499 1435 1612" style="list-style-type: none"> <li>• If the pressure in two adjacent cylinders is low, this indicates that the sealing gasket is damaged.</li> <li>• The valve is seized.</li> <li>• The problem is at the valve seat or on the valve face.</li> </ul>




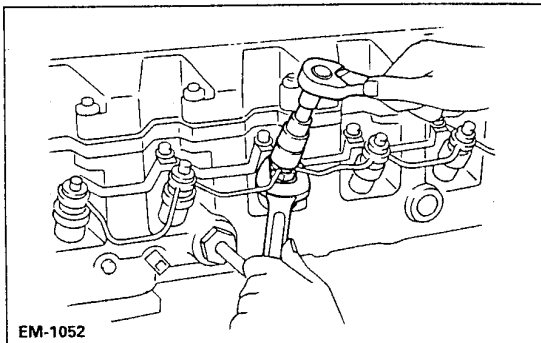
EM-1055

1. Nozzle side
2. Combustion chamber side
3. Seating washer

9. Replace the nozzle gaskets and fit the injectors.


The new gasket must be placed in the direction shown in the figure:

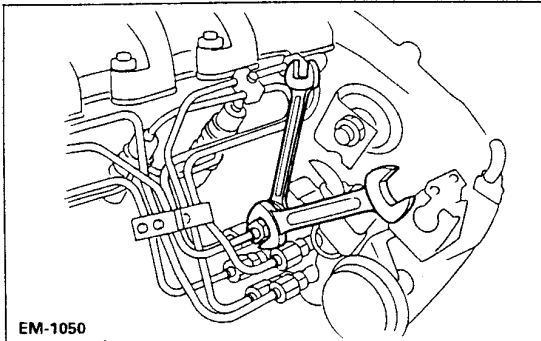
-  Between the injector and the cylinder head  
59-69 Nm  
(6.0-7.0 kgm) (43-51 ft-lb)



EM-1052


10. Hold the nozzle body assembly when installing the leakoff pipe.

-  Leakoff pipe nut  
39-49 Nm  
(4-5 kgm) (29-36 ft-lb)

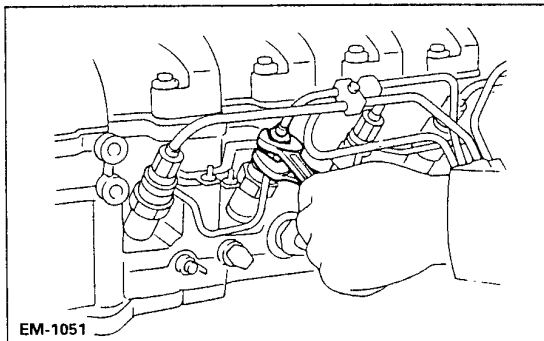


EM-1050

11. Install the injection pipes.

-  Injection pipe  
22-25 Nm  
(2.2-2.5 kgm) (16-18 ft-lb)

Use two wrenches so that the discharge nozzle bracket on the pump side is not loosened.



EM-1051

## CYLINDER HEAD

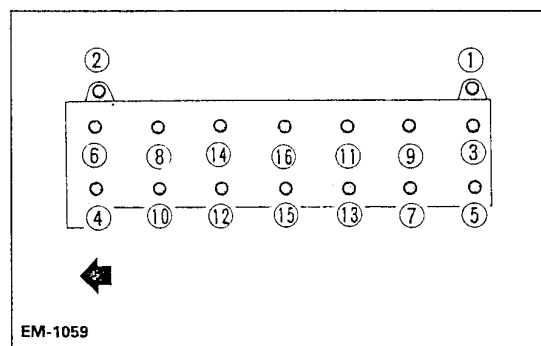
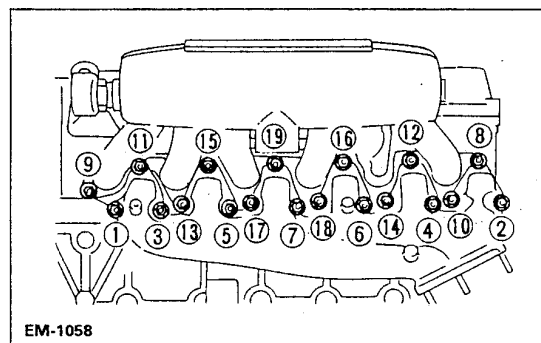
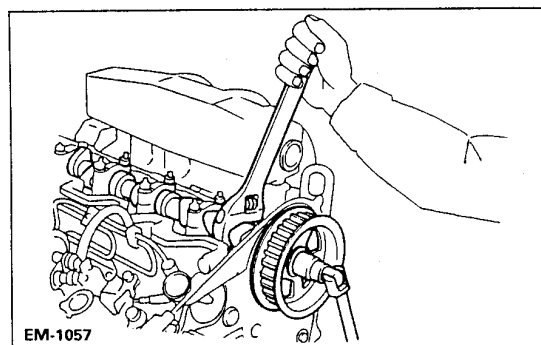
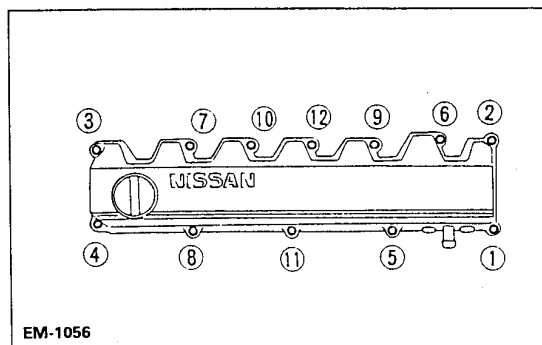
### REMOVAL

1. Drain the coolant and disconnect the water hose.
2. Disconnect the exhaust pipe.
3. Remove the timing belt.

Set the N.º 1 cylinder piston at the B.D.C. of its expansion stroke. See the Section "Replacing the Timing Belt" in Chapter MA.

**Once the timing belt is removed, do not turn the crankshaft or camshaft separately, because the valves would strike against the piston crowns.**

4. Remove the rocker cover retaining bolts in the sequence shown in the figure.



5. Remove the camshaft gear, tensioner pulley and front backplate.

6. Remove the inlet and exhaust manifolds.

Remove the manifold bolts and nuts, following the sequence shown in the figure.

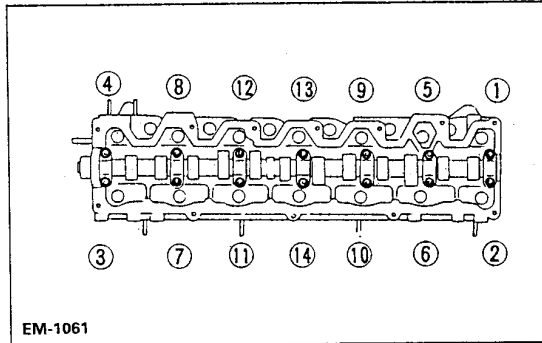
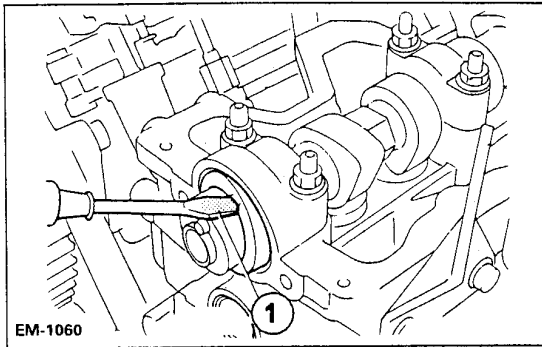
When installing the manifolds, tighten the bolts and nuts in the reverse order of removal. Tighten them in two or three stages.

7. Remove all the injection pipes.
8. Remove the cylinder head.

① ② M8 bolt

③ ⑬ M12 bolt

← Front



## DISASSEMBLY

1. Using the tool (1) or similar, remove the oil seal from the camshaft front bearing housing.

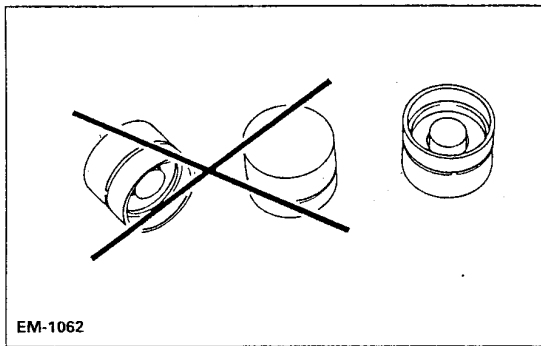
2. Remove the camshaft bearing cap retaining nuts in two or three stages, following the sequence shown in the figure.

To install the camshaft bearing caps, tighten the nuts in reverse order of removal. Tighten the nuts in two or three stages.

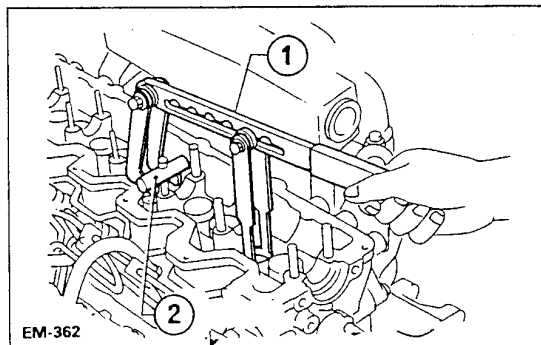
3. Remove the camshaft and the oil gasket.

4. Take out the hydraulic tappets.

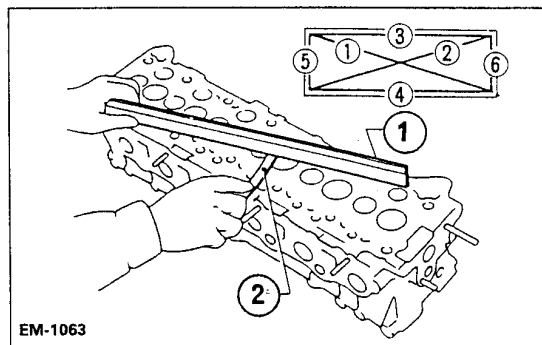
- a. Never leave the tappets turned upside down, as shown in the figure, because air could enter and cause them to be noisy during operation.
- b. Never disassemble the tappets.
- c. Lubricate with engine oil.



5. Use a special tool for valve components or another suitable tool for removing the components.



1. KV-101-09210 Valve spring compressor.
2. KV-101-09220 Adapter.



EM-1063

1. Ruler
2. Feeler gauges

## INSPECTION

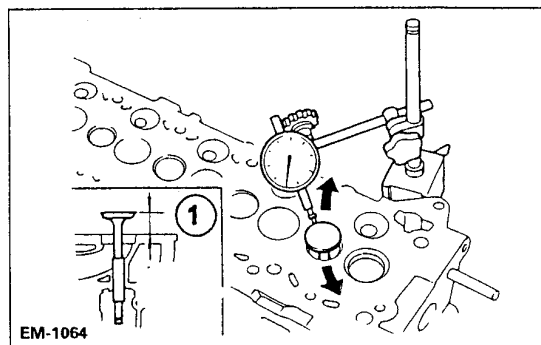
### CYLINDER HEAD DEFORMATION

**Flatness:**  
Less than 0.1 mm (0.004 in)

If the specified limits are exceeded, the cylinder head must be replaced or refinished.

**Refinishing limits:**  
The refinishing limit of the cylinder head face is directly related with that of the engine block face. Where, "A" is the refinishing value of the cylinder head pressure face, and "B" is the refinishing value of the engine block face, the maximum refinishing limit is:

$$A + B = 0.1 \text{ mm (0.004 in)}$$



EM-1064

1. 15 mm (0.59 in)

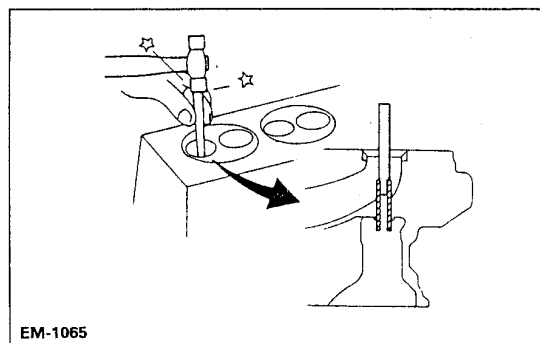
### VALVE GUIDE CLEARANCE

1. Insert the valve stem in the valve guide and apply pressure in the directions indicated, making the valve slide downwards.

If a rocking movement is observed, and the stem goes in and comes out excessively off-center, or does not slide correctly, the valve or the valve guide, or both, must be replaced.

2. Insert the valve stem in the corresponding guide.
3. Measure the deviation.

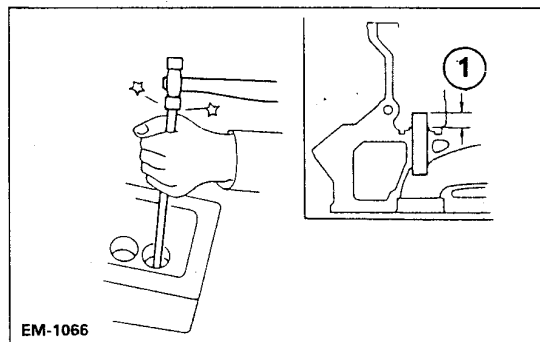
**Deviation limit between the stem and guide:**  
0.1 mm (0.004 in)  
(Half of the indicator reading)



EM-1065

### REPLACING THE VALVE GUIDE

1. Heat the cylinder head in an oil bath to 150-160 °C (303-320 °F).
2. Remove the valve guide with a suitable tool (see figure).

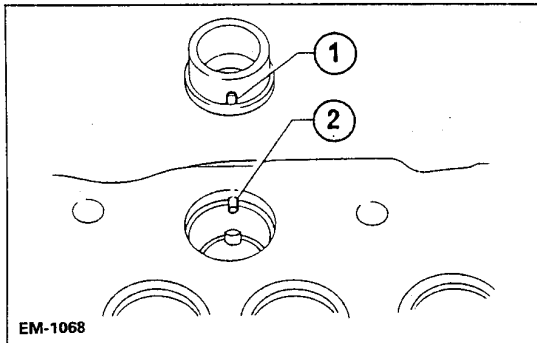
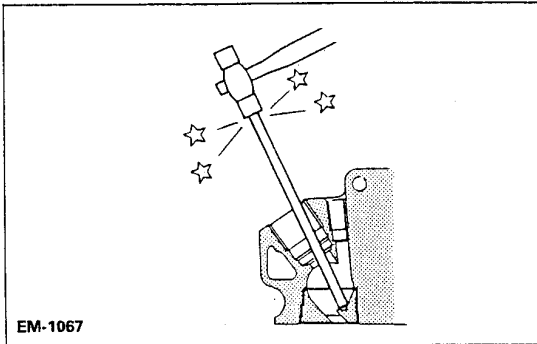


EM-1066

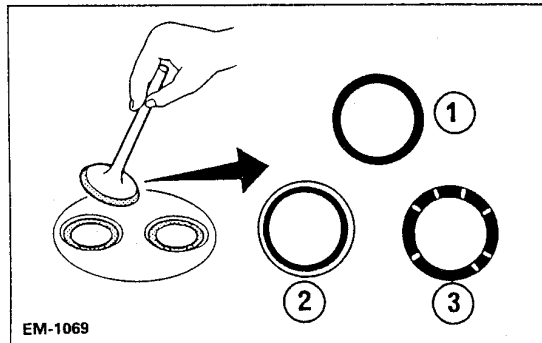
1. Approximately 10.3 mm (0.406 in).

3. Insert a new valve guide until it protrudes 10.3 mm (0.406 in).
4. Ream the bore.

**Reaming diameter:**  
7.000-7.018 mm (0.2756-0.2763 in)



1. Pin
2. Notch



### REPLACING THE COMBUSTION CHAMBER

Under normal circumstances it is not necessary to remove the combustion chambers.

However, if they are cracked or very worn, they must be replaced.

1. Remove the connecting parts of the incandescent plugs, the plugs themselves and the injector nozzles.
2. Remove the combustion chamber so as to ensure that the cylinder head does not become damaged.

Be careful not to scratch the nozzle orifice.

3. Install the combustion chamber.

- a. Heat the cylinder head in oil to a temperature of 150-160 °C (302-320 °F).
- b. Align the combustion chamber pin (1) and the notch (2) of the cylinder head; then fit the combustion chamber in the cylinder head with the aid of a plastic-faced hammer.

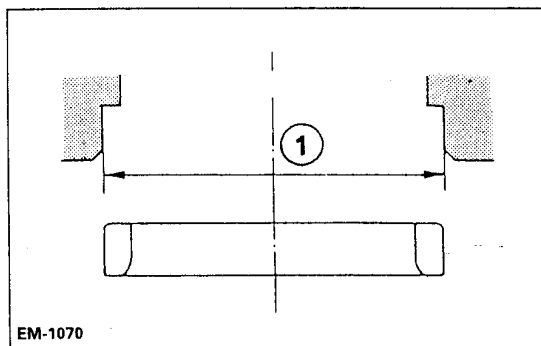
### VALVE SEATS

1. Check if the valves fits perfectly on its seat.

Apply prussian blue to the valve face. If the valve does not make perfect contact with the seat, it will be necessary to regrind the seat. If the blue covers 360° of the valve face (1), this means that the valve stem and face are concentric with one another; if this is not the case, the valve must be reground or replaced (see 2 and 3).

2. Check that the valve seats are not corroded on their contact face and, if they are excessively worn, they must be replaced.

Before regrinding the valve seats, previously check that the valves and guides are not worn, since if they are, they must be replaced. Then regrind the valve seats.



1. Recess diameter

**REPLACING THE VALVE SEAT**

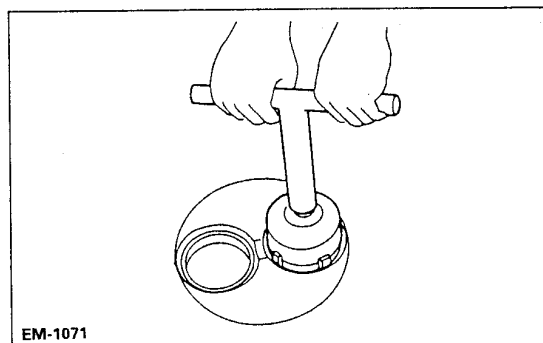
- Using a cutter, machine the old seat until it is released.  
The depth stop of the tool should be set so that the cutter cannot go deeper than the bottom face of the seat recess in the cylinder head.
- Grind the recess in the cylinder head.

**Valve seat recess grinding diameter:****0.5 mm (0.020 in) oversize:****Inlet****41.432-41.454 mm (1.6312-1.6320 in)****Exhaust****35.432-35.454 mm (1.3950-1.3958 in)**

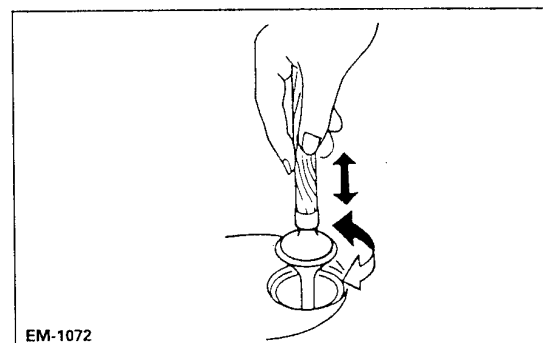
The grinding must be carried out in concentric circles around the center of the valve guide, so that the valve seat is correctly fitted.

- Heat the cylinder head to 150-160 °C (302-320 °F) and press-fit the seat to its limit.

When a valve seat is replaced, it will be necessary to also replace the valve.



EM-1071



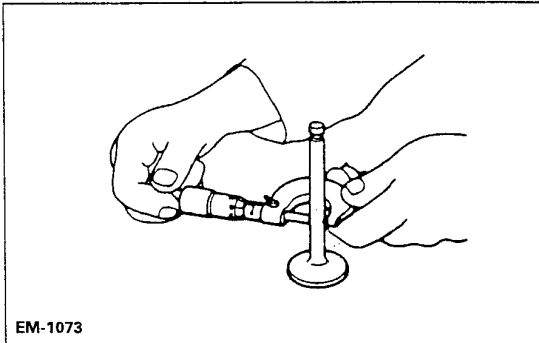
EM-1072

- Use the correct tool to regrind the valve seats to the dimensions indicated in the Section TECHNICAL DATA AND SPECIFICATIONS.

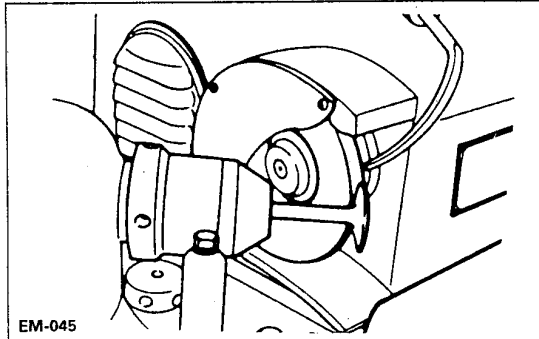
In order for the grinding to be even, both hands must be used.

- Apply a small amount of lapping compound on the valve face and insert the valve in the guide.

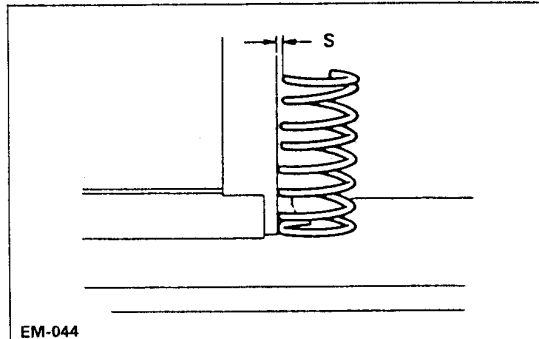
Rotate the valve whilst applying pressure to it, until perfect contact is obtained between the valve face and the seat. Remove the valve and clean both the valve and the seat.



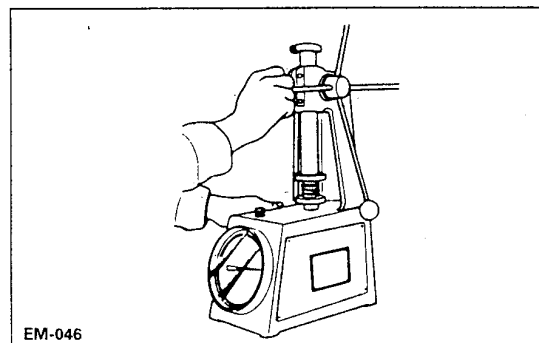
EM-1073



EM-045



EM-044



EM-046

### VALVE DIMENSIONS

1. Check the dimensions of each valve. For this, see the Section TECHNICAL DATA AND SPECIFICATIONS.
2. Regrind or replace any valve that is defective.

3. The valve face and the foot of the stem, must be refinished on a valve grinding machine.

If the cylinder head has reached the wear limit of 0.5 mm (0.020 in) in the thickness, it must be replaced.

The regrinding tolerance at the foot of the stem is 0.2 mm (0.008 in) or less.

### PERPENDICULARITY OF THE VALVE SPRINGS

Check the perpendicularity of the valves springs with a square.

If the valve spring is out of square (value "S") by more than the specified value, it must be replaced.

#### Limit:

##### Outside

Less than 1.9 mm (0.075 in)

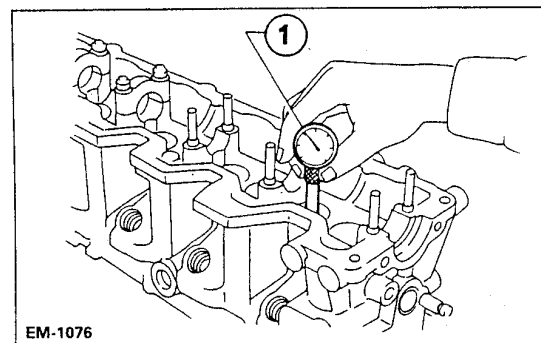
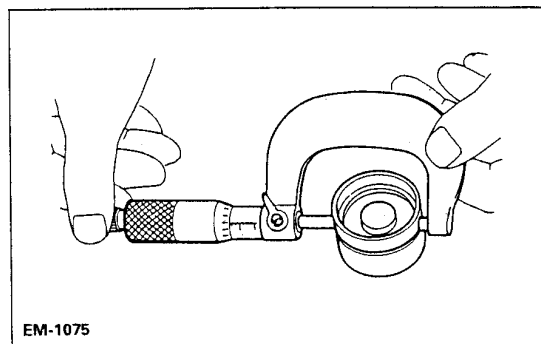
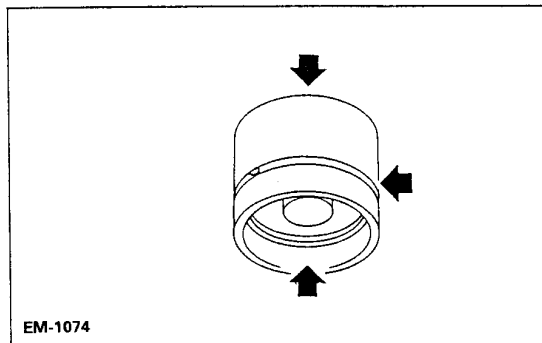
##### Inside

Less than 1.6 mm (0.063 in)

### VALVE SPRING PRESSURE LOAD

Measure the total length and tension of each spring. If the measured value exceeds the specified limit, the spring must be replaced. See the Section TECHNICAL DATA AND SPECIFICATIONS.





1. Bore gauge

**HYDRAULIC TAPPETS**

1. Check that the contact and sliding surfaces are not worn or scratched.

2. Check the diameter of a tappet.

**Outside diameter:**

**34.959-34.975 mm (1.3763-1.3770 in)**

3. Check the tappet guide orifice.

**Orifice diameter:**

**34.998-35.018 mm (1.3779-1.3787 in)**

**Original clearance:**

**0.023-0.059 mm (0.0009-0.0023 in)**

If the tappets are noisy, check them.

a. Push the gudgeon pin hard with the finger.

If it goes in approximately 1 mm (0.04 in), this indicates that the tappet has air trapped inside.

b. Refit the tappet.

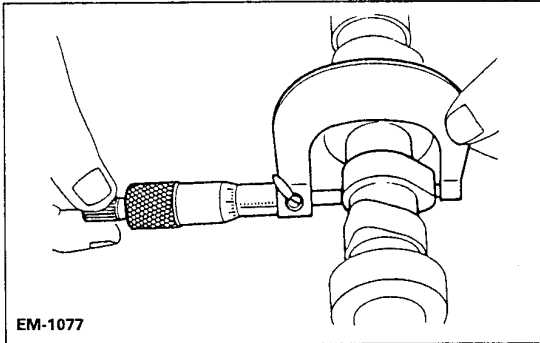
c. Bleed the air by running the engine at 2400 rpm without load for about 20 minutes.

**WARNING:**

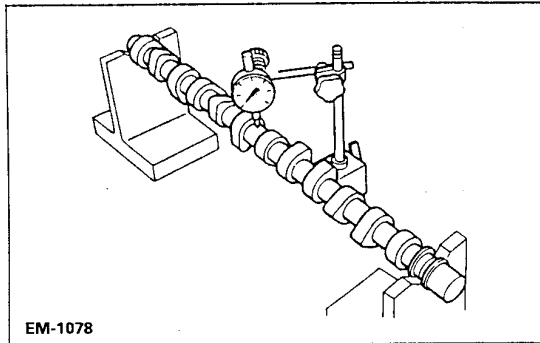
Whenever the camshaft is removed to install, remove or inspect the hydraulic tappets, one must wait at least 30 minutes after installing the camshaft before restarting the engine. (Wait until the hydraulic tappets have become stabilized). Before starting the engine, turn the crankshaft over by hand so as to ensure that the pistons do not come into contact with the valves.

d. Next, check if all the air has been expulsed. See (a) on Point (3).

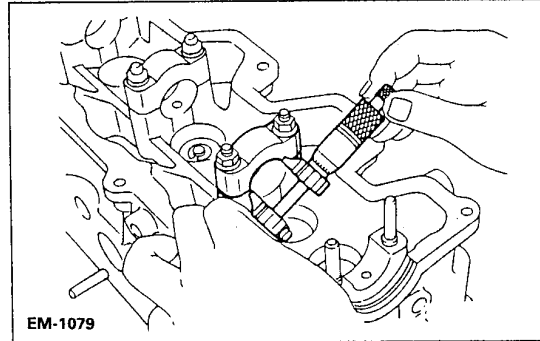
e. If this is not so, the tappet must be replaced.



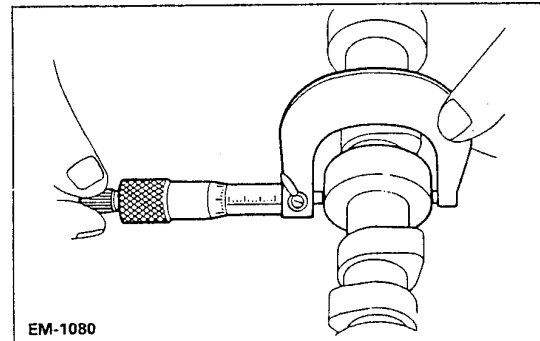
EM-1077



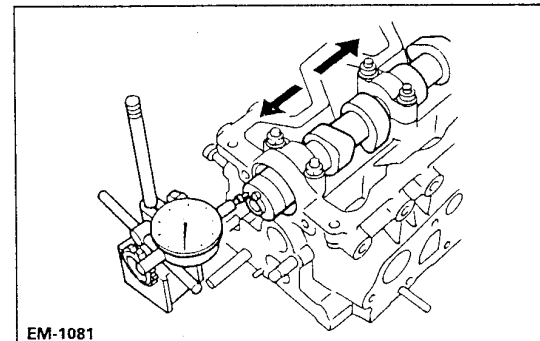
EM-1078



EM-1079



EM-1080



EM-1081

### VISUAL INSPECTION OF THE CAMSHAFT

Check that the camshaft is not scored, seized or worn.

### CAM HEIGHT

Original cam height;

Inlet (RD28)  
48.70-48.75 mm (1.9173-1.9193 in)

Inlet (RD28T)  
47.65-47.70 mm (1.8760-1.8779 in)

Exhaust  
49.15-49.20 mm (1.9350-1.9370 in)

Cam wear:  
Limit: 0.15 mm (0.0059 in)

If the wear is greater than specified, the camshaft must be replaced.

### CAMSHAFT RUNNOUT

Camshaft runnout (Total indicator reading):  
Limit: 0.02 mm (0.0008 in)

Replace the camshaft if this value is exceeded.

### CAMSHAFT BEARING CLEARANCE

1. Measure the bore of the camshaft bearings.

Original bore:  
30.000-30.021 mm (1.1811-1.1819 in)

2. Measure the outside diameter of the camshaft journal.

Original outside diameter:  
29.935-29.955 mm (1.1785-1.1793 in)

If the clearance is greater than the maximum, replace camshaft and/or cylinder head.

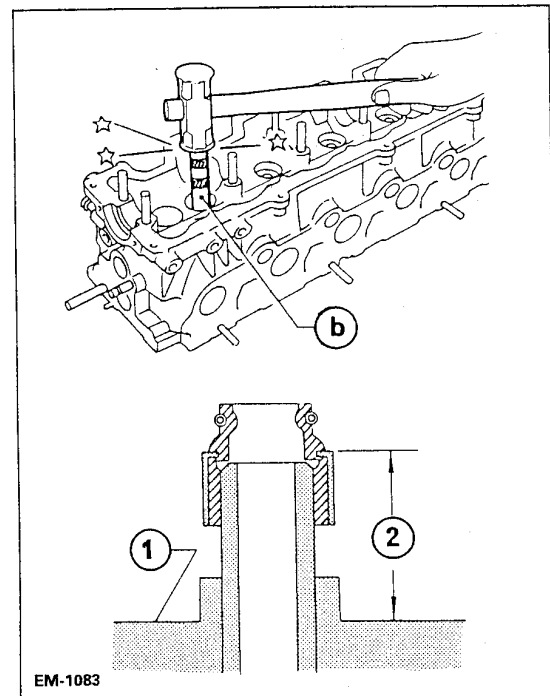
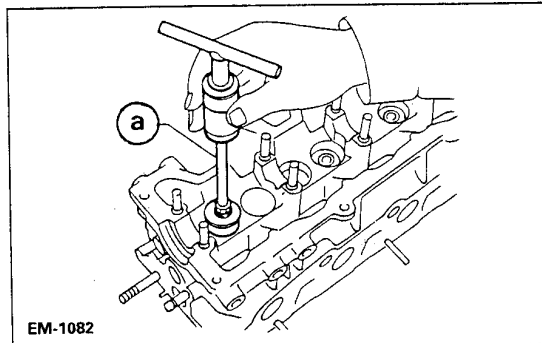
Maximum clearance:  
0.045 - 0.086 mm (0.0018 - 0.0034 in)

### CAMSHAFT END FLOAT

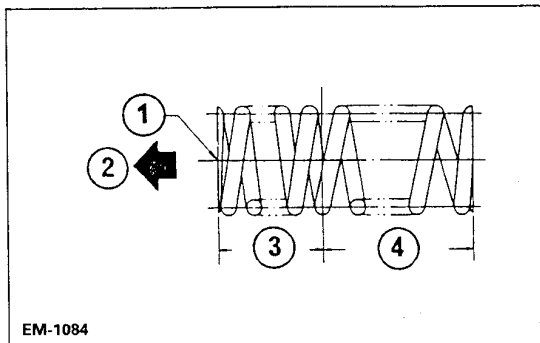
1. Install the camshaft on the cylinder head.

2. Measure the end float.

Camshaft end float:  
0.065-0.169 mm (0.0026-0.0067 in)



1. Cylinder head
2. Approximately 15 mm (0.59 in)



1. Painted side
2. Cylinder head side
3. Narrow spiral
4. Wide spiral

## REASSEMBLY

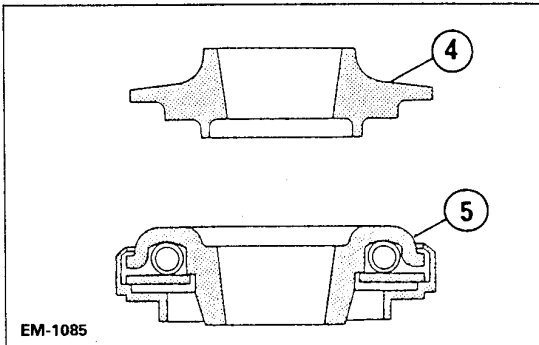
1. Check the valve guide oil seals and replace them if necessary.
2. Remove the oil seals with the tool KV-101-07900 (a).

3. Lubricate the oil seals with engine oil and fit them in place with the special tool KV-101-07501 (b).

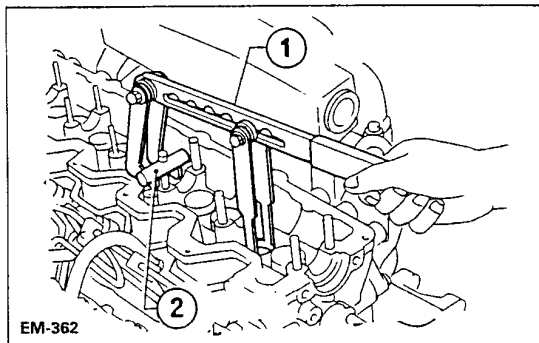
4. Install the valve components.

Fit the valve spring, with the narrowest pitch of the spiral towards the cylinder head.

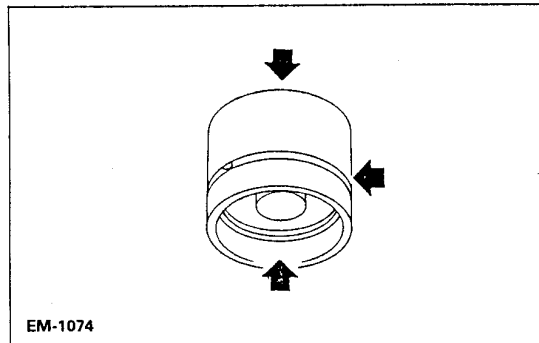
- a. When fitting the valve, smear the stem and the edge of the oil seal with engine oil.
- b. Check that the valve face is free of foreign materials.



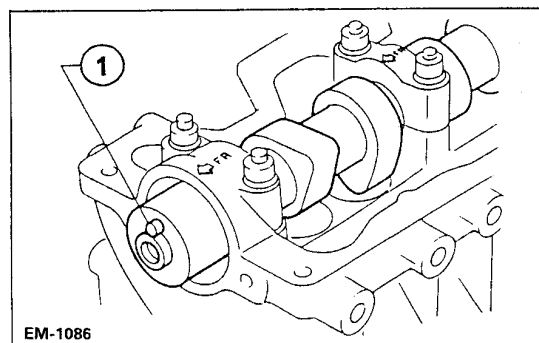
- c. Place the valve spring retainers (4) on the inlet side, and the valve rotators (5) on the exhaust side.
- d. The valve rotators (5) cannot be disassembled.



5. With the aid of the Tool KV-101-09210 (1), and KV-101-09220 (2), compress the valve spring and insert the split cones.




6. Fit the tappets in the cylinder head as shown in the figure.

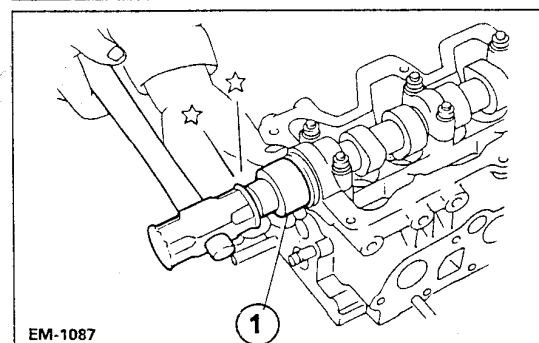


7. Install the camshaft.

**Install the camshaft with the key (1) facing upwards.**

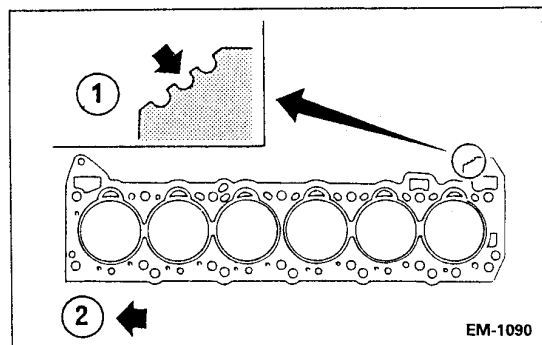
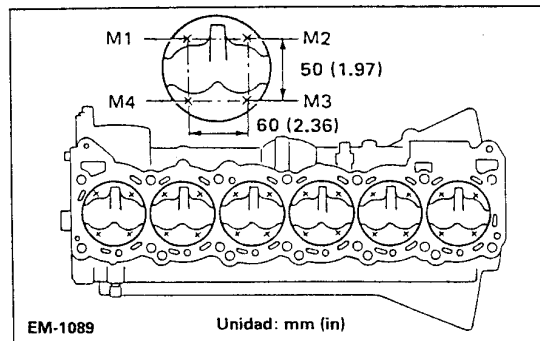
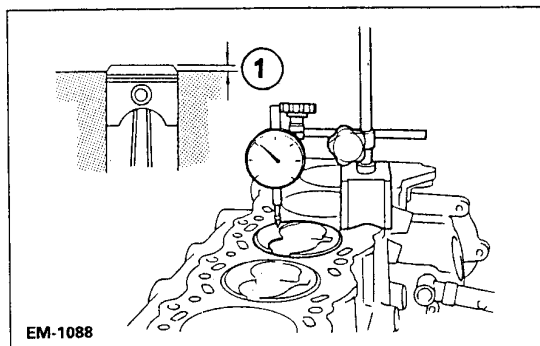
8. Install the camshaft bearing caps so that the mark is facing the front of the engine.

 **Bearing cap nuts**  
 (Tighten in two or three stages)  
 18-22 Nm  
 (1.8-2.2 kgm) (13-16 ft-lb)



9. Smear the new oil seal with engine oil and fit it in place.

1. Correct tool



1. Muestras  
2. Lado frontal

## REPLACEMENT

1. Fit the cylinder head gasket.
  - a. When only the cylinder head gasket is to be replaced, use one of the same grade as that removed.
  - b. When the engine block, cylinder head, piston, connecting rod and crankshaft is replaced or repaired, select a gasket in accordance with the following:

Step 1:  
Measure the projection of the piston (1).

- (a) Zero the dial indicator on the engine block pressure face.
- (b) Set the dial indicator over the piston that is to be measured, taking care not to alter the zero setting.
- (c) Set each piston at T.D.C. Whilst the piston is in this position, measure its projection at four points, M1, M2, M3 and M4, and note down the measured values (see figure).

**Make sure to correctly measure the piston projections at the four points of each cylinder, as shown in the figure.**

Step 2: Calculate the average of the projections measured at each cylinder.

Step 3: Calculate the average projections of all the pistons'

Step 4: Round off the average.

Step 5: Using Table A, determine the thickness of the gasket.

Relation between the projection of the piston and the cylinder head gasket  
(Table A)

Unit: mm (in)

CLASS		PISTON PROJECTION AVERAGE	GASKET THICKNESS	N.º OF NOTCHES
RD28	A	Less than 0.49 (0.0193)	1.12 (0.0441)	1
	B	0.49-0.575 (0.0193-0.0226)	1.20 (0.0472)	2
	C	Greater than 0.575 (0.0226)	1.28 (0.0504)	3
RD28T	A	Less than 0.79 (0.0311)	1.42 ± 0.05 (0.0559 ± 0.0020)	1
	B	0.79-0.875 (0.0311-0.0344)	1.50 ± 0.05 (0.0591 ± 0.0020)	2
	C	Greater than 0.875 (0.0344)	1.58 ± 0.05 (0.0622 ± 0.0020)	3

**Step 6:**

Check if the average of each projection of the Step 2 exceeds the maximum value of the original projection (of the selected gasket) plus 0.08 mm (0.0031 in).

**Step 7:**

If it is, a thicker grade gasket must be used.

If it is not, the gasket selected at the Step 4 must be used.

**EXAMPLE**

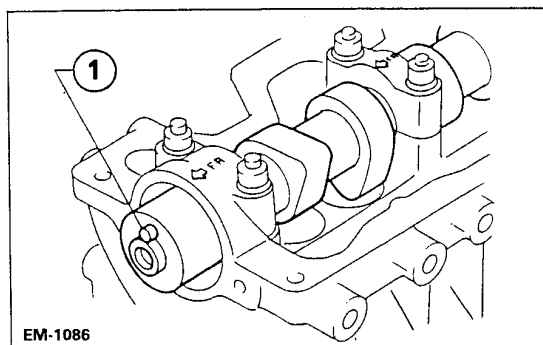
Unit: mm (in)

STEP	CYL. N.° VALUES	1				2				3				4				5				6			
		M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4
1	Measurement value	0.53 (0.020)	0.56 (0.022)	0.53 (0.020)	0.56 (0.022)	0.59 (0.023)	0.55 (0.021)	0.59 (0.023)	0.55 (0.021)	0.53 (0.020)	0.58 (0.0228)	0.57 (0.0224)	0.54 (0.0212)	0.58 (0.0228)	0.51 (0.020)	0.52 (0.020)	0.57 (0.0224)	0.53 (0.020)	0.58 (0.0228)	0.57 (0.0224)	0.54 (0.0212)	0.57 (0.0224)	0.52 (0.020)	0.51 (0.020)	0.58 (0.0228)
2	Average per piston	0.545 (0.0204)				0.57 (0.0224)				0.555 (0.0218)				0.545 (0.0214)				0.555 (0.0218)				0.545 (0.0214)			
3	Average of all pistons	0.5525 (0.0217)																							
4	Rounded off	0.55*1 (0.02)																							
5	Gasket thickness (provisional)	1.20 (Class B) (0.0472)																							
6	X: Maximum value of the original projection of the selected gasket 0.575 (0.0226) (in the Table A) + 0.08 = 0.655 (0.0257) *2 Y: Maximum value in Step 2 = 0.57 (0.0224) The relation between X and Y is «X ≥ Y»																								
7	Gasket thickness (final)	The same gasket that was provisionally determined in Step 5.° 1.20 (Class B) *2 (0.0472)																							

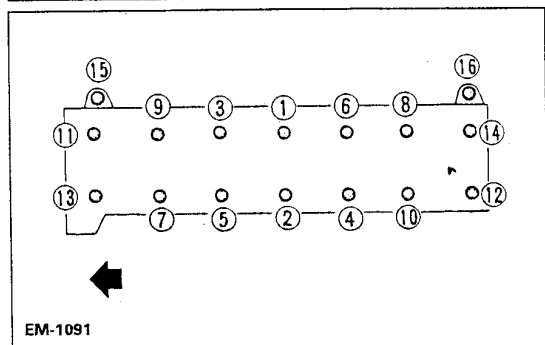
\*1: If the average of all the piston projections is, for example, 0.55(2) 5, as shown in the Table above, the value should be rounded off as follows:

If the figure at the third decimal place (in this case marked between brackets) is smaller than 5, it is considered that the average is 0.55 mm; if the value is greater than 5, it is considered that the average is 0.56 mm (0.0220 in).

\*2: If X is smaller than Y (X < Y), and a value greater than 0.655 mm (0.0257) is obtained in Step 2, a gasket of 1.28 mm (0.0503 in) RD28 and 1.58 mm (0.0622 in) RD28T (Class C) must be used.



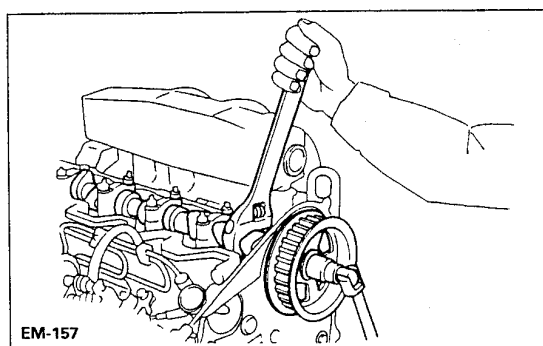
EM-1086



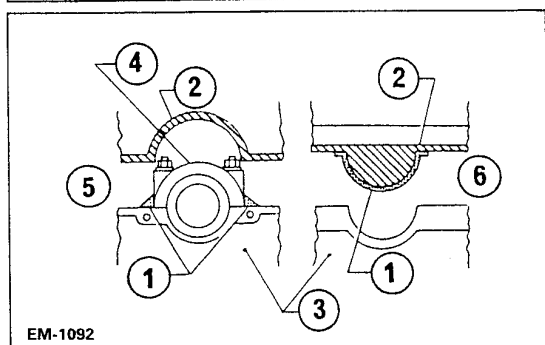
EM-1091

①-⑭ M12  
⑮-⑯ M8

← Front



EM-157



EM-1092

1. Sealant                    4. Camshaft bearing housing  
2. Rocker cover            5. Front side  
3. Cylinder head            6. Rear side

2. Place the new cylinder head gasket on the engine block and centered by the two pins.
3. Place the cylinder head on the engine block.
  - a. Make sure that cylinder N.º 1 piston is at B.D.C.
  - b. Make sure that the N.º 1 cam of the camshaft is at B.D.C. of its expansion stroke.

1. Key facing upwards.

- c. Tighten the cylinder head bolts to the specified torque in the following sequence:

**Tightening procedure.**

**M12 bolt**

1. Tighten all the bolts to 29 Nm (3.0 kgm) (22 ft-lb).
2. Tighten all the bolts to 113 Nm (11.5 kgm) (83 ft-lb).
3. Slacken off all the bolts.
4. Tighten all the bolts to 29 Nm (3.0 kgm) (22 ft-lb).
5. Tighten all the bolts to a torque of 118-127 Nm (12.0-13.0 kgm) (87-94 ft-lb), or if an angular tightening adapter is available, turn all the studs to 100-105° in a clockwise direction.

**M8 bolt**

- 16-21 Nm (1.6-2.1 kgm) (12-16 ft-lb).

4. Install the front rear cover and the camshaft pulley.

Front rear cover  
3-5 Nm  
(0.3-0.5 kgm) (2.2-3.6 ft-lb)

Camshaft pulley  
123-132 Nm  
(12.5-13.5 kgm) (90-98 ft-lb)

5. Fit the timing belt. See the Section "Replacing the Timing Belt" in Chapter MA.
6. Install the rocker cover.

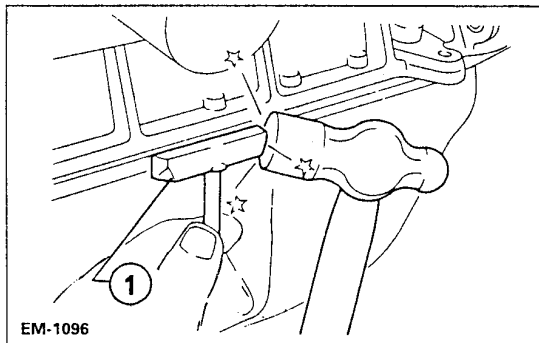
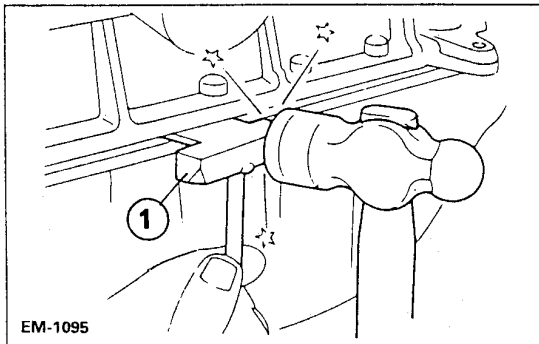
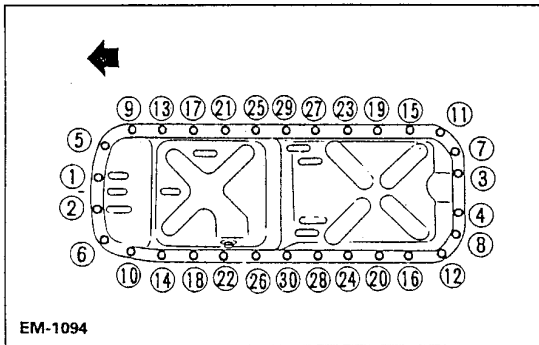
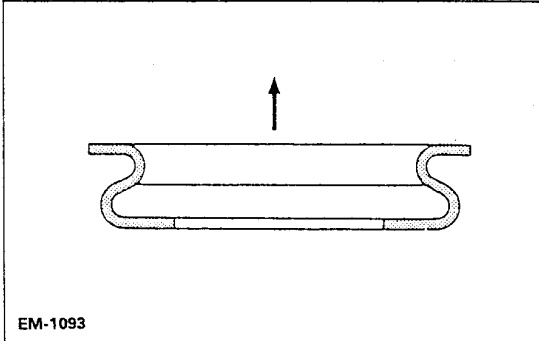
When installing the rocker cover, tighten the bolts/nuts in reverse order of removal. Tighten them in two or three stages.

**Apply sealant (1) to the rocker cover gasket (2), as indicated.**

**Do not apply an excessive amount of sealant (1).**

7. Install the inlet and exhaust manifolds. See page 13, point 6.

## OIL PAN AND OIL PUMP




### REMOVAL

1. Drain the engine oil.

When refitting the drain plug washer, make sure to position it correctly.

Discard the old drain plug washer and fit a new one.

 Drain plug tightening torque:  
29-39 Nm (3.0-4.0 kgm) (22-29 ft-lb)

2. Remove the triangular connection plates and the oil pan.

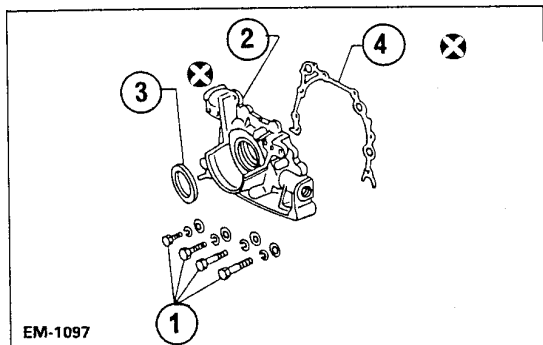
Remove the bolts in the sequence shown in the figure, alternately at the left and right of the center.

3. Insert the Tool KV-101-11100(1) between the engine block and the oil pan.

- Do not insert the tool so far that it comes into contact with the oil pump or the rear oil seal, because it would damage the seating faces.
- Do not use a screwdriver for this operation, because it could deform the flange of the oil pan.

4. Slide the tool along the flange of the oil pan, tapping gently with a hammer, and then remove the oil pan.





- Loosen and remove the bolts (1), the oil pump (2), front oil seal (3) and the gasket (4).

### DISASSEMBLY

- To carry out the disassembly, refer to Section LC.

### INSPECTION

- See Section LC.

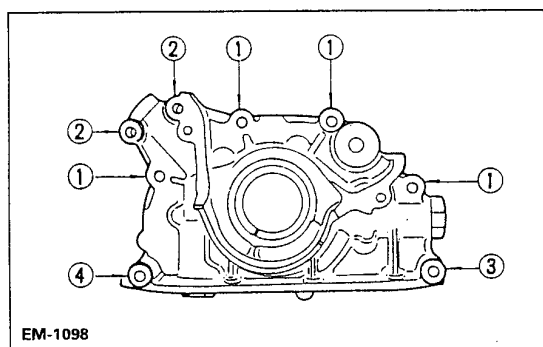
### REASSEMBLY

- See Section LC.


### REPLACEMENT

Always use a new gasket.

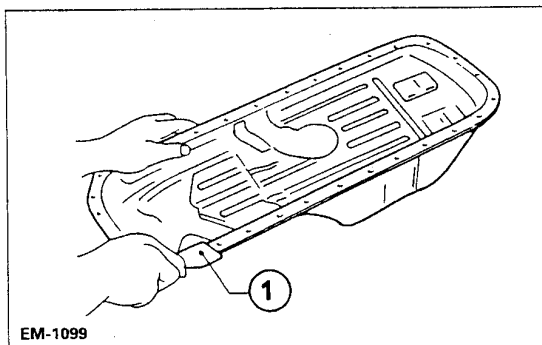
- Place the oil pump on the engine block and secure it with the bolts, following the indications shown in the figure.

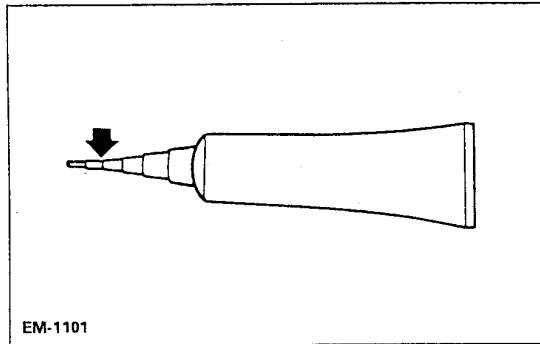
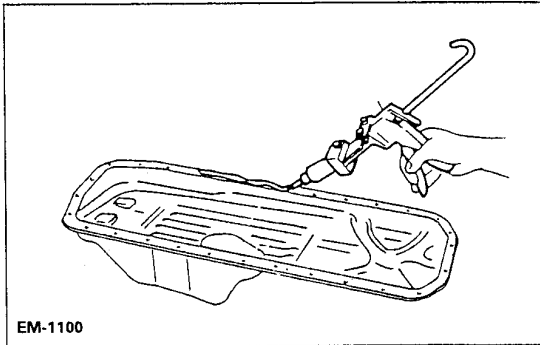


POSITION	LENGTH OF THE BOLTS mm (in)
1	20 (0.79)
2	35 (1.38)
3	45 (1.77)
4	55 (2.17)

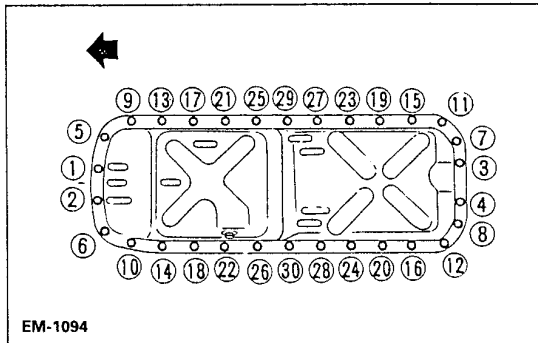
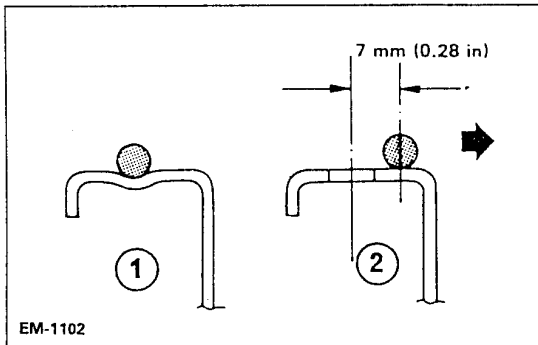
-  Bolt tightening torque:  
10-12 Nm  
(1.0-1.2 kgm) (7-9 ft-lb)

- Before installing the oil pan, use a scraper (1) to remove all traces of sealant from the oil pan mating face.
  - Likewise, remove all traces of gasket from the mating face of the engine block.





← Cut here



3. Apply a continuous bead of sealant on the mating surface of the oil pan.

- The sealant bead should have a thickness of 3.5-4.5 mm (0.138-0.177 in).

- Use sealant KV-510-000150 or equivalent.

4. Apply sealant to the grooved surface (1) and in the bolt holes (2), working towards the inside of the lip, as shown in the figure.

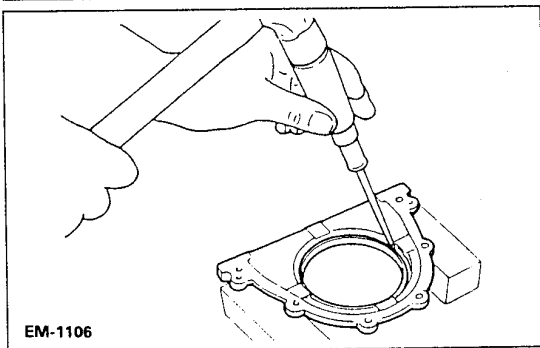
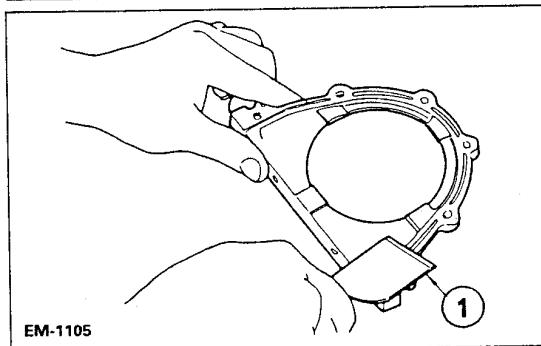
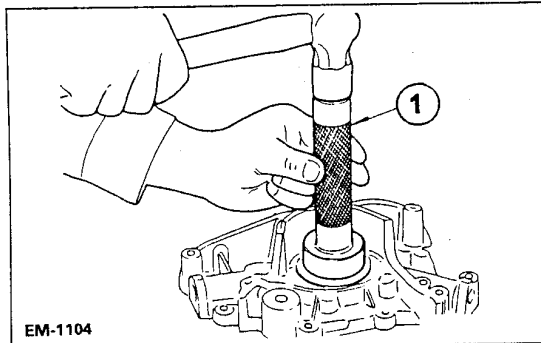
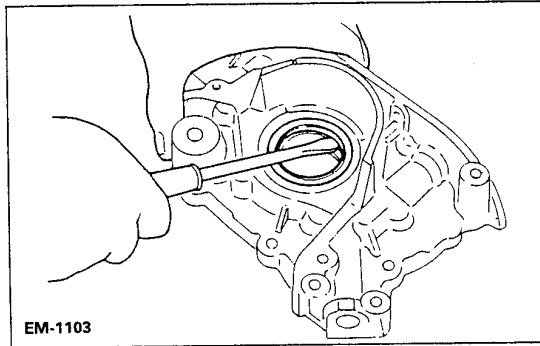
- Fit the oil pan in place on the engine block five minutes after having applied the sealant.

5. Put the bolts in place in reverse order to that shown in the figure.

- ☑ Bolts, oil pan to engine block:  
7-8 Nm (0.7-0.8 kgm) (5.1-5.8 ft-lb)

- Wait at least 30 minutes before filling the engine with oil and starting it.

## FRONT AND REAR OIL SEALS



### OIL PUMP FRONT OIL SEAL

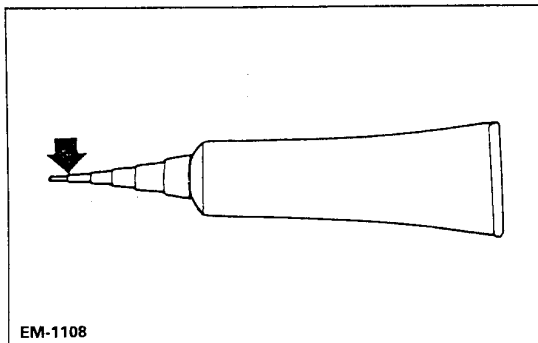
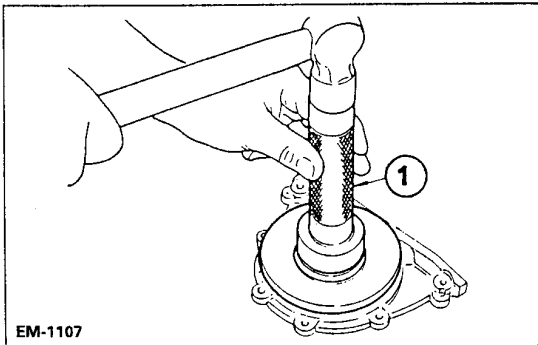
1. With the oil pump removed.
2. Remove the oil seal from its housing.

3. Smear the oil seal with engine oil and, using the correct tool, install the oil seal in its housing.

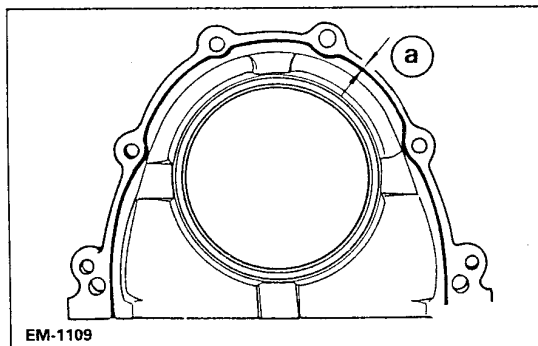
### REAR OIL SEAL

1. With the rear oil seal support removed.
2. Using the scraper (1), remove any remains of sealant.

3. Using a tool and nylon-faced hammer, remove the rear oil seal from its housing.



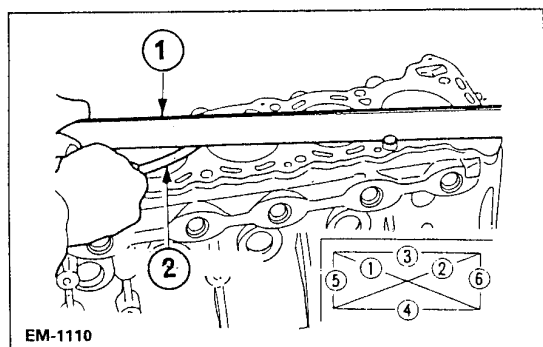
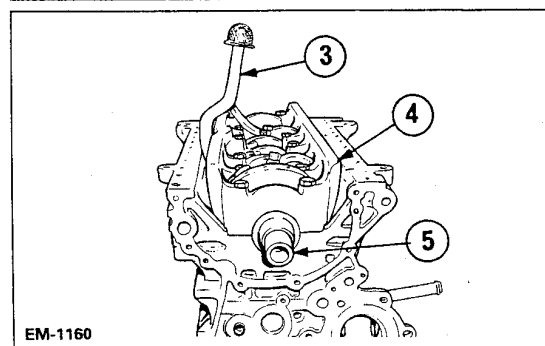
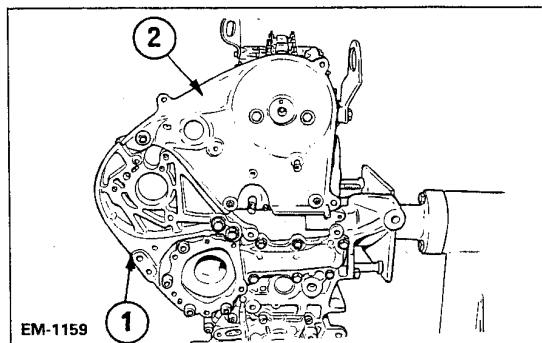
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4. Check the condition of the support and, above all, the oil seal housing. Replace if defective.
5. Smear the oil seal with engine oil and, using the correct tool (1), install the oil seal in its housing.

6. Apply a continuous bead of sealant (KP-510-00150 or similar) to the rear oil seal support.
  - a. The sealant bead should have a diameter (a) of 2.0-3.0 mm (0.079-0.118 in).
  - b. Place the oil seal support on the engine block five minutes after having applied the sealant.
  - c. Wait for at least 30 minutes before filling the engine with oil and starting it.

## ENGINE BLOCK



1. Ruler
2. Feeler gauges

### DISASSEMBLY

1. With the block located on the engine support **ST-050-1S000** and the universal flange **KV-101-06500**.
2. Remove the timing belt (see Section MA).
3. Remove the fuel injection pump (see Section EF).
4. Remove the water pump and the water pump and fuel injection pump bracket (1).
5. Drain the oil.
6. Remove the oil pan and oil pump (see Page 26).
7. Remove the timing case (2).
8. Remove the cylinder head (see Page 13).
9. Remove the piston and connecting rods assembly.
10. Remove the suction pipe (3).
11. Remove the tappet assembly (4) and the crankshaft (5).

### INSPECTION

#### ENGINE BLOCK DEFORMATION AND WEAR

Clean the top face of the engine block and measure the deformation.

- Original:**  
 Less than 0.03 mm (0.0012 in)  
**Limit:**  
 0.10 mm (0.0039 in)

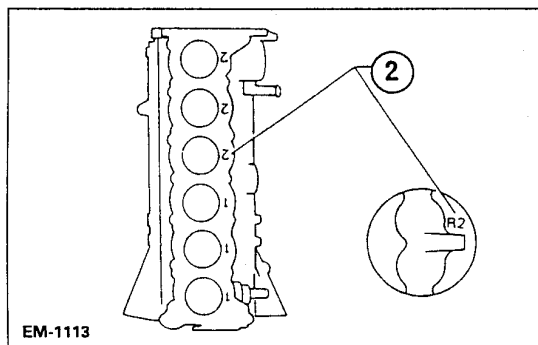
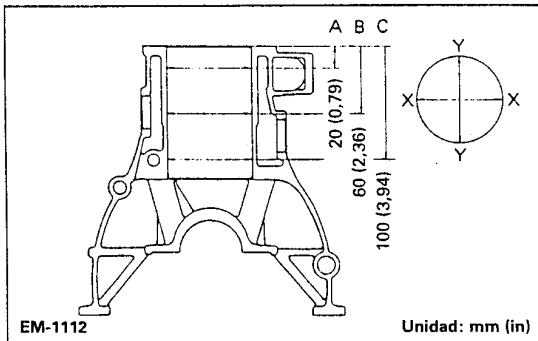
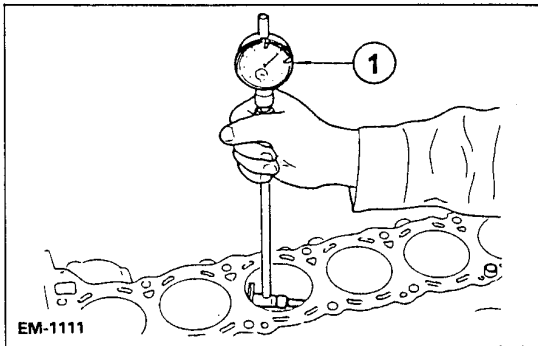
If the tolerance is exceeded, the top face must be refinished.

The refinishing limit of the engine block is determined by the refinishing of the cylinder head.

Where "A" is the refinishing limit of the cylinder head, and "B" the refinishing limit of the engine block, the maximum limit is:

$$A + B = 0.1 \text{ mm (0.004 in)}$$

Replace the engine block if necessary.



### BORE DIAMETER

- Using a bore gauge (1), check the cylinder for wear, ovalization and taper.

Original bore diameter:

85.000-85.050 mm (3.3465-3.3484 in)

See the Section **TECHNICAL DATA AND SPECIFICATIONS**.

Wear limit:

0.20 mm (0.0079 in)

Ovalization limit (X-Y):

0.015 mm (0.0006 in)

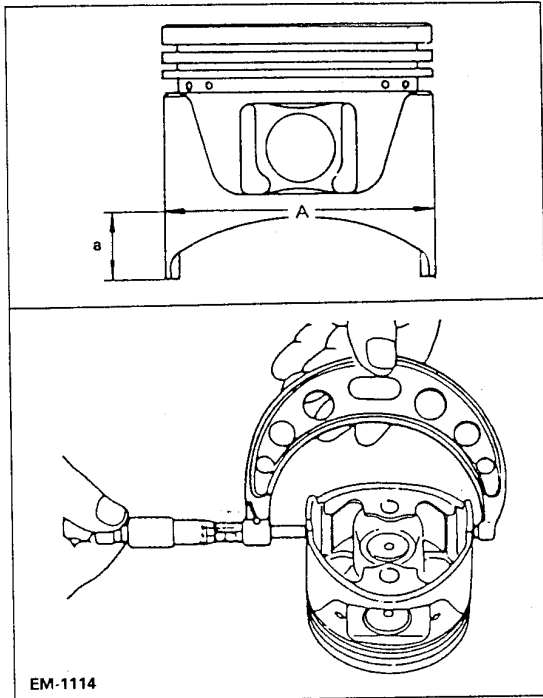
Taper limit (A-B):

0.010 mm (0.004 in)

If the limits are exceeded, the six cylinders must be re-ground. If necessary, replace the block.

- Check for signs of scoring or seizing. If there are signs of seizing, the cylinders must be ground by friction.

- If the engine block and pistons are replaced together, the pistons must be selected in accordance with the part number (2), stamped on the top face of the engine block.



### CLEARANCE BETWEEN THE PISTON AND CYLINDER WALLS

1. Measure the diameter of the piston and the cylinder bore.

**Piston diameter "A":**

See the Section **TECHNICAL DATA AND SPECIFICATIONS**.

**Measurement value "a" (Distance from the bottom of the skirt):**

14.5 mm (0.571 in)

2. Check that the piston clearance is within the specified value.

**Piston clearance: [at 20 °C (68 °F)]**

0.025-0.045 mm (0.0010-0.0018 in) (RD28)

0.030-0.050 mm (0.0012-0.0020 in) (RD28T)

### REGRINDING THE CYLINDERS

If one cylinder requires regrinding, all the others must be also reground.

1. Determine the piston oversize value in accordance with the cylinder wear.

**Oversize pistons are available for repair operations.**

See the Section **TECHNICAL DATA AND SPECIFICATIONS**.

2. Determine the diameter to which the cylinders must be reground, by adding the clearance between the piston and the cylinder wall at the piston skirt diameter "A".

**Height "a"**

14.5 mm (0.571 in)

**Calculation of the regrinding diameter**

$D = A + B - C = A + [0.005-0.0025 \text{ mm}]$   
(0.0002-0.0010 in)

**Where,**

**D: Regrinding diameter**

**A: Skirt diameter**

**B: Clearance between piston and cylinder wall:**  
0.025-0.045 mm (0.0010-0.0018 in)

**C: Amount for burnishing: 0.02 mm (0.0008 in)**

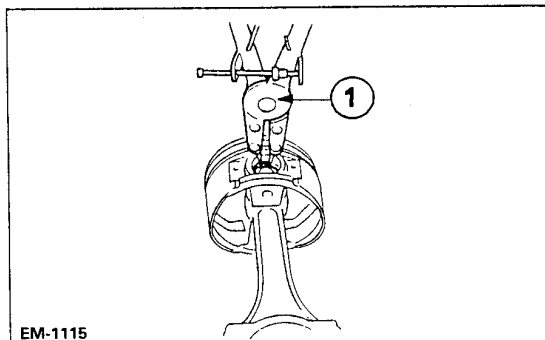
3. Fit the main bearing caps in place and tighten them to the specified torque so as to avoid all deformation of the cylinder bores during final installation.
4. Regrind the cylinder bores.
  - Do not grind too much from the bore at one time. Remove about 0.005 mm (0.0020 in) at a time.
5. Regrind the bores so that the piston-cylinder wall clearance corresponds to the specified value.

**Burnishing limit: 0.02 mm (0.0008 in).**

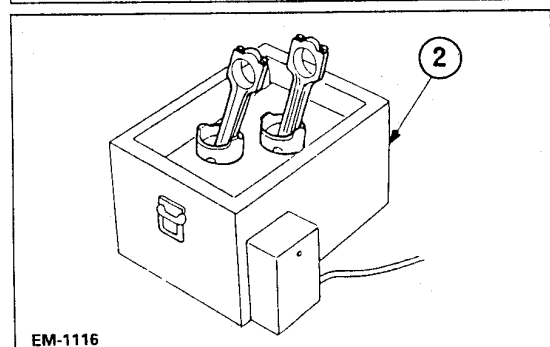
6. Check that the final size of the bore is not oval or tapered.

- Extreme care must be taken when measuring the diameter of a recently ground cylinder, since the heat produced during regrinding causes expansion of the material.

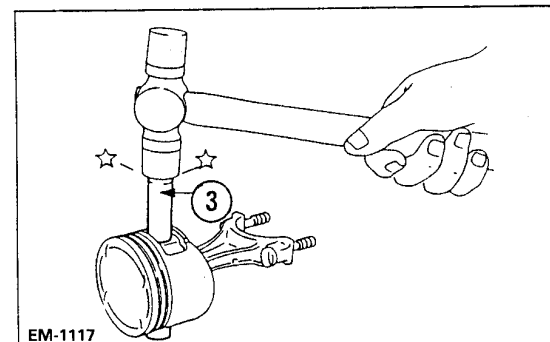
## PISTONS AND CONNECTING RODS



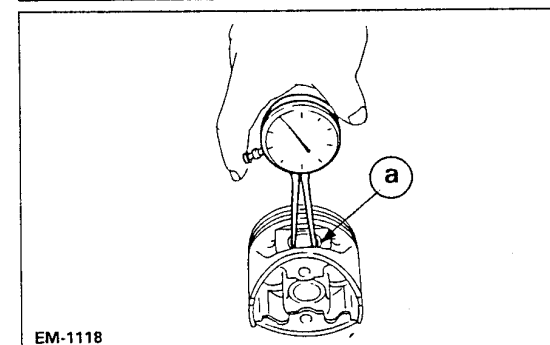
EM-1115



EM-1116



EM-1117



EM-1118

### DISASSEMBLY

#### GUDGEON PIN

1. Remove the circlip with the aid of circlip pliers (1).

2. Place the pistons in an oil bath (2) and heat them to a temperature of 60-70 °C (140-159 °F).

3. Remove the gudgeon pin with the correct tool (3).

- The piston and gudgeon pin form a matched pair.

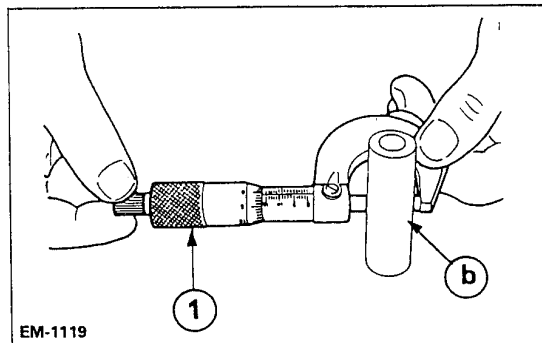
Fit the pistons, gudgeon pins, circlips, connecting rods and bearings in the corresponding order.

### INSPECTION

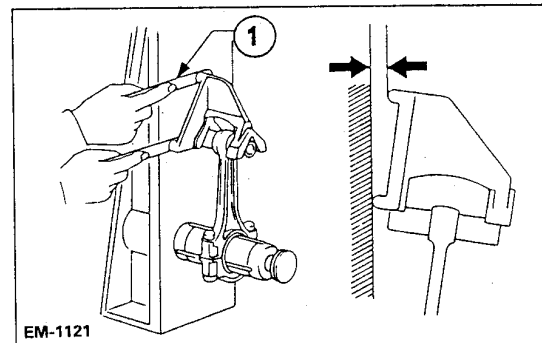
#### GUDGEON PIN AND GUDGEON PIN BORE

1. Measure the gudgeon pin bore (a) in the piston.



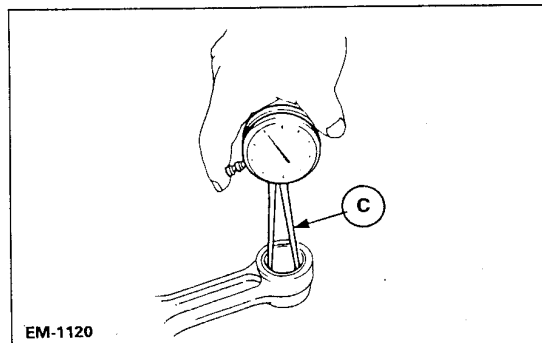


EM-1119

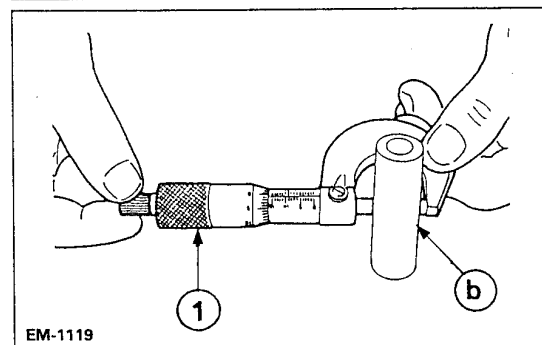


EM-1121

1. Feeler gauges



EM-1120



EM-1119

2. Measure the gudgeon pin outside diameter (b) with a micrometer (1).
3. Calculate the clearance between the gudgeon pin and piston.

$$a - b = \text{between } -0.004 \text{ and } 0 \text{ mm } (-0.0002-0 \text{ in})$$

[interference fit at 20 °C (68 °F)]

If the limit is exceeded, the piston and gudgeon pin assembly must be replaced.

### CONNECTING ROD PARALLELISM AND TWIST

Parallelism and twist:  
 0.025 mm (0.0010 in)  
 per 100 mm (3.94 in) of length.

If the limits are exceeded, the connecting rod assembly must be replaced.

### SMALL END BUSH

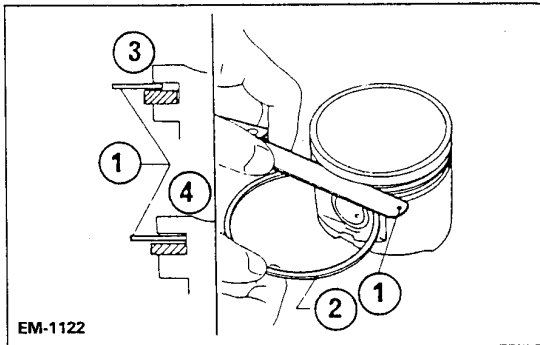
1. Measure the bore (c) of the bush.

2. Measure the gudgeon pin outside diameter (b) with a micrometer (1).
3. Calculate the connecting rod bush clearance.

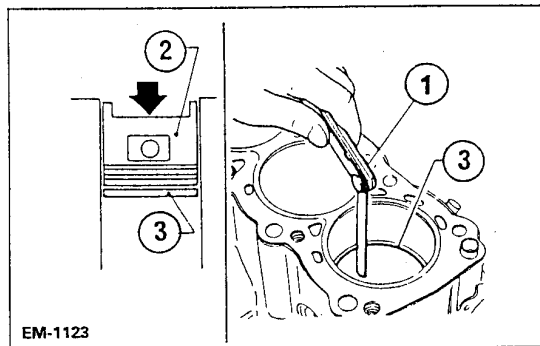
$$C - b = 0.025-0.044 \text{ mm } (0.0010-0.0017 \text{ in})$$

[at 20 °C (68 °F)]

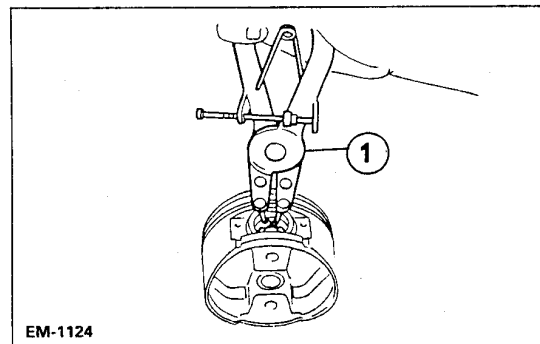
If the limits are exceeded, the bush and/or the piston-gudgeon pin assembly must be replaced.



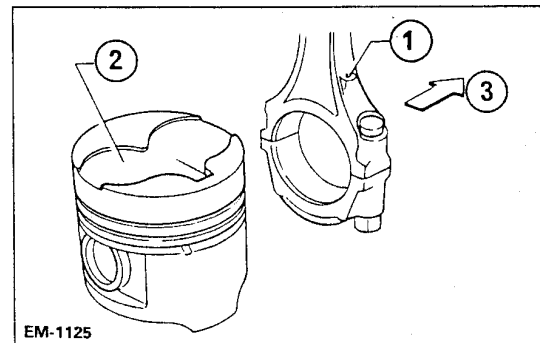
1. Feeler gauges
2. Piston ring
3. Incorrect
4. Correct



1. Feeler gauges
2. Forced adjustment
3. Piston ring



EM-1124



EM-1125

1. Lubrication hole
2. Piston crown face
3. Front of engine block

### PISTON RING SIDE CLEARANCE

Side clearance:

Top ring:

0.060-0.093 mm (0.0024-0.0037 in)

Second ring:

0.040-0.073 mm (0.0016-0.0029 in)

Maximum side clearance:

0.1 mm (0.004 in)

If the clearance exceeds the specified value, the piston-gudgeon pin assembly must be replaced.

### PISTON RING GAP

Original gap:

Top ring:

0.12-0.30 mm (0.0047-0.0118 in)

Second ring:

0.20-0.35 mm (0.0079-0.0138 in) (RD28)

0.38-0.53 mm (0.0150-0.0209 in) (RD28T)

Maximum gap:

0.4 mm (0.016 mm)

If the gap exceeds the specified value, the piston ring must be replaced.

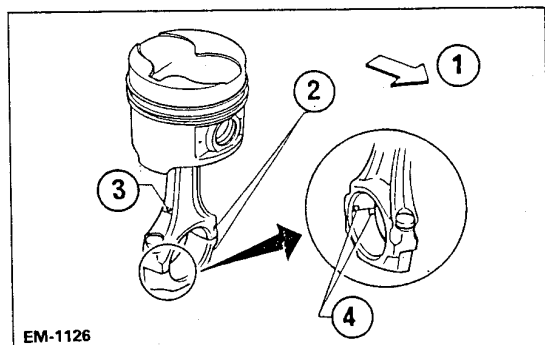
If the gap still exceeds the limit when a new ring is used, the cylinder bore must be reground and an oversize piston/piston ring assembly used.

### REASSEMBLY

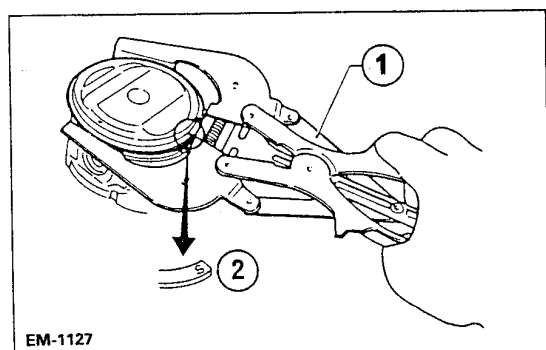
#### PISTON

1. Using circlip pliers (1), fit a new circlip in one of the gudgeon pin grooves of the piston.

Proceed with the alignment of the piston and connecting rod (see figure).



1. Front of the engine
2. Cylinder N.º
3. Lubrication hole
4. Position recesses



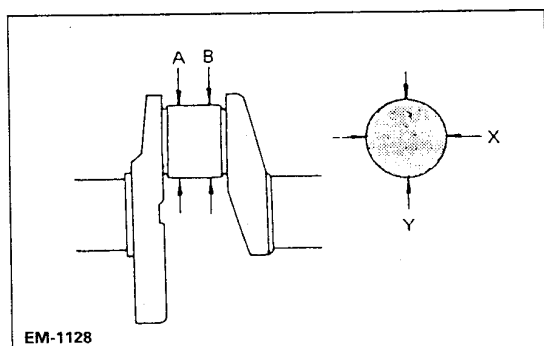
2. Heat the piston to 60-70 °C (140-158 °F) and install the piston, gudgeon pin, connecting rod and new circlip.

- Proceed with the alignment of the piston and connecting rod.
- The numbers stamped on the connecting rod and bearing cap, correspond to each cylinder. Care must be taken to respect the correct combination of these components.
- When installing the assembly, apply engine oil to the gudgeon pin and small end bush.

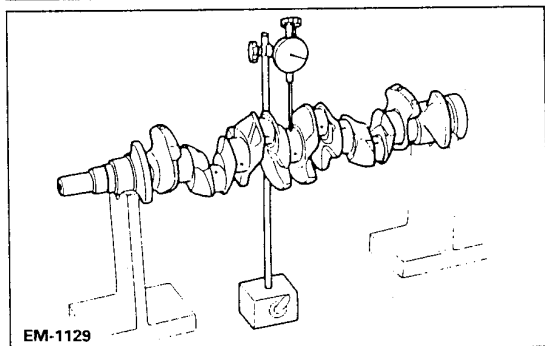
3. Using a shop tool (1), install the piston rings, starting with the oil scraper ring, which is located nearest to the gudgeon pin.

Install the piston rings so that the mark (2) is upwards.

## CRANKSHAFT



EM-1128



EM-1129

### INSPECTION

1. Check that the crankshaft crankpins and journals are not scored, have hair cracks or are off-center. If there are slight defects, correct them with fine emery cloth.
2. Using a micrometer, check the crankpins and journals for ovalization or taper.

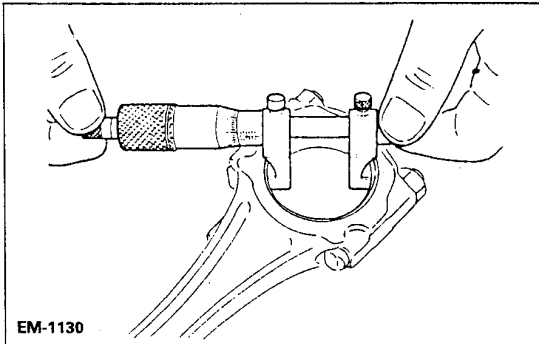
**Ovalization (X-Y): 0.005 mm (0.0002 in)**  
**Taper (A-B): 0.005 mm (0.0002 in)**

If the limits are exceeded, the crankshaft must be replaced.

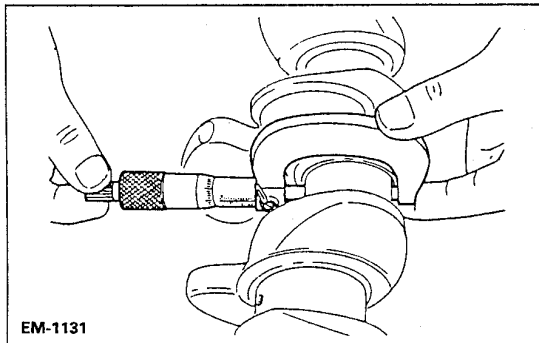
3. Check the crankshaft runout.

**Runout [Total indicator reading]**  
**Less than 0.1 mm (0.002 in)**

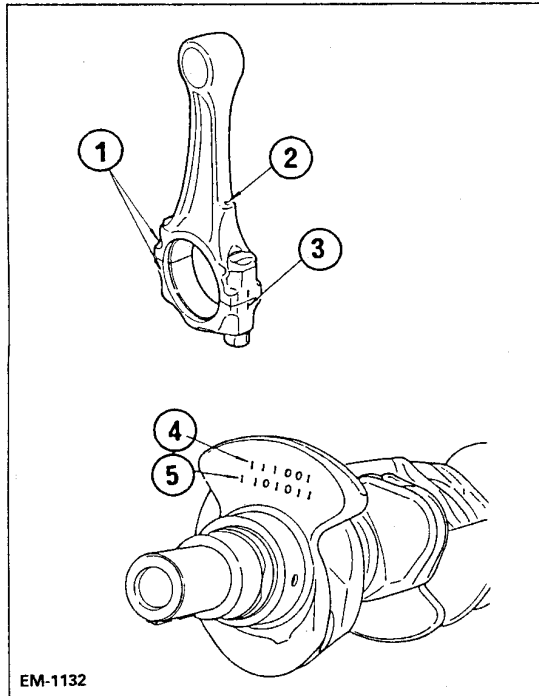
If the limits are exceeded, the crankshaft must be replaced.



EM-1130



EM-1131



EM-1132

1. Cylinder N.° identification reference
2. Lubrication hole
3. Connecting rod big-end identification grade N.°
4. Crankpin upper reference N.° 1-6 from the left
5. Journal lower reference N.° 1-7 from the left

**CONNECTING ROD BIG-END CLEARANCE**

1. Install the bearing and the bearing cap.
2. Secure the bearing cap to the connecting rod.

Apply oil to the bolt threads and on the nut seating face.  
 1st. tightening: 14-16 Nm (1.4-1.6 kgm) (10-12 lb-ft)  
 2nd. tightening: 37-45 Nm (3.8-4.6 kgm) (27-33 lb-ft)  
 or if an angular tightening adapter is available, turn the bolts 60-65° clockwise.

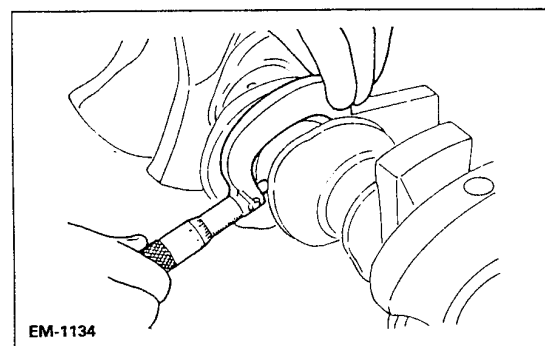
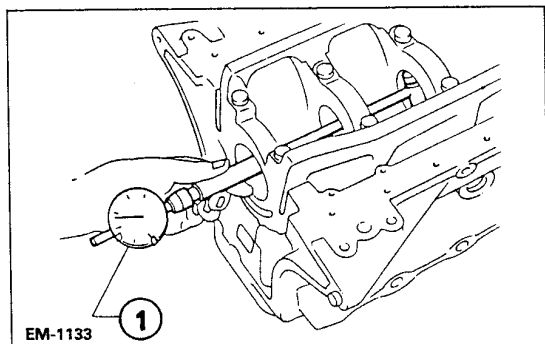
3. Measure the bore "C" of the bearing.
4. Measure the outside diameter "Dp" of the crankpin.
5. Calculate the clearance between the bearing and connecting rod.

Connecting rod bearing clearance = C - Dp  
 Original: 0.031-0.055 mm (0.0012-0.0022 in)  
 Limit: 0.11 mm (0.0043 in)

- If the limit is exceeded, replace the bearing.
- If the limit is still exceeded with a new bearing, regrind the crankpin and use undersize bearings.
- See the Section TECHNICAL DATA AND SPECIFICATIONS, for all that related to the regrinding of the crankshaft and the tools to be used for the repair.
- If the bearings, crankshaft or the connecting rod are replaced with new ones, the connecting rod bearings must be selected in accordance with the grade number of the crankpins and connecting rods, and based on the following Table:

		CONNECTING ROD GRADE N.°	
		0	1
Crankpin grade N.°		CONNECTING ROD BEARING GRADE N.°	
		0	1
	1	1	2

Identification colour:	RD28	RD28T
Grade 0	No colour	Black
Grade 1	Brown	Yellow
Grade 2	Green	Blue



**MAIN BEARING CLEARANCE**

1. Fit the bearings in the engine block and in the main bearing caps.
2. Secure the bearing caps to the engine block.

**Tighten all the bolts in the correct order, and in two or three stages.**

**69-78 Nm (7.0-8.0 kgm) (51-58 lb-ft)**

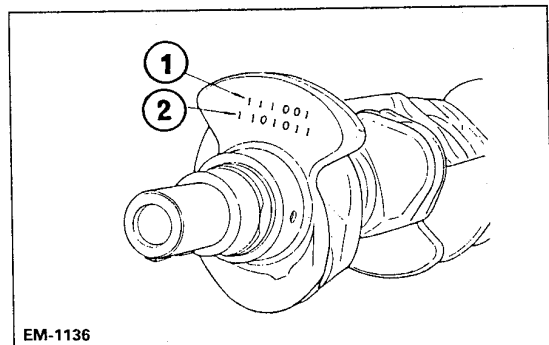
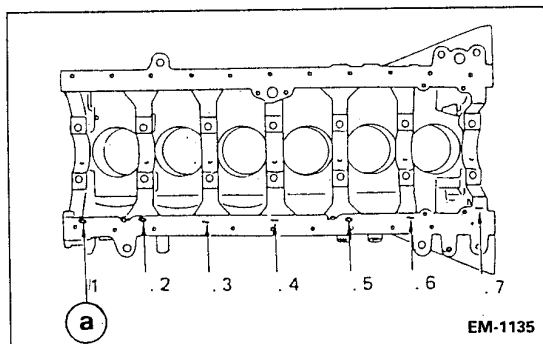
3. Measure the crankshaft journal bore "A" with a bore gauge (1).
4. Measure the crankshaft journal outside diameter "Dm".
5. Calculate the bearing clearance.

**Main bearing clearance: A-Dm**

**Original: 0.036-0.063 mm (0.0014-0.0025 in)**

**Limit: 0.12 mm (0.0047 in)**

- If the limit is exceeded, replace the bearing.
- If the limit is still exceeded with a new bearing, regrind the crankshaft journal and use undersize bearings.
- See the Section **TECHNICAL DATA AND SPECIFICATIONS** for all that related with the regrinding of the crankshaft and the tools to be used for the repair.

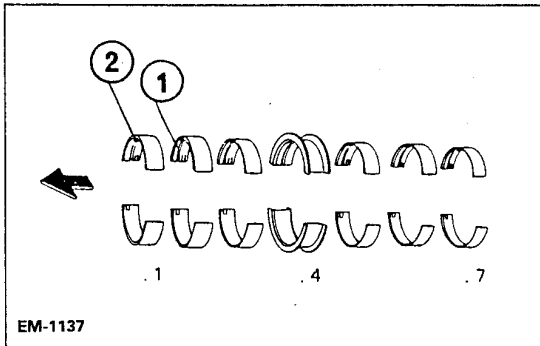


1. Crankpin upper reference N.º 1-6 from the left
2. Journal lower reference N.º 1-7 from the left

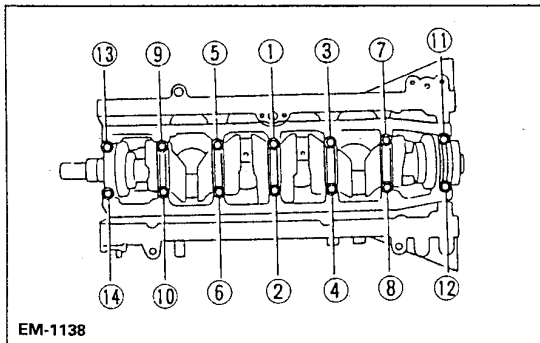
- If the bearings, crankshaft or engine block are replaced, the main bearings must be selected in accordance with the grade N.º (a) of the journal and engine block housings, and based on the following Table.

	JOURNAL GRADE N.º			
	0	1	2	
	MAIN BEARING GRADE N.º			
Journal grade N.º	0	0	1	2
	1	1	2	3
	2	2	3	4

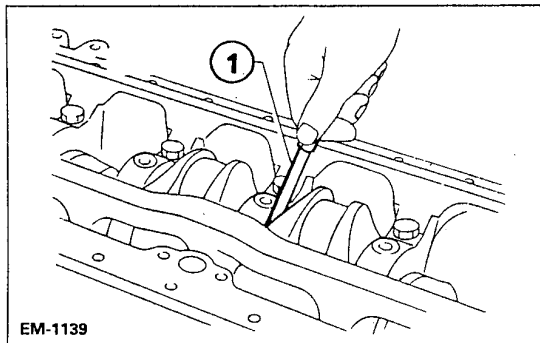
<b>Identification colour:</b>	<b>RD28</b>	<b>RD28T</b>
<b>Grade 0</b>	No colour	Black
<b>Grade 1</b>	No colour	Brown
<b>Grade 2</b>	Black	—
<b>Grade 3</b>	Brown	Yellow
<b>Grade 4</b>	Green	Blue



EM-1137

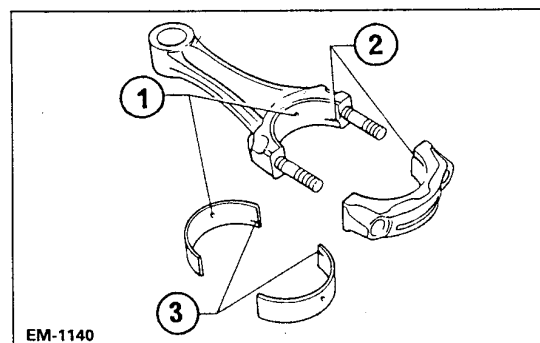


EM-1138



EM-1139

1. Feeler gauges



EM-1140

1. Lubrication hole
2. Position groove
3. Position tongue

## REASSEMBLY

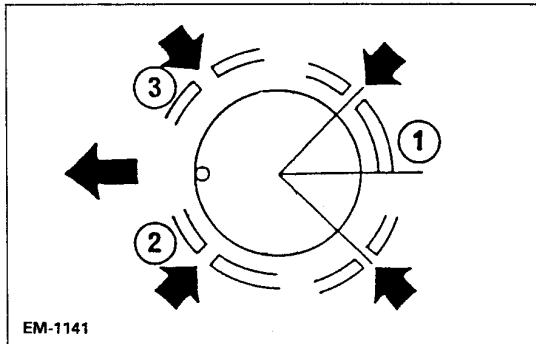
1. Fit the main bearings and the bearing caps in their correct position on the engine block.
  - Check that the main bearings are of the correct size. For this, see the Sub-Section "Inspection" of this Chapter.
  - The upper bearings (engine block side), have oil grooves (1) and holes (2).
2. Apply engine oil to the engine block and bearing cap sides of the main bearings.
3. Install the crankshaft and main bearing caps and tighten the bolts to the specified torque:
  - ☞ 69-78 Nm (7.0-8.0 kgm) (51-58 lb-ft)
  - Tighten the bolts in two or three stages.
  - Once the main bearing cap bolts are tightened, check that the crankshaft turns freely by hand.
4. Measure the crankshaft end float.
 

**Crankshaft end float:**  
**Original:**  
 0.05-0.18 mm (0.0020-0.0071 in)  
**Limit:**  
 0.30 mm (0.0118 in)

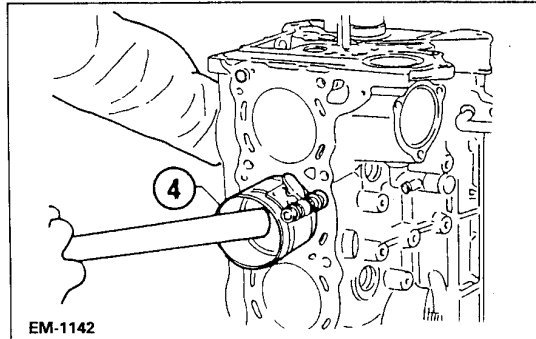
If the limits are exceeded, replace the main bearing.

## REPLACING THE PISTON AND CONNECTING ROD

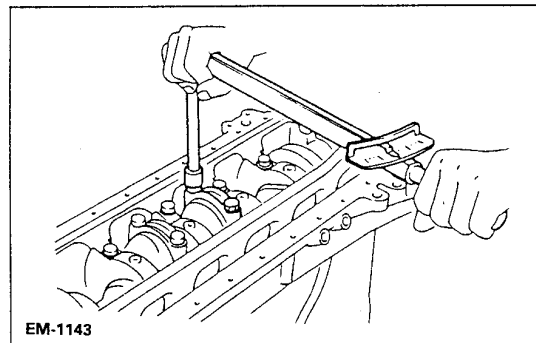
1. Place the bearing in the connecting rods and fit the bearing caps.
  - Make sure to use correct size bearings. For this, see the Sub-Section "Inspection" of this Chapter.
  - Fit the bearings with lubrication holes, in the connecting rod.



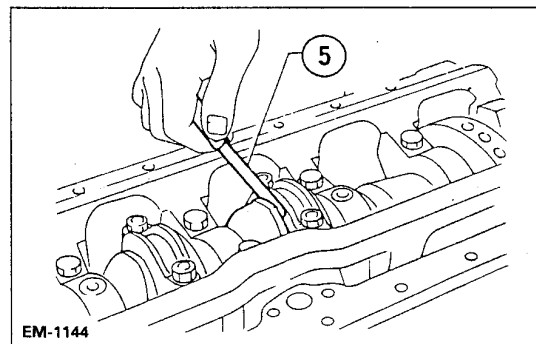
EM-1141



EM-1142



EM-1143



EM-1144

2. Fit the piston rings with the gaps at 180° to one another, and making sure that their position does not coincide with that of the gudgeon pin. See the position (1), (2) and (3) of each ring in the figure.

3. Install the pistons together with their connecting rods.  
a. Introduce them in the corresponding cylinder, using the special tool EM-037-70000 (4) or a suitable tool.

- Take care not to scratch the cylinder walls with the connecting rod.
- Apply engine oil to the cylinder walls, piston and bearing.
- Check that the grade N.° on the piston crown is towards the front of the engine.

b. Tighten the connecting rod bearing cap bolts.

**Tightening procedure**

1st tightening: 14-16 Nm (1.4-1.6 kgm) (10-12 lb-ft)

2nd tightening: 37-45 Nm (3.8-4.6 kgm) (27-33 lb-ft)

or if an angular tightening adapter is available, turn the bolts 60-65° clockwise.

4. Measure the connecting rod side clearance with the feeler gauges (5).

**Connecting rod side clearance:**

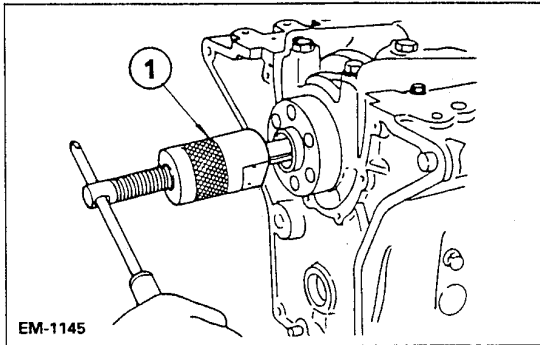
**Original**

0.2-0.3 mm (0.008-0.012 in)

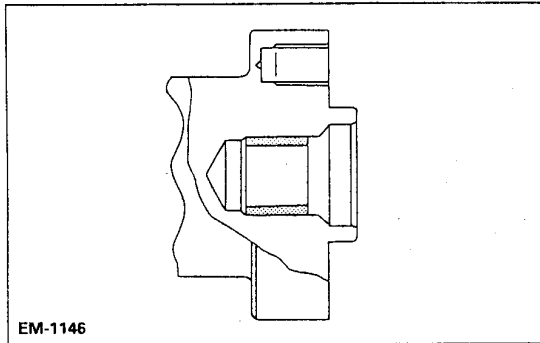
**Limit**

0.40 mm (0.0157 in)

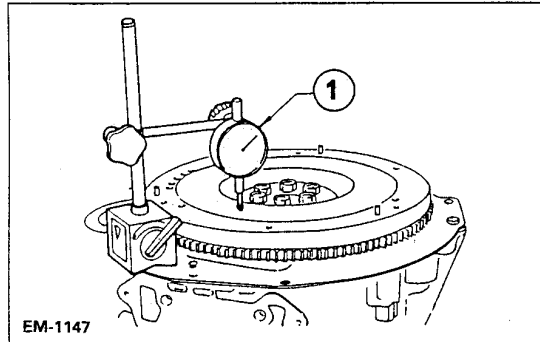
If the limits are exceeded, replace the connecting rod and/or the crankshaft.



EM-1145



EM-1146



EM-1147

#### REPLACING THE GUIDE BUSH

1. Remove the guide bush with the tool **ST-166-10001** (1).

2. Install the guide bush with the aid of a suitable tool.

#### FLYWHEEL RUNNOUT

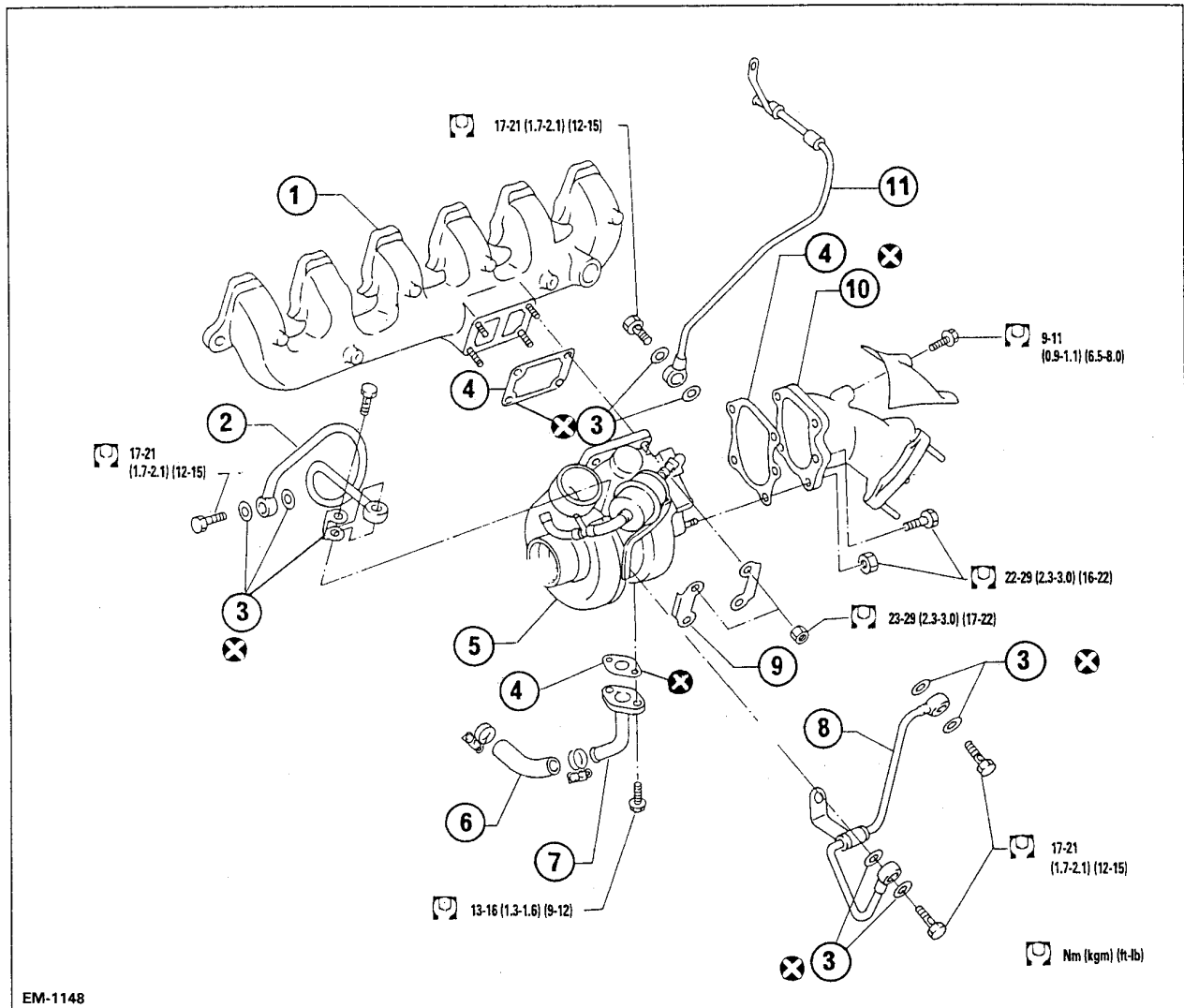
1. Using a dial indicator (1), check the flywheel runout.

**Runout [Total indicator reading]  
Less than 0.10 mm (0.0039 in)**

If the limits are exceeded, replace the flywheel.



## TURBOCHARGER



EM-1148

## COMPONENTS

1. Exhaust manifold
2. Oil inlet pipe
3. Washers
4. Gaskets
5. Turbocharger
6. Oil return hose
7. Oil return pipe
8. Water inlet pipe
9. Lockwashers
10. Exhaust elbow
11. Water outlet pipe

## REMOVING AND REPLACING THE TURBOCHARGER

1. Drain the cooling system.
2. Remove the following assemblies:
  - Air pipes and hoses
  - Air inlet pipe to manifold
  - E.G.R. connection pipe
  - Inlet manifold
  - Front exhaust pipe
  - Heat protection plates
  - Oil inlet and return pipes
  - Water inlet and outlet pipes
3. Remove the exhaust manifold and turbocharger from the engine block.
4. When connecting the turbocharger to the exhaust manifold, tighten the nuts firmly and bend up the lockwasher tabs.
  - The turbocharger should not be disassembled.

## TECHNICAL DATA AND SPECIFICATIONS

### GENERAL SPECIFICATIONS

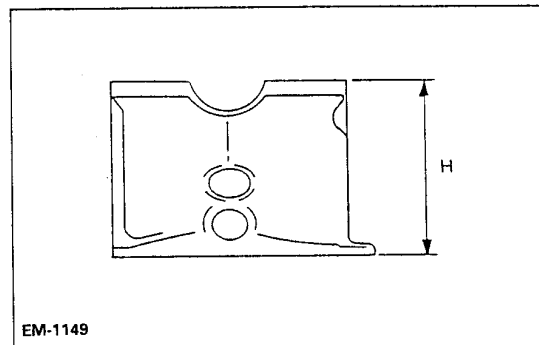
Cylinder arrangement	6 in-line	
Cubic capacity	cm <sup>3</sup> (in <sup>3</sup> )	2,826 (172.44)
Bore and stroke	mm (in)	85 × 83 (3.35 × 3.27)
Camshaft arrangement	Overhead	
Firing order	1-5-3-6-2-4	
Number of piston rings		
Compression	2	
Oil scraper	1	
Number of main bearings	7	
Compression ratio	21.2 ± 1.2:1	

Unit: kPa (bar) (kg/cm<sup>2</sup>) (lb/in<sup>2</sup>)/rpm

Compression pressure	
Original	3,040 (30.4) (31) (111)/200
Minimum	2,452 (24.5) (25) (356)/200
Difference limit between cylinders	490 (4.9) (5) (71)/200

### INSPECTION AND AJUSTMENT

#### CYLINDER HEAD

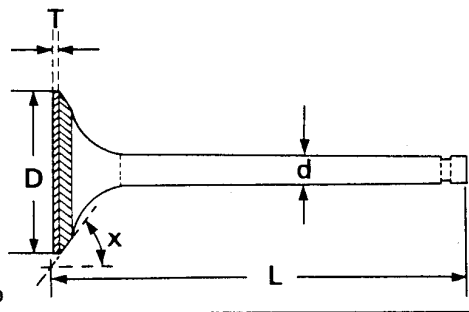


Unit: mm (in)

	ORIGINAL	LIMIT
Height (H)	139.9-140.1 (5.5079-5.5157)	—
Cylinder head flatness	—	0.1 (0.004)

## VALVES

Unit: mm (in)



Valve head diameter «D»	
Inlet	39.0-39.2 (1.535-1.543)
Exhaust	32.0-32.2 (1.260-1.268)
Valve length «L»	
Inlet	101.53-101.97 (3.9972-4.0146)*
Exhaust	101.38-101.82 (3.9913-4.0087)*
Stem diameter «d»	
Inlet	6.965-6.980 (0.2742-0.2748)
Exhaust	6.945-6.960 (0.2734-0.2740)
Valve face angle «α»	
Inlet	45° 15' - 45° 45'
Exhaust	
Dimension «T»	
Inlet	1.35-1.65 (0.0531-0.0650)
Exhaust	1.65-1.95 (0.0650-0.0768)
Limit «T»	
	0.5 (0.020)
Stem foot grinding limit	
	0.2 (0.008)
Valve clearance	
Inlet	0 (0)
Exhaust	

\* Model with E.G.R. (Exhaust gas recirculation)

## VALVE SPRING

Unit: mm (in)

Manufacturing height		42.25 (1.6631)*	43.2 (1.701)
Outer		36.57 (1.4398)*	38.2 (1.504)
Inner			
Spring length under load			
Outer	mm/N	25.7/437.69 (25.7/44.63)	26.7/437.4 (26.7/44.6)
Inner	(mm/kg) (in/lb)	(1.012/98.41)* 22.2/233.21 (22.2/23.78)	(1.051/98.3) 23.2/233.4 (23.2/23.8)
		(0.874/52.43)*	(0.913/52.5)
Perpendicularity			
Outer	mm (in)	1.9 (0.075)	
Inner		1.6 (0.063)	

\* Model with E.G.R.

## HYDRAULIC TAPPETS

Unit: mm (in)

Tappet outside diameter	34.959-34.975 (1.3763-1.3770)
Guide inside diameter	34.998-35.018 (1.3779-1.3787)
Clearance between tappet and guide	0.023-0.059 (0.0009-0.0023)

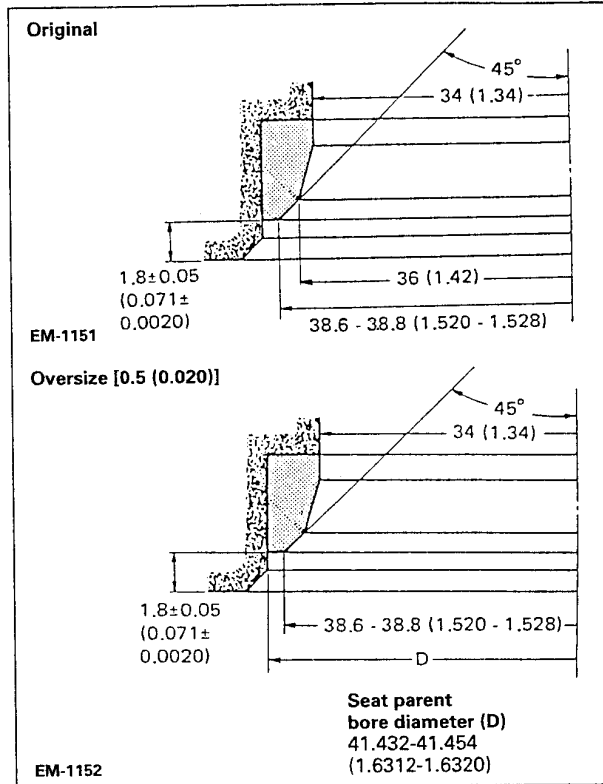
**VALVE GUIDE**

Unit: mm (in)

	ORIGINAL	SERVICE
<b>Valve guide outside diameter</b> Inlet Exhaust	11.023-11.034 (0.4340-0.4344)	11.223-11.234 (0.4418-0.4423)
<b>Valve guide inside diameter (Final size)</b> Inlet Exhaust	7.000-7.018 (0.2756-0.2763)	
<b>Valve guide bore in cylinder head</b> Inlet Exhaust	10.985-10.996 (0.4325-0.4329)	11.185-11.196 (0.4404-0.4408)
<b>Valve guide interference fit</b> Inlet Exhaust	0.037-0.049 (0.0015-0.0019)	
<b>MAXIMUM TOLERANCE</b>		
<b>Clearance between stem and guide</b> Inlet	0.020-0.050 (0.0008-0.0020)	0.1 (0.004)
Exhaust	0.040-0.070 (0.0016-0.0028)	
<b>Deflection limit</b>	0.2 (0.008)	

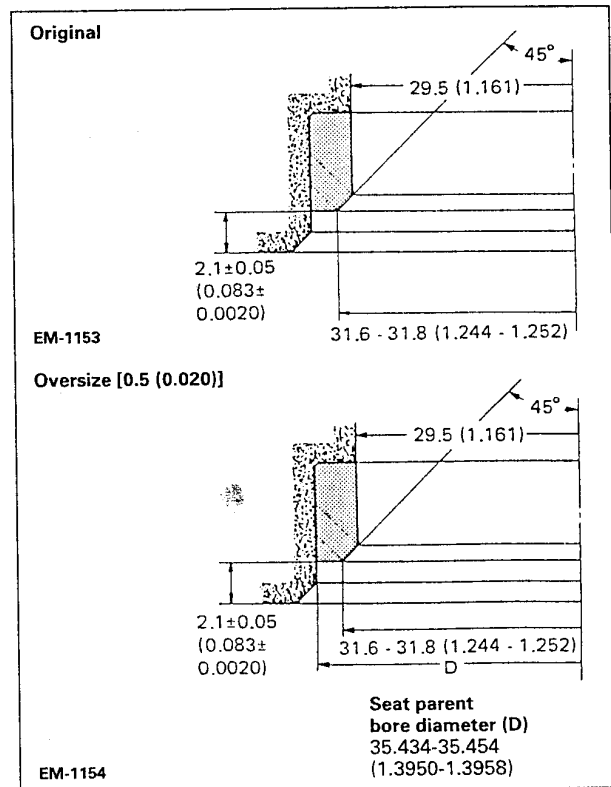
**INLET VALVE SEAT**

Unit: mm (in)



**EXHAUST VALVE SEAT**

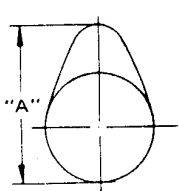
Unit: mm (in)



**CAMSHAFT AND CAMSHAFT JOURNALS**

Unit: mm (in)

	ORIGINAL	MAXIMUM TOLERANCE
Clearance between journal and bearing	0.045-0.086 (0.0018-0.0034)	0.1 (0.004)
Bearing inside diameter	30.000-30.021 (1.1811-1.1819)	—
Journal outside diameter	29.935-29.955 (1.1785-1.1793)	—
Camshaft runnout [T.I.R.*]	Less than 0.02 (0.008)	—
Camshaft end clearance	0.065-0.169 (0.0026-0.0067)	—

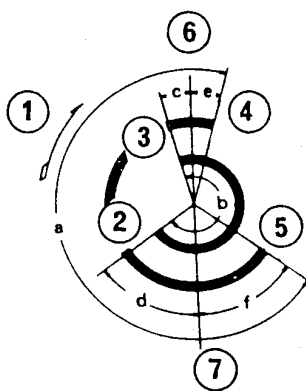
EM-179

Cam height «A» Inlet Exhaust	47.65-47.70 (1.8760-1.8779) 48.70-48.75 (1.9173-1.9193)** 49.15-49.20 (1.9350-1.9370)
Cam height wear limit	0.15 (0.0059)

\* Total indicator reading  
\*\* RD28 Engine

**Valve setting**

1. Direction of rotation
2. Inlet valve closes
3. Inlet valve opens
4. Exhaust valve closes
5. Exhaust valve opens
6. T.D.C.
7. B.D.C.



EM-516

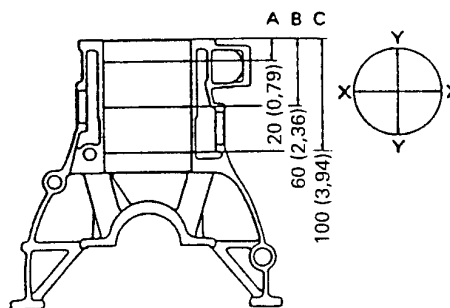
Unit: degree

a	b	c	d	e	f
248	224 (232)*	14	30 (38)*	8	60

\* RD28 Engine

**ENGINE BLOCK**

Unit: mm (in)



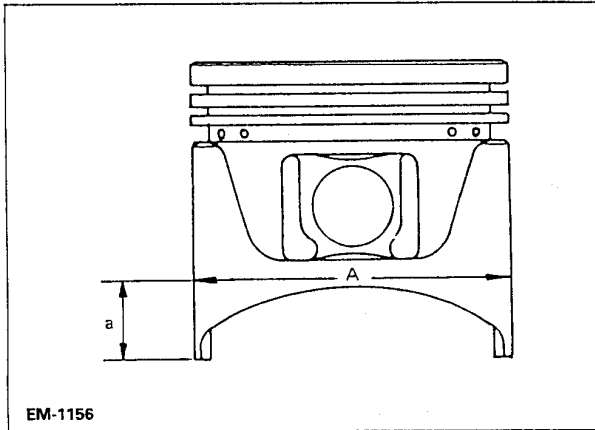
EM-1112

Surface flatness Original Limit	Less than 0.03 (0.0012) 0.10 (0.0039)
Cylinder bore diameter Original Grade n.° 1 Grade n.° 2 Grade n.° 3 Grade n.° 4 Grade n.° 5	85.000-85.010 (3.3465-3.3468) 85.010-85.020 (3.3468-3.3472) 85.020-85.030 (3.3472-3.3476) 85.030-85.040 (3.3476-3.3480) 85.040-85.050 (3.3480-3.3484)
Service limit	0.20 (0.0079)
Ovalization (X-Y)	Less than 0.015 (0.0006)
Taper (A-B-C)	Less than 0.010 (0.0004)
Main bearing inside diameter Grade n.° 0 Grade n.° 1 Grade n.° 2	58.645-58.654 (2.3089-2.3092) 58.654-58.663 (2.3092-2.3096) 58.663-58.672 (2.3096-2.3099)
Bore difference between cylinders	Less than 0.05 (0.0020)

PISTON, PISTON RING AND GUDGEON PIN

Pistons

Unit: mm (in)



EM-1156

<b>Skirt diameter «A»</b>	
Original	
Grade n.° 1	84.965-84.975 (3.3451-3.3455)*
Grade n.° 2	84.975-84.985 (3.3455-3.3459)
Grade n.° 3	84.985-84.995 (3.3459-3.3463)
Grade n.° 4	84.995-85.005 (3.3463-3.3466)
Grade n.° 5	85.005-85.015 (3.3466-3.3470)
Grade n.° 1	84.960-84.970 (3.3449-3.3453)
Grade n.° 2	84.970-84.980 (3.3453-3.3457)
Grade n.° 3	84.980-84.990 (3.3457-3.3461)
Grade n.° 4	84.990-85.000 (3.3461-3.3465)
Grade n.° 5	85.000-85.010 (3.3465-3.3468)
Oversize (service)	
0.02 (0.0008) (mark: «STD»)	84.985-85.035 (3.3459-3.3478)* 84.980-85.030 (3.3457-3.3476)
0.50 (0.0197) (mark: «50»)	85.465-85.515 (3.3648-3.3667)* 85.460-85.510 (3.3646-3.3665)
1.00 (0.0394) (mark: «100»)	85.965-85.015 (3.3844-3.3864)* 85.960-86.010 (3.3842-3.3862)
<b>Height «a»</b>	14.5 (0.571)
<b>Gudgeon pin bore in piston</b>	24.991-24.999 (0.9839-0.9842)* 26.991-26.999 (1.0626-1.0630)
<b>Clearance between piston and cylinder wall</b>	0.025-0.045 (0.0010-0.0018)* 0.030-0.050 (0.0012-0.0020)

\* RD28 Engine

Values measured at an ambient temperature of 20 °C (68 °F)

PISTON RINGS

Unit: mm (in)

	ORIGINAL	LIMIT
<b>Side clearance Top ring</b>	0.060-0.093 (0.0024-0.0037)	0.1 (0.004)
<b>Second ring</b>	0.040-0.073 (0.0016-0.0029)	
<b>Gap D = 85.000 (3.3465) Top ring</b>	0.12-0.30 (0.0047-0.0118)	0.4 (0.016)
<b>Second ring</b>	0.20-0.35 (0.0079-0.0138)* 0.38-0.53 (0.0150-0.0209)	

\* RD28 Engine

GUDGEON PIN

Unit: mm (in)

<b>Gudgeon pin outside diameter</b>	24.994-25.000 (0.9840-0.9843)* 26.994-27.000 (1.0628-1.0630)
<b>Interference fit between gudgeon pin and piston</b>	-0.004 and 0 (-002-0)
<b>Clearance between gudgeon pin and connecting rod bush</b>	0.025-0.044 (0.0010-0.0017)

\* RD28 Engine

Values measured at an ambient temperature of 20 °C (68 °F)

CONNECTING ROD

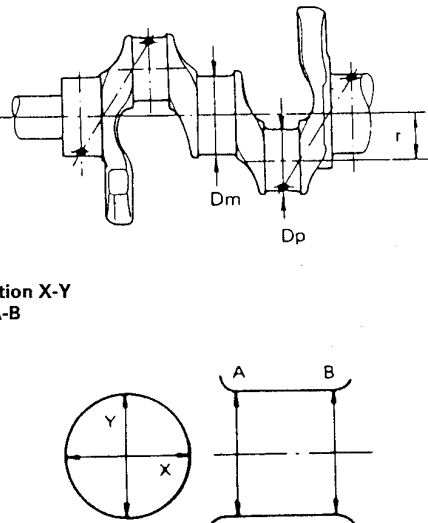
Unit: mm (in)

<b>Distance between centers</b>	140.0 (5.512)
<b>Parallelism and twist [per 100 (3.94)] Limit</b>	0.025 (0.0010)
<b>Gudgeon pin bush bore</b>	25.025-25.038 (0.9852-0.9859)* 27.025-27.038 (1.0640-1.0645)
<b>Connecting rod big-end bore</b>	
Grade n.° 0	53.000-53.007 (2.0866-2.0869)
Grade n.° 1	53.007-53.013 (2.0869-2.0871)
<b>Side clearance</b>	
Original	0.20-0.30 (0.0079-0.0118)
Limit	0.40 (0.0157)

\* RD28 Engine

## CRANKSHAFT

Unit: mm (in)

Journal diameter «Dm» Grade n.º 0 Grade n.º 1 Grade n.º 2	54.967-54.975 (2.1641-2.1644) 54.959-54.967 (2.1637-2.1641) 54.951-54.959 (2.1634-2.1637)
Crankpin diameter «Dp» Grade n.º 0 Grade n.º 1	49.968-49.974 (1.9672-1.9675) 49.961-49.968 (1.9670-1.9672)
Distance between centers «r»	41.47-41.53 (1.6327-1.6350)
Ovalization X-Y Original	Less than 0.005 (0.0002)
Taper (A-B) Original	Less than 0.005 (0.0002)
Runout [T.I.R.]* Original	Less than 0.10 (0.0039)
End float Original Limit	0.05-0.18 (0.0020-0.0071) 0.30 (0.0118)
 <p>Ovalization X-Y Taper A-B</p> <p>EM-1157</p>	

\* Total indicator reading

## MAIN BEARING

Original

Unit: mm (in)

GRADE N.º	THICKNESS	COLOUR IDENTIFICATION	
		RD28T	RD28
0	1.813-1.817 (0.0714-0.0715)	Black	—
1	1.817-1.821 (0.0715-0.0717)	Brown	—
2	1.821-1.825 (0.0717-0.0719)	—	Black
3	1.825-1.829 (0.0719-0.0720)	Yellow	Brown
4	1.829-1.833 (0.0720-0.0722)	Blue	Green

Undersize (service)

Unit: mm (in)

	THICKNESS	JOURNAL DIAMETER «DM»
0.25 (0.0098)	1.946-1.950 (0.766-0.768) 1.952-1.960* (0.0769-0.0772)	Grind until the clearance at the journals corresponds to the specified value.

\* N.º 4 bearing

## BIG-END BEARING

Original

Unit: mm (in)

GRADE N.º	THICKNESS	COLOUR IDENTIFICATION	
		RD28T	RD28
0	1.492-1.496 (0.0587-0.0589)	Black	—
1	1.496-1.500 (0.0589-0.0591)	Yellow	Brown
2	1.500-1.504 (0.0591-0.0592)	Blue	Green

Undersize (service)

Unit: mm (in)

	THICKNESS	CRANKPIN DIAMETER «Dp»
0.08 (0.0031)	1.536-1.540 (0.0605-0.0606)	Grind until the crankpin clearance corresponds to the specified value.
0.12 (0.0047)	1.556-1.560 (0.0613-0.0614)	
0.25 (0.0098)	1.621-1.625 (0.0638-0.0640)	

## BEARING CLEARANCE

Unit: mm (in)

Crankshaft bearing clearance Original Limit	0.036-0.063 (0.0014-0.0025) 0.12 (0.0047)
Connecting rod bearing clearance Original Limit	0.031-0.055 (0.0012-0.0022) 0.11 (0.0043)

## MISCELLANEOUS COMPONENTS

Unit: mm (in)

Flywheel Flywheel runnout*	0.1 (0.004)
-------------------------------	-------------

\* Total indicator reading

## TURBOCHARGER

Bypass valve regulator pressure and stroke	0.38 mm (0.0150 in)/85.3-90.6 kPa (853-906 mbar), (640-680 mmHg) (25.20-26.77 inHg)
End play	0.0130-0.0965 mm (0.0005-0.0038 in)

## TIGHTENING TORQUES

## INTERNAL PARTS

COMPONENT	Nm	kgm	ft-lb
Nuts, connecting rod bearing cap	See Page 41		
Bolts, cylinder head	See Page 25		
Bolts, flywheel	137-157	14.0-16.0	101-116
Bolts, main bearing cap	69-78	7.0-8.0	51-58
Bolts, oil pan	8-12	0.8-1.2	5.8-8.7
Nuts, oil pan	10-14	1.0-1.4	7-10
Drain plug, oil pan	29-39	3.0-4.0	22-29
Bolts, oil filter	16-21	1.6-2.1	12-15
Bolts, rocker cover	4-8	0.4-0.8	2.9-5.8

## ENGINE EXTERNAL PARTS

COMPONENT	Nm	kgm	ft-lb
Alternator bracket	43-58	4.4-5.9	32-43
Bolt, alternator to tensioner	16-21	1.6-2.1	12-15
Alternator/bracket	43-58	4.4-5.9	32-43
Bolts, crankshaft pulley	142-152	14.5-15.5	105-112
Bolts, front cover	3-5	0.3-0.5	2.2-3.6
Bolts, rear cover	7-8	0.7-0.8	5.1-5.8
Bolts, inlet manifold	16-21	1.6-2.1	12-15
Incandescent plugs	15-20	1.5-2.0	11-14
Nuts, incandescent plugs plate	0.8-1.5	0.08-0.15	0.6-1.1
Fuel injection pump bracket	22-29	2.2-3.0	16-22
Nut, fuel injection pump pulley	54-64	5.5-6.5	40-47
Nuts, fuel injection pump	16-21	1.6-2.1	12-15
Nuts, injection pipe	22-25	2.2-2.5	16-18
Nuts and bolts, manifold (M10)	25-29	2.6-3.0	19-22
(M8)	16-20	1.6-2.0	12-14
Fuel injection nozzle	59-69	6.0-7.0	43-51
Bolts, oil cooler bracket	16-21	1.6-2.1	12-15
Bolts, oil pump	10-12	1.0-1.2	7-9
Nuts, camshaft bearing cap	18-22	1.8-2.2	13-16
Bolt, power steering pump to bracket	16-21	1.6-2.1	12-15
Nuts, leak-off pipe	39-49	4.0-5.0	29-36
Nuts, tensioner pulley	32-40	3.3-4.1	24-30
Bolts, camshaft pulley	123-132	12.5-13.5	90-98
Bolts, idler pulley	32-40	3.3-4.1	24-30
Thermostat housing	16-21	1.6-2.1	12-15
Bolts, water outlet pipe	16-21	1.6-2.1	12-15
Bolts, water pump	16-21	1.6-2.1	12-15
Air conditioning compressor/bracket	43-58	4.4-5.9	32-43

## TURBOCHARGER

COMPONENT	Nm	kgm	ft-lb
Adapter, water inlet and outlet pipe	17-21	1.7-2.1	12-15
Adapter, oil inlet pipe	17-21	1.7-2.1	12-15
Bolt, water outlet pipe	13-16	1.3-1.6	9-12
Nut, turbocharger to exhaust manifold	23-29	2.3-3	17-22
Bolt and nut, exhaust elbow to turbocharger	22-29	2.2-3	16-22
Bolt, protection plate	9-11	0.9-1.1	6.5-8



## TROUBLE SHOOTING CHART

## Situation 1: Lack of engine power.

## Probable cause

Air leak at the air compressor casing connection with the suction hose, or the intake pipe, or at the connection between the intake pipe and the inlet manifold.

Exhaust gas leak at the connection between the turbine casing and the exhaust manifold, the connection pipe or the exhaust pipe.

The bypass valve is open.

Shaft or bearing seized or worn.

Shaft broken

Sludge behind the turbine impeller.

Turbine impeller broken.

## Remedy

Repair the connection.

Repair the connection or replace the gasket.

Replace the turbocharger assembly.

## Situation 2: Excessive engine power

## Probable cause

Rubber hose disconnected or cracked.

Bypass valve closed.

Replace the turbocharger assembly.

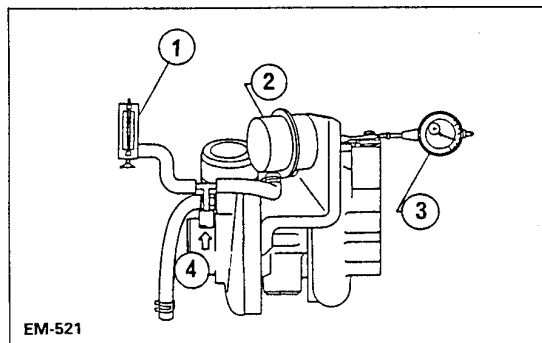
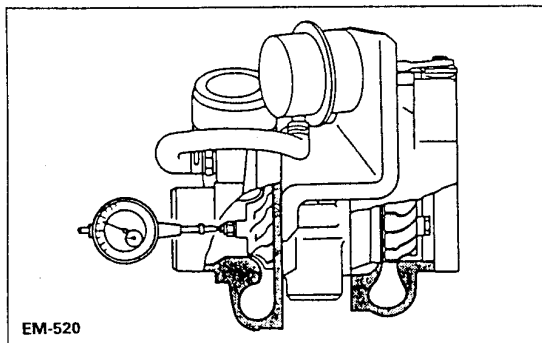
## Remedy

Repair or replace the hose.

Regulator diaphragm broken.

**Situation 3: Excessive oil consumption or blue exhaust smoke.**

Probable cause	Remedy
Oil leak at lubrication pipe connection.	Repair the connection.
Oil leak at turbine oil seal.	Replace turbocharger assembly.
Oil leak at air compressor oil seal.	
Shaft or bearing worn.	



1. Mercury pressure gauge
2. Bypass valve regulator
3. Dial indicator
4. Compression

1. Inspect the exhaust gas and compressor turbine, in accordance with the following instructions:

- Visually check for cracks, obstructions, deformations or other defects.
- Rotate the turbines to check that they move freely without abnormal noise or rubbing.
- Measure the end float.

End float:  
0.0130-0.0965 mm (0.0005-0.0038 in)

2. Check the operation of the bypass valve regulator.

- Move the bypass valve to check that it is not seized or scored.
- Measure the play at the end of the bypass valve regulator stem.

Never apply a pressure of more than 98 kPa (0.98 bar) (1.0 kg/cm<sup>2</sup>) (14 lb/in<sup>2</sup>) at the regulator diaphragm.

Bypass valve regulator stroke and pressure:  
0.38 mm (0.0150 in) (85.3-90.6 kPa)  
(853-906 mbar) (640-680 mmHg)  
(25.20-26.77 inHg)

When faults appear in the turbocharger, always replace the complete assembly.

# ENGINE LUBRICATION AND COOLING SYSTEMS

## SECTION **LC**

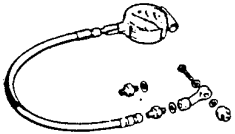
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**LC**



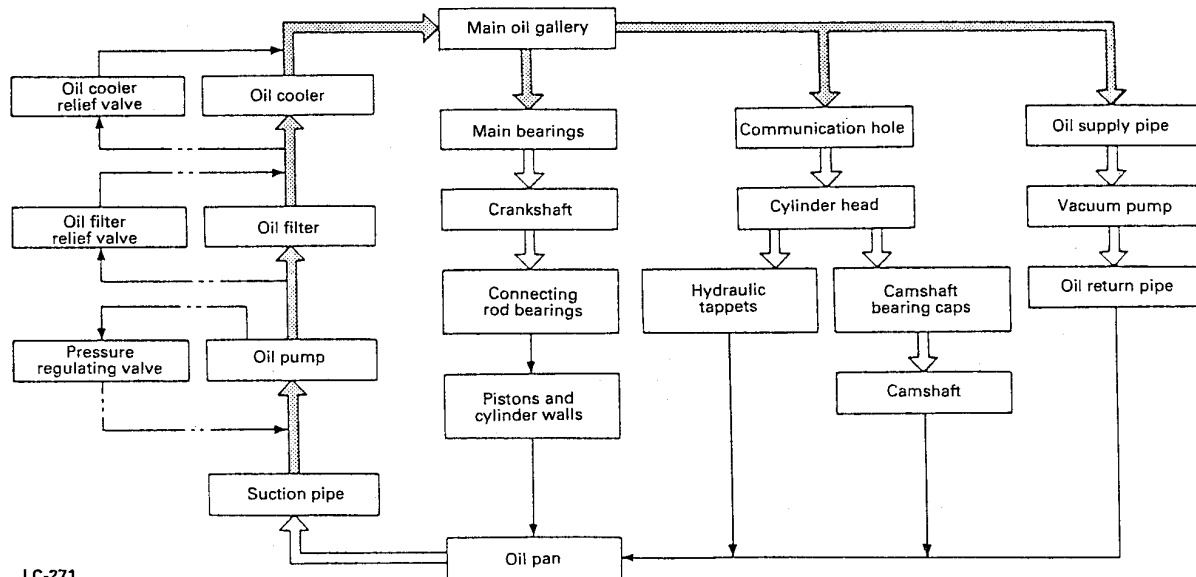
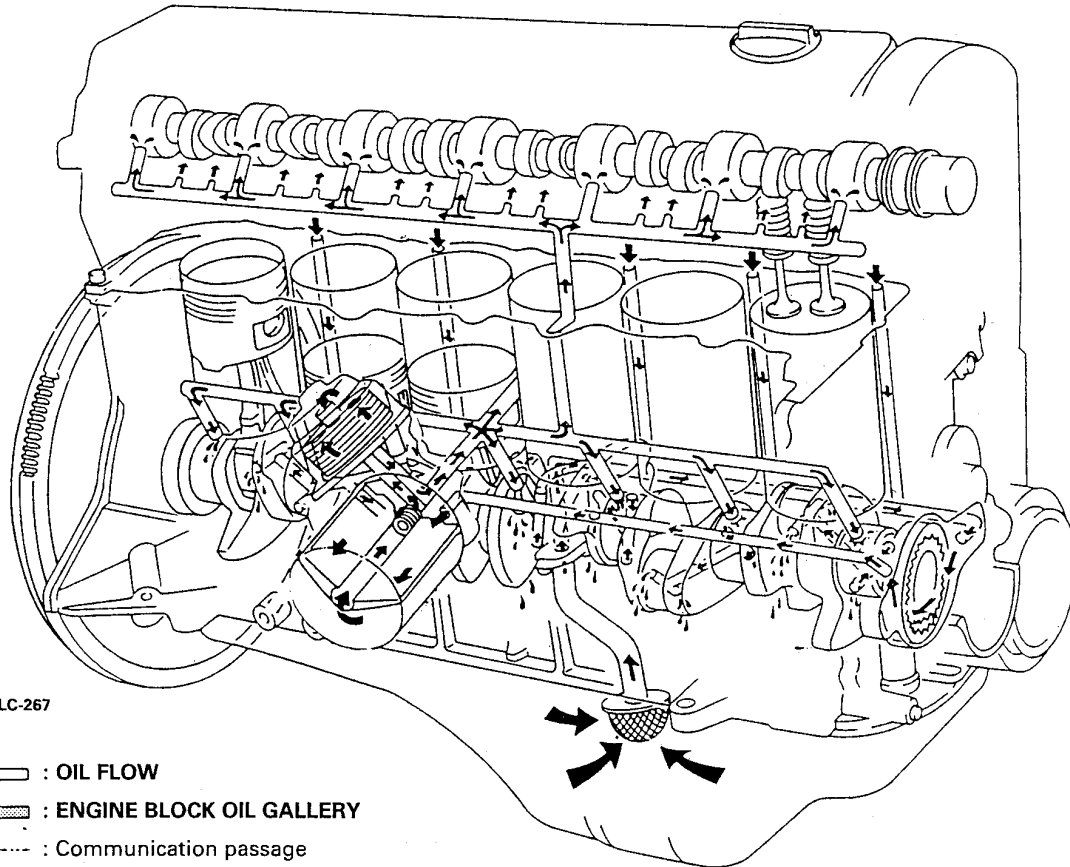
### SPECIAL SERVICE TOOLS

TOOL N.º	DENOMINATION	APPLICATION	
		RD28	RD28T
ST-022-1S000	Oil pressure, pressure gauge. (Low pressure)  	X	X

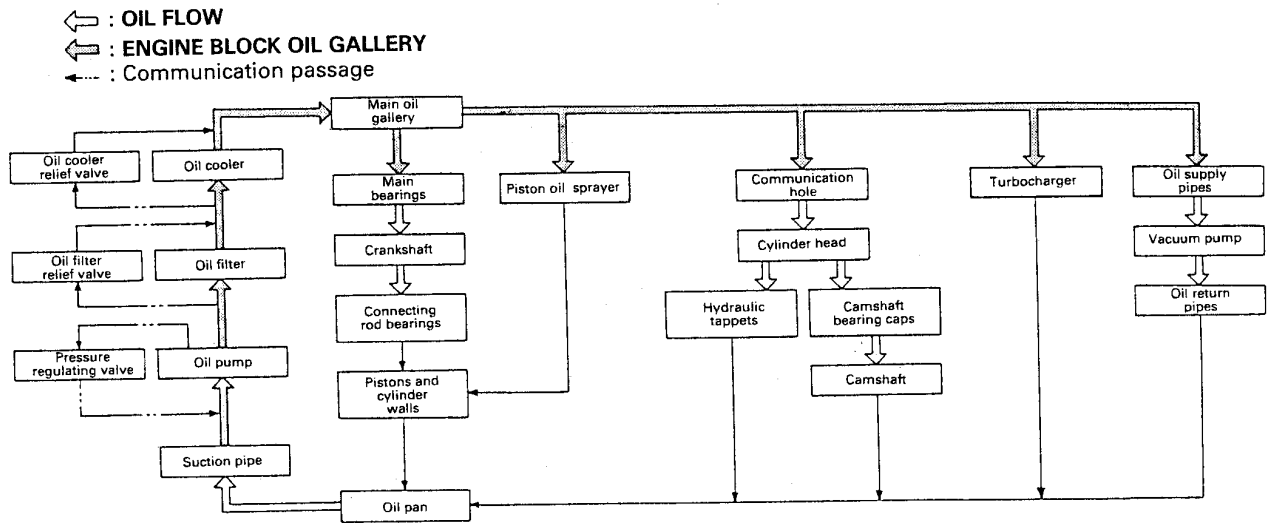
# LUBRICATION SYSTEM

## LUBRICATION DIAGRAM

### RD28 ENGINE

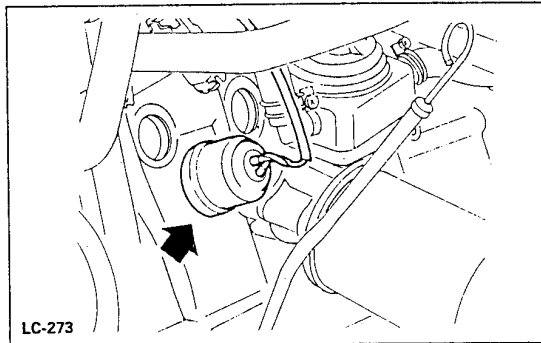


RD28T ENGINE



LC-272

CHECKING THE OIL PRESSURE

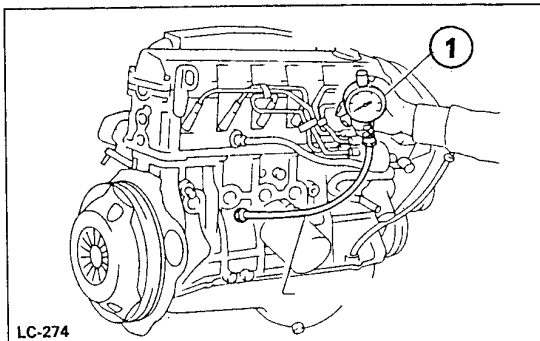


LC-273

Take care not to burn yourself, because the oil and the engine may still be hot.

1. Start the engine and run it until reaching its operating temperature.
2. Stop the engine and remove the pressure transmitter.
3. Install a liquid pressure gauge (1) ST-022-1S000, with a range of 0-1000 kPa (0-9.81 bar) (0-10 kg/cm<sup>2</sup>) (0-143 lb/in<sup>2</sup>).
4. Start the engine and check the oil pressure.

**NOTE:** The oil must be of the specified type, at the working temperature and must not be at the limit of its use.



LC-274

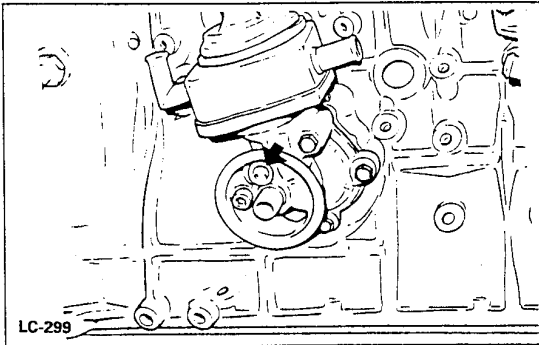
1. ST-022-1S000

ENGINE SPEED	APPROXIMATE PRESSURE kPa (bar) (kg/cm <sup>2</sup> ) (lb/in <sup>2</sup> )
RD28 Engine At idling speed At 3,200 rpm	Above 78 (0.78) (0.8) (11) 314-432 (3.14-4.32) (3.2-4.4) (46-63)
RD28T Engine At idling speed At 3,000 rpm	Above 78 (0.78) (0.8) (11) 318.7-424.6 (3.19-4.25) (3.25-4.33) (46.2-61.6)

If the differences are great, check for oil leaks at the pipes or at the oil pump.

5. Apply sealant to the pressure transmitter and install it.

Pressure transmitter to engine block:  
 10-16 Nm (1-1.6 kgm) (7-12 ft-lb)

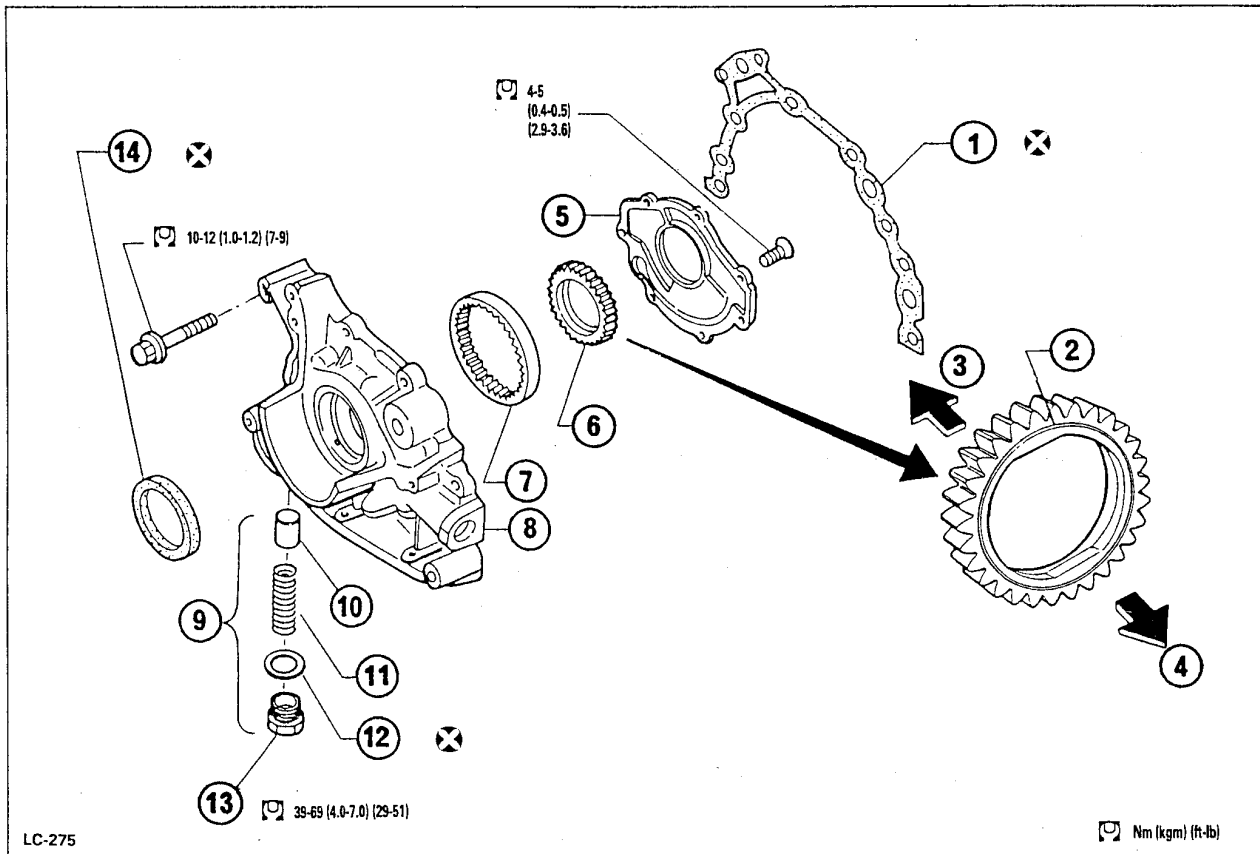


### CHECKING THE OIL PRESSURE RELIEF VALVE

Push the ball to see if the valve slides correctly, and check for cracks or breaks. If it is necessary to replace the valve, withdraw it by levering with a screwdriver.

Install the new valve by tapping it gently.

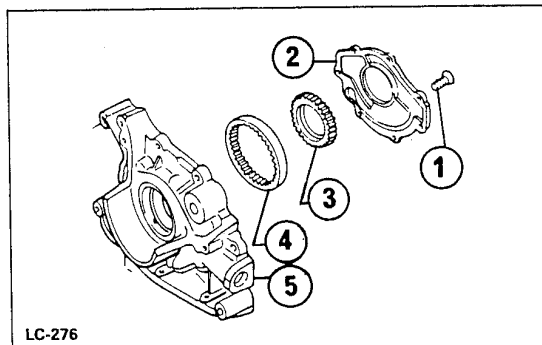
### OIL PUMP



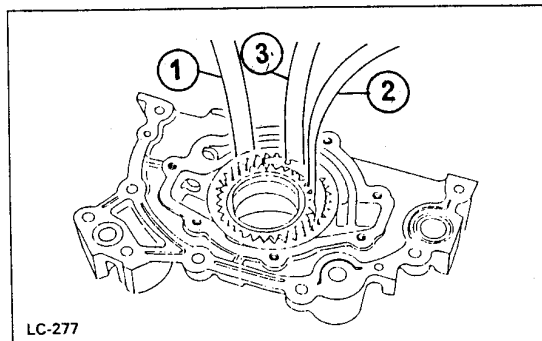
#### COMPONENTS

- |               |                              |
|---------------|------------------------------|
| 1. Gasket     | 8. Pump casing               |
| 2. Groove     | 9. Pressure regulating valve |
| 3. Pump side  | 10. Piston                   |
| 4. Cover side | 11. Spring                   |
| 5. Pump cover | 12. Washer                   |
| 6. Inner gear | 13. Plug                     |
| 7. Outer gear | 14. Front oil seal           |

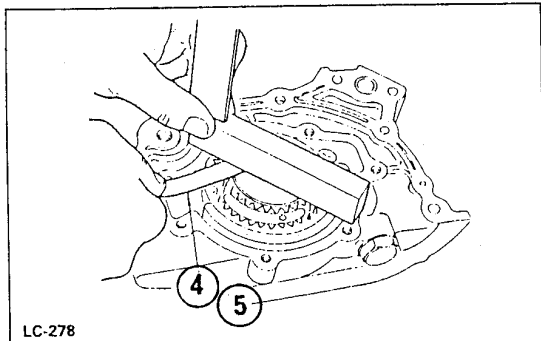




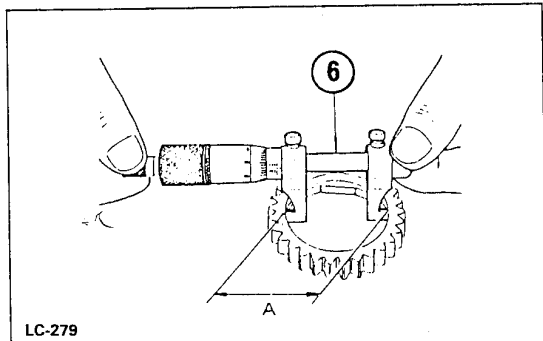
LC-276



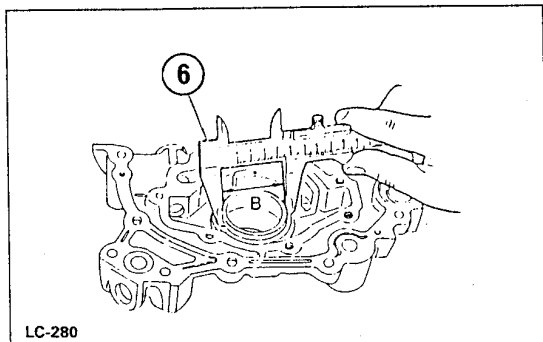
LC-277



LC-278



LC-279



LC-280

**REMOVAL**

1. For the removal, see Section EM.

**DISASSEMBLY**

1. Loosen and remove the bolts (1), cover (2), inner gear (3) and outer gear (4) from the pump casing (5).

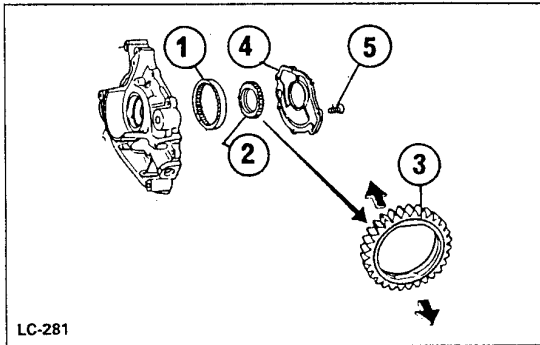
**NOTE:** If the specified limits are exceeded, replace the gear set or the oil pump assembly.

**INSPECTION**

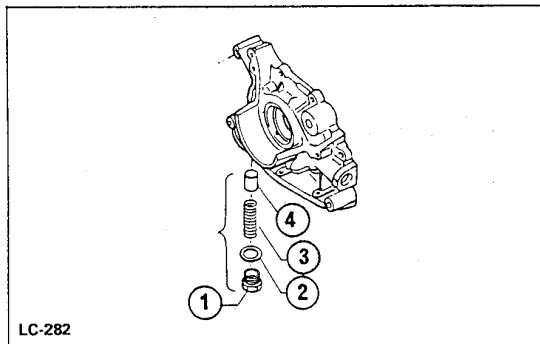
1. Using feeler gauges, measure the following clearances:

Unit: mm (in)

Clearance between casing and outer gear ①	0.11-0.20 (0.0043-0.0079)
Clearance between inner gear and half-shoulder ②	0.216-0.326 (0.0085-0.0128)
Clearance between outer gear and half-shoulder ③	0.21-0.32 (0.0083-0.0126)
Clearance between housing and inner gear ④	0.05-0.09 (0.0020-0.0035)
Clearance between housing and outer gear ⑤	0.05-0.11 (0.0020-0.0043)
Clearance between inner gear and projecting part of the housing ⑥ = A-B	0.106-0.152 (0.0042-0.0060)



LC-281



LC-282

**REASSEMBLY**

1. Fit the outer gear (1) and inner gear (2).

**NOTE:** Fit the inner gear as shown in the figure, with the face of the groove (3) towards the cover (4).

2. Lubricate the gears abundantly with oil.
3. Fit the cover (4) and tighten the bolts (5) to the specified torque.

Retaining bolts, cover to pump casing:  
4-5 Nm (0.4-0.5 kgm) (2.9-3.6 ft-lb)

**PRESSURE REGULATING VALVE**

**DISASSEMBLY**

1. Remove the plug (1), washer (2), spring (3) and piston (4).

**INSPECTION**

1. Visually inspect the components for signs of wear or damage.
2. Check the sliding surface of the pressure valve piston and spring.
3. Lubricate the valve with engine oil and check that it descends in the orifice under its own weight.

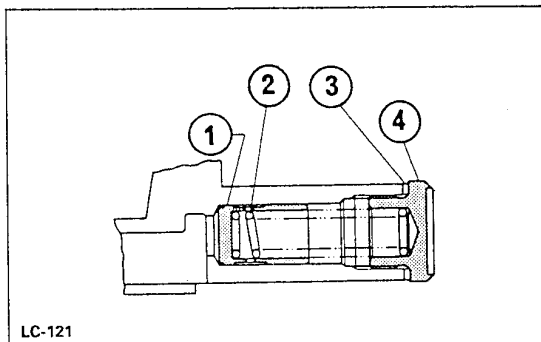
**REASSEMBLY**

1. Proceed in reverse order to disassembly and taking the following points into account:

- Lubricate the piston (1) with oil.
- Place the spring (2) correctly in the piston housing.
- Fit the washer (3) and plug (4) in place and tighten the plug to the specified torque.

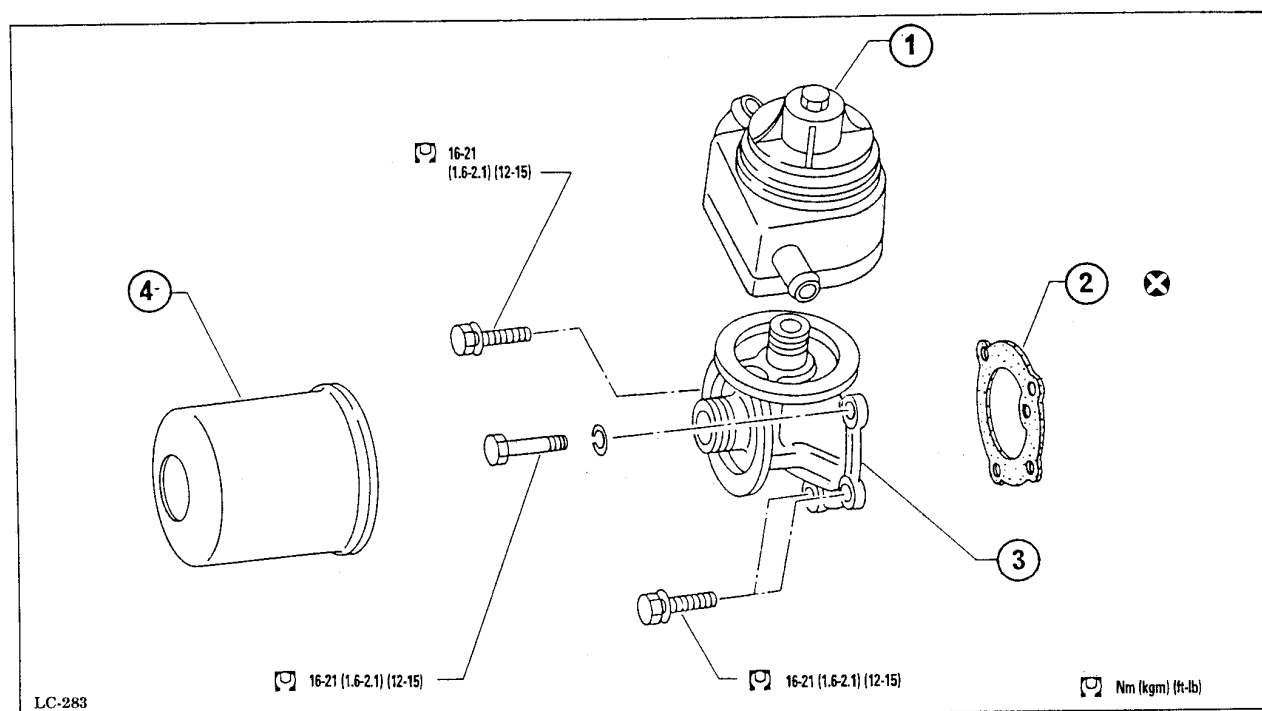
Pressure regulating valve plug:  
39-69 Nm (4-7 kgm) (29-51 ft-lb)

**NOTE:** If damaged, the regulating valve must be replaced.



LC-121

## OIL COOLER AND FILTER



## COMPONENTS

1. Oil cooler
2. Head gasket
3. Head
4. Oil filter

## REMOVAL

1. See Section EM.

## DISASSEMBLY

1. Do not disassemble the oil cooler. In the event of incorrect operation, replace the complete assembly.

## INSPECTION

Check the oil cooler element and its support for cracks.

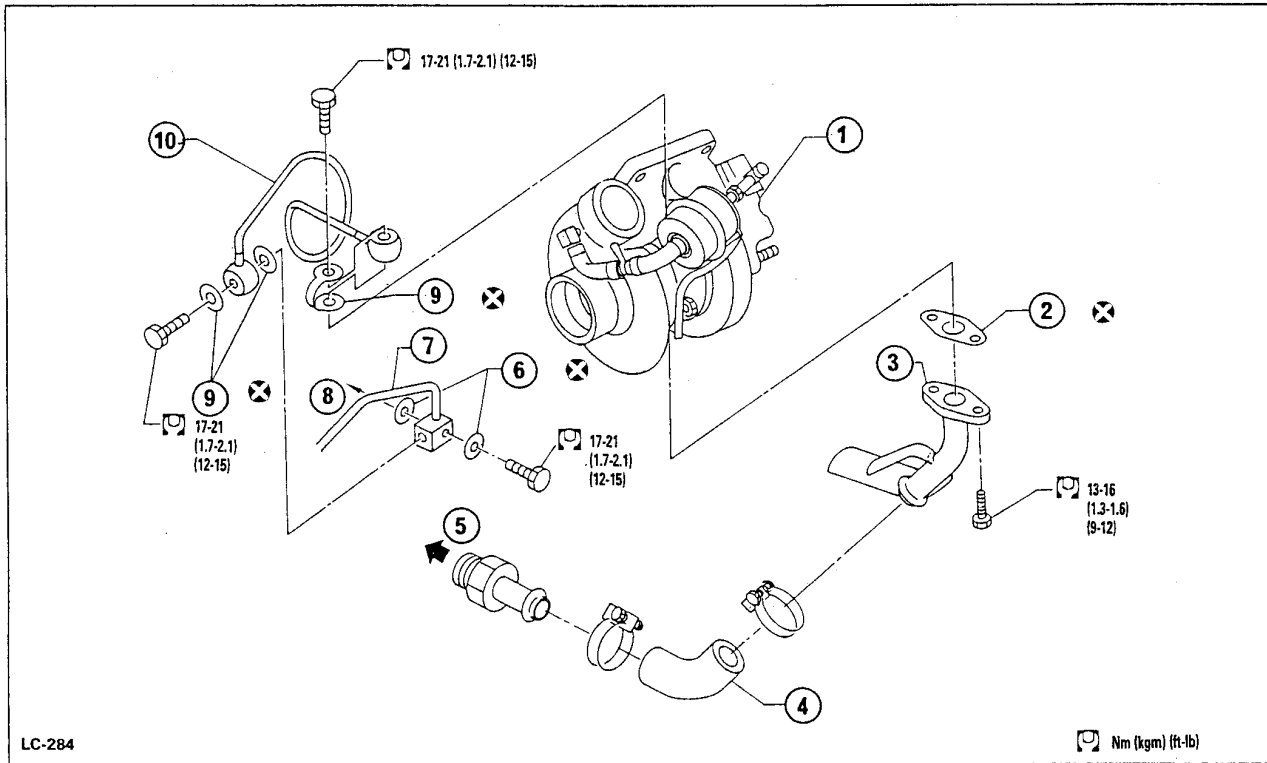
## REPLACEMENT

1. See Section EM.
- After replacement, run the engine for a few minutes to check for leaks.

## OIL FILTER

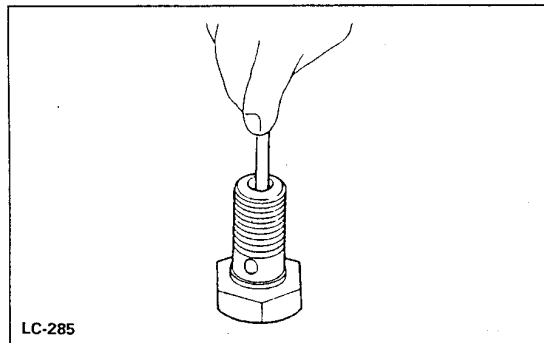
To remove and replace the oil filter, see Section MA of this Manual.

**TURBOCHARGER LUBRICATION PIPES (RD28T ENGINE)**



**COMPONENTS**

- |                    |                    |
|--------------------|--------------------|
| 1. Turbocharger    | 6. Sealing gaskets |
| 2. Gasket          | 7. Oil supply pipe |
| 3. Oil outlet pipe | 8. To engine block |
| 4. Oil return hose | 9. Sealing gasket  |
| 5. To engine block | 10. Oil inlet pipe |



**NOTES:**

- During the replacement, make sure not to bend the turbocharger oil supply and outlet pipes.
- After replacement, run the engine for a few minutes at idling speed and check for leaks.

**PISTON SPRAYERS**

**REMOVAL**

1. Remove the adapter, piston sprayer and washer from the engine block.

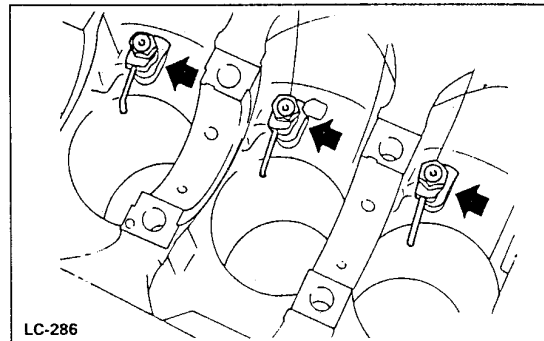
**INSPECTION**

1. Press on the inside of the adapter and check that the ball opens the inlet orifice.
2. Check that the ball slides smoothly and that it returns due to the force of its own spring.

**REPLACEMENT**

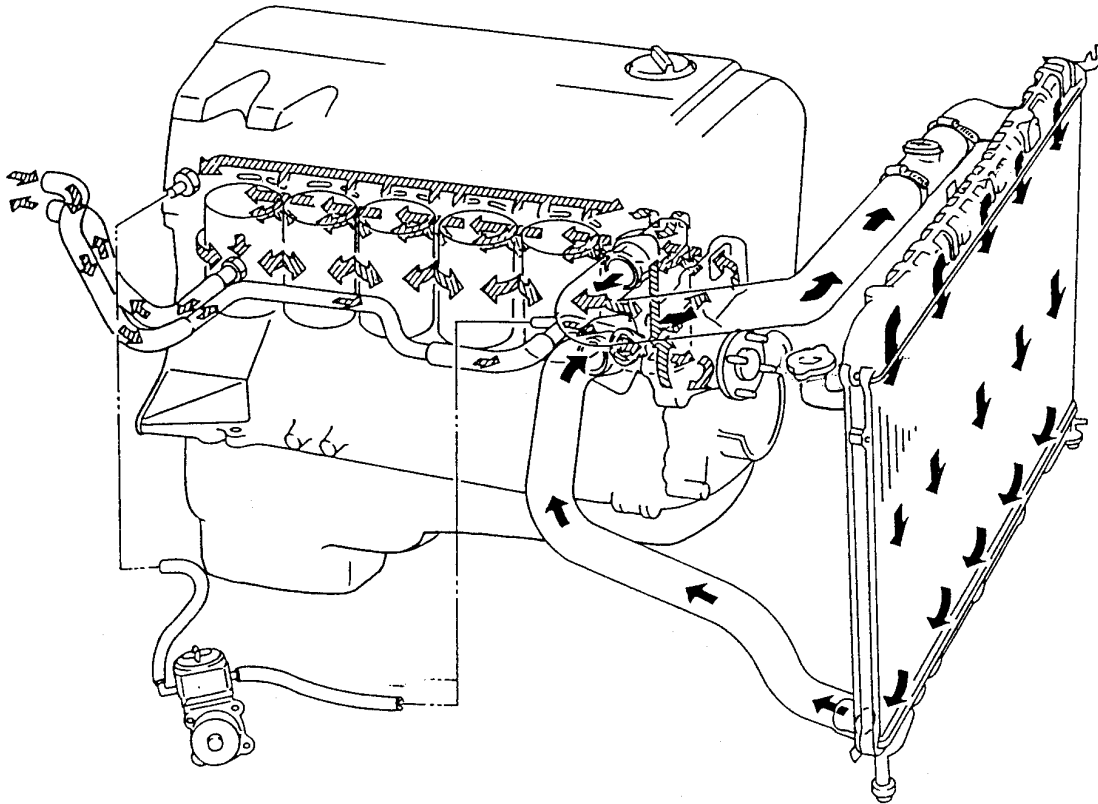
1. When installing the piston sprayers, align them as shown in the figure.

☞ Adapter to engine block:  
30-40 Nm (3.1-4.1 kgm) (22-30 ft-lb)



# COOLING SYSTEM

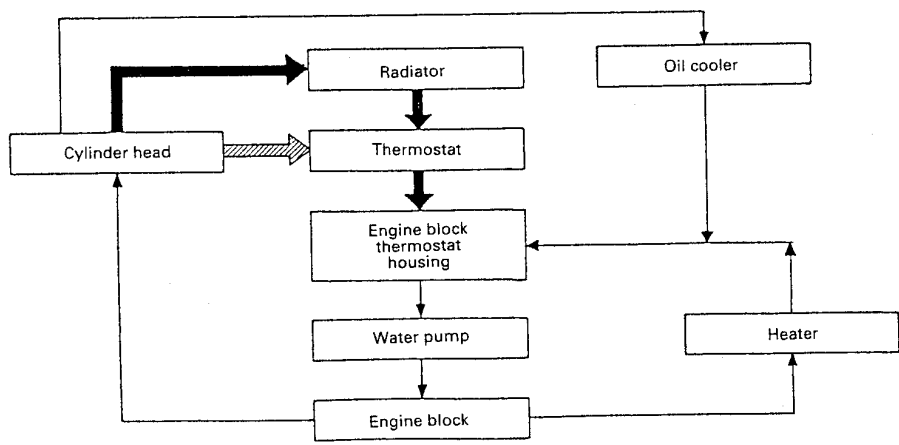
## COOLING CIRCUIT



LC-287



## RD28 ENGINE

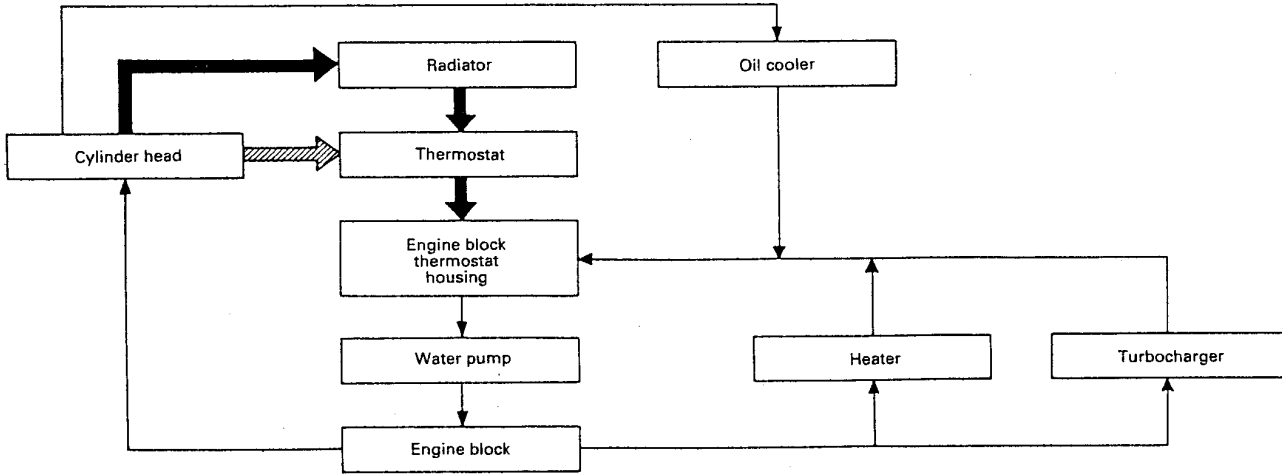
← : THERMOSTAT OPEN  
↙ : THERMOSTAT CLOSED



LC-288

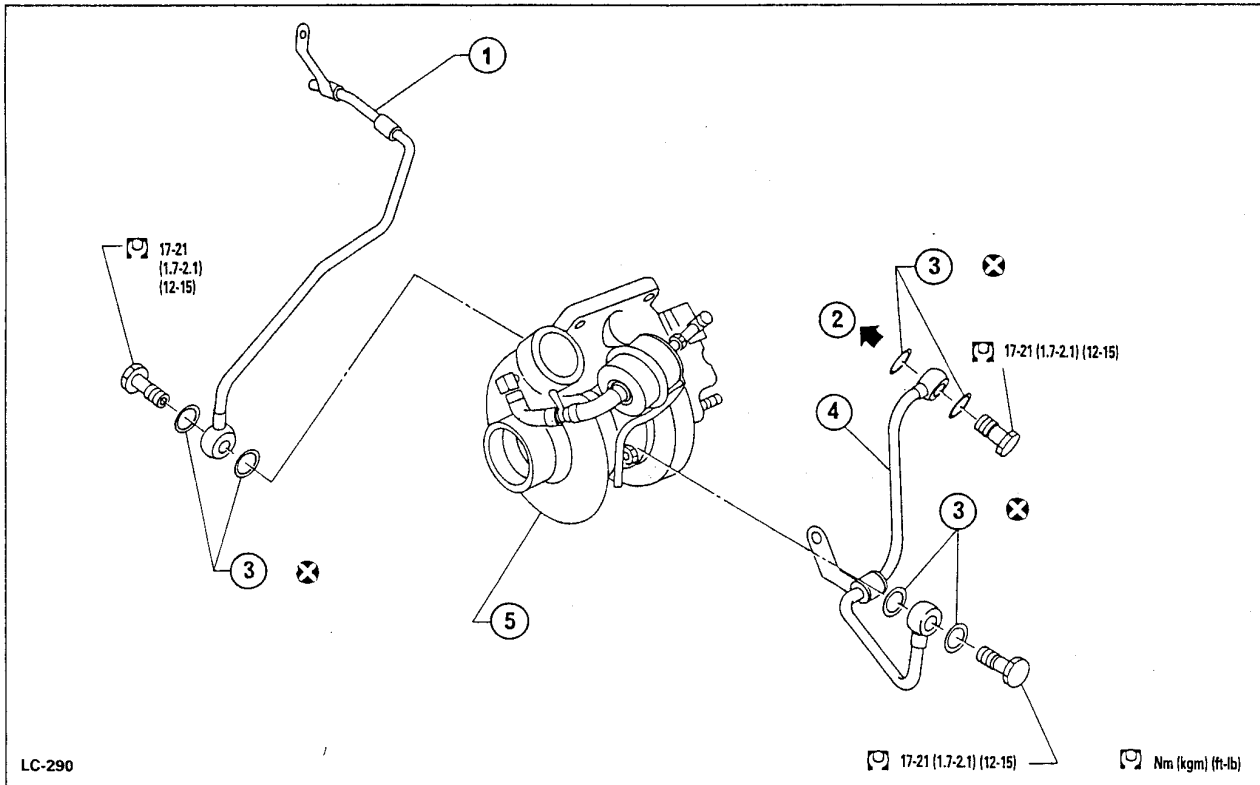
RD28T ENGINE

 : THERMOSTAT OPEN  
 : THERMOSTAT CLOSED



LC-289

TURBOCHARGER COOLING PIPES



LC-290

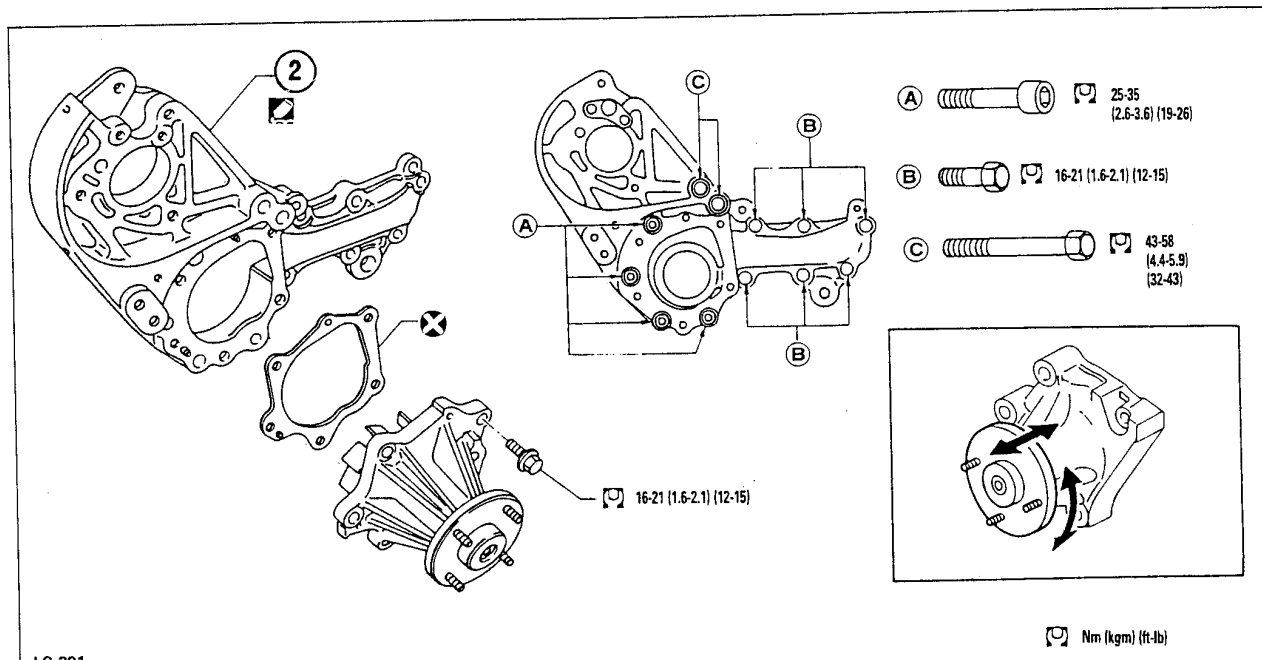
17-21 (1.7-2.1) (12-15)

Nm (kgm) (ft-lb)

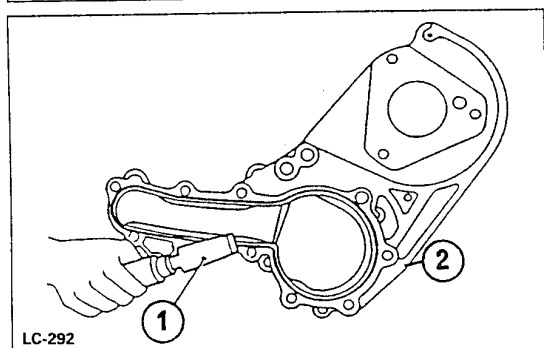
COMPONENTS

- |                      |                      |
|----------------------|----------------------|
| 1. Water outlet pipe | 4. Water outlet pipe |
| 2. To engine block   | 5. Turbocharger      |
| 3. Sealing washers   |                      |

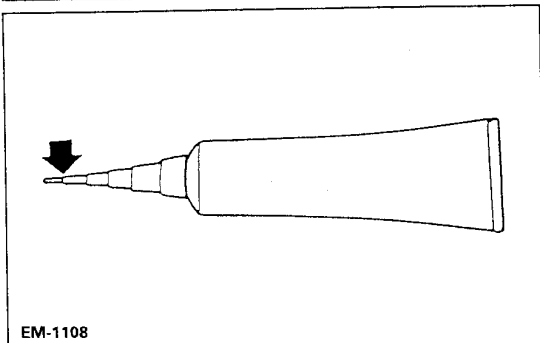
# WATER PUMP



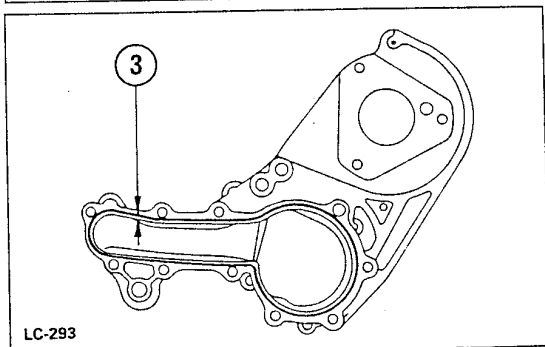
LC-291



LC-292



EM-1108



LC-293

## INSPECTION

Check for excessive end play and that the pump operates smoothly.

## REPLACEMENT

- Using a scraper (1), remove the sealant from the pump housing mating face (2).

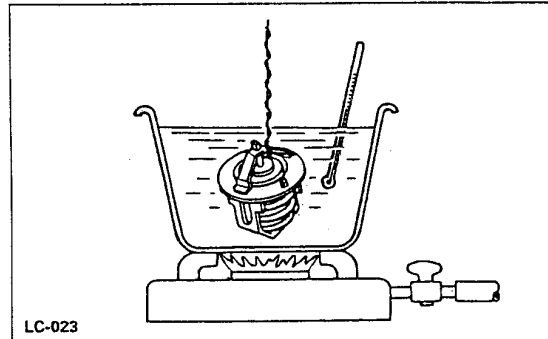
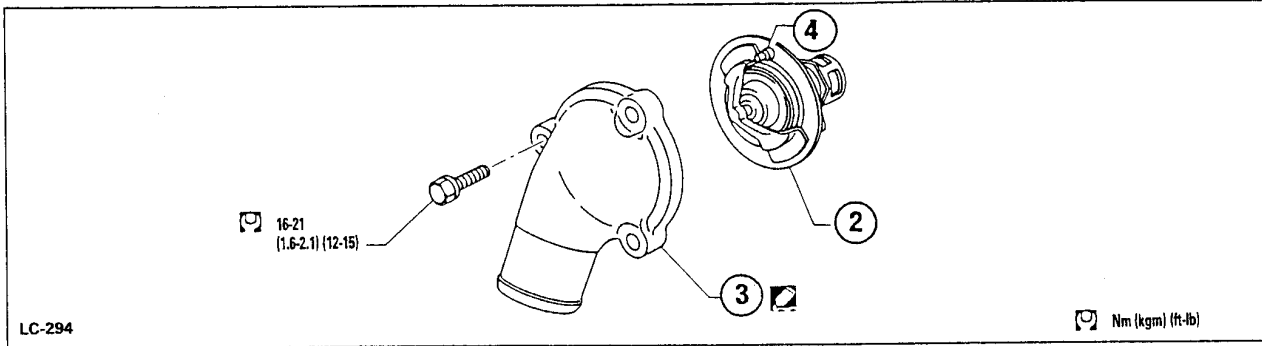
Check that there is no sealant in the grooves.

- Remove the sealant from the engine block mating face.
- Using petrol (lead free), remove all traces of gasket.
- Cut off the end of the sealant tube (KP-510-00150 or similar), as shown in the figure.

← Cut here

- Apply a continuous bead of sealant to the pump housing contact face, as shown in the figure.
  - a. Make sure that the sealant bead thickness is 2.0-3.0 mm (0.079-0.118 in) (3).
  - b. Place the pump housing on the engine block five minutes after having applied the sealant.
  - c. After fitting the pump housing, wait for at least 30 minutes before starting the engine.

THERMOSTAT

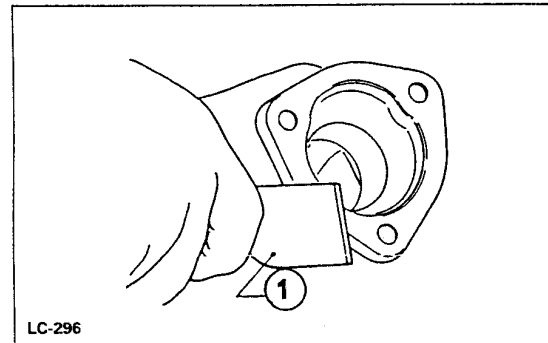


INSPECTION

1. Check the thermostat setting at normal temperature. It should be tightly closed.
2. Check the temperature at which the thermostat opens and its maximum lift.

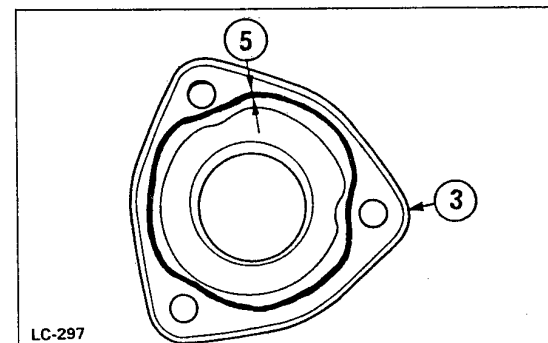
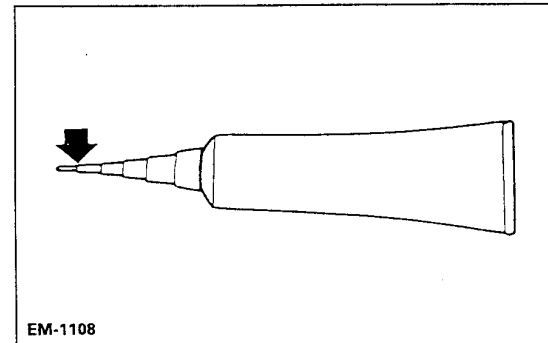
Thermostat opening temperature	°C (°F)	82.0 (180)
Maximum lift	mm/°C (in/°F)	10/90 (0.39/194)

3. Check that the thermostat closes at 5 °C (9 °F) below its opening temperature.



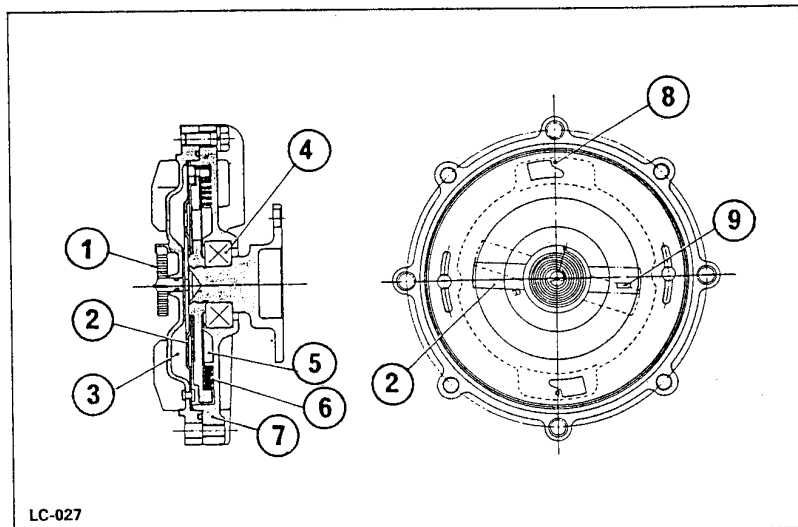
REPLACEMENT

- Using the scraper (1), remove all traces of sealant from the thermostat mating face (2).
- Remove all traces of gasket from the engine block mating face.
- Using lead-free petrol, remove all traces of gasket.
- Place the thermostat in the engine block housing, with the oscillating valve (4) at the top.
- Cut off the end of the sealant tube (KP-510-00150 or similar), as shown in the figure.
- Apply a continuous bead of sealant to the thermostat housing mating face (3), as shown in the figure.
  - a. Make sure that the sealant bead has a thickness of 2.0-3.0 mm (0.079-0.118 in).
  - b. Place the thermostat housing on the engine block five minutes after having applied the sealant.
  - c. After fitting the thermostat housing, wait for at least 30 minutes before starting the engine.





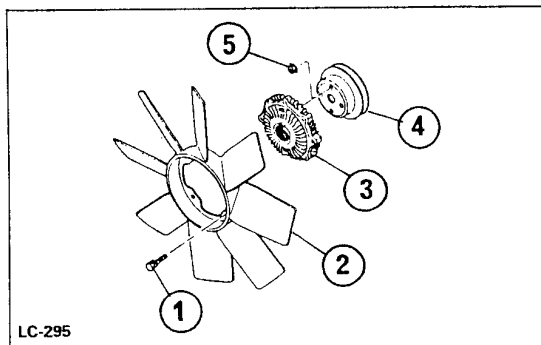
FAN VISCOUS COUPLING



COMPONENTS

- 1. Bi-metal thermostat
- 2. Sliding valve
- 3. Reserve chamber for "OFF" position
- 4. Bearing
- 5. Drive chamber
- 6. Coupling part (laberinth)
- 7. Driven part
- 8. Pump assembly oil outlet
- 9. Oil inlet

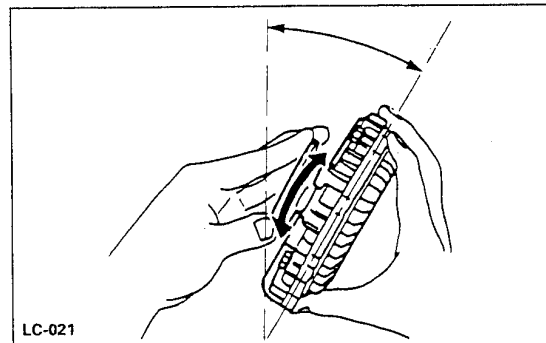
LC-027



LC-295

REMOVAL

1. Remove the bolts (1) and the fan (2).
2. Loosen the nut (5) and withdraw the viscous coupling (3).
3. Remove the water pump pulley (4).



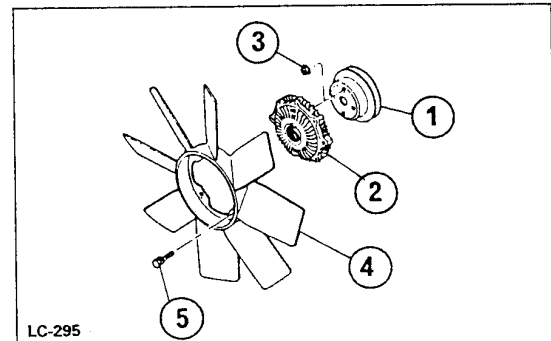
LC-021

INSPECTION

Check for oil leaks at the viscous coupling and if the bi-metal spiral is bent.

To avoid leaks of silicone from inside the coupling, it is essential that the coupling does not remain in the horizontal position or with an inclination greater than 45° in relation to the vertical.

If any of the said problems are observed, the viscous coupling must be replaced with a new one.

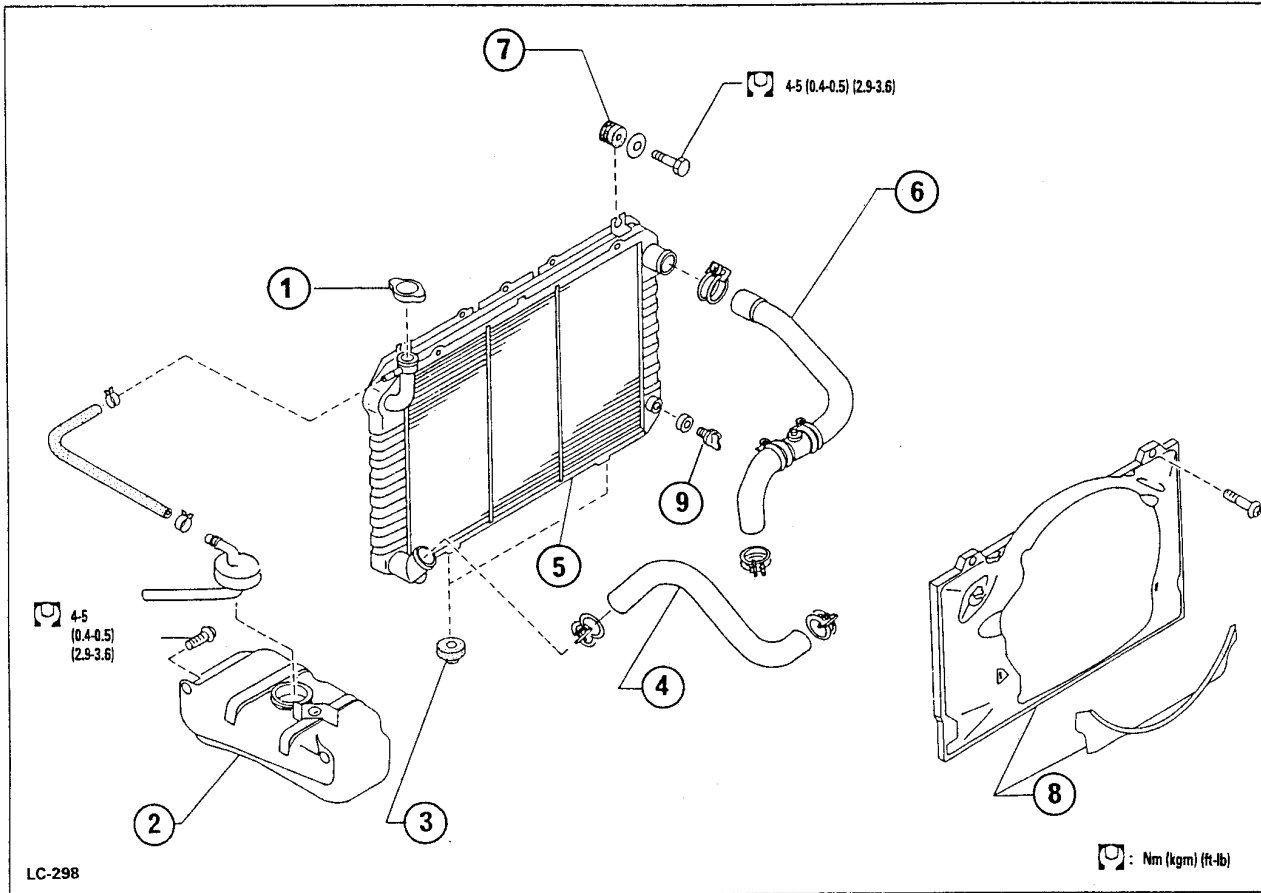


LC-295

REPLACEMENT

1. Fit the pulley (1) and the viscous coupling (2).
2. Secure them with the nuts (3) tightened to the specified torque:
  - 7-8 Nm (0.7-0.8 kgm) (5.1-5.8 ft-lb)
3. Fit the fan (4) and the bolts (5).
  - Fan retaining bolts: 7-8 Nm (0.7-0.8 kgm) (5.1-5.8 ft-lb)

**RADIATOR**



**COMPONENTS**

- |                                |                     |
|--------------------------------|---------------------|
| 1. Radiator cap                | 6. Top hose         |
| 2. Reserve tank                | 7. Tensioner damper |
| 3. Radiator resilient mounting | 8. Radiator shroud  |
| 4. Bottom hose                 | 9. Drain plug       |
| 5. Radiator                    |                     |

## TECHNICAL DATA AND SPECIFICATIONS

### LUBRICATION SYSTEM

#### CHECKING THE OIL PRESSURE

ENGINE SPEED	APPROXIMATE PRESSURE kPa (bar) (kg/cm <sup>2</sup> ) (lb/in <sup>2</sup> )
RD28 Engine At idling speed	Above 78 (0.78) (0.8) (11)
At 3,200 rpm	314-432 (3.14-4.32) (3.2-4.4) (46-63)
RD28T Engine At idling speed	Above 78 (0.78) (0.8) (11)
At 3,000 rpm	318.7-424.6 (3.19-4.25) (3.25-4.33) (46.2-61.6)

#### TIGHTENING TORQUES

COMPONENT	Nm	kgm	ft-lb
Retaining bolts, oil pump	10-12	1.0-1.2	7-9
Bolts, oil pump cover	4-5	0.4-0.5	2.9-3.6
Bolts, pressure regulating valve cover	39-69	4.0-7.0	29-51
Oil filter attachment	See Section MA		
Connector, oil pressure pipe	10-16	1.0-1.6	7-12
Head, oil cooler	16-21	1.6-2.1	12-15

#### OIL PUMP

Unit: mm (in)

Clearance between casing and outer gear ①	0.11-0.20 (0.0043-0.0079)
Clearance between inner gear and half-shoulder ②	0.216-0.326 (0.0085-0.0128)
Clearance between outer gear and half-shoulder ③	0.21-0.32 (0.0083-0.0126)
Clearance between housing and inner gear ④	0.05-0.09 (0.0020-0.0035)
Clearance between housing and outer gear ⑤	0.05-0.11 (0.0020-0.0043)
Clearance between inner gear and projection part of housing ⑥	0.106-0.152 (0.0042-0.0060)

### COOLING SYSTEM

#### THERMOSTAT

Thermostat opening temperature	°C (°F)	82.0 (180)
Maximum lift	mm/°C (in/°F)	10/90 (0.39/194)

#### TIGHTENING TORQUES

COMPONENT	Nm	kgm	ft-lb
Retaining bolts, water pump	16-21	1.6-2.1	12-15
Water inlet pipe	16-21	1.6-2.1	12-15
Retaining bolts, fan coupling	7-8	0.7-0.8	5.1-5.8



# ENGINE FUEL SYSTEM

## SECTION **EF**

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**EF**



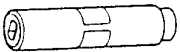

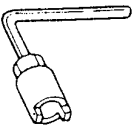
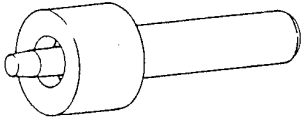
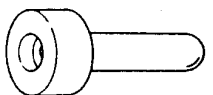
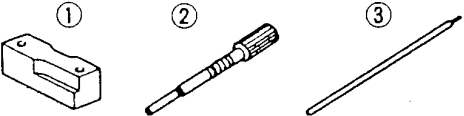
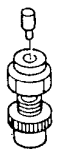
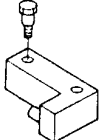
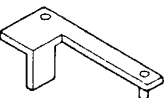
## SPECIAL SERVICE TOOLS

### SETTING

PART N.º	DENOMINATION	APLICACION	
		RD28	RD28T
<p><b>KV-112-29352</b></p> <p>Measuring device (installed piston spring length)</p> <p>① KV-112-29350 Support ② KV-112-29360 Nut ③ KV-112-29370 Stylus ④ KV-112-54410 Dial indicator</p>		X	X

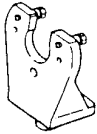
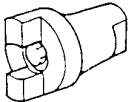
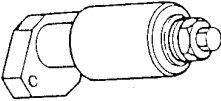


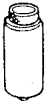
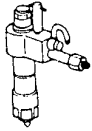

### DISASSEMBLY AND REASSEMBLY TOOLS

<p><b>KV-112-94005</b></p> <p>① KV-112-44260</p>	<p>Universal bench vice assembly</p> <p>Fuel injection pump retaining plate</p>		X	—
<p>① KV-112-44852</p> <p>② KV-112-44872</p> <p>③ KV-112-44792</p>	<p>Universal bench Support</p> <p>Support</p>		—	X
<b>KV-112-29072</b>	Inserter		X	X
<b>KV-112-14110</b>	Socket wrench for flow valve		X	X
<b>KV-112-14270</b>	Socket wrench for adjustment screw		X	X

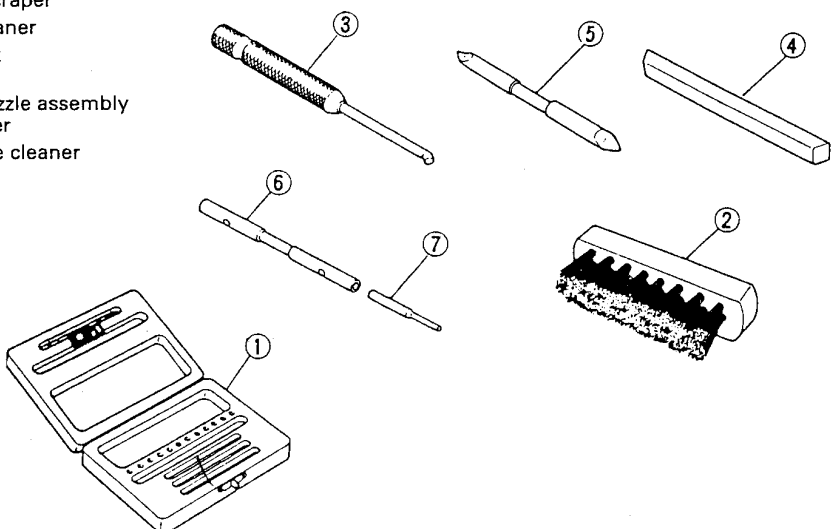
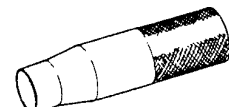
PART N.°	DENOMINATION	APPLICATION	
		RD28	RD28T
KV-112-14260	Socket wrench for regulating valve 	X	X
KV-112-14250	Socket wrench for distributor head plug 	X	X
KV-112-15262	Regulation shaft adjusting device 	X	X
KV-112-29542	Feed pump support 	—	X
KV-112-29540	Fuel injection pump support 	X	—
KV-112-29852 ① KV-112-29110 ② KV-112-29820 ③ KV-112-29830	Measuring device assembly for "MS" dimension Block gauge Driven shaft Rod 	X	X
KV-112-29042	Measuring device for "K" and "KF" dimensions 	X	X
KV-112-29752	Block gauge for the "MS" dimension (for compensator) 	—	X
KV-112-29762	Block gauge (for compensator) 	—	X



## PUMP TESTER ADJUSTMENT DEVICE

PART N.°	DENOMINATION	APPLICATION	
		RD28	RD28T
KV-112-81036	Attachment bracket 	X	X
KV-112-42452	Coupling 	X	X
KV-112-82815	Measuring device (advance angle) 	X	X
KV-112-05032	Injection pipe [840 mm (33.07 in)] 	X	X
KV-112-29462	Extractor (Regulating valve removal) 	X	X
KV-112-29522	Inserting device (Regulating valve replacement) 	X	X
KV-112-57802	Injector nozzle assembly (Type Bosch EF8511-9A) 	X	X
KV-112-57800	Nozzle (Type Bosch DN 12 SD 12 T) 	X	X

**INJECTOR**

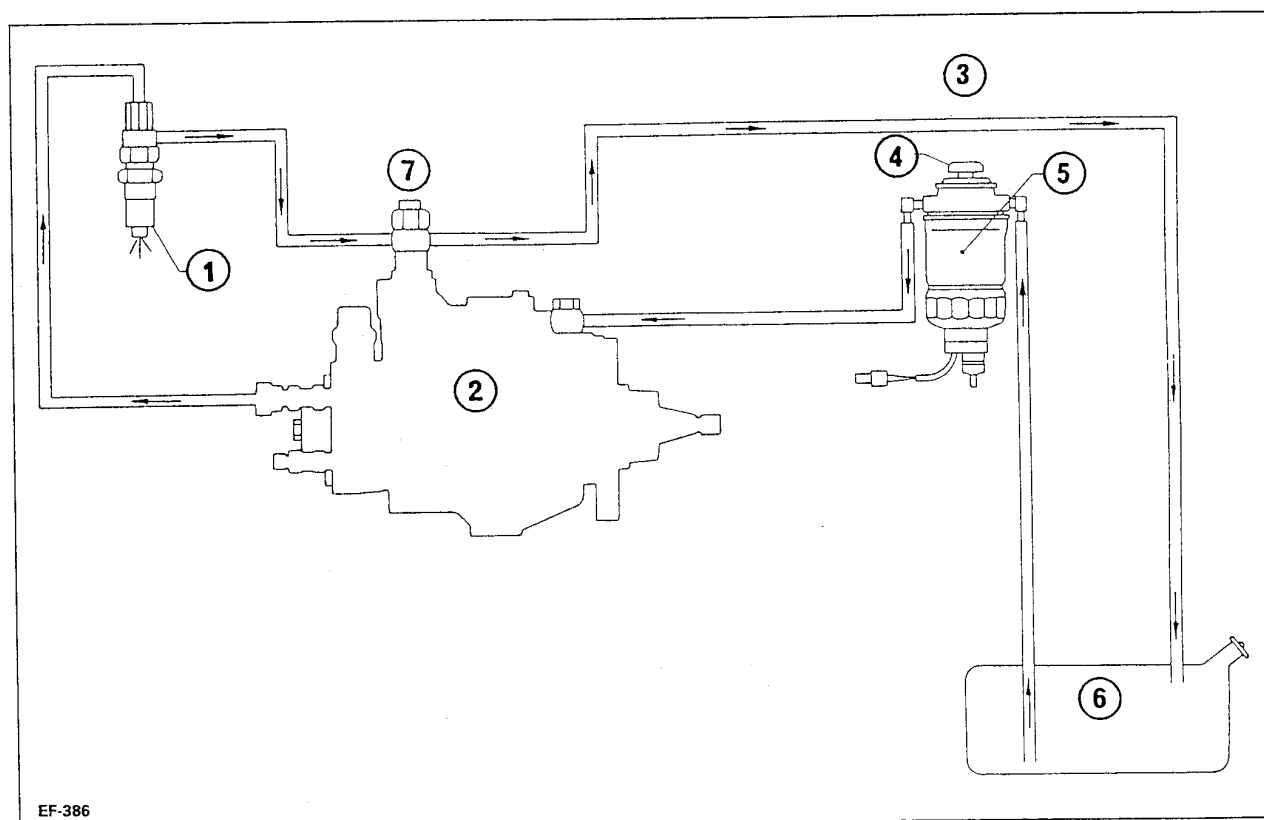
PART N.º	DENOMINATION
<p><b>KV-112-89004</b>                      ① KV-112-90012                      ② KV-112-90110                      ③ KV-112-90122                      ④ KV-112-90140                      ⑤ KV-112-90150                      ⑥ KV-112-90210                      ⑦ KV-112-90220</p>	<p>Nozzle cleaning equipment</p> <ul style="list-style-type: none"> <li>Case</li> <li>Brush</li> <li>Nozzle fuel collector scraper</li> <li>Needle cleaner</li> <li>Nozzle seat scraper</li> <li>Injector nozzle assembly hole cleaner</li> <li>Nozzle hole cleaner</li> </ul>  <p>EF-154</p>
<p><b>KV-112-92010</b></p>	<p>Nozzle centering device</p> 

## INJECTION SYSTEM

### CAUTION:

- The disassembly and reassembly of the fuel injection pump must be exclusively carried out in workshops authorized by NISSAN MOTOR IBERICA, or by the pump manufacturer.
- For pump maintenance operations, it is necessary to have a special injector pump tester.
- Before removing the fuel injection pump from the vehicle, make sure that the pump is in fact damaged.

### FUEL CIRCUIT



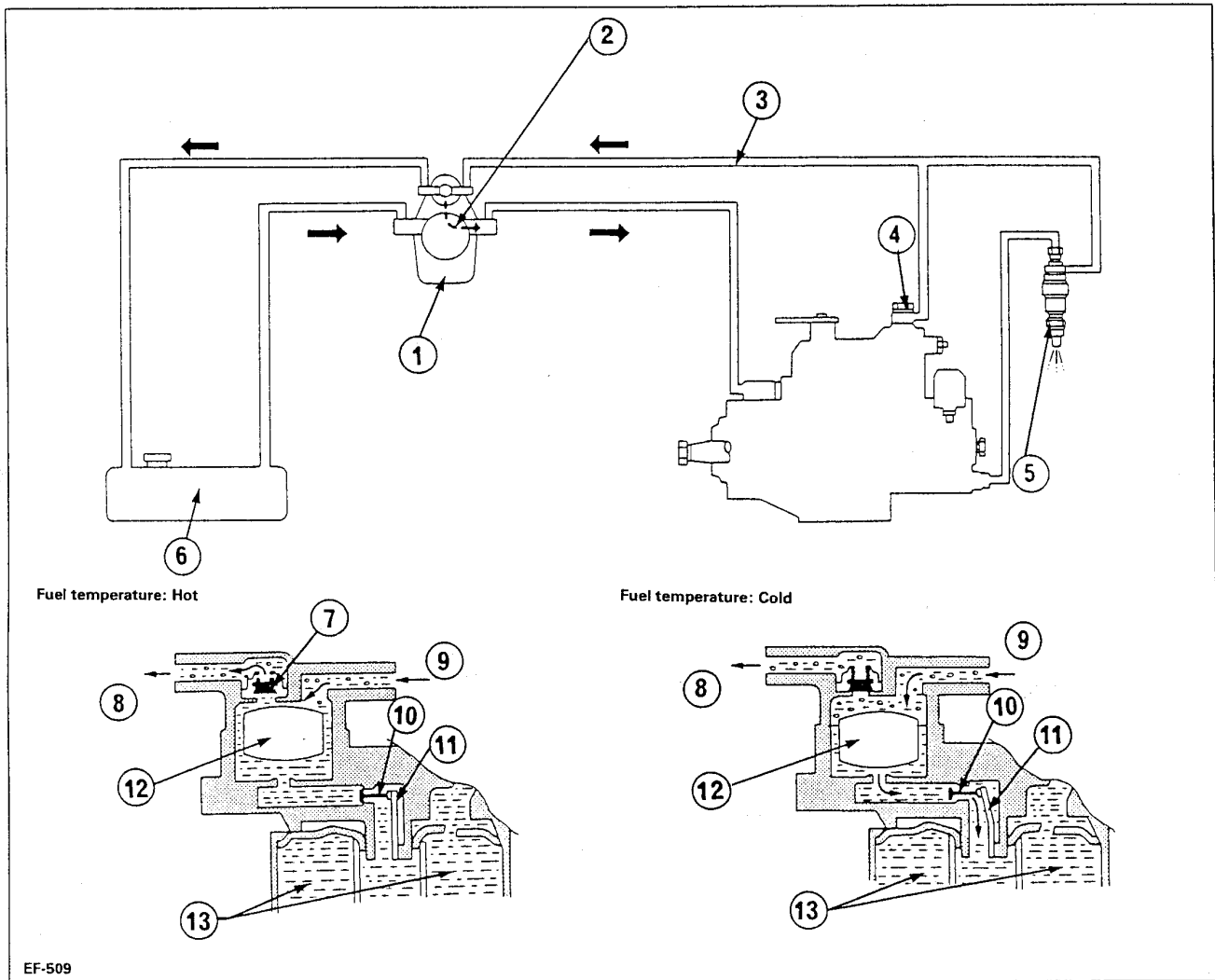
### COMPONENTS

- |                        |                   |
|------------------------|-------------------|
| 1. Injector            | 5. Fuel filter    |
| 2. Fuel injection pump | 6. Fuel tank      |
| 3. Return lines        | 7. Leak off valve |
| 4. Priming pump        |                   |

**MODELS FOR COLD AREAS**

Fuel Return Control System (F.R.C.S.) prevents clogging of the fuel filter by circulating overflow fuel warmed by the fuel injection pump when ambient temperature are low. The float valve in the system prevents trapped air from circulating through the fuel line and the check valve prevents reverse flow of fuel from the fuel tank. When the fuel temperature is above 30 °C (86 °F), a bimetal valve activates to stop fuel circulation.

**FUEL CIRCUIT**



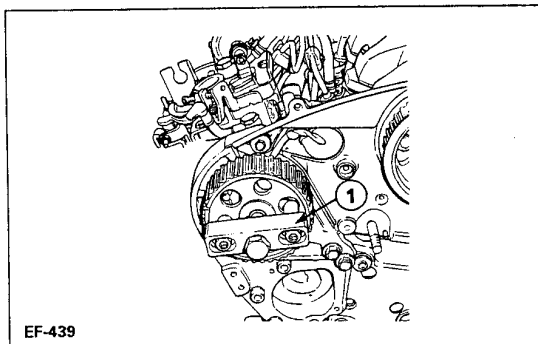
**COMPONENTS**

- |  |                        |
|--|------------------------|
| 1. Fuel filter                                   | 7. Check valve         |
| 2. By-pass passage<br>(Fuel temperature is cold) | 8. To fuel tank        |
| 3. Fuel return passage                           | 9. From injection pump |
| 4. Overflow valve                                | 10. Return valve       |
| 5. Injection nozzle                              | 11. Bimetal            |
| 6. Fuel tank                                     | 12. Float              |
|  | 13. Element            |

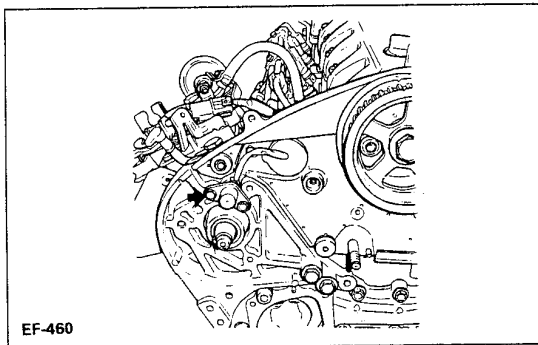
## FUEL INJECTION PUMP

### REMOVAL

1. Drain the coolant.
2. Disconnect the following cables and pipes:
  - Accelerator cable.
  - Fuel pipe.
  - Idling speed regulation cable.
  - Connector of the fuel shut-off switch solenoid wire harness.
3. Remove the timing belt (see Section MA, Page 13).
4. Using a suitable tool, extract the fuel injection pump gear.
5. Remove all injection pipes (see Section EM, Page 10).

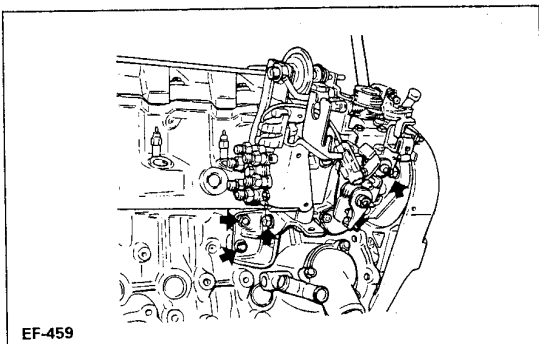


1. KV-111-02900



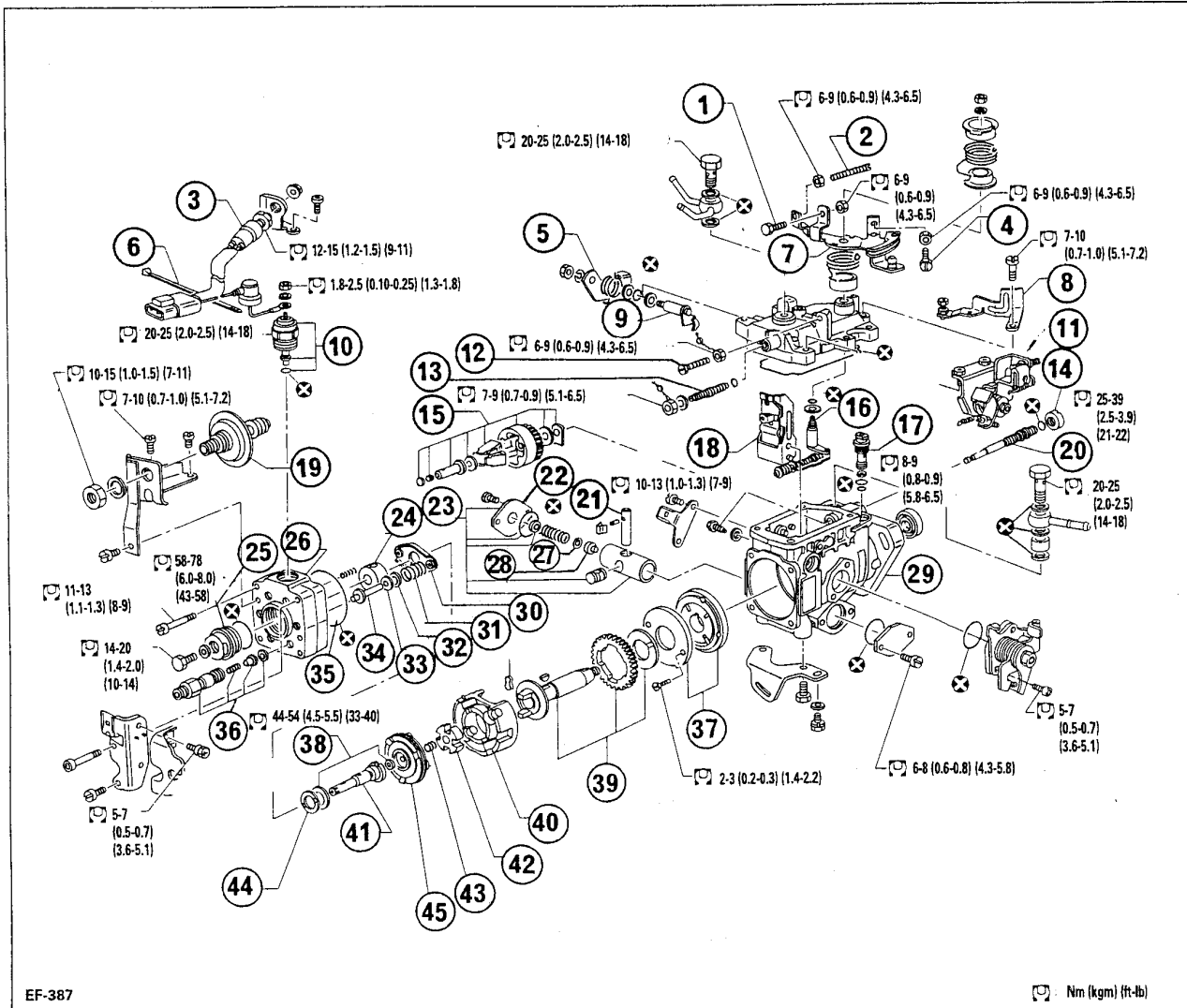
6. Remove the engine revolutions sensor.

**NOTE:** Make sure not to damage the sensor when withdrawing it from its housing.



7. Remove the pump retaining nuts and the bolts from the rear support.
8. Remove the fuel injection pump.

ENGINE WITHOUT TURBOCHARGER



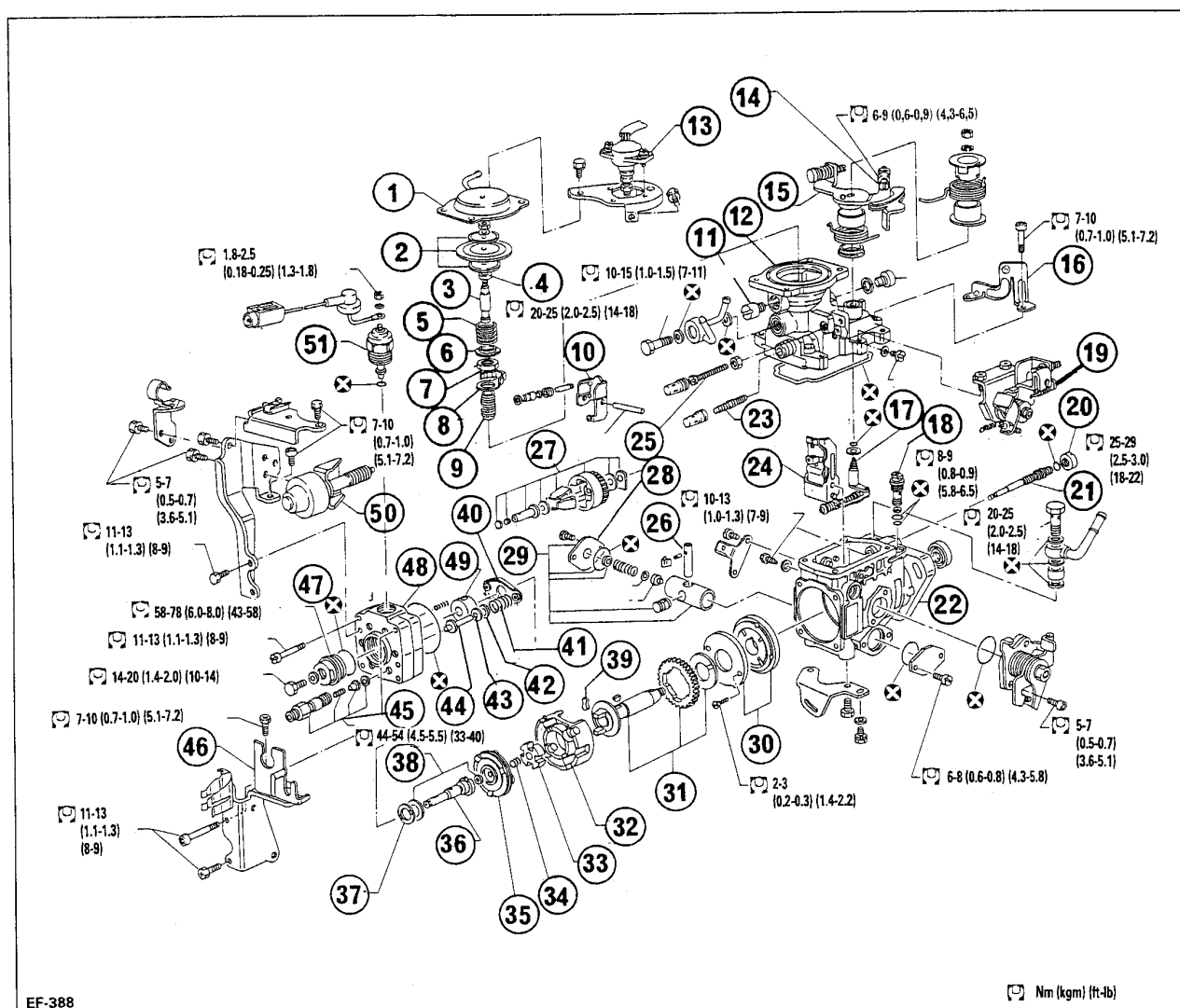
EF-387

Nm (kgm) (ft-lb)

COMPONENTS

- |   |                                  |
|---|----------------------------------|
| 1. Screw, idling speed adjustment       | 24. Control sleeve               |
| 2. Bolt, damper adjustment              | 25. Plug                         |
| 3. Idling switch (optional)             | 26. Distributor head             |
| 4. Screw, idling adjustment             | 27. Spring ring                  |
| 5. Governor control shaft               | 28. Servomechanism valve         |
| 6. Clamp                                | 29. Pump casing                  |
| 7. Control lever                        | 30. Spring lower seat            |
| 8. Retainer                             | 31. Impeller spring              |
| 9. Governor control shaft               | 32. Spring seat                  |
| 10. Fuel shut-off switch solenoid valve | 33. Adjustment shim              |
| 11. Accelerated idling device           | 34. Guide pin                    |
| 12. Screw, maximum speed adjustment     | 35. Rubber stop                  |
| 13. Screw, full power adjustment        | 36. Impeller valve assembly      |
| 14. Retaining nut                       | 37. Lift pump assembly           |
| 15. Flywheel assembly                   | 38. Adjustment shim              |
| 16. Control shaft assembly              | 39. Engine shaft assembly        |
| 17. Regulating valve                    | 40. Cylinder and cylinder-holder |
| 18. Governor lever                      | 41. Impeller                     |
| 19. Damper                              | 42. Impeller disc                |
| 20. Governor shaft                      | 43. Adjustment shim              |
| 21. Fulcrum pin                         | 44. Washer                       |
| 22. Advance regulator cover             | 45. Cam disc                     |
| 23. Advance regulator assembly          |                                  |

## ENGINE WITH TURBOCHARGER



EF-388

Nm (kgm) (ft-lb)

## COMPONENTS

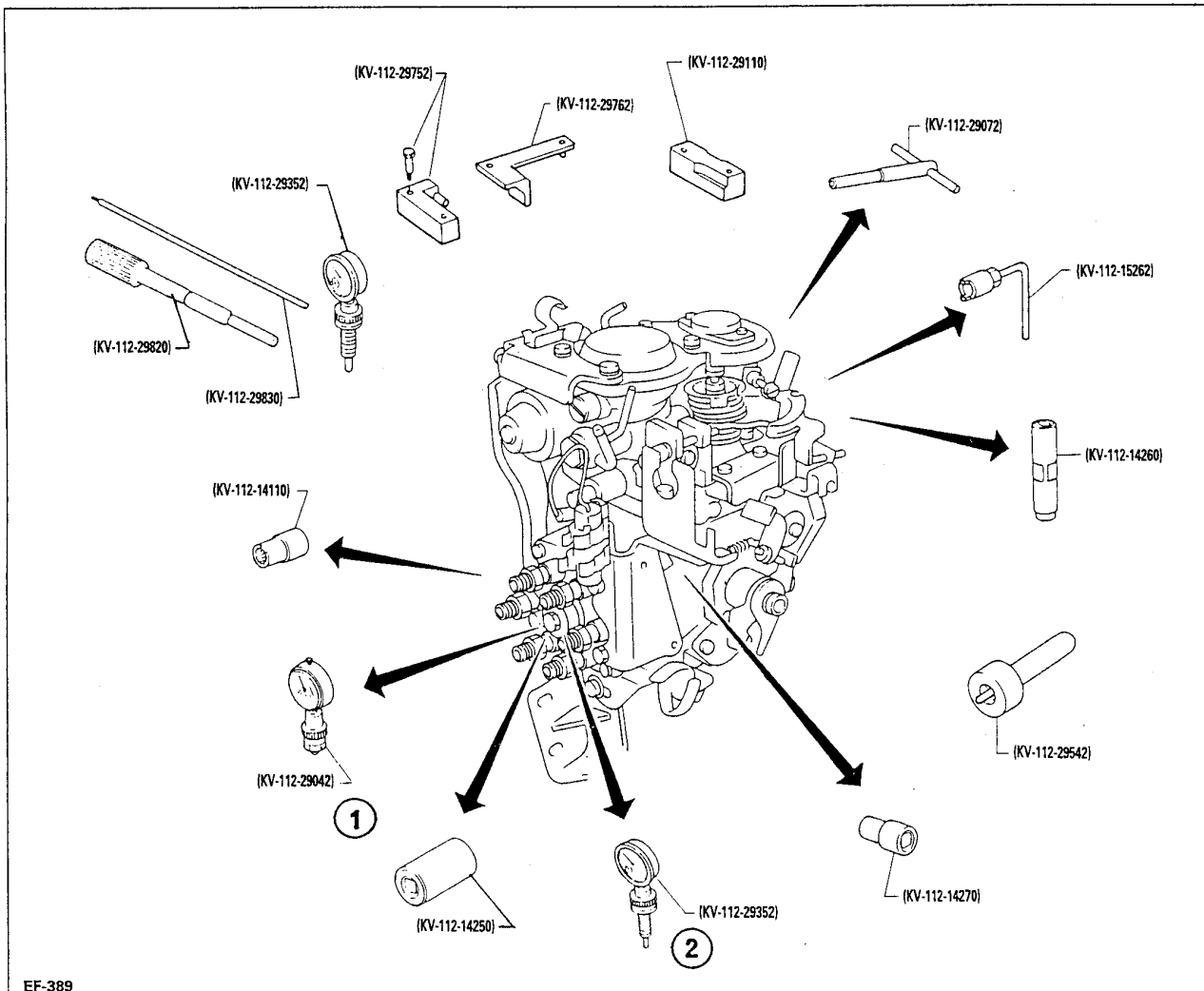
- |                              |                                     |                               |
|------------------------------|-------------------------------------|-------------------------------|
| 1. Compensator cover         | 18. Regulating valve                | 35. Cam disc                  |
| 2. Diaphragm assembly        | 19. Accelerated idling device       | 36. Plunger                   |
| 3. Adjustment stop           | 20. Locknut                         | 37. Seating washer            |
| 4. Spacer                    | 21. Adjustment shaft                | 38. Spacers                   |
| 5. Spring                    | 22. Pump casing                     | 39. Damper assembly           |
| 6. Nut, casing               | 23. Screw, full power adjustment    | 40. Distributor spring seat   |
| 7. Locknut                   | 24. Adjustment lever                | 41. Plunger spring            |
| 8. Lock plate                | 25. Screw, maximum speed adjustment | 42. Spring seat               |
| 9. Threaded bush             | 26. Stop fulcrum pin                | 43. Spacer                    |
| 10. Adjustment lever         | 27. Inertia counterweight assembly  | 44. Guide stop                |
| 11. Air regulator            | 28. Advance cover                   | 45. Flow valve assembly       |
| 12. Regulator cover          | 29. Advance assembly                | 46. Accelerator cable bracket |
| 13. Potentiometer (optional) | 30. Feed pump assembly              | 47. Plug and bolt             |
| 14. Screw, idling adjustment | 31. Operating shaft assembly        | 48. Distributor head          |
| 15. Control lever            | 32. Roller and roller carrier       | 49. Control sleeve            |
| 16. Closing lever            | 33. Drive disc                      | 50. Damper                    |
| 17. Control shaft assembly   | 34. Spacer spring                   | 51. Solenoid valve            |

**DISASSEMBLY**

**PREPARATION**

- Whenever possible, check the pump before disassembling and adjusting it, and write down the results obtained.
- Before disassembling it, remove all dust and dirt from the outside.
- Disconnect the leakoff valve and drain the fuel.
- Thoroughly clean the workbench of all foreign materials.
- Take out the tools required for disassembling and reassembling the pump.
- Take care not to bend nor scratch any part.

**Specially designed tools are required for disassembling and reassembling the fuel injection pump.**

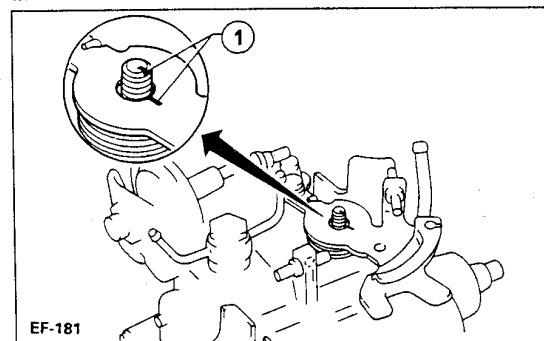
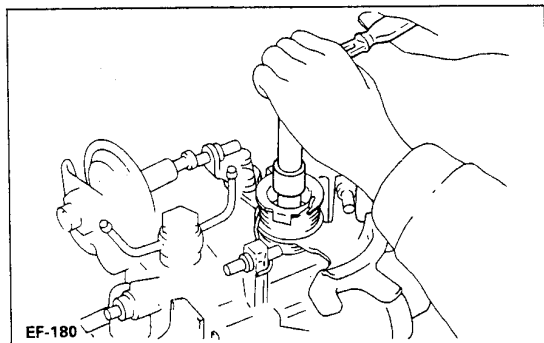


1. To determine the dimensions "K" and "KF"
2. To determine the static injection advance



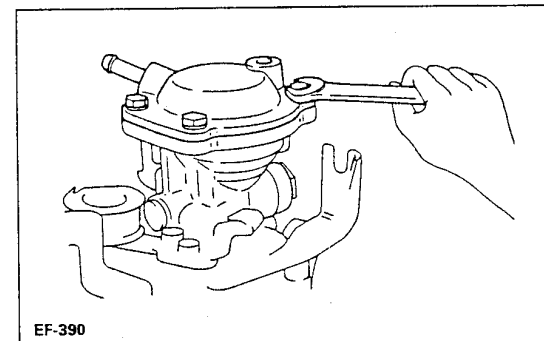
**GOVERNOR COVER****Without compensator**

1. Remove the nut, spring washer, lower spring seat and control lever spring.

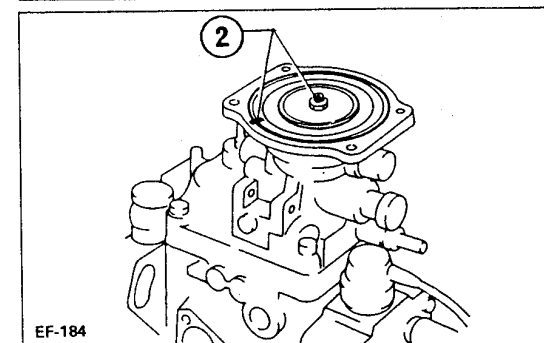


2. Mark (1) the control lever and control shaft so as align the parts during reassembly.

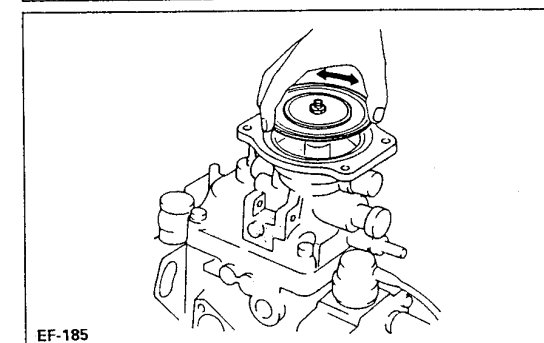
Remove the governor cover.

**With compensator**

3. Remove the diaphragm cover.

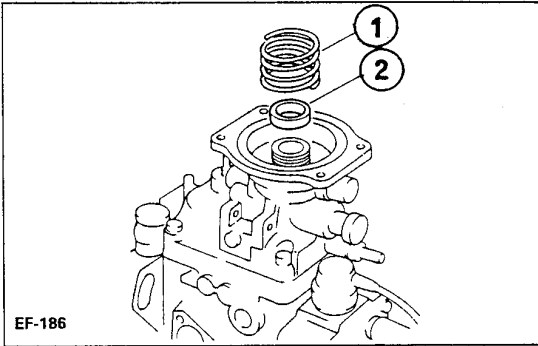


4. Mark (2) the diaphragm, adjustment pin and governor cover.

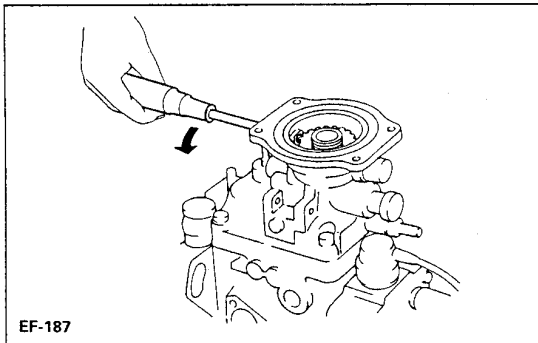


5. Remove the diaphragm assembly.

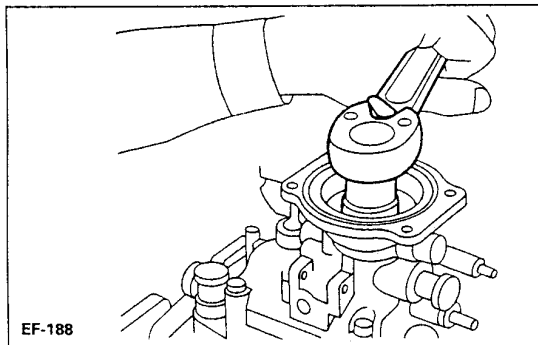
Turn the diaphragm to find the position for withdrawing it.



6. Remove the compensator spring (1) and spacer (2).

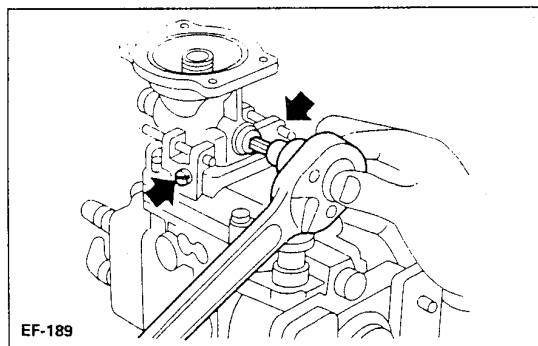


7. Loosen the bush locknut.

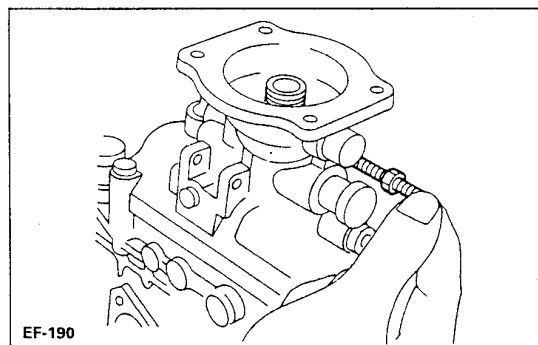


8. Remove the nut and the lock plate.

**Use a specially designed sleeve so as to avoid interference with the casing. [Outside diameter 31 mm (1.22 in)]**

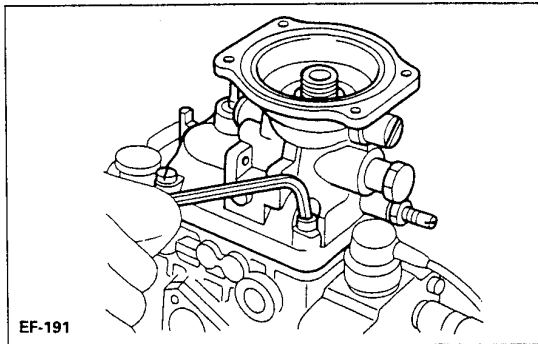


9. Remove the governor cover plugs.



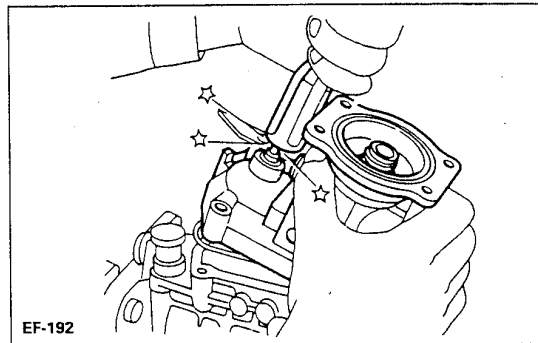
10. Removing the governor cover.

a. Remove the wire-lock and the maximum speed adjustment screw.



EF-191

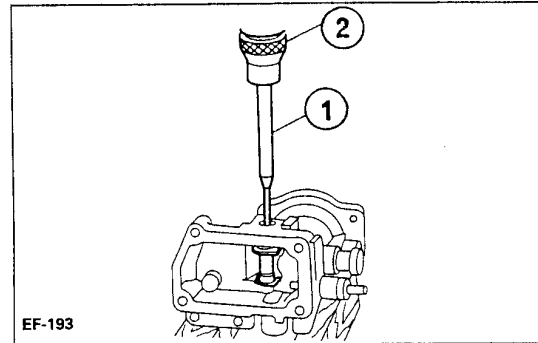
b. Remove the governor cover retaining bolts.



EF-192

c. Remove the governor cover.

Slide the control shaft downwards by tapping its end gently with a wooden mallet.



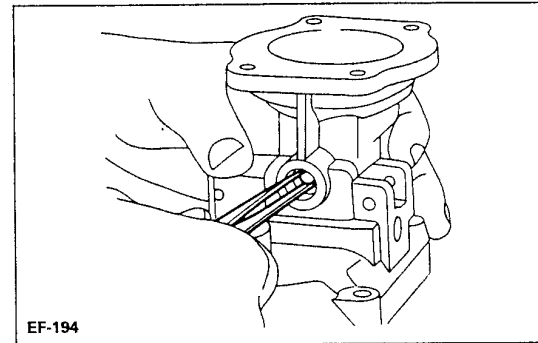
EF-193

11. Removing the compensator parts.

a. Remove the plugs.

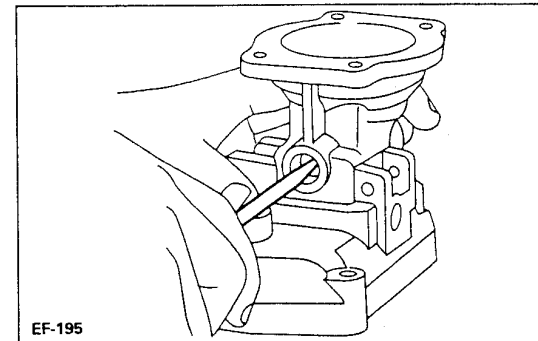
b. Remove the lever pin and lever, using a suitable mandril (1) and a press (2).

**The lever pin can only be removed from the right hand side, when seen from the drive shaft end.**



EF-194

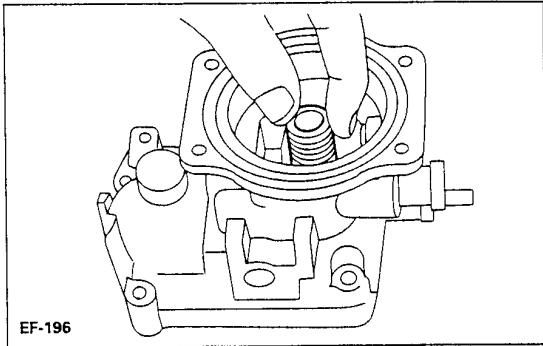
c. Remove the plug and the pin.



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d. Remove the oil seal, sleeve and washer.

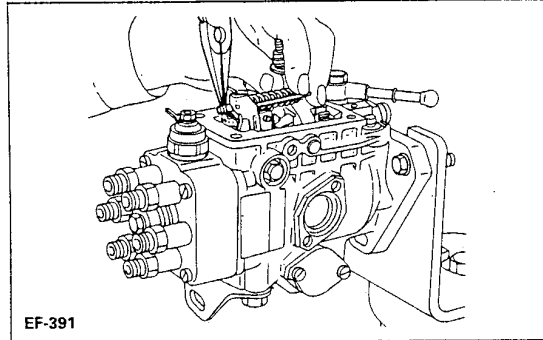
**Use a suitable tool to remove the oil seal.**



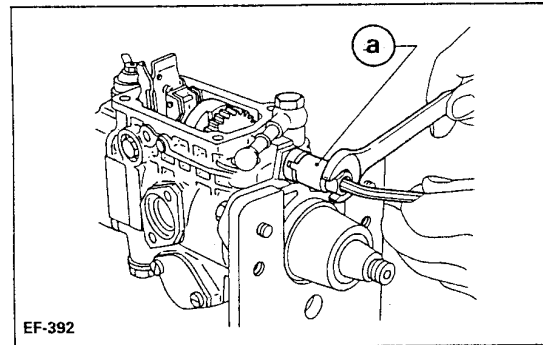
- e. Remove the threaded bush from its housing in the governor cover.

**INTERNAL PARTS**

**NOTE:** The operations described below are common for both engines.



1. Remove the adjustment lever control shaft.

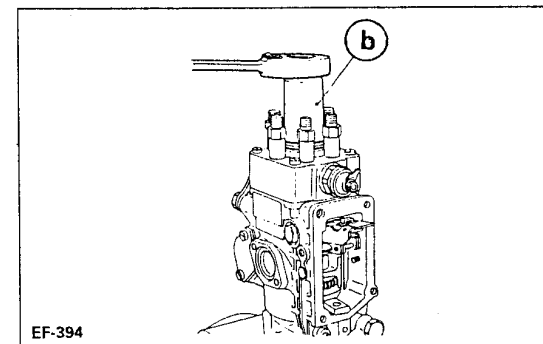
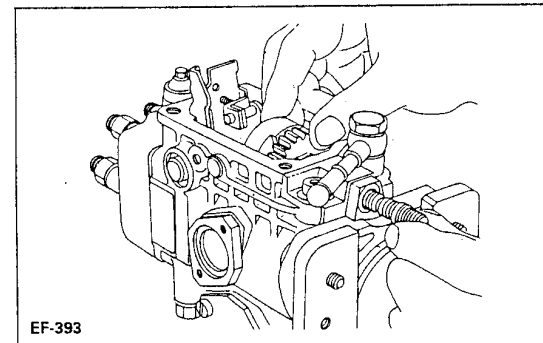


2. Remove the governor shaft.

To loosen the locknut, turn it clockwise.

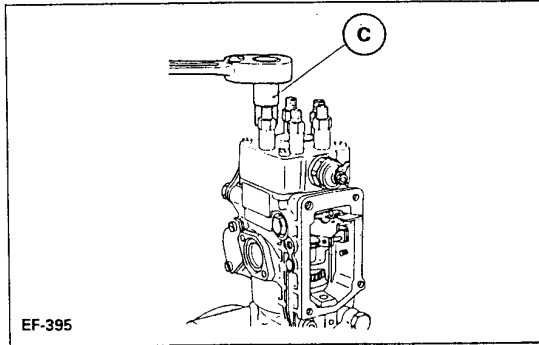
a: KV-112-15262

3. Remove the governor sleeve, washer and inertia counterweights together with the counterweight bracket; then take out the washer and spacer or spacers.

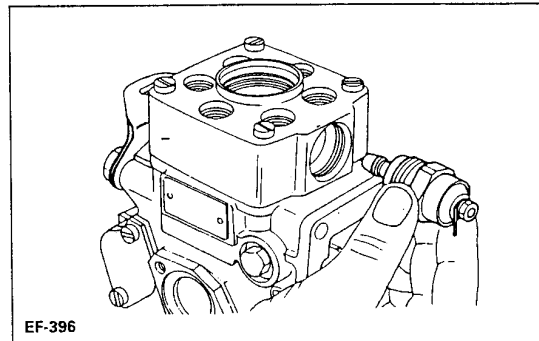


4. Using a suitable tool, loosen and remove the plug from the hydraulic head.

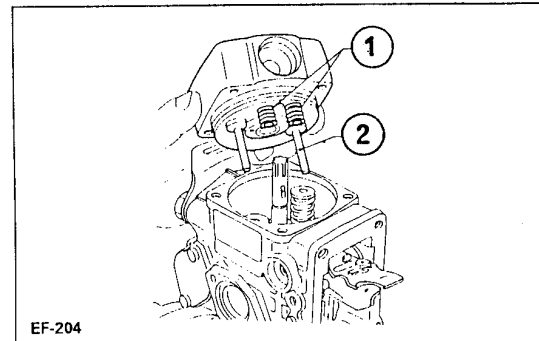
b: KV-112-14250



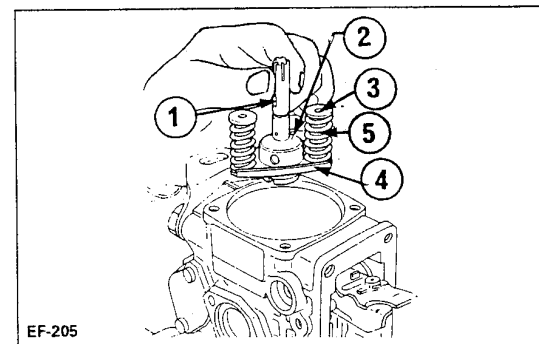
c: KV-112-14110



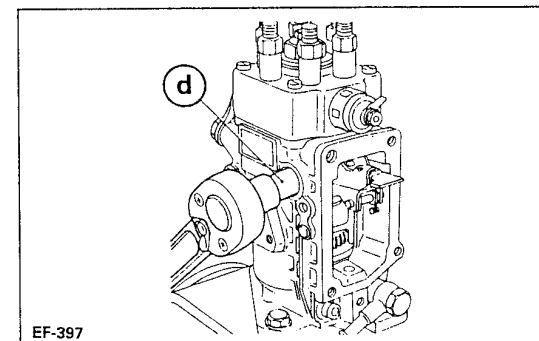
EF-396



EF-204



EF-205



EF-397

d: KV-112-14270

5. Remove the flow valve bracket, spring, valve and gasket.

The distributor head is marked with the letters A, B, C, D, E and F. Carefully replace the parts in alphabetical order.

6. Remove the fuel shut-off solenoid valve.

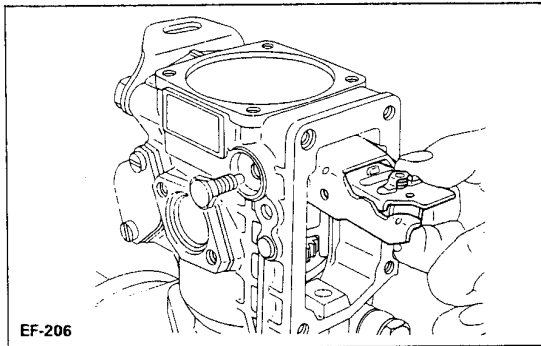
7. Remove the distributor head.

Be careful not to lose the two support springs (1) and the guide pins (2).

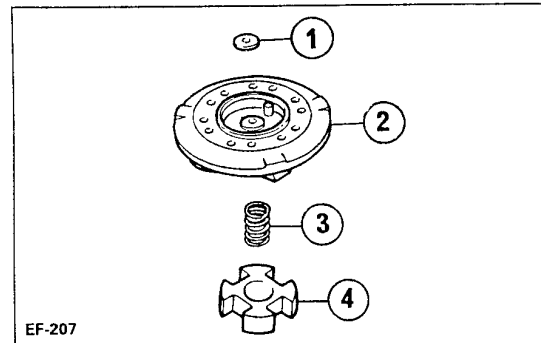
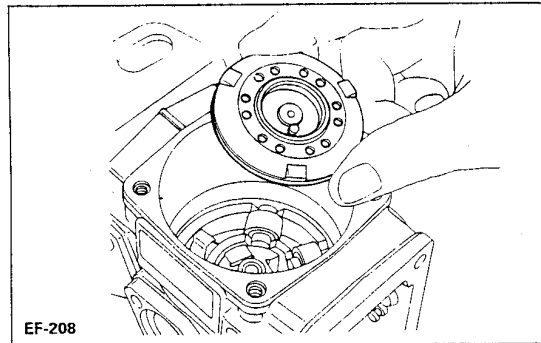
8. Remove the plunger assembly.

Lift the plunger (1), together with the control sleeve (2), spacer (3), spring seat (4) and plunger spring (5).

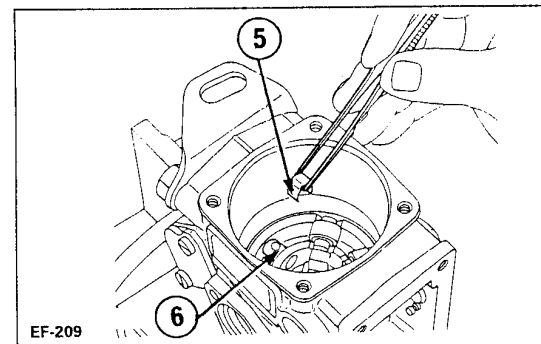
9. Loosen the fulcrum bolts on the right and left hand side of the governor.



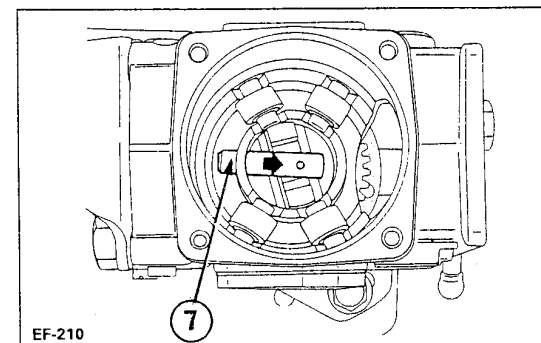
10. Remove the adjustment lever assembly.  
Do not pull on the starting and idling springs.



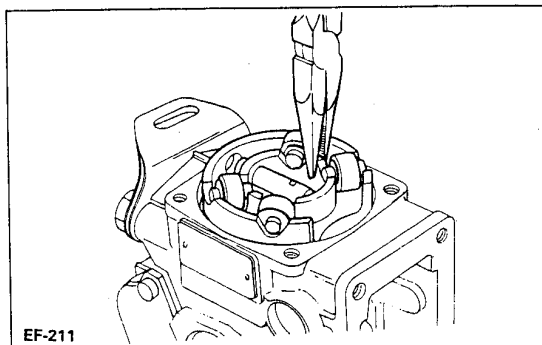
11. Remove the spacer (1), cam disc (2), spring (3) and drive disc (4).



12. Remove the clips (5) and pins (6).

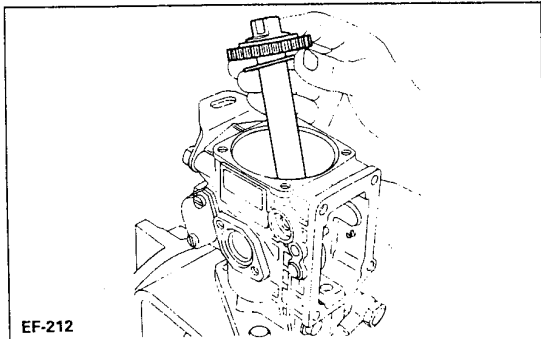


13. Slide the adjustment pin (7) to the center of the roller-carrier, as shown in the figure.



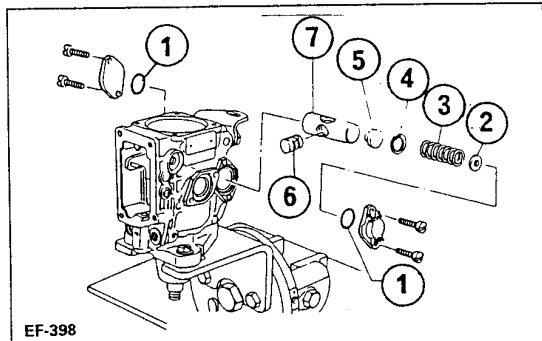
14. Lift and remove the roller-carrier along with the rollers, without tipping it.

**Take care that the rollers do not drop.**

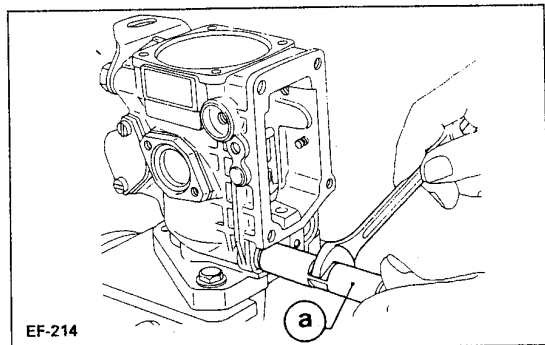


15. Remove the operating shaft.

- a. Take care not to scratch the inner surface of the fuel injection pump casing.
- b. Make sure that the key does not drop inside.

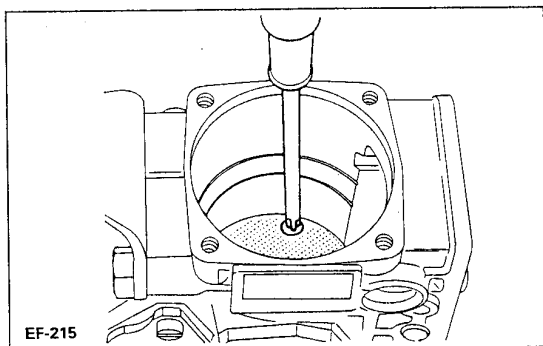


16. Remove the cover of the advance assembly, the O-ring (1), supplements (2), spring (3), restrictor ring (4), piston valve (5), slide (6) and piston (7).

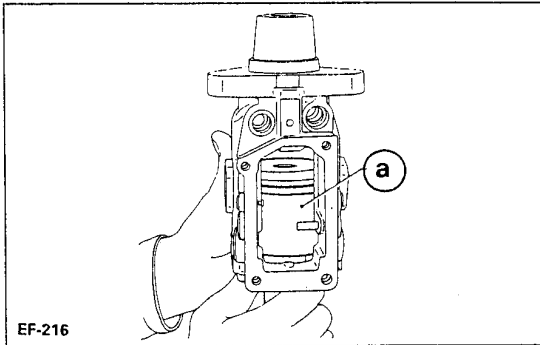


17. Using a suitable tool, remove the regulating valve.

a: KV-112-14260

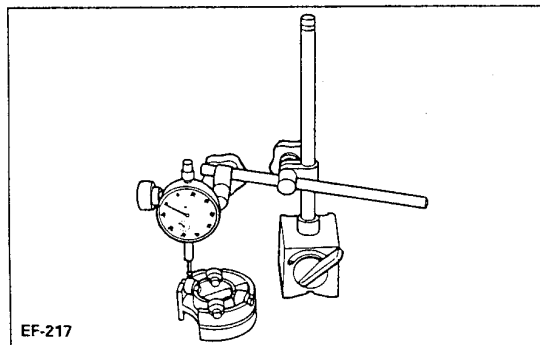


18. Loosen the feed pump cover screw.



a: KV-112-29542

19. Removing the cover assembly and the feed pump, without separating the components.
  - a. Insert the special tool in the fuel injection pump housing.
  - b. Turn the fuel injection pump so that the head is facing downwards, as shown in the figure.
  - c. Remove the cover assembly and the feed pump.
    - If it is difficult to remove the cover and feed pump, or it is stuck, tap the pump casing gently with a softfaced hammer.
    - Do not alter the position of the blades.



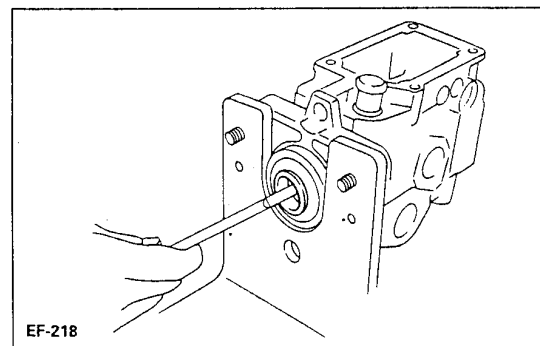
**INSPECTION**

It is recommended that the assemblies of the following parts be renewed as a complete unit.

- Distributor head, control sleeve and plunger.
- Fuel feed pump (rotor and blades with eccentric ring).
- Plunger spring assembly.
- Roller assembly.
- Inertia counterweight assembly.
- Adjustment lever assembly.

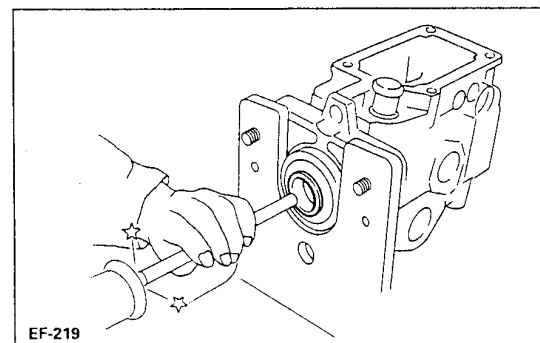
1. Thoroughly wash all parts.
2. Replace any worn or damaged parts.
3. The plunger operating edge should not be worn, and the contact faces must show signs of rubbing; if they do, the plunger must be replaced.
4. Check the height of the rollers.

The difference between the maximum and minimum heights of the rollers should be less than 0.02 mm (0.0008 in).



**REPLACING THE OIL SEAL**

1. Using a suitable tool, remove the oil seal.



2. Lubricate the oil seal so as to make its replacement easier.
3. Fit the oil seal as shown in the figure.



## REASSEMBLY

### INTERNAL PARTS

The following parts must be replaced as an assembly:

- Distributor head, control sleeve and plunger.
- Fuel feed pump (pump rotor and blades with eccentric ring).
- Spring and plunger.
- Rollers.
- Flywheel.
- Adjustment lever.

### PREPARATION

Immerse all moving parts and O rings in test oil and clean them.

1. Place the feed pump cover, rotor with blades and the ring on the special tool.
  - a. Align the three holes of the pump cover and the ring.
  - b. Do not alter the position of the blades.
  - c. The holes A and B are not equally spaced from the internal wall of the ring.
2. Install the feed pump cover (1), the rotor (2) with its blades and the ring in the pump casing (3).

**Make sure to install the liner in the correct position. If the position of the right and left side holes is reversed, the feed pump will not deliver fuel.**

Pump rotation clockwise (Reference R).

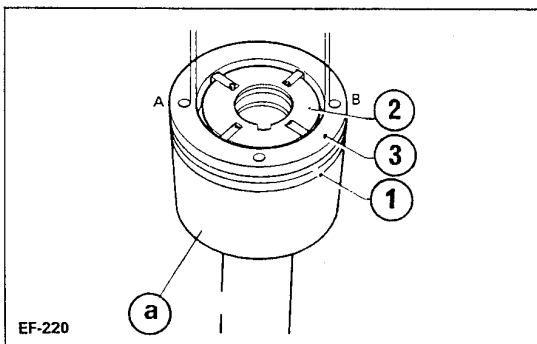
- A - Larger side
- B - Smaller side

Pump rotation counterclockwise (Reference L).

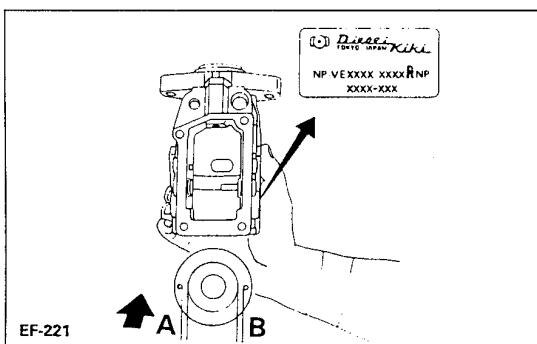
- B - Smaller side
- A - Larger side

The following explanation is valid for pumps with clockwise rotation (Reference R).

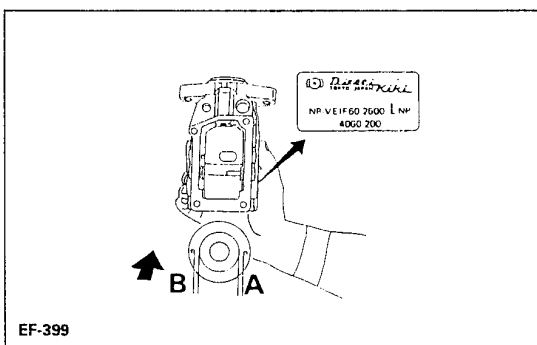
3. Turn the fuel injection pump 180° and remove the special tool. Secure the pump cover with the bolt.
  - a. When tightening the bolt, take care not to scratch the inner wall of the pump housing.
  - b. Once the bolts are tightened, check that the rotor (1) and its blades turn freely.



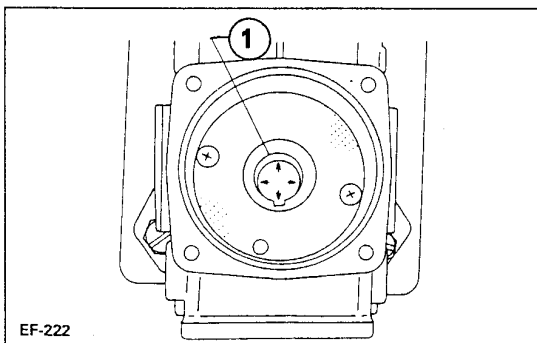
a: KV-112-29542



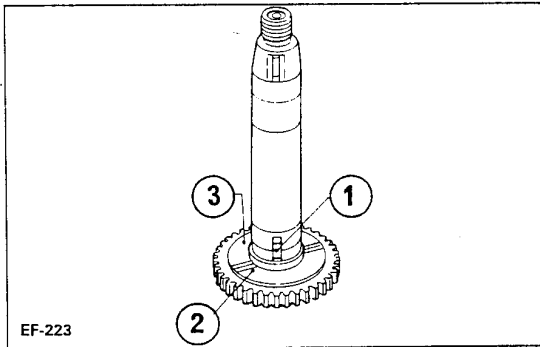
EF-221



EF-399



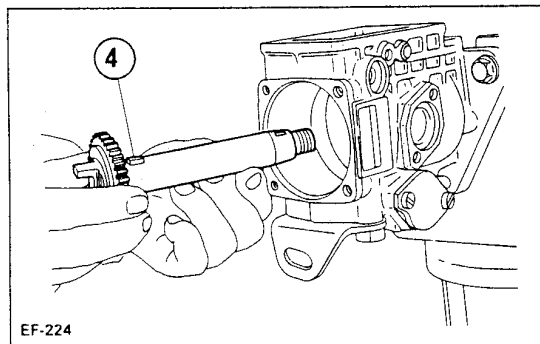
EF-222



4. Check that the shaft and drive gear are correctly fitted, as shown in the figure.

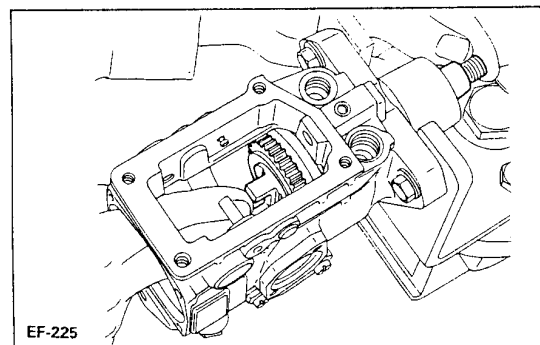
1. Key
2. Washer
3. Apply grease

**Do not forget the rubber dampers.**

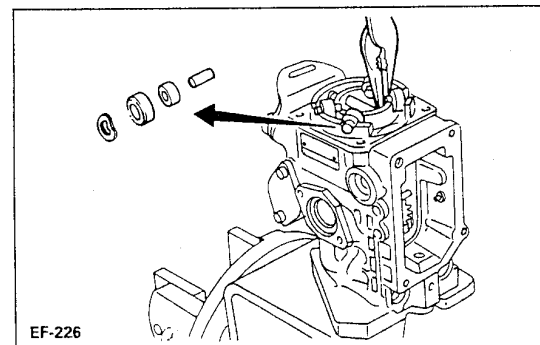


5. Install the drive shaft in the housing, so that the key (4) of the shaft is located in the rotor keyway.

**Take care not to scratch the oil seals or the inner wall of the housing.**

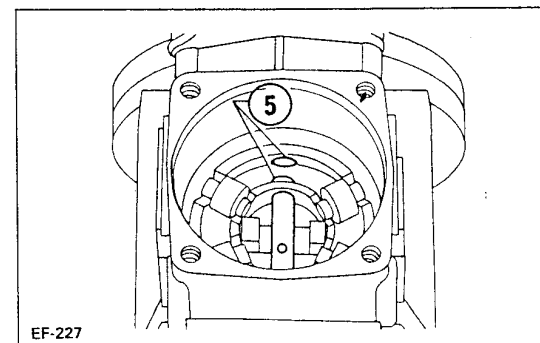


6. Position the drive shaft lug parallel to the advance.

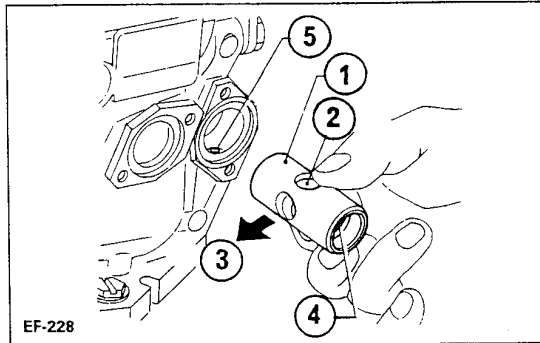


7. Install the rollers and roller-carrier.

- a. **Do not alter the positions of the rollers; if the positions are changed, see the Sub-Section "INSPECTION" to correct them.**
- b. **Make sure that the washer is outside the rollers.**

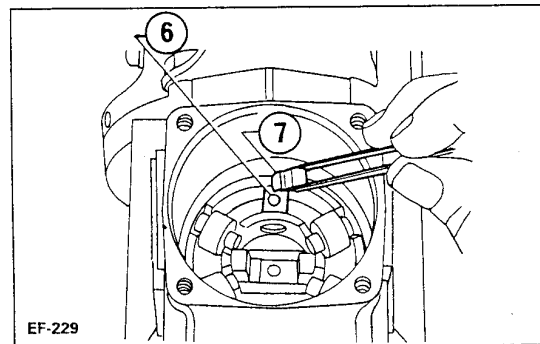


8. Align the holes of the roller-carrier adjustment pins (5) and the advance indicator.



EF-228

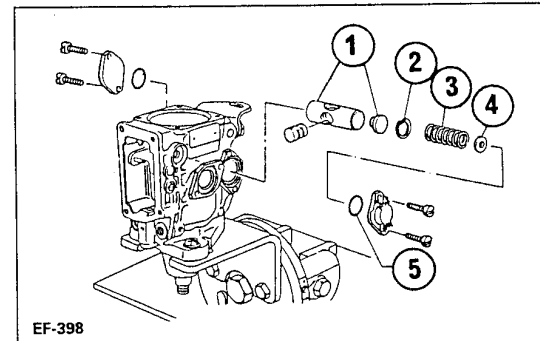
9. Install the assembly formed by the plunger (1), and slider (2) of the advance indicator.
  - a. Make sure that the slider hole (3) faces the roller-carrier.
  - b. Make sure that the concave opening (4) of the plunger is on the same side as the return hole (5).



EF-229

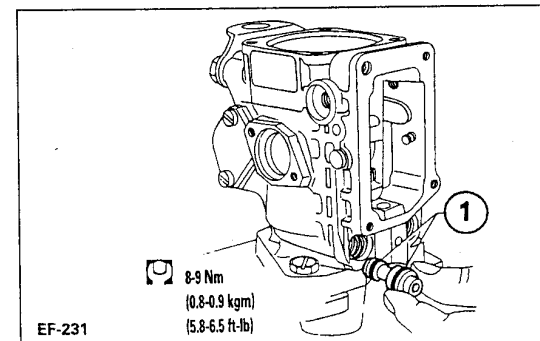
10. Insert the distributor adjustment pin (6) in the plunger slider and secure it with the retaining pin and clip (7).

Check that the advance plunger slides smoothly.



EF-398

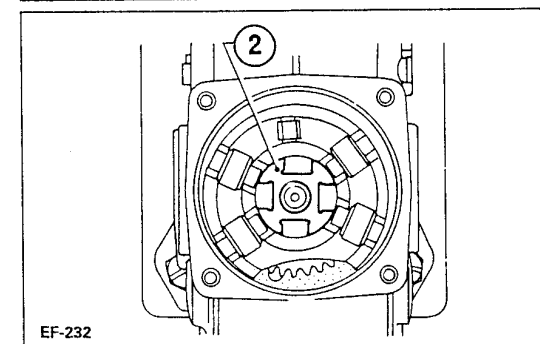
11. Install the advance assembly (1), using a 0.6 mm (0.024 in) spacer, and then fit the spring (2), spacer (3), O ring (4) and advance assembly cover, in this order.
  - a. Use at least one spacer at each side of the plunger spring.
  - b. Use only spacers that have been selected on the test bench.



EF-231

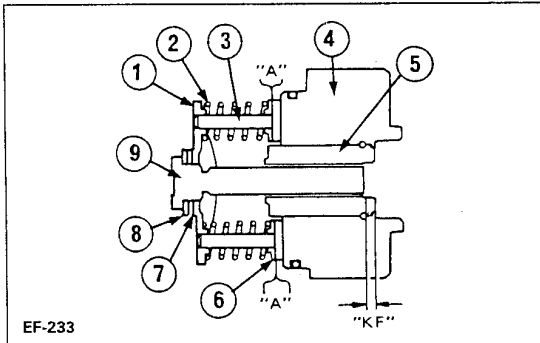
12. Install the regulating valve.
 

Take care not to damage the O rings (1).

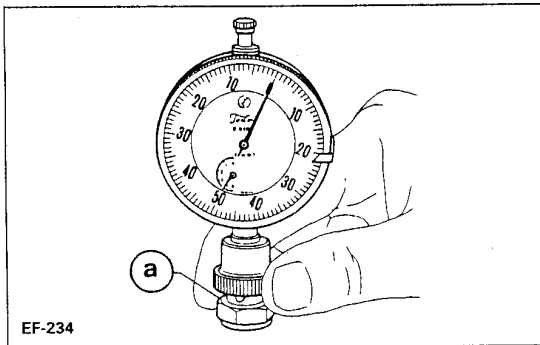


EF-232

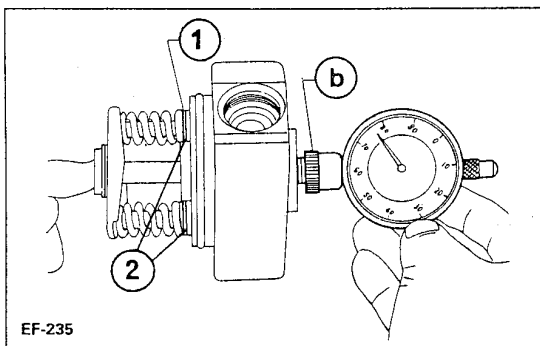
13. Install the drive disc (2), with the concave face upwards.



- |                         |                |
|-------------------------|----------------|
| 1. Spring seat          | 6. Spring seat |
| 2. Plunger spring       | 7. Washer      |
| 3. Guide pin            | 8. Spacer      |
| 4. Distributor cylinder | 9. Plunger     |
| 5. Distributor head     |                |



a: KV-112-29042



b: KV-112-29042

1. Spring seat
2. With spacers

14. Measure the length of the installed plunger (dimension "KF").

Dimension "KF" is the distance between the end faces of the distributor cylinder and the plunger.

- a. Install the distributor head as shown in the figure.
  - Do not insert the spacer at the position "A", when dimension "KF" is measured.

- b. Adjust the dial indicator for a maximum travel of 25 mm (0.98 in) and reset it to zero.

- c. Without compressing the plunger spring, apply force in an axial direction to the underside of the plunger, and measure the dimension "KF" with the dial indicator, as shown in the figure.

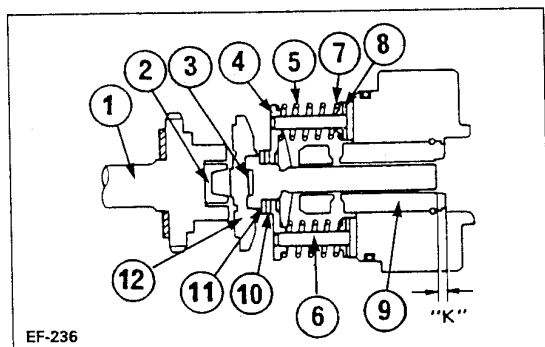
- d. Determine the spacer to be used, calculating the difference between the original dimensions and those obtained during the measurement.

To determine the dimension "KF", see the Section "TECHNICAL DATA AND SPECIFICATIONS".

Example:

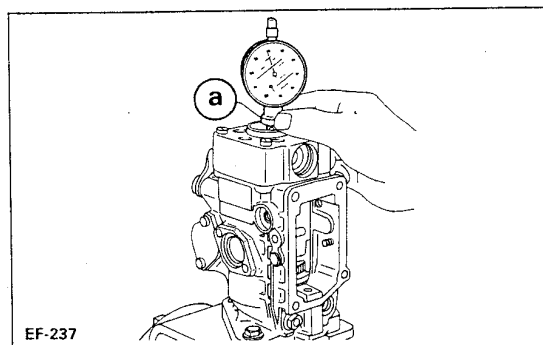
The measured value (indicator reading) is 6.54 mm (0.257 in).  
 "KF" 6.54 mm (0.257 in) = spacer thickness.

- a. When spacers of the specified size are not available, use the next larger size.
- b. Use the same size spacers on both sides of the distributor head.
- c. To determine the spacers available, see the Section "TECHNICAL DATA AND SPECIFICATIONS".



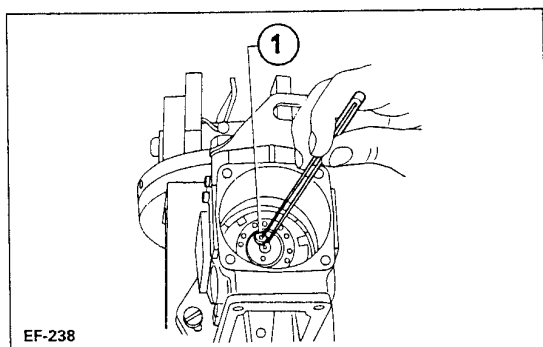
EF-236

1. Operating shaft
2. Drive disc
3. Spacer
4. Spring seat
5. Plunger spring
6. Guide pin
7. Spring seat
8. Spacer
9. Distributor cylinder
10. Washer
11. Spacer
12. Cam disc



EF-237

a: KV-112-29042



EF-238

15. Adjusting the plunger dimensions (measuring the dimension "K").

Dimension "K" is the distance between the end of the distributor cylinder and the upper end of the plunger, when the plunger is at its lowest position.

a. Install the parts as shown in the figure.

- Do not install the spring that goes between the drive disc and the cam disc.
- When fitting the plunger on the cam disc, make sure that the cam disc mounting pin is housed in the groove at the bottom of the plunger.

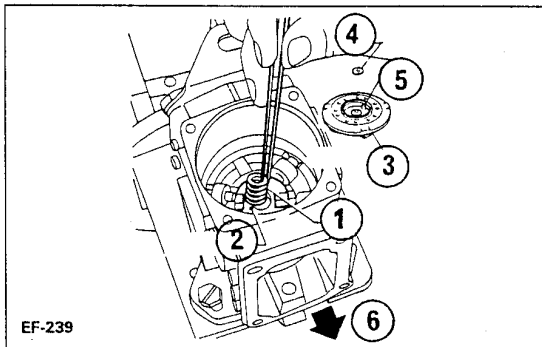
b. Using a dial indicator, measure the dimension as shown in the figure.

- Turn the operating shaft so that the plunger is at the bottom of its stroke.
- Firmly tighten the distributor head with its bolts.

c. Determine the spacer (1) to be fitted, calculating the difference between the measured value (indicator reading and the original dimension "K", and place the spacer on the cam disc.

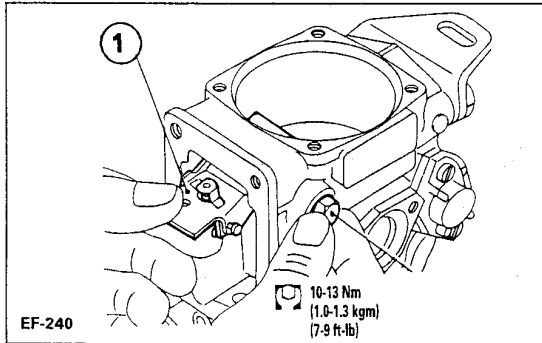
To determine the dimension "K", see the Section "TECHNICAL DATA AND SPECIFICATIONS".

- a. When the measured value is greater than the original dimension "K", use a thicker spacer.
- b. Once the spacer is installed, measure the dimension again to ensure that it is correct.
- c. To determine the spacers available, see the Section "TECHNICAL DATA AND SPECIFICATIONS".



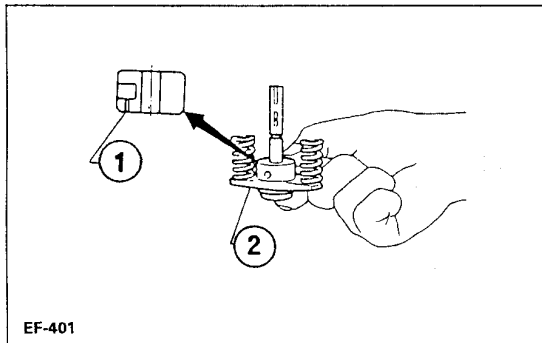
16. Place the spring (1) on the top of the drive disc (2), and fit the cam disc (3) and spacer (4) in this order.

Check that the cam disc mounting pin (5) and the operating shaft key are towards the adjustment lever (6).



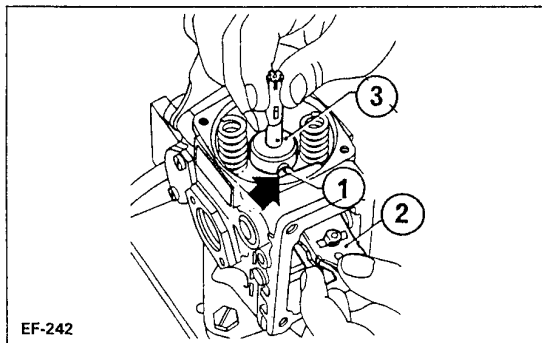
17. Install the adjustment lever (1).

Do not pull on the normal starting or idling speed springs.



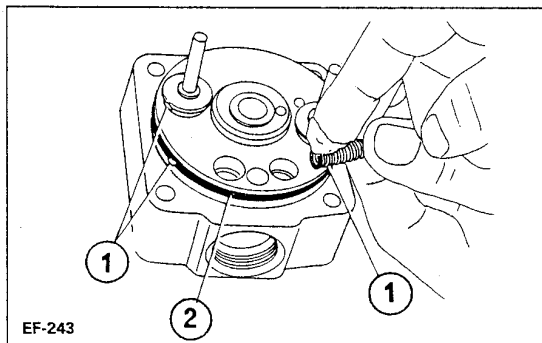
18. Install the plunger assembly.

a. Check that the control cylinder is installed with the smaller hole (1) towards the spring seat (2).



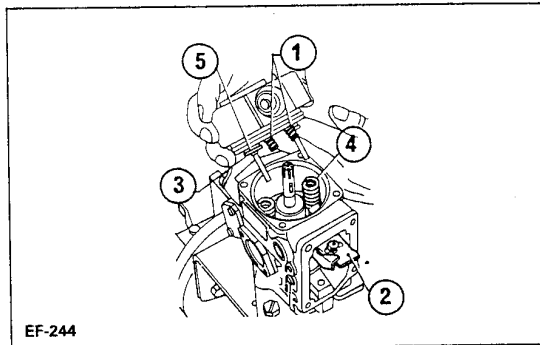
b. When installing the plunger and spacer on the cam disc, check that the cam disc mounting pin is housed in the groove at the bottom of the piston.

c. Insert the ball pin (1) of regulating lever (2) in the opening of the control cylinder (3) (indicated by the arrow).

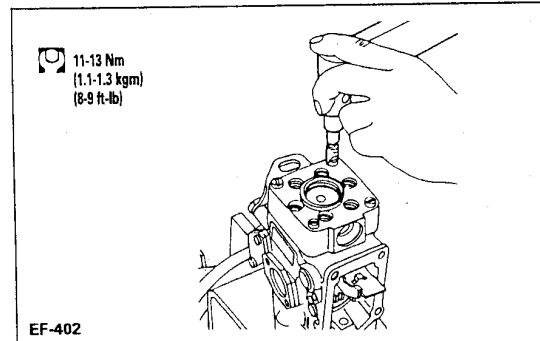


19. Apply grease (1) to the guide pin, spacer and spring seat, and connect the parts to the distributor head.

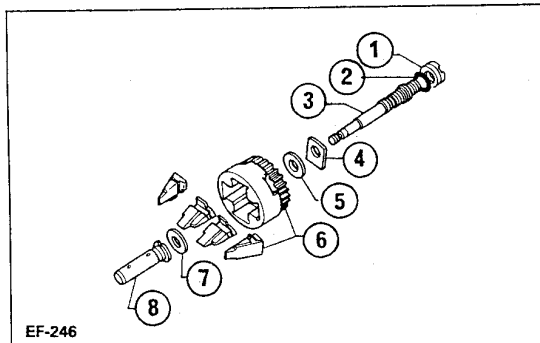
a. Take care not to damage the O ring (2) when installing the distributor head.



EF-244

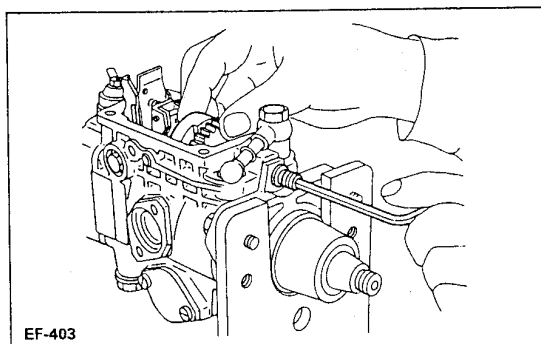


EF-402



EF-246

1. Locknut
2. O ring
3. Governor shaft
4. Spacer
5. Washer
6. Inertia counterweight assembly
7. Spacer
8. Regulating sleeve



EF-403

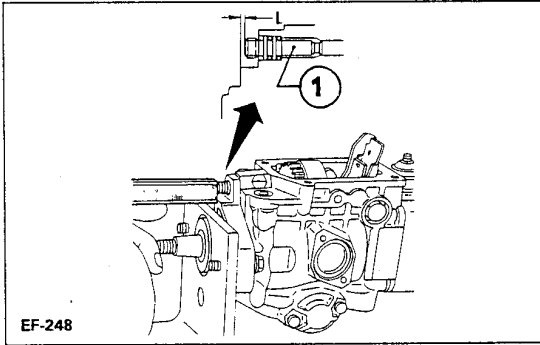
20. Install the distributor head.

- a. Always fit the springs of support (1) facing the regulating lever (2).
- b. Take care that the springs (1) do not drop.
- c. Check that the ball pin of the regulating lever is correctly inserted in the control cylinder hole.
- d. Once the distributor head is installed, check that the guide pin is housed in the orifice of the spring seat (3), spring (4) and spacer (5).

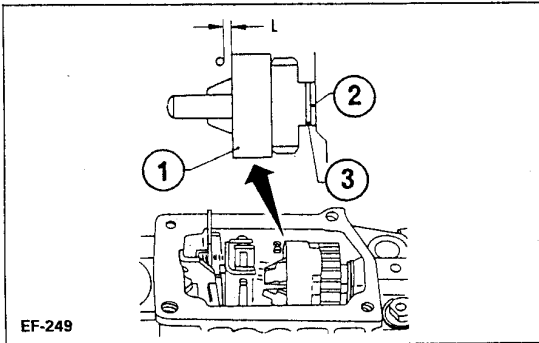
21. Tighten the distributor head.

22. When installing the governor shaft, take care not to damage the O rings.

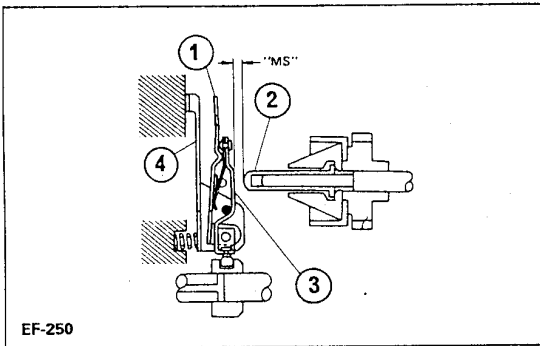
When installing the governor shaft, take care not to damage the O rings.



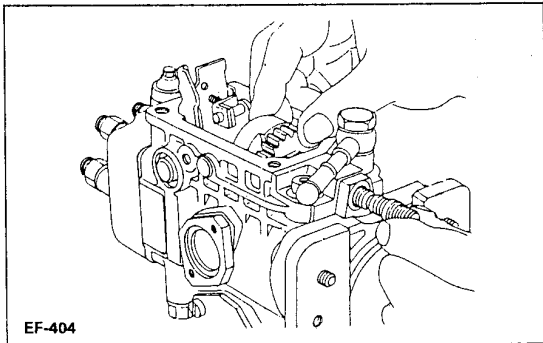
1. Governor shaft



1. Inertial counterweight support  
2. Spacer  
3. Washer



1. Tension lever  
2. Seal plug  
3. Starting lever  
4. Selector lever




EF-404

23. Adjust the dimension "L" as shown in the figure.

"L": 1.5-2.0 mm (0.059-0.079 in)

a. Tighten the locknut to the specified torque.

 25-29 Nm  
(2.5-3.0 kgm) (18-22 ft-lb)

b. The governor shaft has a left-hand thread for fuel injection pumps with clockwise (R) rotation and a right-hand thread for those with counterclockwise (L) rotation.

24. Measure the end float of the inertial counterweight support. If it is not within the specified value, it must be adjusted by using the appropriate spacer.

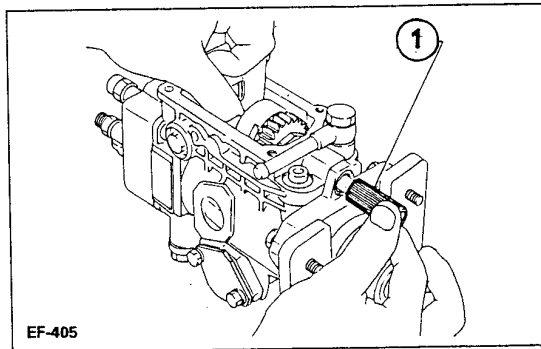
"L": 0.05-0.35 mm (0.0059-0.0138 in)

25. Measure the dimension "MS" (to determine the initial fuel injection volume).

Dimension "MS" is the distance between the seal plug and the starting lever.

a. Remove the locknut, governor shaft and inertial counterweight assembly.

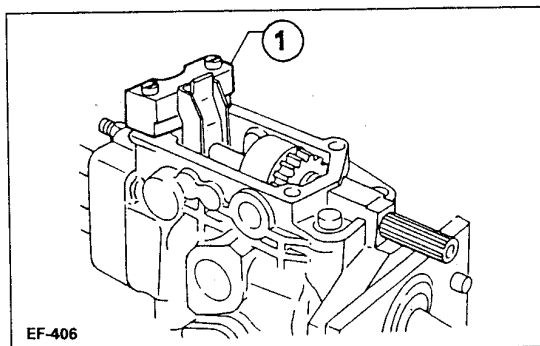




1. KV-112-29820

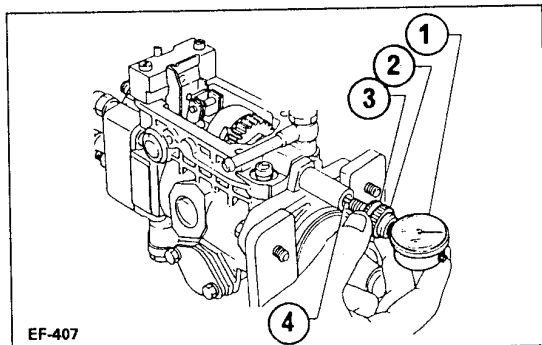
b. At the inertia counterweight assembly, substitute the governor shaft for the special tool.

When reassembling the inertia counterweight assembly, do not forget to fit the spacer and washer.



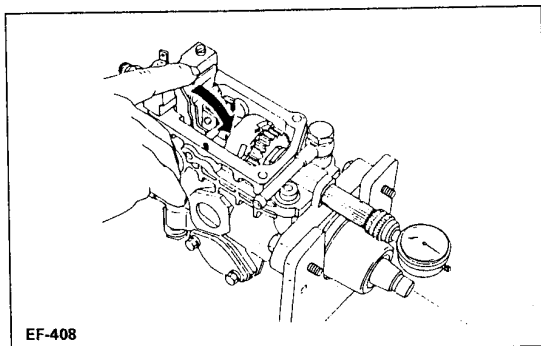
1. KV-112-29110 (RD28)  
KV-112-29752 (RD28T)

c. Fit the special tool (indicator block) on the pump casing.

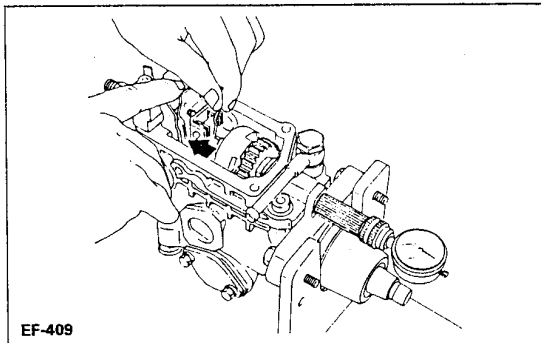


1. KV-112-54410      3. KV-112-29350  
2. KV-112-29360      4. KV-112-29830

d. Fit the dial indicator and the rod (See Special Tools).



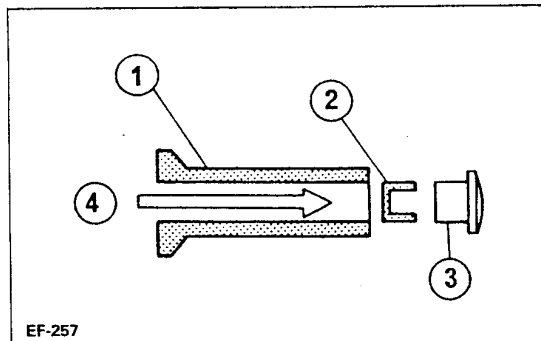
e. Push the regulating sleeve against the inertia counterweights. Hold the regulating sleeve in this position and set the dial indicator to zero.



EF-409

- f. Push the tension lever until it makes contact with the plug pin. Move the regulating sleeve until the starting lever makes contact with the tension lever. Now note the indicator reading.

To determine the dimension "MS", see the Section "TECHNICAL DATA AND SPECIFICATIONS".

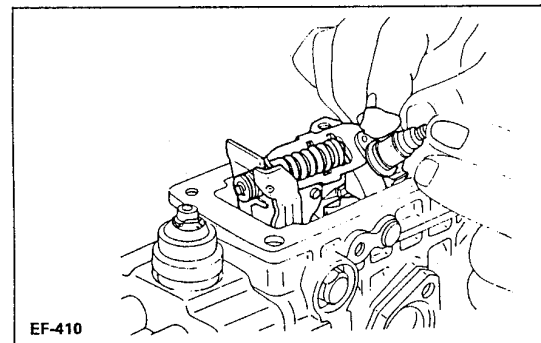


EF-257

- g. If the indicator reading does not comply with the specifications, replace the seal plug and adjust the distance "MS" to the specified value.

To determine the parts available, see the Section "TECHNICAL DATA AND SPECIFICATIONS".

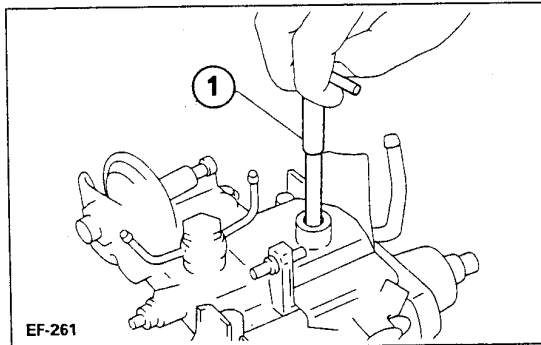
1. Regulating sleeve
2. Locking plug
3. Seal plug
4. Push



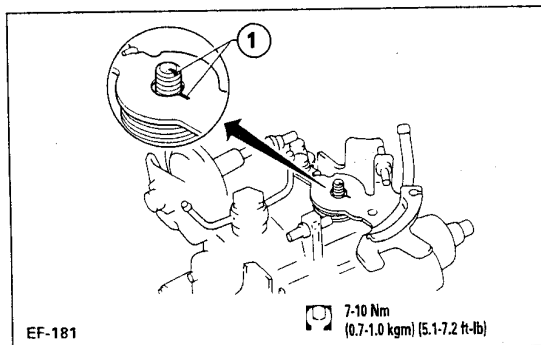
EF-410

26. Install the control lever shaft.

Apply grease to the end of the lever shaft.

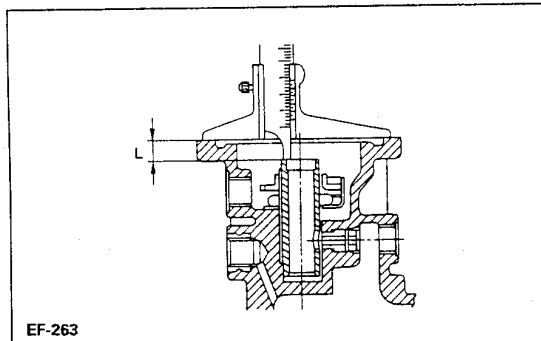


1. KV-112-29072

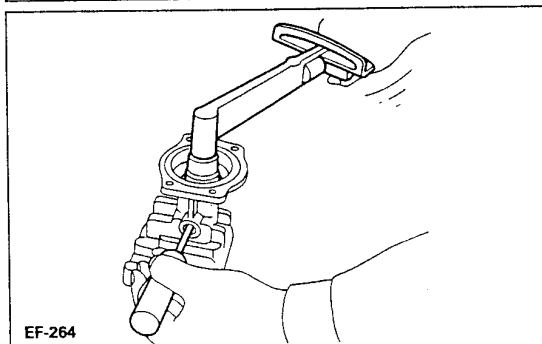


EF-181

7-10 Nm  
(0.7-1.0 kgm) (5.1-7.2 ft-lb)



EF-263



EF-264

## GOVERNOR COVER

### Without compensator

1. Install the governor cover.

2. Install the control lever assembly.

Align the marks (1) of the speed control lever and the control shaft.

### With compensator

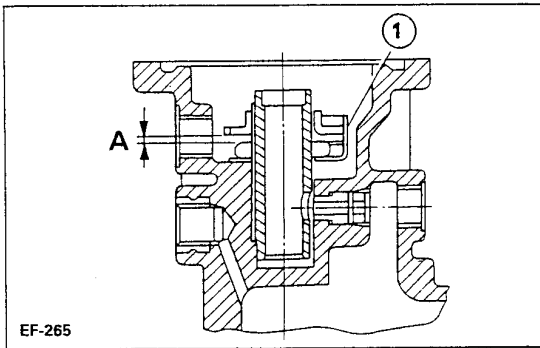
1. Position the adjustment rod bush so that its height above the top surface of the distributor cover is within the specified value.

$$L = 7.5 \pm 0.5 \text{ mm (0.295} \pm 0.020 \text{ in)}$$

Check that the rod bush adjustment holes and the governor cover are correctly aligned.

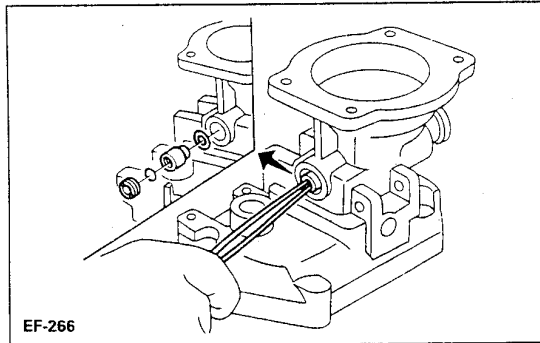
2. Install the plate and locknut.

$$\text{25-34 Nm (2.5-3.5 kgm) (18-25 ft-lb)}$$

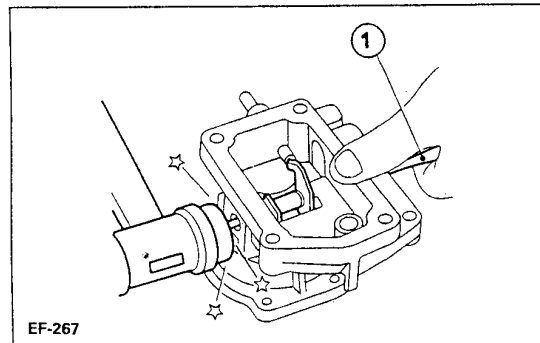


3. Tighten the locknut (1) fully and then back it off about 2.5 turns.

A = 2.5 mm (0.098 in)



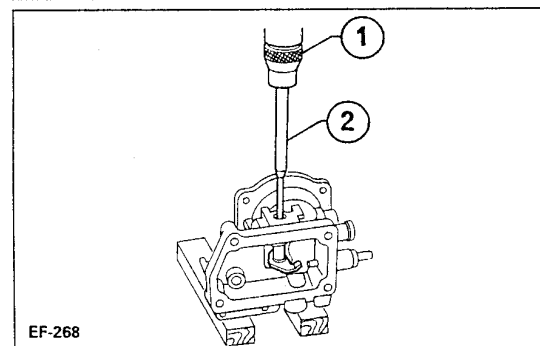
4. Install the washer, sleeve and oil seal.



5. Fit the pin.

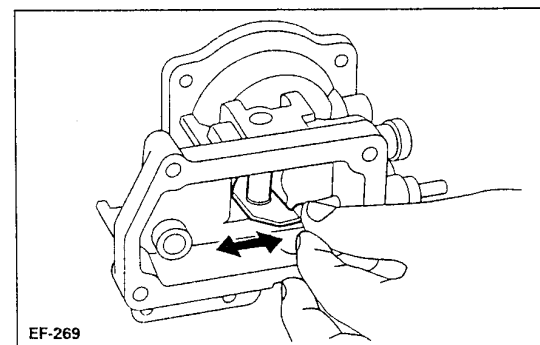
6. Press-fit the lever.

- Fit the pin on the right hand side when seen from the drive shaft.
- Use a suitable bar (1) as guide to install the lever correctly.

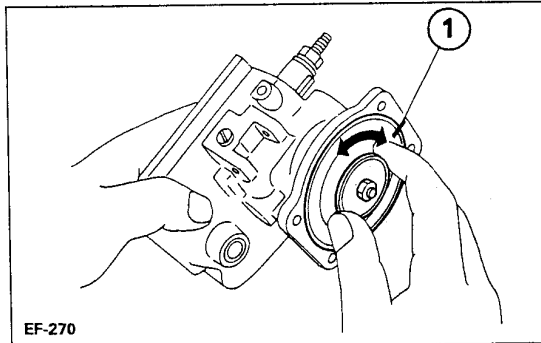


- Insert the pin until the head is about 10 mm (0.39 in) below the surface.

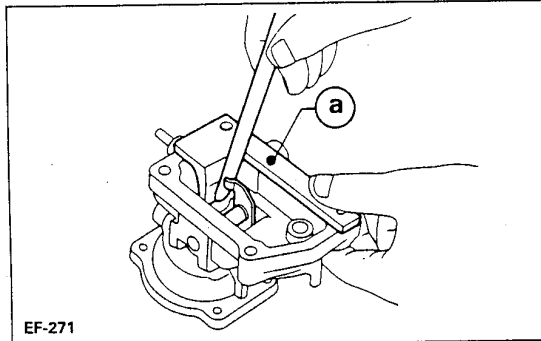
1. Press
2. Special tool



- Check that the lever moves freely.



EF-270



EF-271

a. KV-112-29762

7. Checking the position of the lever.

- a. Fit a calibrator block.
- b. Install the diaphragm assembly. Slide it until resistance is felt. Check that the mark (1) is aligned.

c. Install the diaphragm cover.

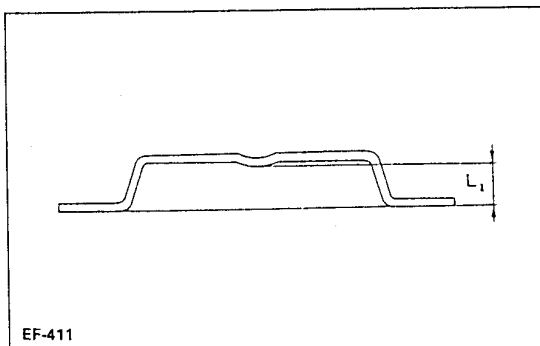
- d. Measure the distance between the calibrator block and the lever.

Clearance: 0.05 mm (0.0020 in)

8. Determine the thickness of the spacer.

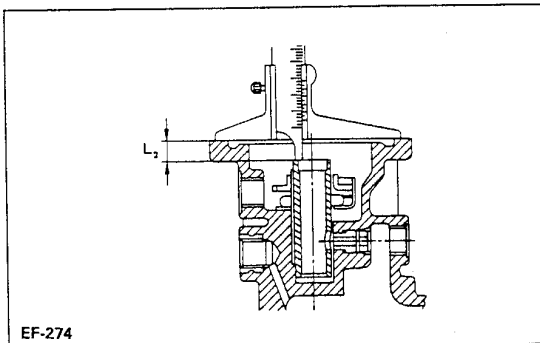
It will not be necessary to adjust the compensator stroke, if the following points have been observed during removal.

- The diaphragm bolt located on the diaphragm cover has not been removed.
- The compensator spacer has not been changed.
- The diaphragm assembly has been replaced in the originally marked position.



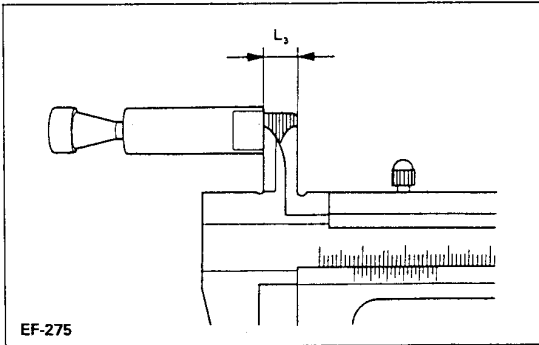
EF-411

- a. Remove the diaphragm cover and measure the distance (L1) between the cover and the inner stop. See figure.

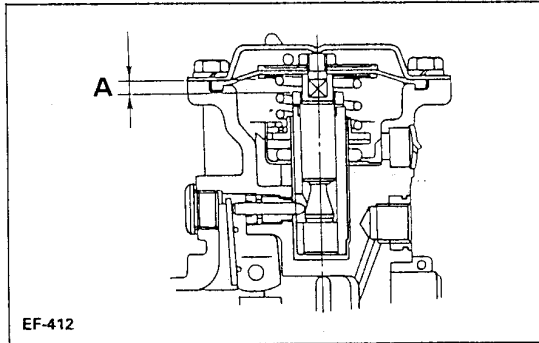


EF-274

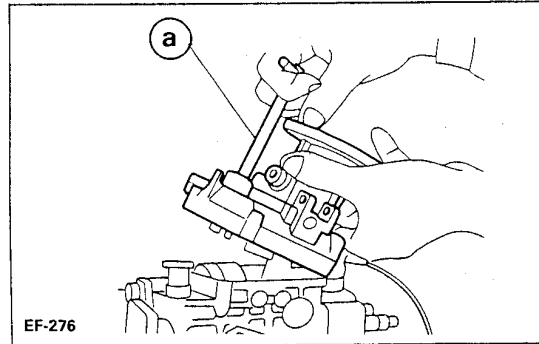
- b. Measure the distance (L2) between the bush and the governor cover. Note down the result.



EF-275

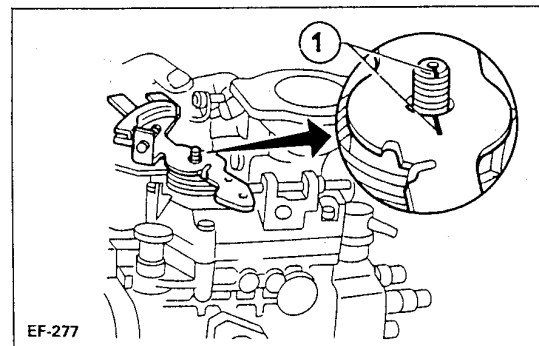


EF-412



EF-276

a. KV-112-29072



EF-277

c. Measure the length ( $L_3$ ) of the pin thread, and note down the result.

d. Determine the thickness of the spacers by means of the equation:

**Spacer thickness**  
 $= L_1 + L_2 - L_3) - \text{compensator stroke (A)}$

**Example:**

$L_1 = 10.5 \text{ mm (0.413 in)}$

$L_2 = 7.5 \text{ mm (0.295 in)}$

$L_3 = 10.5 \text{ mm (0.413 in)}$

**Compensator stroke = 3.7 mm (0.145 in)**

**Spacer thickness**

$= (10.5 + 7.5 - 10.5) - 3.7$

$(0.413 + 0.295 - 0.413) - 0.145$

$= (18.0 - 10.5) - 3.7 (0.508 - 0.413) - 0.145$

$= 7.5 - 3.7 (0.295 - 0.145)$

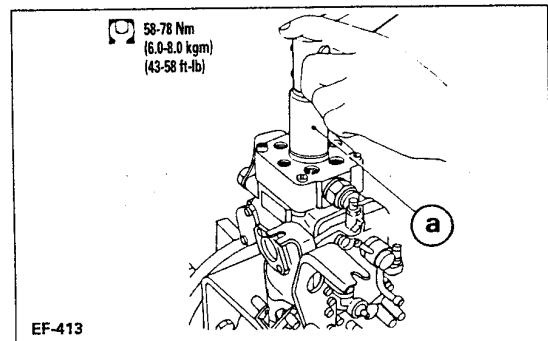
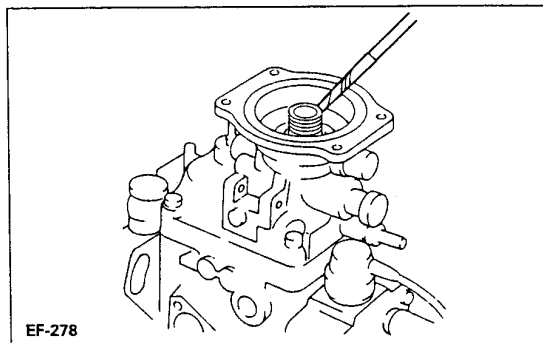
$= 3.8 \text{ mm (0.149 in)}$

To determine the parts available and the compensator stroke, see the Section "TECHNICAL DATA AND SPECIFICATIONS".

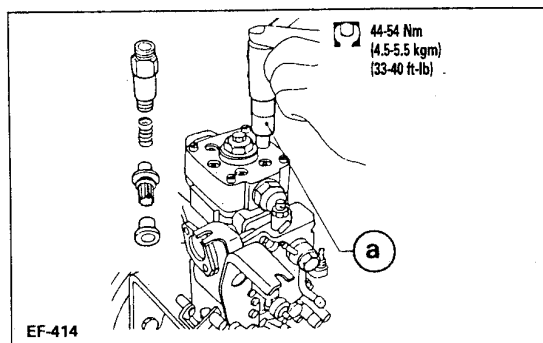
9. Install the governor cover.

10. Install the control lever.

Align the marks (1) of the control lever and its shaft.



a. KV-112-14250



a. KV-112-14110

11. Install the compensation spring.
12. Fill the bush with the recommended oil.  
**Recommended oil type: Shell Clavus.**  
**Capacity: 4-5 cm<sup>3</sup> (3.5-4.4 qt)**
13. Install the diaphragm assembly along with the spacer.  
**Insert the diaphragm assembly until resistance is felt.**  
**Check that the marks are aligned.**
14. Install the diaphragm cover.


15. Install the fuel shut-off solenoid valve and the plug.  
**Always replace the plugs.**

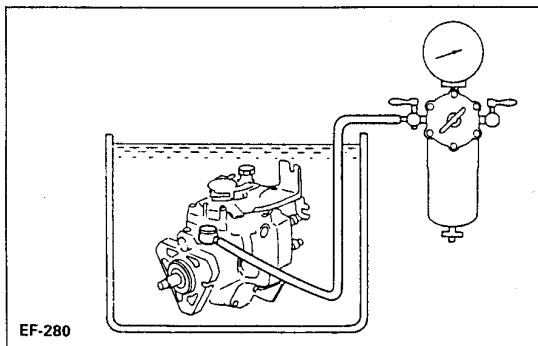
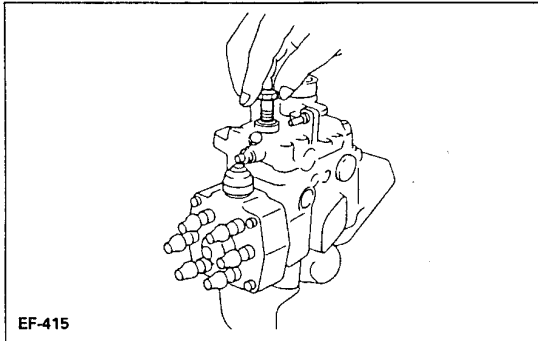
16. Install the flow valve.
  - a. **Always use new washers.**
  - b. **Check that the flow valve is fitted in its original position.**

### COLD STARTING DEVICE

Install the cold starting device.

**Always use a new O ring.**

-  Cold starting device retaining bolt  
5-7 Nm (0.5-0.7 kgm) (3.6-5.1 ft-lb)



### TIGHTENESS TEST

1. Substitute the leak-off outlet adapter for a bolt.
2. Connect a compressed air pipe to the fuel inlet and submerge the pump in a container of fuel.
3. Apply a pressure of 392 kPa (3.9 bar) (4 kg/cm<sup>2</sup>) (57 lb/in<sup>2</sup>) and check for leaks; if there are any, repair them.

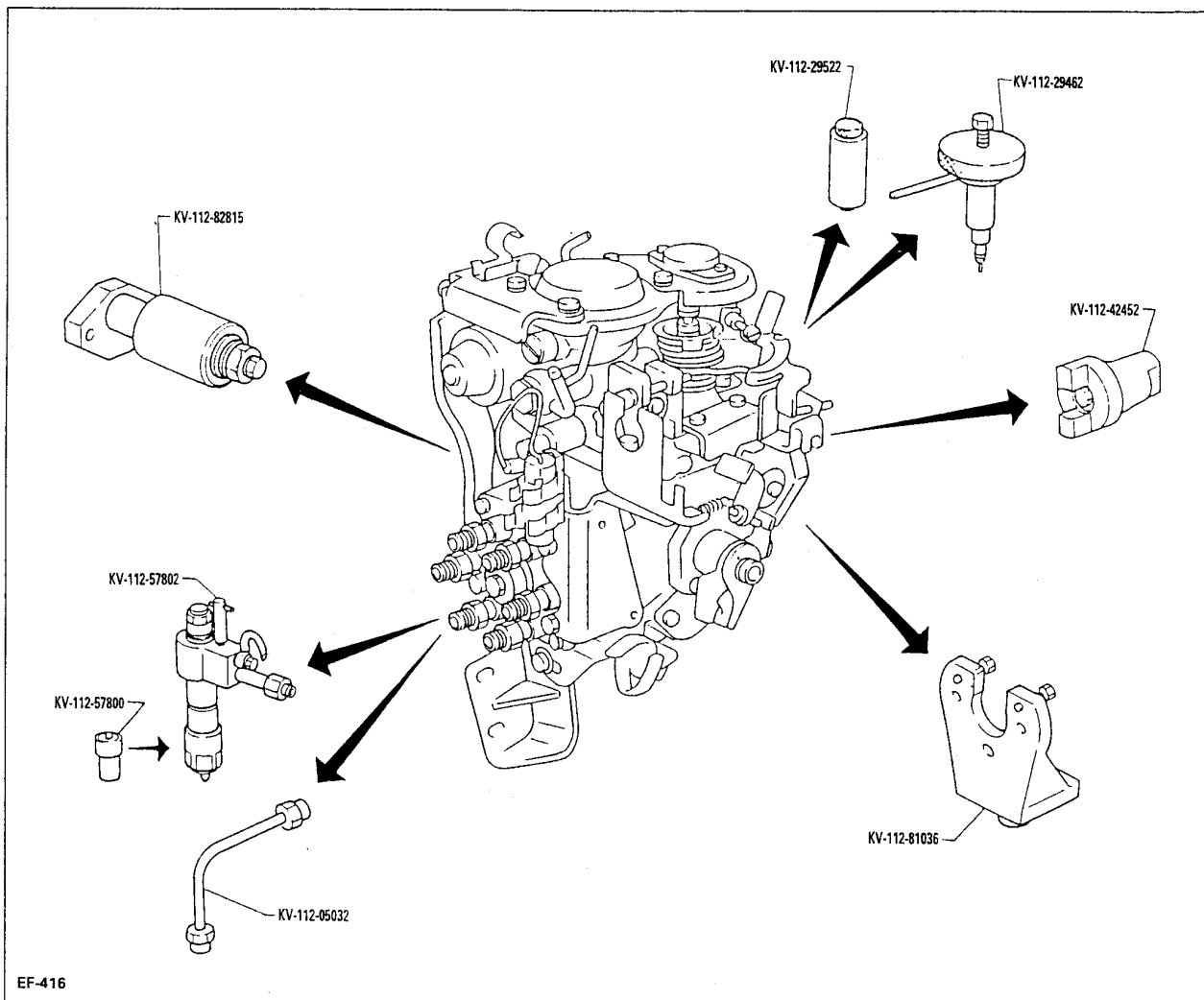


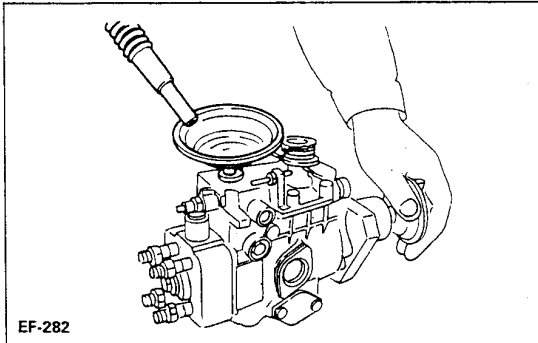
INSPECTION AND ADJUSTMENT

FUEL INJECTION PUMP TEST CONDITIONS

Injector		KV-112-57800
Nozzle body assembly		KV-112-57802
Initial injector pressure	kPa (bar) (kg/cm <sup>2</sup> ) (lb/in <sup>2</sup> )	14,711-15,201 (147.1-152.0) (150-155) (2,133-2,204)
Injector pipe		KV-112-05032
Inside diameter × outside diameter × length	mm (in)	2.0 × 6.0 × 840 (0.079 × 0.236 × 33.07)
Fuel supply pressure	kPa (bar) (kg/cm <sup>2</sup> ) (lb/in <sup>2</sup> )	20 (0.20) (0.2) (2.8)
Liquid (test oil)		ISO 4113 or SAE J967d
Fuel temperature	°C	45-50
Rotation		Clockwise
		(when seen from operating shaft)
Injection order		1-5-3-6-2-4

1. Prepare the necessary special tools.

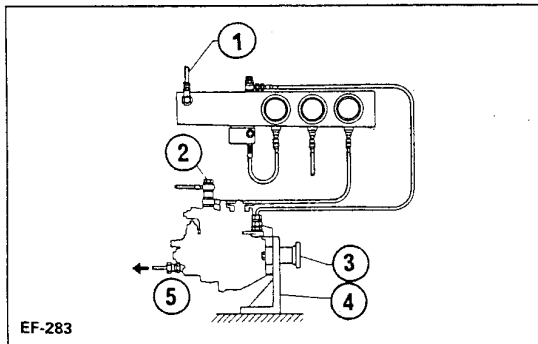




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2. Pour test oil in the fuel injection pump.

The test oil should be of the types ISO 4113, SAE J967d or equivalent.

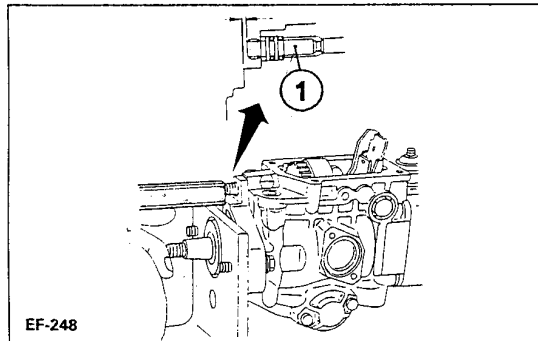


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3. Connect the fuel injection pump to the test equipment.

4. Connect the necessary pipes.

1. Fuel inlet from the test equipment
2. Relief valve
3. Coupling
4. Support
5. To injector nozzle assembly



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5. Check that the regulating shaft is correctly installed.

$L = 1.5-2.0 \text{ mm (0.059-0.079 in)}$

1. Regulating shaft

6. Start the pump, taking the following conditions into account:

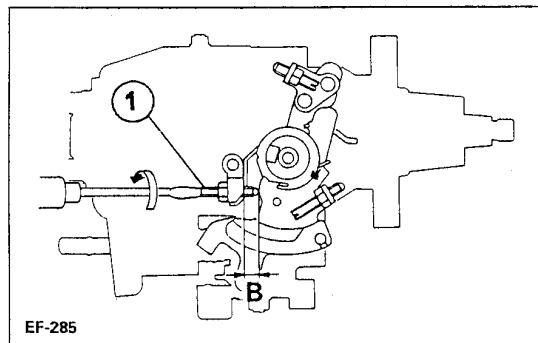
- a. Maintain the temperature of the test oil in the reservoir at  $45-50 \text{ }^\circ\text{C (113-122 }^\circ\text{F)}$ .
- b. Adjust the control lever to "full power" by means of a spring.

1. Maximum speed adjustment screw

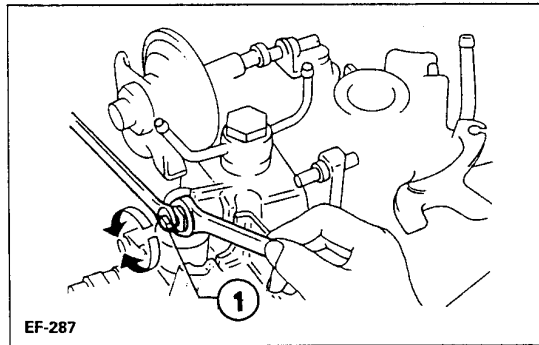
Set the maximum speed adjustment screw to the position shown, by turning it counterclockwise.

- c. Apply 12 V to the fuel shut-off solenoid valve so as to activate it.
- d. Turn over the fuel injection pump by hand, to check that it rotates freely.
- e. Operate the fuel injection pump at 300 rpm, to check that all the air contained in the pump chamber is expelled via the relief valve.
- f. Adjust the oil supply pressure to 20 kPa (0.20 bar) ( $0.2 \text{ kg/cm}^2$ ) ( $2.8 \text{ lb/in}^2$ ).
- g. Operate the fuel injection pump at 1000 rpm for ten minutes.

If fuel leaks, injection faults or abnormal noises are observed, stop the pump testing equipment immediately and check the fuel injection pump for faults.



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1. Full-load adjustment screw

**Maximum flow preliminary adjustment**

1. Set the control lever at the "full-load" position, either by pulling on the spring or by means of suitable tools.

Set the maximum speed adjustment screw to the position shown, by turning it counterclockwise. See "TEST DATA", Page 33.

2. Apply 12 V to activate the fuel shut-off solenoid valve.
3. Operate the fuel injection pump at the specified rpm and measure the injected fuel flow.

To determine the adjustment value of the fuel volume injected at full-load by the test equipment, see the Section "TECHNICAL DATA AND SPECIFICATIONS".

4. Calculate the permissible variation in the injected fuel flow.

$$\text{Permissible variation} = \frac{\text{max. or min. injected flow}}{\text{Average injected flow}}$$

5. If the value corresponding to the permissible variation is not within the specified limits, replace the flow valve assembly.

**Feed pump pressure adjustment**

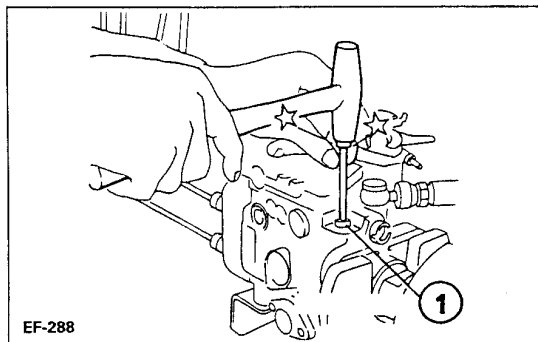
1. Repeat Points 1 and 2 of the Sub-Section "Maximum Flow Preliminary Adjustment".
2. Measure the feed pump pressure at the specified rpm of the fuel injection pump.
  - a. When the measured pressure is lower than the specified value.

Insert the plug in the regulating valve body.

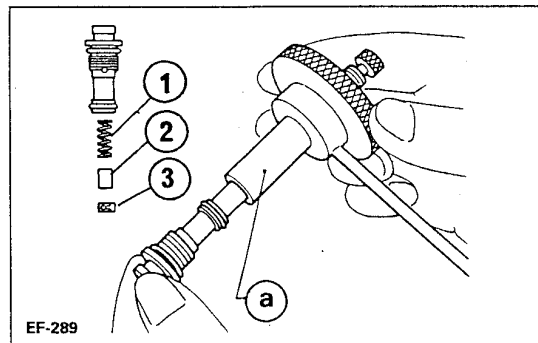
Be careful not to insert the plug too far.

- b. When the measured pressure is above the specified value.

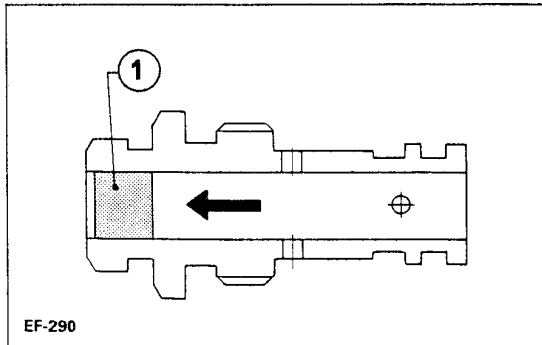
— Disconnect the regulating valve from the fuel injection pump and, using the special tool (a), remove the regulating valve.



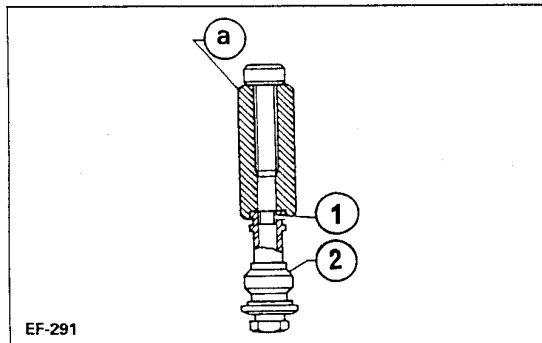
1. Regulating valve



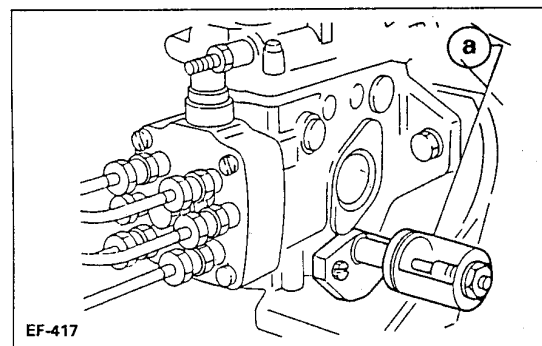
1. Spring
  2. Piston
  3. Circlip
- a. KV-112-29462



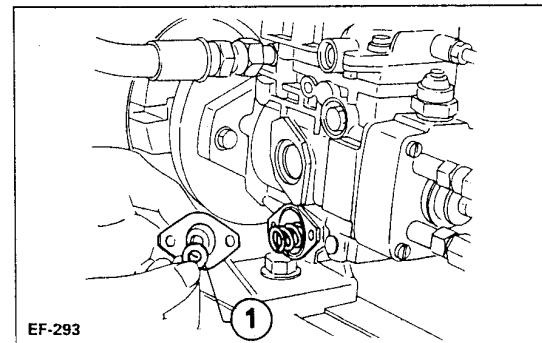
1. Plug



1. Circlip  
2. Regulating valve  
a. KV-112-29522



a. KV-112-82815




1. Spacer

— Push the plug outwards until it is flush with the outside of the regulating valve.

— Install the spring, piston and circlip, in this order, in the regulating valve.

When inserting the circlip in its housing, make sure that it is flush with the outer face of the valve body.

— Connect the regulating valve to the fuel injection pump.

 **Regulating valve**  
8-9 Nm  
(0.8-0.9 kgm) (5.8-6.5 ft-lb)

— Adjust the feed pump pressure in accordance with the specifications. See Point 2 on Page 39.

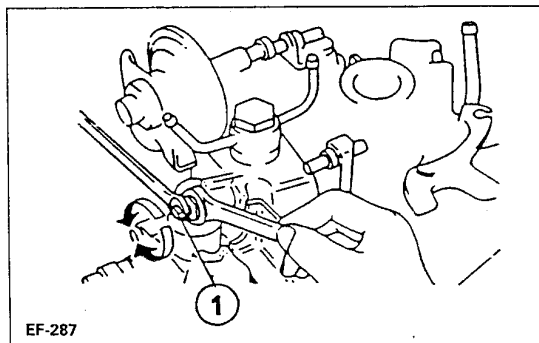
3. Check the fuel injection pump conditions, with regard to the inspection values of the pump testing equipment.

**Advance adjustment**

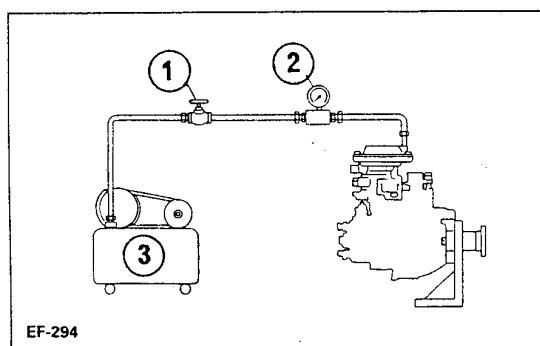
1. Repeat Points 1 and 2 of the Sub-Section "Maximum flow preliminary adjustment".
2. Remove the cover from the high pressure side (side without spring) of the advance, and connect the special tool to that side.
3. Measure the advance piston stroke at the rpm specified for the fuel injection pump.

To determine the adjustment value of the advance piston stroke, see the Section "TECHNICAL DATA AND SPECIFICATIONS".

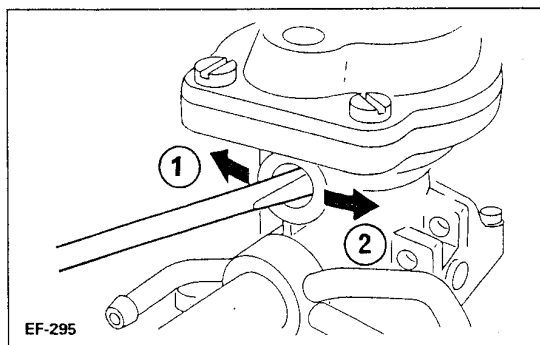
4. If the advance piston stroke is not within the specified values, remove the advance low pressure cover and adjust the piston stroke by adding the required spacers.
  - a. Make sure to place at least one spacer on each side of the advance.
  - b. To determine the parts available, see the Section "TECHNICAL DATA AND SPECIFICATIONS".



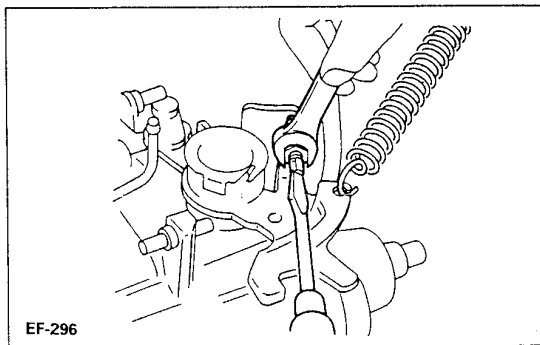
1. Full-load adjustment screw.



1. Regulating valve  
2. Pressure gauge  
3. Air compressor



1. Increase  
2. Decrease



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### Full-load fuel injection adjustment

1. Set the full-load control lever by pulling on the spring or by using the suitable tools.
2. Apply 12 V to activate the fuel shut-off solenoid valve.
3. Measure the fuel injected at the specified rpm of the fuel injection pump.
4. If the injected fuel flow is not within the original values, adjust it by turning the full-load screw.
5. Check the fuel injection pump conditions in relation to the inspection values.

### With compensator

- Adjust by modifying the compensator adjustment pressure.

To determine the full-load injection volume, see the Section "TECHNICAL DATA AND SPECIFICATIONS"

If the injection flow is not in accordance with the specified value, turn the locknut.

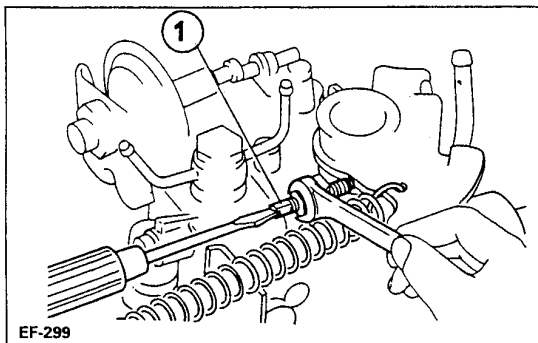
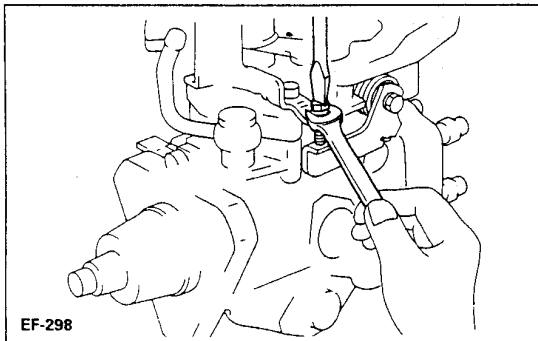
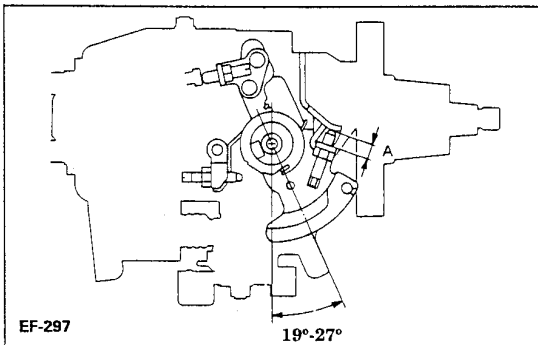
Take care not to damage the threads.

### Fuel injection adjustment at idling speed.

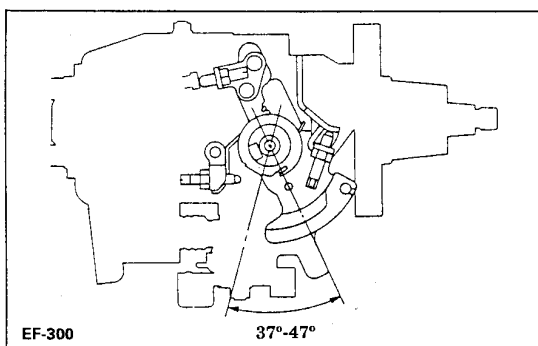
1. Pull on the spring until the idling speed adjustment screw comes into contact with the stop.
2. Apply 12 V to activate the fuel shut-off solenoid valve.
3. Measure the fuel injection at the rpm specified for the fuel injection pump.

To determine the value of the fuel injection volume adjustment, see the Section "TECHNICAL DATA AND SPECIFICATIONS".

4. If the fuel injection is not in accordance with the specified values, adjust it by turning the idling speed screws.
  - a. When this screw is tightened, it increases the fuel injection flow.



1. Maximum speed adjustment screw



- b. Check that the control lever angle is between 19° and 27°.

If the control lever angle is not within the specified range, adjust it by modifying the position of the lever on the control shaft. (One tooth is equivalent to 15°).

After replacing the control lever, measure the injected fuel flow at idling speed again.

5. Check the fuel injection pump conditions in relation to the inspection values.

#### Fuel injection adjustment during starting

1. Set the full-load control lever by pulling on the spring or by using suitable tools.
2. Apply 12 V to activate the fuel shut-off solenoid valve.
3. Measure the injected fuel at the rpm specified for the fuel injection pump.

To determine the adjustment value of injected fuel initial flow, see the Section "TECHNICAL DATA AND SPECIFICATIONS".

4. If the value is not within the specified limits, adjust the control lever screw.

Check that dimension "MS" is within the specified values. See Point 25 of the Sub-Section "Replacing the fuel injection pump". (Page 28).

#### Fuel injection adjustment at maximum speed of the pump

1. Set the control lever at the full-load position, by pulling on the spring or by using the suitable tools.
2. Apply 12 V to activate the fuel shut-off solenoid valve.
3. Measure the fuel injection at the specified rpm.

To determine the adjustment value of the injected fuel flow at maximum pump speed, see the Section "TECHNICAL DATA AND SPECIFICATIONS".

4. If the fuel injection values are not within the original range, turn the maximum speed adjustment screw.

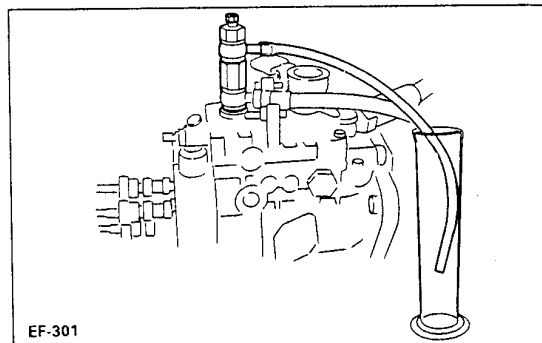
a. When tightening the screw, the fuel injection increases.

b. Check that the control lever angle is between 37° and 47°.

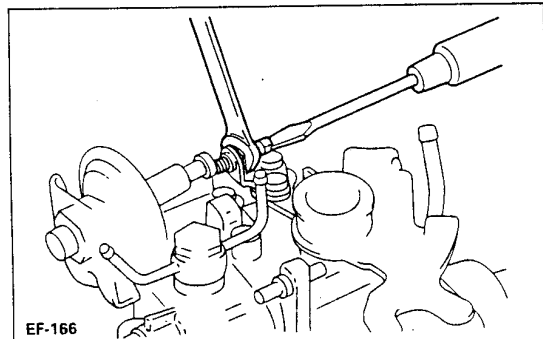
5. Check the fuel injection pump conditions, in relation to the inspection values.

#### Checking the operation of the fuel shut-off solenoid valve.

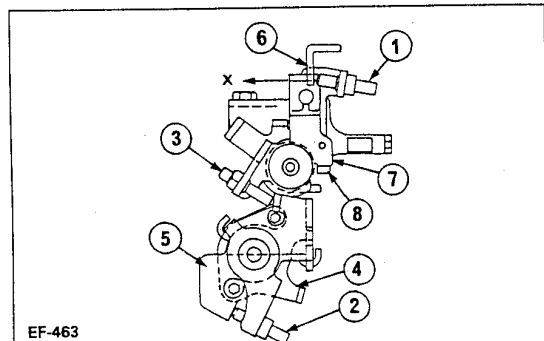
Check that there is no injection when the engine is at idling speed and the solenoid valve current is disconnected. This check should be carried out during approximately 5 seconds.



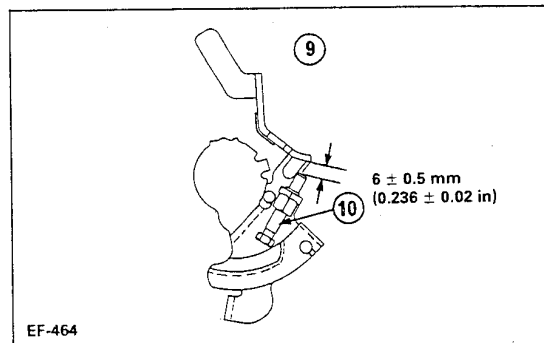
EF-301



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### Measuring the quantity of excess fuel

1. Set the control lever to the full power position, by pulling on the spring or by using the suitable tools.
2. Apply 12 V to activate the fuel shut-off solenoid valve.
3. Measure the excess fuel at the specified rpm of the fuel injection pump.

To determine the inspection value of the excess fuel quantity, see the Section "TECHNICAL DATA AND SPECIFICATIONS".


### DAMPER ADJUSTMENT

Insert a gauge block of  $2.7 \pm 0.05$  mm (0.1063-0.0020 in) RD28 engine and  $3.8 \pm 0.05$  mm (0.1496-0.0020 in) RD28T engine between the idling speed adjustment screw and the retainer, then turn the damper adjustment screw until it makes contact with the rod.

### ACCELERATED IDLING SPEED ADJUSTMENT


#### 1. ACCELERATION CONTROL LEVER ADJUSTMENT

- a) Set the acceleration control lever (6) at the idling speed position.
- b) Move the acceleration control lever (6) clockwise until it makes contact with the stop (4).
- c) In this position, adjust the screw (2) so that the clearance with the lever (5) is  $1.6 \pm 0.2$  mm ( $0.063 \pm 0.008$  in) then tighten the locknut.

 Nut of bolt (2)  
6-9 Nm (0.6-0.9 kgm) (4.3-6.5 ft-lb)

#### 2. SECURING THE INTERMEDIATE LEVER ADJUSTING SCREW


- a) Maintain the lever (5) in the position described in Sub-Section 1, Point (c).
- b) Move the intermediate lever (7) towards "X" and check that it makes contact with the stop (8).
- c) In this position, adjust the screw (3) so that between the bracket (9) and the screw (10), there is a clearance of  $6 \pm 0.5$  mm, then tighten the locknut (1).

 Nut of bolt (1)  
6-9 Nm (0.6-0.9 kgm) (4.3-6.5 ft-lb)

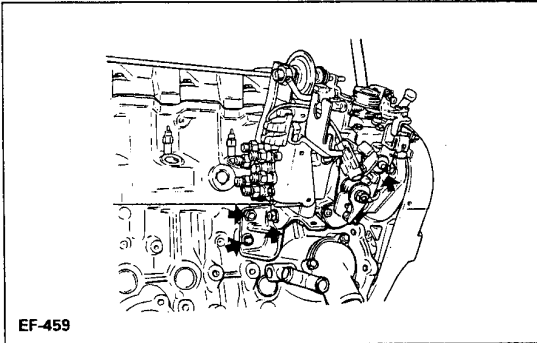
- c) Lastly, check that between the acceleration control lever (6) and the screw (1), there is a clearance of about 1.7 mm.

#### 3. SCREW ADJUSTMENT (1)

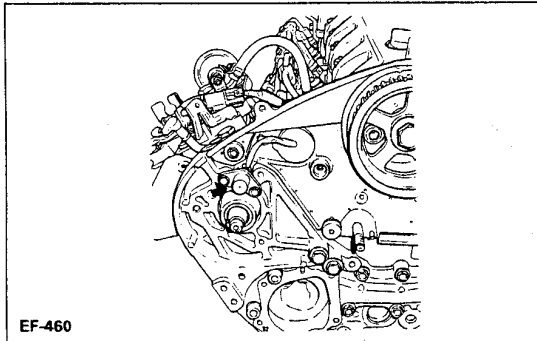
- a) Move the intermediate lever (7) toward "X" until it contacts the stopper (8).
- b) Adjust the position of the screw (1) so that the gap between the idling set bracket (9) and screw (10) is  $6 \pm 0.5$  mm, and fix the screw (1) using the nut.

 Nut of bolt:  
6-9 Nm (0.6-0.9 kgm) (4.3-6.5 ft-lb)

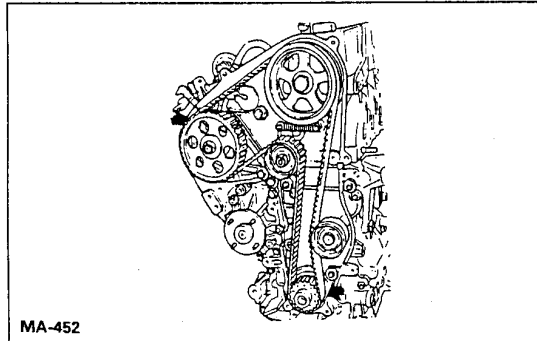
- c) The, confirm that the gap between the control lever (6) and screw (1) is approximately 1.7 mm (0.067 in).



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## REPLACEMENT

Replacement of the fuel injection pump assembly is in reverse order of removal, and taking the following conditions into account:


1. Check that cylinder N.º piston is at the B.D.C. of its expansion stroke.
2. Fit the fuel injection pump on the front and rear brackets.

**Provisionally tighten the fuel injection pump.**

3. Install the engine revolutions sensor and tighten the bolts to the specified torque.

 **Sensor to bracket bolts:**  
7-10 Nm (0.7-1 kgm) (5.1-7.2 ft-lb)

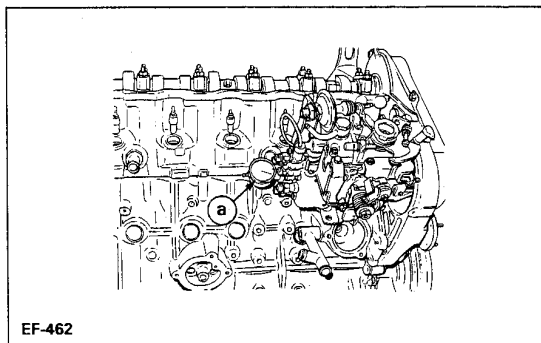
4. Install the fuel injection pump drive gear on the shaft and secure it with the nut.

 **Pump gear nut**  
54-64 Nm  
(5.5-6.5 kgm) (40-47 ft-lb)

5. Install the timing belt, with the marks aligned with those on the timing gears.

See "Replacement of the timing belt" in Section MA.





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a: KV-112-29352

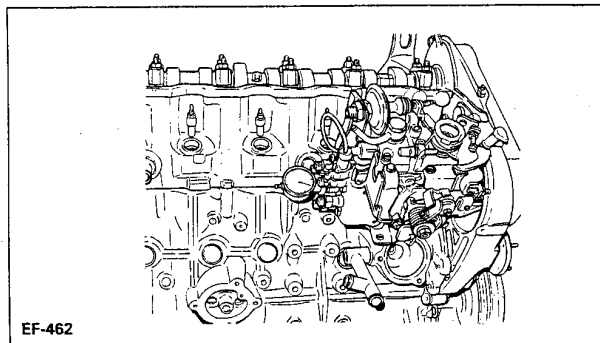
6. Adjust the fuel injection pump synchronisation.
  - a. Remove the plug bolt from the rear of the fuel injection pump and connect the special tool in place of the bolt.
  - b. Make sure to loosen the pump nuts and the bracket bolt.
  - c. Turn the crankshaft (in the normal direction of rotation) until the N.° 1 cylinder piston is at T.D.C. of its compression stroke.
  - d. Turn the crankshaft 20-25° in the opposite direction, finding the rest point of the indicator stylus; in this position, set the dial indicator to 0.
  - e. Turn the crankshaft in the normal direction of rotation, until the N.° 1 cylinder piston is at T.D.C. of its compression stroke.
  - f. The reading on the dial indicator should be:
    - RD28 engine =  $0.75 \pm 0.03$  mm ( $0.0295 \pm 0.0012$  in)
    - RD28T engine =  $0.86 \pm 0.05$  mm ( $0.0339 \pm 0.0020$  in)
  - g. If the indicator reading is not within the specified values, turn the pump body until obtaining the correct value.
  - h. Tighten the pump retaining nuts and the rear bracket bolt.
  - j. Remove the tool from its housing.
7. Fit the plug bolt in its housing.
  - Always replace the plug bolt gasket.
  - Plug bolt
    - 14-20 Nm
    - (1.4-2.0 kgm) (10-14 ft-lb)
8. Connect the fuel injection pipes.
  - Injection pipe nuts
    - 22-25 Nm
    - (2.2-2.5 kgm) (16-18 ft-lb)
9. Bleed the system.
  - See "Bleeding the system" in this Section.

## TECHNICAL DATA AND SPECIFICATIONS

### APPLICATION

ENGINE	P/N	PUMP N.°
RD28	16700-C9600	104669-2170
RD28T	16700-22J00	104669-2151

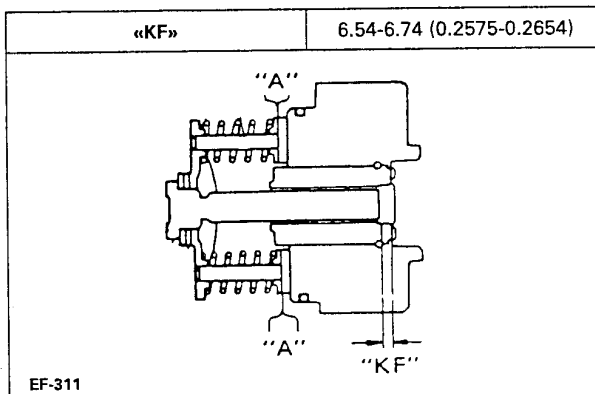
### REPLACING THE FUEL INJECTION PUMP



### INSPECTION AND ADJUSTMENT

#### USE OF THE ADJUSTMENT VALUES AND SPACERS WHEN REPLACING THE FUEL INJECTION PUMP

mm (in)



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#### ADJUSTMENT SPACER «A»

PART N.°	THICKNESS
16882-V0700	0.5 (0.020)
16882-V0701	0.8 (0.031)
16882-V0702	1.0 (0.039)
16882-V0703	1.2 (0.047)
16882-V0704	1.5 (0.059)
16882-V0705	1.8 (0.071)
16882-V0706	2.0 (0.079)

### STATIC INJECTION ADVANCE

<b>Plunger stroke</b>	
<b>Without turbocharger</b>	$0.75 \pm 0.03$ mm $(0.0295 \pm 0.0012)$ in (equivalent to 6° A.P.M.S.)
<b>With turbocharger</b>	$0.86 \pm 0.05$ mm $(0.0339 \pm 0.0020)$ in (equivalent to 8° A.P.M.S.)

mm (in)

«K»	3.2-3.4 (0.126-0.134)
-----	-----------------------

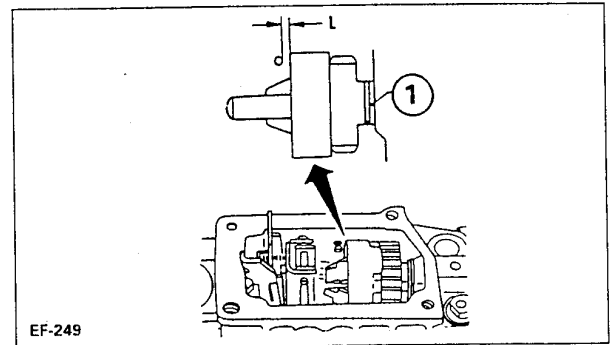
EF-312

**ADJUSTMENT SPACER «B»**

PART N.°	THICKNESS
16884-V3100	1.92 (0.0756)
16884-V3101	2.00 (0.0787)
16884-V3102	2.08 (0.0819)
16884-V3103	2.16 (0.0850)
16884-V3104	2.24 (0.0882)
16884-V3105	2.32 (0.0913)
16884-V3106	2.40 (0.0945)
16884-V3107	2.48 (0.0976)
16884-V3108	2.56 (0.1008)
16884-V3109	2.64 (0.1039)
16884-V3110	2.72 (0.1071)
16884-V3111	2.80 (0.1102)
16884-V3112	2.88 (0.1134)

mm (in)

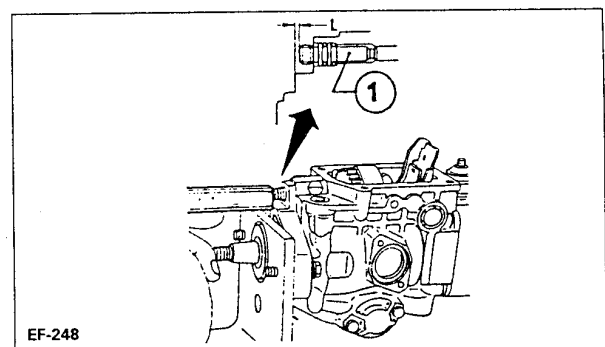
GOVERNOR COUNTERWEIGHT SUPPORT END FLOAT	0.15-0.35 (0.0059-0.0138)
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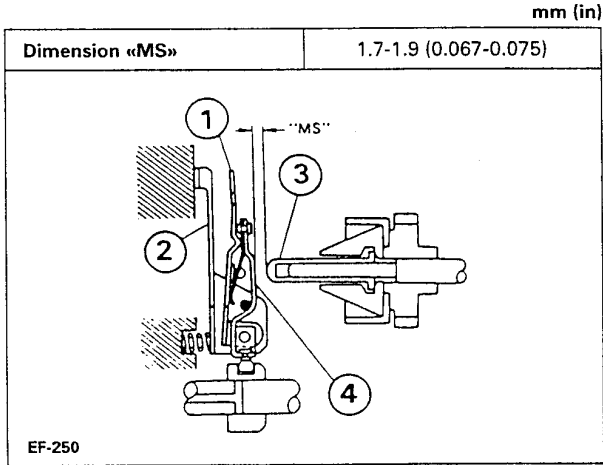
mm (in)

ADJUSTMENT SPACERS	
PART N.°	THICKNESS
19208-V0700	1.05 (0.0413)
19208-V0701	1.25 (0.0492)
19208-V0702	1.45 (0.0571)
19208-V0703	1.65 (0.0650)
19208-V0704	1.85 (0.0728)

DIMENSION «L»	1.5-2.0 (0.059-0.079)
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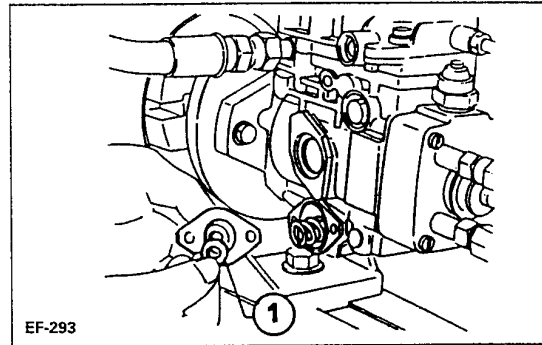


1. Governor shaft



- 1. Tension lever
- 2. Selector lever
- 3. Seal plug
- 4. Starting lever

**ADVANCE ASSEMBLY  
ADJUSTMENT SPACER**



1. Spacer

**SPACERS**

mm (in)

PART N.°	THICKNESS
16880-43G10	0.1 (0.004)
16880-43G11	0.2 (0.008)
16880-43G12	0.25 (0.0098)
16880-43G13	1.0 (0.039)
16880-43G14	2.0 (0.079)

mm (in)

SEAL PLUG ADJUSTMENT	
PART N.°	THICKNESS
19207-V0700	7.8 (0.307)
19207-V0701	8.0 (0.315)
19207-V0702	8.2 (0.323)
19207-V0703	8.4 (0.331)
19207-V0704	8.6 (0.339)
19207-V0705	8.8 (0.346)
19207-V0706	9.0 (0.354)
19207-V0707	9.2 (0.362)

**COMPENSATOR**

mm (in)

Compensator* Stroke	3.8-4.0 (0.150-0.157)
------------------------	-----------------------

\* RD28T ENGINE

**SPACERS\***

mm (in)

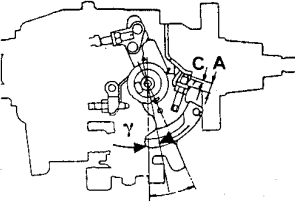
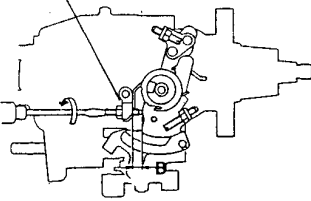
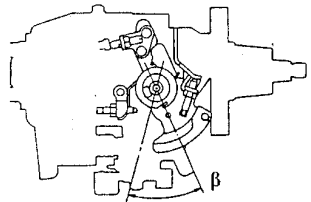
PART N.°	THICKNESS
19275-W3400	3.8 (0.150)
19275-W3401	4.0 (0.157)
19275-W3402	4.2 (0.165)
19275-W3403	4.4 (0.173)
19275-W3404	4.6 (0.181)
19275-W3405	4.8 (0.189)
19275-W3406	5.0 (0.197)

\* RD28T ENGINE

**Fuel control lever angle**

Check the projections of the adjustment screws to determine if the control lever is adjusted to the correct angles for idling speed and maximum speed.

mm (in)

CONTROL LEVER POSITION	FIGURE	SCREW PROJECTION	
Idling speed	 <p>A: idling C: partial load</p> <p>EF-297</p>	A	8.7-12.9 (0.350-0.507)
		X	19°-27°
Maximum	 <p>Maximum speed adjustment screw</p> <p>EF-285</p>	B	11.5-15.2 (0.452-0.598)
	 <p>EF-300</p>		β

**TEST DATA**

**PUMP CALIBRATED VALUES (RD28 Engine)**

PART N.° 104669-2170 (NP-VE6/9F2500RNP59)

Rotation: Clockwise (when seen from the impeller side).

**TEST CONDITIONS**

1. Nozzle: 105780-0000 (NP-DN12SD12T)	4. Injection pipes: 2 × 6 × 840 mm
2. Nozzle body assembly: 105780-2080 (EF8511/9)	5. Oil temperature: 45 + 5 °C (113 + 9 °F)
3. Calibration pressure: 15,000 + 500 kPa (147.1 + 4.90 bar) (150 + 5 kg/cm <sup>2</sup> ) (2,145 + 71.5 lb/in <sup>2</sup> )	6. Pump pressure: 20 kPa (0.196 bar) (0.2 kg/cm <sup>2</sup> ) (2.86 lb/in <sup>2</sup> )

CONCEPT	FUEL INJECTION PUMP (rpm)	SETTING VALUE	REINFORCEMENT PRESSURE kPa (mbar) (mmHg) (inHg)	PERMISSIBLE TOLERANCE
Advance piston stroke	900	1.2-1.6 mm (0.047-0.062 in)	—	—
Feed pump pressure	900	343-402 kPa (3.43-4.02 bar; (3.5-4.1 kg/cm <sup>2</sup> ) (50-58 lb/in <sup>2</sup> )	—	—
<b>Injected fuel flow</b>				
Starting	100	38 cc minimum 2.3 in <sup>3</sup> 1,000 strokes	—	2 cc 0.122 in <sup>3</sup> 1,000 strokes
Idling speed	350	5.8-8.8 cc 0.353-0.536 in <sup>3</sup> 1,000 strokes	—	1.4 cc 0.085 in <sup>3</sup> 1,000 strokes
Full load	900	30.9-31.9 cc 1.88-1.94 in <sup>3</sup> 1,000 strokes	—	2.5 cc 0.152 in <sup>3</sup> 1,000 strokes
Maximum speed	2,600	15.5-21.5 cc 0.945-1.311 in <sup>3</sup> 1,000 strokes	—	5.0 cc 0.305 in <sup>3</sup> 1,000 strokes

**TEST VALUES**

1. Advance variator	rpm mm (in)	900 1.1-1.7 (0.043-0.066)	1,200 2.7-3.5 (0.106-0.137)	—	2,300 8.1-9 (0.318-0.354)
2. Feed pump	rpm kg/cm <sup>2</sup> (lb/in <sup>2</sup> )	900 3.4-4.2 (48.34-59.72)	—	1,800 5.5-6.3 (78.21-89.58)	2,500 7.2-8 (102.38-113.76)
3. Excess flow	rpm cc (in <sup>3</sup> )	900 43-87 (2.62-5.30)	—	—	—

FUEL FLOWS

PUMP CONTROL LEVER	FUEL INJECTION PUMP (rpm)	FEED FLOWS cc (in <sup>3</sup> ) at 1,000 strokes	REINFORCEMENT PRESSURE kPa (mbar) (mmHg) (inHg)	PERMISSIBLE TOLERANCE
Maximum revolutions	600	29.1-33.1 (1.77-2.01)	—	—
	900	30.4-32.4 (1.85-1.97)	—	—
	2,300	28.0-32.0 (1.70-1.95)	—	—
	2,600	15.0-22.0 (0.91-1.34)	—	—
	2,800	5.0 (0.30) Max	—	—
Shut-off	350	0 (0)	—	—
Magnetic valve	900	0 (0)	—	—
Idling speed stop	350	5.3-9.3 (0.32-0.56)	—	—
	500	4.0 (0.24) Max	—	—
Solenoid valve	Max. voltage: 8 V Test voltage: 12-14 V			

DIMENSIONS

K	3.2-3.4 mm (0.125-0.133 in)
KF	6.54-6.74 mm (0.257-0.265 in)
MS	1.7-1.9 mm (0.066-0.074 in)
BCS*	3.8-4.0 mm (0.149-0.157 in)

\*RD28T ENGINE

CONTROL LEVER ANGLES

$\chi$	19-27°
A	8.7-12.9 mm (0.342-0.507 in)
$\beta$	37-47°
B	11.5-15.2 mm (0.452-0.598 in)
$\gamma$	10.5-11.5°
C	5.7-6.3 mm (0.224-0.248 in)

**PUMP CALIBRATION VALUES (RD28T Engine )**

**PART N.º 104669-2151 (NP-VE6/9F2300RNP57)**

**Rotation: Clockwise (when seen from the impeller side).**

**TEST CONDITIONS**

1. Nozzle: 105780-0060 (NP-DN0SD1510)	5. Oil temperature: 45 ± <sup>5</sup> <sub>0</sub> °C (113 ± <sup>9</sup> <sub>0</sub> °F)
2. Nozzle body assembly: 105780-2150	6. Pump pressure: 20 kPa (0.196 bar) (0.2 kg/cm <sup>2</sup> ) (2.86 lb/in <sup>2</sup> )
3. Calibration pressure: (13,300 ± <sup>300</sup> <sub>0</sub> kPa (130.47 ± <sup>2.94</sup> <sub>0</sub> bar) (133 ± <sup>3</sup> <sub>0</sub> kg/cm <sup>2</sup> ) (1,901.9 ± <sup>43</sup> <sub>0</sub> lb/in <sup>2</sup> )	7. Gasket kit: 157641-4720
4. Injection pipes: 2 × 6 × 450 mm	8. Pipes kit: 157641-4020

CONCEPT	FUEL INJECTION PUMP (rpm)	SETTING VALUE	REFORCEMENT PRESSURE kPa (mbar) (mmHg) (inHg)	PERMISSIBLE TOLERANCE
Advance plunger stroke	900	1.1-1.5 mm (0.043-0.059 in)	45.6-48.3 (456-483) (342-362) (13.46-14.24)	—
Feed pump pressure	900	343-402 kPa (3.43-4.02 bar) (3.5-4.1 kg/cm <sup>2</sup> ) (50-58 lb/in <sup>2</sup> )	45.6-48.3 (456-483) (342-362) (13.46-14.24)	—
<b>Injected fuel flow</b>				
Starting	100	38 cc min 2.3 in <sup>3</sup> 1,000 strokes	0	0
Idling speed	350	6.6-8.6 cc 0.40-0.52 in <sup>3</sup> 1,000 strokes	0	0.9 cc 0.055 in <sup>3</sup> 1,000 strokes
Full load	600	31.3-32.1 cc 2.36-2.40 in <sup>3</sup> 1,000 strokes	0	2 cc 0.122 in <sup>3</sup> 1,000 strokes
	900	38.6-39.4 cc 2.36-2.40 in <sup>3</sup> 1,000 strokes	32-35 (320-347) (240-260) (9.45-10.2)	2 cc 0.122 in <sup>3</sup> 1,000 strokes
Max. speed	2,350	35.3-37.3 cc 2.16-2.28 in <sup>3</sup> 1,000 strokes	62.7-65.3 (626.5-653.2) (470-490) (18.5-19.3)	4.5 cc 0.27 in <sup>3</sup> 1,000 strokes

**TEST VALUES**

1. Advance variator	rpm mm (in)	900 1.1-1.5 (0.043-0.059)	1,800 4.3-5.4 (0.17-0.22)	2,300 6.3-7.4 (0.25-0.29)	2,500 6.5-7.4 (0.26-0.29)
2. Feed pump	rpm kg/cm <sup>2</sup> (lb/in <sup>2</sup> )	900 3.5-4.1 (49.7-58.3)	1,800 5.6-6.2 (79.6-88.1)	2,300 6.9-7.5 (98.1-107)	—
3. Excess flow	rpm cc (in <sup>3</sup> )	900 43-87 (2.63-5.31)	—	—	—



**FUEL FLOWS**

<b>PUMP CONTROL LEVER</b>	<b>FUEL INJECTION PUMP (rpm)</b>	<b>FEED FLOWS cc (in<sup>3</sup>) at 1,000 strokes</b>	<b>REINFORCEMENT PRESSURE kPa (mbar) (mmHg) (in Hg)</b>	<b>PERMISSIBLE TOLERANCE</b>
<b>Maximum revolutions</b>	600	30.8-32.6 (1.88-1.99)	0	—
	900	38.1-39.9 (2.33-2.44)	32-35 (320-347) (240-260) (9.45-10.2)	—
	1,200	42-46 (2.56-2.80)	62.65-65.32 (626.5-654) (470-490) (18.50-19.29)	—
	1,800	41.2-45.2 (2.52-2.76)		—
	2,200	40.5-46.5 (2.47-2.84)		—
	2,300	37.8-44.8 (2.30-2.74)		—
	2,350	34.8-37.8 (2.13-2.31)		—
	2,500	14-24 (0.85-1.47)		—
	2,800	3 (0.18) Max.		—
<b>Shut-off</b>	350	0	0	—
<b>Magnetic valve</b>	900	0	45.59-48.25 (455.9-482.5) (342-362) (13.46-14.25)	—
<b>Idling speed stop</b>	350	6.6-8.6 (0.41-0.53)	0	—
	500	3 (0.18) Max	0	—
<b>Partial load</b>	900	6.6-12.6 (0.41-0.77)	0	—
<b>Solenoid valve</b>	Max. voltage: 8 V Test voltage: 12-14 V			

**DIMENSIONS**

See Page 51.

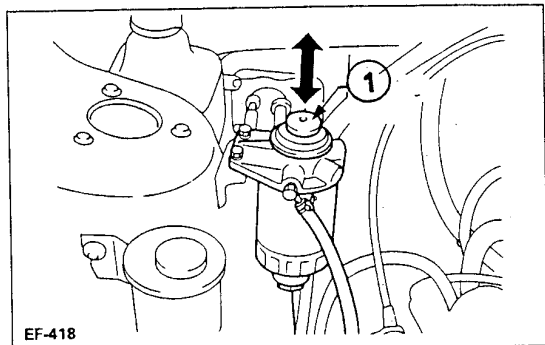
**CONTROL LEVER ANGLES**

See Page 51.

## TIGHTENING TORQUES

COMPONENT	Nm	kgm	ft-lb
Retaining bolt, accelerated idling device	5-7	0.5-0.7	3.6-5.1
Control shaft-control lever	7-10	0.7-1.0	5.1-7.2
Supply valve-distributor head	44-54	4.5-5.5	33-40
Supply valve-pipe	22-25	2.2-2.5	16-18
Distributor head-pump housing	11-13	1.1-1.3	8-9
Nut, no-load, fast speed control lever adjustment bolt	6-9	0.6-0.9	4.3-6.5
Feed pump cover-pump housing	2-3	0.2-0.3	1.4-2.2
Fuel shut-off solenoid valve	20-25	2.0-2.5	14-18
Fuel inlet connection-pump housing	2-3	0.2-0.3	1.4-2.2
Retaining nut, full load adjustment screw	6-9	0.6-0.9	4.3-6.5
Nut, governor control shaft	7-10	0.7-1.0	5.1-7.2
Governor cover-pump housing	7-10	0.7-1.0	5.1-7.2
Retaining nut, governor shaft	25-29	2.5-3.0	18-22
Nut, fuel injection pump drive gear	54-64	5.5-6.5	40-47
Retaining nut, seal plate	25-34	2.5-3.5	18-25
Retaining nut, maximum and idling speed adjustment screw	6-9	0.6-0.9	4.3-6.5
Relief valve	20-25	2.0-2.5	14-18
Fulcrum pin-pump housing	10-13	1.0-1.3	7-9
Plug bolt	14-20	1.4-2.0	10-14
Distributor cover-head	58-78	6.0-8.0	43-58
Locknut, compensator	25-34	2.5-3.5	18-25
Regulating valve-pump housing	8-9	0.8-0.9	5.8-6.5
Governor cover-pump housing	6-8	0.6-0.8	4.3-5.8

## BLEEDING THE FUEL SYSTEM



The fuel system must be bled whenever for any reason the fuel injection pump has been removed or some component of the feed system has been repaired.

1. Operate the priming pump (1), as shown in the figure.
2. If the engine does not function smoothly after starting, depress the accelerator completely two or three times.

## INJECTOR ASSEMBLY

### CAUTION:

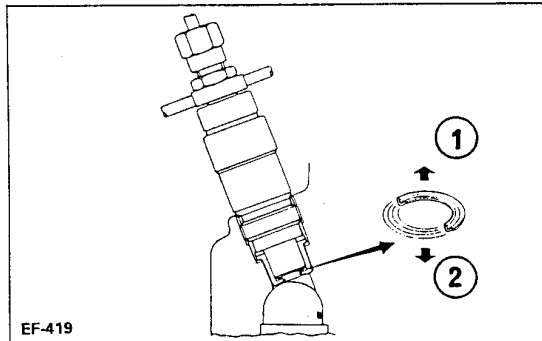
Protect the flared nut with a plug or cloth so as to avoid the entry of dust. Cover the point of the nozzle to protect the needle.

### REMOVAL AND REPLACEMENT

1. Remove the fuel injection pipe and leak-off pipe assembly.
  2. Remove the injector assembly.
- Also remove the washers from the end of the injector.
3. Replace the injector in reverse order of removal.

- ☐ Injector to engine  
59-69 Nm  
(6.0-7.0 kgm) (43-51 ft-lb)
- ☐ Injection pipe  
22-25 Nm  
(2.2-2.5 kgm) (16-18 ft-lb)
- ☐ Turbocharger leak-off pipe  
39-49 Nm  
(4.0-5.0 kgm) (29-36 ft-lb)

- a. Always clean the nozzle orifices.
- b. Always use new washers.
- c. Note that a small washer should be fitted in the direction specified.
- d. Bleed the fuel system.



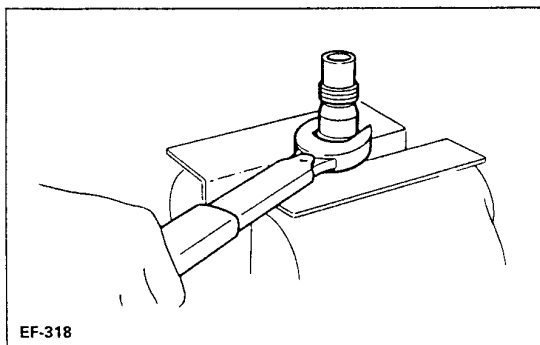
1. Injector side
2. Combustion chamber side

### DISASSEMBLY

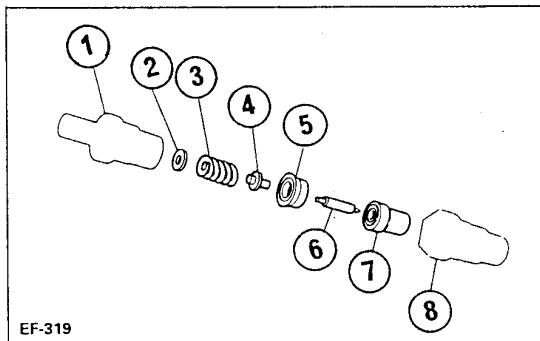
1. Loosen the nozzle nut whilst holding the upper part in a vice to prevent it turning.

2. Place the removed parts in the order shown in the figure.

1. Nozzle body assembly
2. Supplement
3. Spring
4. Pusher
5. Spacer
6. Needle
7. Nozzle
8. Nozzle nut



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## INSPECTION

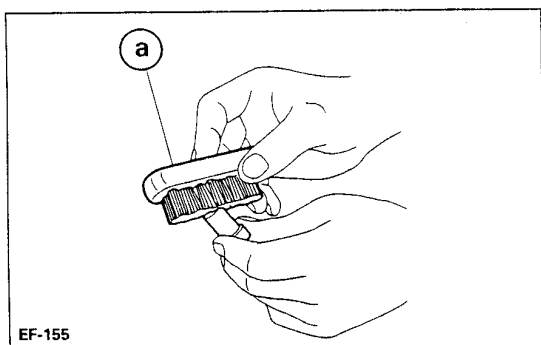
Carefully clean all the removed parts with clean petrol or solvent.

- If the nozzle needle is damaged or blue-coloured, replace the nozzle assembly for a new one.
- If the end of the nozzle is scored or excessively discoloured, replace the nozzle assembly.
- Check that the contact between the nozzle body and the spacer is correct. If the parts are excessively worn or damaged, replace the nozzle assembly or the spacer.
- Check if the contact between the spacer and the nozzle body assembly is correct. If the parts are excessively worn or damaged, replace them.
- Check that the nozzle spring is not excessively worn or damaged; if it is, replace the spring with a new one.

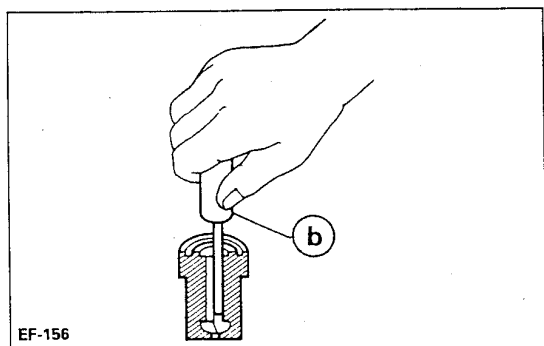
## Cleaning

- a. Do not touch the nozzle mating face with the fingers.
- b. To clean the nozzles, use a toothpick and a brass bristle brush, with clean diesel fuel.

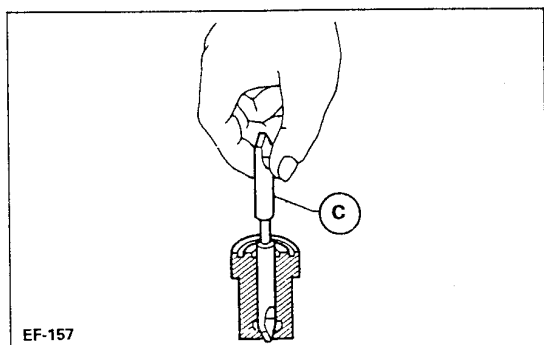
1. Remove any carbon deposits from the outside of the nozzle body (except for the end casing, which is cleaned with as special tool).



a. KV-112-90110



b. KV-112-90122

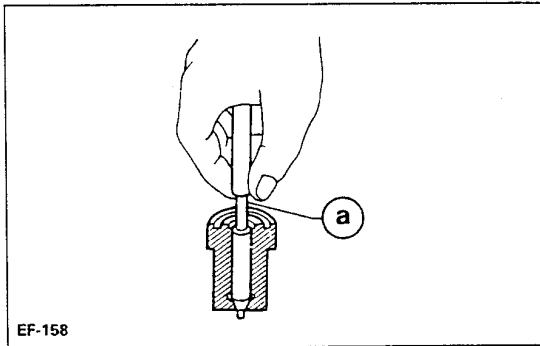


c. KV-112-90150

2. Clean the nozzle fuel collector with the special tool.

3. Clean the needle seat with the special tool.

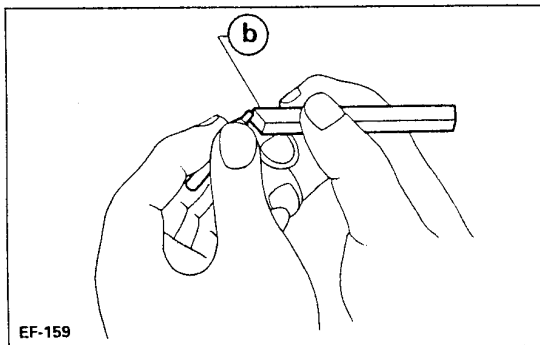
Extreme care should be exercised when carrying out this operation, since the performance of the injector depends to a high degree on the fact that the seat is in perfect condition.



a. KV-112-90220

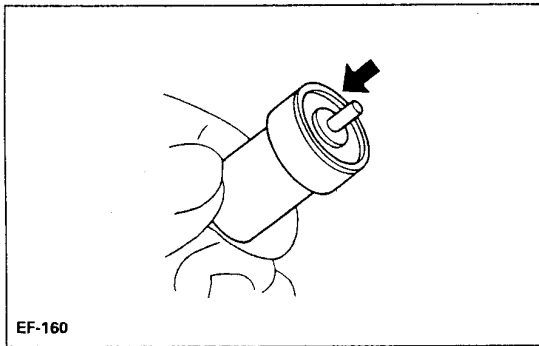
4. Clean the atomizing orifice with the special tool.

Take care not to damage the edges of the atomizing orifice; always carry out the cleaning starting from the inside and working towards the outside.



b. KV-112-90140

5. Using the special tool, clean the carbon from the point of the nozzle needle.

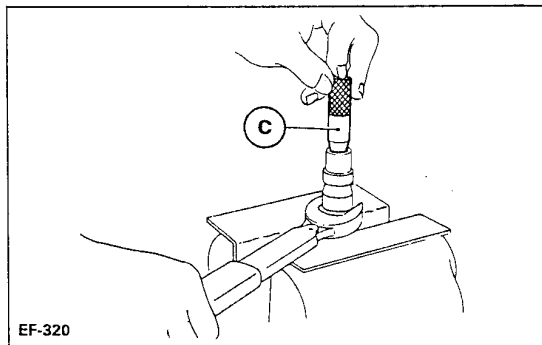


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6. Carry out the needle descent test.

- a. Withdraw the needle approximately half-way from the body and then release the needle.
- b. The needle should descend smoothly inside the body, moved by its own weight.
- c. Repeat this test, slightly turning the needle each time.

If the needle does not descend smoothly in any position, the needle and body must be replaced as an assembly.



c. KV-112-92010

### REASSEMBLY

Reassemble in reverse order of disassembly, and taking the following into account:

If the nozzle body is not correctly installed, it will not be possible to remove the special tool and it could be damaged.

- ⊔ Nozzle body assembly to nozzle nut  
78-98 Nm  
(8.0-10.0 kgm) (58-72 ft-lb)

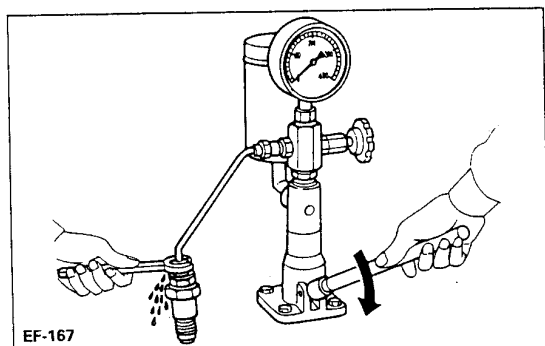
## TESTS AND CALIBRATION

**WARNING:**

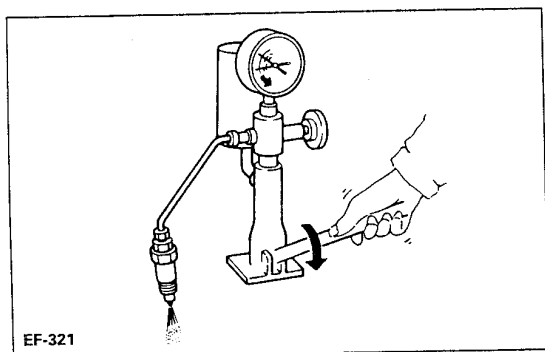
When using the injector tester, ensure that the fuel atomized by the nozzle, does not come into contact with the hands or other parts of the body. Use suitable goggles to protect the eyes.

**Injection pressure test**

1. Install the injector on the tester and bleed the fuel through the flared nut.



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2. Pump slowly with the tester lever (once per second) and note the pressure gauge reading.
3. Note the pressure gauge reading when the pressure starts to drop.

**Injector calibration pressure:****Used**

12.259-13.239 kPa (122.6-132.4 bar)  
(125-135 kg/cm<sup>2</sup>) (1.778-1.920 lb/in<sup>2</sup>)

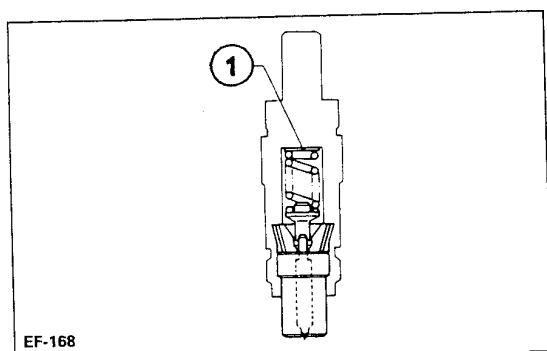
**New**

13.239-14.024 kPa (132.4-140.2 bar)  
(135-143 kg/cm<sup>2</sup>) (1.920-2.033 lb/in<sup>2</sup>)

When new nozzles are used, it is also necessary to check the initial injection pressure.

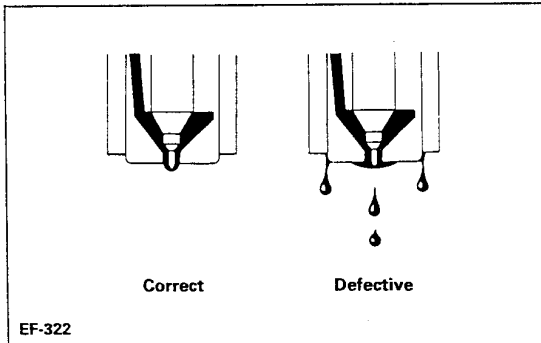
4. To adjust the injection pressure, change the adjustment shims.
  - a. By increasing the thickness of the adjustment shims, the initial injection pressure is also increased.
  - b. A 0.04 mm (0.0016 in) shim, corresponds to a difference of approximately 471 kPa (4.71 bar) (4.8 kg/cm<sup>2</sup>) (68 lb/in<sup>2</sup>) in the initial injection pressure.

For further details about the adjustment shims, see the Section "TECHNICAL DATA AND SPECIFICATIONS".



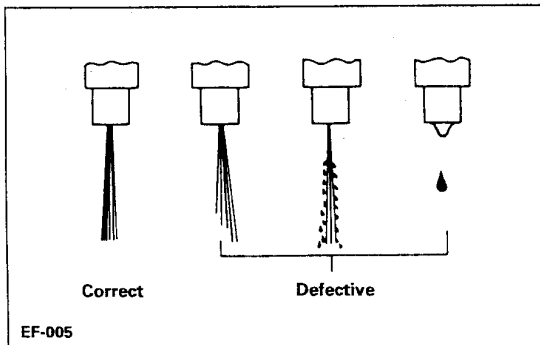
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1. Adjustment shim



#### Checking for leaks

1. Maintain the pressure at approximately 981-1961 kPa (9.8-19.6 bar) (10-20 kg/cm<sup>2</sup>) (142-284 lb/in<sup>2</sup>) below the initial injection pressure.
2. Check that drops are not formed at the point of the nozzle or around the body.
3. If there are leaks, repair or replace the nozzle.



#### Checking the atomization

1. Operate the tester lever once per second.
2. Check the shape of the atomizing cone.
3. If the atomizing cone is not correct, clean or replace the nozzle.



## TECHNICAL DATA AND SPECIFICATIONS

### INJECTOR ASSEMBLY

<b>Initial injection pressure</b>	
<b>New</b> kPa (bar) (kg/cm <sup>2</sup> ) (lb/in <sup>2</sup> )	13,239-14,024 (132.4-140.2) (135-143) (1,920-2,033)
<b>Used</b> kPa (bar) (kg/cm <sup>2</sup> ) (lb/in <sup>2</sup> )	12,259-13,239 (122.6-132.4) (125-135) (1,778-1,920)

### ADJUSTMENT SHIMS

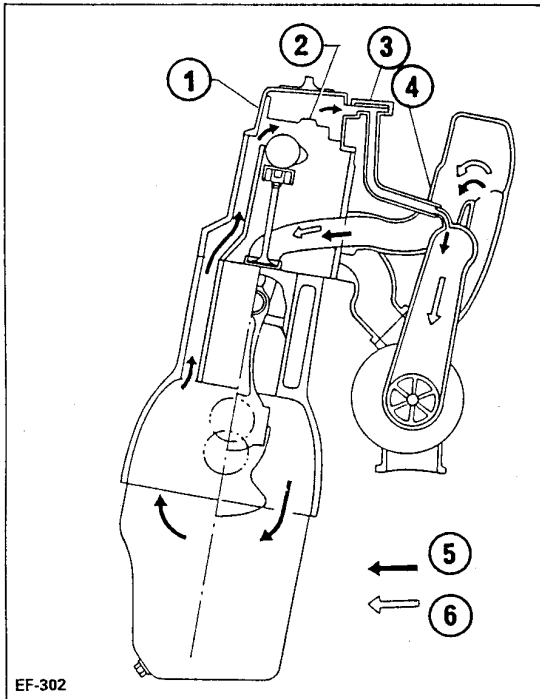
mm (in)

THICKNESS	PART N.º
0.50 (0.0197)	16613-VO700
0.54 (0.0213)	16613-VO702
0.58 (0.0228)	16613-VO704
0.62 (0.0244)	16613-VO706
0.66 (0.0260)	16613-VO708
0.70 (0.0276)	16613-VO710
0.74 (0.0291)	16613-VO712
0.78 (0.0307)	16613-VO714
0.82 (0.0323)	16613-VO716
0.86 (0.0339)	16613-VO718
0.90 (0.0354)	16613-VO720
0.94 (0.0370)	16613-VO722
0.98 (0.0386)	16613-VO724
1.00 (0.0394)	16613-VO760

### TIGHTENING TORQUES

COMPONENT	N.m	kg-m	ft-lb
Injector to engine	59-69	6.0-7.0	43-51
Pipe to injector	22-25	2.2-2.5	16-18
Nut, leak-off pipe	39-49	4.0-5.0	29-36
Nut, nozzle	78-98	8.0-10.0	58-72

## CRANKCASE EMISSION CONTROL SYSTEM



EF-302

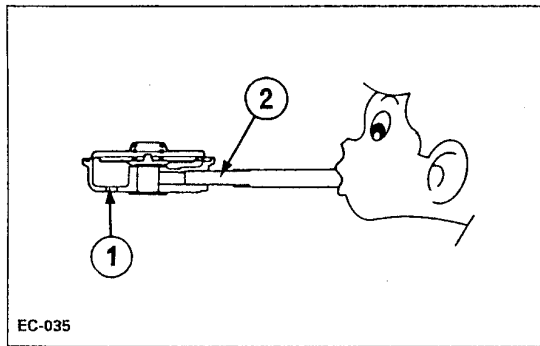
- |                         |   |
|-------------------------|---|
| 1. Rocker cover         | 5. Flow of gases from the combustion chamber to the crankcase |
| 2. Deflector            | 6. Renovated air  |
| 3. Air regulating valve |   |
| 4. Inlet manifold       |   |

### RD28T ENGINE

#### Description

A closed circuit is used for the crankcase gas circulation, which prevents the gases passing to the atmosphere, and maintains a constant pressure inside the crankcase.

The gases are drawn up by the air inlet pipe via the regulating valve, after passing through the oil separator located on the rocker cover.



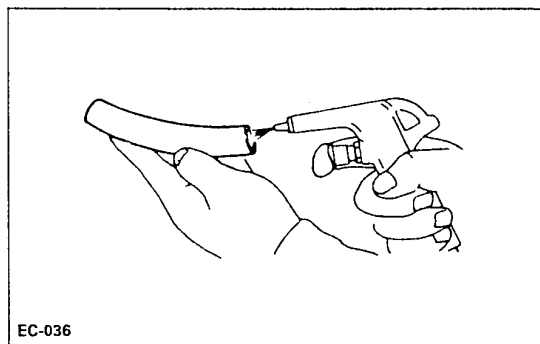
EC-035

1. Inlet
2. Outlet

### INSPECTION

#### AIR REGULATING VALVE

1. Remove the rocker cover.
2. Remove the regulating valve from the rocker cover.
3. After plugging the central orifice with adhesive tape, check that the air flows from the inlet when blowing through the outlet, and does not flow when one inhales.



EC-036

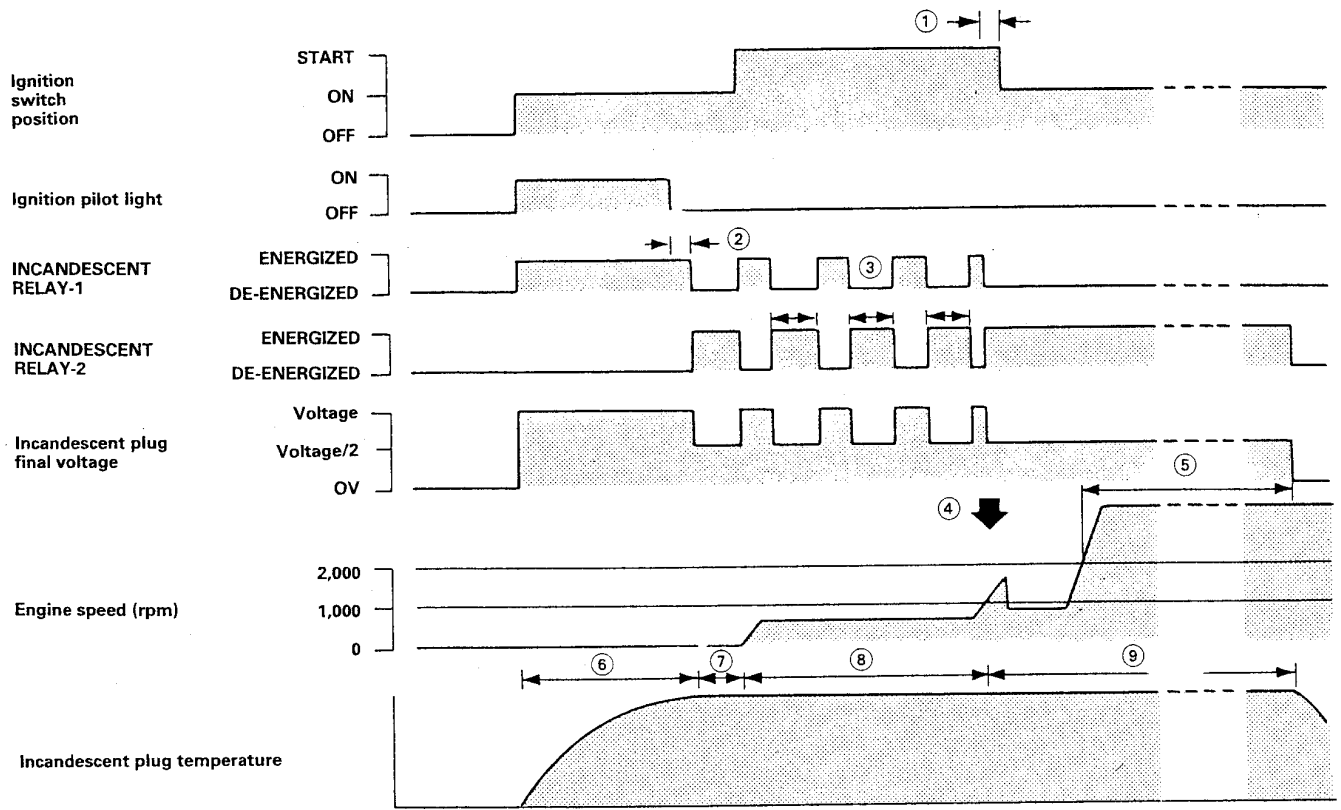
#### Ventilation pipe

1. Check that there are no leaks through the ventilation pipe and its connections.
2. Disconnect the ventilation pipe and clean it with compressed air. If the an obstruction cannot be eliminated, the pipe must be replaced.

**NOTE:** The RD28 engine has the same system, but does not include the air regulating valve. The connection between the inlet manifold and the rocker cover is by means of a hose.

# QUICK IGNITION SYSTEM

When the water temperature is above 75 °C (167 °F), there is no quick ignition.

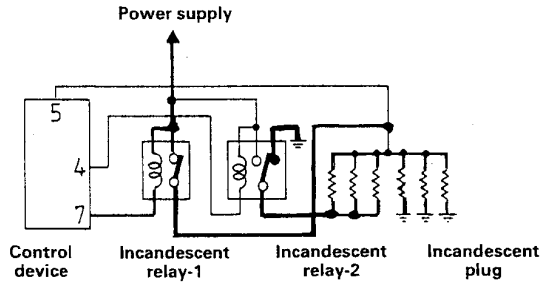


EF-420

1. Switch delayed control
2. 0.5 seconds
3. 2 seconds
4. Complete combustion
5. 30 seconds
6. Quick preheating
7. Heat conservation
8. Alternate
9. Heat conservation (post-incandescence)

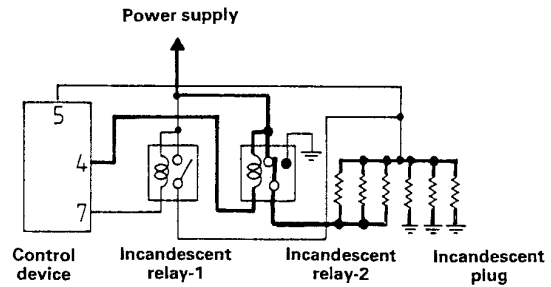
Except for Switzerland and West Germany

Quick preheating circuit



EF-421

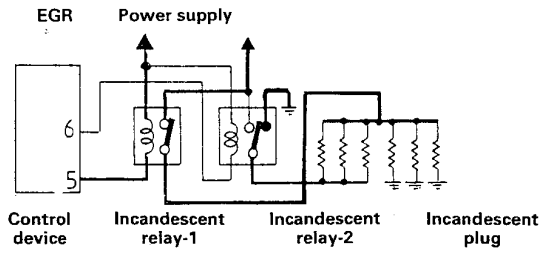
Heat conservation circuit



EF-422

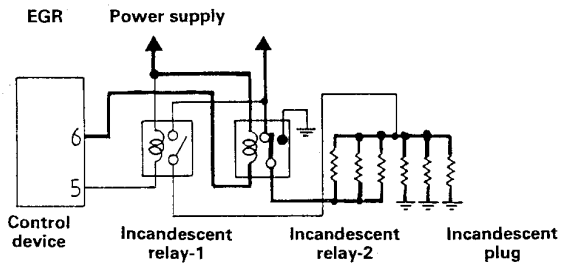
For Switzerland and West Germany

Quick preheating circuit



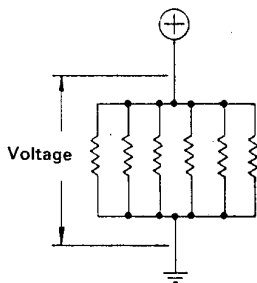
EF-493

Heat conservation circuit

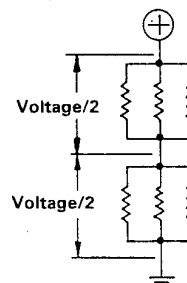


EF-494

Applicable to the previous circuits



EF-423



EF-424

When the ignition switch is turned to the "ON" position, the control device energizes relay-1, thus starting the "quick preheating", and rapidly heating the incandescent plugs.

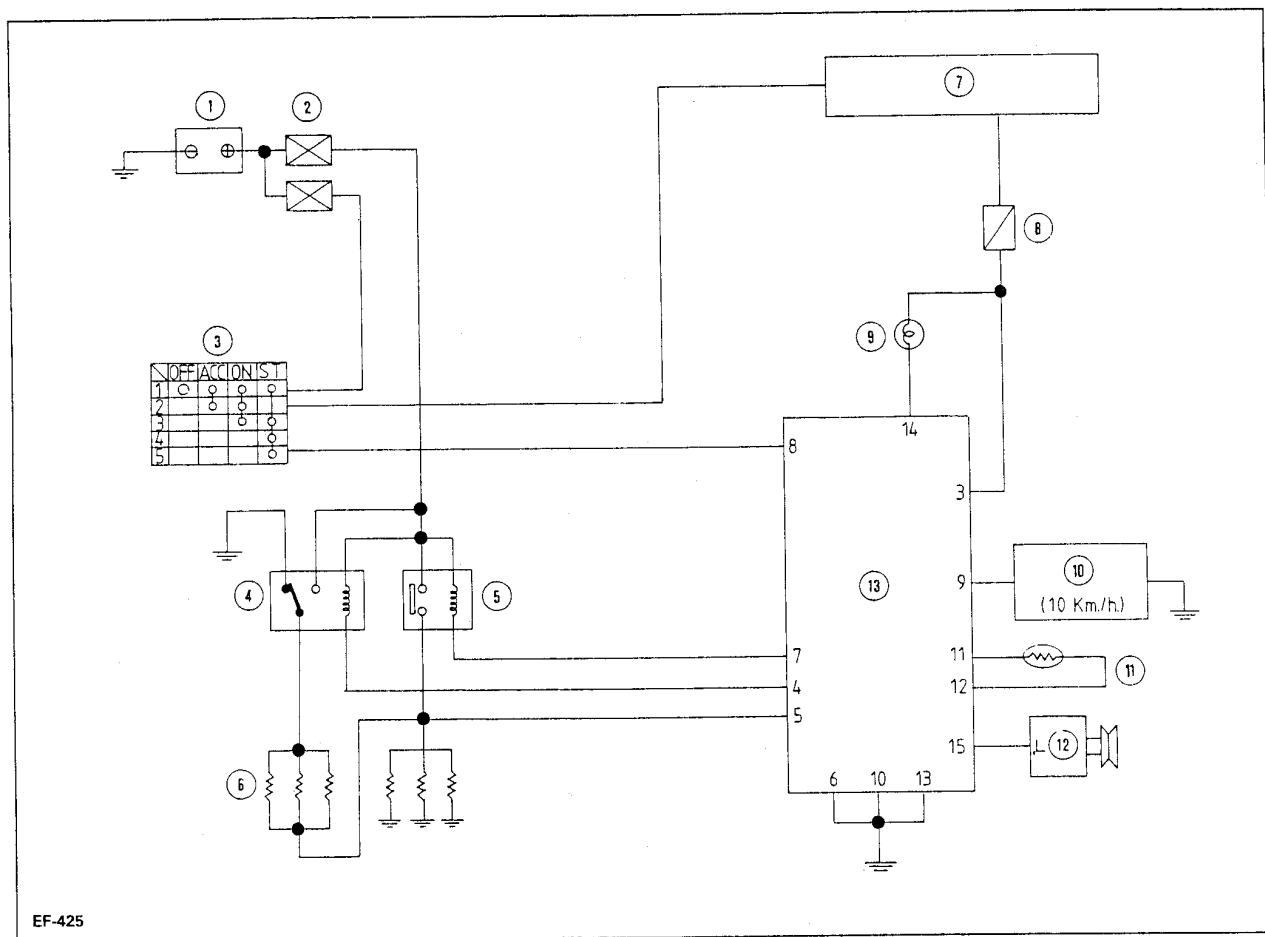
When turning the ignition switch to the "START" position, after "quick preheating", the "quick preheating" and "heat conservation" functions alternate whilst the engine is running at speeds below 1,000 rpm, or when the final alternator voltage "L" remains low. This operation is called chopping. When the engine speed is above 1,000 rpm during starting or a high final voltage "L" is reached at the alternator, the incandescent plugs develop the heat conservation (post-ignition) function. During this phase, the plugs only receive half the

voltage, which permits retaining the heat for a longer time and, with less power consumption.

When the ignition switch is turned from the "START" to "ON" position after starting with the water temperature below 60 °C (140 °F), the post-ignition function continues for 10 minutes. If the engine turns at more than 2,000 rpm when accelerating or starting, or if the vehicle is driven at a speed above 12 km/h (7 mph) for more than 3 minutes, the post-ignition function is interrupted. When the final voltage of the plug becomes excessively low or high, the plug relays are automatically deenergized, and the pilot light flashes for five minutes to indicate that the ignition circuit is not functioning.

DIAGRAM

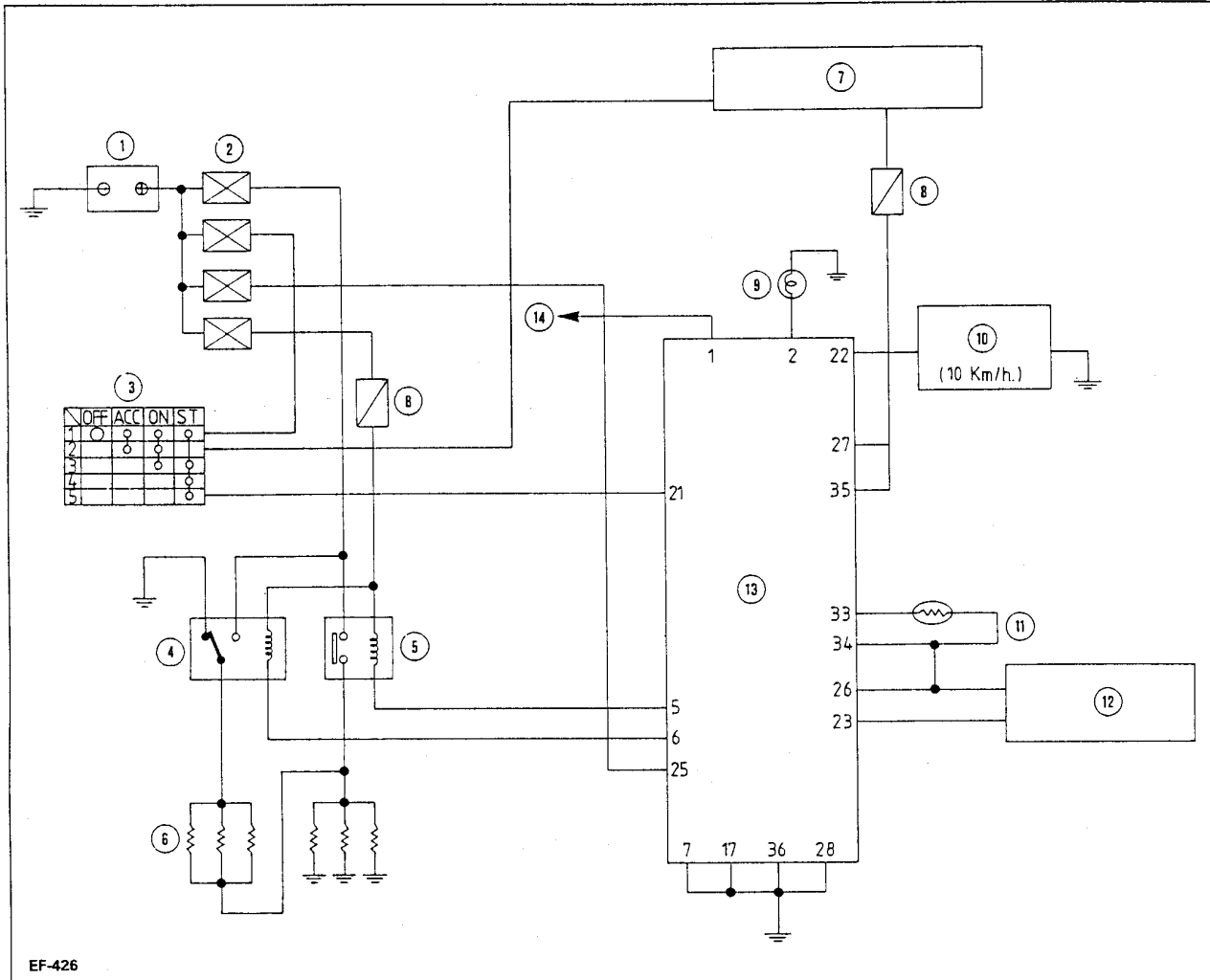
Except for Switzerland and West Germany



COMPONENTS

- 1. Battery
- 2. Link fuses
- 3. Starting switch
- 4. Incandescent plugs relay-2
- 5. Incandescent plugs relay-1
- 6. Incandescent plugs
- 7. Starting switch (at position "ON" or "START")
- 8. 10 A fuse
- 9. Pilot light
- 10. 10 km/h switch (on instrument panel)
- 11. Temperature sensor (on instrument panel)
- 12. Alternator
- 13. Incandescent control unit

For Switzerland and West Germany



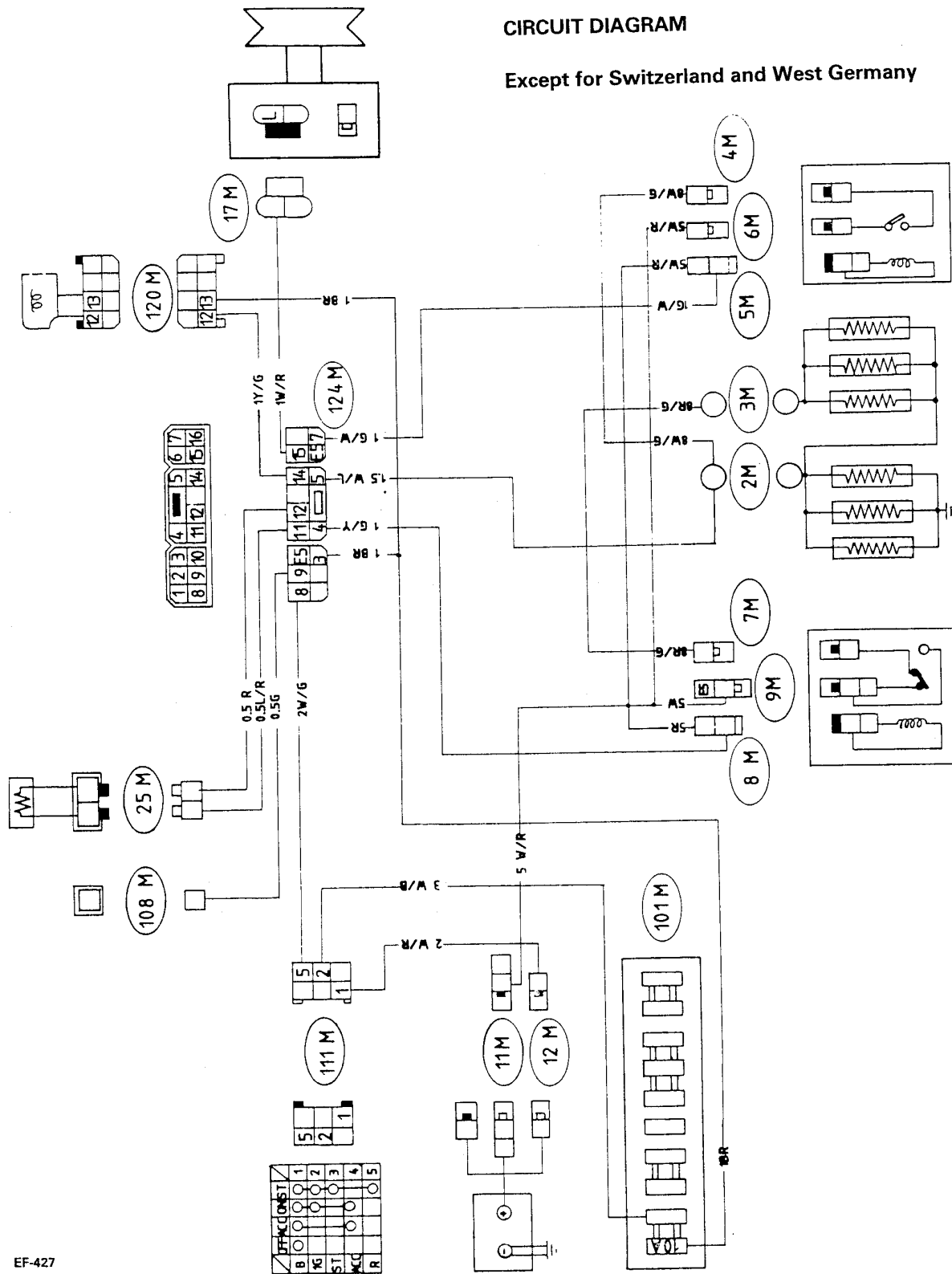
EF-426

COMPONENTS

- |   |   |
|---|---|
| 1. Battery  | 9. Pilot light  |
| 2. Link fuses                                       | 10. 10 km/h switch<br>(on instrument panel)   |
| 3. Starting switch                                  | 11. Temperature sensor<br>(on instrument panel)   |
| 4. Incandescent plugs relay-2                       | 12. Tachometer  |
| 5. Incandescent plugs relay-1                       | 13. Incandescent control unit and EGR<br>To the tachometer<br>(on the instrument panel) |
| 6. Incandescent plugs                               |   |
| 7. Starting switch<br>(at position "ON" or "START") |   |
| 8. 10 A fuse  |   |

CIRCUIT DIAGRAM

Except for Switzerland and West Germany



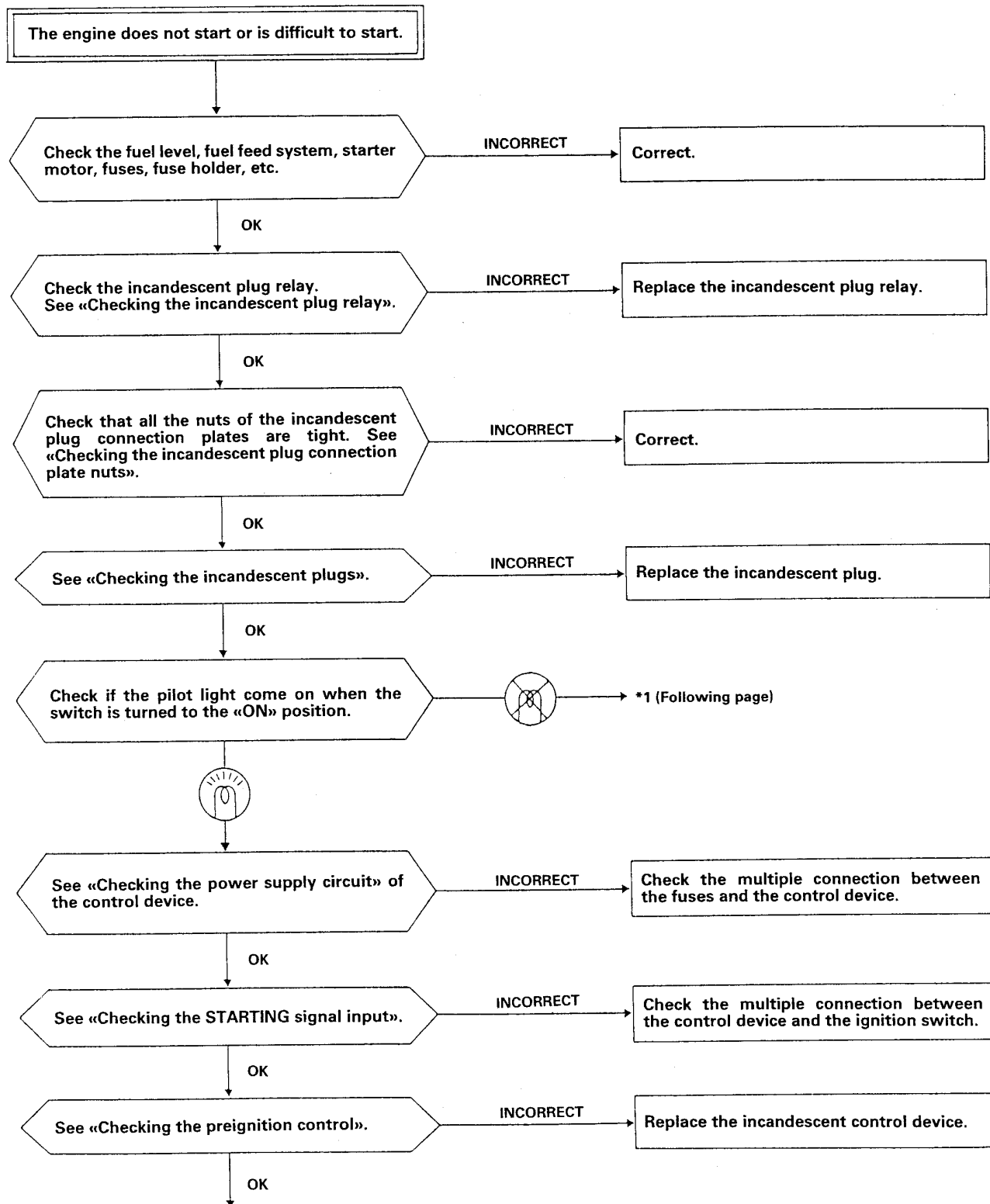
EF-427

- |     |  |      |  |
|-----|--|------|--|
| 2M  | Preheating plugs (mark cables in red)  | 17M  | Alternator. 2-way connector                    |
| 3M  | Preheating plugs (mark cables in blue) | 25M  | Water temperature sensor (at the control unit) |
| 4M  |  | 101M | Main fuse box                                  |
| 5M  | Preheating plugs relay-1               | 108M | Instrument panel (10 km/h connector)           |
| 6M  |  | 111M | Starting switch                                |
| 7M  |  | 120M | Pilot lights                                   |
| 8M  | Preheating plugs relay-2               | 124M | Incandescent control unit                      |
| 9M  |  |      |  |
| 11M | Ling fuses                             |      |  |
| 12M |  |      |  |



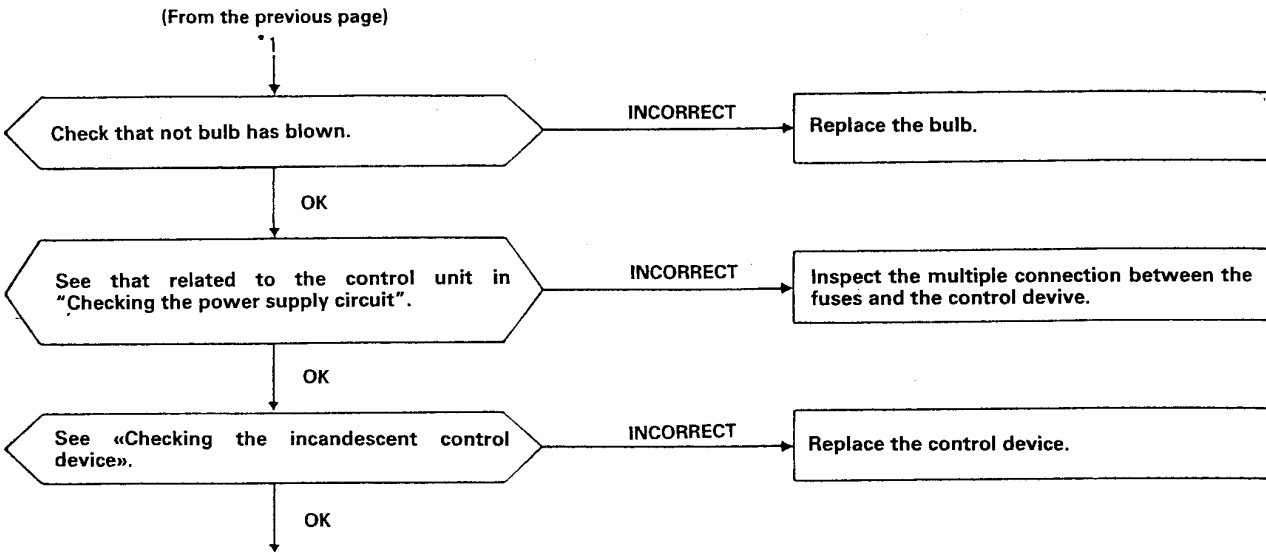


## TROUBLE SHOOTING CHART

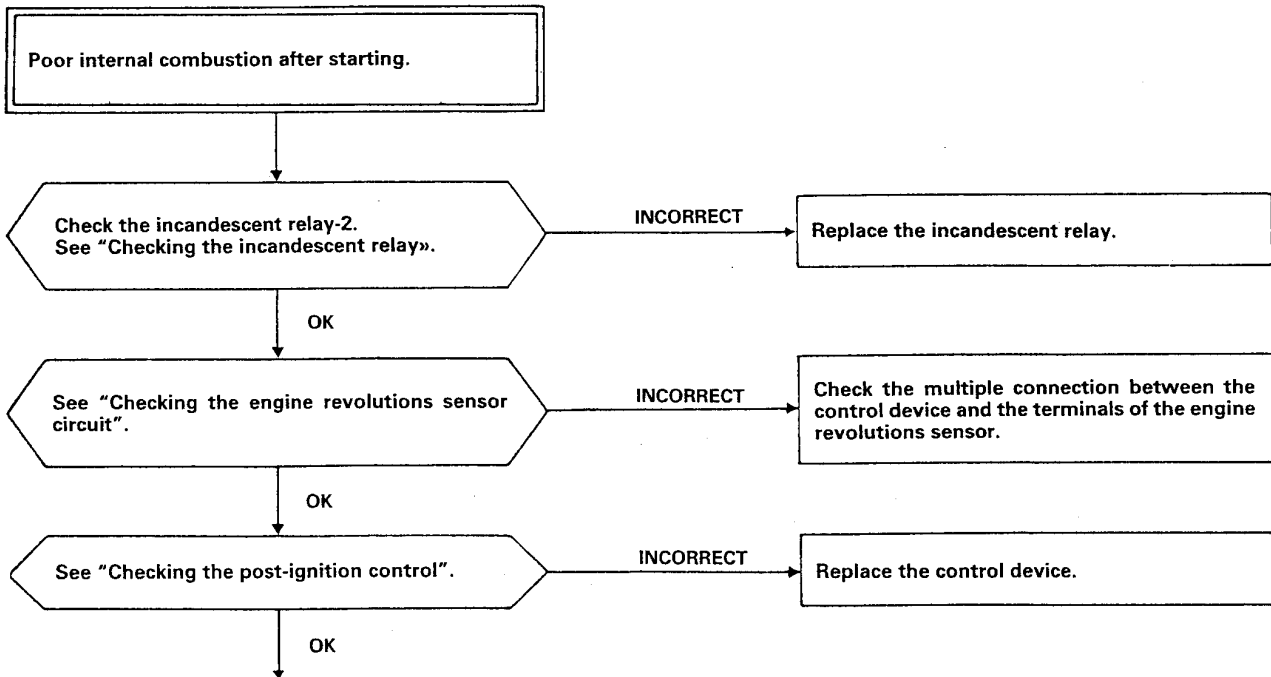


Check the multiple connection between

- the control device and the incandescent relay
- the relay and incandescent plug



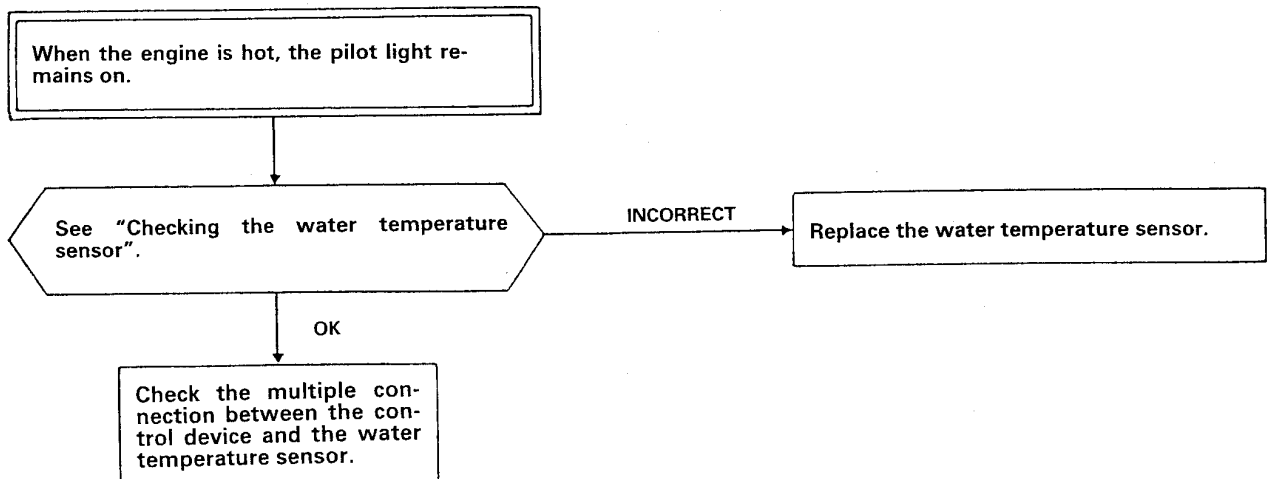
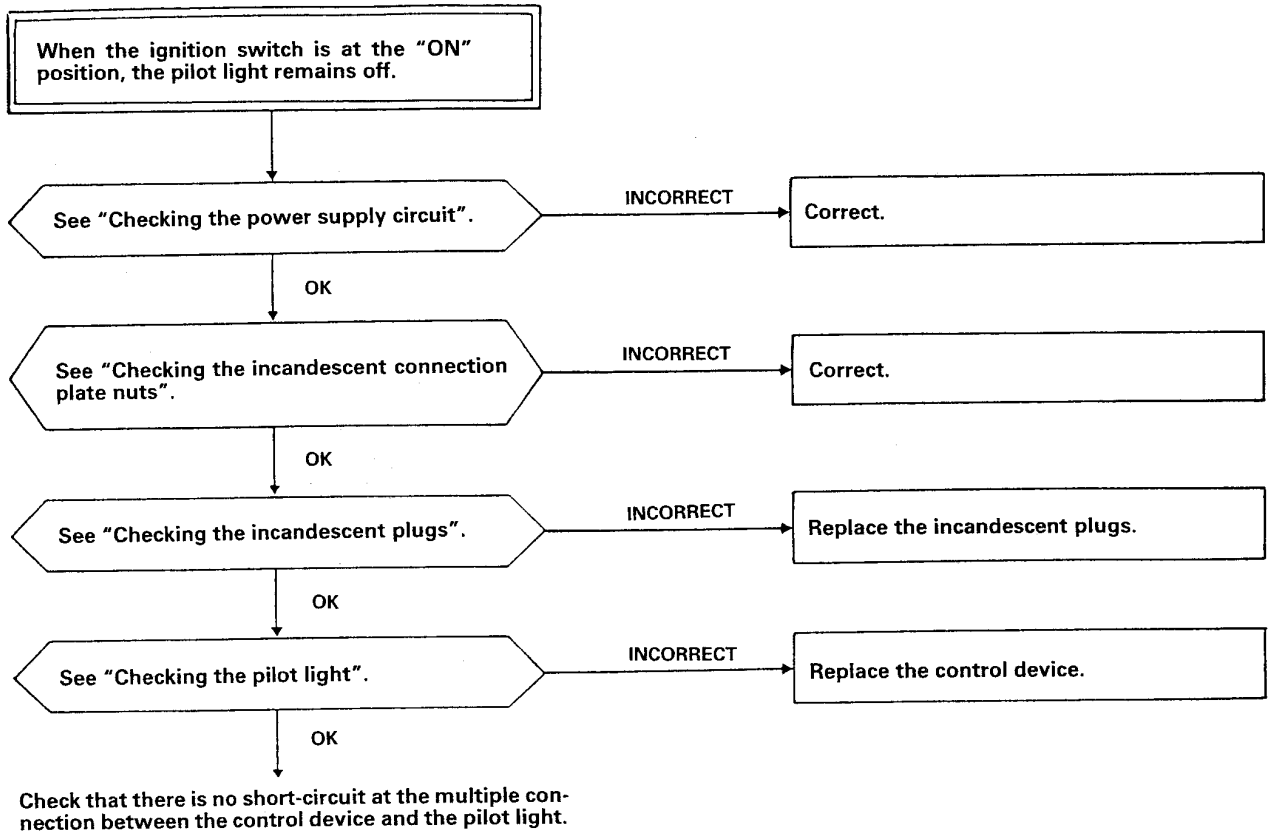
Check that there is not short-circuit at the multiple connection between the ignition switch and the pilot light.



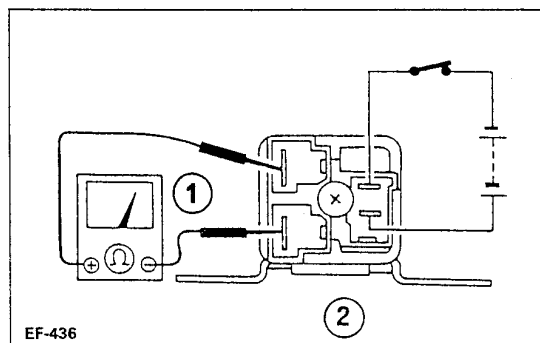
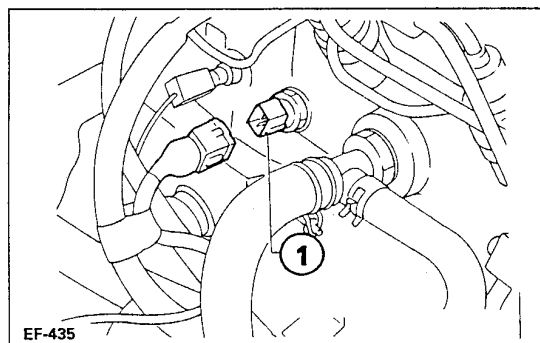
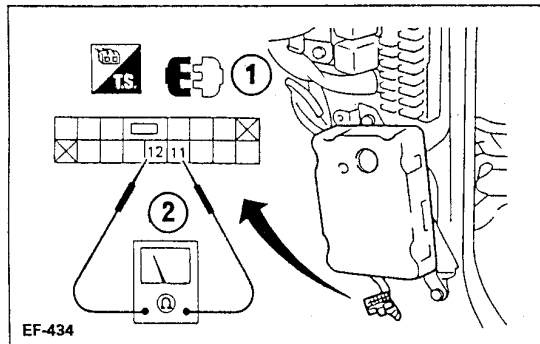
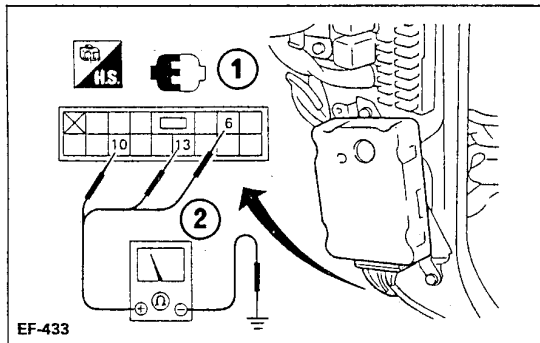
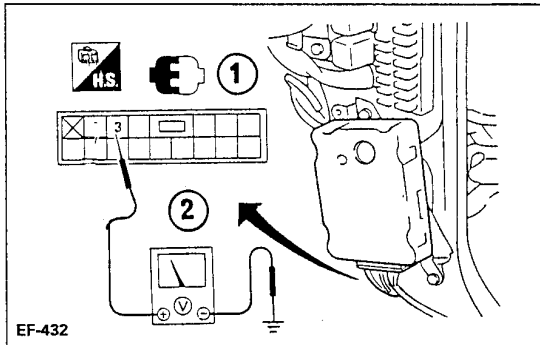
Check the connection between

- the control device and the incandescent relay
- the relay and incandescent plug

EF-430



EF-431



**INSPECTION**

**CHECKING THE POWER SUPPLY CIRCUIT**

1. With the starting switch at the "ON" position, check the final voltage between the terminals 3 (27.35)\* and the ground connection to the body.

Voltage: approx. that of the battery.

- 1. ON
- 2. Voltmeter

2. Check for continuity between the terminals 6, 10, 13 (7, 17, 28, 36)\* and the ground connection to the body.

No continuity ..... INCORRECT

(\*): For units with EGR System carry out these operations using the terminals between brackets. For their location see page 79, connectors 161M and 162M.

- 1. ON
- 2. Ohmmeter

**CHECKING THE WATER TEMPERATURE SENSOR CIRCUIT**

1. Disconnect the multiple connection from the control device and test the continuity.

2. Check for continuity between the terminals 11 (33)\* and 12 (34)\*. Approximately the same resistance as indicated in "Checking the water temperature sensor" should be obtained.

(\*): For units with EGR System carry out these operations using the terminals between brackets. For their location see page 79, connectors 161M and 162M.

- 1. ON
- 2. Ohmmeter

**CHECKING THE WATER TEMPERATURE SENSOR**

Measure the temperature resistance as follows.

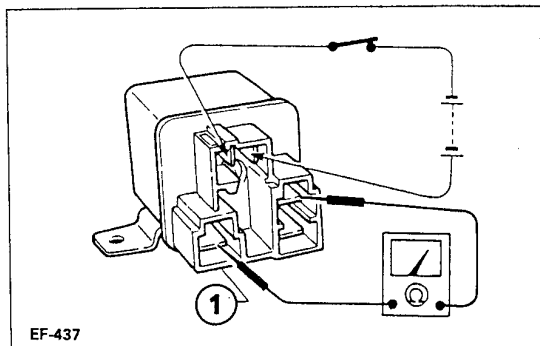
Coolant temperature °C (°F)	Resistance KΩ
-20 (-4)	15.7
3 (37)	5.0
30 (86)	1.7
80 (176)	0.3

1. Water temperature sensor

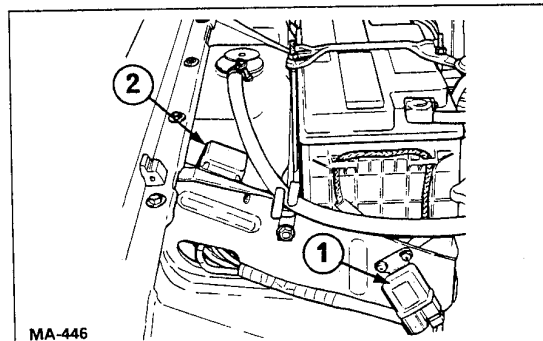
**CHECKING THE INCANDESCENT RELAY**

Under normal conditions, this relay remains open.

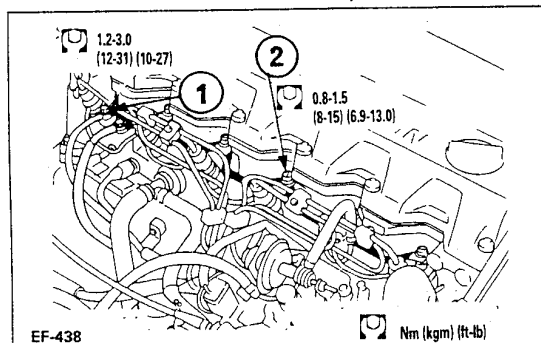
- 1. Ohmmeter
- 2. Incandescent relay



1. Incandescent relay-2

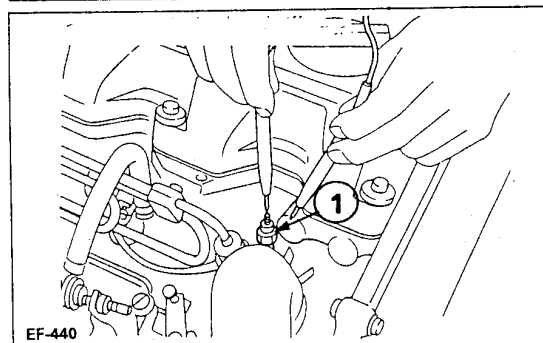


1. Incandescent relay-1  
2. Incandescent relay-2

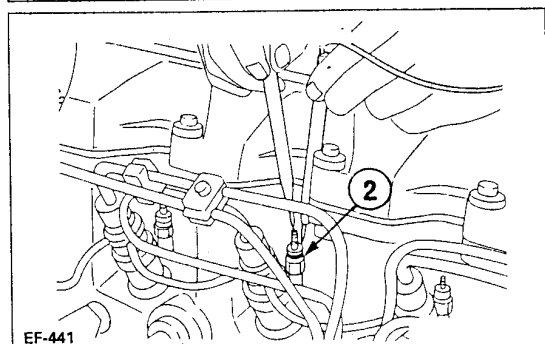


EF-438

Nm (kgm) (ft-lb)



EF-440



EF-441

2. Incandescent plug of cylinders N.º 4, 5 and 6

**CHECKING THE INCANDESCENT PLUGS CONNECTION PLATE NUTS**

Check that the nuts of the multiple connections and incandescent plugs connection plate are firmly tightened.

**CHECKING THE INCANDESCENT PLUGS**

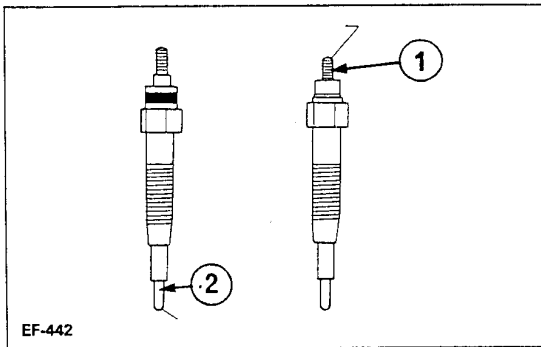
Remove the connection plate from the incandescent plugs and check the continuity between each plug and the cylinder head.

- 1. Multiple connection nut
- 2. Connection plate nut

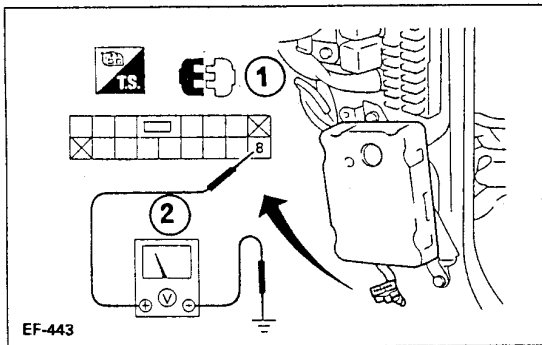
If there is no continuity, the incandescent plug must be replaced.

**CAUTION:**

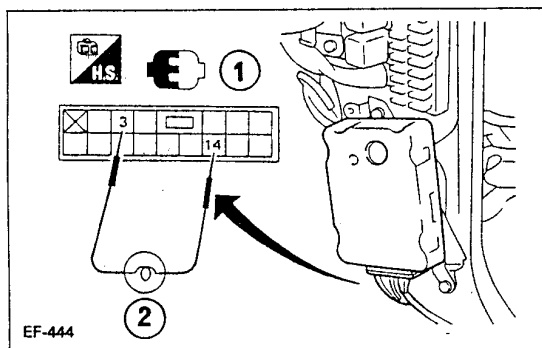
- Do not use incandescent plugs that have been knocked.
- Before installing the incandescent plug, carefully insert one's finger in the plug housing so as to ensure that the silicone rubber seal is in the correct position.
- Do not remove the incandescent plug unless it is going to be replaced with a new one. (As can be seen in the figure, the continuity can be checked without removing the plug).
  - 1. Incandescent plug of cylinders N.º 1, 2 and 3
- The ceramic element is very fragile. After installing the incandescent plug in the cylinder head, test the continuity as shown in the figure, to ensure that the ceramic element has not been broken.
- If on difficulty is encountered when trying to remove the plug, it is probably because there is an accumulation of carbon in the plug housing on the cylinder head.
- Before installing the plug, remove all traces of carbon that might have been accumulated in the plug housing.



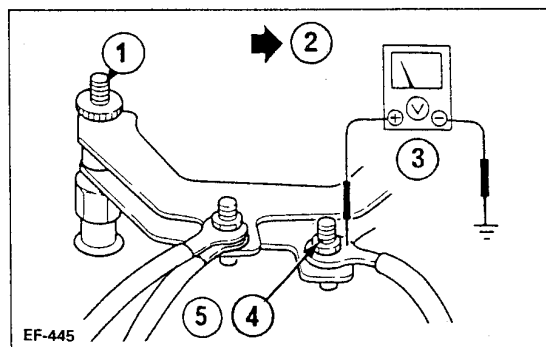
1. For cylinders N.º 1-3
2. For cylinders N.º 4-6



1. OFF
2. Voltmeter



1. ON
2. Pilot light



1. Incandescent plug N.º 6
2. Front
3. Voltmeter
4. M5 bolt (Terminal 3M) (Blue)
5. M5 bolt (Terminals 2M) (Two red cables)

**CHECKING THE STARTING INPUT SIGNAL**

1. Disconnect the ignition switch.
2. Disconnect the multiple connection from terminal "S" of the starter motor.
3. With the ignition switch at the "START" position, check the final voltage between terminal 8 (21)\* and the ground connection to the body.

**Voltage:** approximately that of the battery.

(\*): For units with EGR System carry out these operations using the terminals between brackets. For their location see page 79, connectors 161M and 162M.

**CHECKING THE INCANDESCENT CONTROL DEVICE**  
(With the water temperature below 75 °C (167 °F))

1. Disconnect the ignition switch.
2. Leave the multiple connection joined to the control device.
3. Connect the test lamp to the control device, between the terminals 3 (35)\* and 14 (2)\*.
4. Turn the ignition switch to the "ON" position and measure the time the test lamp stays on.

**Time during which the test lamp stays on.**

**1-10 seconds**

(It would vary in accordance with the final voltage of the incandescent plug and the time during which the ignition switch remains in the "OFF" position.)

(\*): For units with EGR System carry out these operations using the terminals between brackets. For their location see page 79, connectors 161M and 162M.

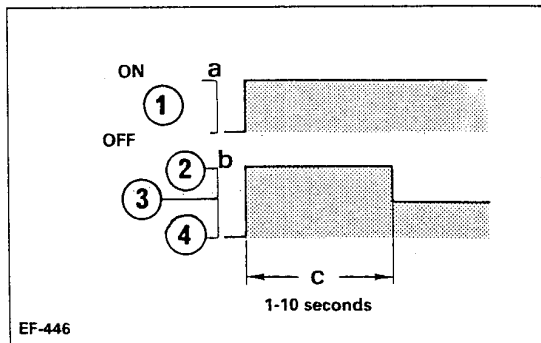
**CHECKING THE INCANDESCENT CONTROL**  
(With the water temperature below 75 °C (167 °F))

- **Checking the preignition control.**

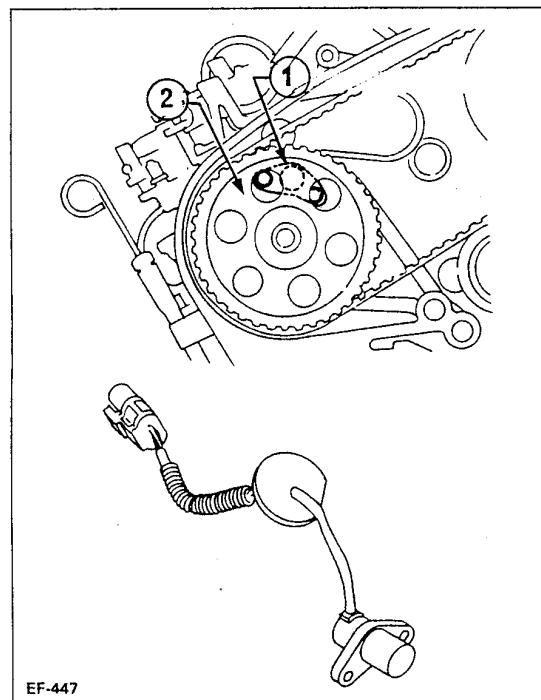
1. Turn the ignition switch to the "ON" position and measure the final voltage of the incandescent plug. Apply the battery voltage for 1-10 seconds\*<sup>1</sup>, and then apply half of the battery voltage for 30 seconds (15 seconds\*<sup>2</sup>).

\*<sup>1</sup>: Depending of the final voltage of the incandescent plug.

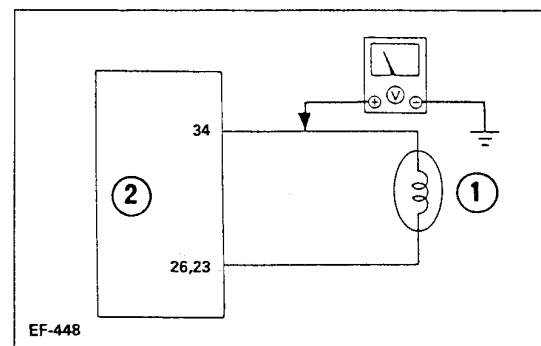
\*<sup>2</sup>: On those models for Switzerland and West Germany.



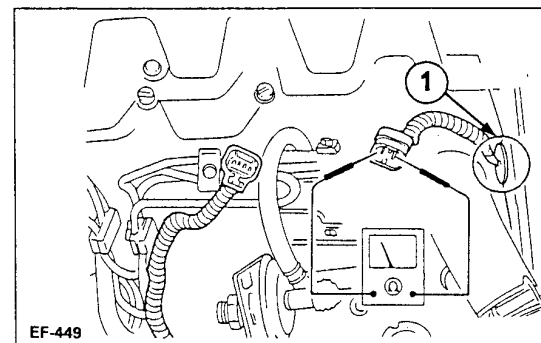
EF-446



EF-447



EF-448



EF-449

1. Engine revolutions sensor

[With the water temperature below 60 °C (140 °F)]

• After checking the incandescence.

2. Turn the ignition switch to the "START" position.
3. Once the engine has started, measure the final voltage of the incandescent plug.

One half the battery voltage must be applied for 10 minutes.

If the engine speed exceeds 2,000 rpm during acceleration or starting, or if the vehicle is driven at more than 12 km/h (7 mph) for more than 3 minutes, the post-ignition control function will cease.

1. Ignition switch position
2. Battery voltage
3. Battery voltage/2
4. Final voltage of the incandescent plug, OV
- a. ON
- b. OFF
- c. 1-10 seconds

## ENGINE REVOLUTIONS SENSOR

### DESCRIPTION

The engine revolutions sensor (1) functions in the same way as the sensors of the tachometers used on conventional diesel models, that is to say, it registers the engine speed in the form of intermittent magnetic fields, and sends signals to the control device. It is installed inside the front cover (behind the fuel injection pump drive gear (2)). Magnetic field intermittence is also provided by the six holes in the gear.

1. Engine revolutions sensor
2. Fuel injection pump drive gear

### CHECKING THE ENGINE REVOLUTIONS SENSOR CIRCUIT

1. With the engine turning under no-load conditions, check the alternating current voltage at terminal 34 and at the ground connection to the body.

Engine turning under no-load condition: 0.5 V approx.

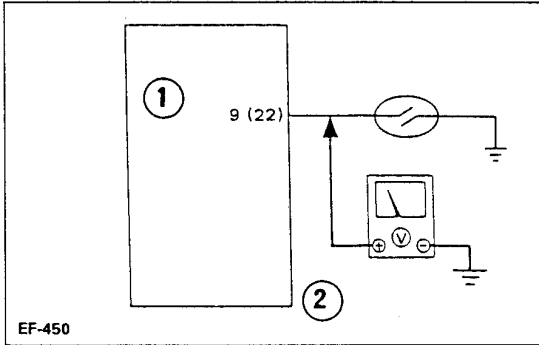
Check that the voltage increases when the engine speed increases.

1. Engine revolutions sensor
2. Control unit

2. If the voltage is not within the specified values, a continuity test must be carried out.

Resistance:

Approx. 700Ω (there is continuity)



EF-450

1. Control device
2. Ignition switch at "ON" position

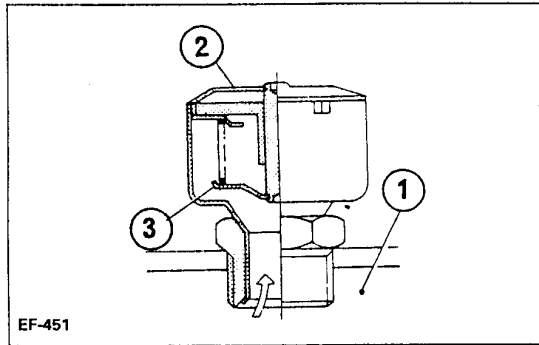
**CHECKING THE VEHICLE SPEED SENSOR**

Jack up the vehicle's rear wheels and turn them by hand.

Check the voltage between terminal 9 (22)\* and the ground connection to the body.

ON/OFF pulses should be detected.

(\*): For units with EGR System carry out these operations using the terminals between brackets. For their location see page 79, connectors 161M and 162M.



EF-451

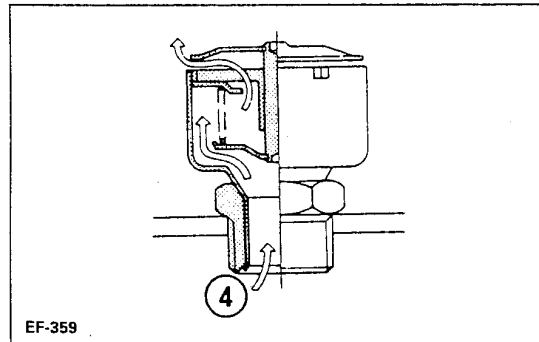
1. Inlet manifold
2. Top cover
3. Diaphragm

**OVERPRESSURE VALVE**

1. The overpressure valve, installed on the inlet manifold, functions in the following way: when the pressure in the inlet manifold exceeds a maximum value, the pressure acts on the diaphragm, which in turn, acts on the cover of the valve, opening the cover and releasing the excess pressure.

a) Pressure in the inlet manifold below the permissible value.

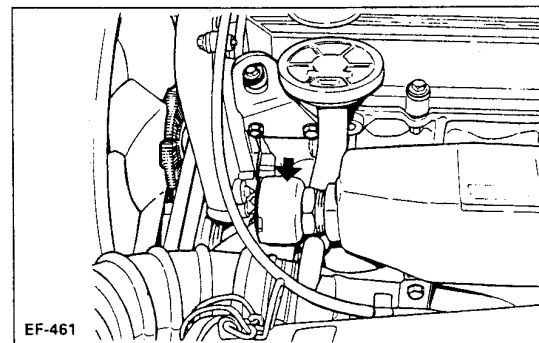
b) Pressure in the inlet manifold above the permissible value.



EF-359

4. Overpressure

2. If it is found that the operation of the valve is defective, the valve must be replaced with a new one.

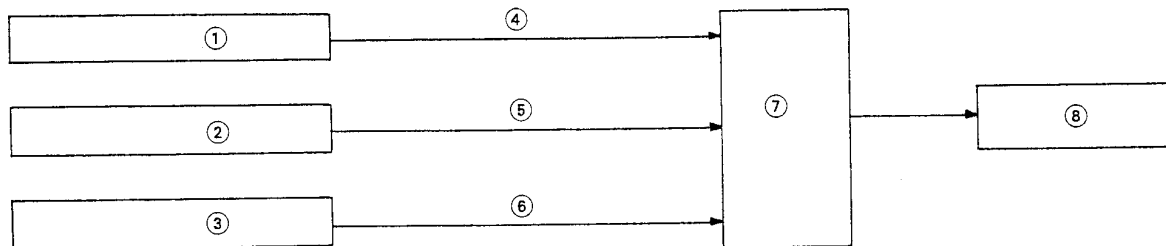


EF-461



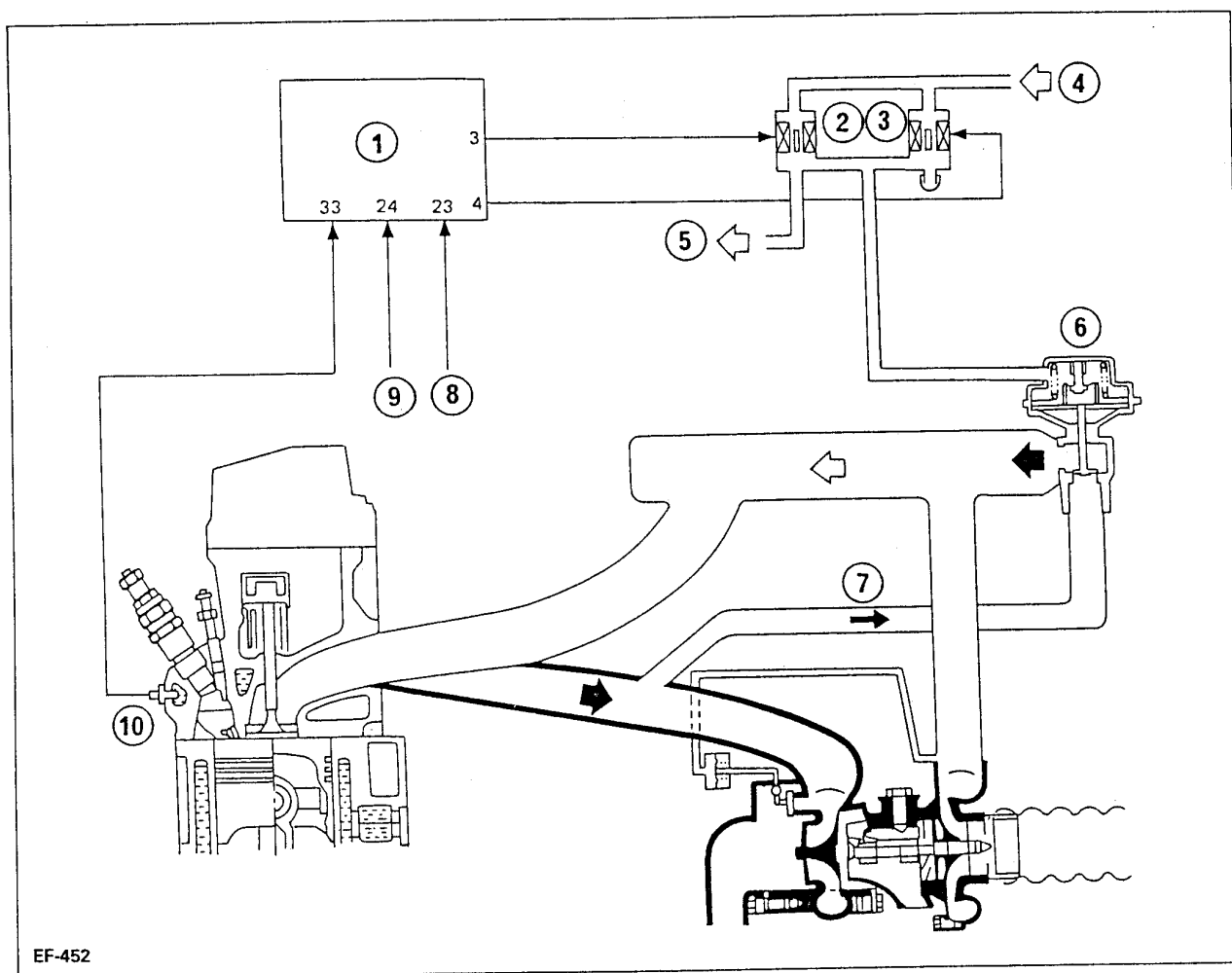
# E.G.R. SYSTEM

FOR SWITZERLAND AND WEST GERMANY



**COMPONENTS**

- |                              |                                  |
|------------------------------|----------------------------------|
| 1. Potentiometer             | 5. Engine speed                  |
| 2. Engine revolutions sensor | 6. Engine temperature            |
| 3. Water temperature sensor  | 7. Control device                |
| 4. Engine load               | 8. E.G.R. control solenoid valve |



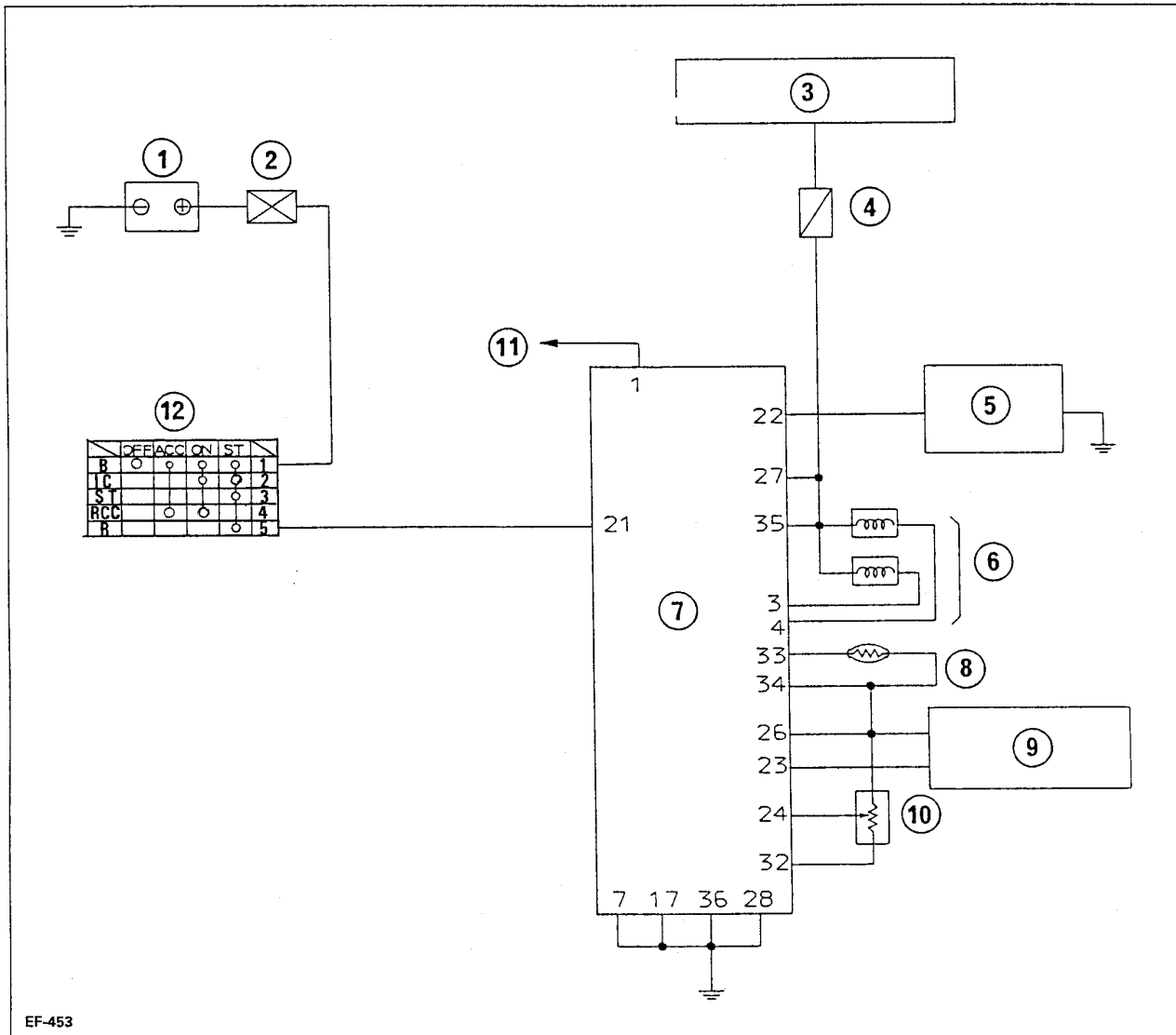
EF-452

**COMPONENTS**

- |                                      |                              |
|--------------------------------------|------------------------------|
| 1. Control device (E.G.R.)           | 6. E.G.R. control valve      |
| 2. Control solenoid A valve (E.G.R.) | 7. E.G.R. gases              |
| 3. Control solenoid B valve (E.G.R.) | 8. Engine revolutions sensor |
| 4. Air cleaner                       | 9. Potentiometer             |
| 5. Vacuum pump                       | 10. Water temperature sensor |

The E.G.R. system, permits controlling the emission of poisonous gases, and returning the exhaust gases to the inlet manifold via the E.G.R. control valve.

DIAGRAM

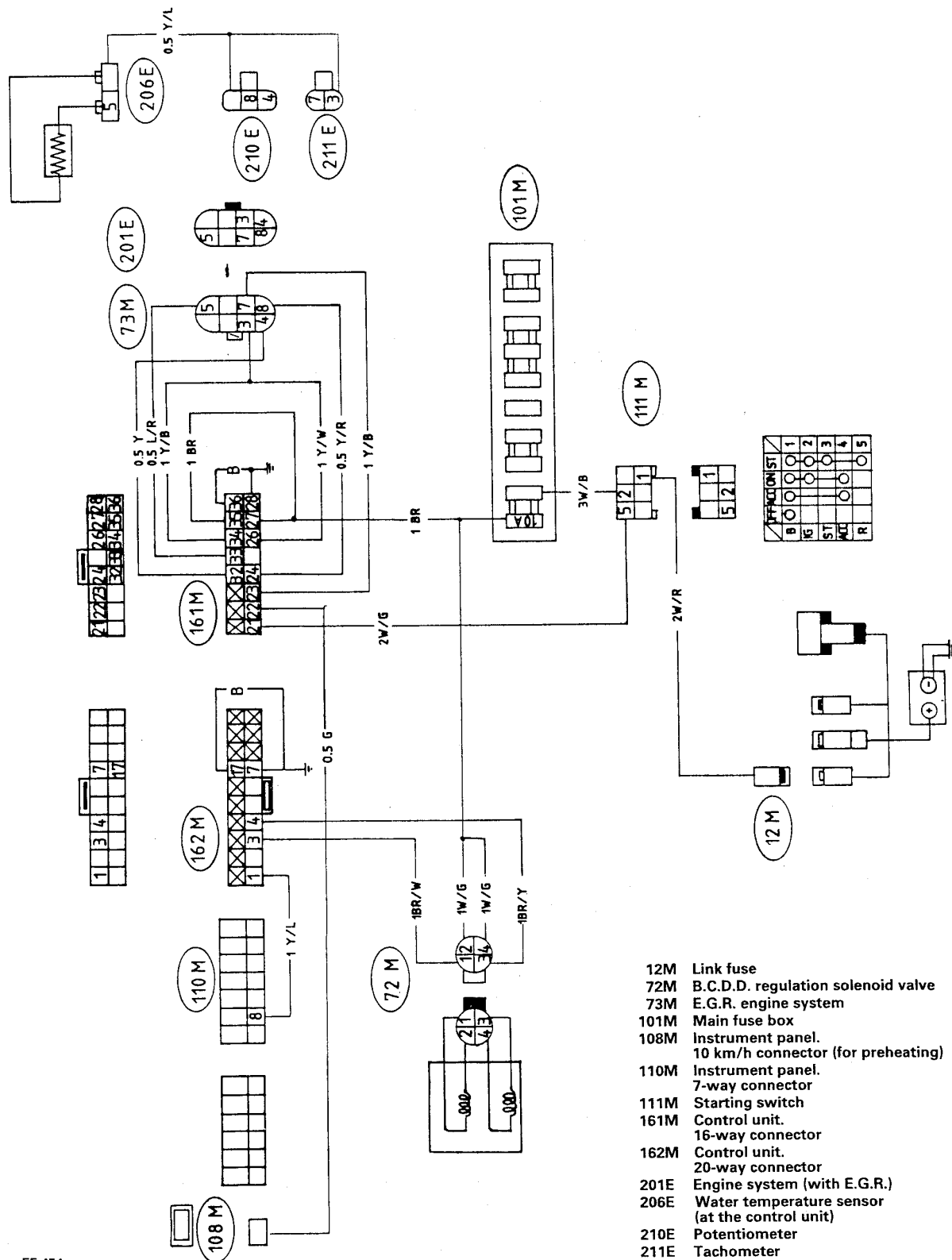


EF-453

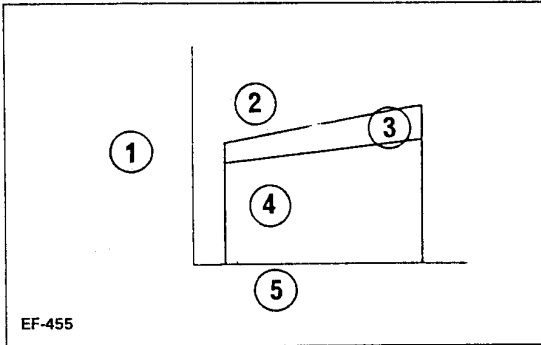
COMPONENTS

- 1. Battery
- 2. Link fuse
- 3. Ignition switch. ON or OFF
- 4. Fuse
- 5. Vehicle speed sensor
- 6. E.G.R. control solenoid valve
- 7. Incandescent control device and E.G.R.
- 8. Water temperature sensor
- 9. Engine revolutions sensor
- 10. Potentiometer
- 11. To the tachometer
- 12. Ignition switch

CIRCUIT DIAGRAM



EF-454



- 1. Fuel injection pump control lever opening
- 2. Phase III
- 3. Phase II
- 4. Phase I
- 5. Engine speed

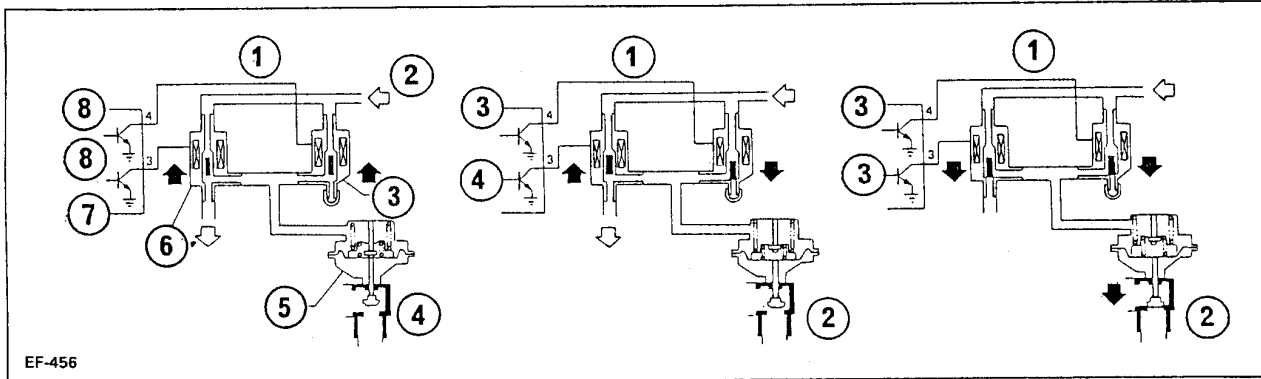
**OPERATION**

The E.G.R. flow is controlled in three phases, in accordance with the engine speed and load. The first phase, "high E.G.R.," is reached when the E.G.R. control valve is fully open.

The second phase, "reduced E.G.R.," is reached when the R.G.R. valve is half open.

The third phase, "nil E.G.R.," is reached when the E.G.R. valve is closed.

PHASE	E.G.R. CONTROL SOLENOID VALVE A	E.G.R. CONTROL SOLENOID VALVE B	E.G.R. CONTROL VALVE	E.G.R. FLOW
First	ON	ON	Fully open	High
Second	ON	OFF	Half open	Low
Third	OFF	OFF	Closed	Nil



- 1. Phase I
- 2. Air cleaner
- 3. Solenoid-B
- 4. Fully open
- 5. E.G.R. control valve
- 6. Solenoid-A
- 7. Control device
- 8. ON

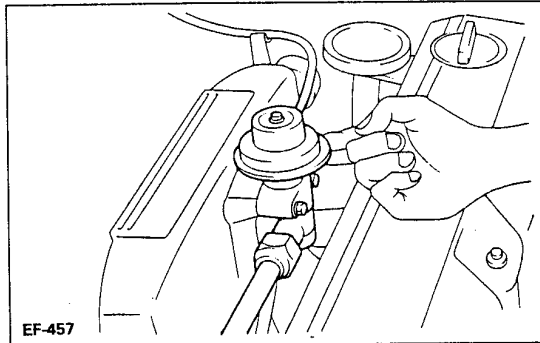
- 1. Phase II
- 2. Half open
- 3. OFF
- 4. ON

- 1. Phase III
- 2. Closed
- 3. OFF
- OFF

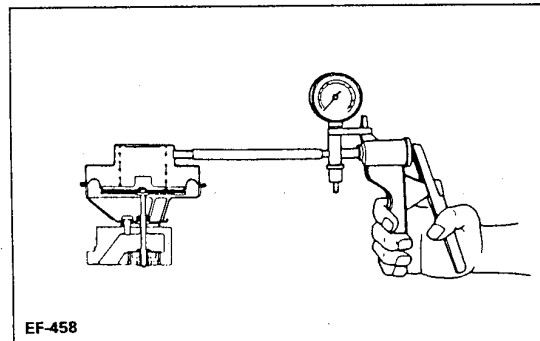
The engine load signal is detected with the potentiometer installed on the fuel injection pump control lever; whereas the engine revolutions sensor located behind the fuel injection pump drive gear, produces the engine speed signal.

The E.G.R. control valve is activated by the vacuum generated by the vacuum pump. The E.G.R. control solenoid valves are used to convert the electrical signal from the control device into a vacuum response.

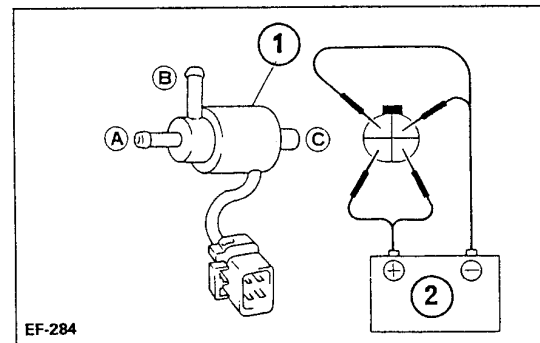
For greater safety when driving the vehicle, the E.G.R. system is deactivated when the water temperature is low. The water temperature sensor is of the thermistor type that detects the temperature at the cylinder head.



EF-457

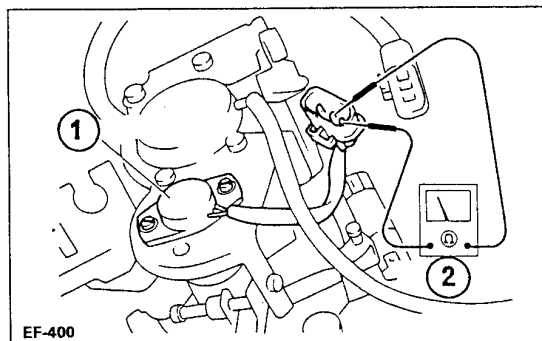


EF-458



EF-284

1. E.G.R. control solenoid valve
2. Battery



EF-400

1. Potentiometer
2. Ohmmeter

**INSPECTION**

**COMPLETE SYSTEM**

1. Check that the vacuum hoses are not loose, squashed or incorrectly connected.
  2. Allow the engine to warm up sufficiently.
  3. Place one's finger on the diaphragm of the E.G.R. control valve, to make sure that the valve functions whilst the engine is being accelerated.
- Be careful that the finger does not become trapped between the diaphragm and housing of the E.G.R. control valve.
  - Check that all multiple connections are correctly connected.

**E.G.R. CONTROL VALVE**

1. Using a portable vacuum pump, create a vacuum at the E.G.R. control valve.
  2. Place one's finger on the valve diaphragm so as to check that the diaphragm is moved up and down by the effect of the vacuum directed to the valve.
- Never create too high a vacuum at the valve.

**E.G.R. CONTROL SOLENOID VALVE**

Check the correct operation of the solenoid valve after having disconnected the multiple connection and all the vacuum hose.

Apply battery current to the solenoid valve, and check for continuity at poles A, B and C.

	Solenoid valve	
	(OFF)	(ON)
Position		
Continuity	B-C	A-B

**POTENTIOMETER**

1. Disconnect the potentiometer multiple connection and connect the ohmmeter as shown in the figure.
2. Check that resistance changes are recorded when the opening angle of the fuel injection pump lever is altered.

**WATER TEMPERATURE SENSOR AND ENGINE REVOLUTIONS SENSOR**

See Pages 72 and 75 of this Section.

