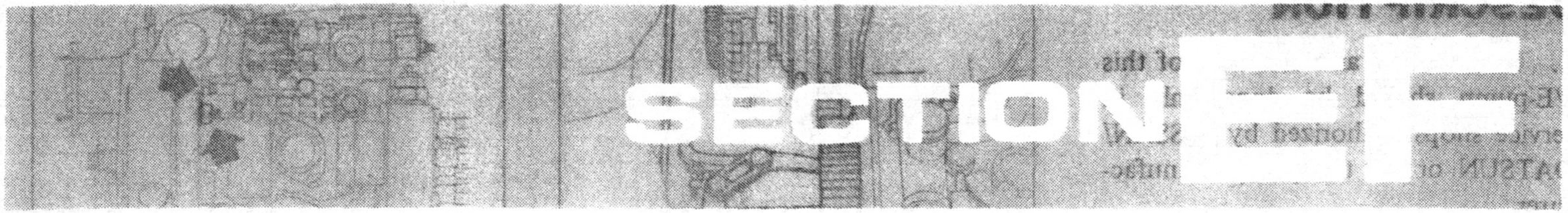
NISSAN

NISSAN

MODEL LD20
&
LD28
DIESEL ENGINE

SERVICE MANUAL

ENGINE FUEL



CONTENTS

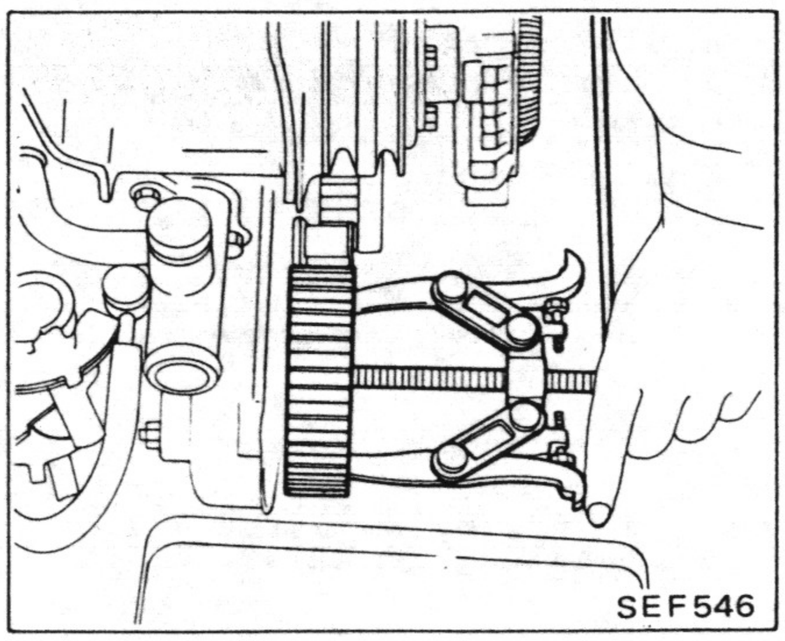
INJECTION PUMP ASSEMBLY (VE-type) . . . . . EF- 2
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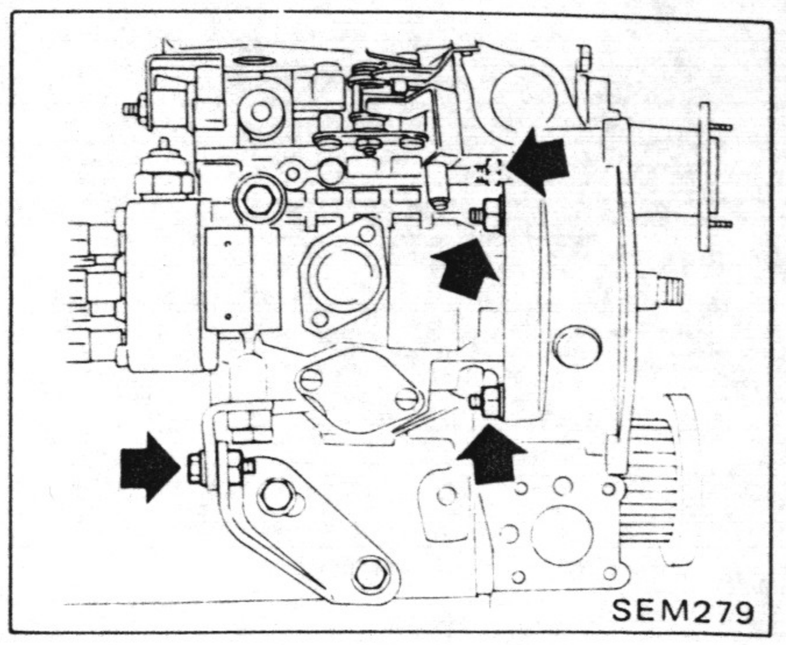
INJECTION PUMP ASSEMBLY (VE-type)

DESCRIPTION

1. Disassembly and assembly of this VE-pump should be done only in service shops authorized by NISSAN/ DATSUN or by the pump manufacturer.
2. Before removing fuel injection pump from vehicle, check closely to make sure that it is apparently malfunctioning.

Refer to Trouble Diagnoses and Corrections in ET section.


SEF546


SEM279

INJECTION PUMP

REMOVAL

1.
- Remove battery (LD28).
- Disconnect battery ground cable (LD20).

2. Remove undercover (LD20).
3. Drain coolant.
4.
- Remove air cleaner duct and resonator (LD28).
- Remove air cleaner duct (LD20).

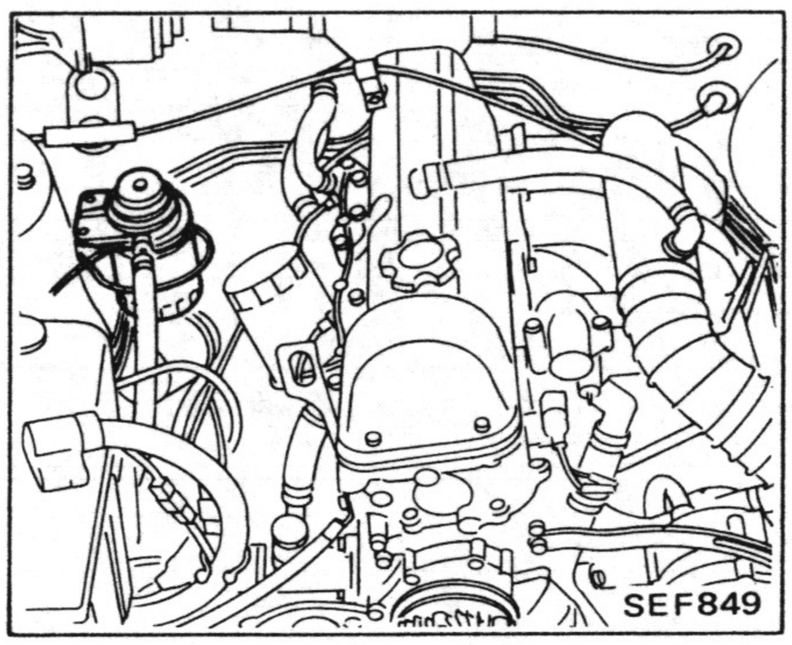
5. Remove radiator grille (LD20).
6. Remove radiator and shroud.
7. Remove cooling fan.
8. Loosen alternator bolts.
9. Remove drive belts.
- Alternator
- Power steering oil pump
- Compressor

10. Remove power steering oil pump (LD28).

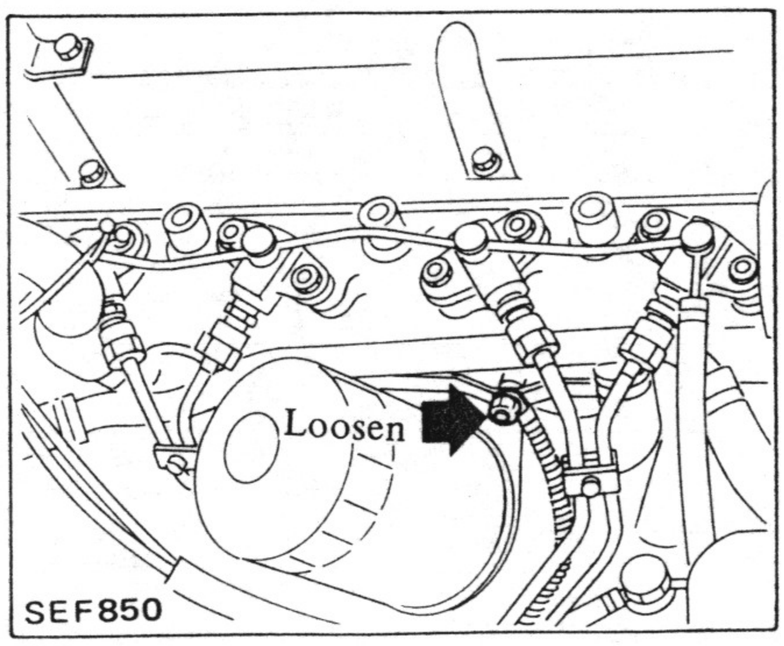
Never drain power steering oil while work is being performed.

11. Disconnect following wires and hoses.
- Accelerator wire
- Throttle control wire
- Fuel hose
- F.I.C.D. vacuum hose.
- Fuel cut solenoid wire.

12. Remove crank damper pulley.
13. Remove dust cover.
14. Loosen spring set pin and set tensioner pulley to "free tension" position. Then tighten them.
15. Remove drive belt.
16. Remove injection pump drive pulley.
17. Disconnect wires and remove starter motor (LD20).
18. Remove water inlet (LD20).
19. Disconnect fuel filter sensor harness, then move fuel filter with bracket to work area for safety purposes (LD20).

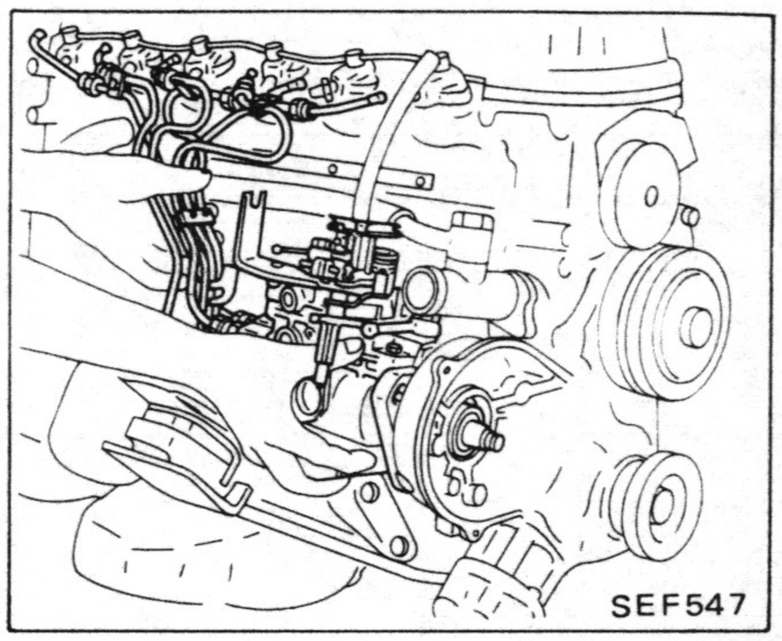

SEF849

20. Remove glow plug harness (LD20).



SEF850

21. Disconnect injection tube at injection nozzle side.
22. Remove injection pump fixing nuts and bracket bolt.
23. Take out injection pump assembly with injection tube.

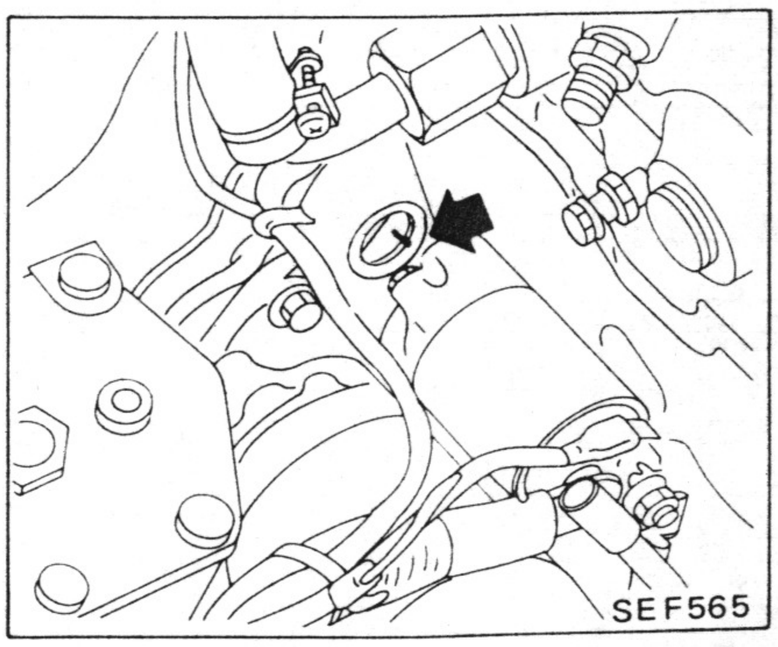

SEF547

INSTALLATION

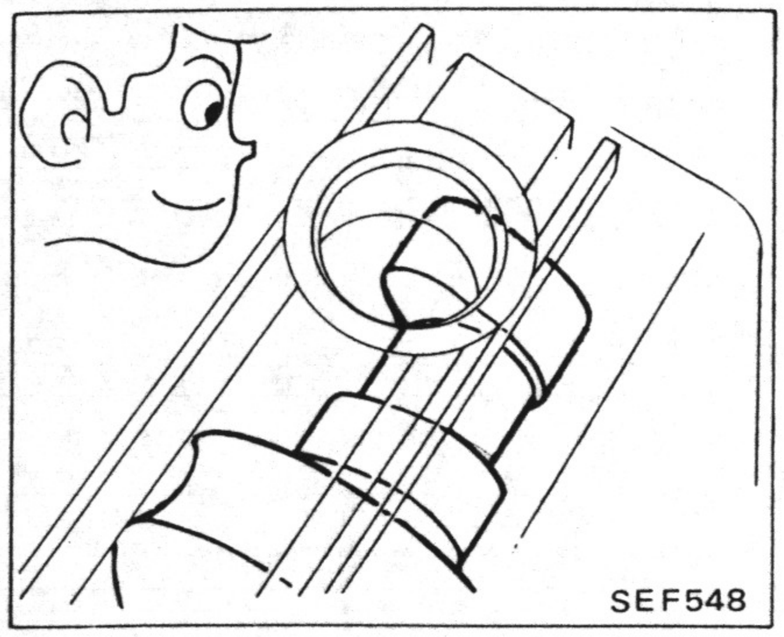
Install injection pump assembly in the reverse order of removal, observing the following.

1. Set No. 1 cylinder at top dead center on compression stroke.

Make sure that grooves in rear plate and drive plates are aligned with each other.

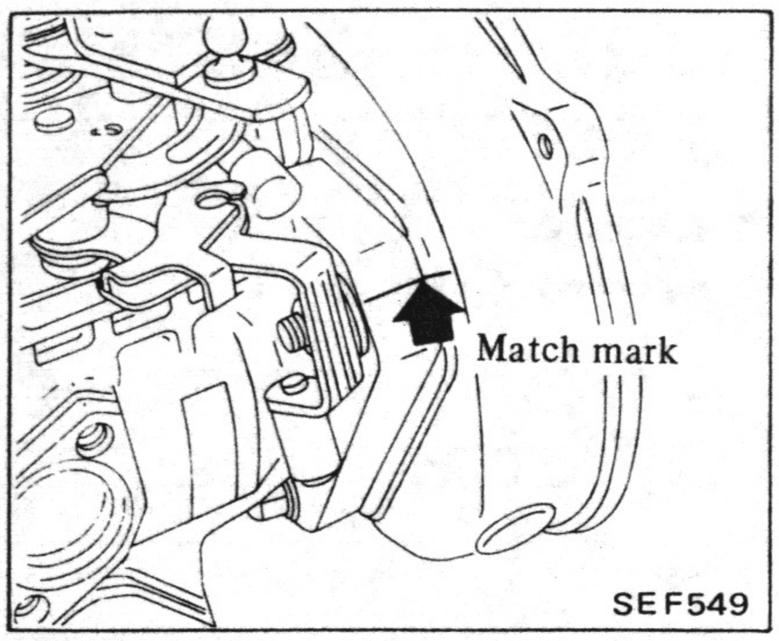

SEF565

Make sure that No. 1 cam of camshaft is in a position as shown.



2. Install fuel injection pump.

Temporarily tighten fuel injection pump after side surface of this pump is aligned with aligning mark on side surface of front cover.



3. Attach fuel injection pump pulley.

There are two grooves and two drive belt align marks on the pulley. When installing injection pump, follow the instructions below.

a. When installing injection pump on LD28, use mark groove (without "A") and align mark.

b. When installing injection pump on LD20, use "A" mark groove and align mark.

c. Fuel injection pump drive shaft is tapered. Use a copper or plastic hammer to drive pulley into place.

Ⓣ : Pulley nut
59 - 69 N-m
(6.0 - 7.0 kg-m,
43 - 51 ft-lb)

d. In case of LD20, install starter motor after installing injection pump.

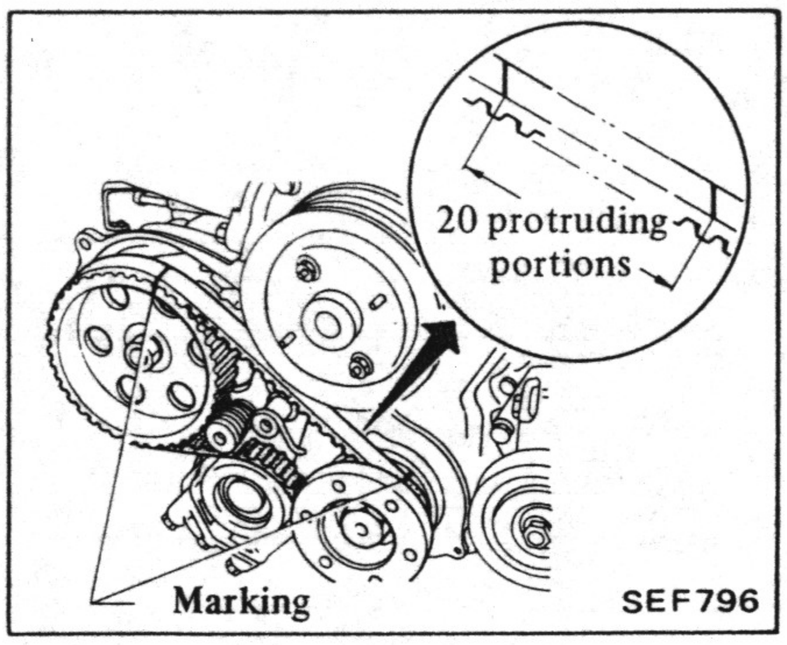
4. Make sure that tensioner is in "free" position.

5. Install injection drive belt.

(1) Align both timing marks of drive belt and crank pulley.

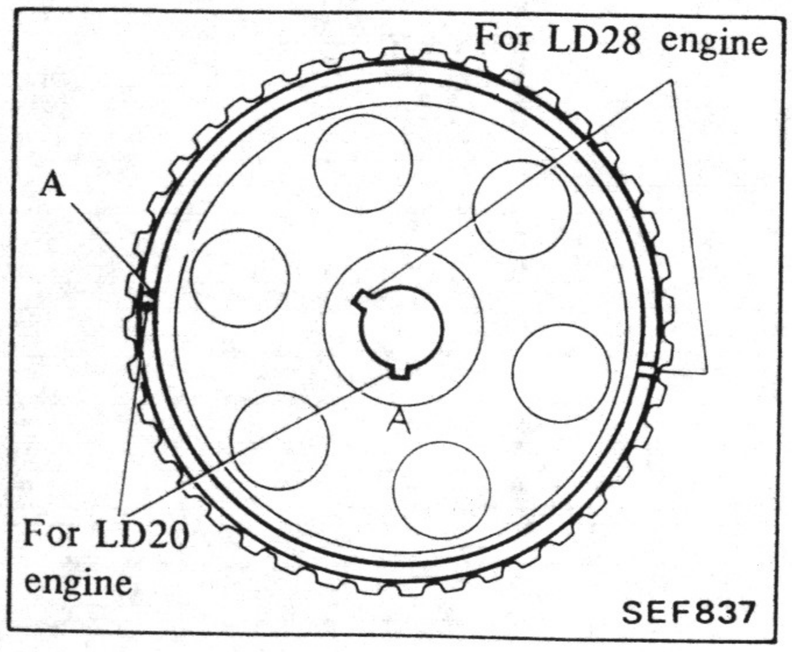
(2) Properly align timing mark of pump pulley with that of drive belt.

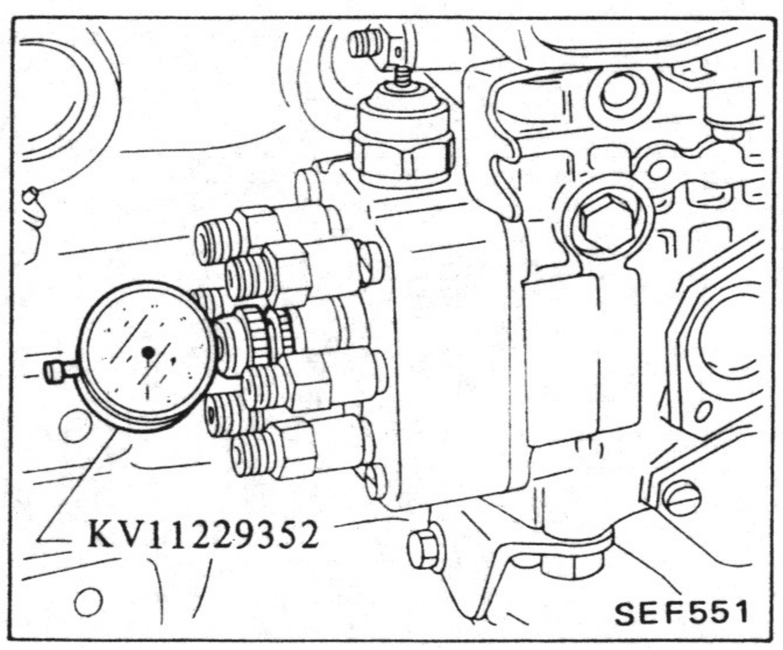
(3) If timing mark of drive belt is not clear enough to permit alignment, set marks of both crank pulley and injection pump pulley at positions so that there are 20 cogs of drive belt between these two marks.



6. Loosen spring set pin and tensioner so that belt is automatically set to "tension" position.

7. Remove air vent screw from rear end of fuel injection pump and, in its opening, attach KV11229352.





8. Plunger lift measurement and adjustment.

(1) Turn crankshaft counterclockwise from No. 1 cylinder at Top Dead Center.

LD28:
15 - 20 degrees
LD20:
20 - 25 degrees

(2) Find dial gauge needle rest point, then set the gauge to zero.

(3) Turn crankshaft clockwise two complete rotations in order to remove play in cam mechanism. Loosen tensioner and retighten.

Belt tension is automatically set by tension spring.

(4) Turn crankshaft clockwise until No. 1 cylinder is set at top dead center on compression stroke.

Make sure that No. 1 cam of camshaft is in same position as indicated in figure under step 1 above.

(5) Read dial gauge indication.

LD28:
Standard
0.75 ±0.04 mm
(0.0295 ±0.0016 in)
LD20:
Standard:
0.78 ±0.04 mm
(0.0307 ±0.0016 in)

(6) If dial gauge indication is not within above range, turn pump body until it falls within standard range.

a. If indication is smaller than 0.71 mm (0.0280 in) [LD28] or 0.74 mm (0.0291 in) [LD20], turn pump body counterclockwise.

b. If indication is larger than 0.79 mm (0.0311 in) [LD28] or 0.82 mm (0.0323 in) [LD20], turn pump body clockwise.

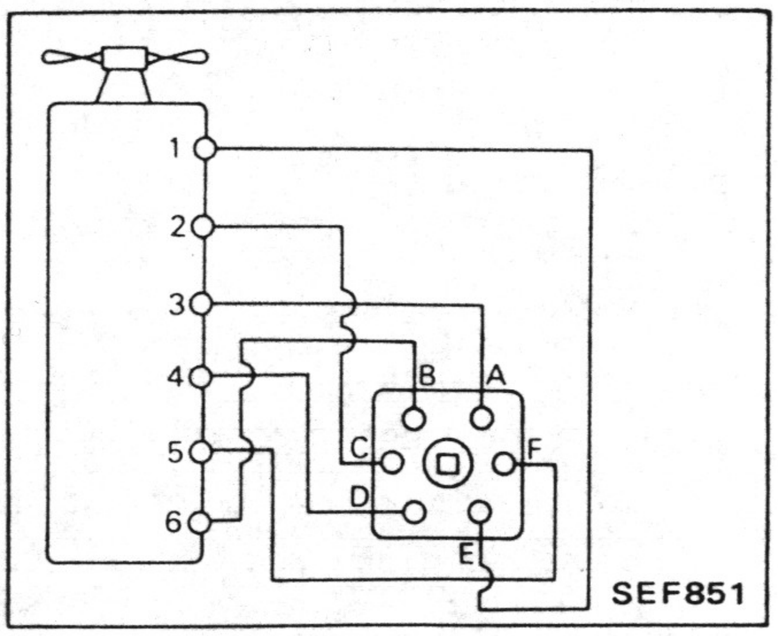
9. Tighten injection pump securely.

10. Disconnect dial gauge and reinstall plug bolt to new washer.

Ⓣ : Plug bolt
14 - 20 N·m
(1.4 - 2.0 kg-m,
10 - 14 ft-lb)

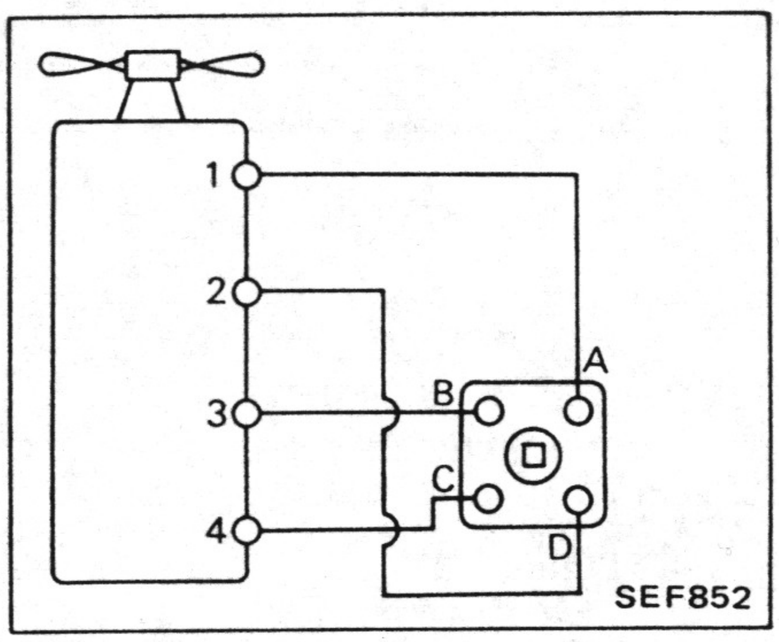
11. Connect fuel tubes.

LD28

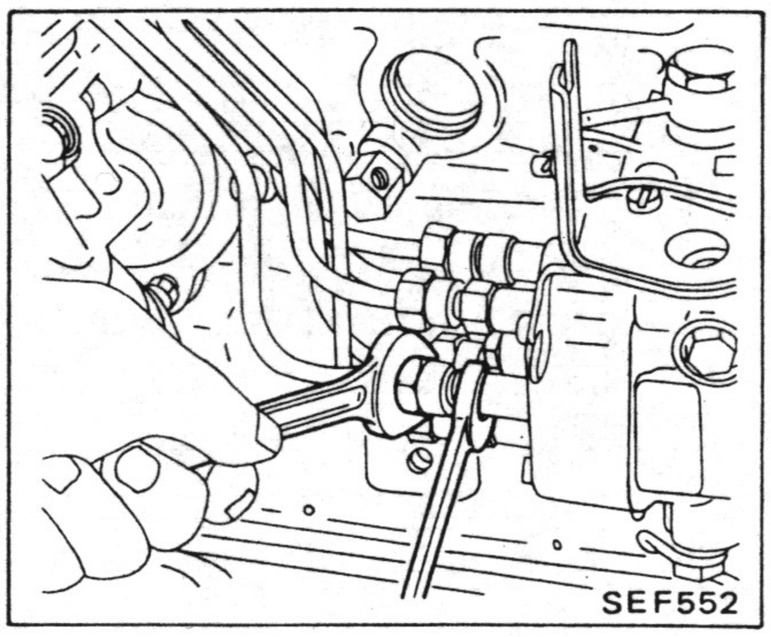


Connect cylinders in the order of 4, 2, 6, 1, 5 and 3.

LD20



Use two wrenches when installing tubes.

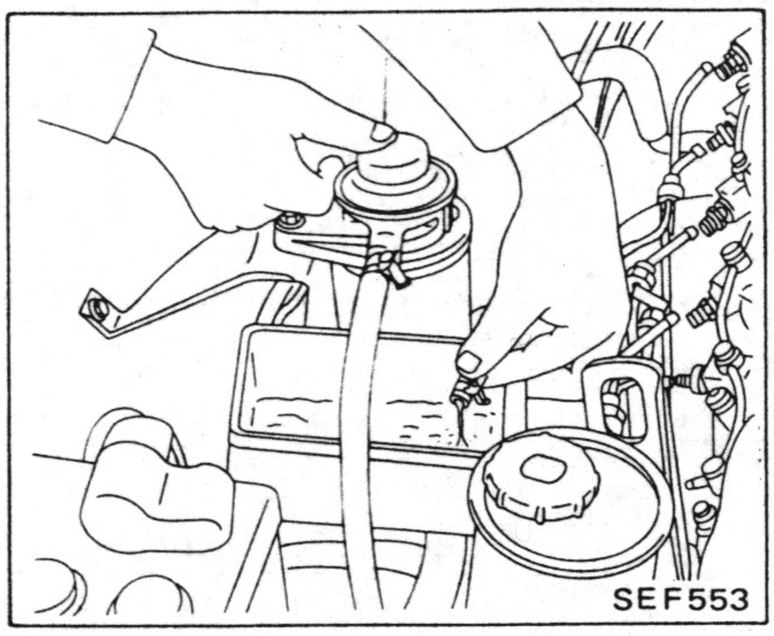


CHECKING PRIMING PUMP

1. Disconnect fuel return hose.

Place a container or jug beneath hose end.

2. Prime priming pump to make sure that fuel overflows at hose end. If not, replace priming pump.



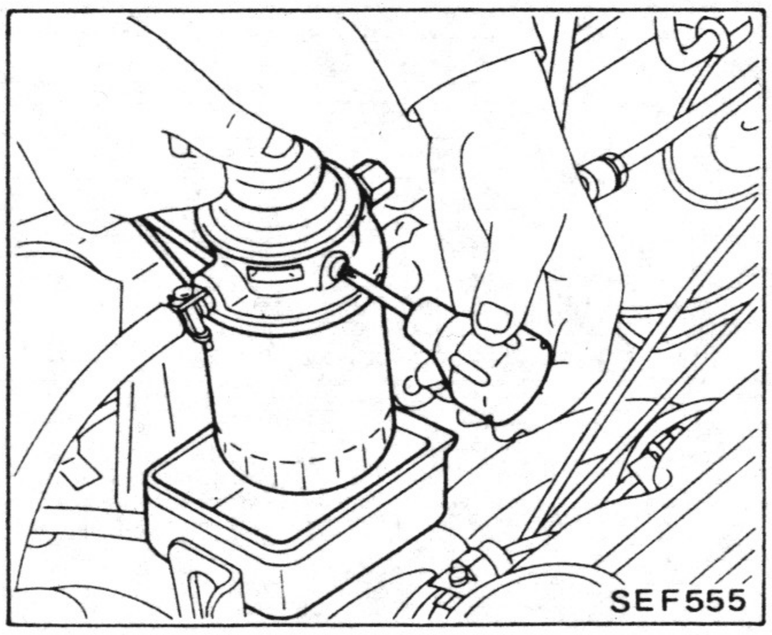
DRAIN WATER

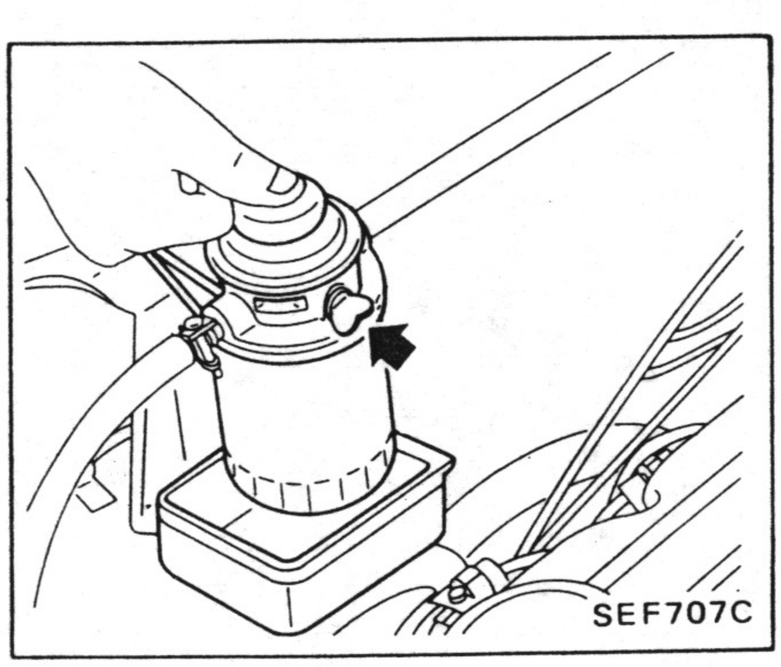
Drain water from fuel filter in accordance with maintenance schedule. Also do this when warning light comes on.

Refer to ET section for drain water of fuel filter.

BLEEDING FUEL SYSTEM

Air should be bled out of fuel system when injection pump is removed or fuel system is repaired.





1. Loosen bleeder screw or cock.
2. Loosen priming pump and priming.

Make sure that fuel overflows at bleeder screw or cock hole.

3. Tighten bleeder screw or cock.
4. Then, disconnect fuel return hose.

Refer to CHECKING PRIMING PUMP.

5. Prime priming pump to make sure that fuel overflows at hose end.
6. Install fuel return hose.
7. Tighten priming pump.

IDLE AND MAXIMUM SPEED ADJUSTMENT

Refer to section ET.

INJECTION NOZZLE ASSEMBLY

REMOVAL AND INSTALLATION

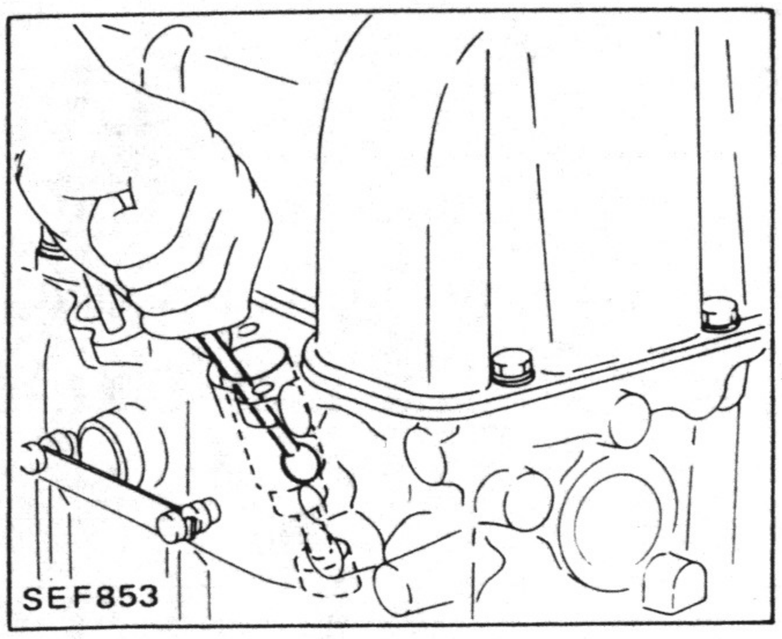
1. Remove fuel injection tube and spill tube assembly.
2. Remove injection nozzle assembly.

Also remove washers from nozzle end.

3. Install injection nozzle in the reverse order of removal.

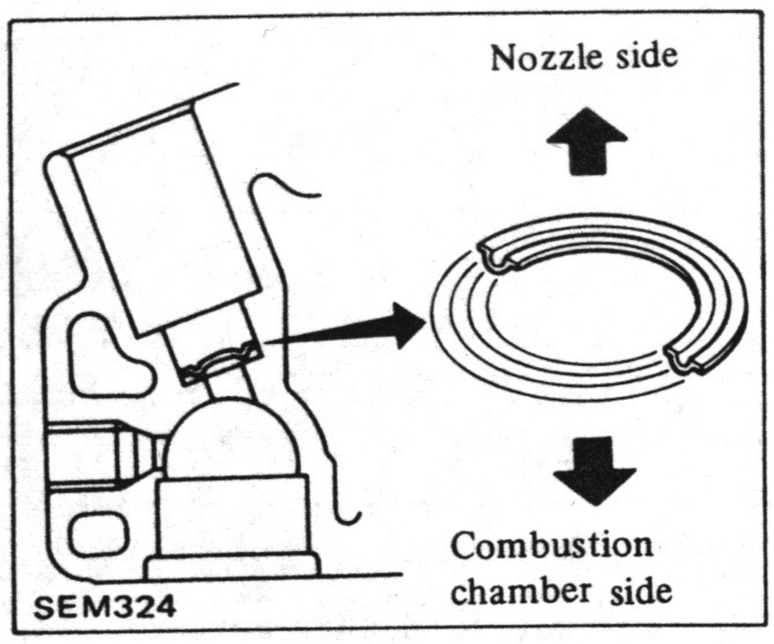
Ⓣ : Injection nozzle to engine
16 - 21 N·m
(1.6 - 2.1 kg-m,
12 - 15 ft-lb)
Injection nozzle to tube
22 - 25 N·m
(2.2 - 2.5 kg-m,
16 - 18 ft-lb)
Spill tube
15 - 18 N·m
(1.5 - 1.8 kg-m,
11 - 13 ft-lb)

a. Always clean nozzle holes.



b. Always use new injection nozzle gasket.

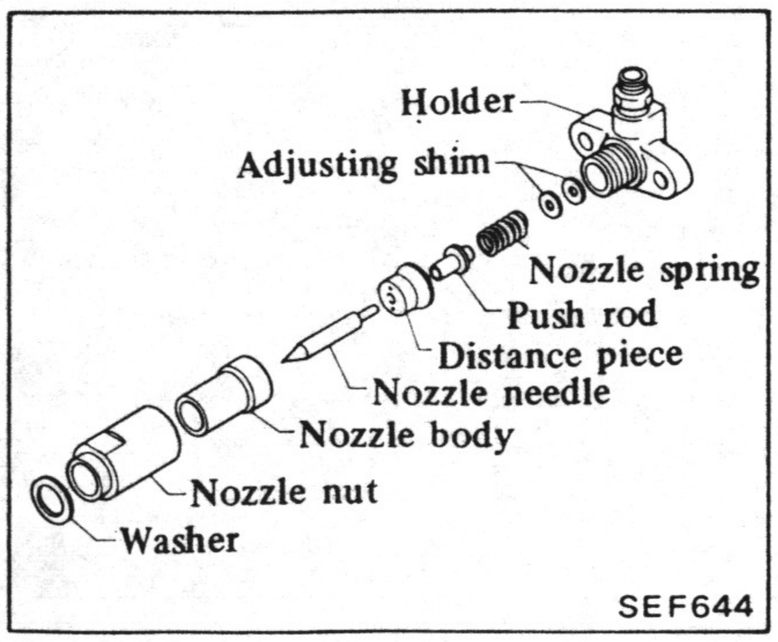
c. Note that small washer should be installed in specified direction.



d. Bleed air from fuel system.

DISASSEMBLY

1. Loosen nozzle nut while keeping nozzle top from turning.
2. Arrange all of disassembled parts in order shown below.



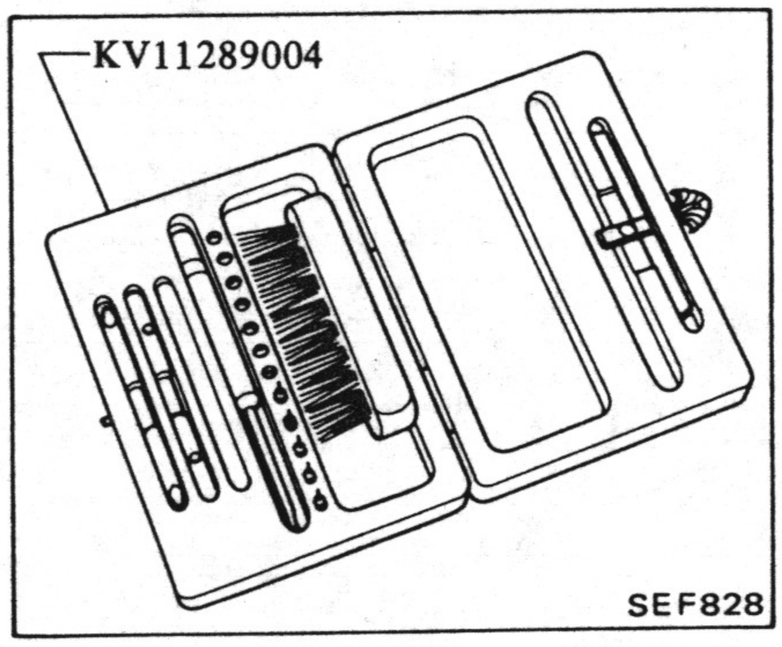
INSPECTION

Thoroughly clean all disassembled parts with fresh kerosene or solvent.

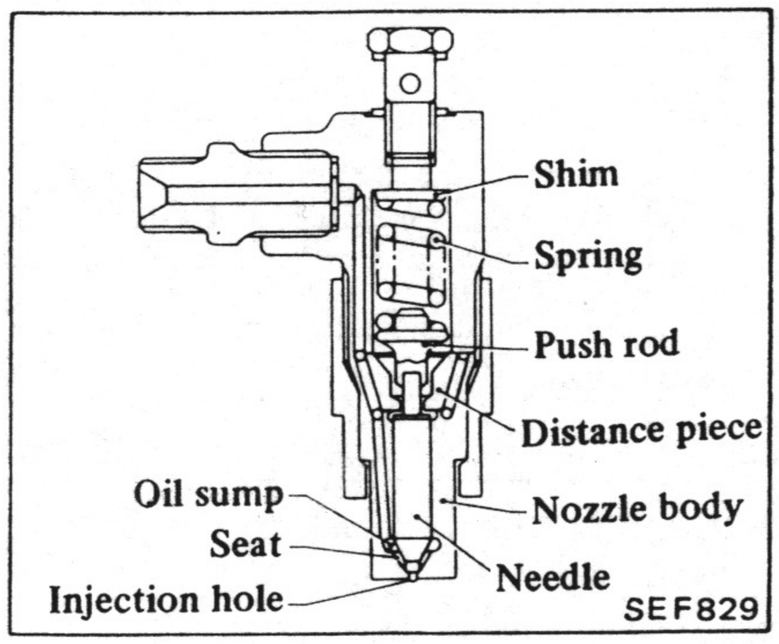
- If nozzle needle is damaged or fused, replace nozzle assembly with a new one.
- If end of nozzle needle is seized or excessively discolored, replace nozzle assembly.
- Check nozzle body and distance piece for proper contact. If excessively worn or damaged, replace nozzle assembly or distance pieces.
- Check distance piece and nozzle holder for proper contact. If excessively worn or damaged, replace distance piece or nozzle holder.
- Check nozzle spring for excessive wear or damage. If excessively worn or damaged, replace it with a new spring.

CLEANING

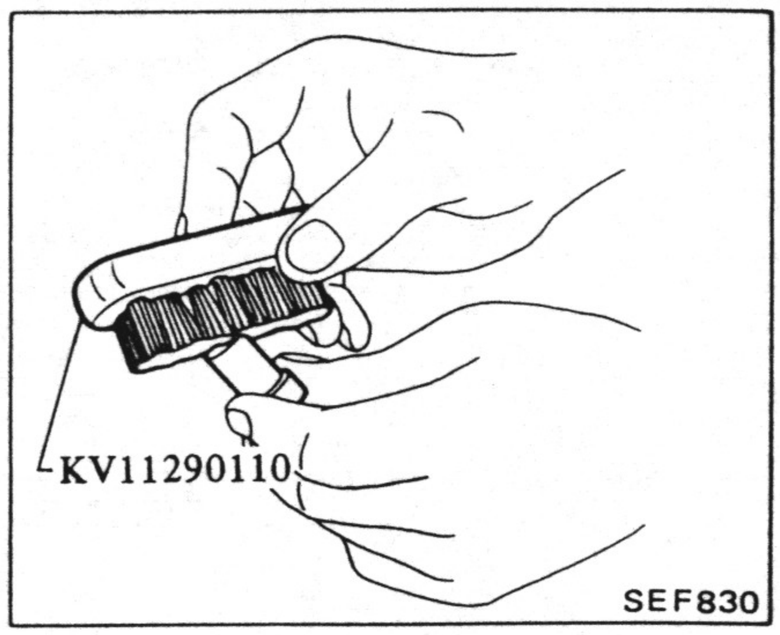
1. Clean nozzle assembly using the Nozzle Cleaning Kit.



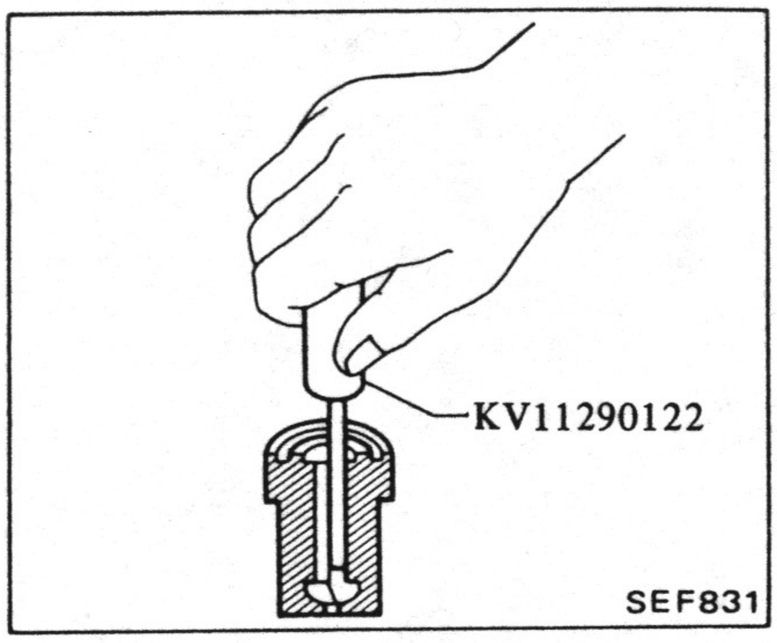
2. Portions which should be cleaned are indicated in figure below.



3. Remove any carbon from exterior of nozzle body (except wrapping angle portion) by using Tool.

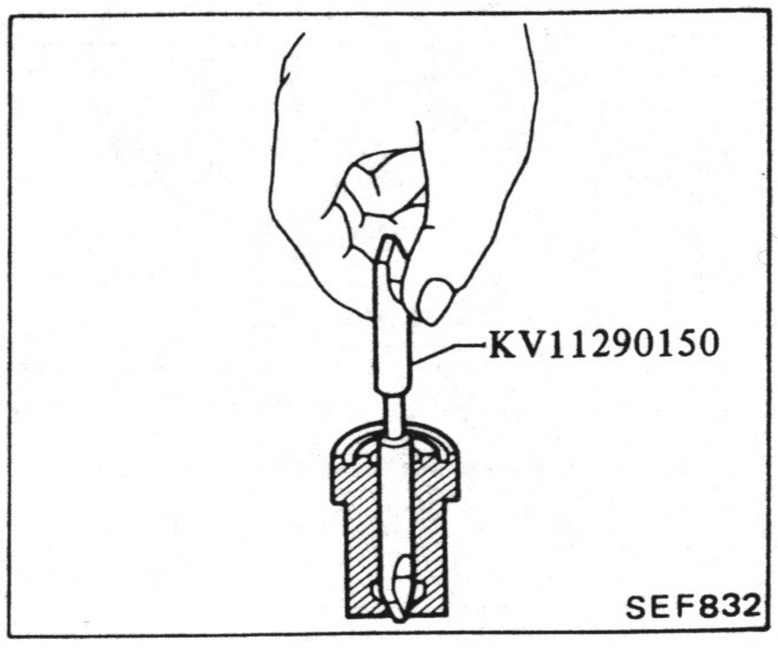


4. Remove oil sump of nozzle body using Tool.



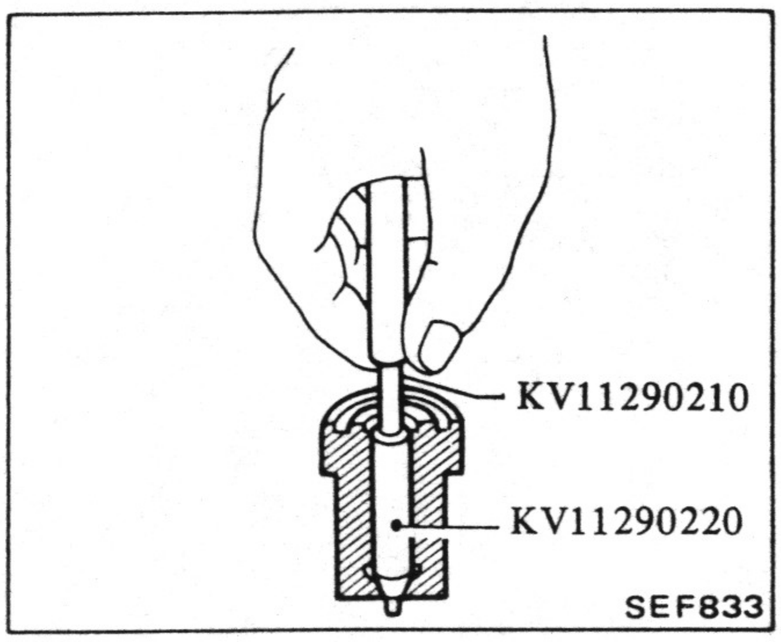
5. Clean nozzle seat by using Tool.

This job should be performed with extra precautions, since efficiency of nozzle depends greatly on a good nozzle seat.

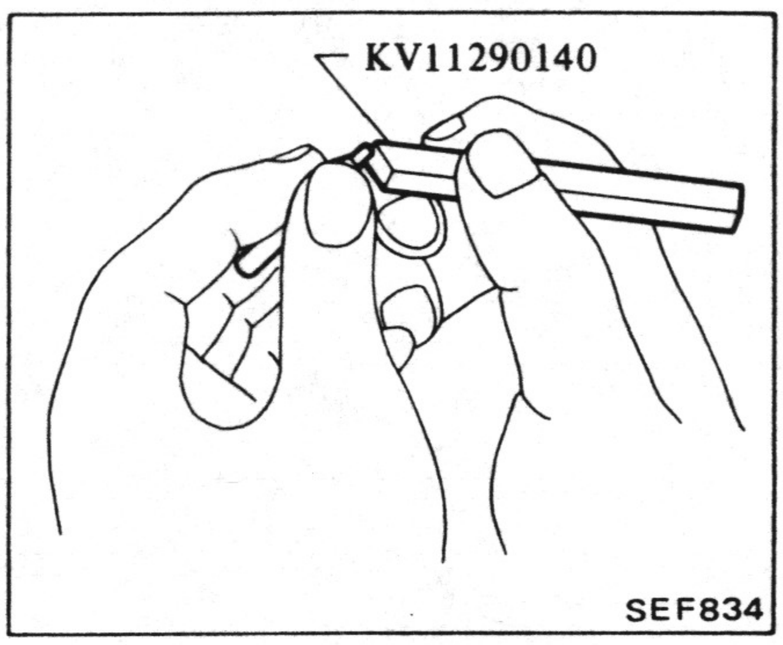


6. Clean spray hole of nozzle body by using Tool.

To prevent spray hole from canting, always clean it by starting with inner side and working towards outside.

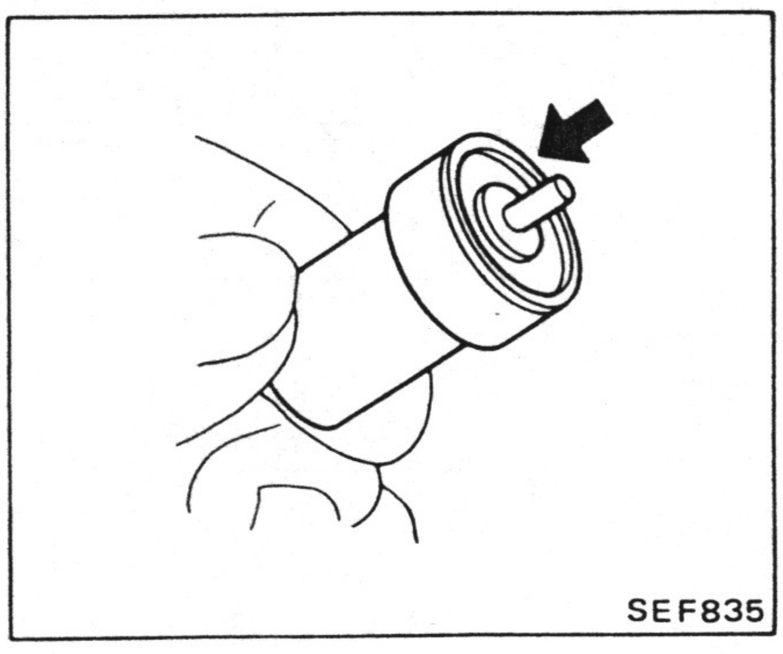


7. Decarbon nozzle needle tip by using Tool.



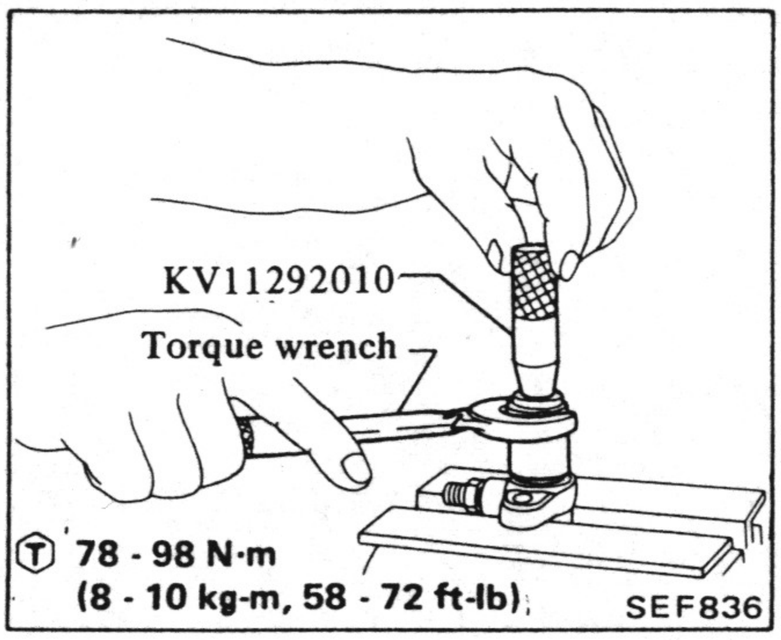
8. Check needle for proper position.
(1) Pull needle about halfway out from body and then release it.
(2) Needle should sink into body very smoothly from just its own weight.
(3) Repeat this test and rotate needle slightly each time.

If needle fails to sink smoothly from any position, replace both needle and body as a unit.



ASSEMBLY

1. Assemble in the reverse order of disassembly, observing the following.

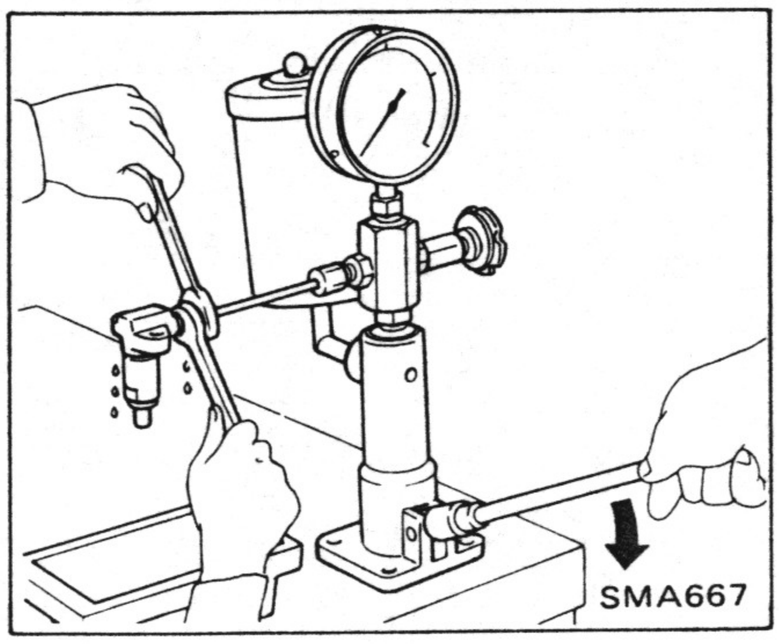


If nozzle body is not installed properly, tool may not come off and could be damaged.

TEST AND ADJUSTMENT

WARNING:
When using nozzle tester, be careful not to allow diesel fuel sprayed from nozzle to come into contact with your hand or body, and make sure that your eyes are properly protected with goggles.

1. Install nozzle to injection nozzle tester and **bleed air from flare nut.**

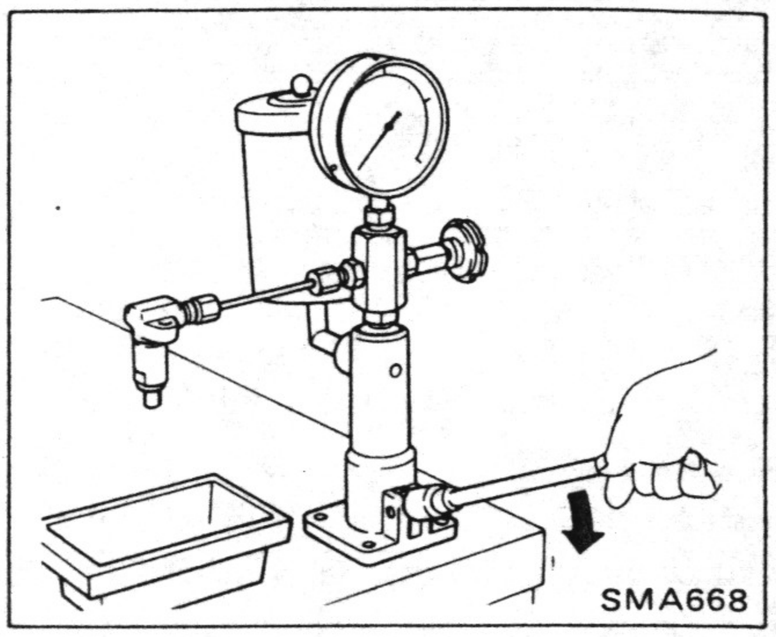


2. Check initial injection pressure by pumping tester handle one time per second.

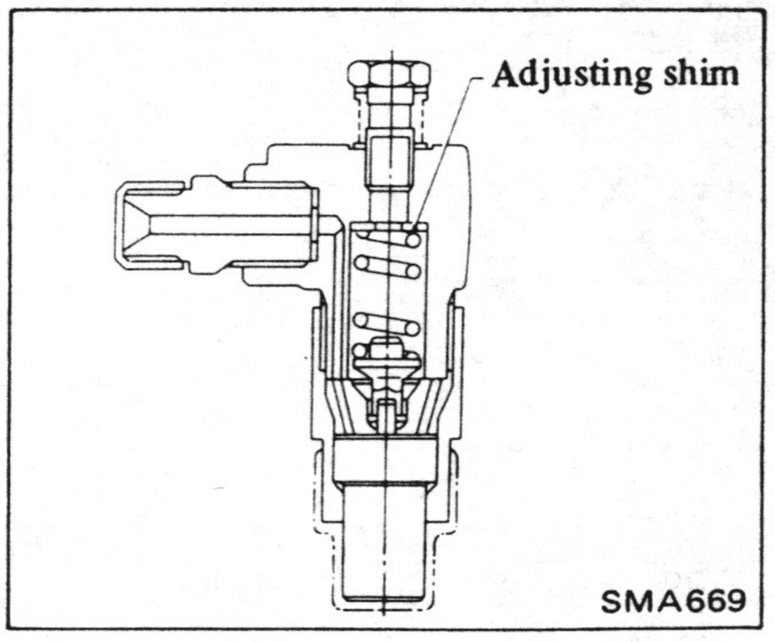
Initial injection pressure:
12,259 - 13,239 kPa
(122.6 - 132.4 bar,
125 - 135 kg/cm^2,
1,778 - 1,920 psi)

New nozzle initial injection pressure:
13, 239 - 14,024 kPa
(132.4 - 140.2 bar,
135 - 143 kg/cm^2,
1,920 - 2,033 psi)

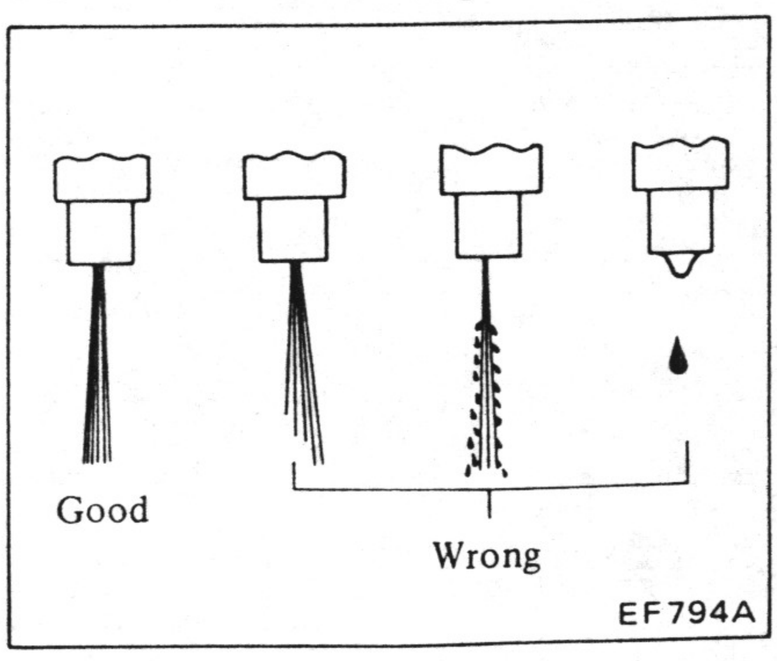
The new nozzle is not required to adjust initial injection pressure.



a. **Increasing the thickness of adjusting shims increases initial injection pressure. Decreasing shim thickness reduces initial injection pressure.**
b. **A shim thickness of 0.04 mm (0.0016 in) corresponds approximately to a difference of 471 kPa (4.71 bar, 4.8 kg/cm^2, 68 psi) in initial injection pressure.**



4. Check spray pattern by pumping tester handle one time per second.



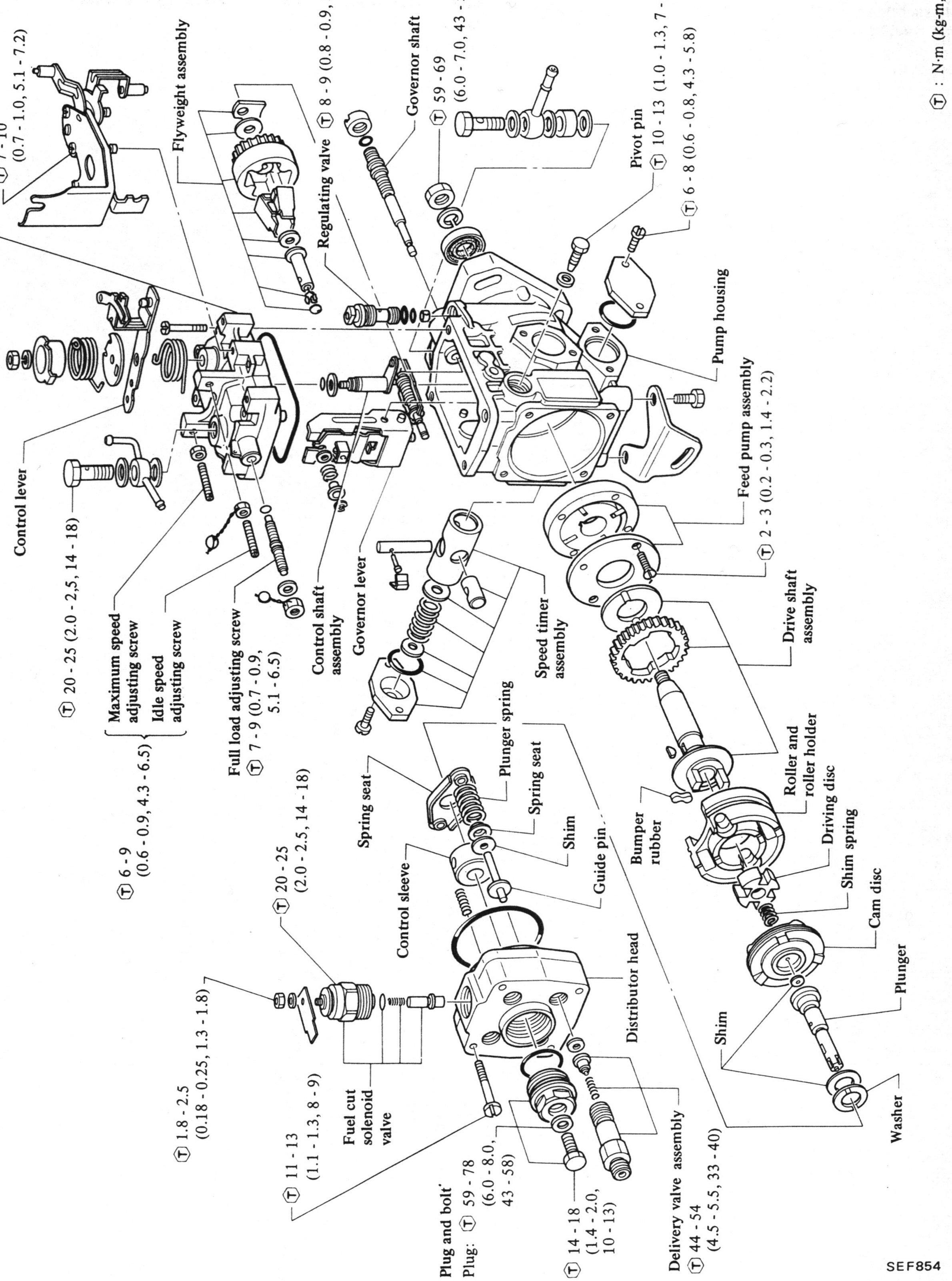
5. Inadequate fuel spray pattern or drips from nozzle end is often due to improper contact of needle with seat. If such a failure is experienced, service injection nozzle.

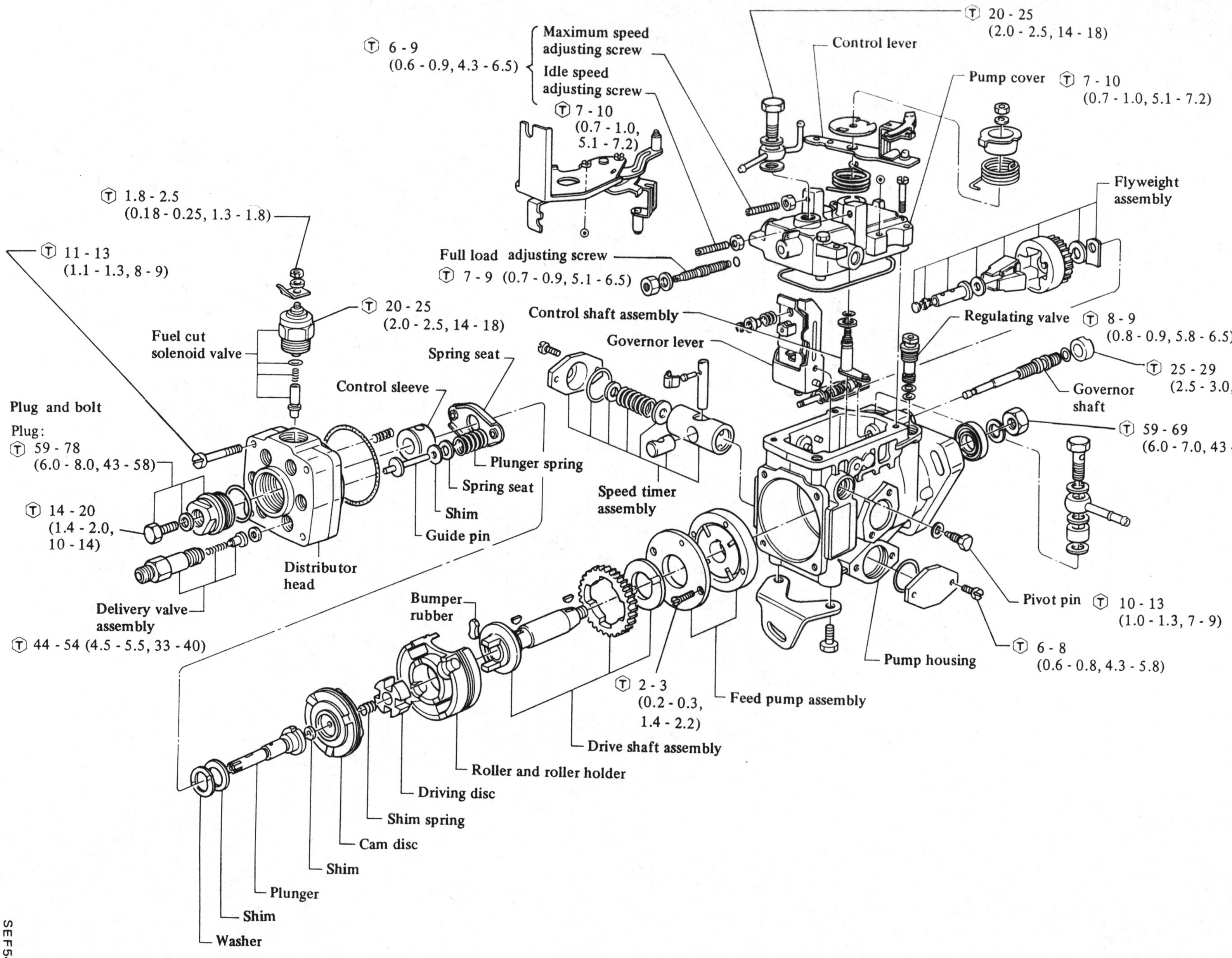
FUEL FILTER

Bleed air from fuel system after installing fuel filter.

DISASSEMBLY

LD20



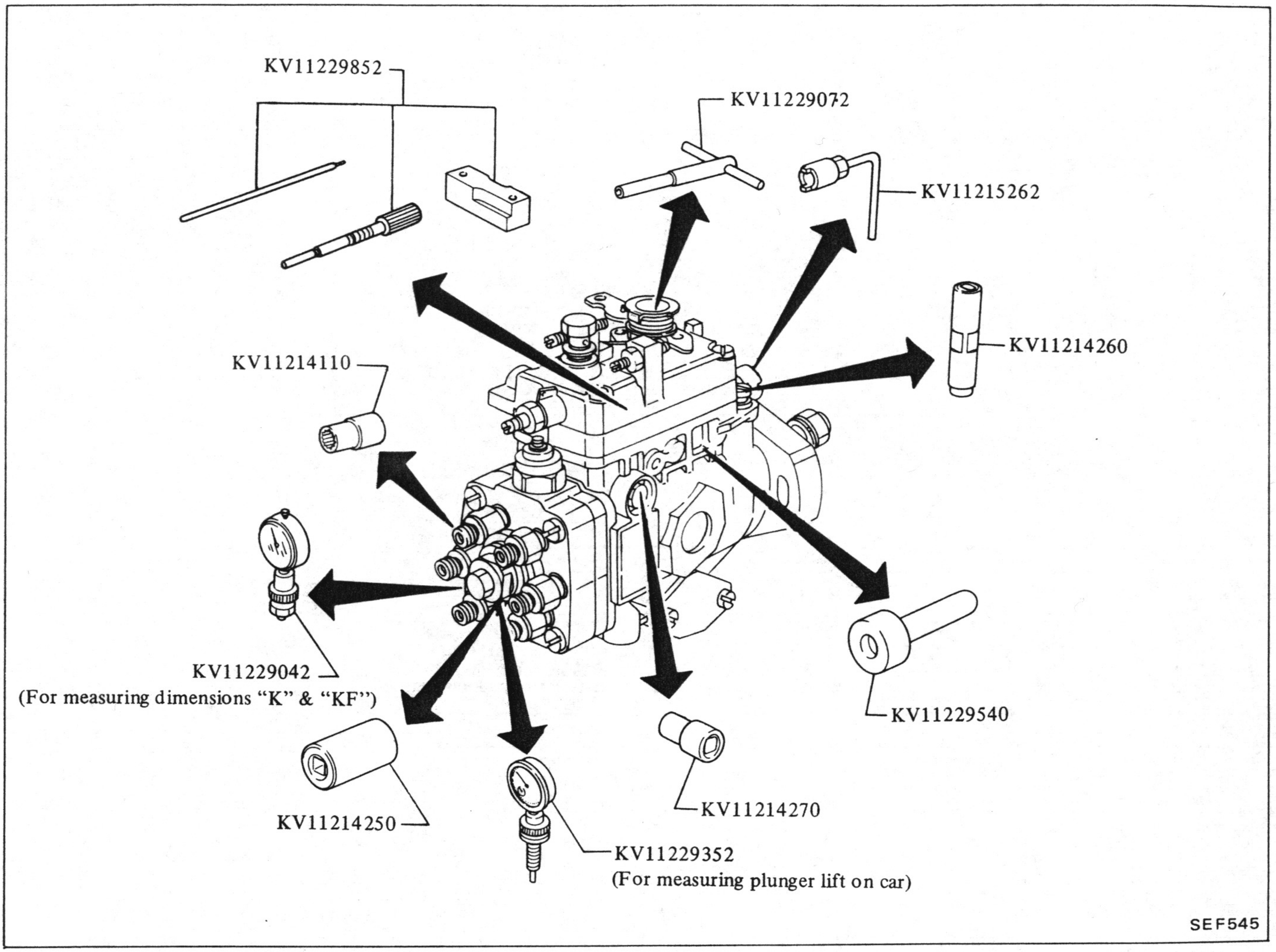

Ⓣ 20 - 25 (2.0 - 2.5, 14 - 18)
Control lever
Pump cover
Ⓣ 7 - 10 (0.7 - 1.0, 5.1 - 7.2)
Ⓣ 6 - 9 (0.6 - 0.9, 4.3 - 6.5)
Maximum speed adjusting screw
Idle speed adjusting screw
Ⓣ 7 - 10 (0.7 - 1.0, 5.1 - 7.2)
Flyweight assembly
Ⓣ 1.8 - 2.5 (0.18 - 0.25, 1.3 - 1.8)
Ⓣ 11 - 13 (1.1 - 1.3, 8 - 9)
Full load adjusting screw
Ⓣ 7 - 9 (0.7 - 0.9, 5.1 - 6.5)
Control shaft assembly
Regulating valve
Ⓣ 8 - 9 (0.8 - 0.9, 5.8 - 6.5)
Ⓣ 20 - 25 (2.0 - 2.5, 14 - 18)
Fuel cut solenoid valve
Governor lever
Spring seat
Control sleeve
Ⓣ 25 - 29 (2.5 - 3.0, 18 - 22)
Governor shaft
Plug and bolt
Plug:
Ⓣ 59 - 78 (6.0 - 8.0, 43 - 58)
Plunger spring
Spring seat
Shim
Guide pin
Speed timer assembly
Ⓣ 59 - 69 (6.0 - 7.0, 43 - 51)
Ⓣ 14 - 20 (1.4 - 2.0, 10 - 14)
Distributor head
Pivot pin
Ⓣ 10 - 13 (1.0 - 1.3, 7 - 9)
Delivery valve assembly
Ⓣ 44 - 54 (4.5 - 5.5, 33 - 40)
Bumper rubber
Pump housing
Ⓣ 6 - 8 (0.6 - 0.8, 4.3 - 5.8)
Ⓣ 2 - 3 (0.2 - 0.3, 1.4 - 2.2)
Feed pump assembly
Drive shaft assembly
Roller and roller holder
Driving disc
Shim spring
Cam disc
Shim
Plunger
Shim
Washer

Ⓣ : N·m (kg-m, ft-lb)

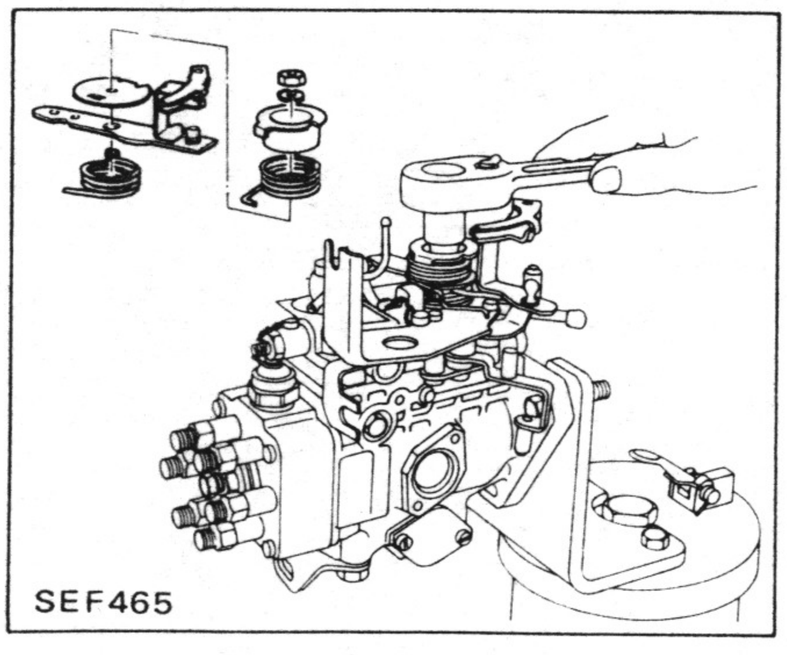
PREPARATION

- Before performing disassembly and adjustment, test fuel injection pump and note test results except when testing is impossible.
- Prior to beginning to disassemble fuel injection pump, clean all dust and dirt from its exterior.
- Disconnect overflow valve, and drain fuel.
- Clean work bench completely, removing all foreign mattter.
- Collect only those service tools necessary for disassembling and reassembling.
- Be careful not to bend or scratch any parts.

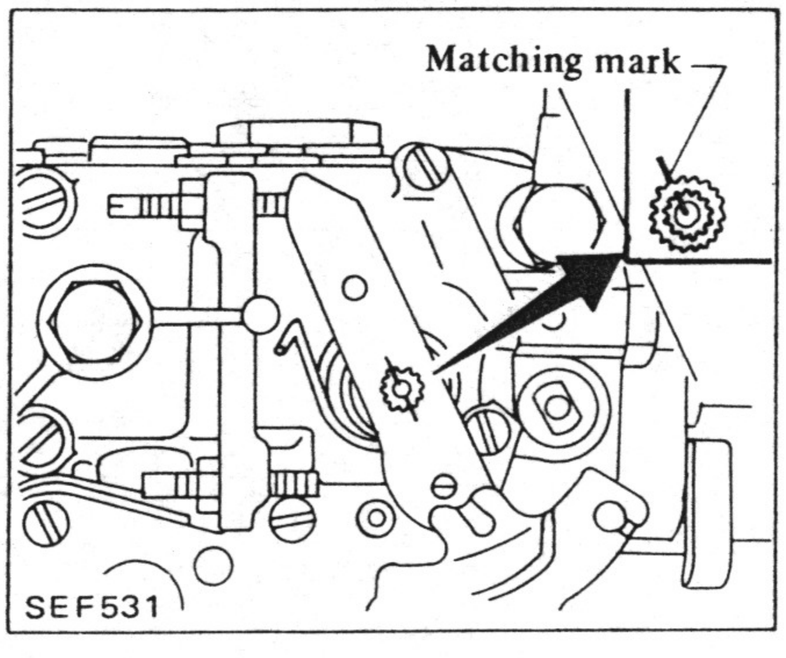
Special tools for disassembling and reassembling fuel injection pump



1. Remove nut, spring washer, spring seat and spring from control lever.

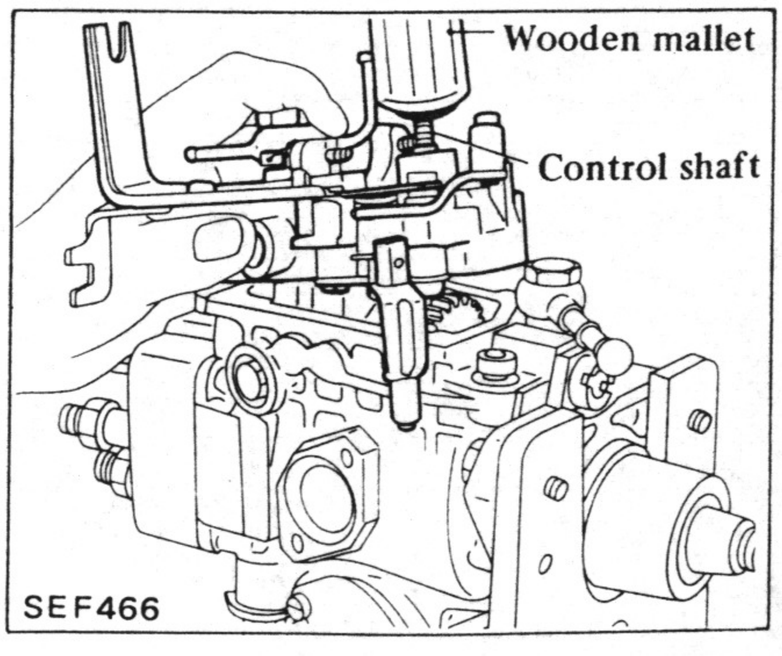


2. Draw aligning marks on control lever and control shaft.

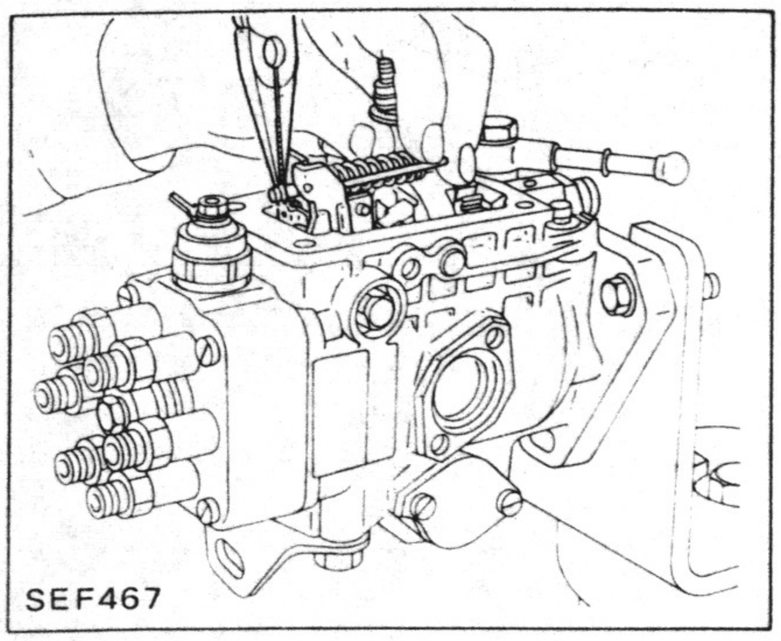


3. Remove governor cover.

Move control shaft down by lightly tapping on the end with a wooden mallet.

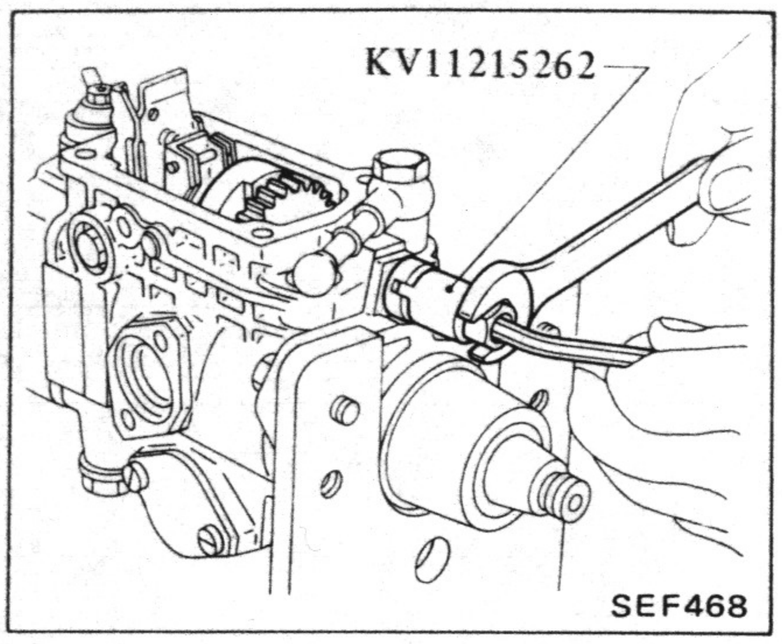


4. Remove control shaft from tension lever.


SEF467

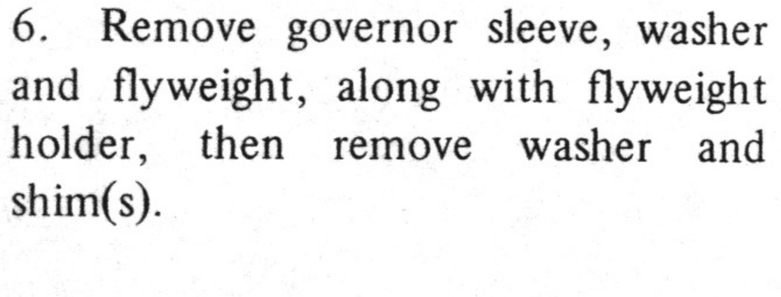
5. Remove governor shaft.

Loosen lock nut by turning it clockwise.

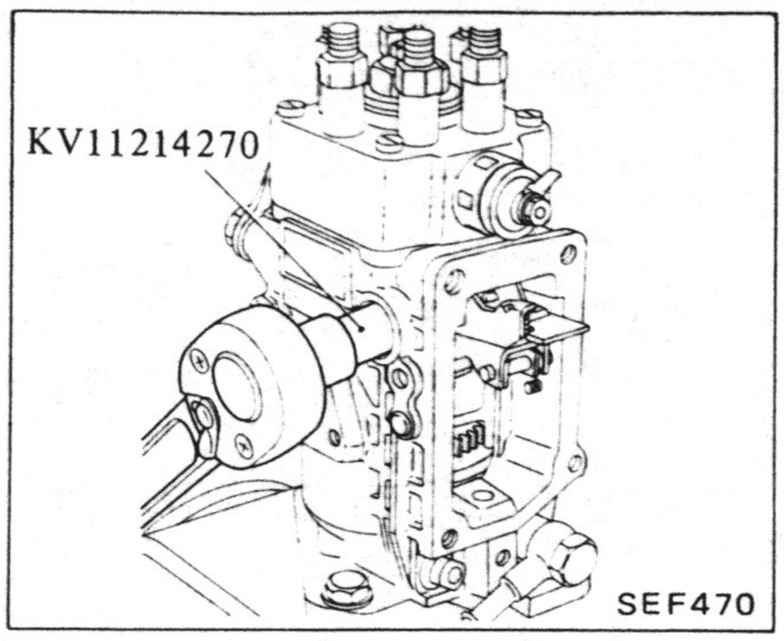


SEF468

6. Remove governor sleeve, washer and flyweight, along with flyweight holder, then remove washer and shim(s).

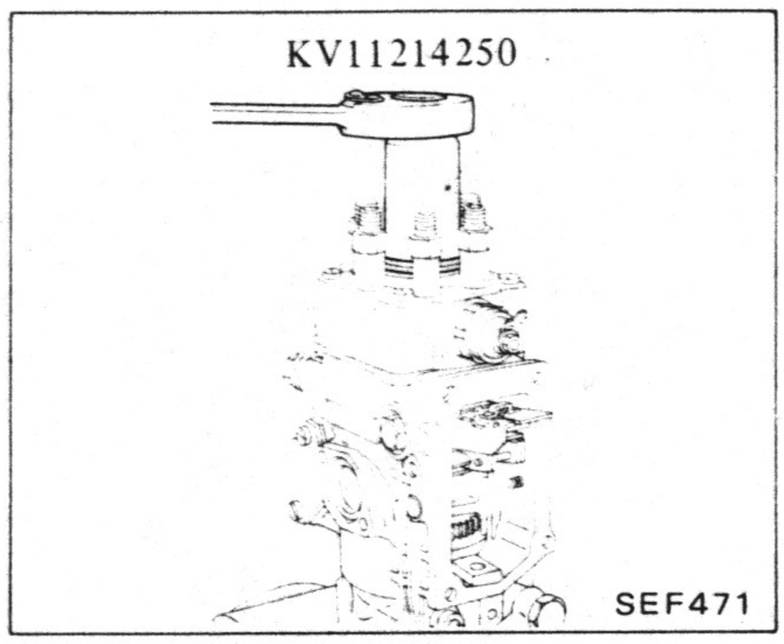

SEF469

7. Loosen left and right governor pivot bolts.



SEF470

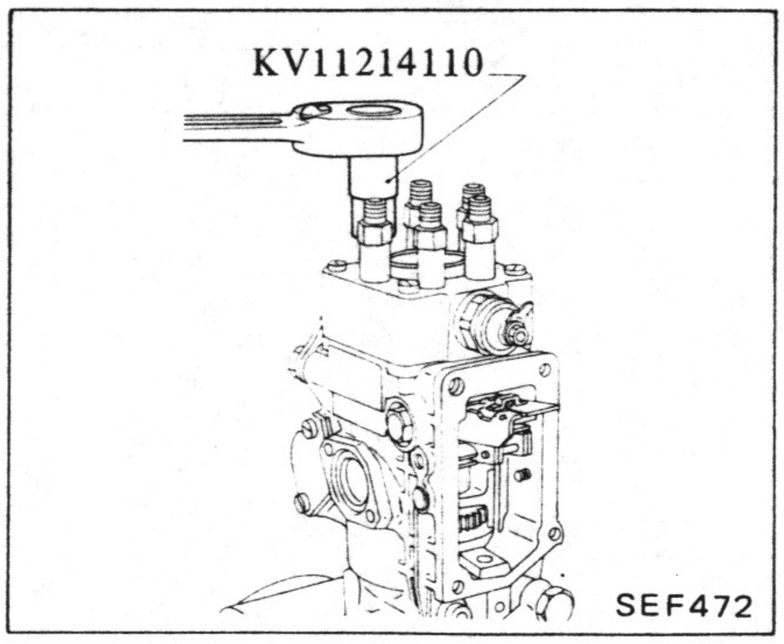
8. Remove plug.



SEF471

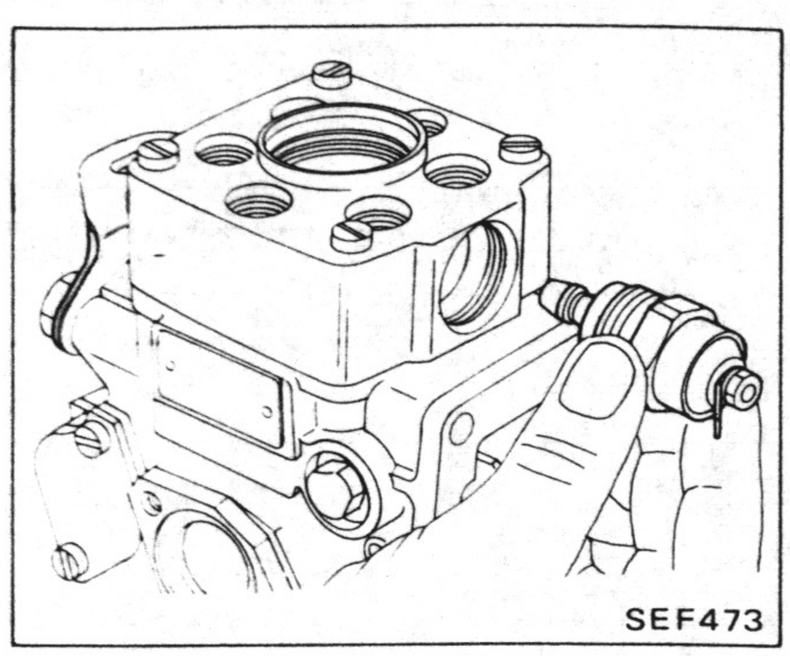
9. Remove delivery holder, spring, delivery valve and gasket.

Distributor head has letters (A, B, C, D, E, and F) stamped on it. Remove lettered parts in alphabetical order and arrange neatly.



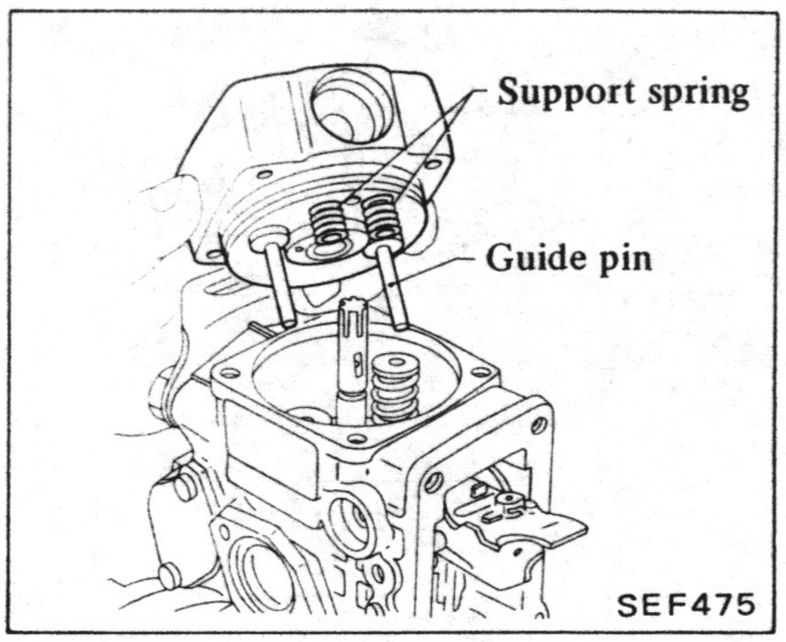
SEF472

10. Remove fuel-cut solenoid valve.


SEF473

11. Remove distributor head.

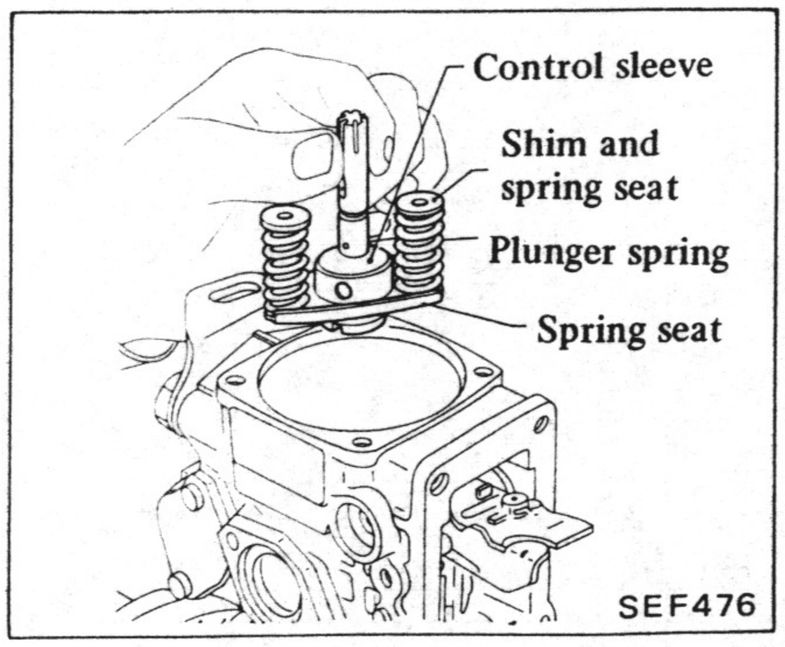
Be careful not to drop the two support springs and guide pins.



SEF475

12. Remove plunger assembly.

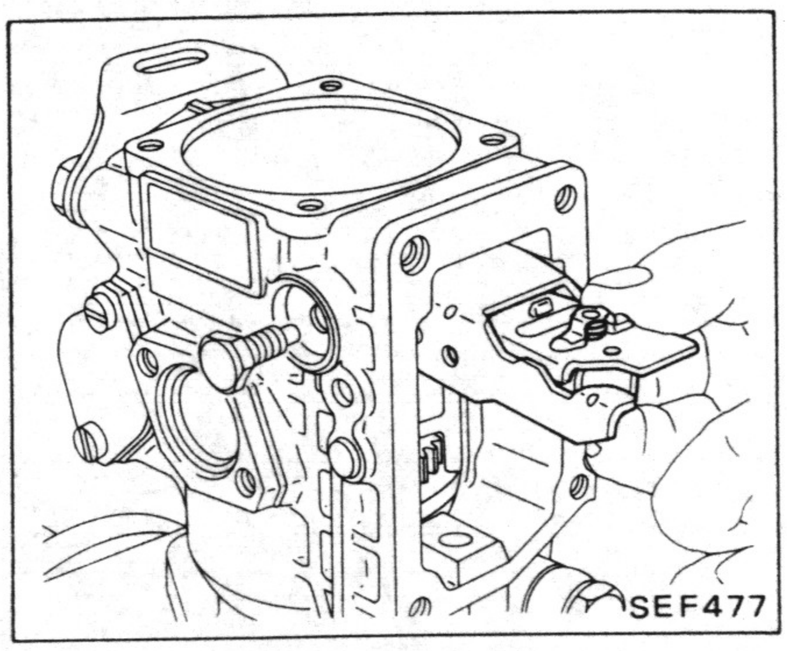
Lift plunger, along with control sleeve, shim, spring seat and plunger spring.



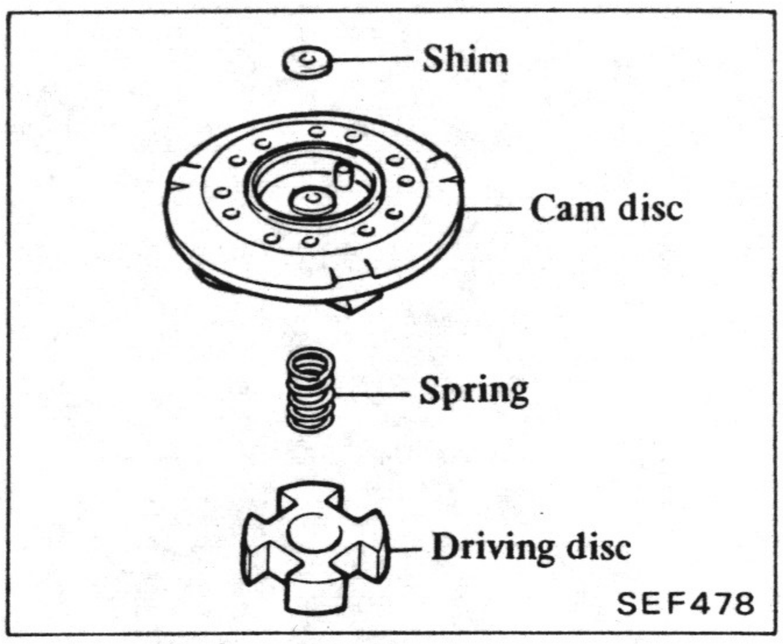
SEF476

13. Remove governor lever assembly.

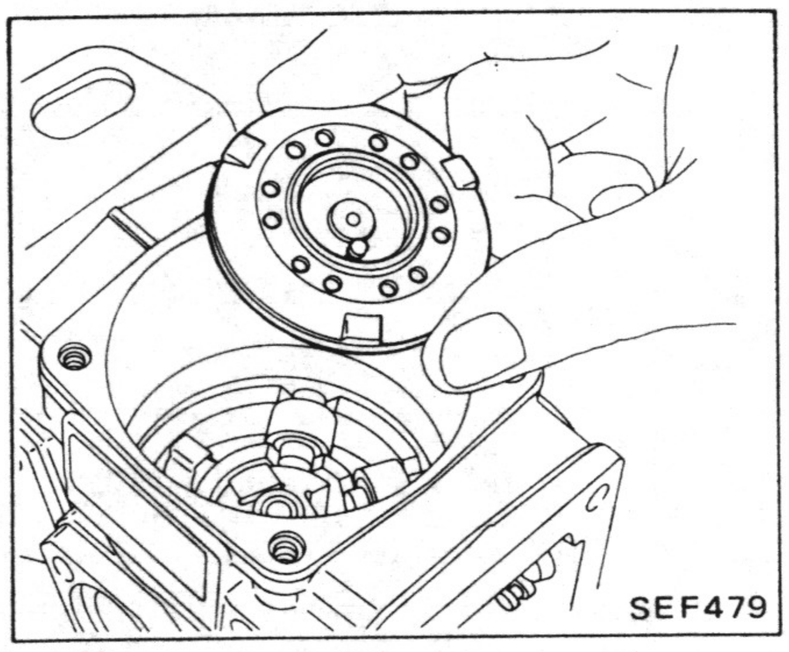
Avoid pulling on start spring and start idle spring.


SEF477

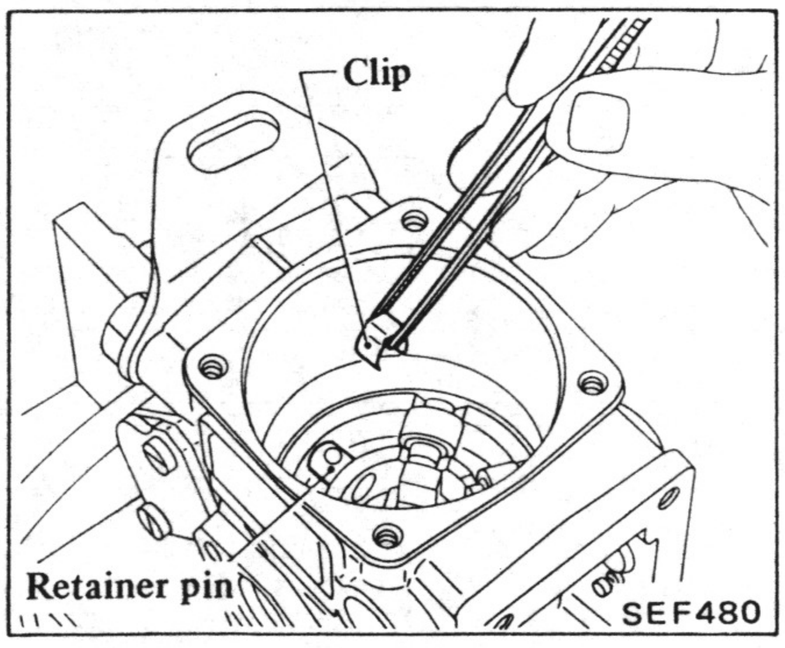
14. Remove shim, cam disc, spring and driving disc.



SEF478

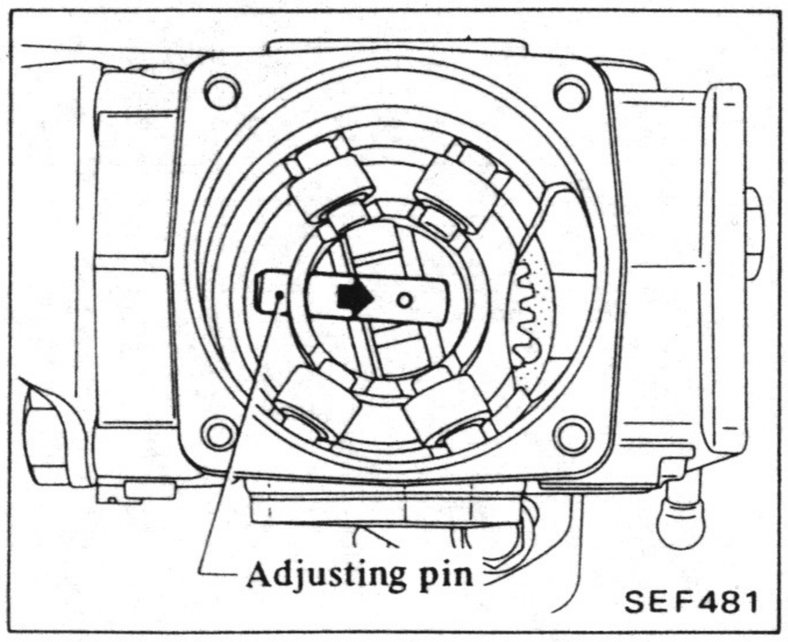

SEF479

15. Remove clips and pins.



SEF480

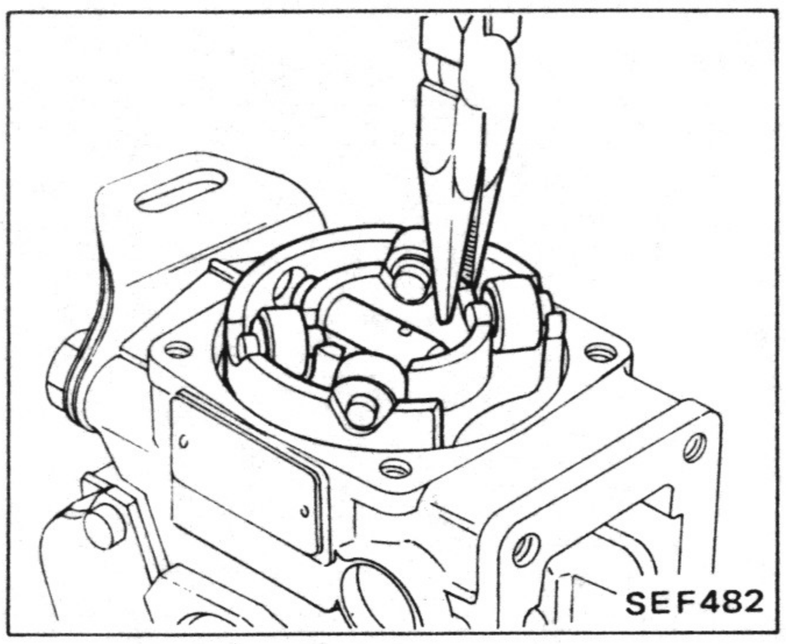
16. Move adjusting pin to center of roller holder, as shown.



SEF481

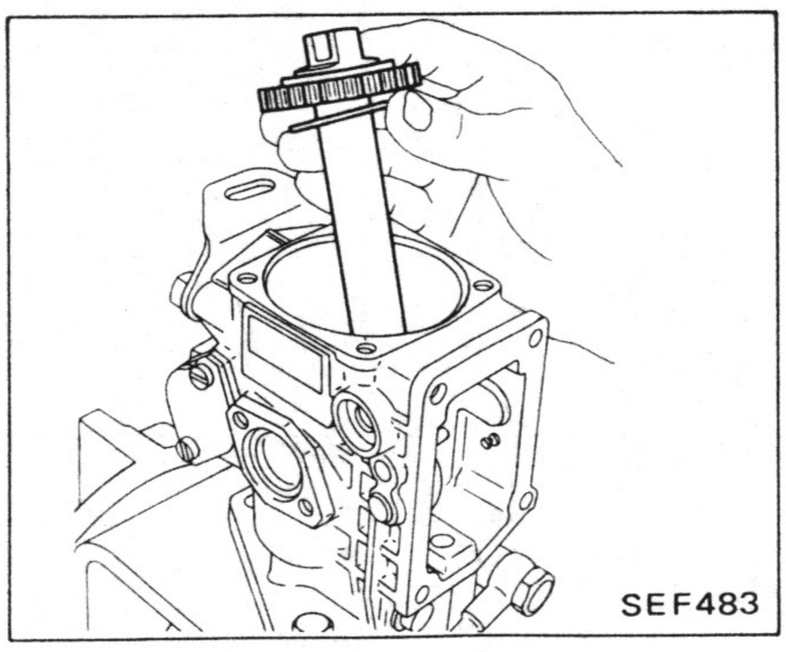
17. Lift out roller holder with rollers without tilting.

Be careful not to drop rollers.

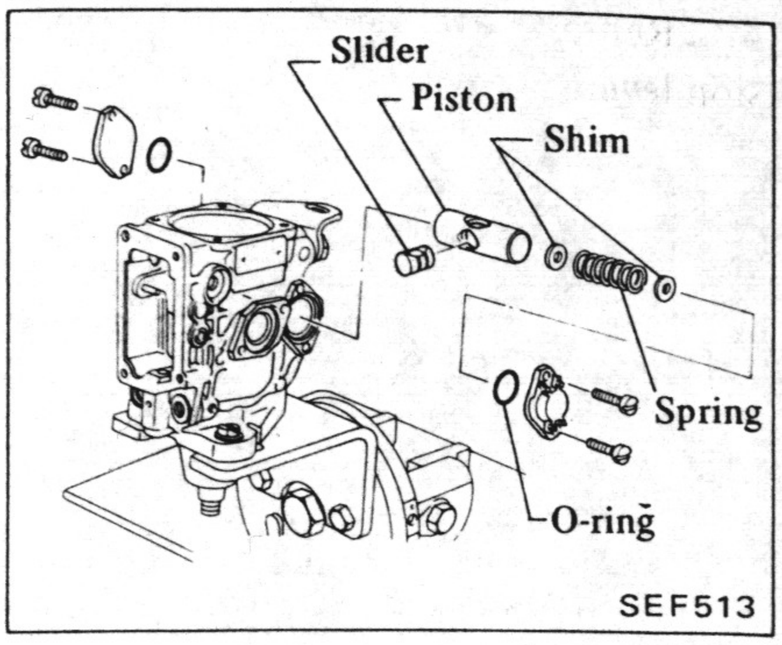

SEF482

18. Remove drive shaft.

a. Be careful not to scratch inner surface of fuel injection pump body.
b. Use care to avoid dropping key.

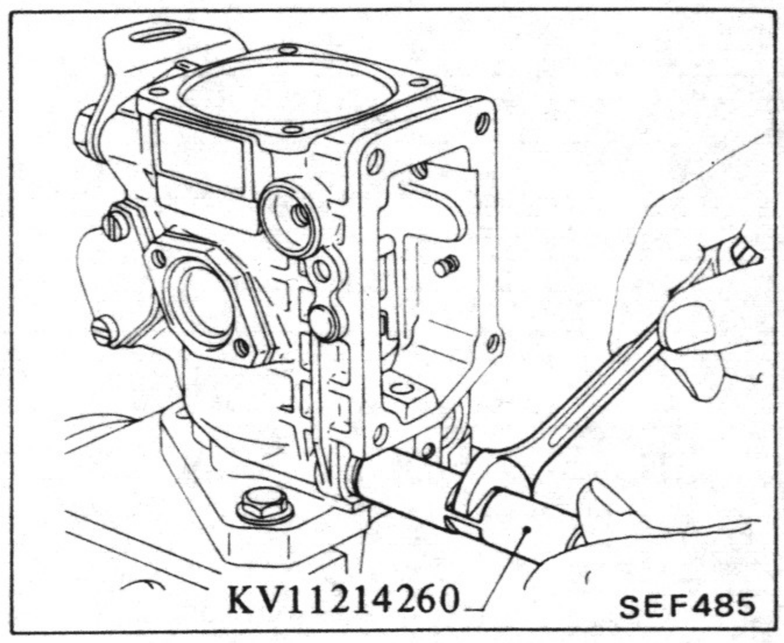

SEF483

19. Remove speed timer cover, O-ring, shims, spring, piston and slider.



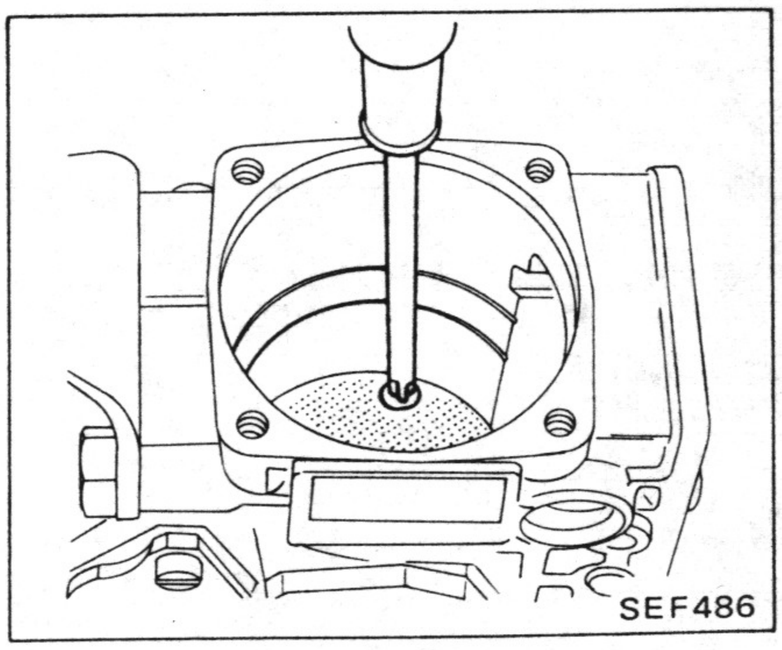
SEF513

20. Remove regulating valve.



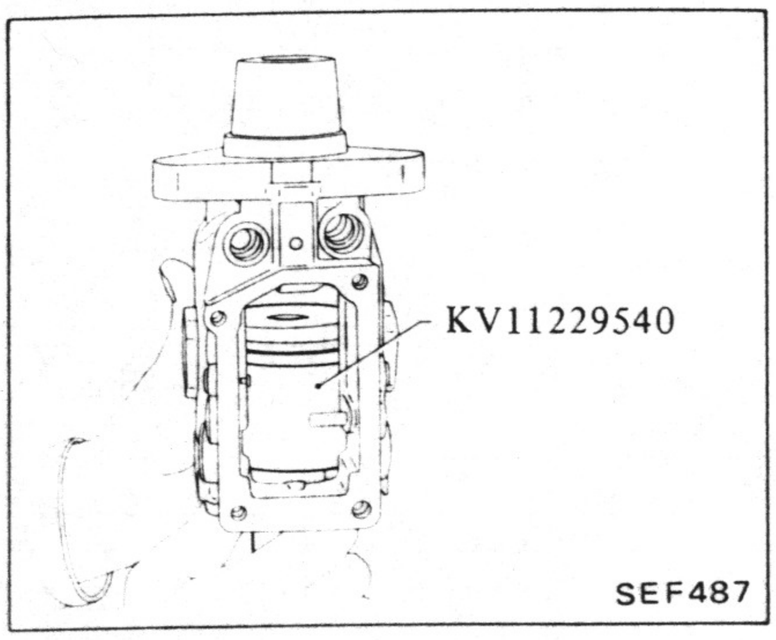
SEF485

21. Loosen screw from feed pump cover.


SEF486

22. Remove cover and feed pump assembly as a unit.
1) Insert service tool KV11229540 into fuel injection pump housing.
2) Turn injection pump's top side down, as shown.
3) Remove cover and feed pump assembly as a unit.

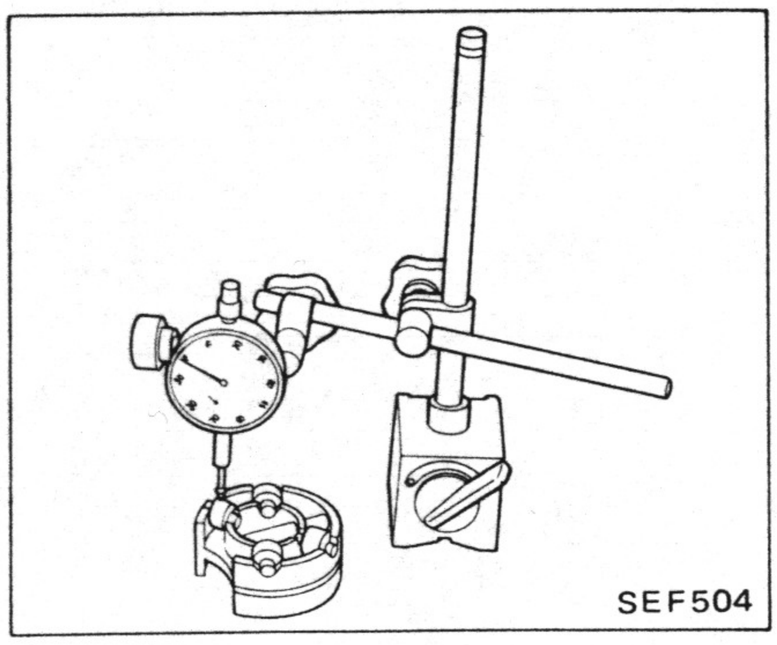
a. If cover and feed pump assembly are hard to remove or stuck midway, strike pump body lightly.
b. Do not move position of vanes.



INSPECTION

1. Wash all parts completely.
2. Replace worn or damaged parts.
3. Control edge of plunger must be sharp and contact surfaces must not exhibit any noticeable running tracks. If such is not the case, replace plunger.
4. Check for height of all rollers.

Difference in max. and min. roller height should be less than 0.02 mm (0.0008 in).

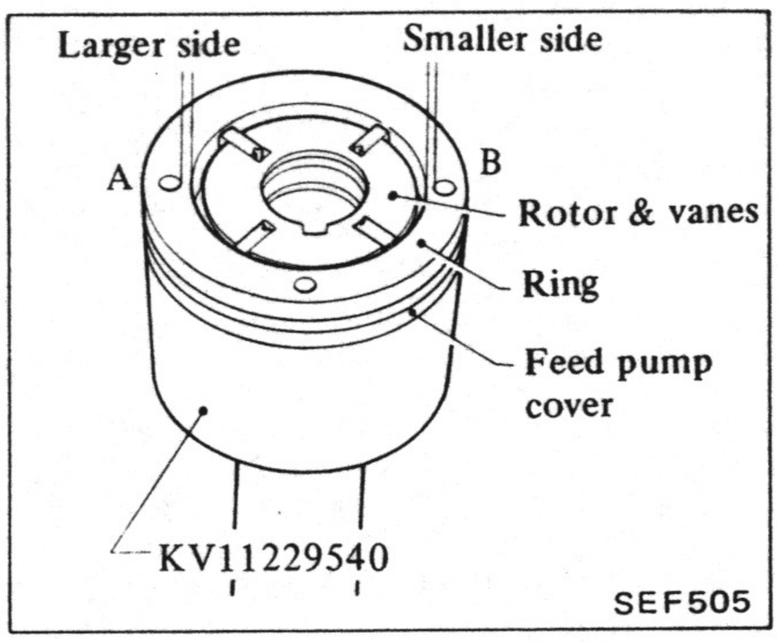


- Feed pump assembly (pump impeller and vanes with eccentric ring)
- Plunger spring kit
- Roller assembly
- Flyweight kit
- Governor lever assembly

PREPARATION

Dip all movable parts and O-rings in test oil and clean.

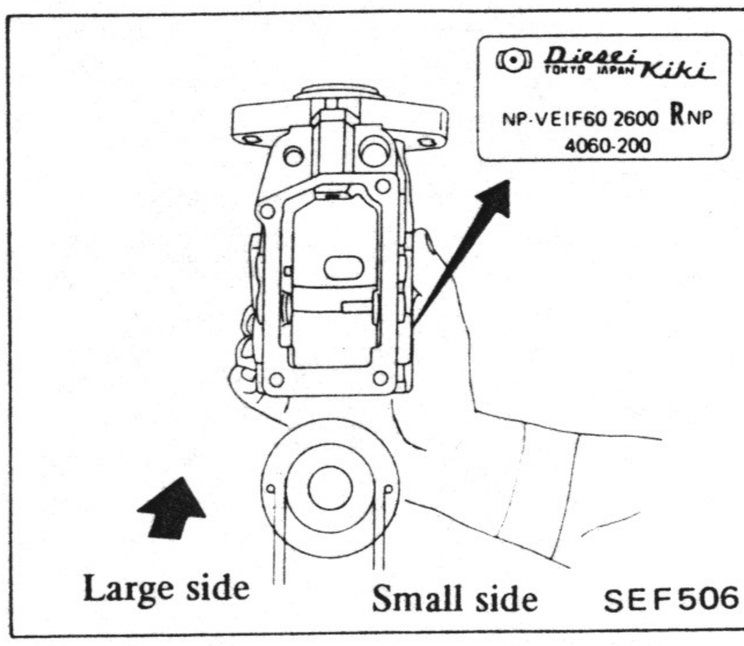
1. Set feed pump cover, rotor with vanes, and ring on service tool KV11229540.
   1) Align the three holes in feed pump cover and ring.
   2) Do not change positions of vanes.
   3) Holes A and B in ring are not equally spaced to inner wall of ring.



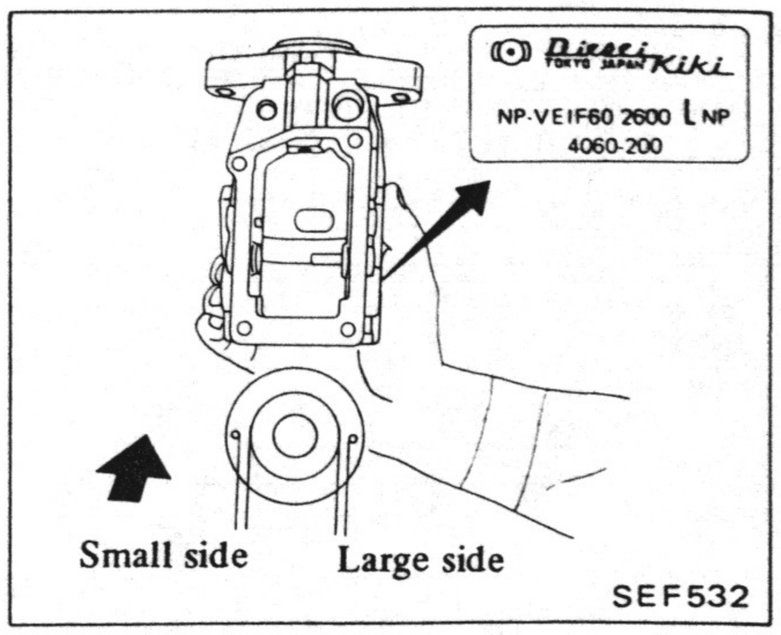
2. Install feed pump cover, rotor with vanes, and ring to pump housing.

Be careful to install liner correctly. If left and right are reversed, fuel will not be discharged from feed pump.

When fuel injection pump rotates in direction "R"



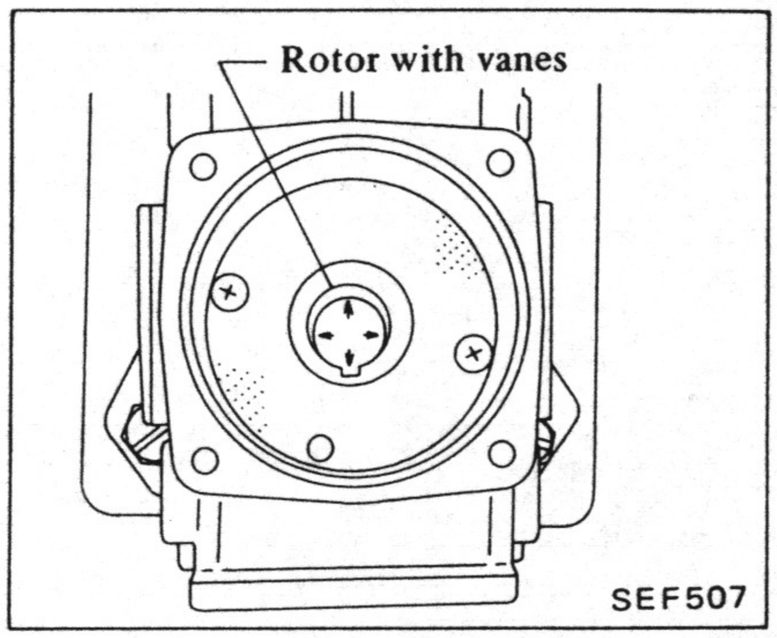
When fuel injection pump rotates in direction "L"



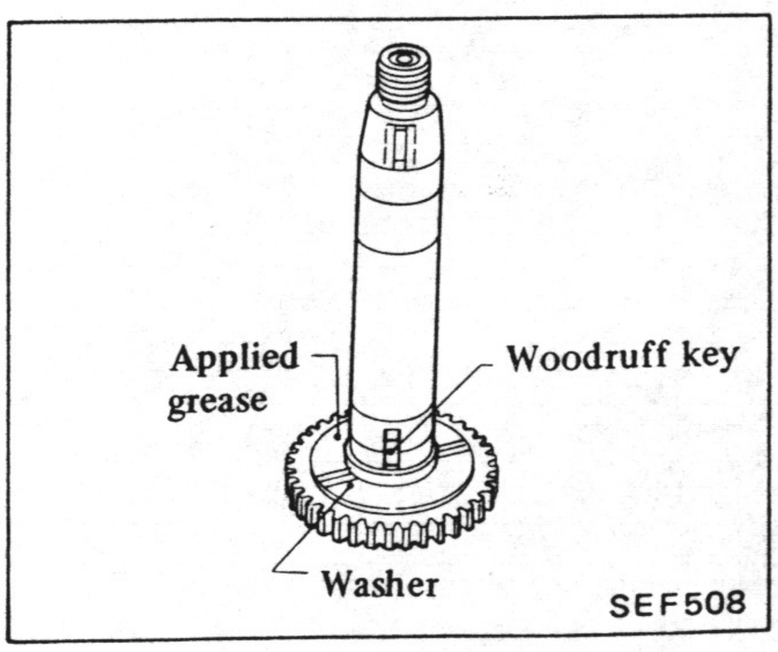
The following description applies to fuel injection pumps that rotate in direction "R".

3. Turn fuel injection pump 180°, and remove service tool KV11229540. Tighten screw to retain pump cover.

a. When tightening screws, be careful not to scratch inner wall of pump housing.
b. After tightening screws, make sure that rotor with vanes moves smoothly.



4. Make sure that drive shaft and gear are assembled properly, as shown.



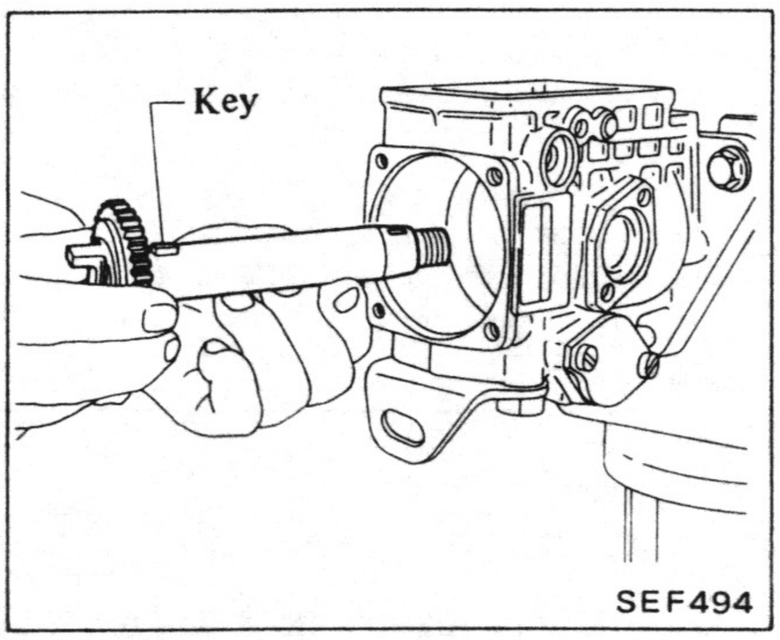
ASSEMBLY

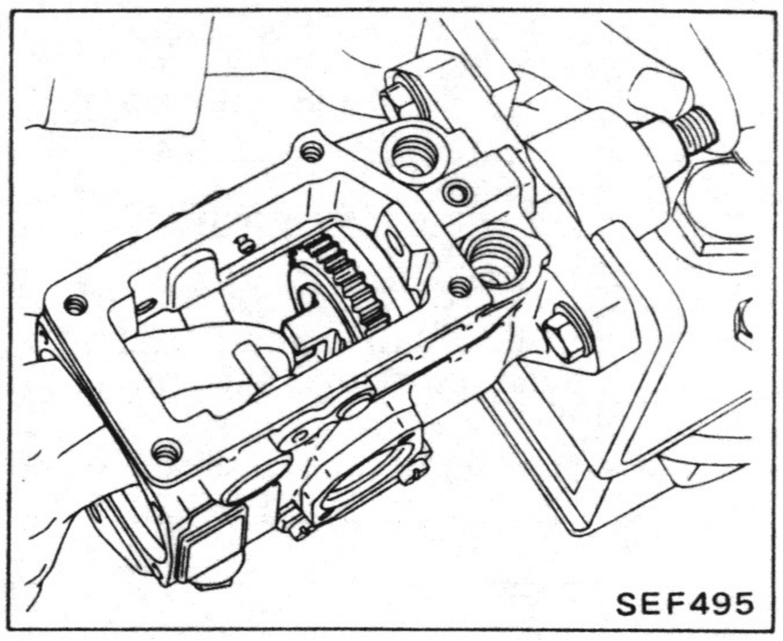
It should be noted that following service parts assemblies should always be replaced as a unit.

- Distributor head, control sleeve and plunger

5. Install drive shaft to housing while key in drive shaft engages with key groove in rotor.

Be careful not to scratch oil seals and inner wall of housing.

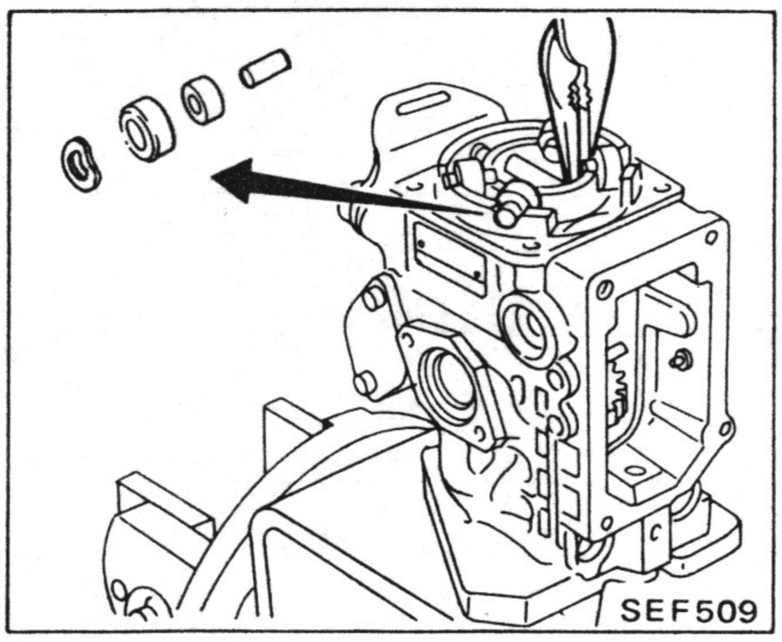




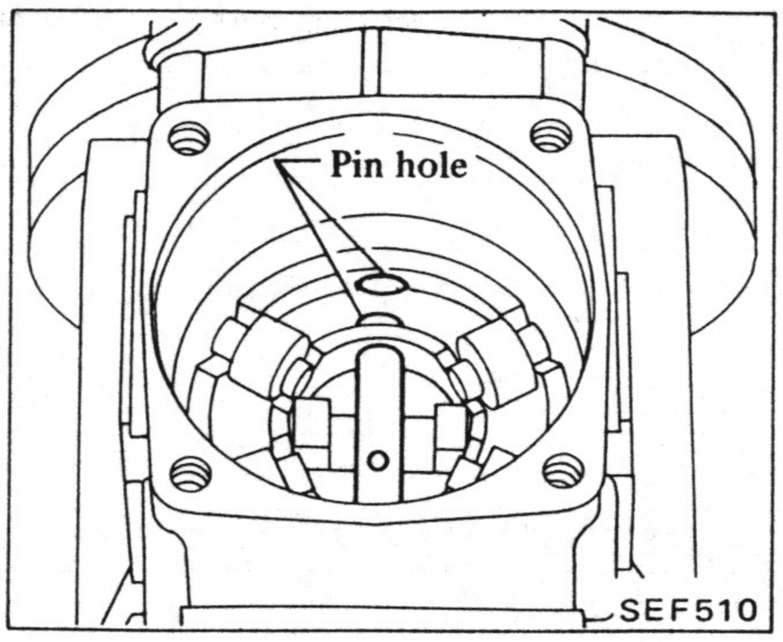
6. Set drive shaft's nail parallel to timer.

7. Install roller and holder.

a. **Do not interchange roller positions. If they are interchanged, refer to Inspection for correction.**
b. **Make sure that washer is situated outward of rollers.**

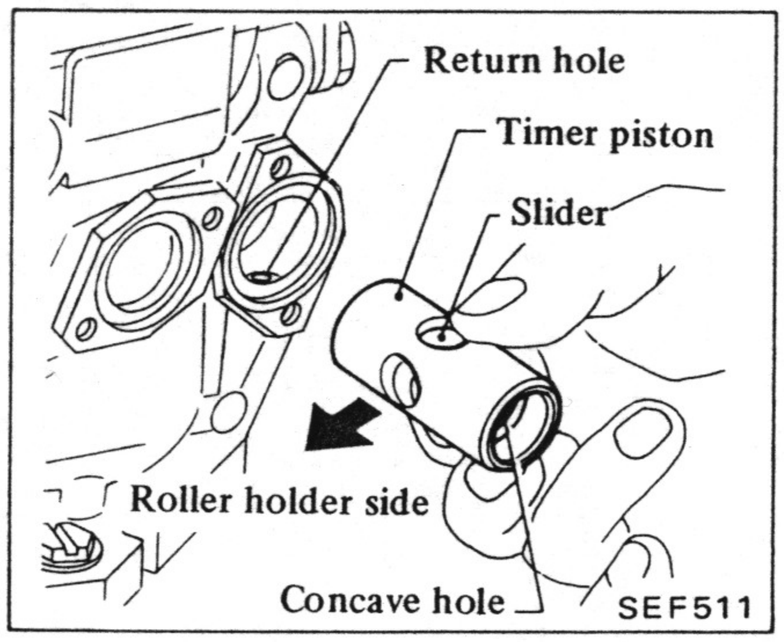


8. Align holder and timer adjusting pin holes.



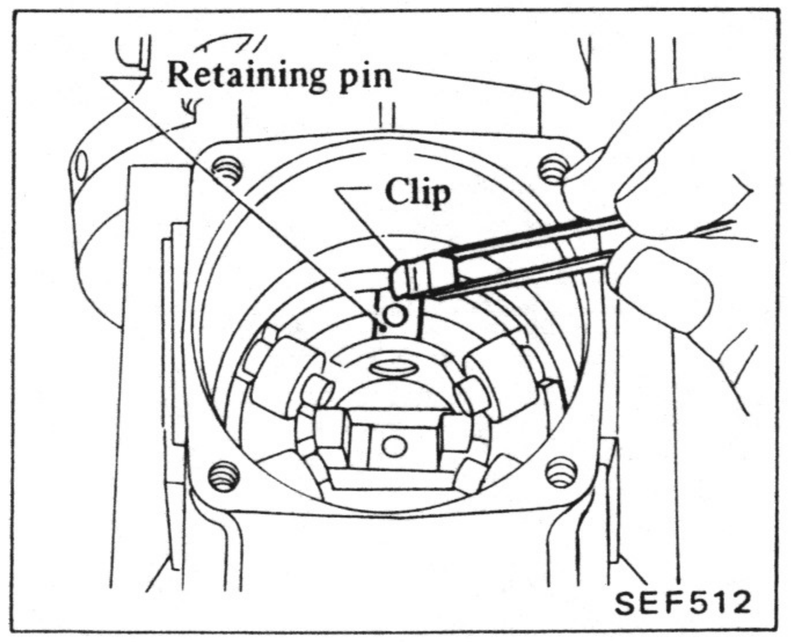
9. Install timer piston and slider as a unit.

a. **Make sure that hole in slider faces towards roller holder.**
b. **Make sure that concave hole in piston is on same side as return hole.**



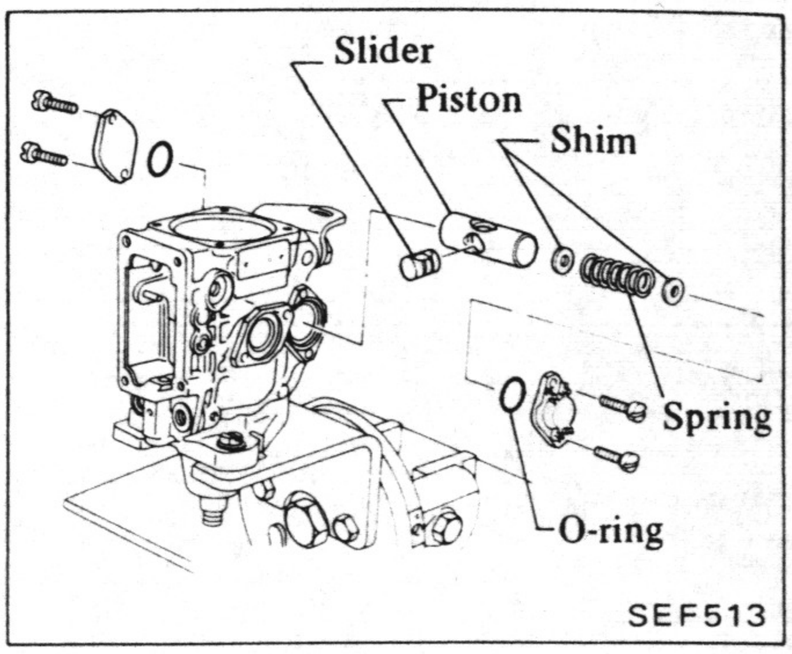
10. Insert timer adjusting pin into timer piston slider, and secure with retaining pin and clip.

Make sure that timer piston moves smoothly.



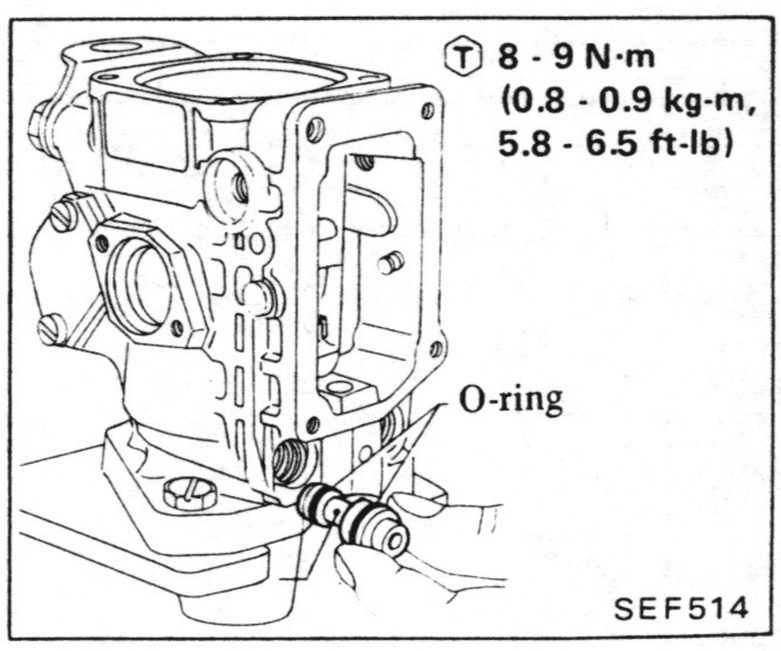
11. Install timer, using a 0.6 mm (0.024 in) thick shim, then install timer spring, shim, O-ring, and cover, in that order.

a. **Use at least one shim on each side of timer spring.**
b. **Use shims that have been selected during bench test.**

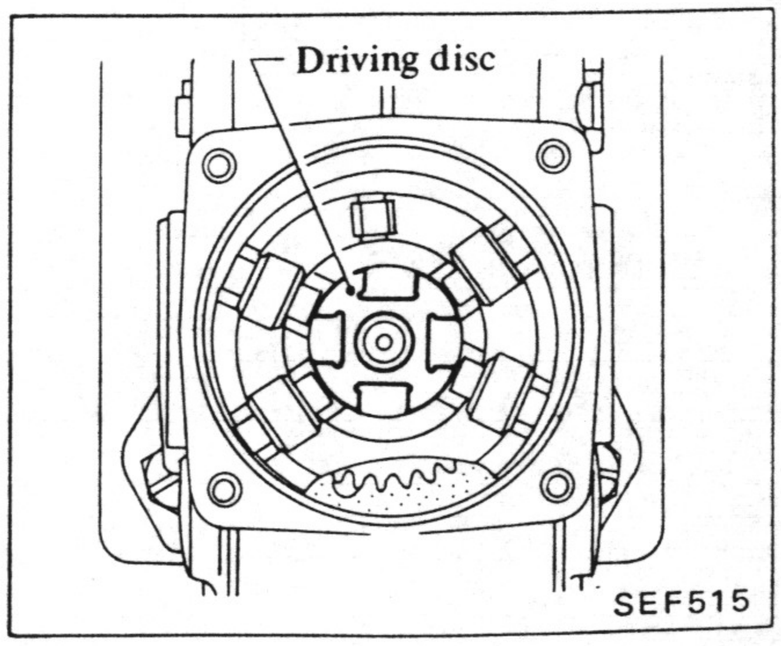


12. Install regulating valve.

Be careful not to scratch O-rings.



13. Install driving disc with its concave side facing up.

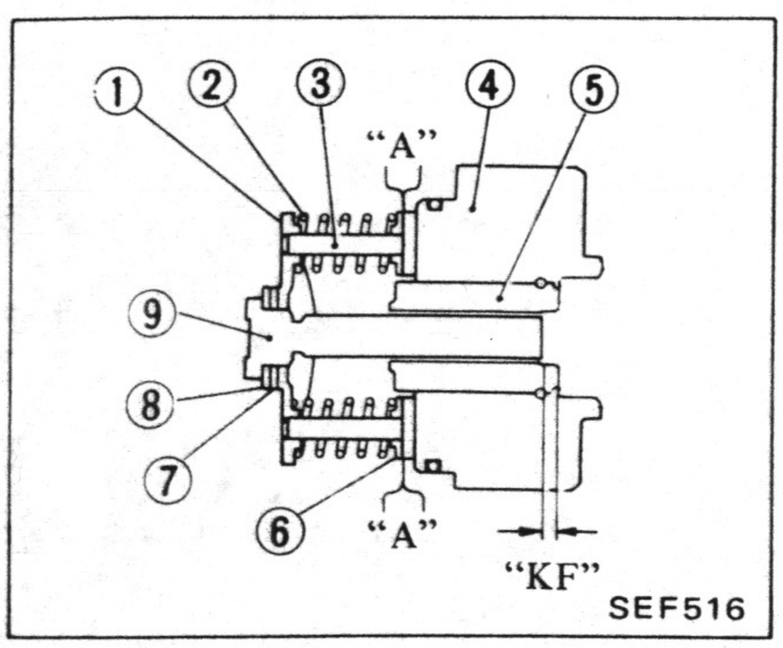


14. Measurement of plunger spring set length (dimension "KF")

Dimension "KF" is the distance between the end face of the distributor barrel and the end face of the plunger.

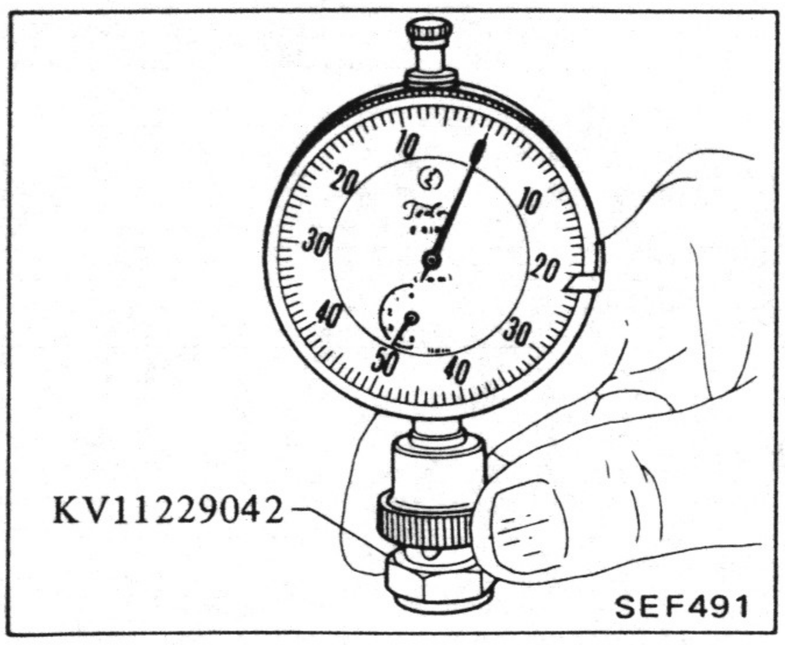
(1) Install distributor head, as shown.

- **Do not insert shim into "A" portion before measuring.**

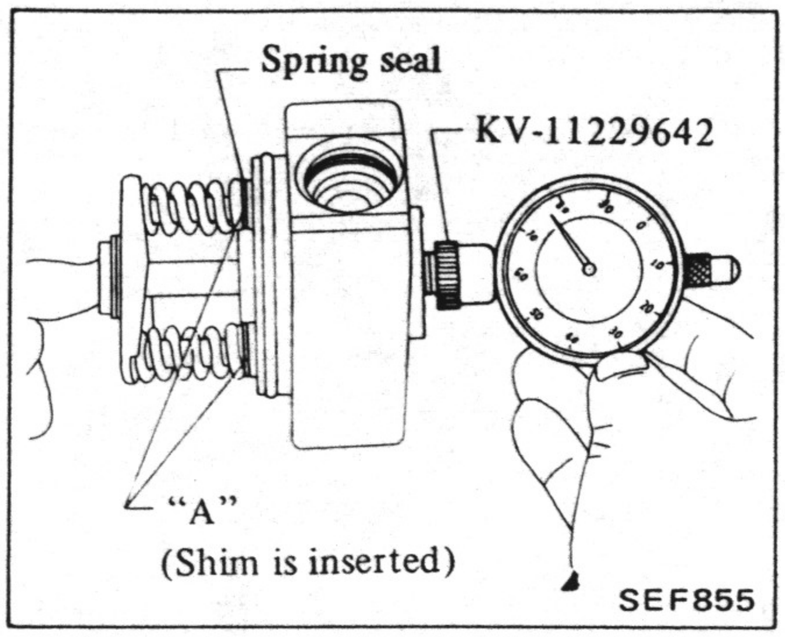


1 Spring seat
2 Plunger spring
3 Guide pin
4 Distributor head
5 Distributor barrel
6 Spring seat
7 Washer
8 Shim
9 Plunger

(2) Set dial gauge so that it can compress 25 mm (0.98 in), and reset to zero.



(3) Apply force (not enough to compress plunger spring) to plunger's bottom in axial direction, and measure dimension "KF" with dial gauge, as shown.



(4) Determine the shim to be used by calculating difference between standard and measured dimensions.

Standard dimension "KF":
LD20
5.8 mm (0.228 in)
LD28
6.6 mm (0.260 in)

[Example]

When measured (dial gauge reading) value is 5.4 mm,
6.6 mm - 5.4 mm = 1.2 mm (shim thickness to be used)

a. **When there are not shims available of a thickness which matches specified dimensions, use slightly thicker shim.**
b. **Use selected shim with distributor head in step 14-(3) above.**
c. **Use the same size shim on each side of distributor head.**
d. **Shims are available in seven different thicknesses.**

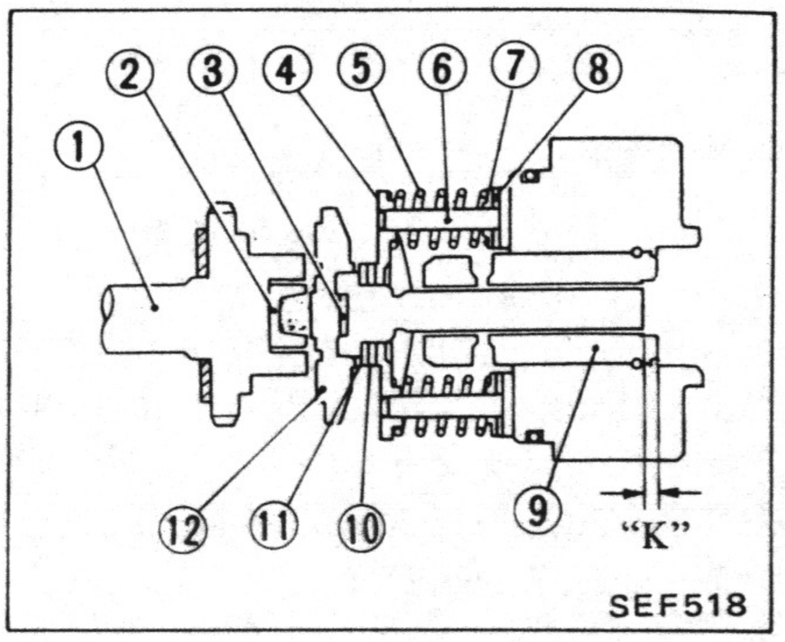
Part number	Thickness mm (in)
16882-V0700	0.5 (0.020)
16882-V0701	0.8 (0.031)
16882-V0702	1.0 (0.039)
16882-V0703	1.2 (0.047)
16882-V0704	1.5 (0.059)
16882-V0705	1.8 (0.071)
16882-V0706	2.0 (0.079)

15. Adjustment of plunger dimensions (Measurement of dimension "K")

Dimension "K" is the distance from the end face of the distributor barrel to the end face of the plunger top, when the plunger is at the bottom dead center position.

(1) Install parts as shown.

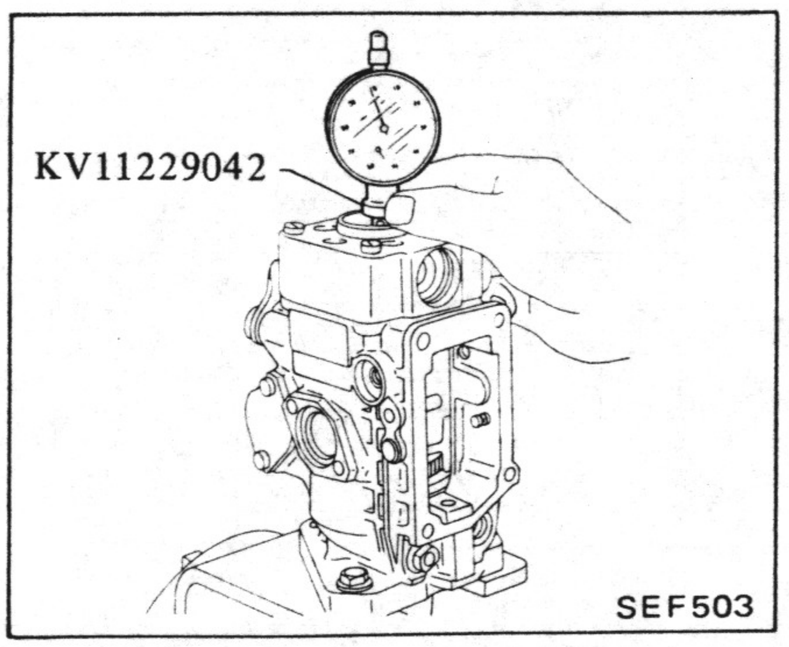
a. **Do not install "spring" on driving disc.**
b. **When inserting plunger and shim into cam disc, make sure that drive pin is situated in groove at bottom of plunger.**



1 Drive shaft
2 Driving disc
3 Shim
4 Spring seat
5 Plunger spring
6 Guide pin
7 Spring seat
8 Shim
9 Distributor barrel
10 Washer
11 Shim
12 Cam disc

(2) Using a dial gauge, measure dimension as shown.

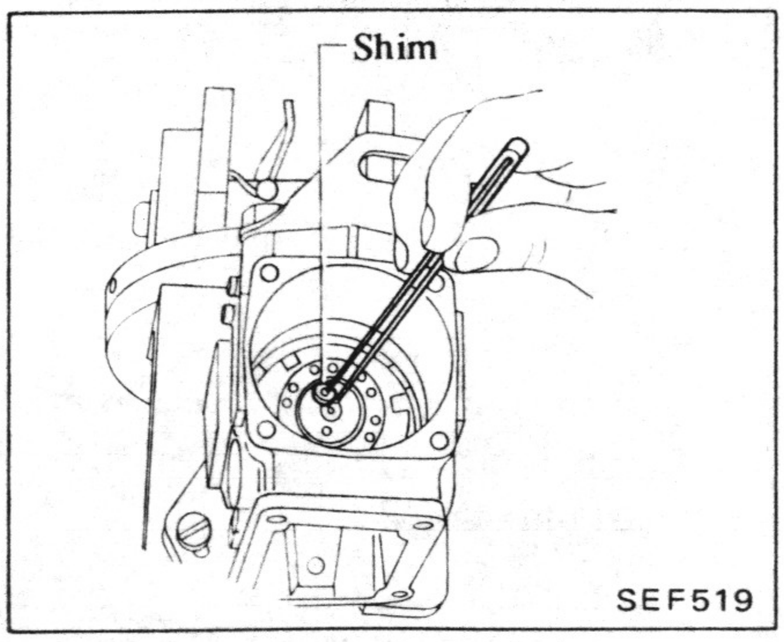
a. **Rotate drive shaft so that plunge is set at bottom dead center.**
b. **Securely mount distributor head with screws.**



(3) Determine shim to be used by calculating difference between measured (dial gauge reading) value and standard dimension "K", and position

that shim on plunger's bottom.

"K" = 3.3 mm (0.130 in)

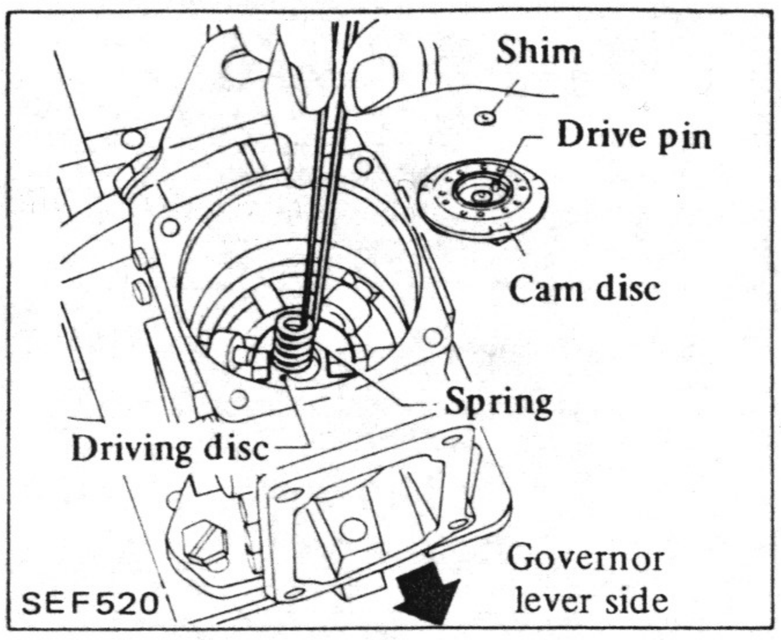


a. **When measured value is greater than standard dimension "K", use a thicker shim.**
b. **After shim has been positioned, measure dimension again to ensure that it is correct.**
c. **Shims are available in thirteen difference thickness.**

Part number	Thickness mm (in)
16884-V0700	1.92 (0.0756)
16884-V0701	2.00 (0.0787)
16884-V0702	2.08 (0.0819)
16884-V0703	2.16 (0.0850)
16884-V0704	2.24 (0.0882)
16884-V0705	2.32 (0.0913)
16884-V0706	2.40 (0.0945)
16884-V0707	2.48 (0.0976)
16884-V0708	2.56 (0.1008)
16884-V0709	2.64 (0.1039)
16884-V0710	2.72 (0.1071)
16884-V0711	2.80 (0.1102)
16884-V0712	2.88 (0.1134)

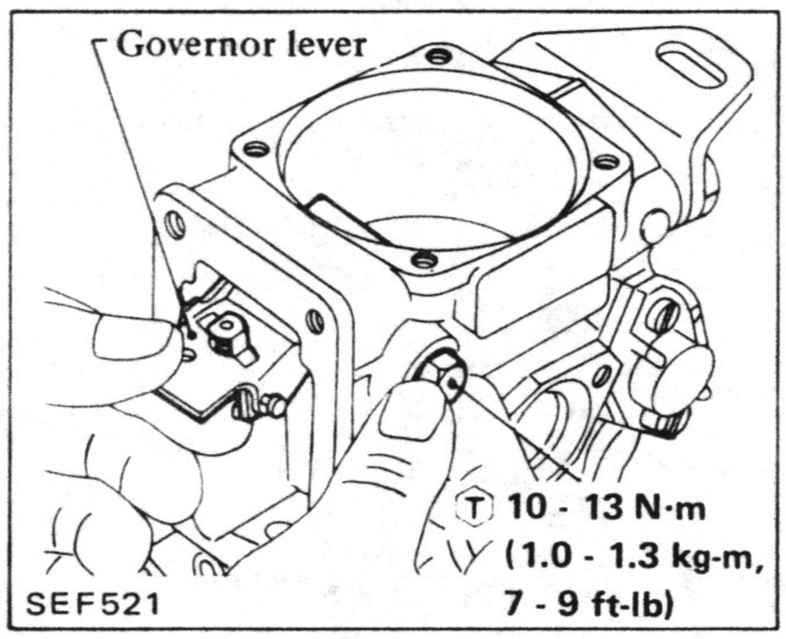
16. Install spring in top of driving disc, and install cam disc and shim in that order.

Make sure cam disc drive pin and drive shaft key way face governor lever side.



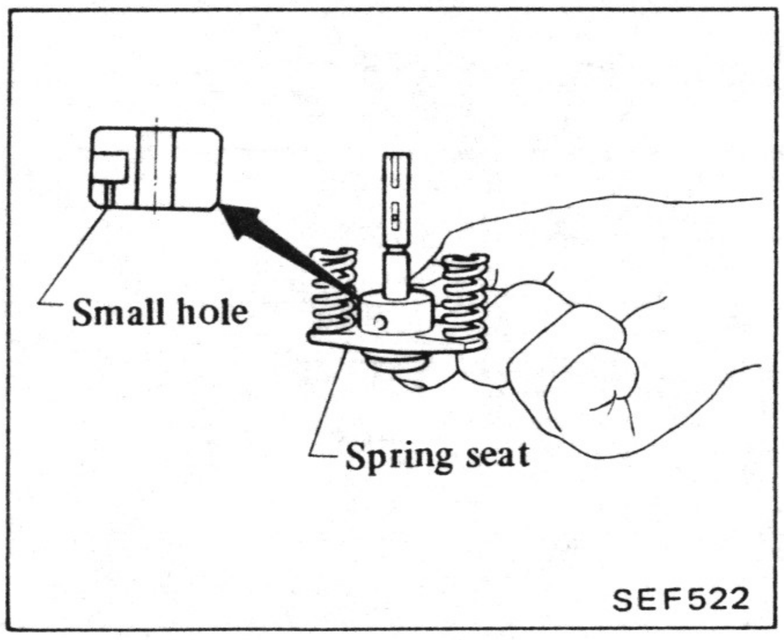
17. Install governor lever.

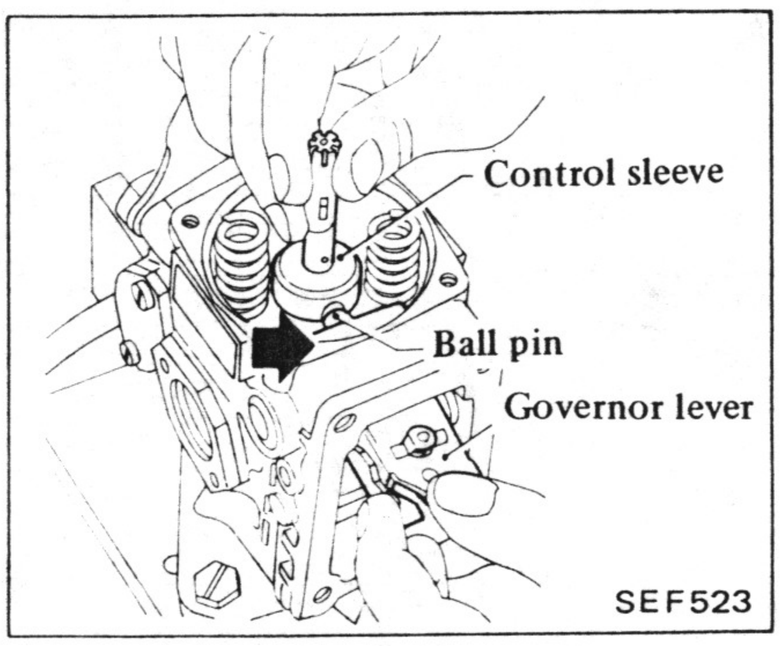
Avoid pulling on start spring and start idle spring.



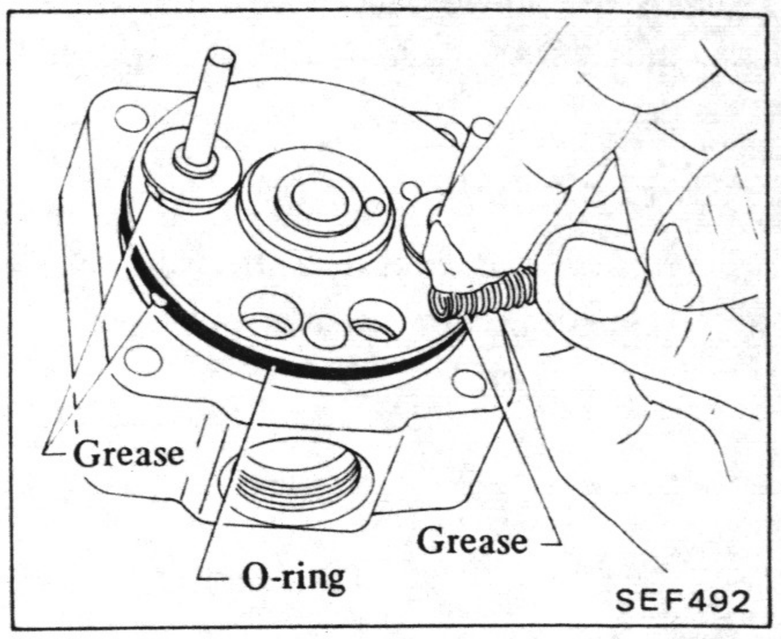
18. Install plunger assembly.

a. **Insert ball pin for governor lever into hole in control sleeve (shown by arrow).**
b. **Make sure control sleeve is installed with its small hole facing spring seat side.**



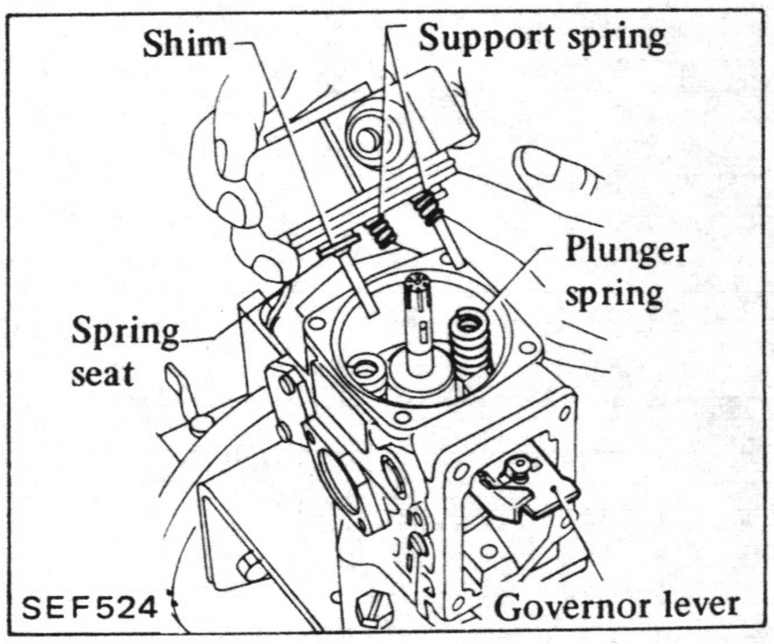


19. Apply a coat of grease to guide pin, shim and spring seat, and attach these parts to distributor head.

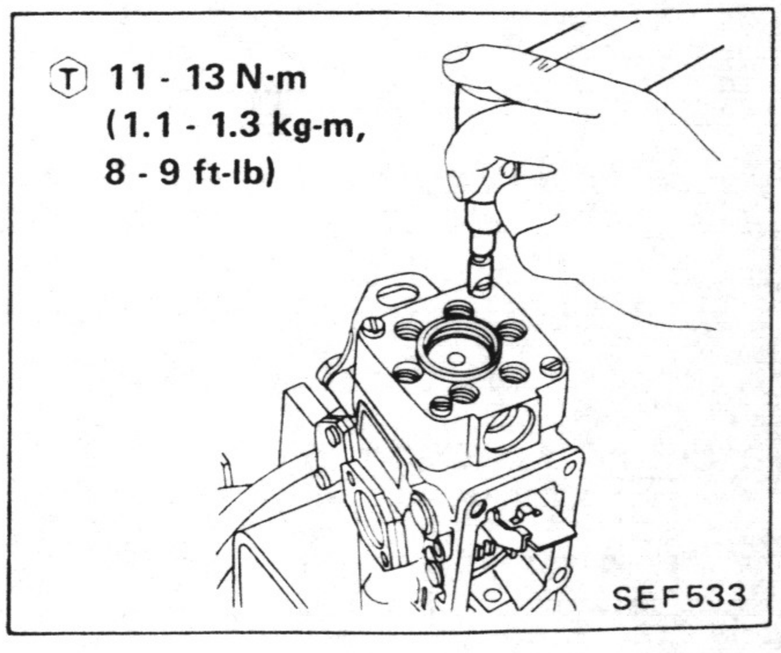


20. Install distributor head.

a. **Always face support spring toward governor lever.**
b. **Be careful not to drop spring.**
c. **Make sure that ball pin for governor lever is inserted properly into hole in control sleeve.**
d. **After installing distributor head, make sure that plunger spring is at guide hole in spring seat.**

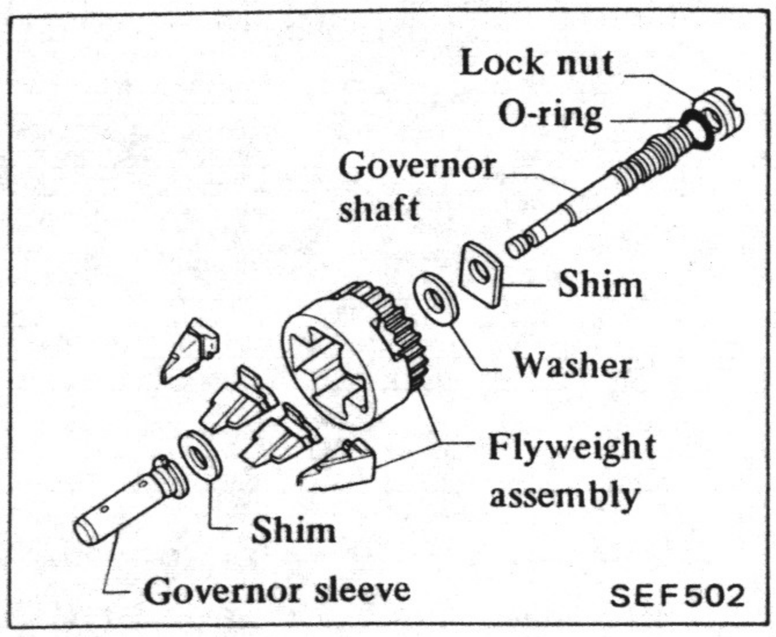


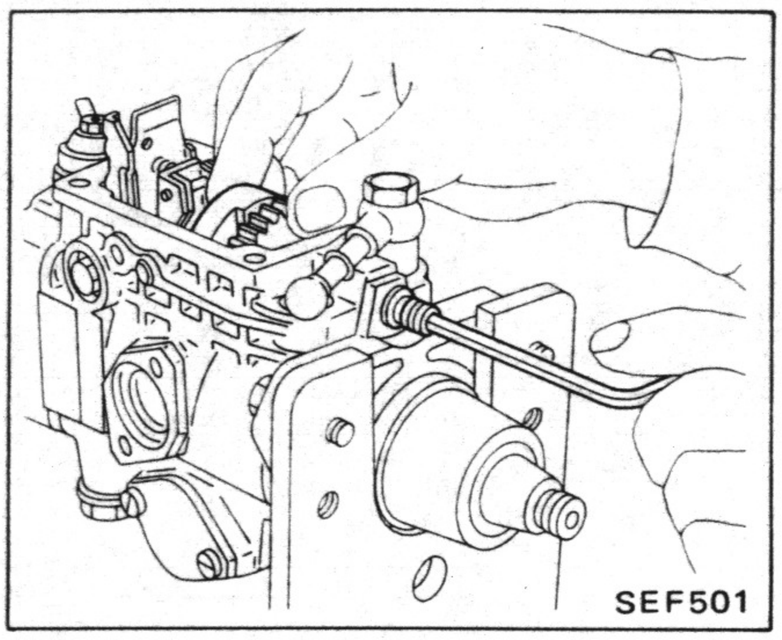
21. Tighten distributor head.



22. Attach governor weight assembly.

When installing governor shaft, be careful not to scratch O-rings.





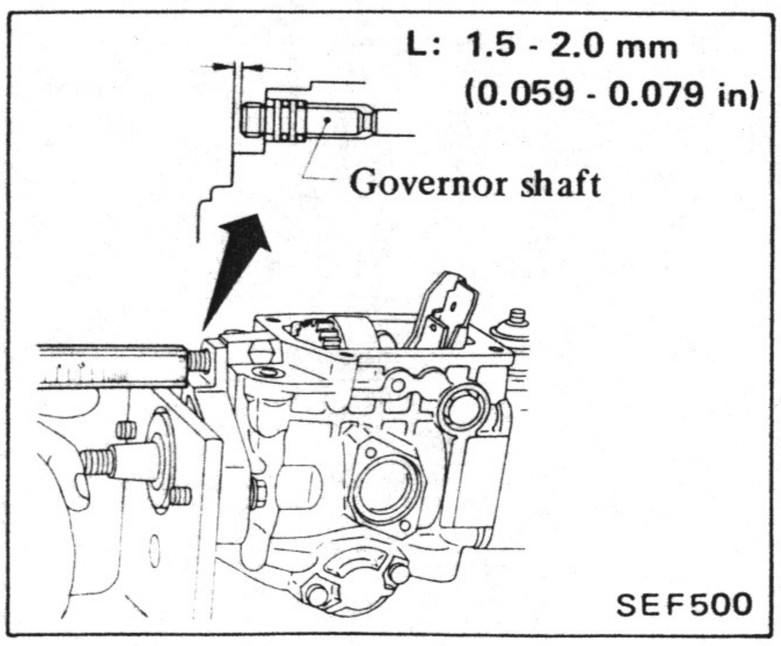
23. Adjust dimension "L", as shown.

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

a. Tighten lock nut to specified torque.

Ⓣ : 25 - 29 N·m
(2.5 - 3.0 kg-m,
18 - 22 ft-lb)

b. Governor shaft has a left hand thread for injection pumps designed to rotate in "R" direction, and a right hand thread for those rotating in "L" direction.

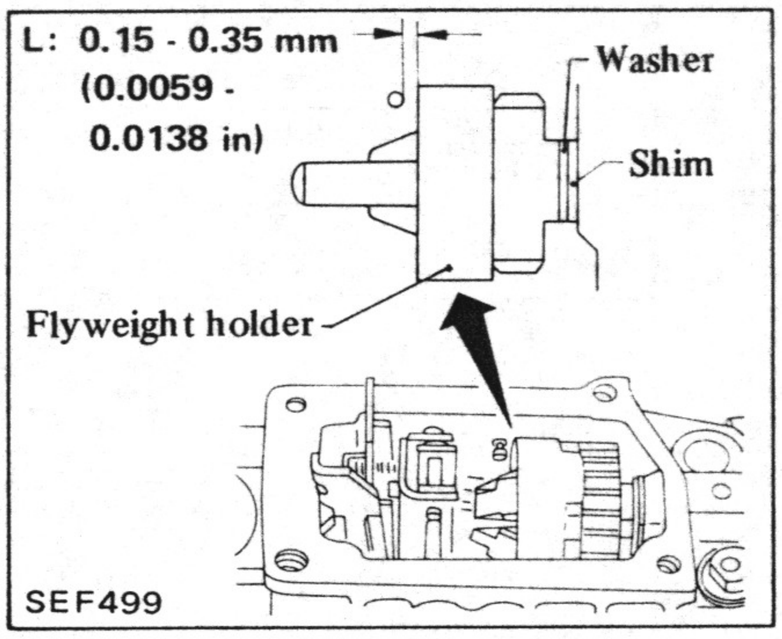


24. Measure axial play of flyweight holder. If it is not within specified range, adjust it by means of shim.

"L":
0.15 - 0.35 mm
(0.0059 - 0.0138 in)

Shims are available in five different thickness.

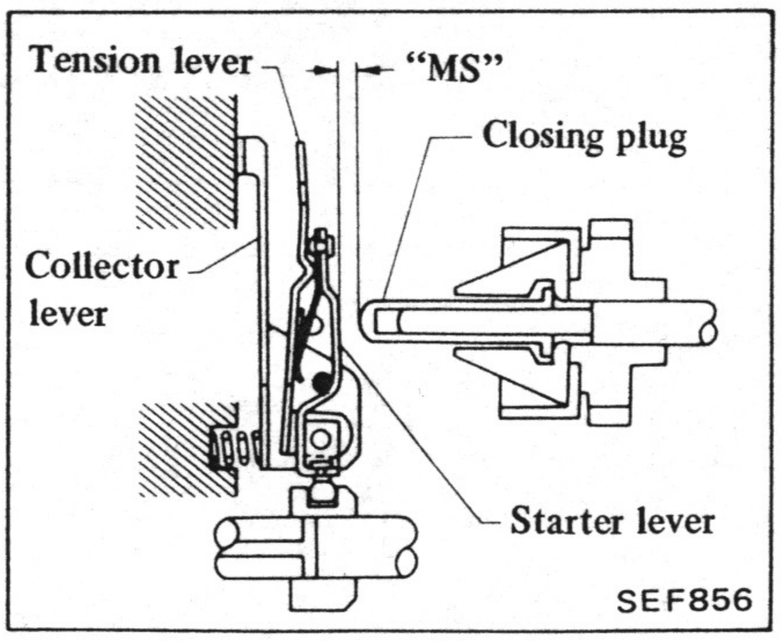
Part number	Thickness mm (in)
19208-V0700	1.05 (0.0413)
19208-V0701	1.25 (0.0492)
19208-V0702	1.45 (0.0571)
19208-V0703	1.65 (0.0650)
19208-V0704	1.85 (0.0728)



25. Measurement of dimension "MS" (for determing starting amount of fuel injection)

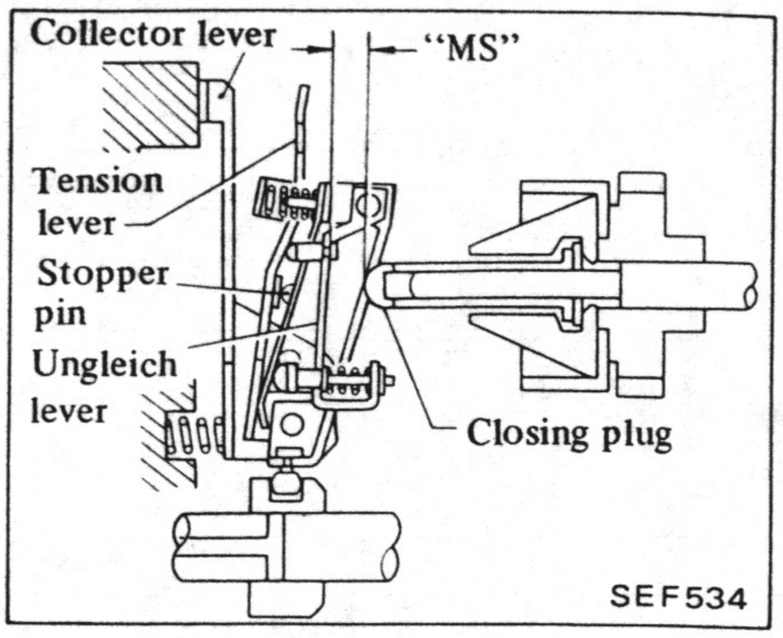
LD20 engine

Dimension "MS" is the distance from closing plug to start lever.

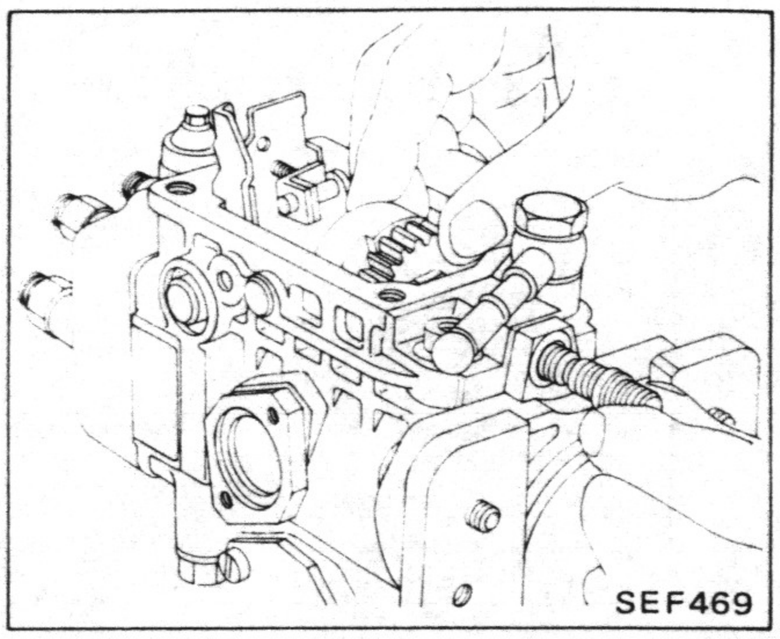


LD28 engine

Dimension "MS" is the distance from closing plug to Ungleich lever.

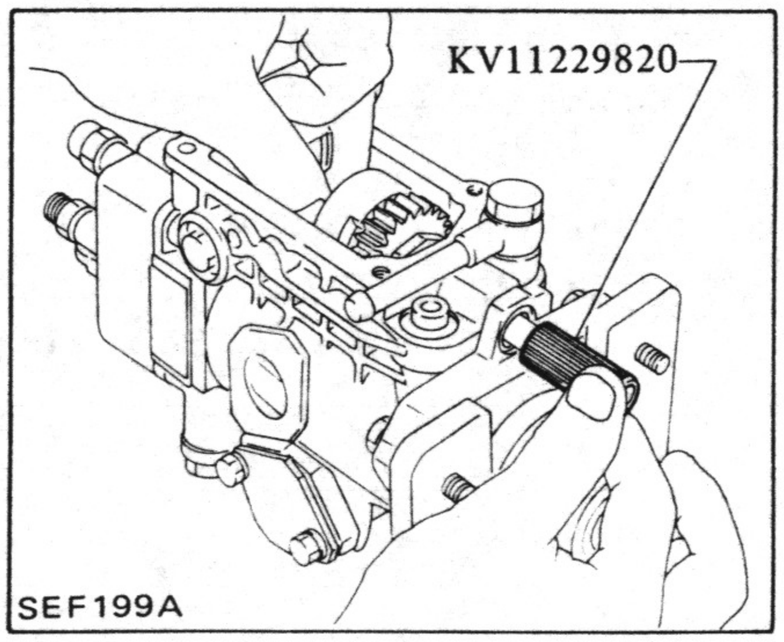


(1) Remove lock nut, governor shaft and flyweight assembly.

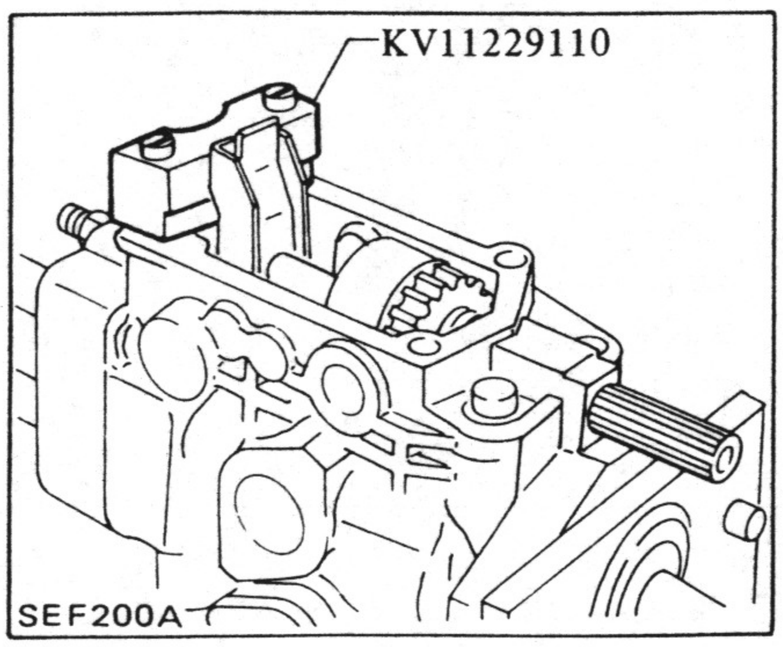


(2) Install Tool and flyweight assembly in place of governor shaft.

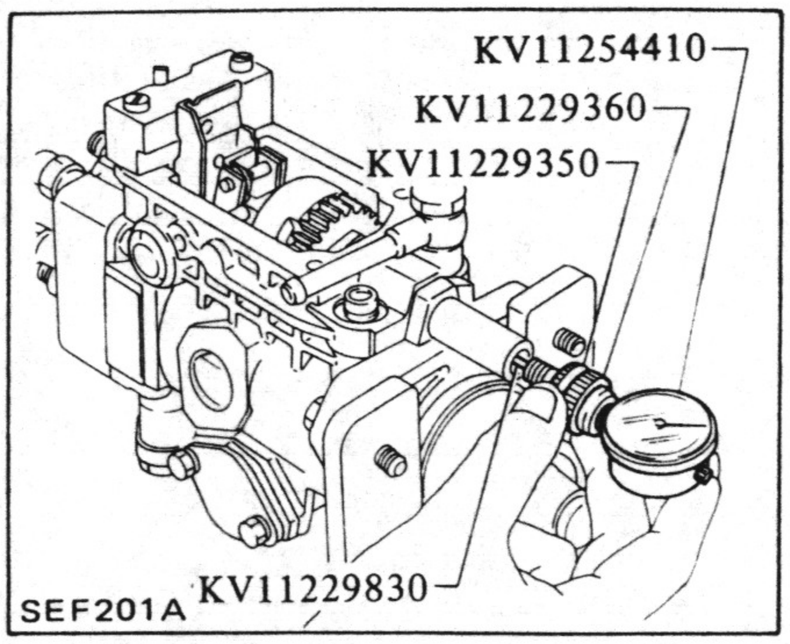
Be sure to install shim and washer when installing flyweight assembly.



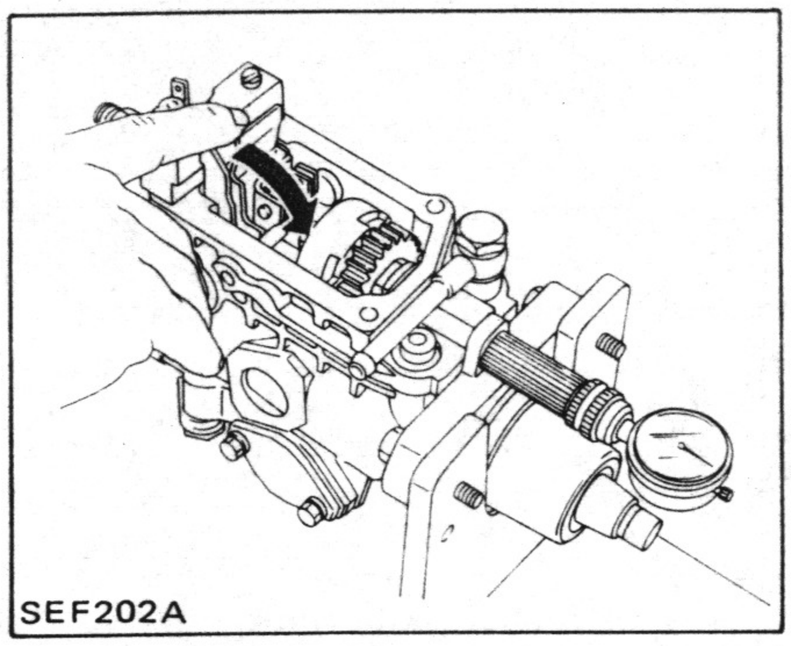
(3) Set Tool, as shown.



(4) Install dial gauge together with rod.



(5) Press governor sleeve to flyweight and set dial gauge to "0".



(6) Push tension lever until it comes into contact with stopper pin. Return governor sleeve until start lever (LD20) or Ungleich lever (LD28) comes into contact with tension lever and read dial gauge.

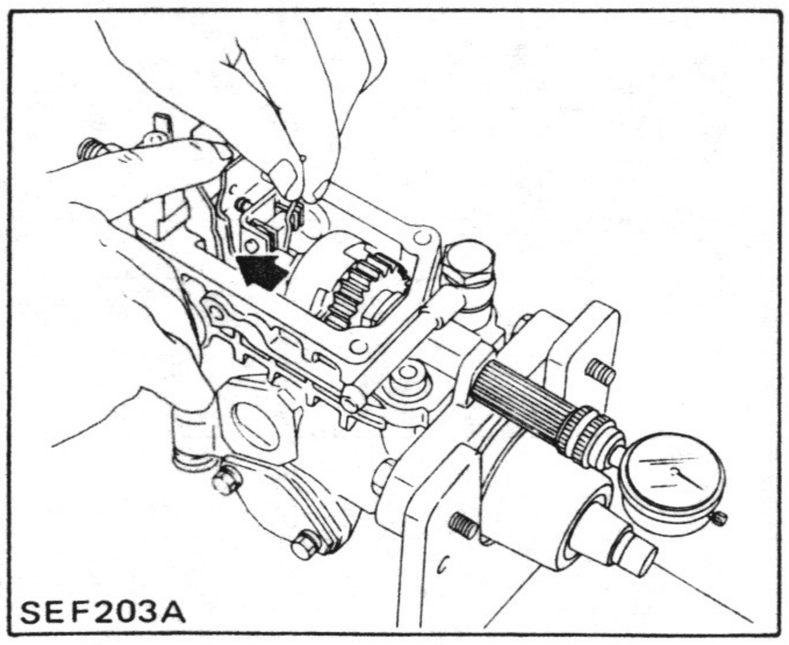
MS:

LD20

1.1 - 1.3 mm (0.043 - 0.051 in)

LD28

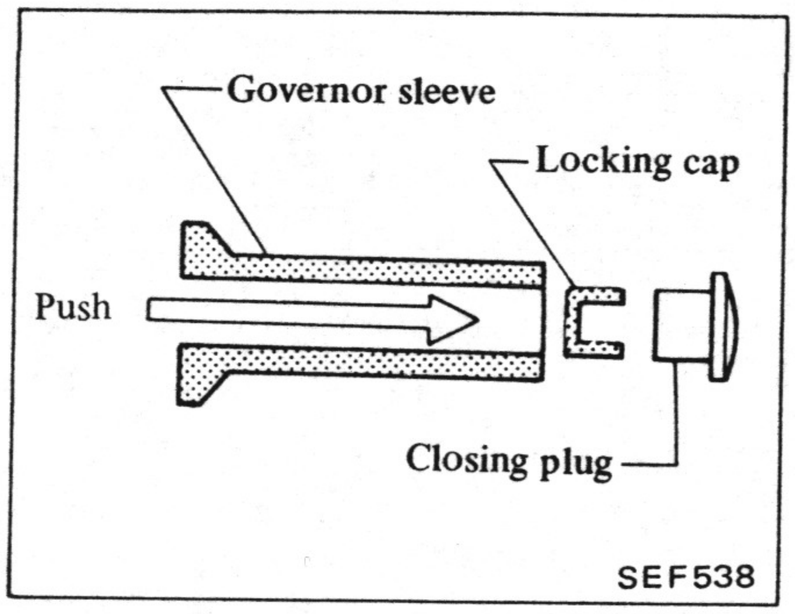
1.7 - 1.9 mm (0.067 - 0.075 in)



(7) If dial gauge indication is not within this range, replace closing plug and adjust dimension "MS" to that range.

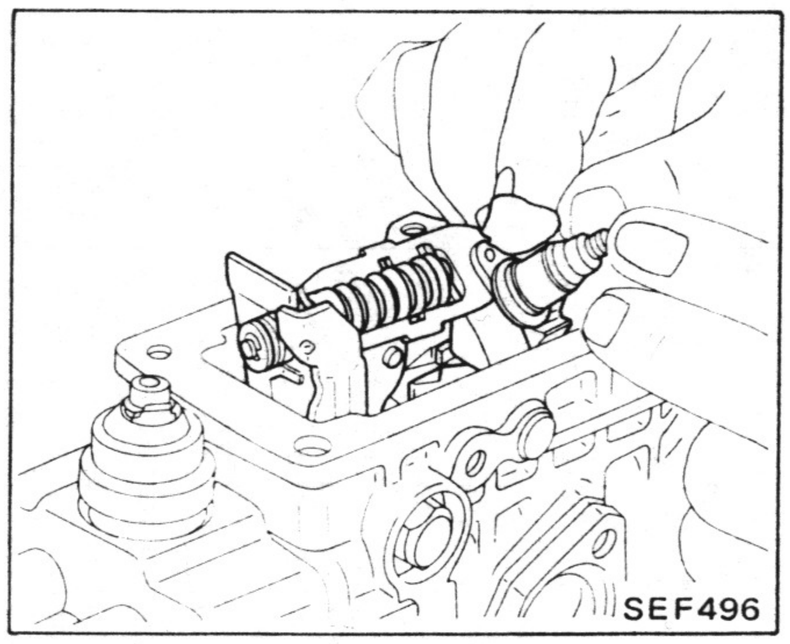
Closing plugs are available in eight different thickness.

Part number	Thickness mm (in)	Applied	
		LD20	LD28
19207-V0700	7.8 (0.307)	–	X
19207-V0701	8.0 (0.315)	–	X
19207-V0702	8.2 (0.323)	–	X
19207-V0703	8.4 (0.331)	–	X
19207-V0704	8.6 (0.339)	–	X
19207-V0705	8.8 (0.346)	X	X
19207-V0706	9.0 (0.354)	X	X
19207-V0707	9.2 (0.362)	X	X
19207-W1700	9.4 (0.370)	X	–
19207-W1701	9.6 (0.378)	X	–
19207-W1702	9.8 (0.386)	X	–
19207-W1703	10.0 (0.394)	X	–
19207-W1704	10.2 (0.402)	X	–

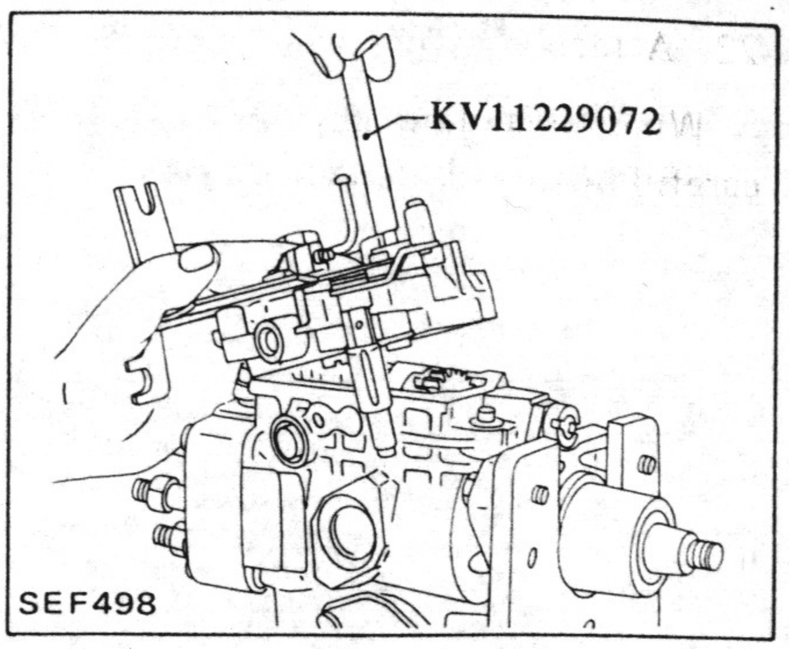


26. Install control lever shaft.

Apply a coat of grease to lever shaft end.

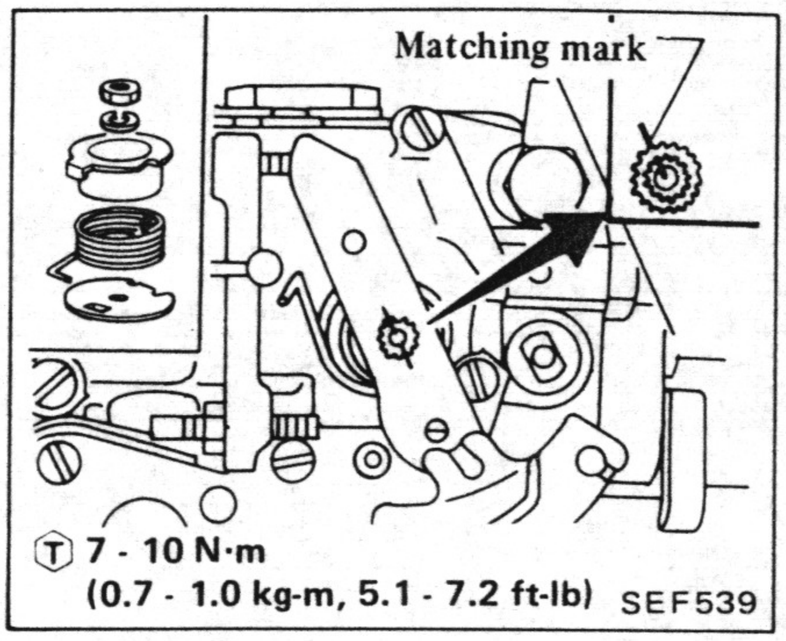


27. Install pump cover.



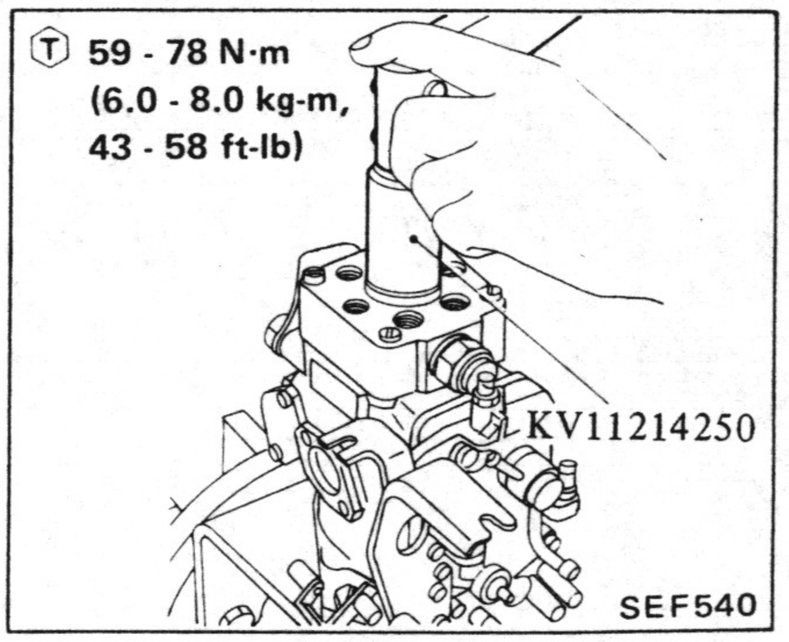
28. Install speed control lever assembly.

Align aligning marks of speed control lever and control lever shaft.



29. Install fuel cut solenoid valve and plug.

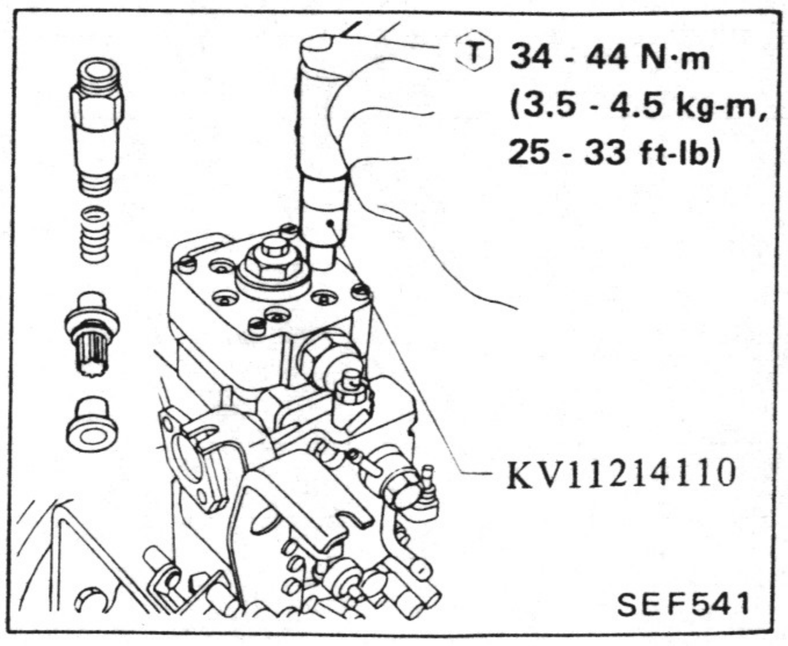
Always replace plugs with new ones.



30. Install delivery valve.

a. **Always use new washers.**

b. **Make sure that delivery valve is reinstalled in its original position.**



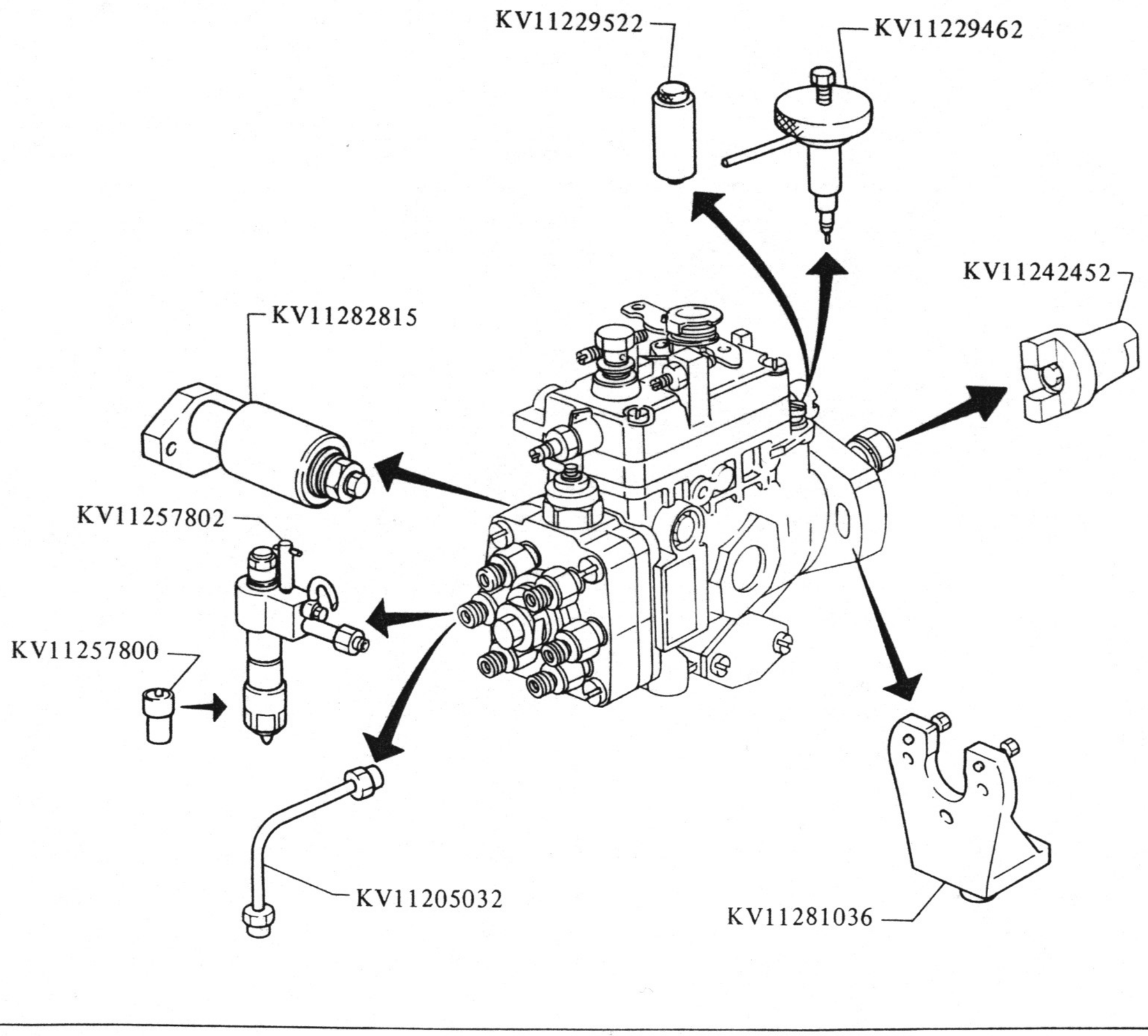
TESTING OF INJECTION PUMP

PREPARATION

INJECTION PUMP TEST CONDITIONS

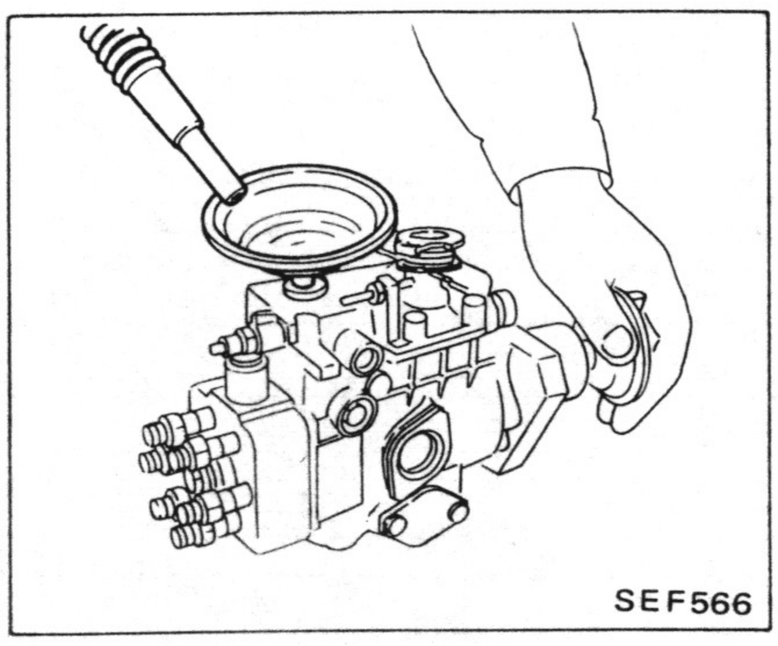
Nozzle	KV11257800
Nozzle holder	KV11257802
Nozzle starting pressure kPa (bar, kg/cm², psi)	14,711 - 15,201 (147.1 - 152.0, 150 - 155, 2,133 - 2,204)
Nozzle tube Inner dia. x outer dia. x length mm (in)	KV11205032 2.0 x 6.0 x 840 (0.079 x 0.236 x 33.07)
Fuel feed pressure kPa (bar, kg/cm², psi)	20 (0.20, 0.2, 2.8)
Fuel (test oil)	Shell calibration fluid B, Bosch oil OL61V11
Fuel temperature °C (°F)	45 - 50 (113 - 122)
Rotating direction	Right (observed from the drive shaft)
Injection sequence	LD20 1 - 3 - 4 - 2 LD28 1 - 5 - 3 - 6 - 2 - 4

1. Prepare necessary service tools.

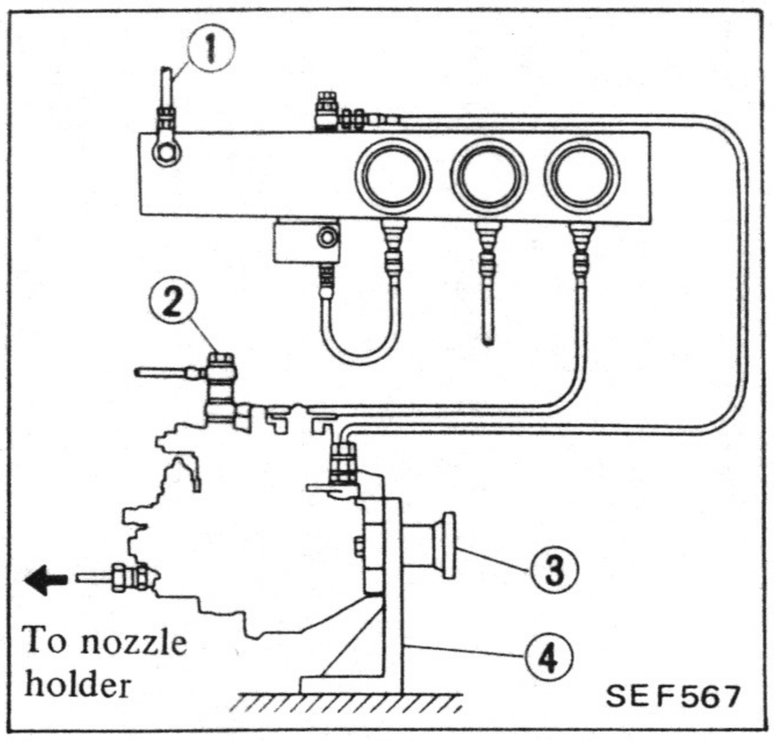


2. Pour test oil into fuel injection pump.

Test oil should be Shell calibration fluid B, Bosch test oil-OL61V11 or its equivalent.


SEF566

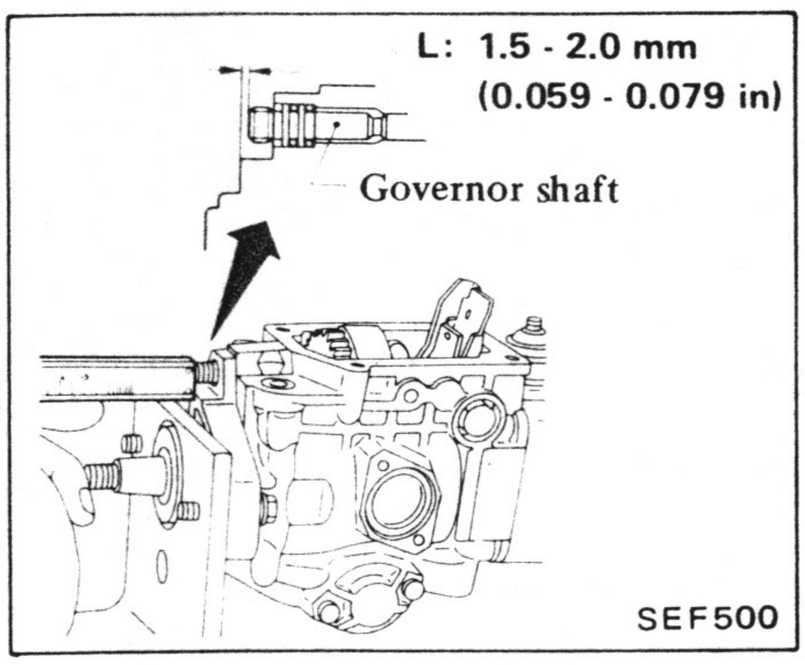
3. Install fuel injection pump to pump tester.
4. Connect necessary piping.



SEF567

1 Fuel supply inlet from pump tester
2 Overflow valve
3 Coupling
4 Fixing stand

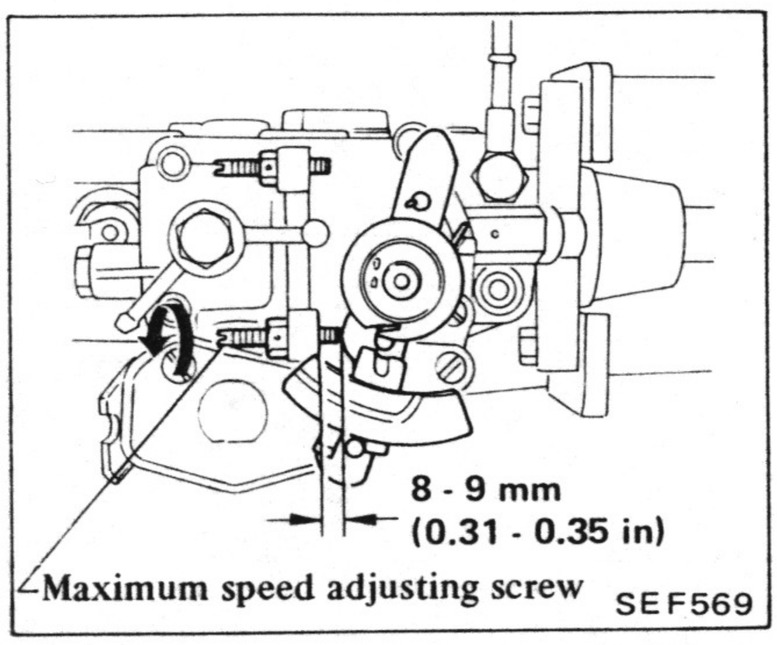
5. Make sure that governor shaft is properly installed.



SEF500

6. Run in fuel injection pump as follows:
(1) Maintain test oil in tank to 45 to 50°C (113 to 122°F).
(2) Set control lever at "full load" using a spring.

Set maximum speed adjusting screw in position shown, by turning counter-clockwise.



SEF569

(3) Furnish specified voltage of 12 volts to fuel-cut solenoid valve to activate it.
(4) Rotate fuel injection pump by hand to see if it moves smoothly.
(5) Rotate fuel injection pump at 300 rpm to make sure that all air inside pump chamber is discharged through overflow valve.
(6) Set feed oil pressure at 20 kPa (0.20 bar, 0.2 kg/cm², 2.8 psi).
(7) Run in fuel injection pump by rotating it at 1,000 rpm for ten minutes.

If fuel leakage, fuel injection failure or unusual noise is noticed, immediately halt pump tester operation and check fuel injection pump for abnormalities.

ADJUSTMENT

PREADJUST FULL-LOAD DELIVERY

1. Set control lever at "full load" using a spring.

Set maximum speed adjusting screw in position shown, by turning counter-clockwise. Refer to step 6–(2) in Preparation.

2. Furnish specified voltage of 12 volts to activate fuel-cut solenoid valve.
3. Rotate fuel injection pump at specified rpm, and measure amount of fuel injection.

Standard fuel injection:

LD20

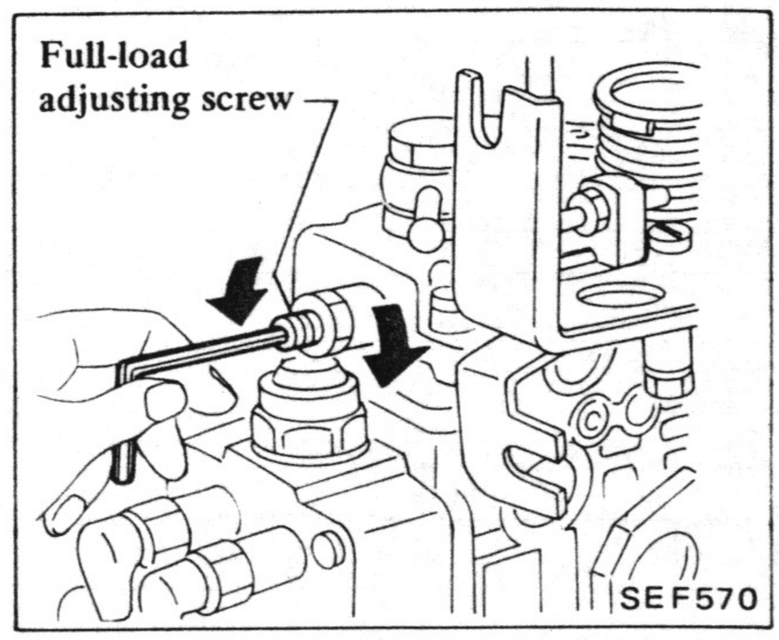
33.3 - 34.3 mℓ
(1.17 - 1.21 Imp fl oz)/1,000 stroke at 900 rpm

LD28

34.6 - 35.6 mℓ
(1.22 - 1.25 Imp. fl oz)/1,000 stroke at 1,200 rpm

4. If fuel injection is less than standard, adjust it with full-load adjusting screw.

Turn adjusting screw clockwise to increase fuel injection.



SEF570

ADJUSTMENT OF FEED PUMP PRESSURE

1. Repeat steps 1 and 2 outlined under heading "Preadjust Full Load Delivery".
2. Measure feed pump pressure at specified fuel injection pump rpms'.

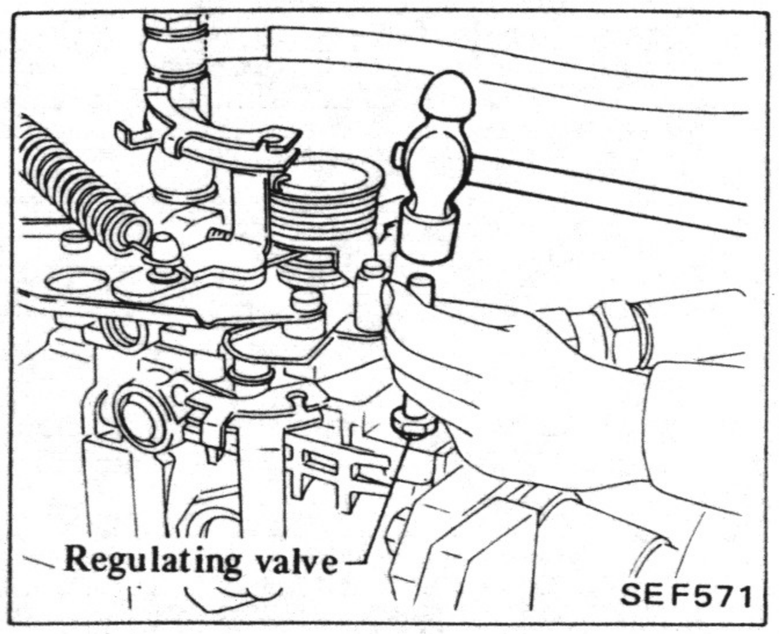
LD20

Fuel injection pump rpm	Specified pressure kPa (bar, kg/cm², psi)
900	294 - 353 (2.94 - 3.53, 3.0 - 3.6, 43 - 51)
1,800	500 - 559 (5.00 - 5.59, 5.1 - 5.7, 73 - 81)
2,300	628 - 686 (6.28 - 6.86, 6.4 - 7.0, 91 - 100)

LD28

Fuel injection pump rpm	Specified pressure kPa (bar, kg/cm², psi)
800	353 - 412 (3.53 - 4.12, 3.6 - 4.2, 51 - 60)
1,800	579 - 637 (5.79 - 6.37, 5.9 - 6.5, 84 - 92)
2,500	726 - 785 (7.26 - 7.85, 7.4 - 8.0, 105 - 114)

a. When measured pressure is lower than specifications.

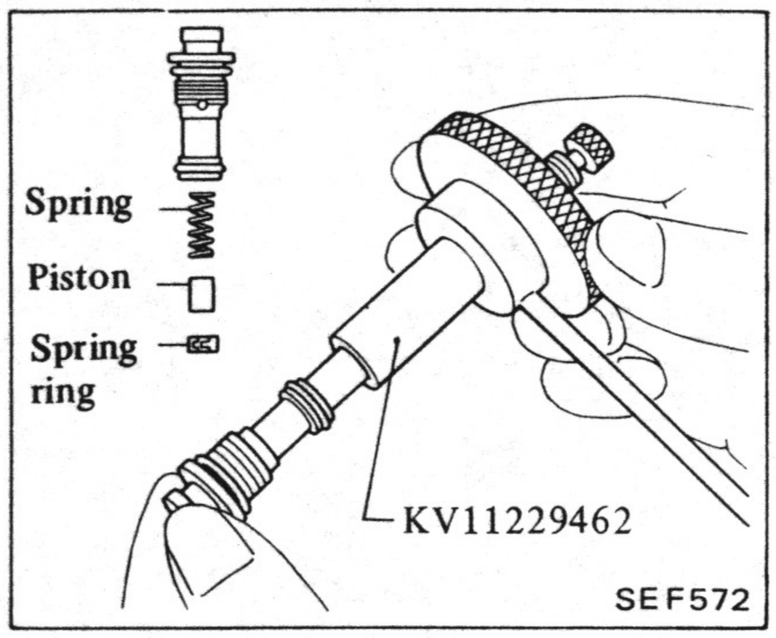


Push in plug that is driven into regulating valve body.

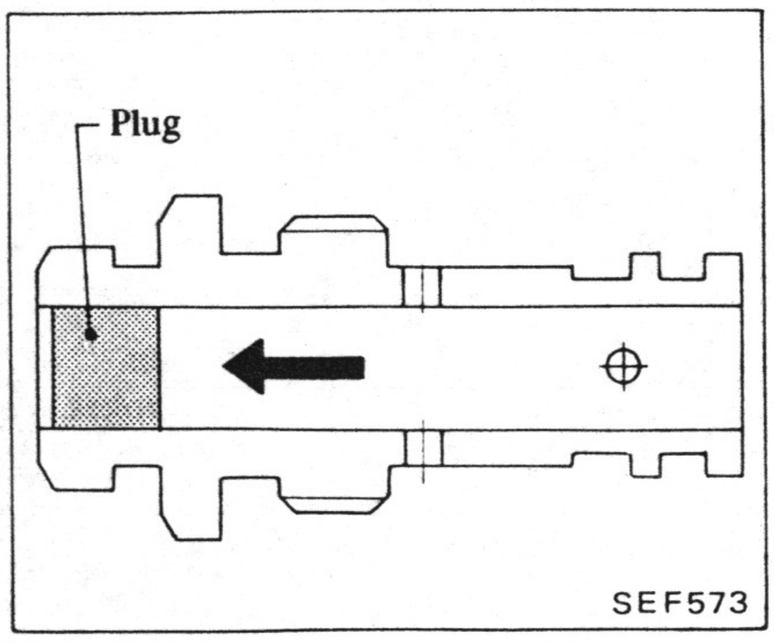
Be careful not to push plug in too far.

b. When measured pressure is higher than specifications.

Remove regulating valve from fuel injection pump, and disassemble regulating valve using KV11229462.

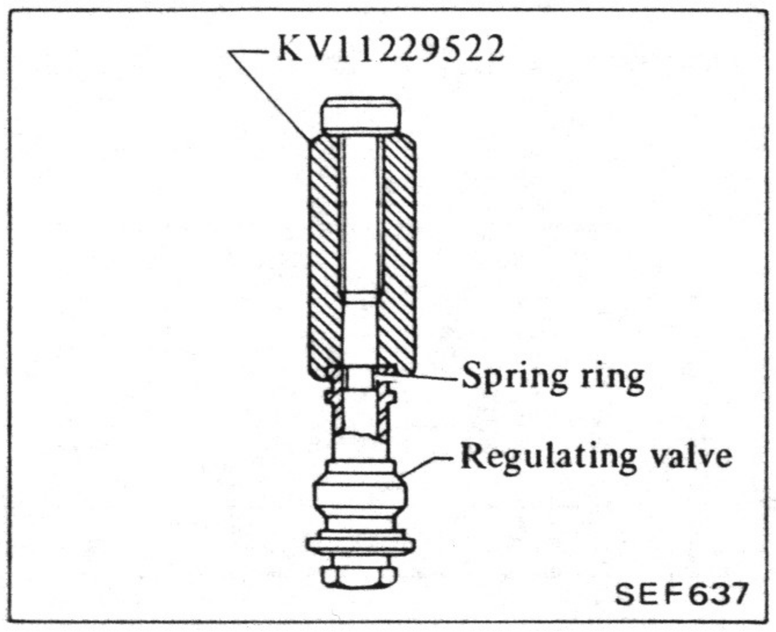


Drive plug out until it is flush with end face of regulating valve.



Install spring, piston and spring ring, in that order, to regulating valve.

Make sure that spring ring is flush with end face or regulating valve body when it is pushed in.



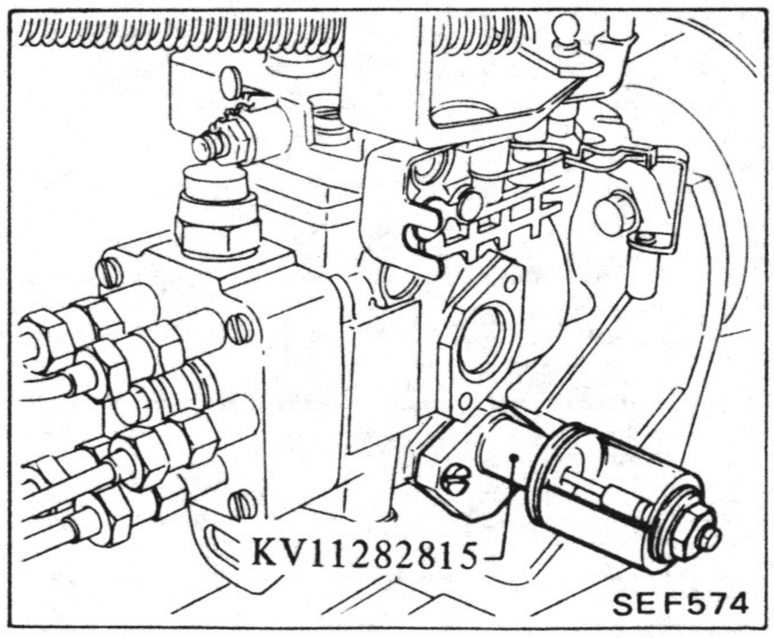
Attach regulating valve to fuel injection pump.

Ⓣ : **Regulating valve**
8 - 9 N·m
(0.8 - 0.9 kg-m,
5.8 - 6.5 ft-lb)

Adjust supply pump pressure to specifications. Refer to step 2-a.

ADJUST SPEED TIMER

1. Repeat steps 1 and 2 outlined under heading "Preadjust Full-Load Delivery".
2. Remove cover from high pressure side (side without spring) of timer, **and attach service tool KV11282815 to that side.**



3. Measure timer piston strokes at specified fuel injection pump rpm indicated below.

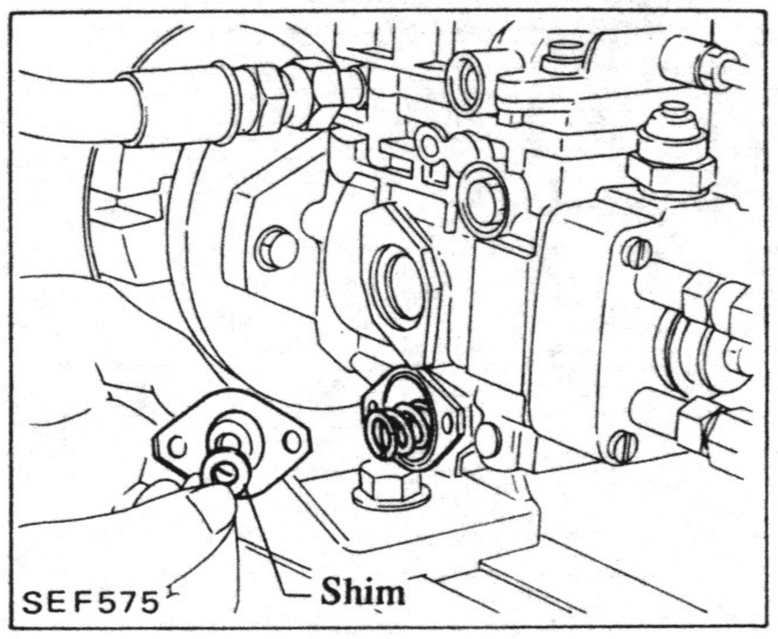
LD20

Fuel injection pump rpm	Timer piston stroke mm (in)
900	1.1 - 1.7 (0.043 - 0.067)
1,800	4.6 - 5.8 (0.181 - 0.228)
2,300	6.9 - 7.8 (0.272 - 0.307)

LD28

Fuel injection pump rpm	Timer piston stroke mm (in)
1,200	2.5 - 3.1 (0.098 - 0.122)
1,800	4.9 - 6.1 (0.193 - 0.240)
2,300	7.7 - 8.6 (0.303 - 0.339)

4. If timer piston stroke is not within specified range, remove cover from low pressure side of timer and adjust piston stroke by adding shim(s).



a. Shims (service parts)

Parts number	Thickness mm (in)
16880-V0700	0.6 (0.024)
16880-V0701	0.7 (0.028)
16880-V0702	0.9 (0.035)
16880-V0703	1.0 (0.039)
16880-V0704	1.2 (0.047)

b. Make sure that at least one shim is used on each side of timer spring.

ADJUST FUEL INJECTION UNDER FULL-LOAD

1. Set control lever at "full load" using a spring.
2. Furnish specified voltage of 12 volts to activate fuel cut solenoid valve.
3. Measure fuel injection at each specified fuel injection pump rpm.

Standard fuel injection:

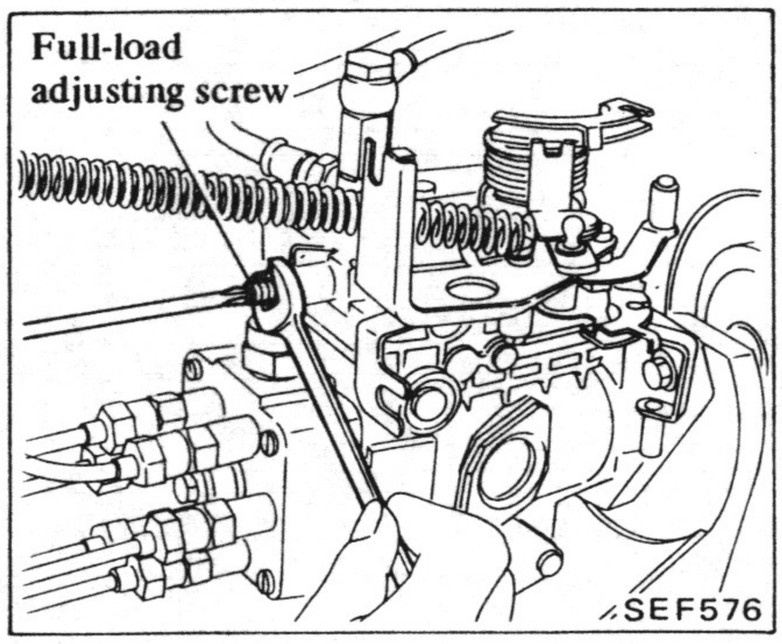
LD20

Fuel injection pump rpm	Standard fuel injection mℓ (Imp fl oz)/1,000 stroke
600	32 - 36 (1.13 - 1.27)
900	33.3 - 34.3 (1.17 - 1.21)
2,300	31.4 - 35.4 (1.11 - 1.25)

LD28

Fuel injection pump rpm	Standard fuel injection mℓ (Imp fl oz)/1,000 stroke
600	28.5 - 32.5 (1.00 - 1.14)
1,200	34.6 - 35.6 (1.22 - 1.25)
2,300	28.8 - 32.8 (1.01 - 1.15)

4. If fuel injection is not within standard range, adjust it using full-load adjusting screw.



ADJUST FUEL INJECTION DURING IDLE

1. Pull spring until control lever comes into contact with idle speed adjusting screw.
2. Furnish specified voltage of 12 volts to activate fuel cut solenoid valve.
3. Measure fuel injection at specified fuel injection pump rpm.

Standard fuel injection:

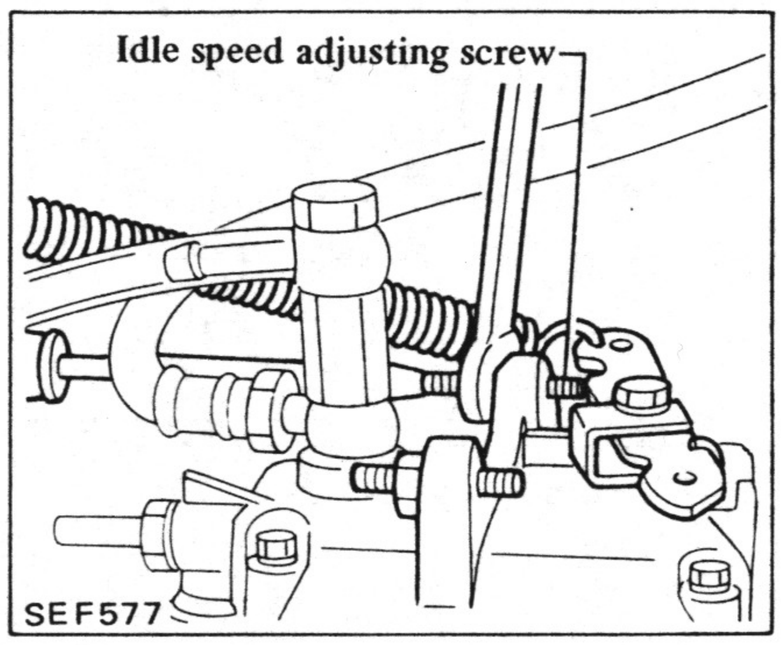
LD20

Fuel injection pump rpm	Standard fuel injection mℓ (Imp fl oz)/1,000 stroke
325	8.9 - 11.9 (0.31 - 0.42)
500	Less than 4 (0.14)

LD28

Fuel injection pump rpm	Standard fuel injection mℓ (Imp fl oz)/1,000 stroke
350	7.1 - 10.1 (0.25 - 0.36)
500	Less than 4 (0.14)

4. If fuel injection is not within specified range, adjust using idle speed adjusting screw.

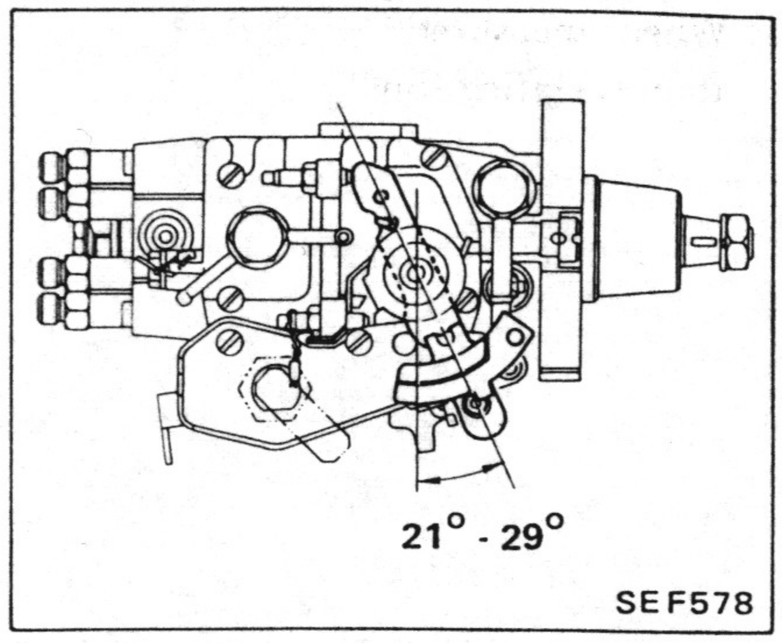


a. Tightening this screw will increase fuel injection amount.

b. Make sure that control lever angle is set at 21 to 29° range.

If control lever angle is not within specified range, adjust it by re-positioning control lever on control shaft. (One serration pitch: 15°)

After control lever has been re-positioned, be sure to measure amount of fuel injection at idle speed again.



ADJUST FUEL INJECTION DURING START

1. Set control lever at "full load" by pulling spring.
2. Furnish specified voltage of 12 volts to activate fuel-cut solenoid valve.
3. Measure fuel injection at specified fuel injection pump rpm.

Standard fuel injection:

LD20

More than 53 mℓ (1.87 Imp fl oz)/1,000 stroke at 100 rpm

LD28

More than 50 mℓ (1.76 Imp fl oz)/1,000 stroke at 100 rpm

4. If fuel injection is lower than standard, check "MS" dimension. Refer to step 25 for Injection Pump Assembly.

ADJUST FUEL INJECTION AT MAX. PUMP RPM

1. Set control lever at "full load" by pulling spring.
2. Furnish specified voltage of 12 volts to activate fuel-cut solenoid valve.
3. Measure fuel injection at specified fuel injection rpm.

Standard fuel injection:

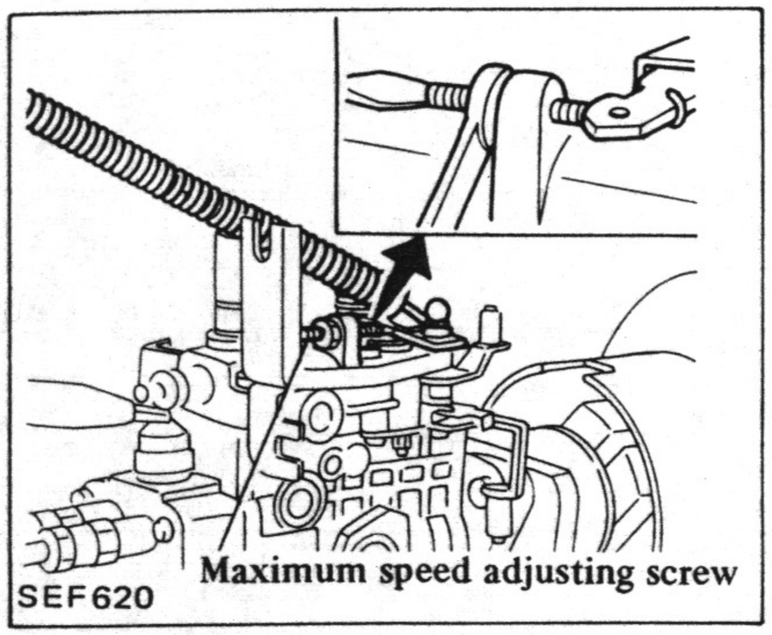
LD20

Fuel injection pump rpm	Standard fuel injection mℓ (Imp fl oz)/1,000 strokes
2,700	7.5 - 13.5 (0.26 - 0.48)
2,800	Less than 6 (0.21)

LD28

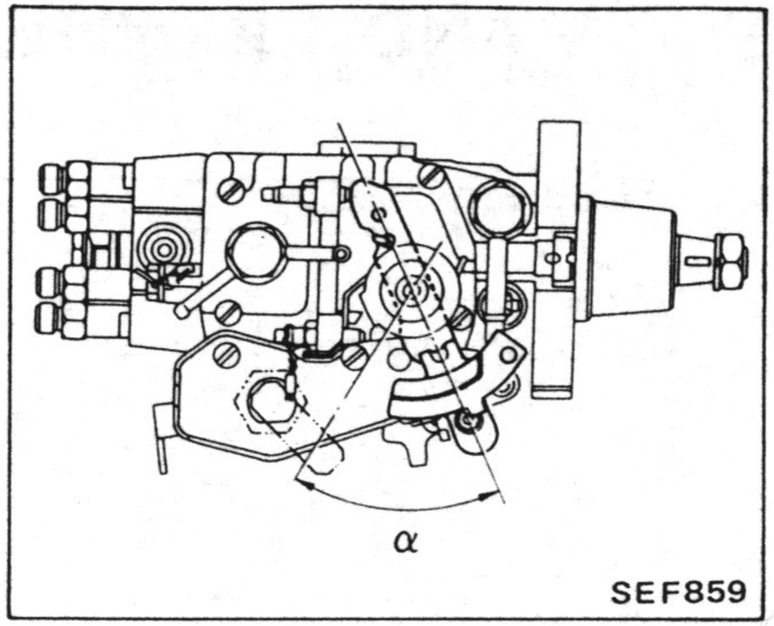
Fuel injection pump rpm	Standard fuel injection mℓ (Imp fl oz)/1,000 stroke
2,700	8.7 - 14.7 (0.31 - 0.52)
2,800	Less than 5 (0.18)

4. If fuel injection is not within standard range, adjust using max. speed adjusting screw.



a. Tightening screw will increase fuel injection.

b. Make sure that control lever angle is within 36° to 46° range (LD20), or within 39° to 49° range.



α: **LD20 36° - 46°**
LD28 39° - 49°

MEASURE OVERFLOW AMOUNT

1. Set control lever at "full load" by pulling spring.
2. Furnish specified voltage of 12 volts to activate fuel-cut solenoid valve.
3. Measure fuel overflow at specified fuel injection rpm.

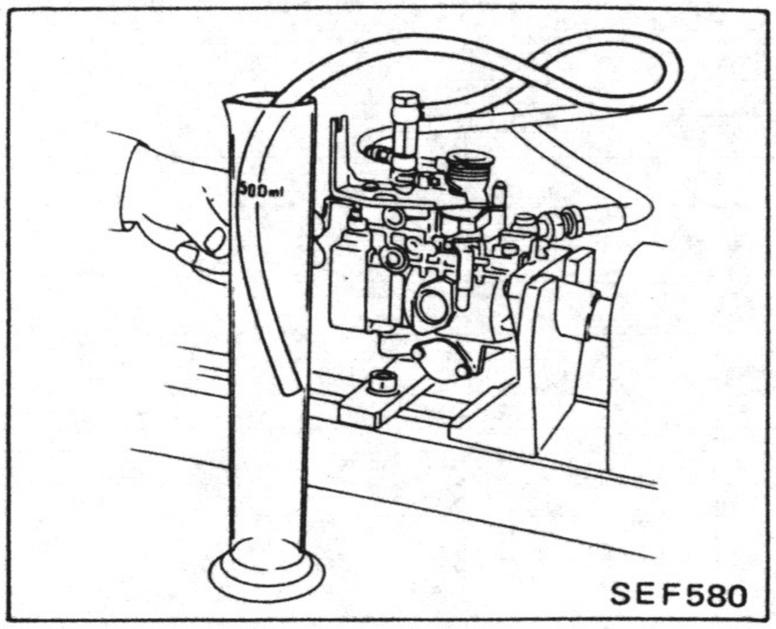
Fuel overflow:

LD20

31 - 75 mℓ
(1.09 - 2.64 Imp fl oz)/10 sec.
at 1,000 rpm

LD28

48 - 92 mℓ
(1.69 - 3.24 Imp fl oz)/10 sec.
at 1,000 rpm



OPERATION CHECK OF FUEL CUT SOLENOID VALVE

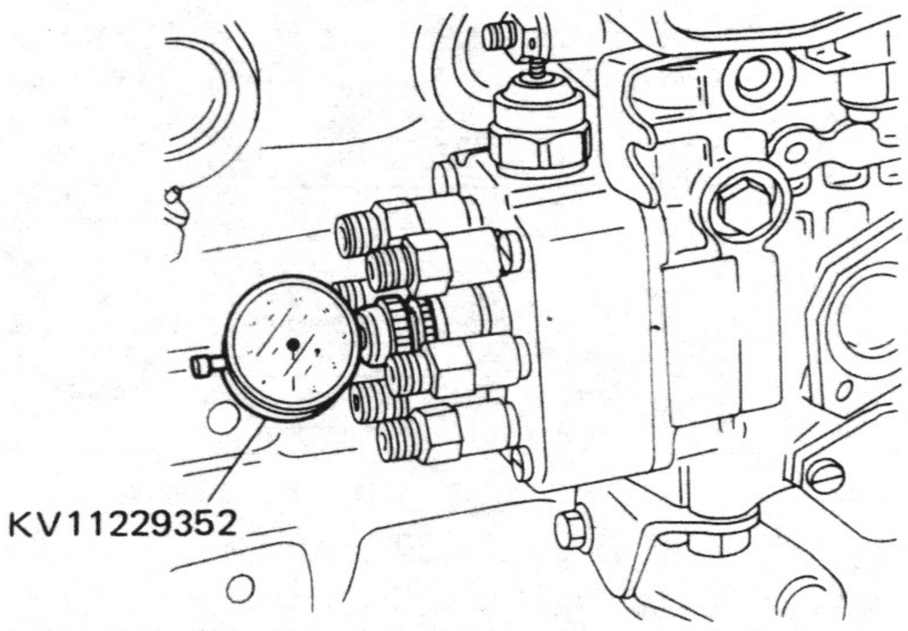
When engine is idling and fuel-cut solenoid valve current is OFF, be sure there is no injection. This check has to be done for approx. 5 seconds.

SERVICE DATA AND SPECIFICATIONS

INSPECTION AND ADJUSTMENT

INSTALLATION OF INJECTION PUMP

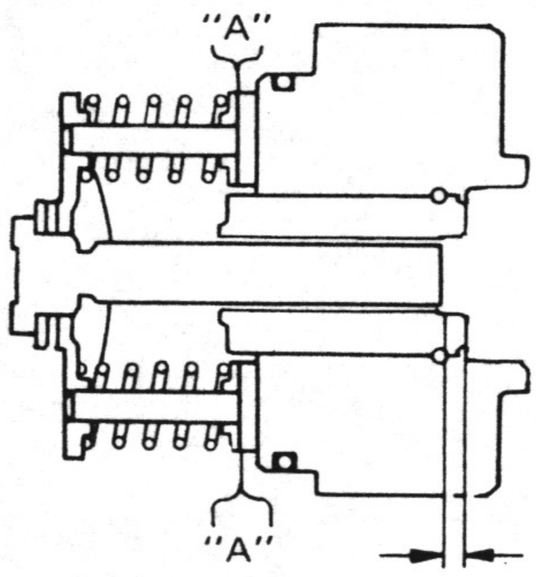
Item \ Applied engine	LD20	LD28
Plunger lift mm (in)	0.78 ±0.04 (0.0307 ±0.0016)	0.75 ±0.04 (0.0295 ±0.0016)



SEF551

USE OF ADJUSTMENT VALUE AND ADJUSTING SHIM WHEN INSTALLING INJECTION PUMP

Item \ Applied engine	LD20	LD28
Dimension "KF" mm (in)	5.8 (0.228)	6.6 (0.260)

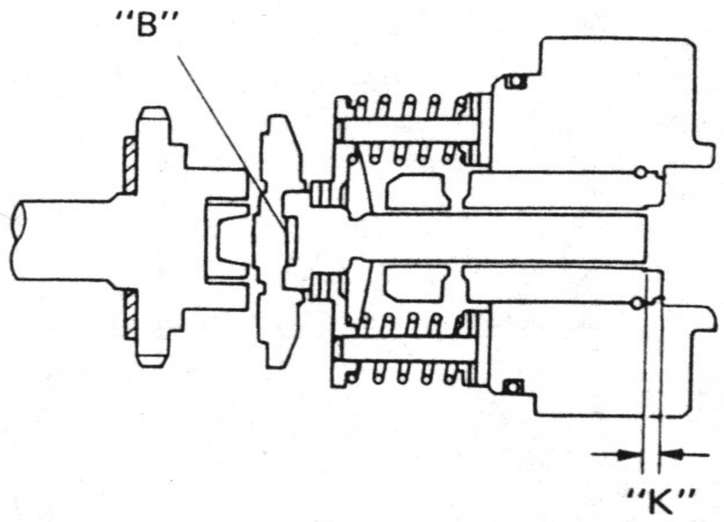


SEF638

Adjusting shim ("A" position)

Part number	Thickness mm (in)
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)

Item \ Engine	LD20 & LD28
Dimension "K" mm (in)	3.3 (0.130)

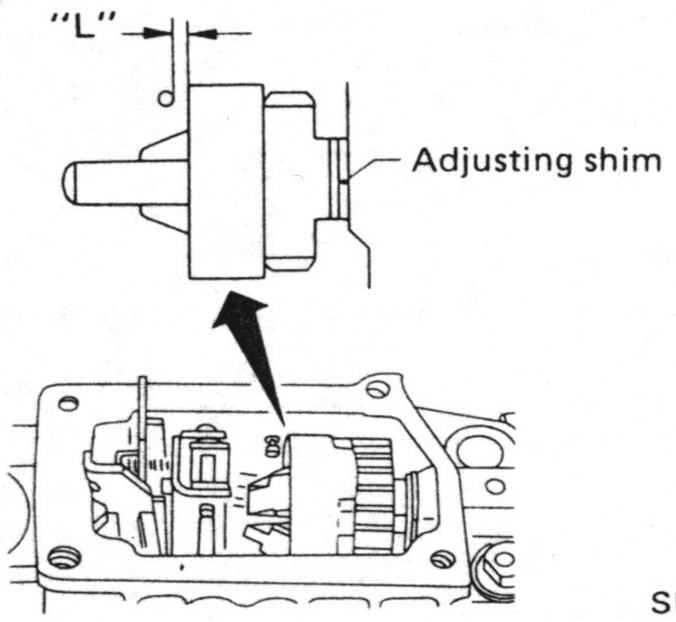


SEF639

Adjusting shim ("B" position)

Part number	Thickness mm (in)
16884-V0700	1.92 (0.0756)
16884-V0701	2.00 (0.0787)
16884-V0702	2.08 (0.0819)
16884-V0703	2.16 (0.0850)
16884-V0704	2.24 (0.0882)
16884-V0705	2.32 (0.0913)
16884-V0706	2.40 (0.0945)
16884-V0707	2.48 (0.0976)
16884-V0708	2.56 (0.1008)
16884-V0709	2.64 (0.1039)
16884-V0710	2.72 (0.1071)
16884-V0711	2.80 (0.1102)
16884-V0712	2.88 (0.1134)

Axial play of flyweight holder "L" mm (in)	0.15 - 0.35 (0.0059 - 0.0138)

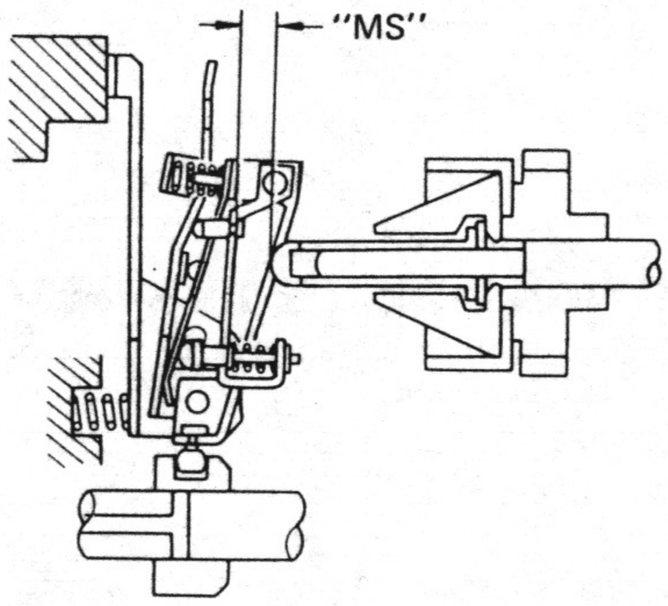


SEF499

Adjusting shim

Part number	Thickness mm (in)
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)

Item \ Applied engine	LD20	LD28
Dimension "MS" mm (in)	1.1 - 1.3 (0.043 - 0.051)	1.7 - 1.9 (0.067 - 0.075)



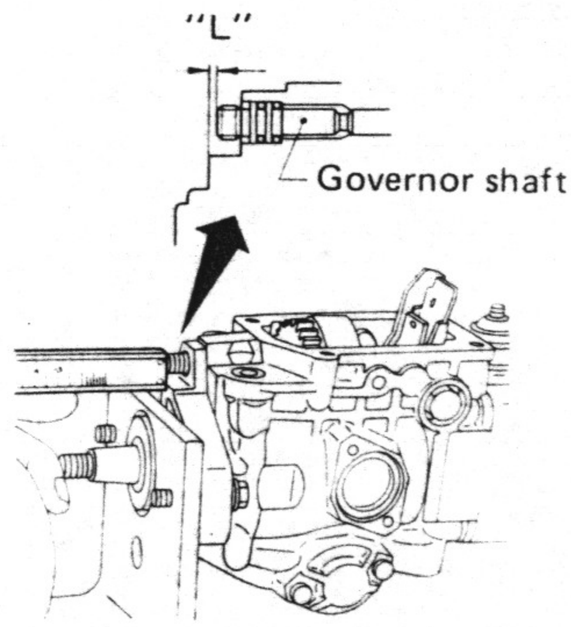
SEF640

Adjusting closing plug

Part number	LD20	LD28
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)	

Part number	LD20	LD28
19207-W1700	9.4 (0.370)	–
19207-W1701	9.6 (0.378)	–
19207-W1702	9.8 (0.386)	–
19207-W1703	10.0 (0.394)	–
19207-W1704	10.2 (0.402)	–

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



SEF500

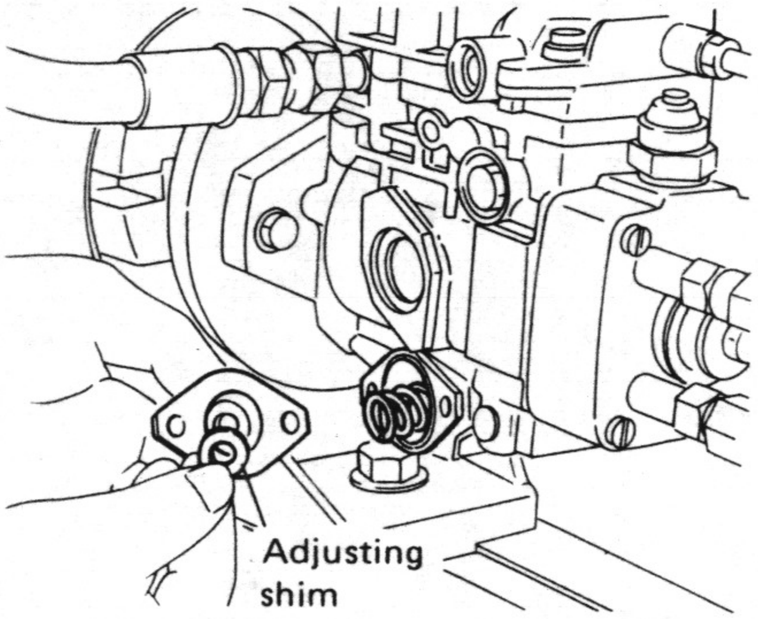
ADJUSTMENT VALUE ON INJECTION PUMP TESTER

Feed pump pressure

Fuel injection pump rpm	Specified pressure kPa (bar, kg/cm^2, psi)	
	LD20	LD28
800	–	353 - 412 (3.53 - 4.12, 3.6 - 4.2, 51 - 60)
900	294 - 353 (2.94 - 3.53, 3.0 - 3.6, 43 - 51)	–
1,800	500 - 559 (5.00 - 5.59, 5.1 - 5.7, 73 - 81)	579 - 637 (5.79 - 6.37, 5.9 - 6.5, 84 - 92)
2,300	628 - 686 (6.28 - 6.86, 6.4 - 7.0, 91 - 100)	–
2,500	–	726 - 785 (7.26 - 7.85, 7.4 - 8.0, 105 - 114)

Speed timer (Timer piston stroke)

Fuel injection pump rpm	Timer piston stroke mm (in)	
	LD20	LD28
900	1.1 - 1.7 (0.043 - 0.067)	–
1,200	–	2.5 - 3.1 (0.098 - 0.122)
1,800	4.6 - 5.8 (0.181 - 0.228)	4.9 - 6.1 (0.193 - 0.240)
2,300	6.9 - 7.8 (0.272 - 0.307)	7.7 - 8.6 (0.303 - 0.339)



Adjusting shim

Part number	Thickness mm (in)
16880-V0700	0.6 (0.024)
16880-V0701	0.7 (0.028)
16880-V0702	0.9 (0.035)
16880-V0703	1.0 (0.039)
16880-V0704	1.2 (0.047)

Fuel injection quantity

Setting condition of fuel injection pump	Fuel injection pump rpm	Standard fuel injection mℓ (Imp fl oz)/1,000 stroke	
		LD20	LD28
Start	100	More than 53 (1.87)	More than 50 (1.76)
Idle	325	8.9 - 11.9 (0.31 - 0.42)	–
	350	–	7.1 - 10.1 (0.25 - 0.36)
	500	Less than 4 (0.14)	Less than 4 (0.14)
Full-load	600	32 - 36 (1.13 - 1.27)	28.5 - 32.5 (1.00 - 1.14)
	900	33.3 - 34.3 (1.17 - 1.21)	–
	1,200	–	34.6 - 35.6 (1.22 - 1.25)
	2,300	31.4 - 35.4 (1.11 - 1.25)	28.8 - 32.8 (1.01 - 1.15)
Max. pump speed	2,700	7.5 - 13.5 (0.26 - 0.48)	8.7 - 14.7 (0.31 - 0.52)
	2,800	Less than 6 (0.21)	Less than 5 (0.18)
Fuel overflow (10 sec at 1,000 rpm)		31 - 75 mℓ (1.09 - 2.64 Imp fl oz)	48 - 92 mℓ (1.69 - 3.24 Imp fl oz)

INJECTION NOZZLE ASSEMBLY

Type	Closed, throttle type
Injection angle	0°
Initial injection pressure kPa (bar, kg/cm², psi)	
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)

Adjusting shim

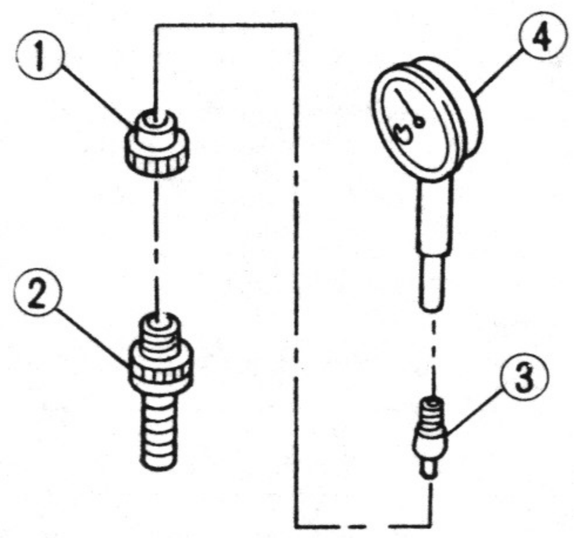
Part number	Thickness mm (in)
16613-V0700	0.50 (0.0197)
16613-V0702	0.54 (0.0213)
16613-V0704	0.58 (0.0228)
16613-V0706	0.62 (0.0244)
16613-V0708	0.66 (0.0260)
16613-V0710	0.70 (0.0276)
16613-V0712	0.74 (0.0291)
16613-V0714	0.78 (0.0307)
16613-V0716	0.82 (0.0323)
16613-V0718	0.86 (0.0339)
16613-V0720	0.90 (0.0354)
16613-V0722	0.94 (0.0370)
16613-V0724	0.98 (0.0386)
16613-V0760	1.00 (0.0394)

TIGHTENING TORQUE

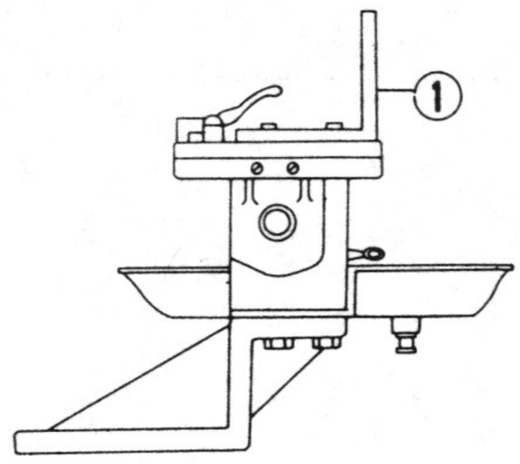
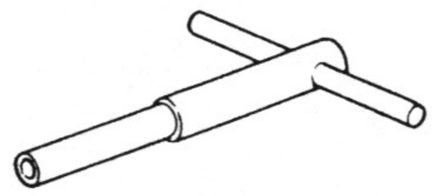
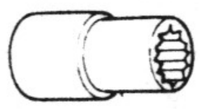
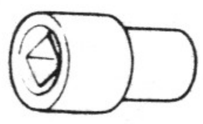
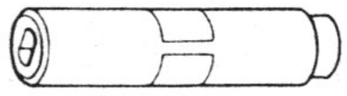
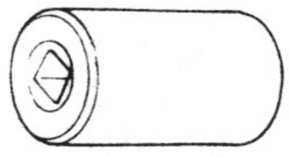
Unit	N·m	kg-m	fl-lb
Distributor head to pump housing	11 - 13	1.1 - 1.3	8 - 9
Plug to distributor head	59 - 78	6.0 - 8.0	43 - 58
Delivery valve to distributor head	44 - 54	4.5 - 5.5	33 - 40
Pivot pin to pump housing	10 - 13	1.0 - 1.3	7 - 9
Regulating valve to pump housing	8 - 9	0.8 - 0.9	5.8 - 6.5
Control shaft to control lever	7 - 10	0.7 - 1.0	5.1 - 7.2
Injection pump pulley nut	59 - 69	6.0 - 7.0	43 - 51
Injection nozzle to engine	16 - 21	1.6 - 2.1	12 - 15
Injection nozzle to tube	22 - 25	2.2 - 2.5	16 - 18
Spill tube	15 - 18	1.5 - 1.8	11 - 13
Feed pump cover to pump housing	2 - 3	0.2 - 0.3	1.4 - 2.2
Speed timer cover to pump housing	6 - 8	0.6 - 0.8	4.3 - 5.8
Governer shaft lock nut	25 - 29	2.5 - 3.0	18 - 22
Overflow valve	20 - 25	2.0 - 2.5	14 - 18
Maximum and idle speed adjusting screw lock nut	6 - 9	0.6 - 0.9	4.3 - 6.5
Full load adjusting screw lock nut	6 - 9	0.6 - 0.9	4.3 - 6.5
Fuel cut solenoid valve	20 - 25	2.0 - 2.5	14 - 18
Plug bolt	14 - 20	1.4 - 2.0	10 - 14

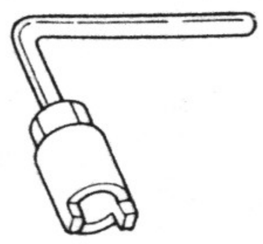
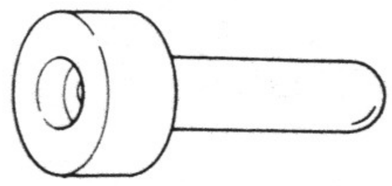
SPECIAL SERVICE TOOLS

Adjusting device on car

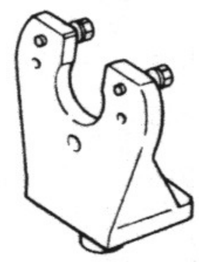
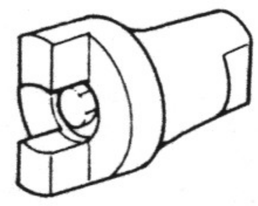
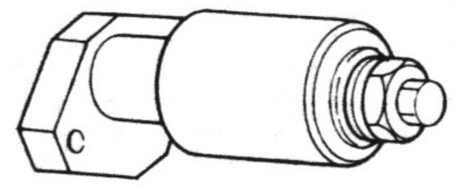
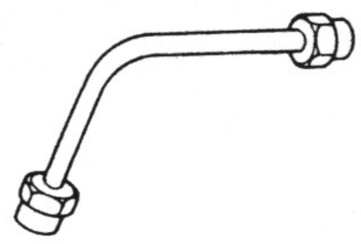
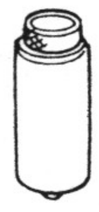
Tool number	Tool name	
KV11229352 ① KV11229350 ② KV11229360 ③ KV11229370 ④ KV11254410	Measuring device (Set length of plunger spring) Holder Nut Pin Dial gauge	

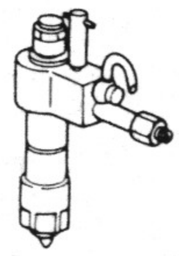
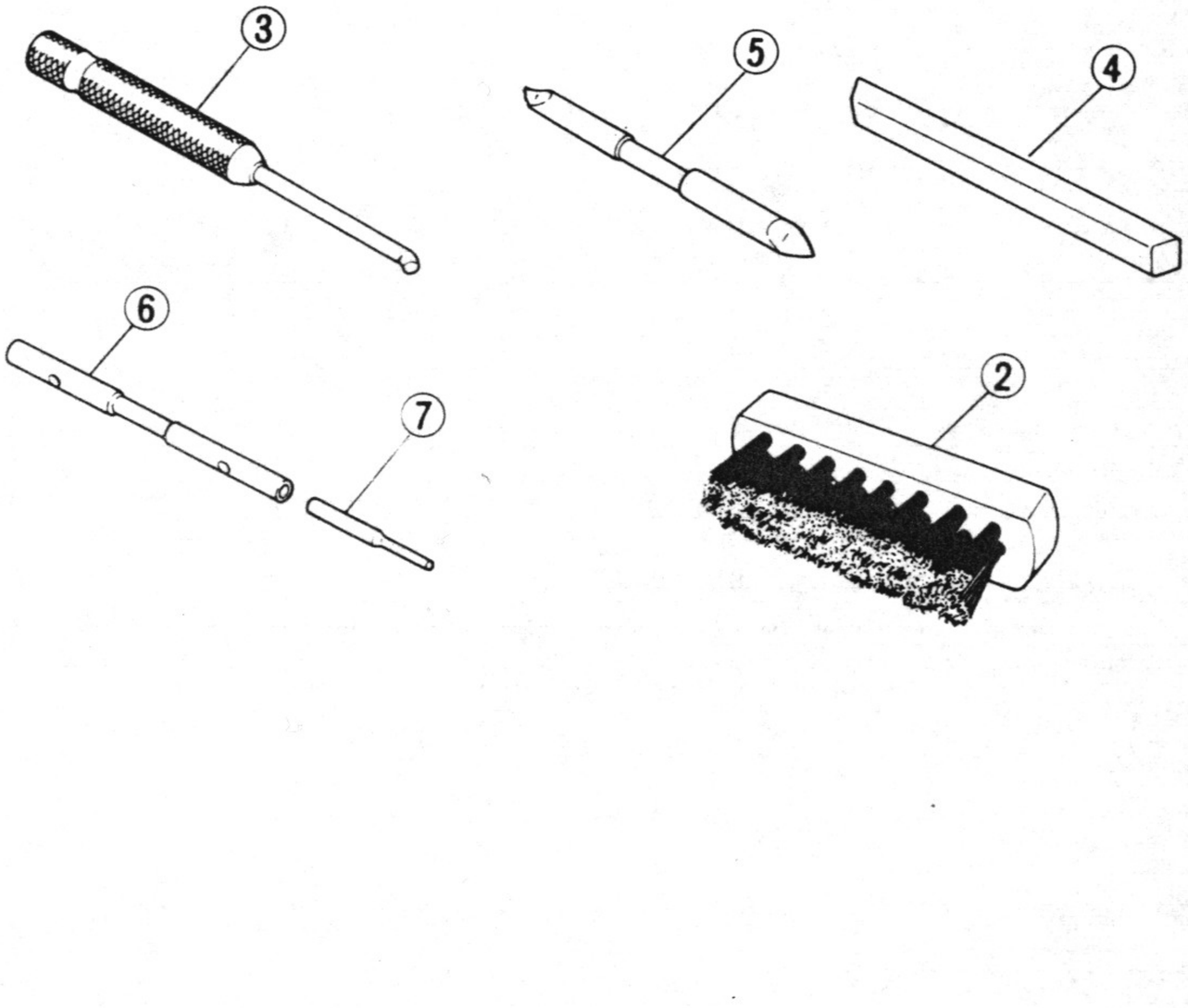
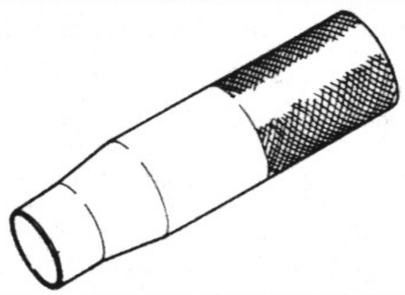
Disassembling and assembling tools

KV11294005 ① KV11244260	Universal vice assembly Injection pump attaching plate	
KV11229072	Insert device	
KV11214110	Socket wrench for delivery valve	
KV11214270	Socket wrench for governor pivot bolt	
KV11214260	Socket wrench for regulating valve	
KV11214250	Socket wrench for distributor head plug	

Tool number	Tool name
KV11215262	Governor shaft adjusting device 
KV11229540	Feed pump holder 
KV11229852 ① KV11229110 ② KV11229820 ③ KV11229830	"MS" measuring device set Block gauge Dummy shaft Rod 
KV11229042	"K" & "KF" measuring device 

Adjusting device on pump tester

KV11281036	Fixing stand 
KV11242452	Coupling 
KV11282815	Measuring device (Timer advance angle) 
KV11205032	Injection pipe [840 mm (33.07 in)] 
KV11229462	Extractor (Disassembling of regulating valve) 
KV11229522	Insert device (Assembling of regulating valve) 

Tool number	Tool name
KV11257802	Nozzle holder (Bosch type EF8511-9A) 
KV11257800	Nozzle (Bosch type DN 12SD12T) 
KV11289004 ① KV11290012 ② KV11290110 ③ KV11290122 ④ KV11290140 ⑤ KV11290150 ⑥ KV11290210 ⑦ KV11290220	Nozzle cleaning kit Box Brush Nozzle oil sump scraper Nozzle needle tip cleaner Nozzle seat scraper Nozzle holder Nozzle hole cleaning needle 
KV11292010	Nozzle centering device 

SECTION EG

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ENGINE SERIAL NUMBER LOCATION . . EG-2
TIGHTENING TORQUE OF STANDARD BOLT EG-3

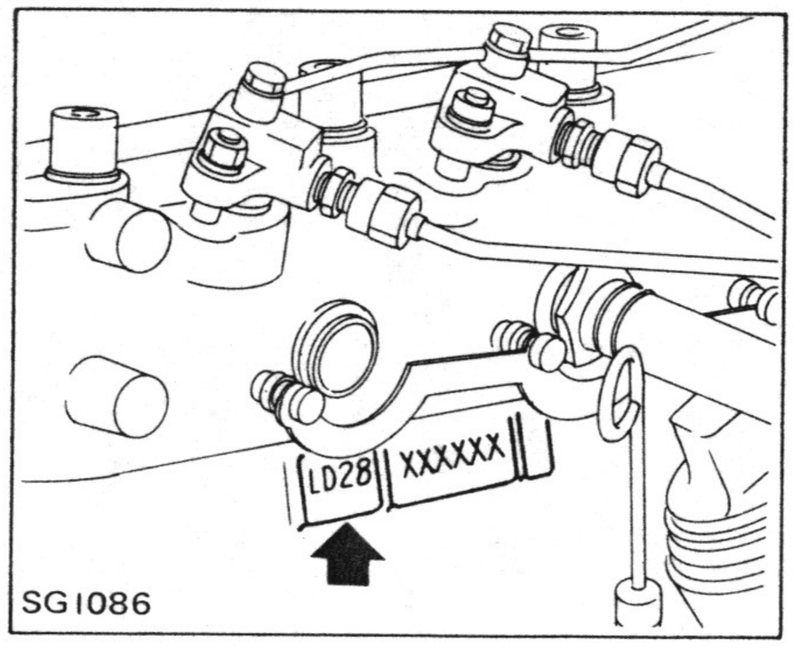
SPECIFICATIONS

Engine model		LD28	LD20
Cylinder arrangement		In-line	
Number of cylinders		6	4
Valve arrangement		O.H.C.	
Bore x stroke	mm (in)	84.5 x 83.0 (3.327 x 3.268)	85.0 x 86.0 (3.346 x 3.386)
Displacement	cm^3 (cu in)	2,792 (170.37)	1,952 (119.11)
Firing order		1-5-3-6-2-4	1-3-4-2
Number of piston rings	Compression	2	
	Oil	1	
Number of main bearings		7	5
Compression ratio		22.0	22.2
Cetane number of diesel fuel		More than 45	

ENGINE SERIAL NUMBER LOCATION

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

LD28 XXXXXX
- XXXXXX — Serial No.
- LD28 — Engine model (LD20 or LD28)



TIGHTENING TORQUE OF STANDARD BOLT

Grade	Nominal size	Diameter mm	Pitch mm	Tightening torque		
				N·m	kg-m	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. **Special parts are excluded.**
2. **This standard is applicable to bolts having the following marks embossed on the bolt head.**

Grade	Mark
4T	4
7T	7
9T	9

ENGINE MECHANICAL



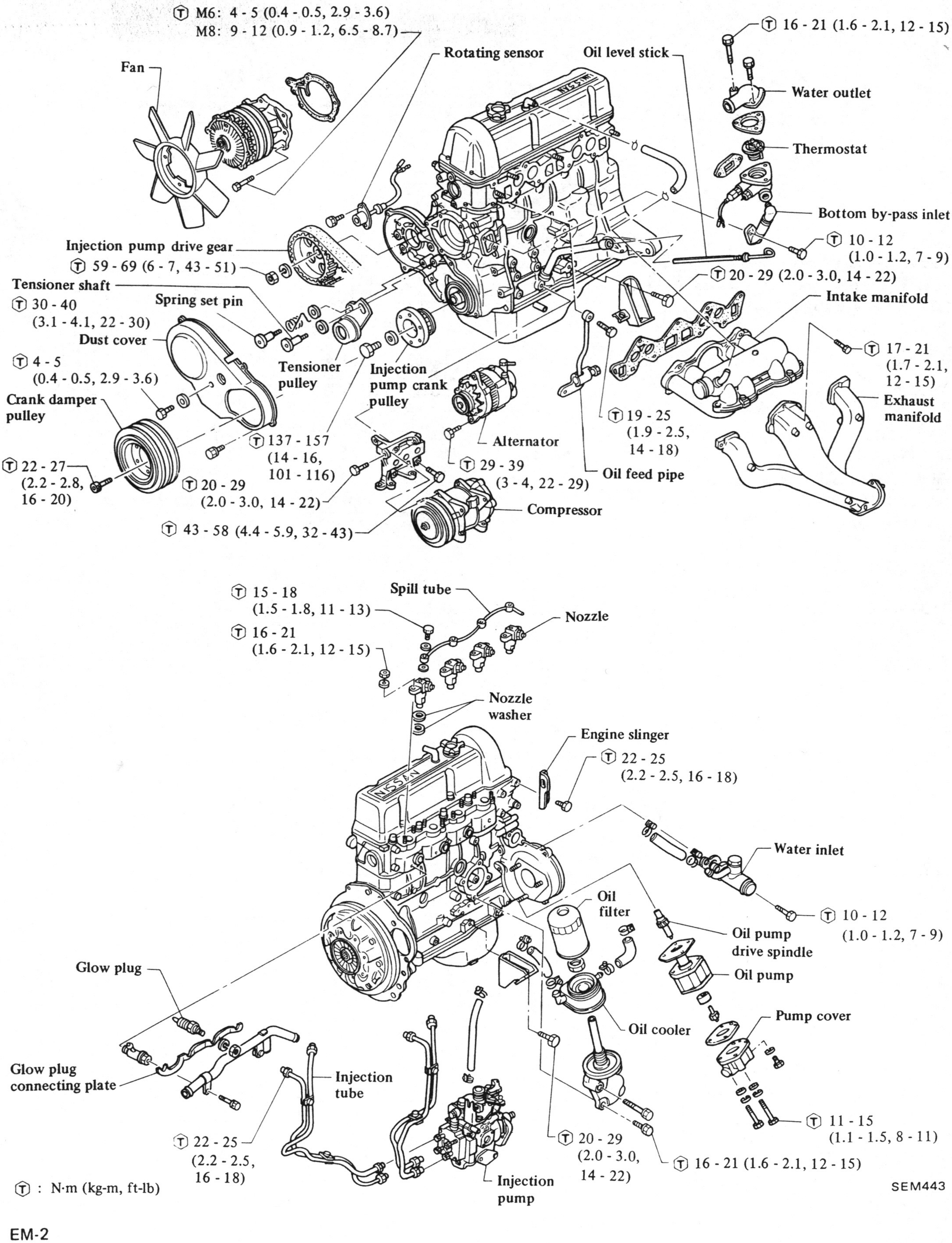
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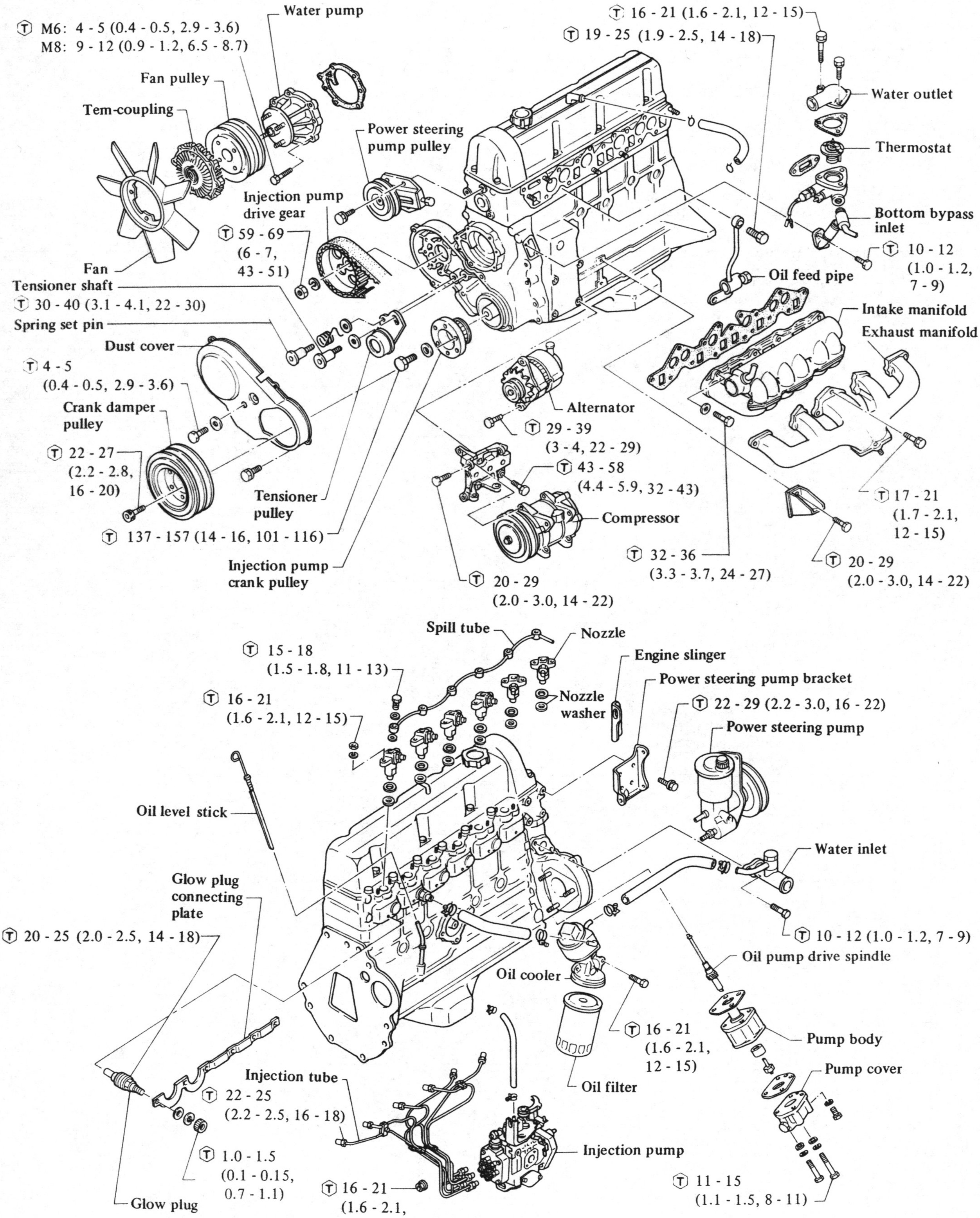
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ENGINE DISASSEMBLY ..... EM- 6
PRECAUTIONS ..... EM- 6
DISASSEMBLY ..... EM- 6
DISASSEMBLING PISTON AND CONNECTING ROD ..... EM- 9
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ENGINE COMPONENT (Outer parts)

LD20 engine



LD28 engine

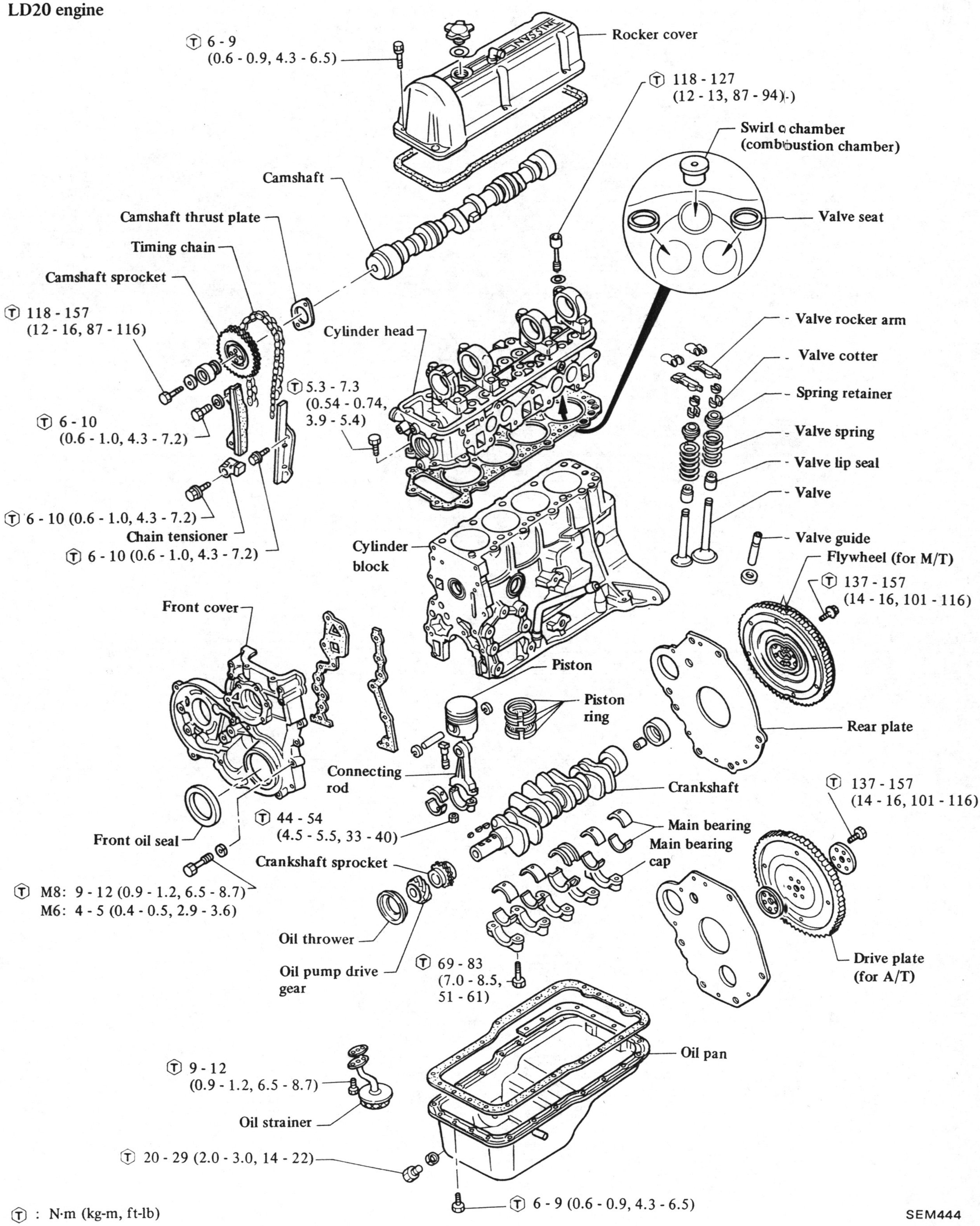


Ⓣ : N·m (kg-m, ft-lb)

SEM267

ENGINE COMPONENT (Body parts)

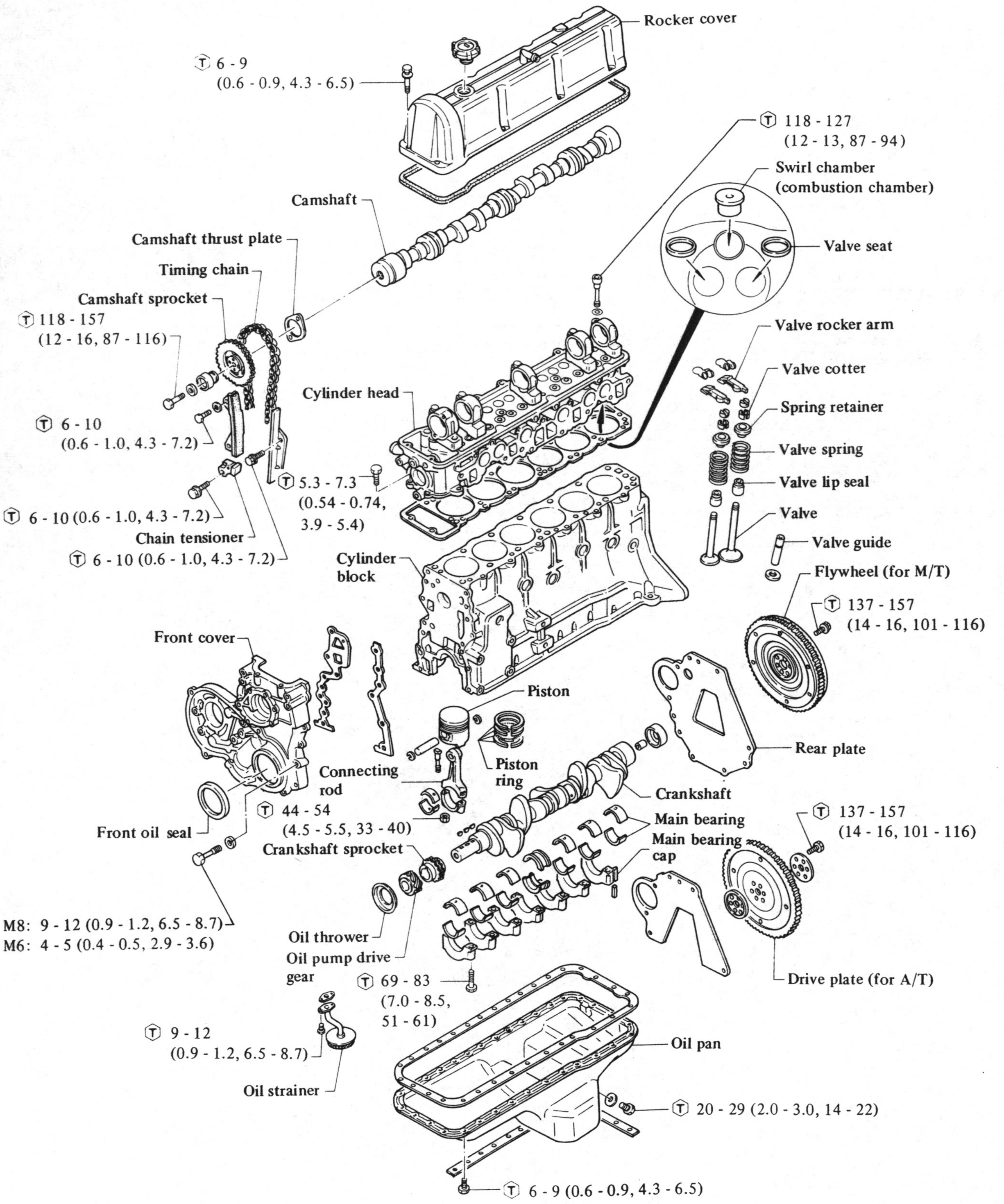
LD20 engine



Ⓣ : N·m (kg-m, ft-lb)

SEM444

LD28 engine



T : N·m (kg-m, ft-lb)

SEM268

ENGINE DISASSEMBLY

PRECAUTIONS

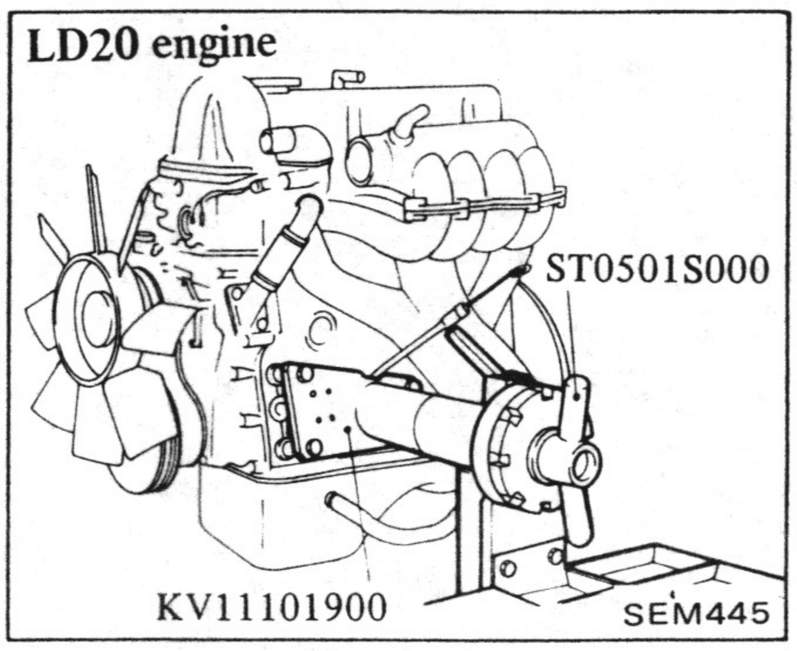
Arrange the disassembled parts on the parts stand in accordance with their assembled locations, sequence, etc., so that the parts will be re-assembled in their original locations. Place mating marks on the parts if necessary.

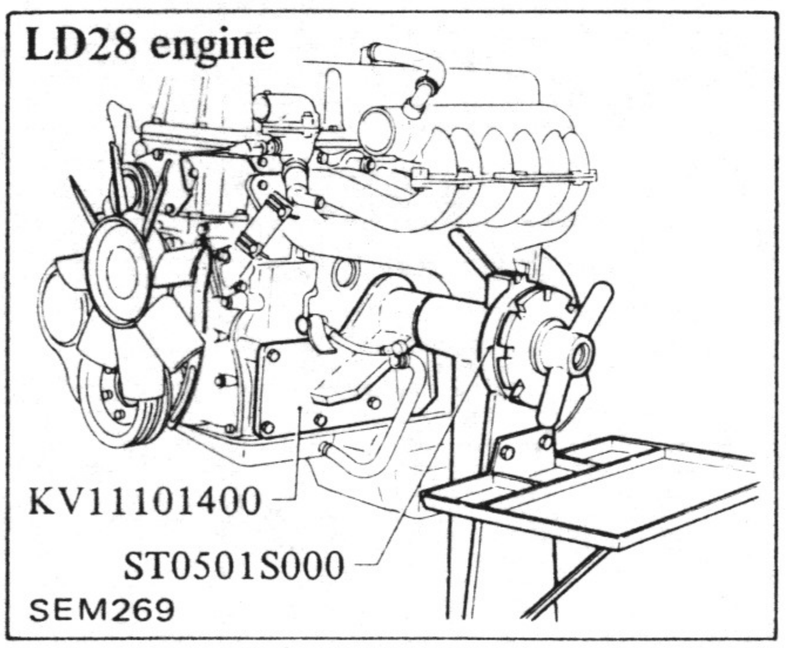
DISASSEMBLY

MOUNTING ENGINE ON WORK STAND

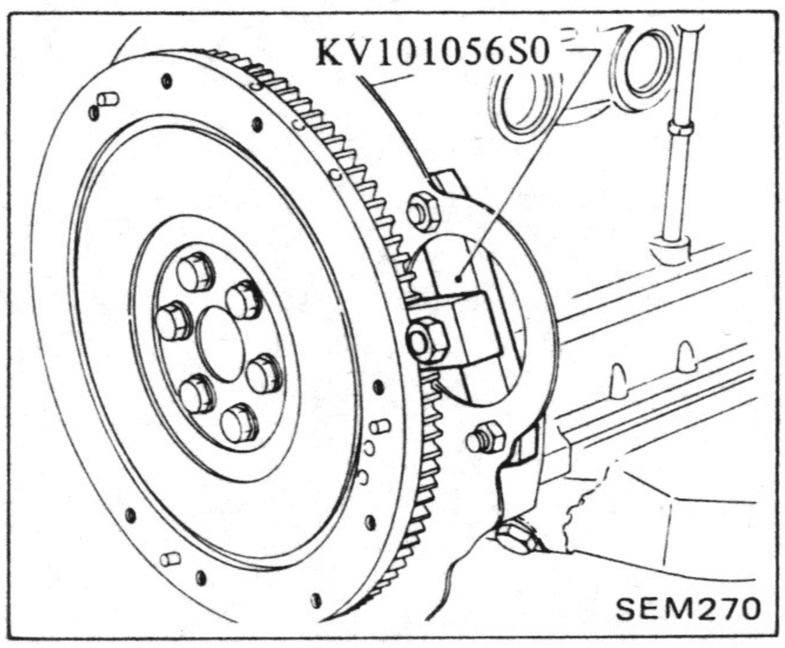
1. Remove rear and left side parts.
- Starter motor (on right side of engine)
- Transmission assembly
- Clutch cover assembly (M/T)
- Engine mounting bracket
- Alternator assembly and fan belt
- Alternator bracket (on air conditioner equipped models, one bracket holds both alternator and compressor)

2. Install engine attachment to cylinder block. Then, mount the engine on the work stand.





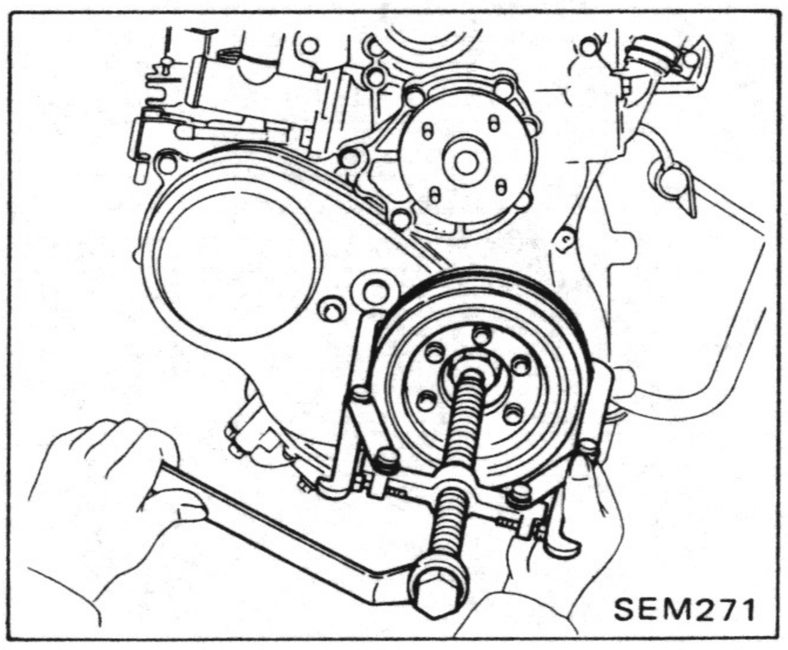
3. Install Tool, to prevent crankshaft rotation.



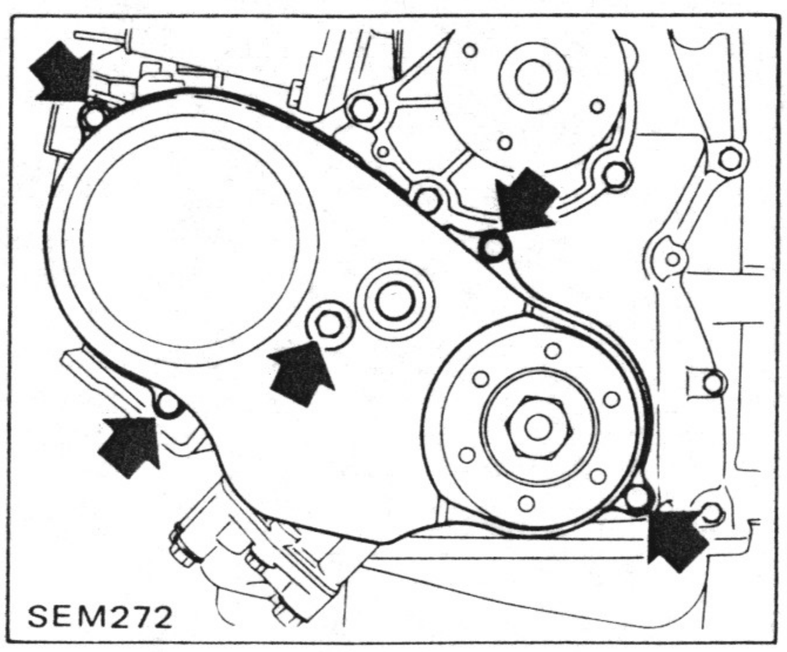
4. Drain engine oil and coolant.

REMOVING OUTER PARTS

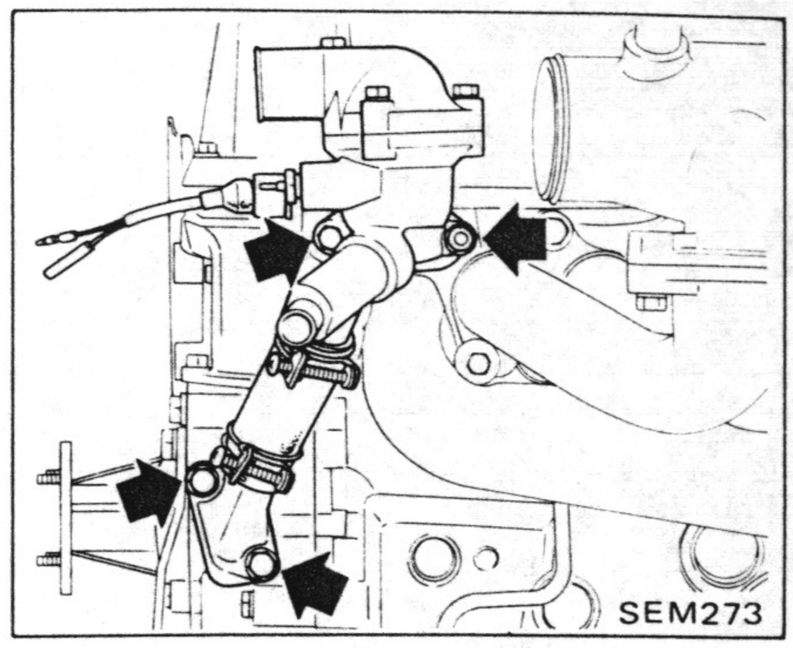
1. Remove front side engine parts:
- Fan, tem-coupling and fan pulley
- Alternator adjusting bar
- Remove crank damper pulley by lightly tapping around it. **If it is difficult to remove, use a puller.**



- Pulley bracket with idler pulley (If so equipped)
- Front dust cover

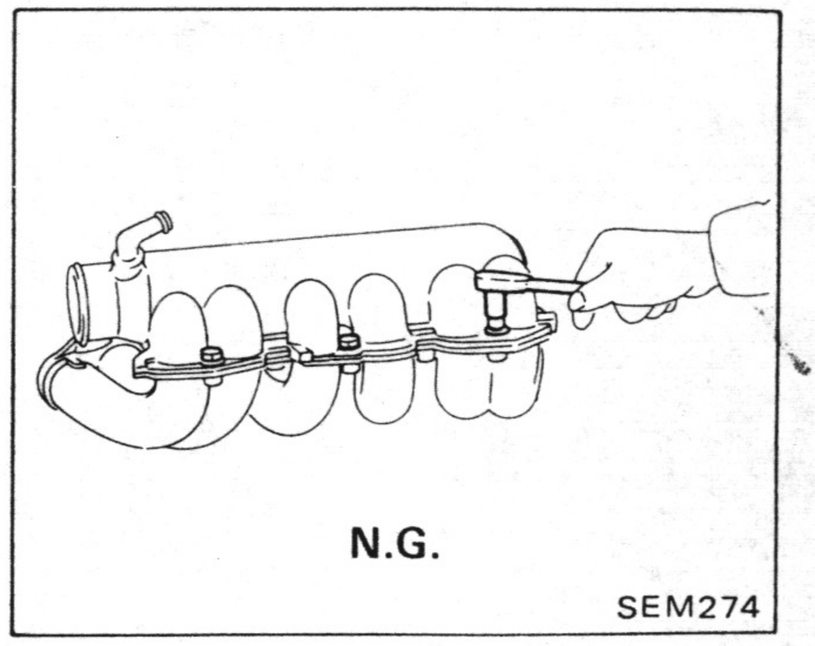


2. Remove left side engine parts.
- Thermostat housing and bottom bypass inlet with hose.

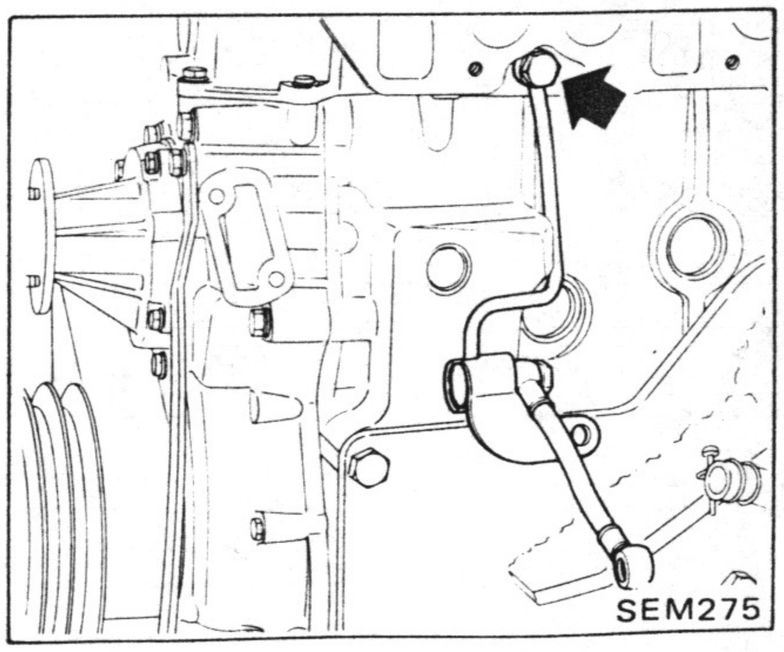


- Intake, exhaust manifold and engine slinger

Do not separate the intake manifold.

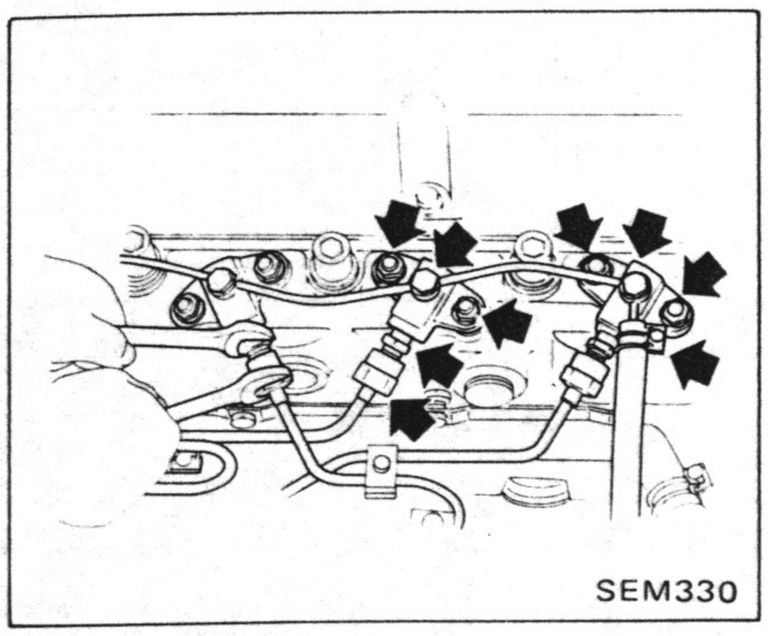


- Oil feed pipe



- Oil return hose from oil pan

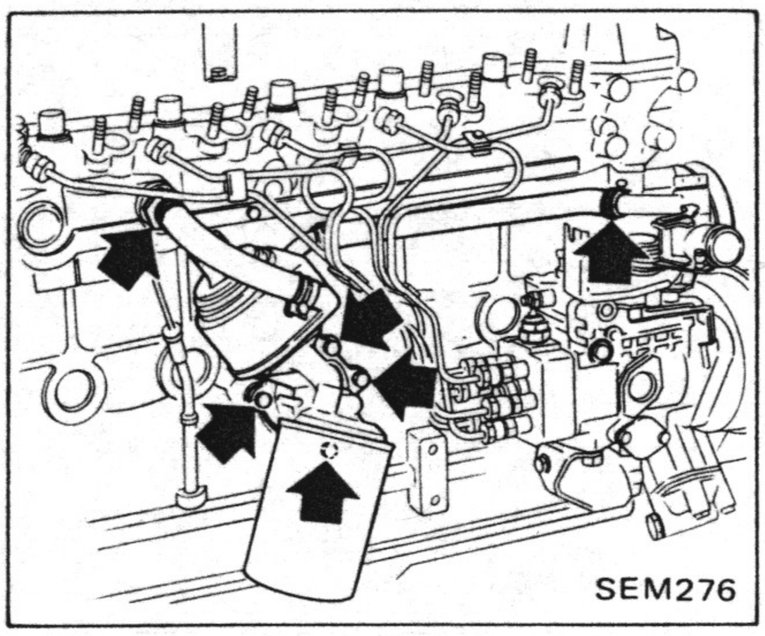
3. Remove right side engine parts.
- Spill tube
- Fuel return hose
- Injection tubes at nozzle side
- Injection nozzles
- Nozzle washers


SEM330

Plug nozzle holes to prevent entry of dust and dirt.

- Oil cooler and coolant hoses with oil filter

Above parts can be removed only after injection pump has been detached (LD20 engine).

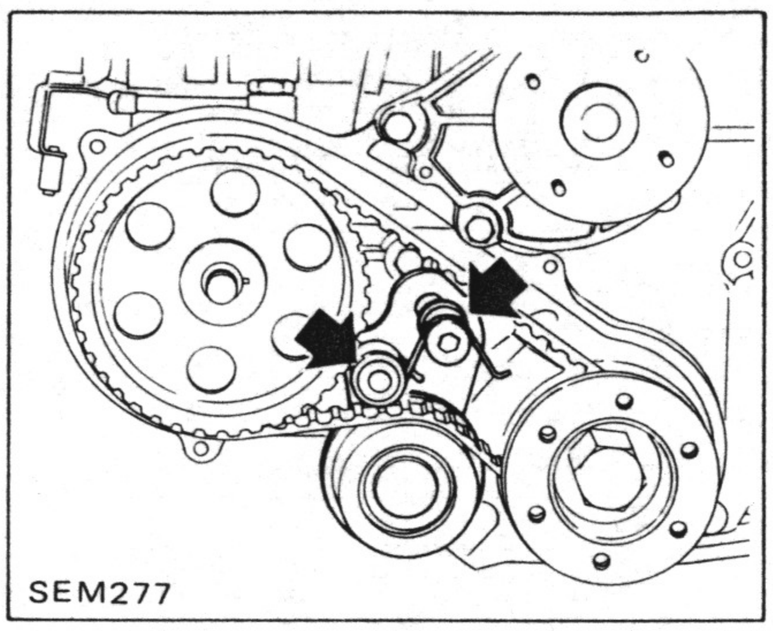

SEM276

- Water inlet
- Oil level stick
- Engine mounting bracket
- Engine slinger (If power steering is equipped, remove power steering oil pump bracket.)
- Oil pump

REMOVING BODY PARTS

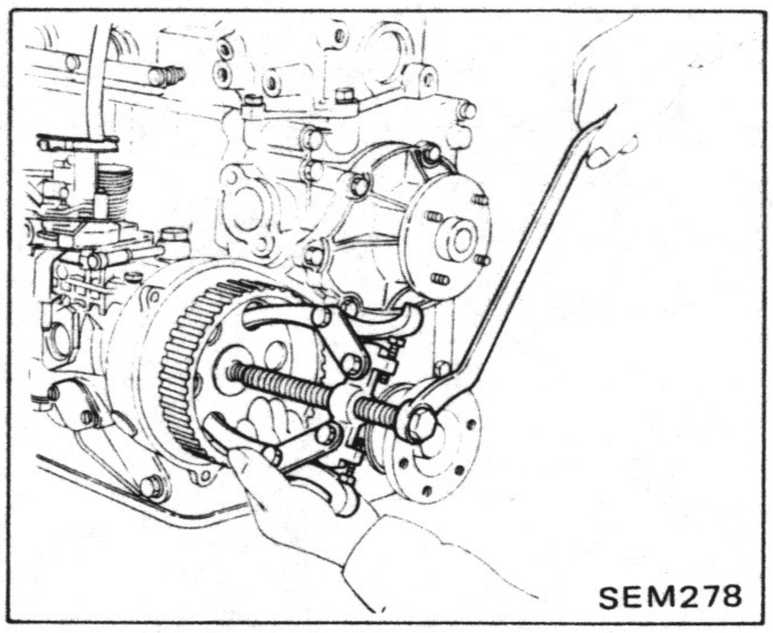
1. Remove oil pan and oil strainer.
2. Injection pump

(1) Remove tensioner shaft and spring set pin, then remove tensioner pulley. (Tensioner pulley is fastened with a tensioner shaft and spring pin.)

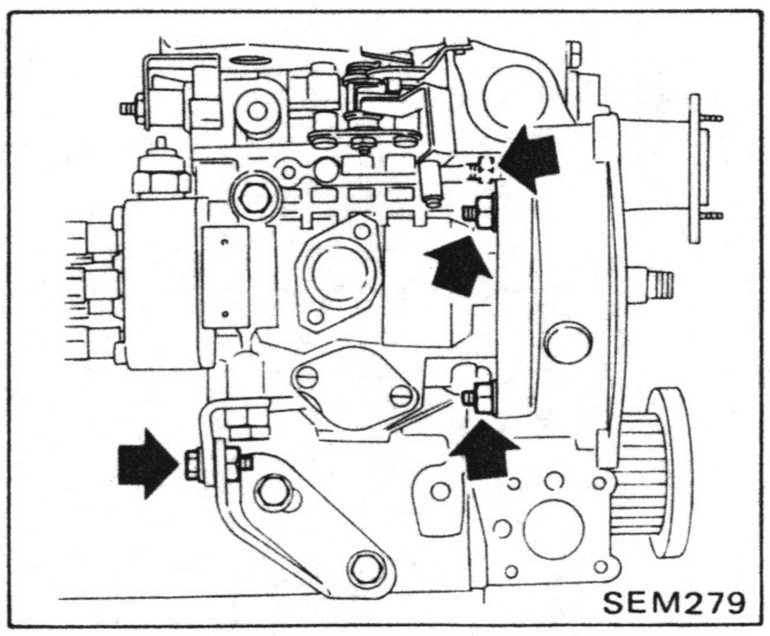

SEM277

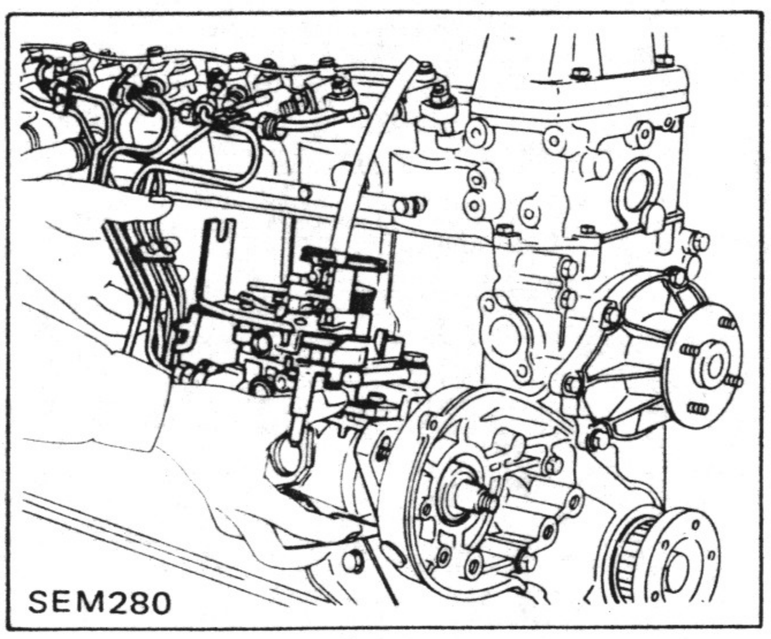
(2) Remove injection pump drive belt.
(3) Remove injection pump drive gear.

Do not remove drive shaft nut as this will cause drive gear to pop out.


SEM278

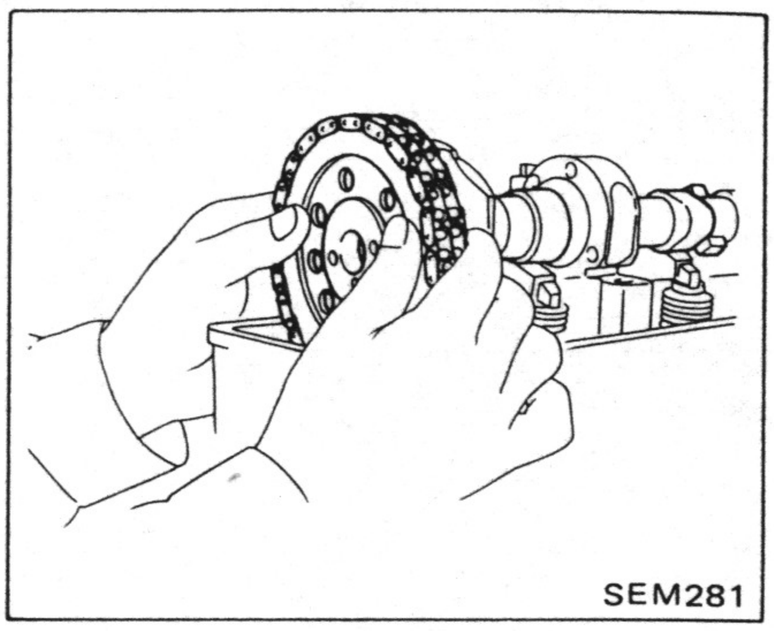
(4) Remove injection pump assembly with injection tubes.


SEM279


SEM280

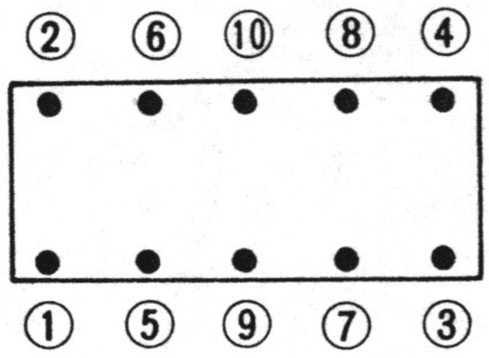
3. Remove valve rocker cover.
4. Cylinder head assembly

(1) Remove camshaft bolt.
(2) Remove camshaft sprocket and slowly lower timing chain.


SEM281

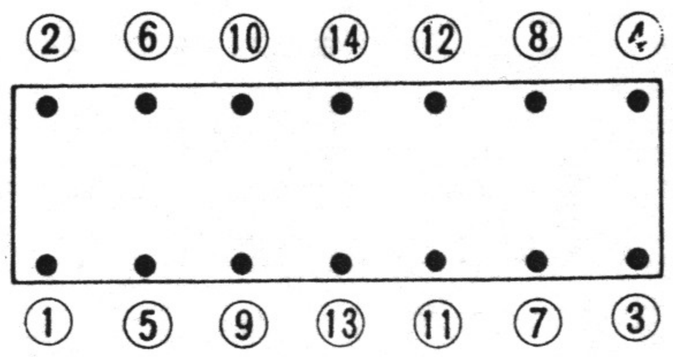
(3) Remove bolts securing cylinder head to front cover.
(4) Loosen cylinder head bolts in the sequence as shown.

LD20 engine



SEM446

LD28 engine



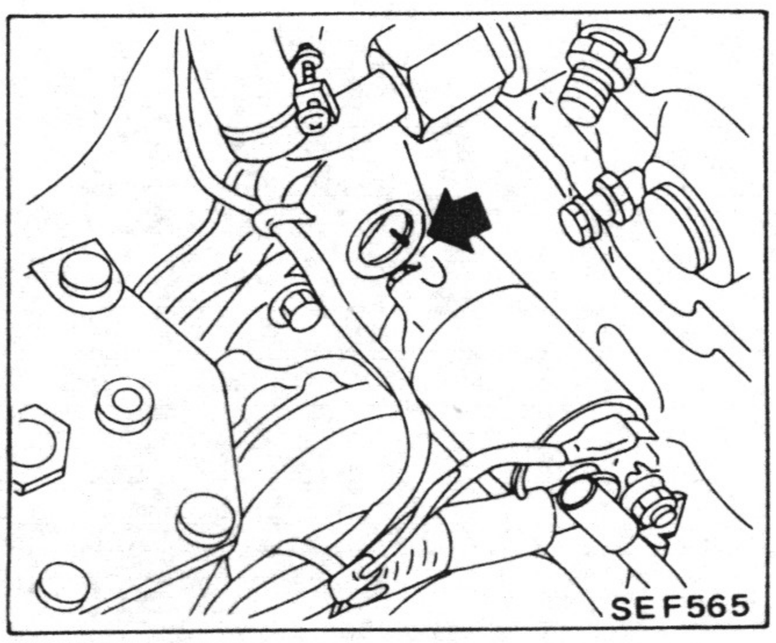
EM708

Gradually loosen cylinder head bolts in two or three stages.

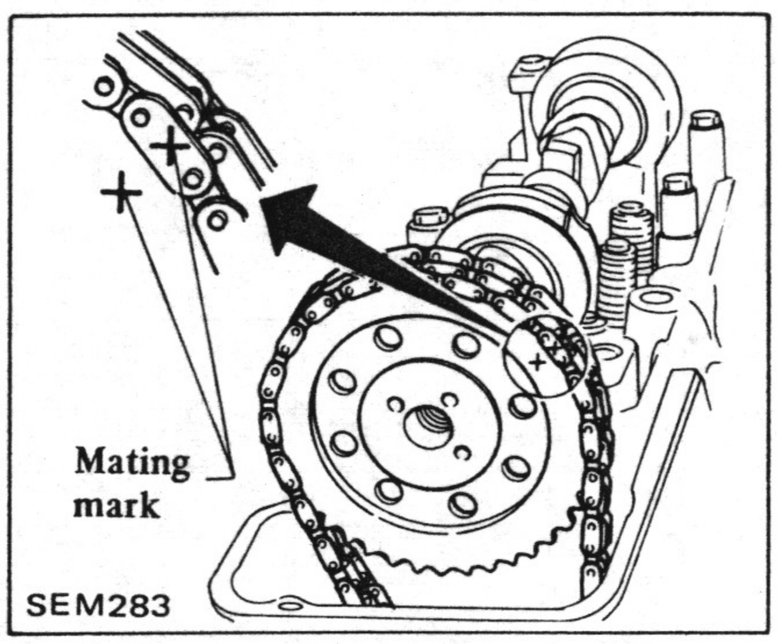
(5) Remove cylinder head.

When removing cylinder head from engine installed on car, follow the instructions below.

a. Remove blind plug from rear plate. Rotate crankshaft until timing marks on flywheel and rear plate are properly aligned. Make sure that No.1 piston is at T.D.C. on its compression stroke.

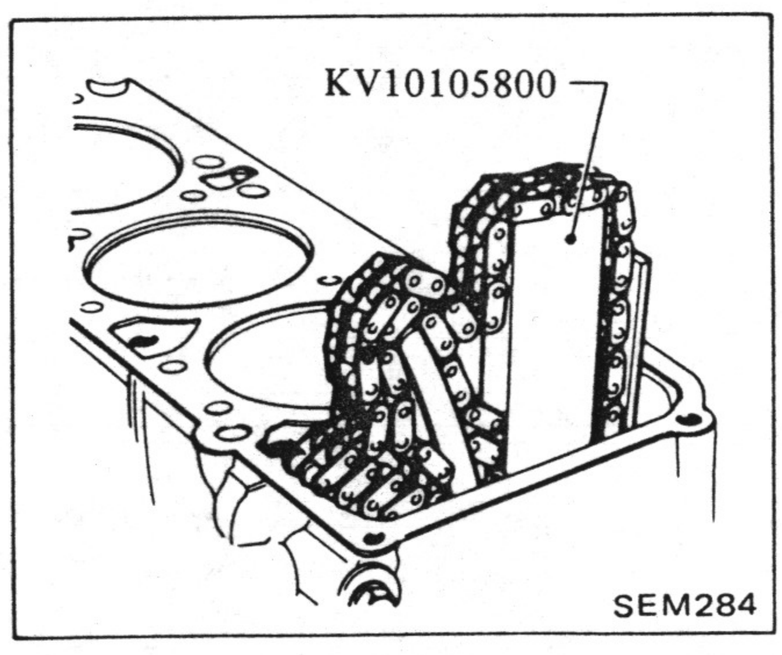

SEF565

b. To facilitate assembly operation, scribe a mark on timing chain and camshaft sprocket prior to removal.



SEM283

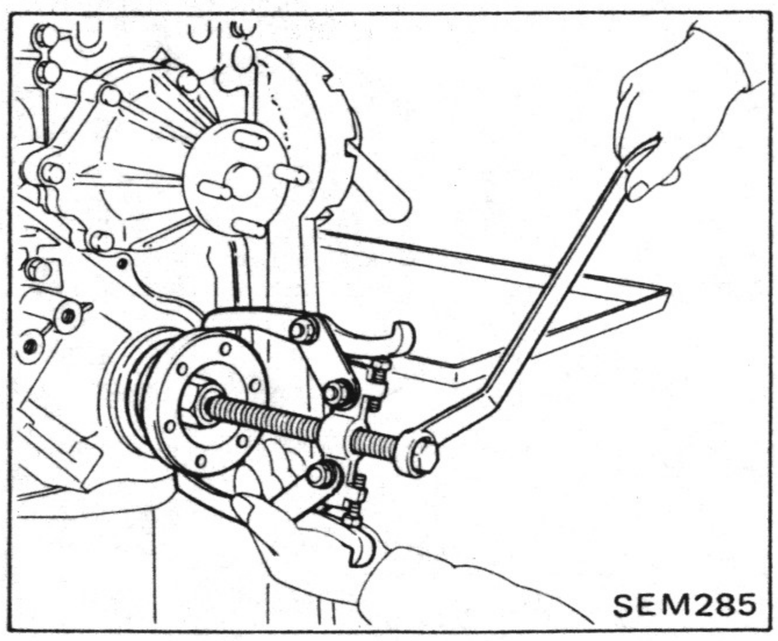
c. Support timing chain by placing Tool between timing chains.



SEM284

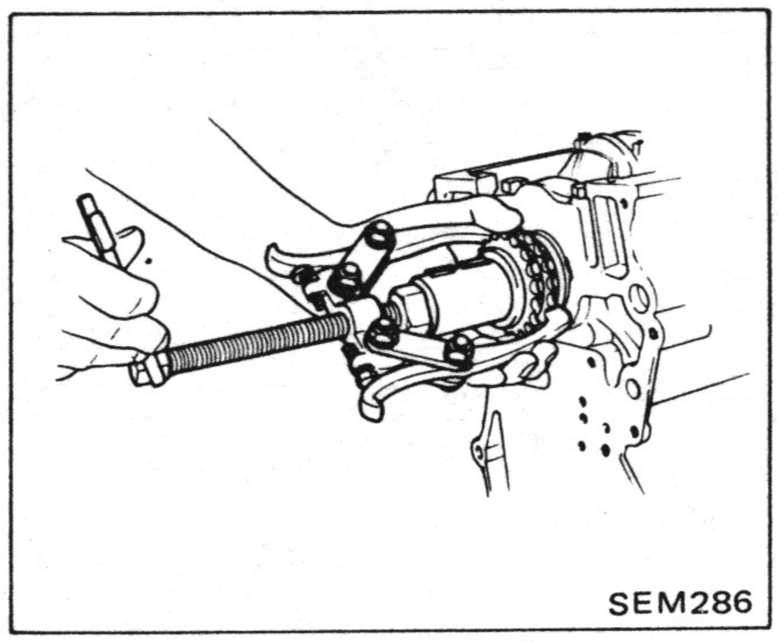
d. Install cylinder head, and then install camshaft sprocket by aligning marks on it and timing chain.

5. Remove front side parts.
Loosen bolt and pull out injection pump drive crank pulley.

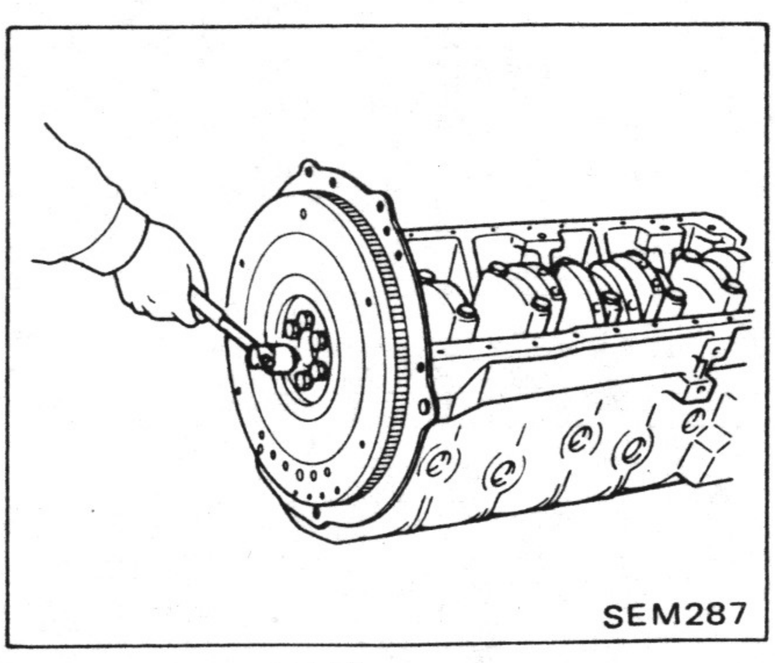

SEM285

- Water pump
- Front cover
- Timing chain
- Chain tensioner and chain guides
- Oil thrower, oil pump drive gear from crankshaft

If it is hard to extract crankshaft, use a suitable puller.

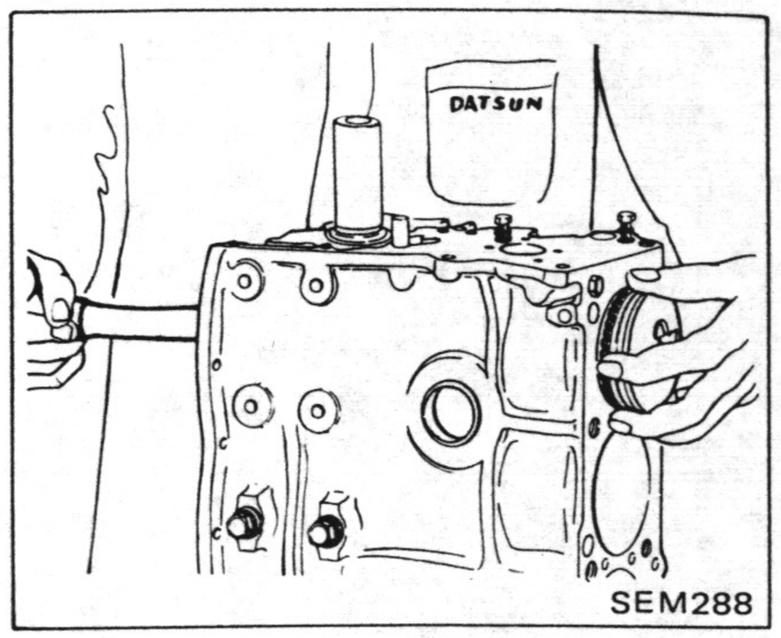

SEM286

6. Remove flywheel (M/T) or drive plate (A/T).


SEM287

WARNING:
When removing flywheel, be careful not to drop it.

7. Piston and connecting rod assembly
(1) Remove connecting rod bearing cap with bearing.
(2) Push out piston with connecting rod toward cylinder head side.

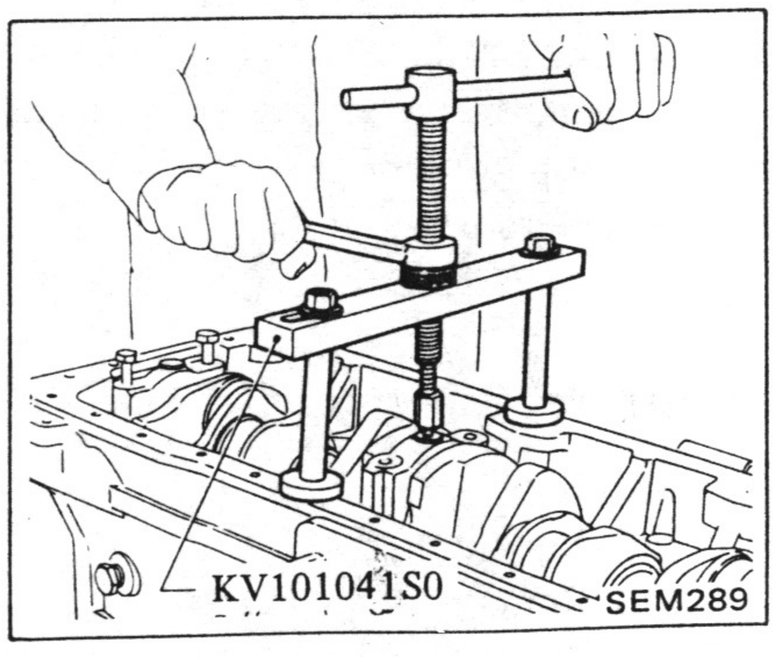


SEM288

a. Piston can be easily removed by scraping carbon off top face of cylinder with a scraper.
b. Numbers are stamped on connecting rod and cap corresponding to each cylinder. Care should be taken to avoid wrong combination including bearing.

8. Crankshaft
(1) Remove main bearing cap with bearing.

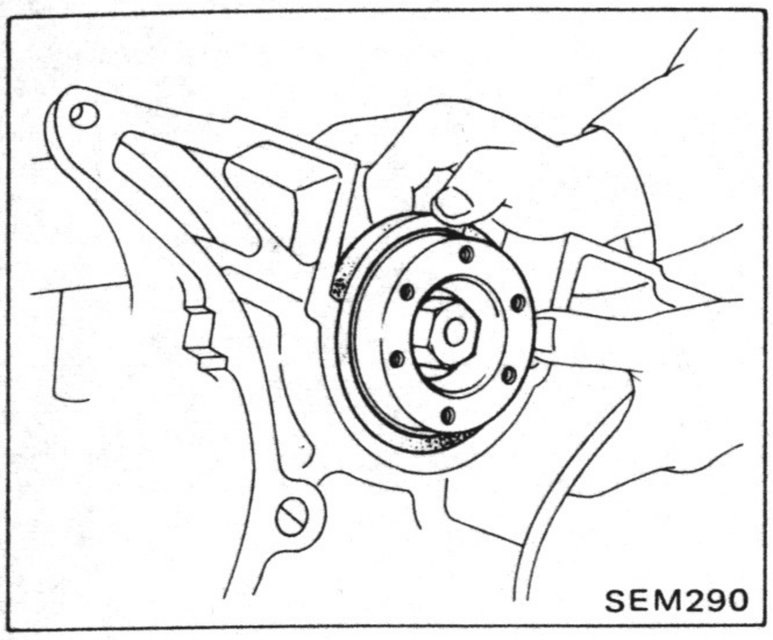
a. When loosening main bearing cap bolts, loosen from outside in sequence.
Do not completely loosen bolts in one step.
Instead use two or three steps for this procedure.
b. Remove center and rear main bearing caps using Tool.



SEM289

c. Keep them in order.

(2) Remove rear oil seal.


SEM290

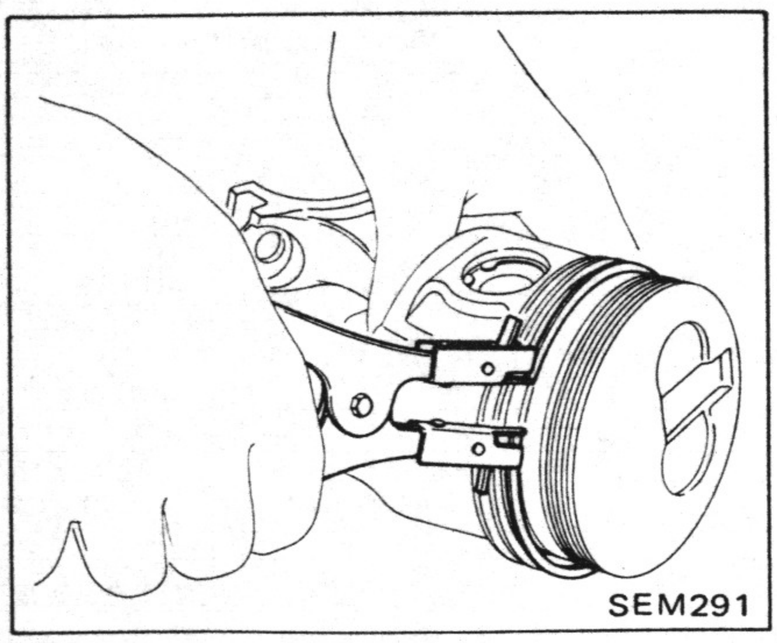
When removing rear oil seal without removing main bearing cap, pry it off with a screwdriver so as not to damage crankshaft.

(3) Remove crankshaft.
(4) Remove main bearing from the side of the block.

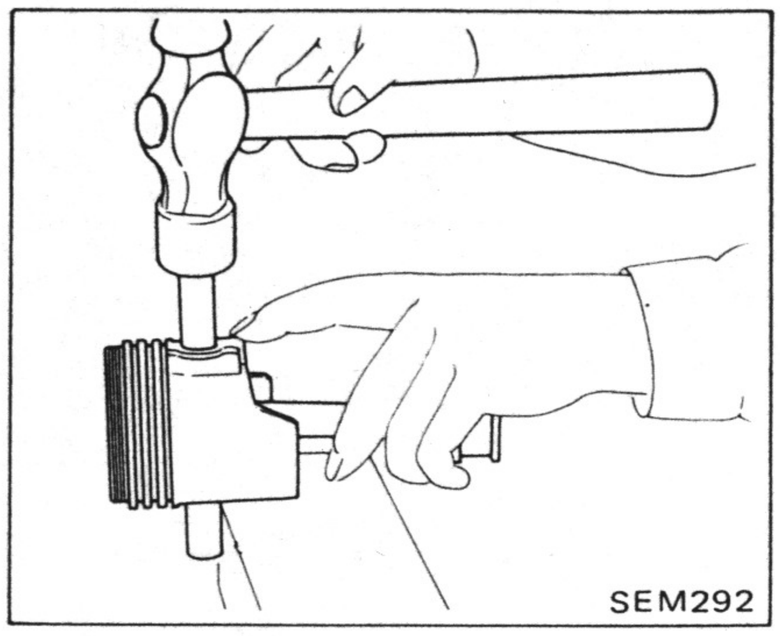
DISASSEMBLING PISTON AND CONNECTING ROD

1. Remove top, second piston rings and rails with a ring remover and remove oil ring expander by hand.

When removing piston rings, be careful not to scratch piston.

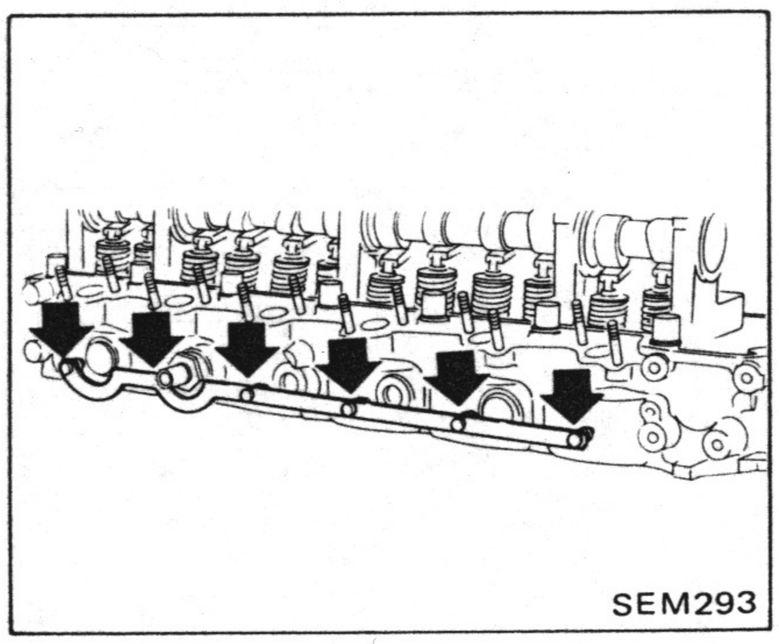

SEM291

2. Heat piston to approximately 60 to 70°C (140 to 158°F), using heater or hot water, and take out piston pin with a suitable drift.

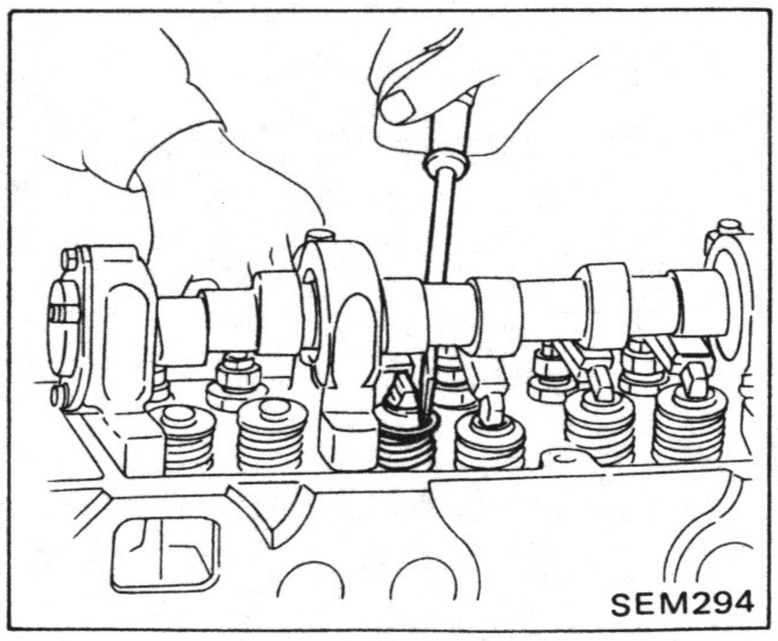

SEM292

DISASSEMBLING CYLINDER HEAD

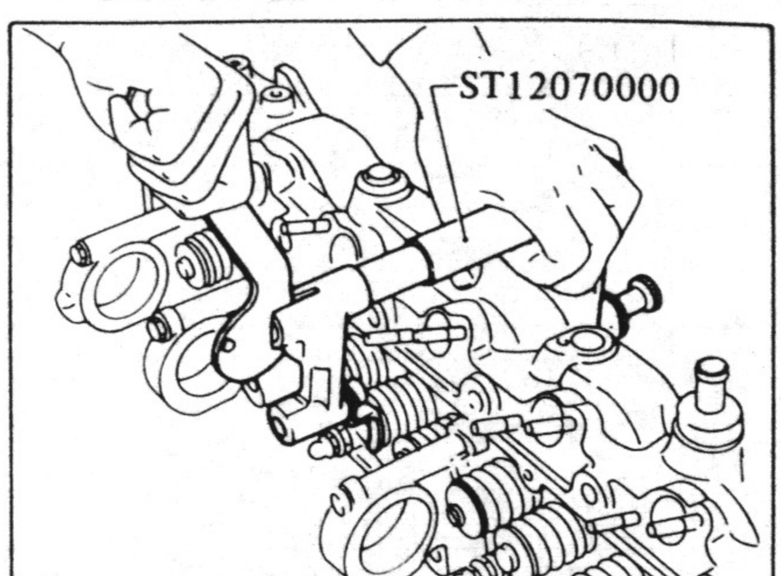
1. Remove glow plug connecting plate and glow plugs.


SEM293

2. Remove valve rocker spring.
3. Loosen valve rocker pivot lock nut and set cam nose to upper position, then remove rocker arm by pressing down on valve spring.


SEM294

4. Remove camshaft.
5. Remove valves, valve springs and relating parts using Tool.



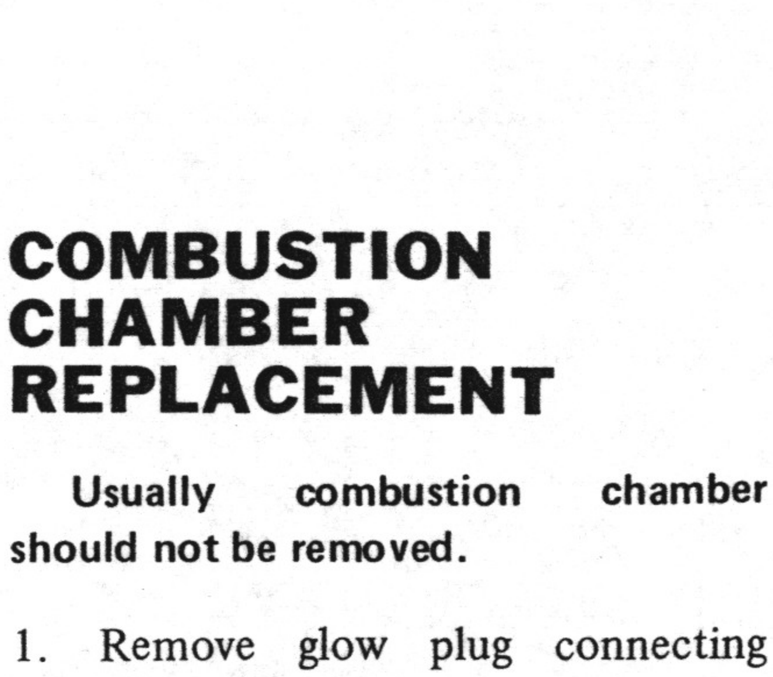
SEM586

- **Keep the disassembled parts in order.**
- **Do not remove rocker pivot bushing from cylinder head.**
- **Do not remove camshaft bearing from cylinder head.**

COMBUSTION CHAMBER REPLACEMENT

Usually combustion chamber should not be removed.

1. Remove glow plug connecting plate and glow plugs.
2. Remove combustion chamber so that cylinder head will not be damaged.


SEM587

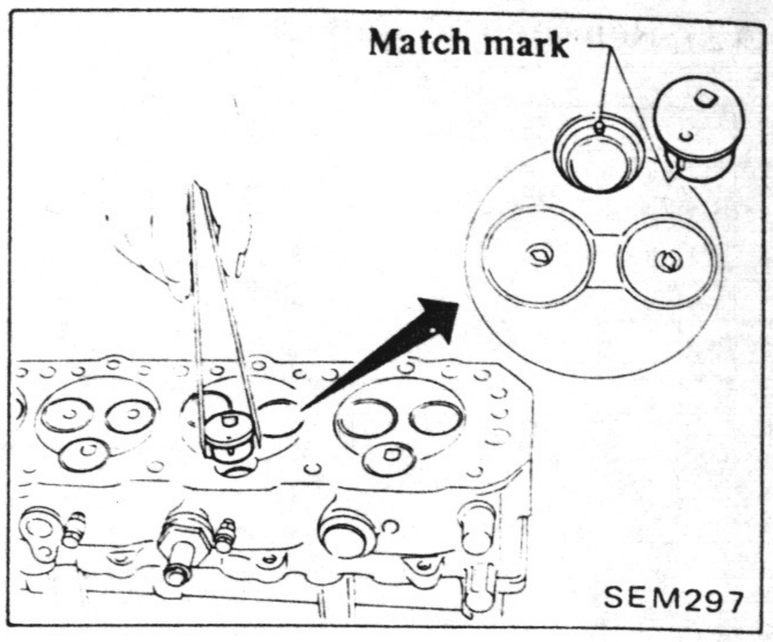
Be careful not to scratch inside of nozzle hole.

Install combustion chamber.

1. Cool combustion chamber with dry ice for approximately 5 to 10 minutes.

WARNING:
Do not touch cooled combustion chamber with bare hand.

2. Align combustion chamber knock pin with cylinder head notch, and install it into cylinder head using a plastic-tip hammer.



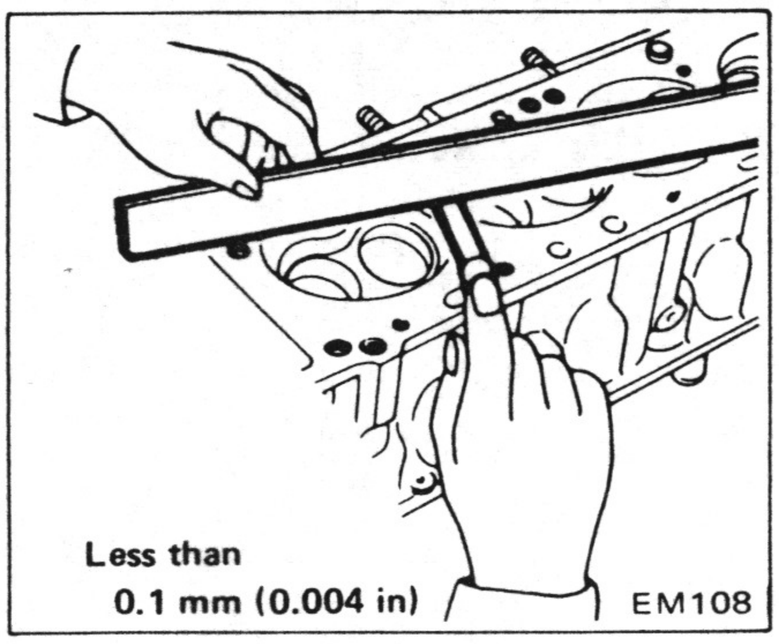
INSPECTION AND REPAIR

CYLINDER HEAD

CHECKING CYLINDER HEAD MATING FACE

1. Make a visual check for cracks or flaws. If cracks or melted areas are found in combustion chamber, replace.
2. Measure the surface of cylinder head (on cylinder block side) for warpage.

If beyond the specified limit, correct with a surface grinder.

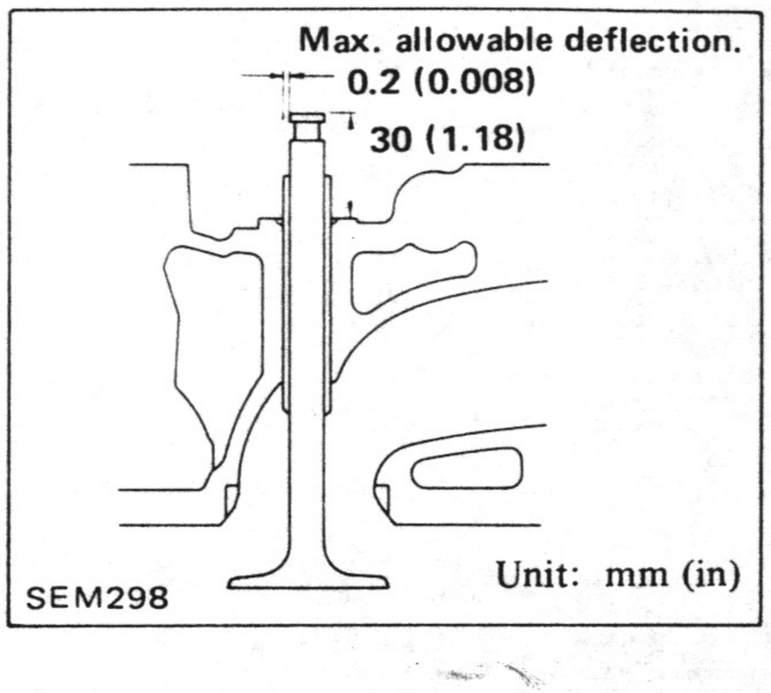


Nominal height:
89.5±0.1 mm (3.524±0.004 in)

Surface grinding limit:
The grinding limit of cylinder head is determined by the cylinder block grinding in an engine.
Depth of cylinder head grinding is "A"
Depth of cylinder block grinding is "B"
The limit is as follows:
A + B = 0.2 mm (0.008 in)

VALVE GUIDE

Measure the clearance between valve guide and valve stem. If the clearance exceeds the specified limit, replace the worn parts or both valve and valve guide. In this case, it is essential to determine if such a clearance has been caused by a worn or bend valve stem or by a worn valve guide.



Valve should be moved in parallel with rocker arm. (Generally, a large amount of wear occurs in this direction.)

Determining clearance

1. Precise method:
(1) Measure the diameter of valve stem with a micrometer in three places; top, center and bottom.
(2) Measure valve guide bore at center using telescope hole gauge.
(3) Subtract the highest reading of valve stem diameter from valve guide bore to obtain the stem to guide clearance.

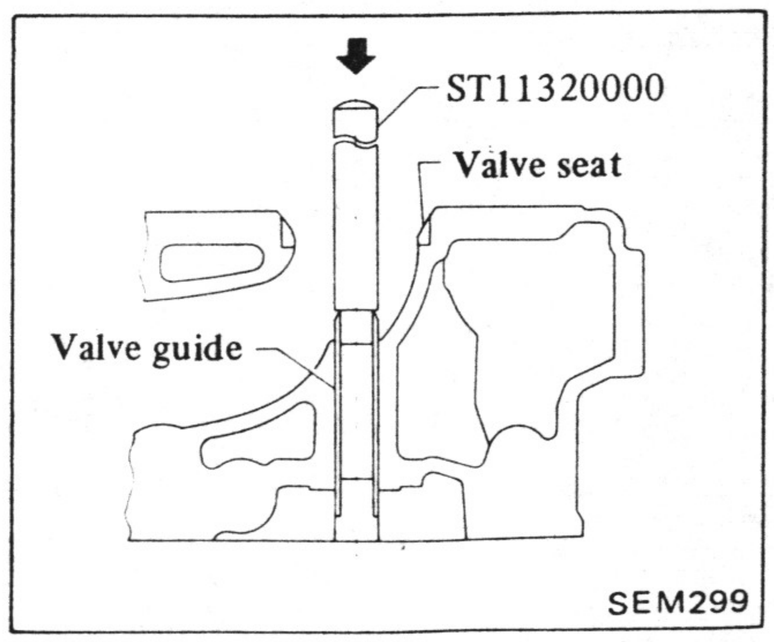
Stem to guide clearance:
Maximum Limit
0.10 mm (0.0039 in)

2. Expedient method
Pry the valve in a lateral direction, and measure the deflection at stem tip with dial gauge.

Replacement of valve guide

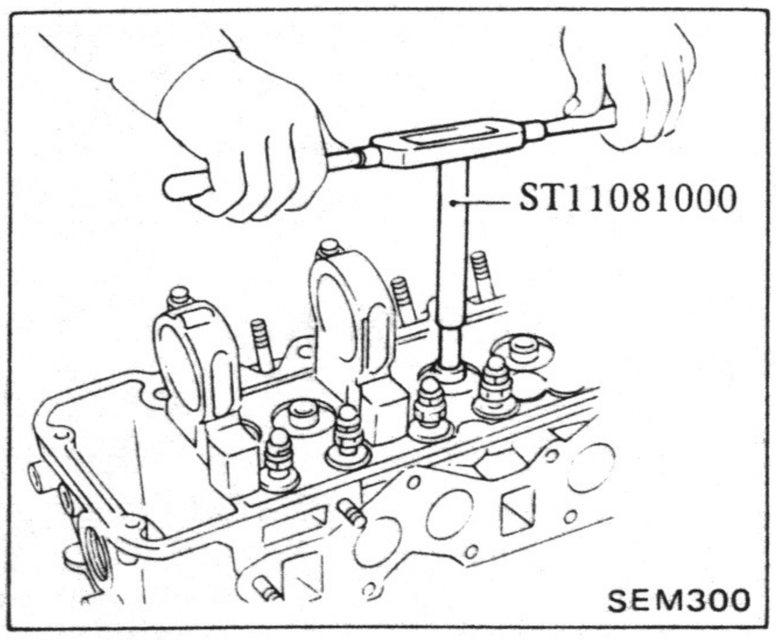
To remove old guides, use a press [under a 20 kN (2 t, 2.2 US ton, 2.0 Imp ton) pressure] or a hammer, and Tool.

1. Drive them out toward rocker cover side using Tool.



2. Ream cylinder head valve guide hole using Tool at room temperature.

Reaming bore:
12.223 - 12.234 mm
(0.4812 - 0.4817 in)



3. Fit snap ring on new valve guide. Press the guide onto cylinder head until the snap ring comes in contact with cylinder head surface.

Valve guide with 0.2 mm (0.008 in) oversize diameter is available for service.

Refer to S.D.S.

4. Ream the bore using Tool ST11032000.

Reaming bore:
8.000 - 8.018 mm
(0.3150 - 0.3157 in)

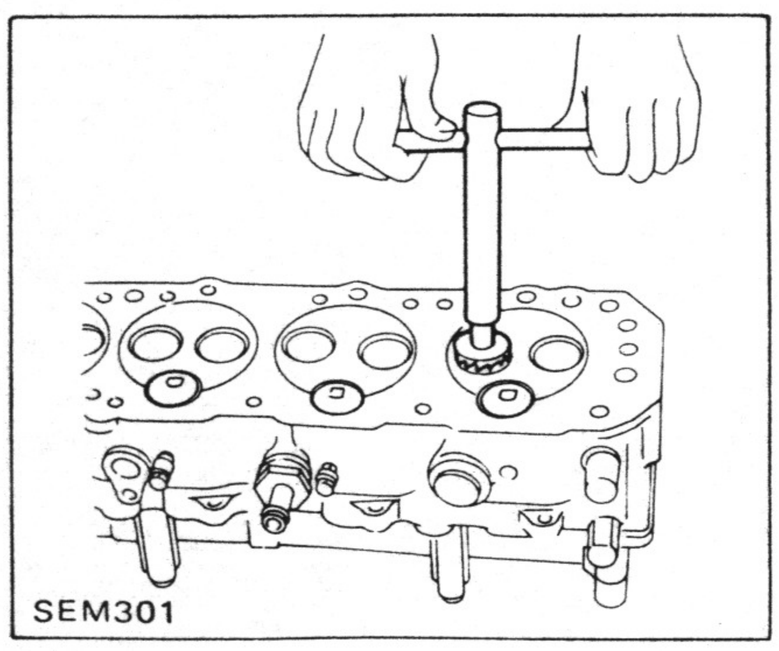
5. Correct valve seat surface with new valve guide as the axis.

VALVE SEAT INSERTS

Check valve seat inserts for any evidence of pitting on valve contact surface, and reseat or replace if worn out excessively.

Correct valve seat surface with Tool and grind with a grinding compound.

Oversize valve seat insert of 0.5 mm (0.020 in) is available for service. Refer to S.D.S.



a. When repairing valve seat, check valve and valve guide for wear beforehand. If worn, replace them. Then correct valve seat.
b. The cutting should be done with both hands for uniform cutting.

Replacement

1. Old insert can be removed by boring it out until it collapses. The machine depth stop should be set so that boring cannot continue beyond the bottom face of the insert recess in the cylinder head.
2. Select a suitable valve seat insert and check its outside diameter.
3. Machine the cylinder head recess in concentric circles which center on the valve guide.
4. Ream the cylinder head recess at room temperature. Refer to S.D.S.
5. Cool valve seat with dry ice for approximately 5 to 10 minutes.
6. Fit insert, ensuring that it bends on the bottom face of its recess, and caulk more than 4 points.
7. Newly-fitted valve seats should be cut or ground using Tool ST11650001 at the specified dimensions as shown in S.D.S.
8. Apply small amount of fine grinding compound to valve contacting face and put valve into guide.

Lap valve against its seat until proper valve seating is obtained. Remove valve and then clean valve and valve seat.

VALVE

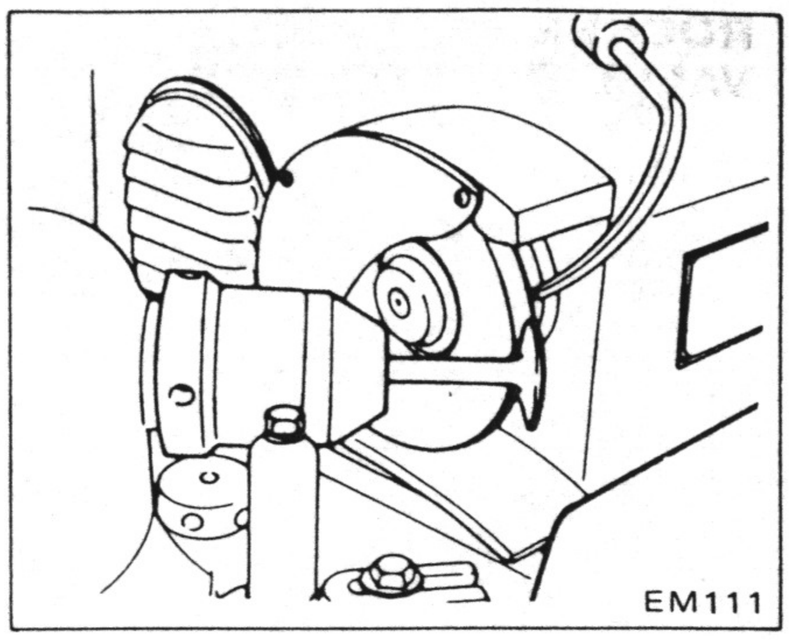
1. Check each of the intake and exhaust valves for worn, damaged or deformed valve head or stem.

Correct or replace any valve that is faulty.

2. Valve face or valve stem end surface should be refaced by using a valve grinder.

When valve head has been worn down to 0.5 mm (0.020 in) in-margin-thickness, replace the valve.

Grinding allowance for valve stem end surface is 0.5 mm (0.020 in) or less.

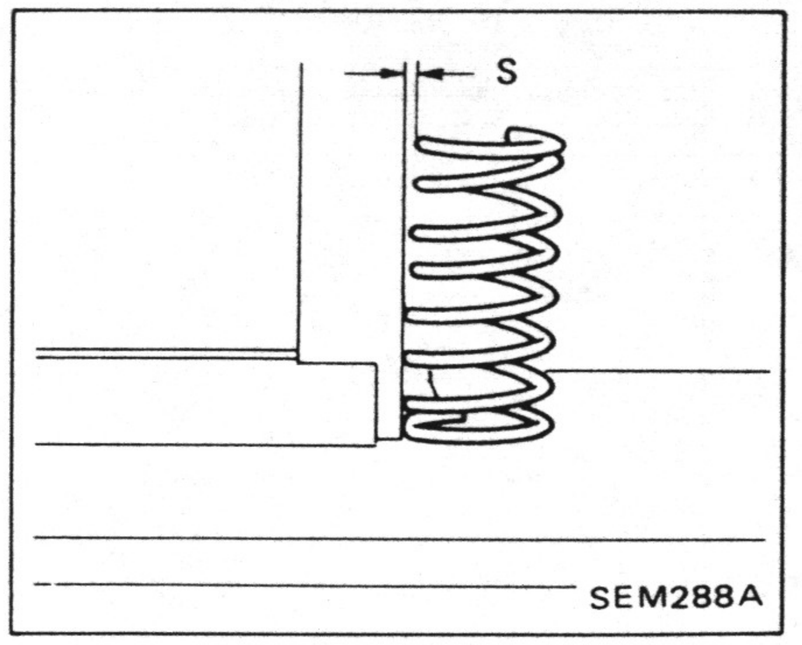


VALVE SPRING

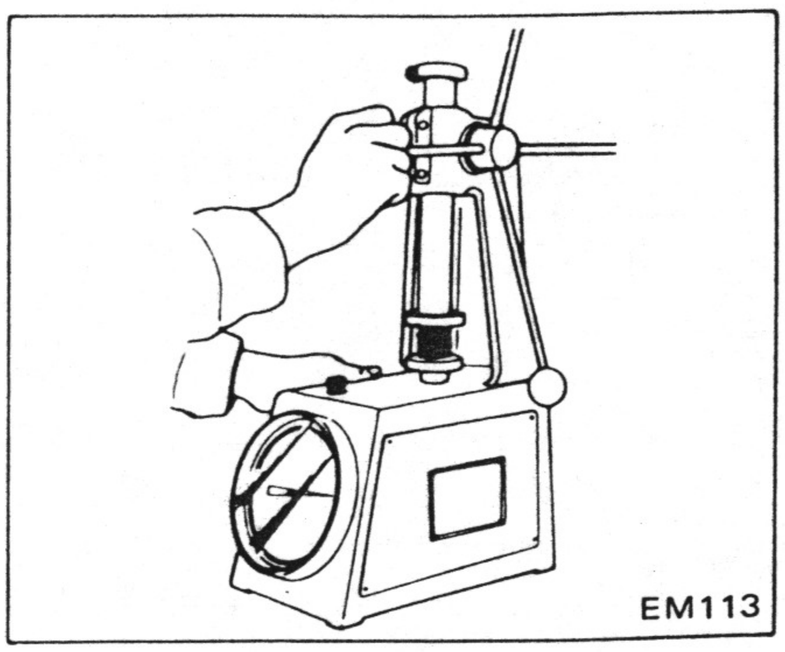
1. Check valve spring for squareness using a steel square and surface plate.

If spring is out of square "S" more than specified limit, replace with new one.

Out of square:
2.2 mm (0.087 in)



2. Measure the free length and the tension of each spring. If the measured value exceeds the specified limit, replace spring. Refer to S.D.S.



ROCKER ARM AND VALVE ROCKER PIVOT

Check pivot head, and cam contact and pivot contact surfaces of rocker arm for damage or wear.

If faulty, replace them.

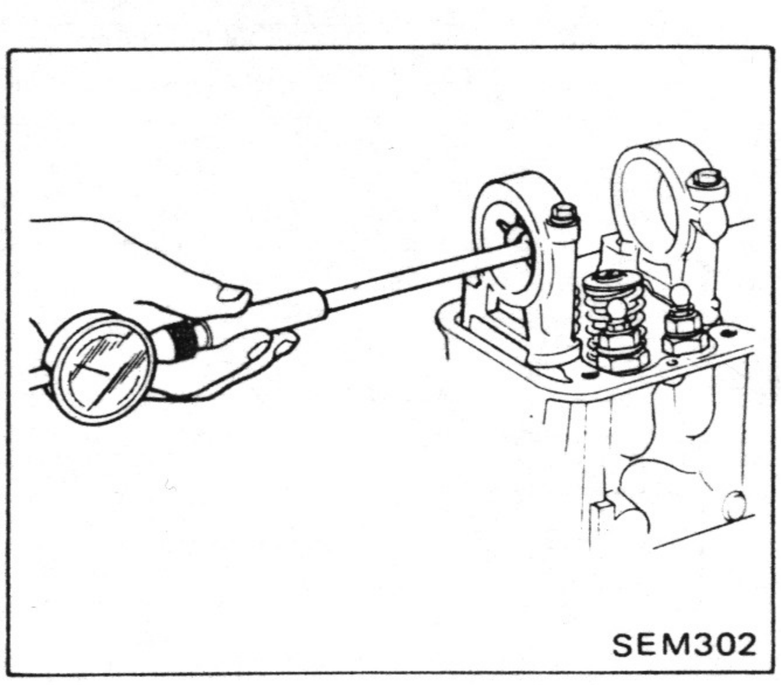
A faulty pivot must be replaced together with the corresponding rocker arm.

CAMSHAFT AND CAMSHAFT BEARING

CAMSHAFT BEARING CLEARANCE

Measure the inside diameter of camshaft bearing with an inside dial gauge and the outside diameter of camshaft journal with a micrometer. If any malfunction is found, replace camshaft or cylinder head assembly.

Max. tolerance of camshaft bearing clearance:
0.1 mm (0.004 in)

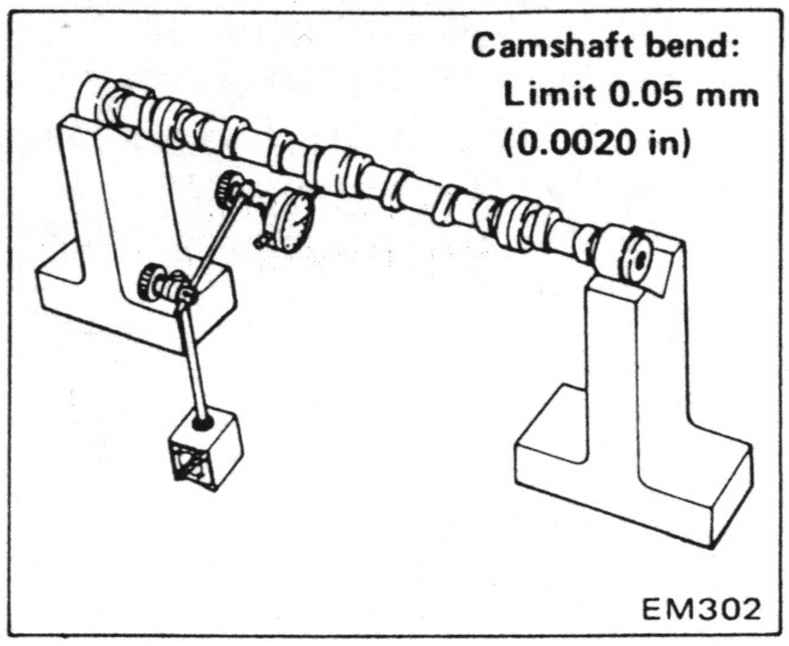


SEM302

Do not remove camshaft brackets. If camshaft bracket were removed, install them by checking for a smooth rotation with the camshaft.

CAMSHAFT ALIGNMENT

1. Check camshaft, camshaft journal and cam surface for bend, wear or damage. If beyond specified limits, replace them.
2. Camshaft can be checked for bend by placing it on V-blocks and using a dial gauge with its indicating finger resting on center journal.

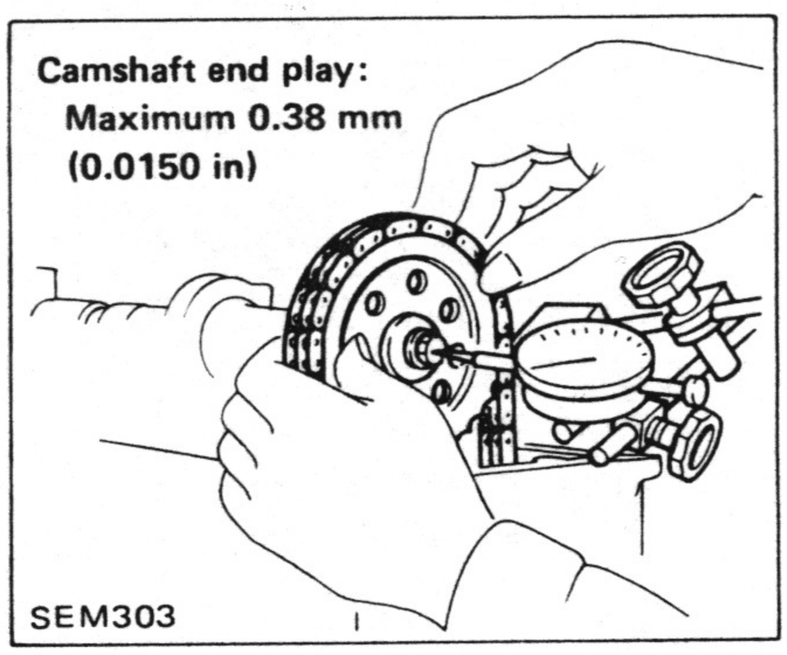


EM302

3. Measure camshaft cam height. If beyond the specified limit, replace camshaft.

Wear limit of cam height:
0.15 mm (0.0059 in)

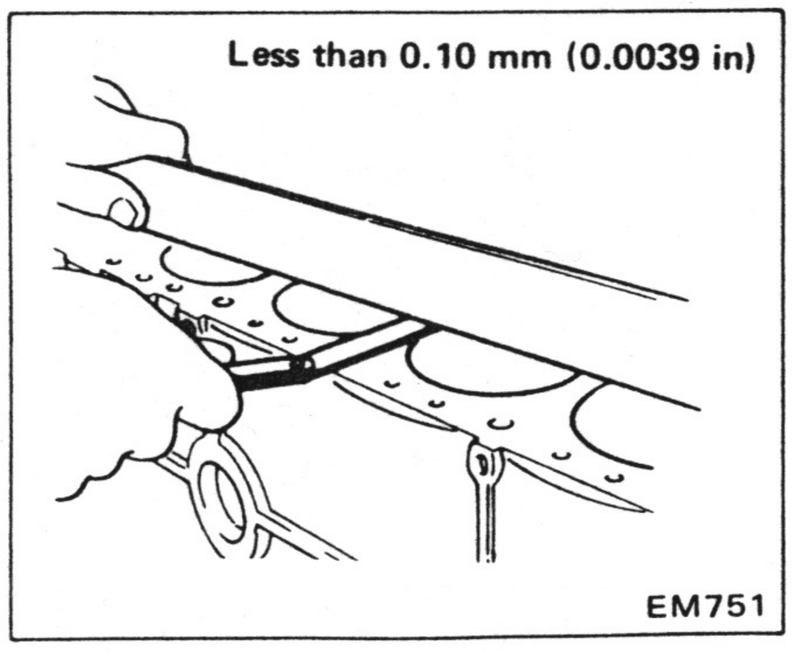
4. Measure camshaft end play. If beyond the specified limit, replace thrust plate.



SEM303

CYLINDER BLOCK

1. Visually check cylinder block for cracks or flaws.
2. Measure the top of cylinder block (cylinder head mating face) for warpage. If warpage exceeds the specified limit, correct with a grinder.



EM751

Nominal height
(From crankshaft center):
227.45±0.05 mm
(8.9547±0.0020 in)

Surface grinding limit;
The grinding limit of cylinder block is determined by the cylinder head grinding in an engine.

Depth of cylinder head grinding is "A"

Depth of cylinder block grinding is "B"

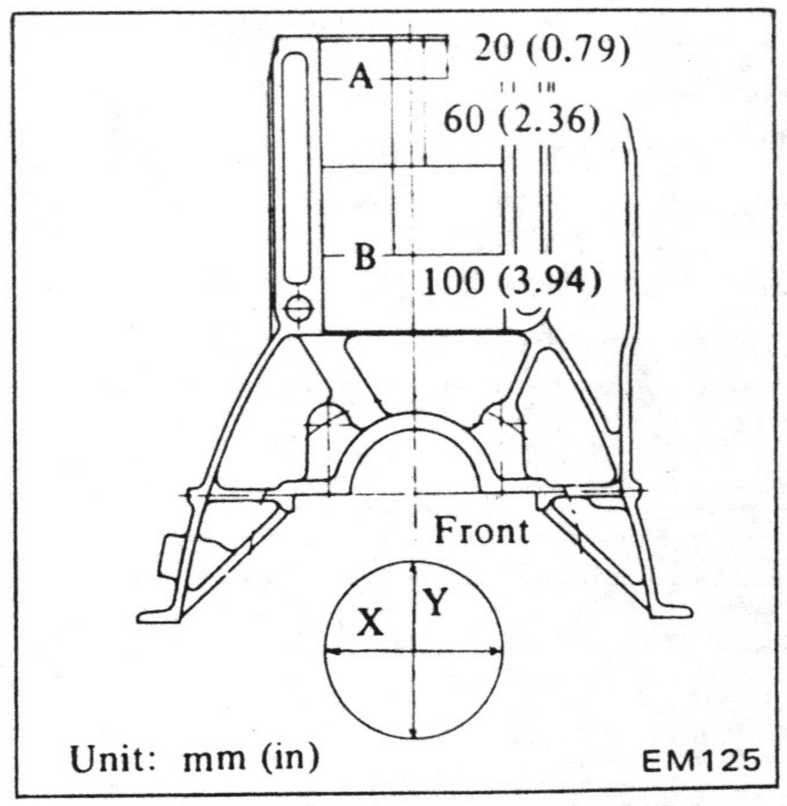
The limit is as follows:

A + B = 0.2 mm (0.008 in)

3. Using a bore gauge, measure cylinder bore for wear, out-of-round or taper. If they are excessive, rebore the cylinder walls with a boring machine. Measurement should be taken along bores for taper and around bores for out-of-round.

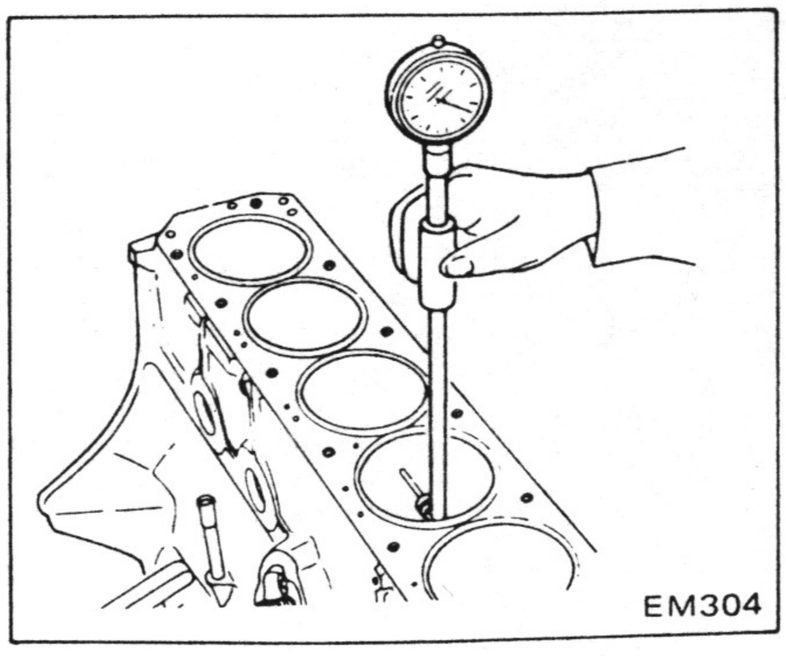
Refer to S.D.S.

Out-of-round . . . . . **X-Y**
Taper . . . . . **A-B**



Unit: mm (in)

EM125



EM304

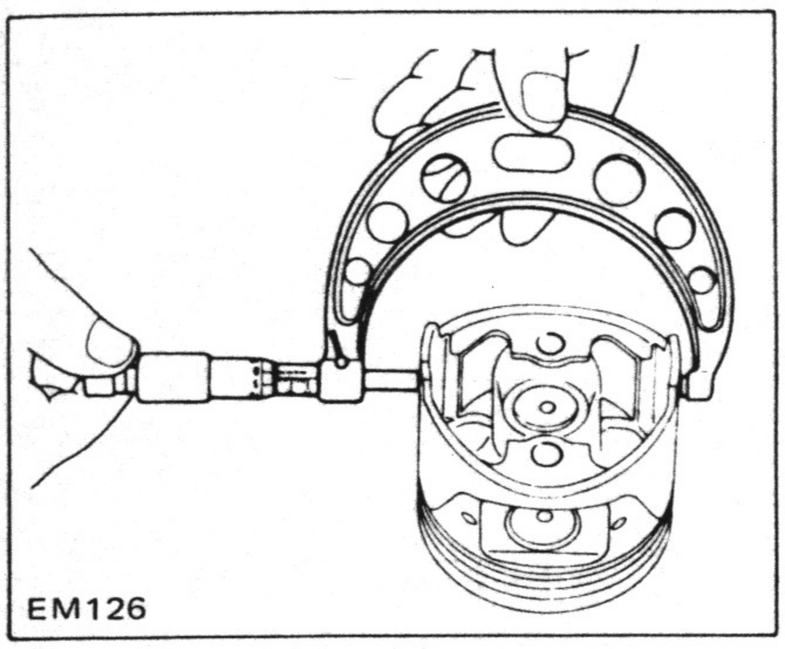
4. When wear, taper or out-of-round is minor and within the limit, remove the step at the topmost portion of cylinder using a ridge reamer or other similar tool.

CYLINDER BORING

When any cylinder needs boring, all other cylinders must also be bored at the same time.

Determining bore size

1. Determine piston oversize according to amount of cylinder wear. Refer to S.D.S.
2. The size to which cylinders must be honed is determined by adding piston-to-cylinder clearance to the piston skirt diameter.


EM126

Rebored size calculation

D = A + B – C = A + [0.005 to 0.025 mm (0.0002 to 0.0010 in)]

Where:

D = Honed diameter
A = Skirt diameter as measured
B = Piston-to-wall clearance
C = Machining allowance
0.02 mm (0.0008 in)

Boring

1. Install main bearing caps in place, and tighten to the specified torque to prevent distortion of the cylinder bores in final assembly.
2. Cut cylinder bores.

- **Do not cut too much out of the cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.**
- **Bore the cylinders in the order of 1-3-4-2 (LD20) or 1-5-3-6-2-4 (LD28) to prevent heat strain due to cutting.**

3. Hone the cylinders to the required size referring to S.D.S.
- Use clean sharp stones of proper grade.
- Cross-hatch pattern should be approximately 45°.

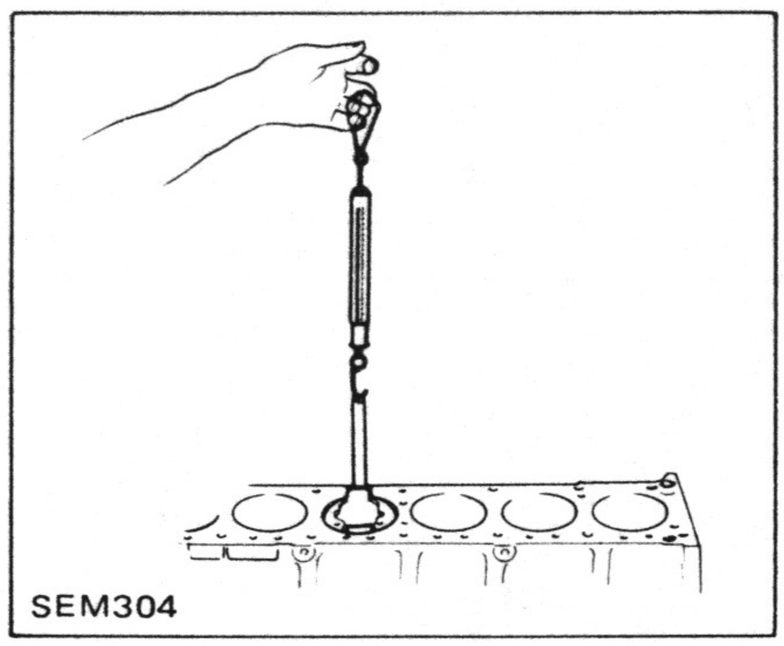
4. Measure the finished cylinder bore for out-of-round and taper.

Measuring piston-to-cylinder clearance

Measure the extracting force, and pull feeler gauge straight upward.

It is recommended that piston and cylinder be heated to 20°C (68°F).

Feeler gauge thickness:
0.06 mm (0.0024 in)
Extracting force:
5.9 - 11.8 N
(0.6 - 1.2 kg,
1.3 - 2.6 lb)


SEM304

PISTON, PISTON PIN AND PISTON RING

PISTON

1. Scrape carbon off piston and ring grooves with a carbon scraper and a curved steel wire.

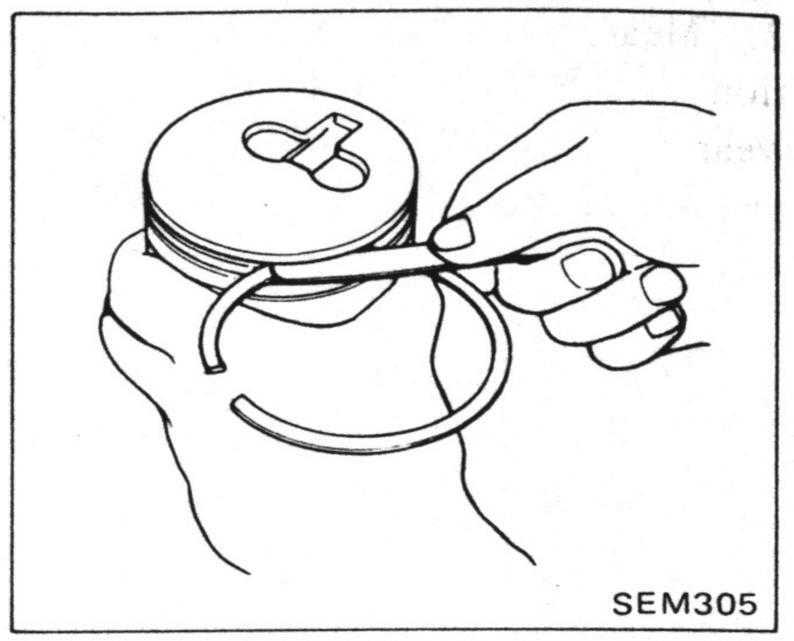
Clean out oil slots in bottom land of oil ring groove.

2. Check for damage, scratches and wear.

Replace if such a faulty is detected.

3. Measure the side clearance of rings in ring grooves as each ring is installed.

Max. tolerance of side clearance:
Top ring: 0.20 mm (0.0079 in)
2nd ring: 0.15 mm (0.0059 in)
Oil ring: 0.10 mm (0.0039 in)


SEM305

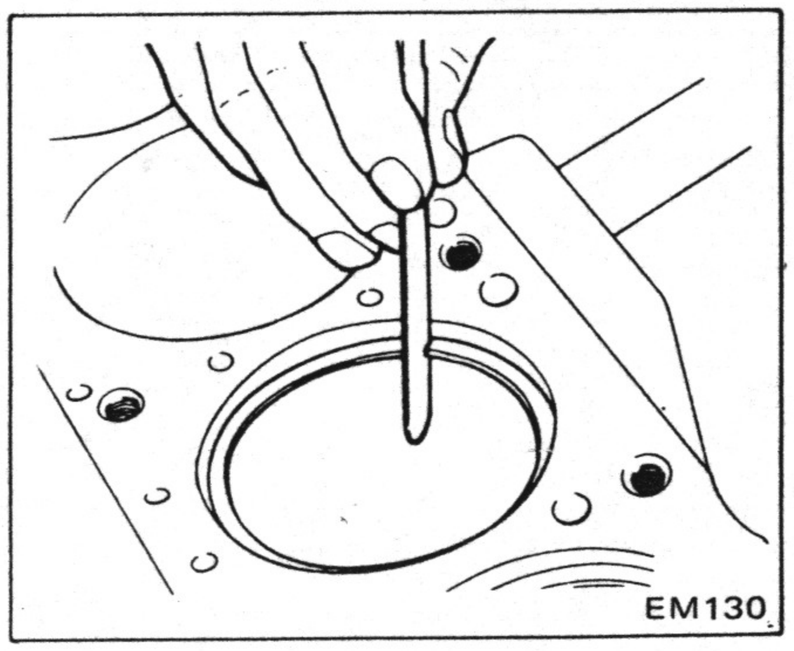
If side clearance exceeds the specified limit, replace piston together with piston ring.

PISTON RING

Measure ring gap with a feeler gauge, placing ring squarely in cylinder using piston.

Ring should be placed to diameter at upper or lower limit of ring travel.

Max. tolerance of ring gap:
Top ring: 0.6 mm (0.024 in)
2nd ring: 0.8 mm (0.031 in)
Oil ring: 1.0 mm (0.039 in)


EM130

a. When piston ring only is to be replaced, without cylinder bore being corrected, measure the gap at the bottom of cylinder where the wear is minor.
b. Oversize piston rings are available for service.

0.5 mm (0.020 in),
1.0 mm (0.039 in) oversize

PISTON PIN

1. Check piston pin and piston pin hole for signs of sticking and other abnormalities.

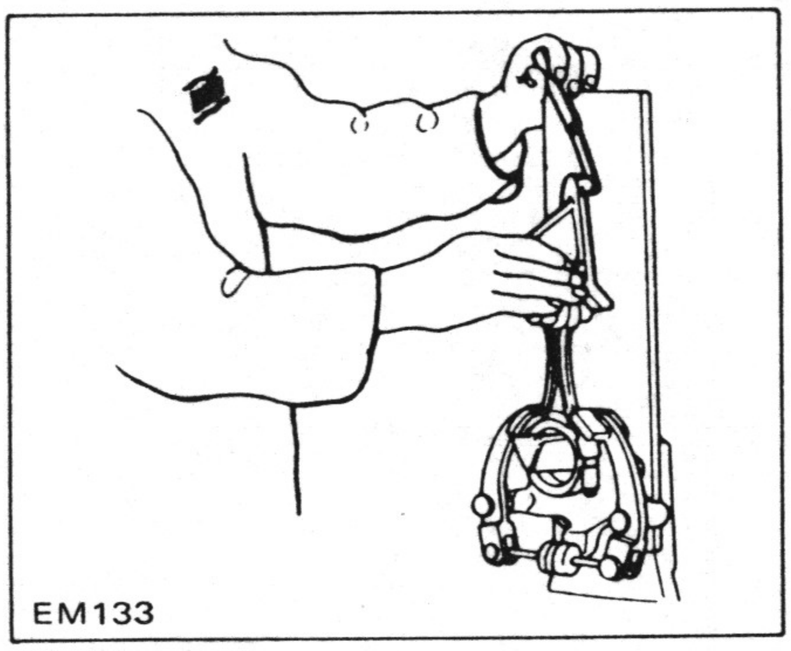
2. Measure piston pin hole in relation to the outer diameter of pin. If wear exceeds the limit, replace such piston pin together with piston on which it is installed.

Piston pin to piston clearance:
0 - 0.004 mm
(0 - 0.0002 in)

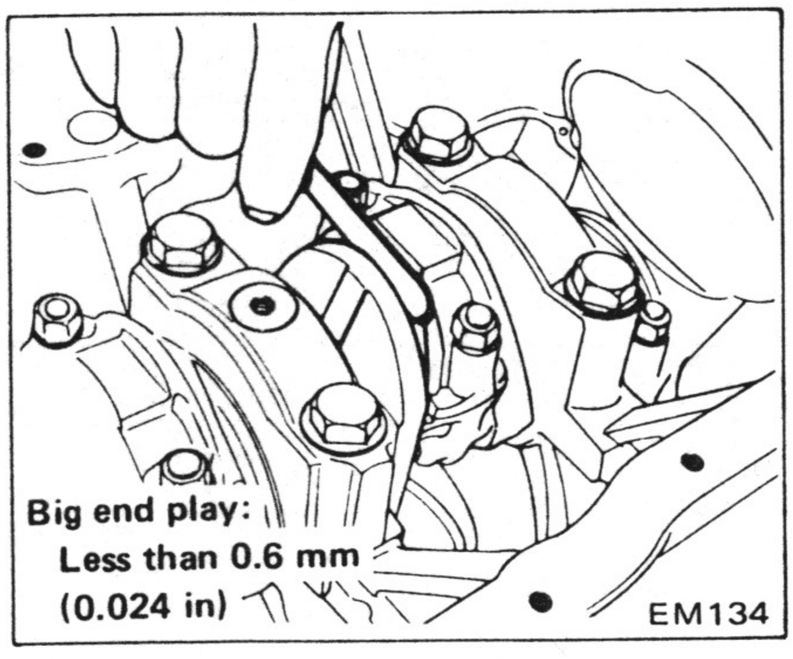
CONNECTING ROD

1. If a connecting rod has any flaw on both sides of the thrust face and the large end, correct or replace it.
2. Check connecting rod for bend or torsion using a connecting rod aligner. If bend or torsion exceeds the limit, correct or replace.

Bend and torsion
[per 100 mm (3.94 in) length]:
Less than
0.05 mm (0.0020 in)


EM133

3. Install connecting rods with bearings on to corresponding crank pins and measure the thrust clearance. If the measured value exceeds the limit, replace such connecting rod.



EM134

When replacing connecting rod, select so that weight difference between each cylinder is within the specified limit in the condition of piston and connecting rod assembly.

Weight difference limit:
4 gr (0.14 oz)

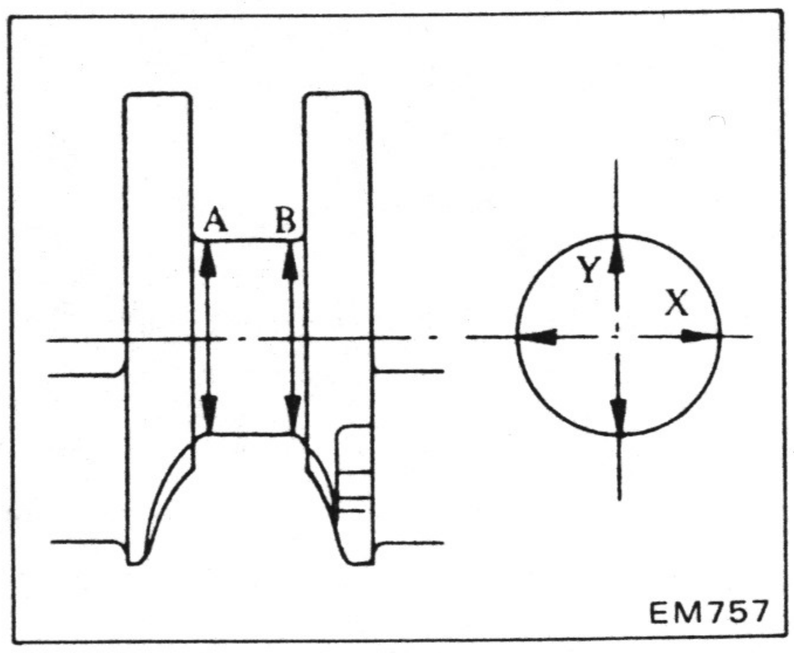
CRANKSHAFT

CRANK JOURNAL AND PIN

1. Repair or replace as required. If faults are minor, correct with fine crocus cloth.
2. Check journals and crank pins with a micrometer for taper and out-of-round. Measurement should be taken along journals for taper and around journals for out-of-round.

If out-of-round or taper exceeds the specified limit, replace or repair.

Out-of-round (X-Y) and
Taper (A-B):
Less than 0.03 mm (0.0012 in)



EM757

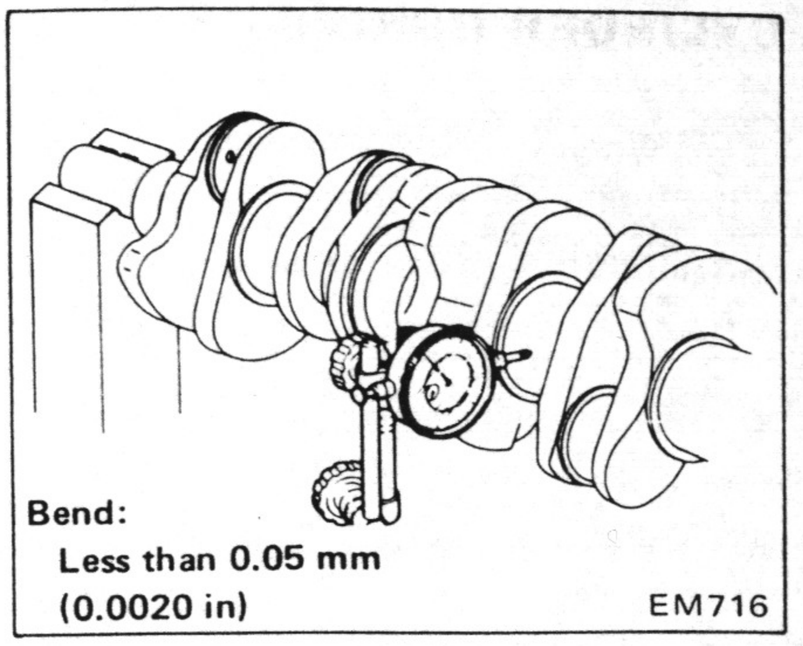
3. After regrinding crankshaft, finish it to the necessary size indicated in the chart under S.D.S. by using an adequate undersize bearing according to the extent of required repair.

BEND AND END PLAY

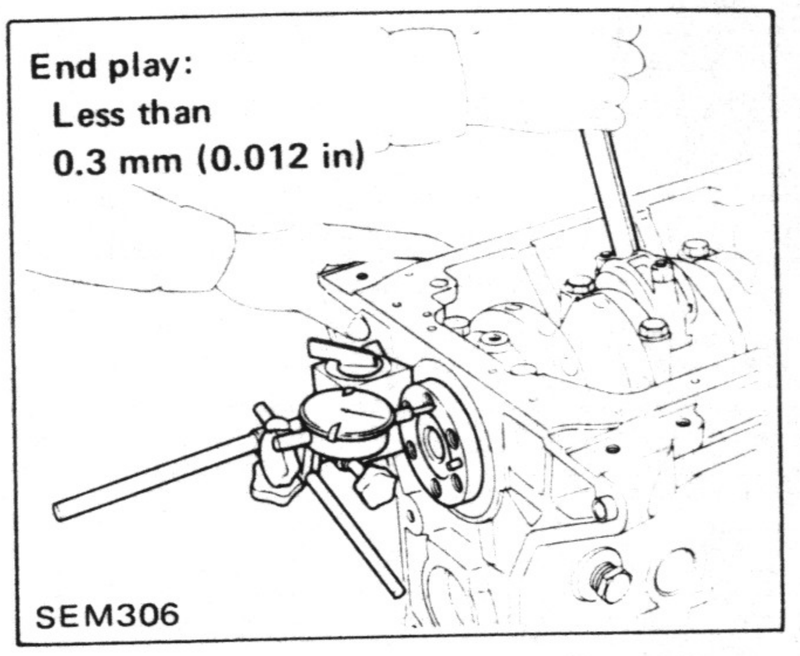
1. Crankshaft can be checked for bend by placing it on V-blocks and using a dial gauge with its indicating finger resting on the center journal.

Bend value is half of the gauge reading obtained when crankshaft is turned one full revolution.

If bend exceeds the specified limit, replace or repair.


Bend:
Less than 0.05 mm
(0.0020 in)
EM716

2. Install crankshaft in cylinder block and measure cranksahft free end play at the center bearing.

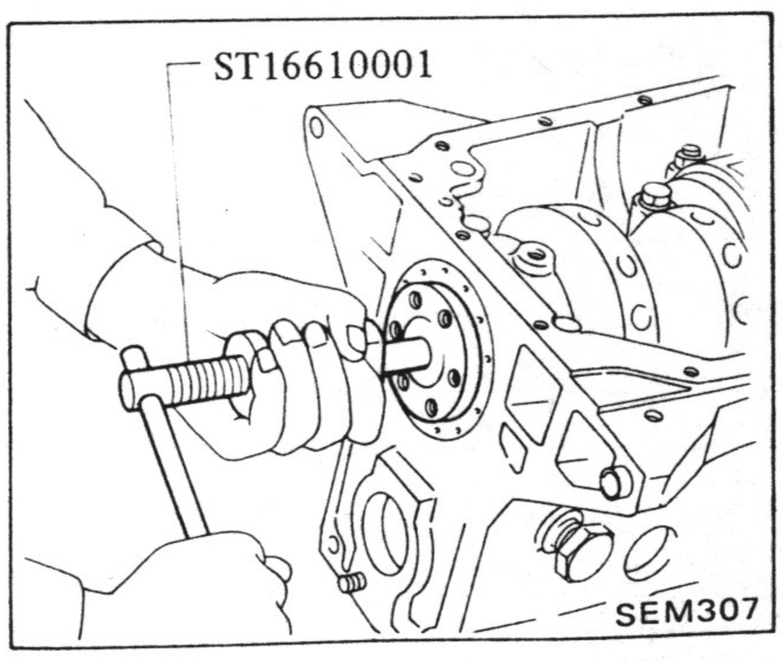


SEM306

REPLACING PILOT BUSHING

To replace crankshaft rear pilot bushing, proceed as follows:

1. Pull out bushing using Tool.

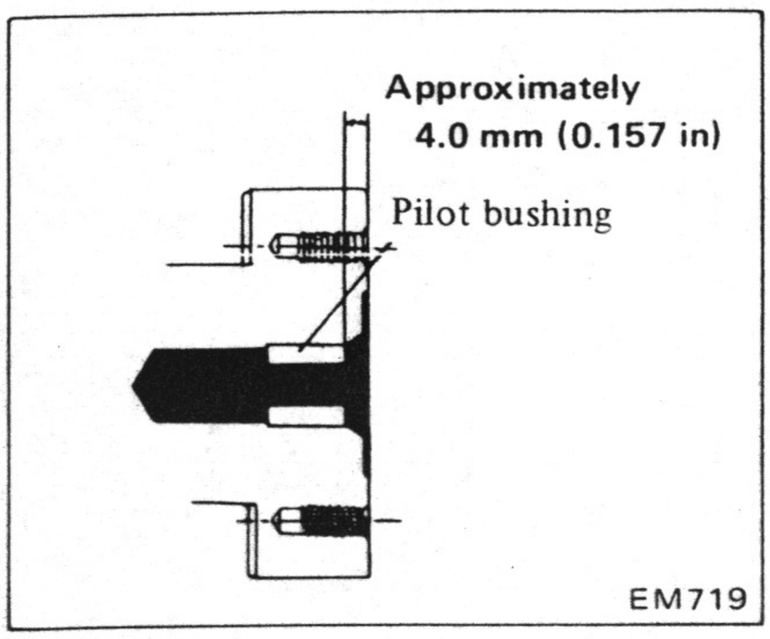


SEM307

2. Before installing a new bushing thoroughly clean bushing hole.

3. Insert pilot bushing until distance between flange end and pilot bushing is the specified distance.

When installing pilot bushing, be careful not to damage edge of pilot bushing and do not insert excessively.



MAIN BEARING AND CONNECTING ROD BEARING

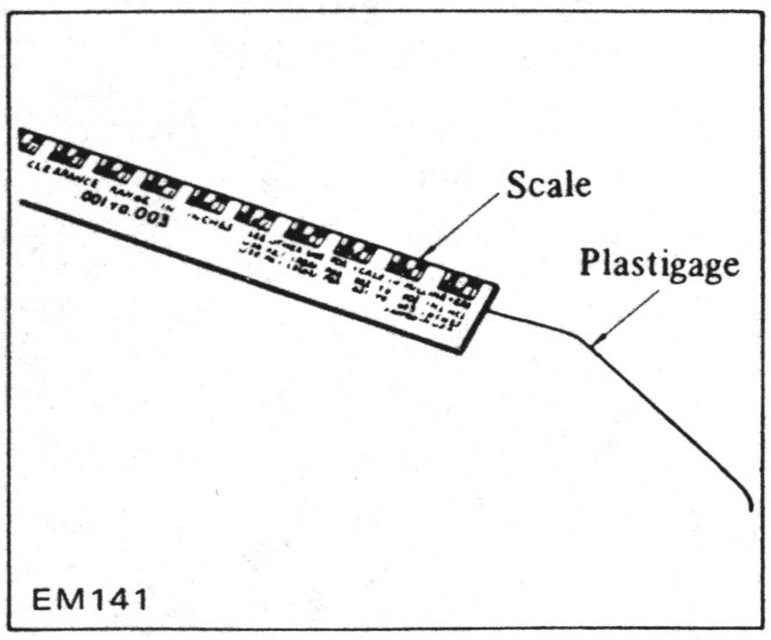
MAIN BEARING

1. Thoroughly clean all bearings and check for scratches, melt, score or wear.

Replace bearings, if faulty.

2. Measure bearing clearance as follows:

(1) Cut a plastigage to the width of bearing and place it in parallel with crank journal, getting clear of the oil hole.



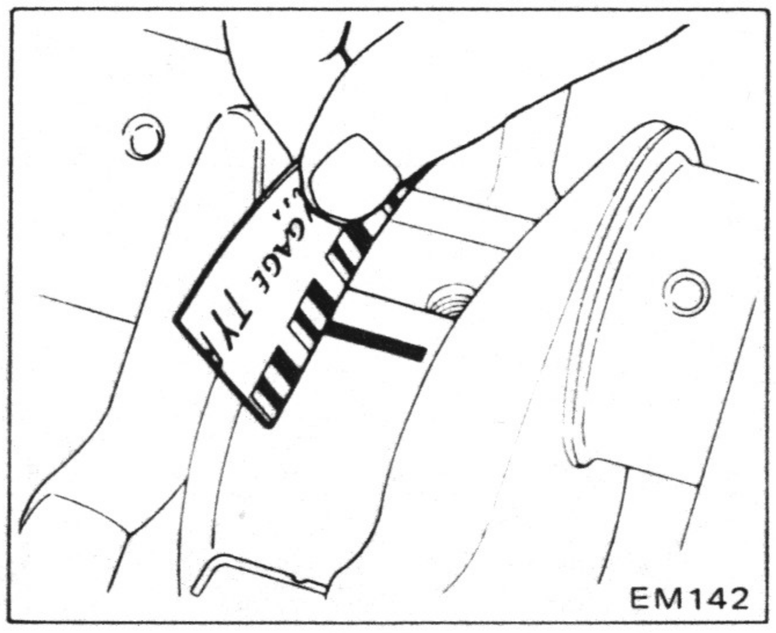
(2) Install crankshaft, bearings and bearing cap, with the bolts tightened to the specified torque.

Ⓣ : **Main bearing cap**
69 - 83 N·m
(7.0 - 8.5 kg-m,
51 - 61 ft-lb)

Do not rotate crankshaft while the plastigage is being inserted.

(3) Remove cap, and compare width of the plastigage at its widest part with the scale printed in the plastigage envelope.

Max. tolerance of main bearing:
0.12 mm (0.0047 in)



3. If clearance exceeds the specified value, replace bearing with an undersize bearing and grind crankshaft journal adequately. Refer to S.D.S.

CONNECTING ROD BEARING

1. Measure connecting rod bearing clearance in the same manner as above.

Ⓣ : **Connecting rod big end nuts**
44 - 54 N·m
(4.5 - 5.5 kg-m,
33 - 40 ft-lb)

Max. tolerance of connecting rod bearing clearance:
0.12 mm (0.0047 in)

2. If clearance exceeds the specified value, replace bearing with an undersize bearing and grind the crankshaft journal adequately. Refer to S.D.S.

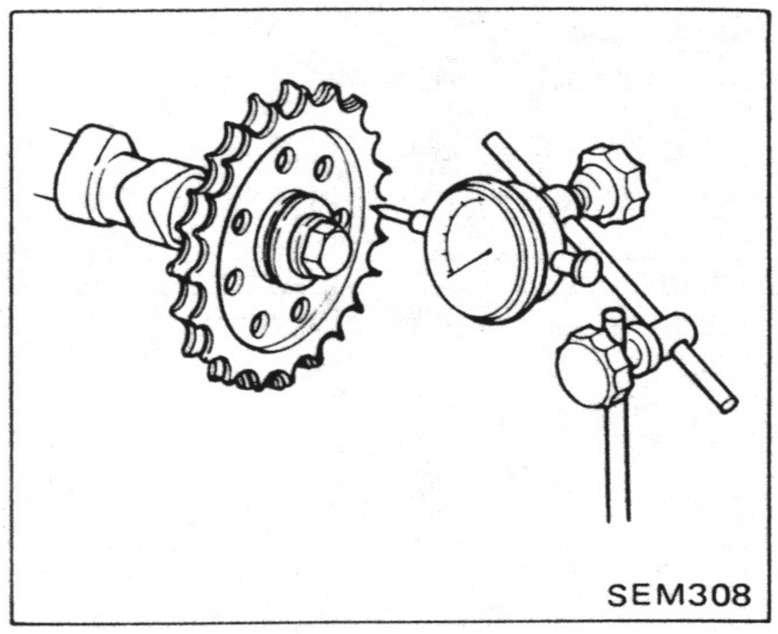
MISCELLANEOUS COMPONENTS

CAMSHAFT SPROCKET

1. Check tooth surface for flaws or wear. Replace sprocket if faulty.

2. Install camshaft sprocket in position and check for runout. If runout exceeds the specified limit, replace camshaft sprocket.

Runout: (Total indicator reading)
Less than 0.1 mm (0.004 in)



CHAIN

Check chain for damage and excessive wear at roller links. Replace if faulty.

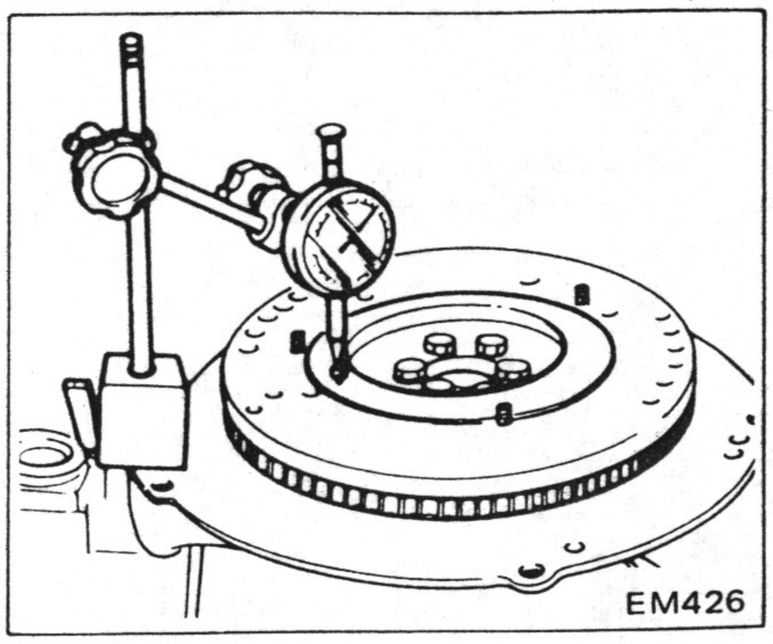
CHAIN TENSIONER AND CHAIN GUIDE

Check for wear and breakage. Replace if necessary.

FLYWHEEL

1. Check the clutch disc contact surface on flywheel for damage or wear. Repair or replace if necessary.
2. Measure runout of the clutch disc contact surface with a dial gauge. If it exceeds the specified limit, replace it.

Runout: (Total indicator reading)
Less than 0.15 mm (0.0059 in)



3. Check tooth surface of ring gear for flaws or wear. Replace if necessary.

Install ring gear on flywheel, heating ring gear to about 180 to 220°C (356 to 428°F).

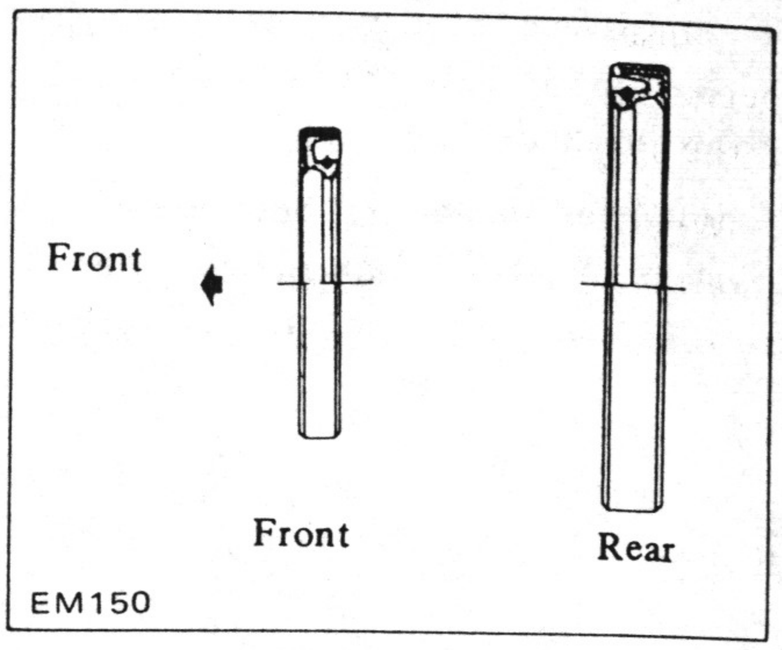
DRIVE PLATE (A/T models)

1. Check drive plate for cracks or distortion.
2. Check tooth surface of ring gear for flaws or wear. Replace drive plate assembly if necessary.

FRONT AND REAR OIL SEAL

Check front and rear oil seal for worn or folded over sealing lip and oil leakage. If necessary, replace with a new seal. When installing a new front or rear seal, be sure that it is mounted in the right direction.

It is good practice to renew oil seal whenever engine is overhauled.



ENGINE ASSEMBLY

PRECAUTIONS

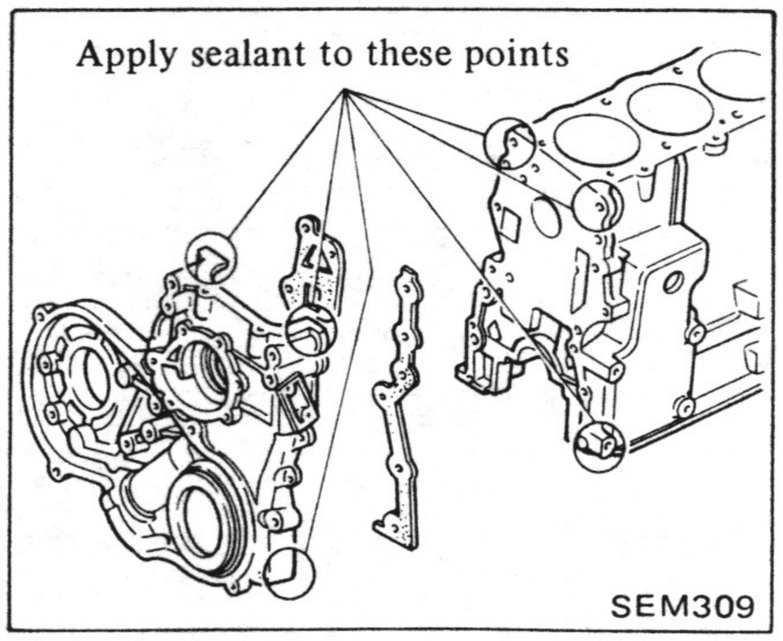
1. When installing sliding parts such as bearings, be sure to apply engine oil on the sliding surfaces.
2. Use new packings and oil seals.
3. Be sure to follow the specified order and tightening torque.
4. Applying sealant

Use sealant to eliminate water and oil leaks.

Do not apply too much sealant.

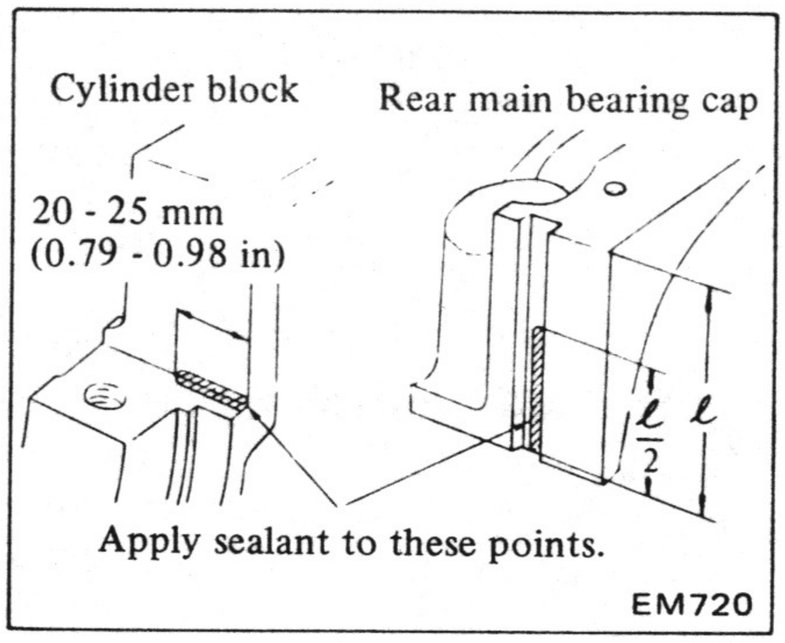
Parts requiring sealant are:

(1) Front cover



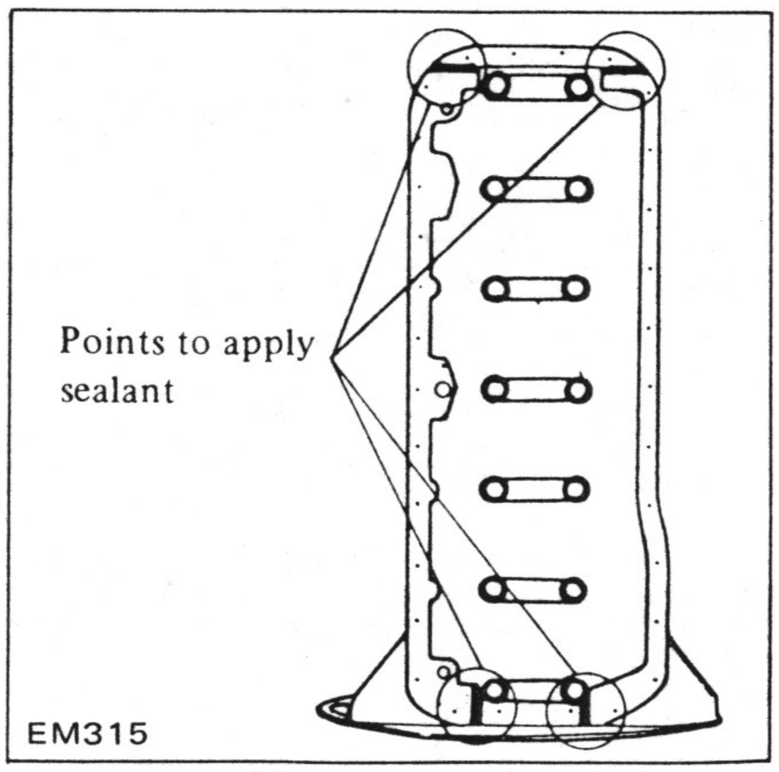
(2) Main bearing cap and cylinder block:

Each side of rear main bearing cap and each corner of cylinder block.



(3) Cylinder block:

Step portions on the bottom and at the four mating surfaces (cylinder block to front cover and cylinder block to rear main bearing cap).



After inserting rear bearing cap side seals, apply sealant to rear main bearing cap.

ASSEMBLING CYLINDER HEAD

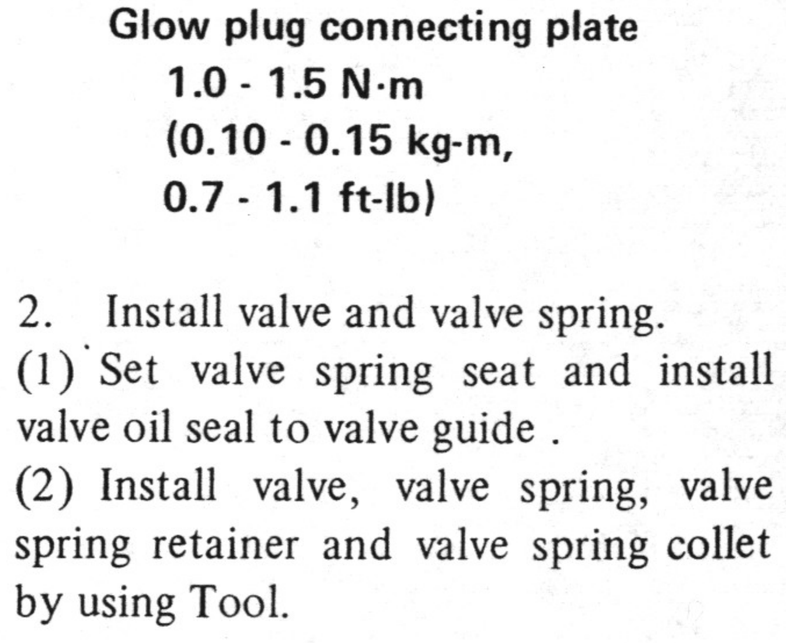
1. Install glow plug and glow plug connecting plate.

Ⓣ : Glow plug
20 - 25 N·m
(2.0 - 2.5 kg-m,
14 - 18 ft-lb)
Glow plug connecting plate
1.0 - 1.5 N·m
(0.10 - 0.15 kg-m,
0.7 - 1.1 ft-lb)

2. Install valve and valve spring.

(1) Set valve spring seat and install valve oil seal to valve guide .

(2) Install valve, valve spring, valve spring retainer and valve spring collet by using Tool.



a. When installing valve, apply engine oil on the valve stem and lip of valve oil seal.
b. Check whether the valve face is free from foreign matter.

3. Install valve rocker pivot assembly.

Screw valve rocker pivots joined with lock nuts into pivot bushing.

Install valve rocker spring retainer.

Fully screw in valve rocker pivot.

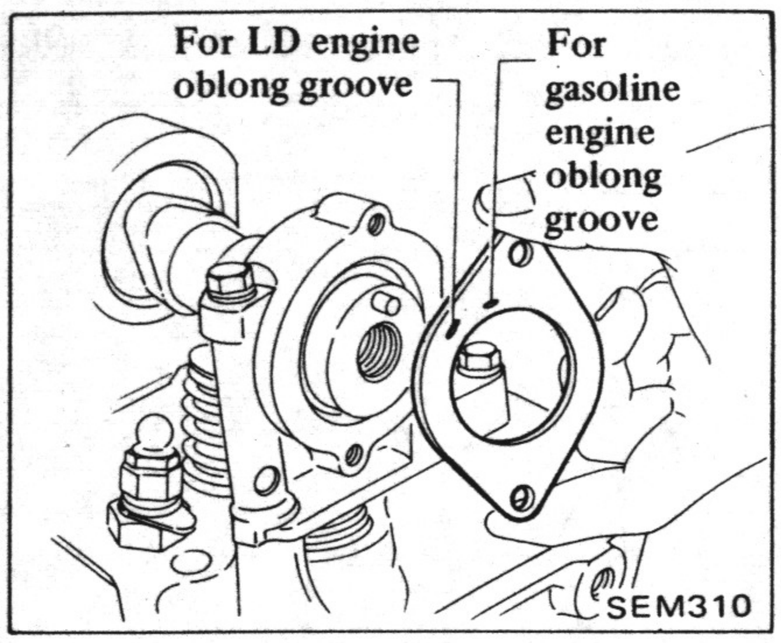
4. Install camshaft assembly in cylinder head carefully.

Do not damage the bearing inside.

5. Set thrust plate.

Ⓣ : Camshaft thrust plate
6 - 10 N·m
(0.6 - 1.0 kg-m,
4.3 - 7.2 ft-lb)

The oblong groove must be directed toward the front side of engine.



6. Install valve rocker guides.
7. Install rocker arms by pressing valve springs down with a screwdriver, etc.

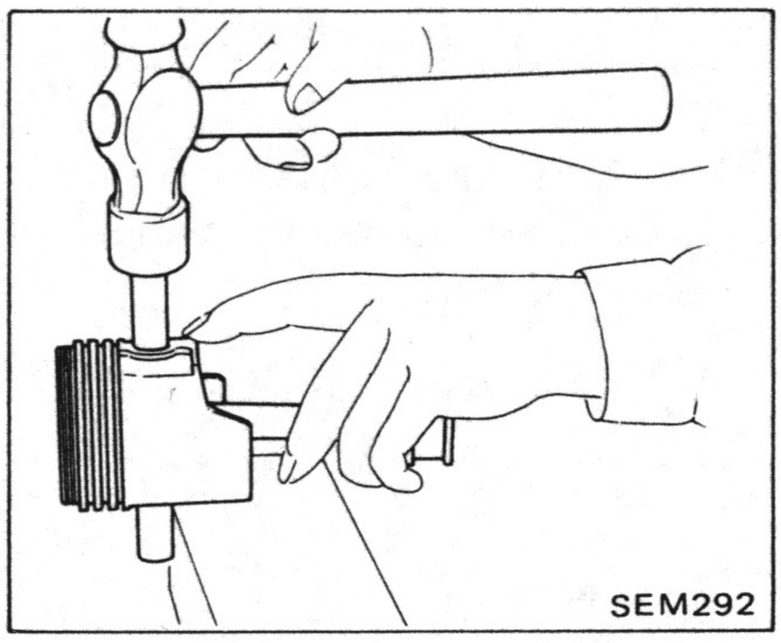
8. Install valve rocker springs.

9. After assembling cylinder head, turn camshaft until No. 1 piston is at T.D.C. on its compression stroke.

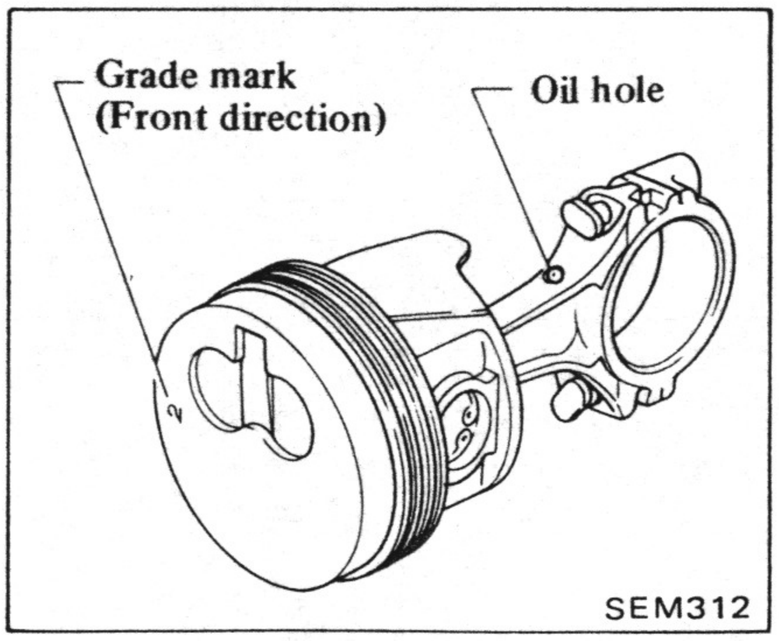
ASSEMBLING PISTON AND CONNECTING ROD

1. Assemble pistons, piston pins and connecting rods of the designated cylinder.

a. Heat piston with a heater or hot water [approximately 60 to 70°C (140 to 158°F)], insert piston pin into piston hole with your hand while aligning piston and connecting rod.



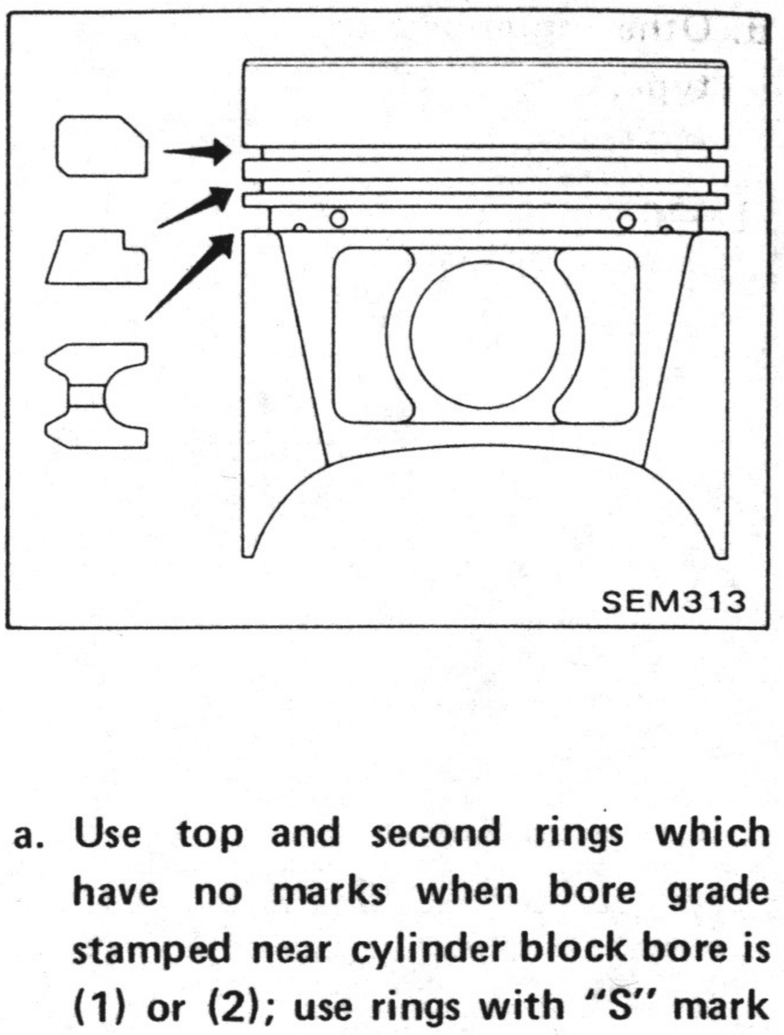
b. Arrange so that oil jet of connecting rod big end is directed toward the right side of cylinder block.



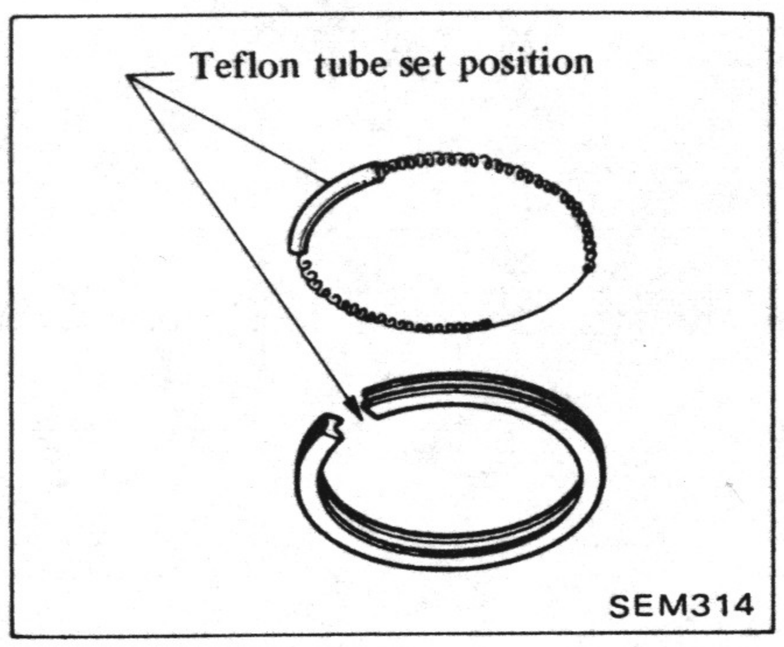
c. Connecting rods are marked at side of big end for indentifying the designated cylinder.

2. Install piston rings.

Install so that stamped mark on ring faces upward.



a. Use top and second rings which have no marks when bore grade stamped near cylinder block bore is (1) or (2); use rings with "S" mark when bore grade is (3), (4) or (5).
b. Align teflon tube with ring gap.



ASSEMBLING ENGINE OVERALL

INSTALLING BODY PARTS

First, mount cylinder block on work stand (refer to Engine Disassembly).

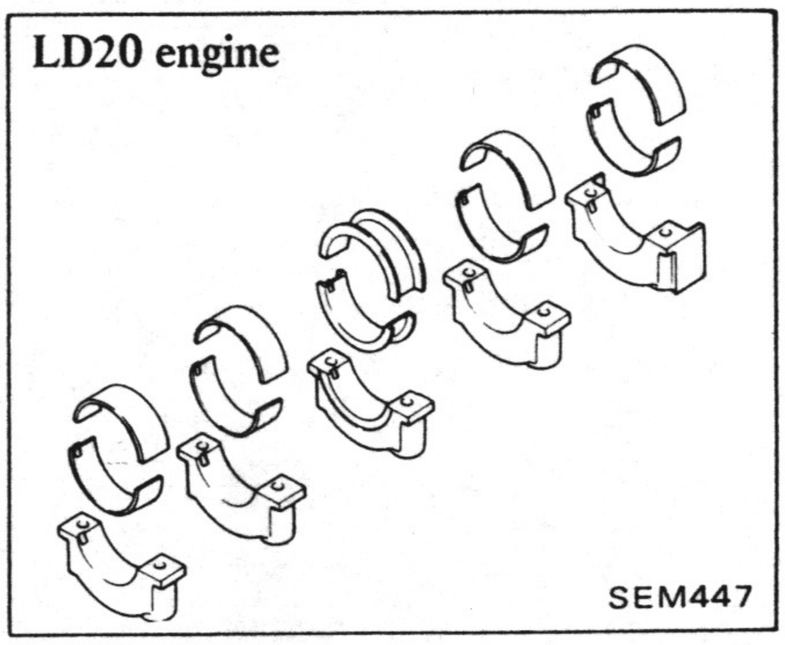
Then install following parts:

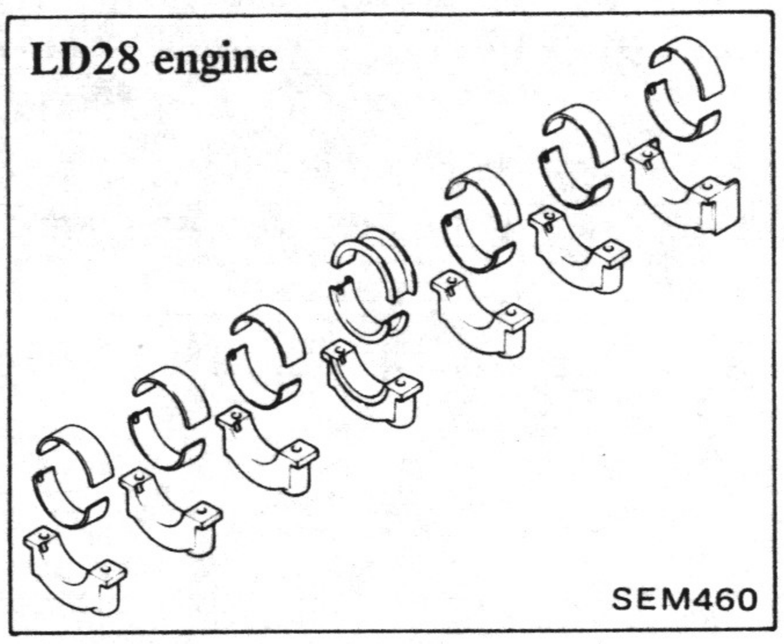
1. Crankshaft.

(1) Set upper main bearings at the proper portion of cylinder block.

a. Upper bearings have oil hole and oil groove, however lower bearings do not.
b. Only center bearing is a flange type.
c. Front bearing is also the same type as rear bearing.

d. Other inter-bearings are the same type.

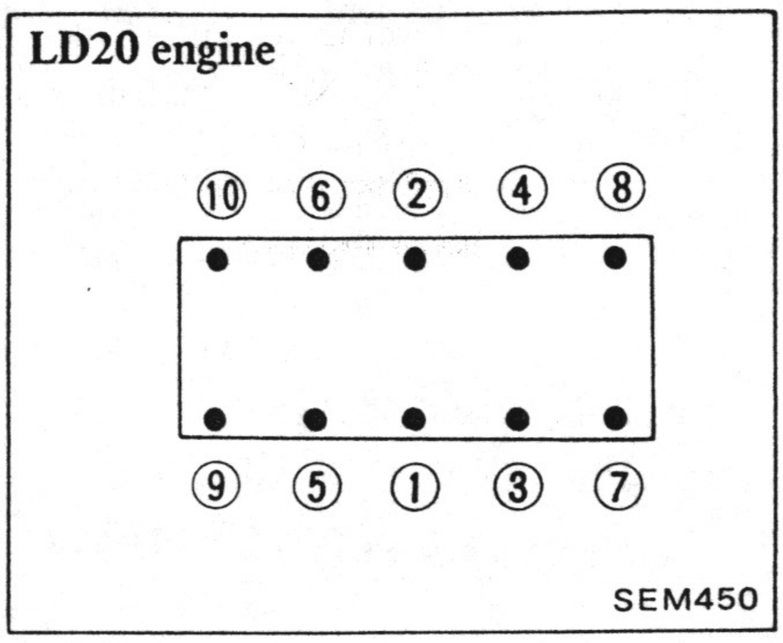




(2) Apply engine oil to main bearing surfaces on both sides of cylinder block and cap.
(3) Install crankshaft.
(4) Install main bearing cap and tighten bolts to specified torque.

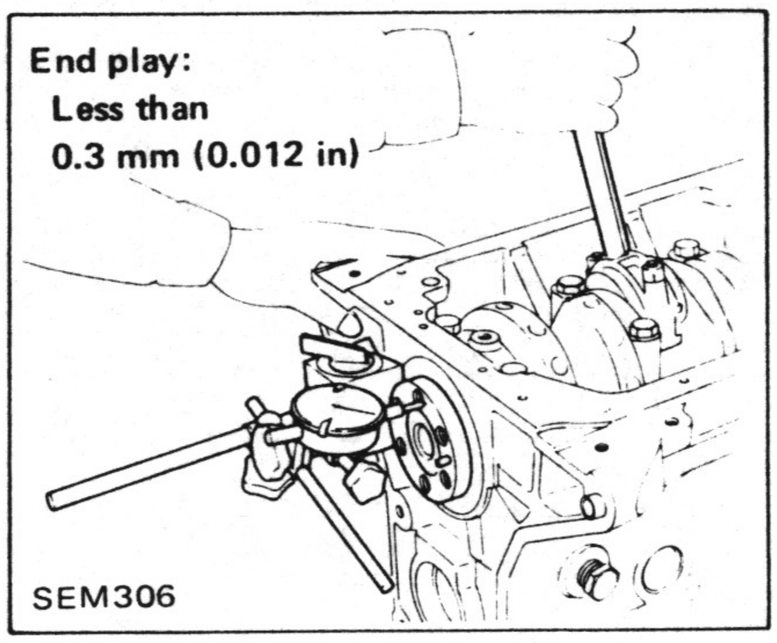
Ⓣ : **Main bearing cap bolts**
69 - 83 N·m
(7.0 - 8.5 kg-m,
51 - 61 ft-lb)

a. Apply sealant to each side of rear main bearing cap and each corner of cylinder block. Refer to Precautions.
b. Arrange the parts so that the arrow mark on bearing cap faces toward the front of engine.
c. Prior to tightening bearing cap bolts, place bearing cap in proper position by shifting crankshaft in the axial direction.
d. Tighten bearing cap bolts gradually in separating two to three stages and in sequence outwardly from center bearing.

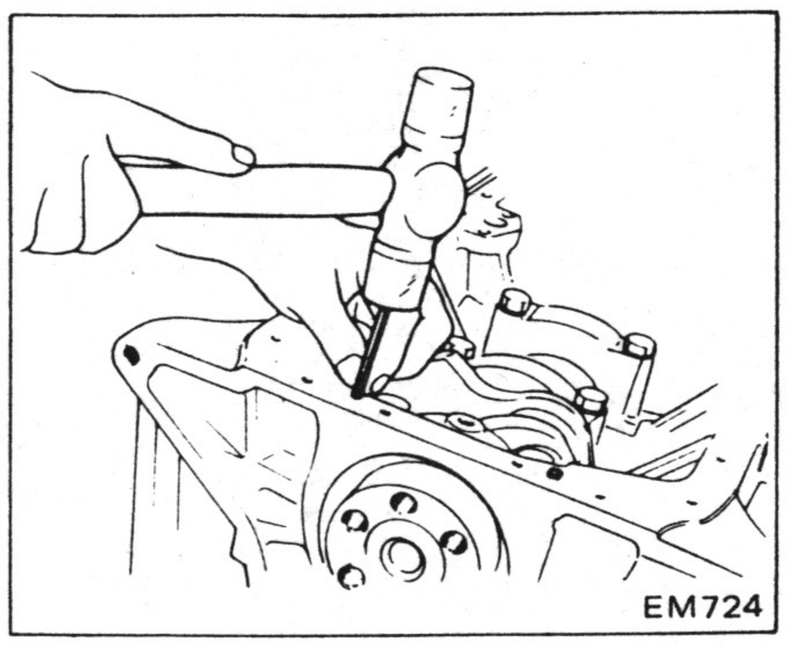


e. After securing bearing cap bolts, ascertain that crankshaft turns smoothly by hand.

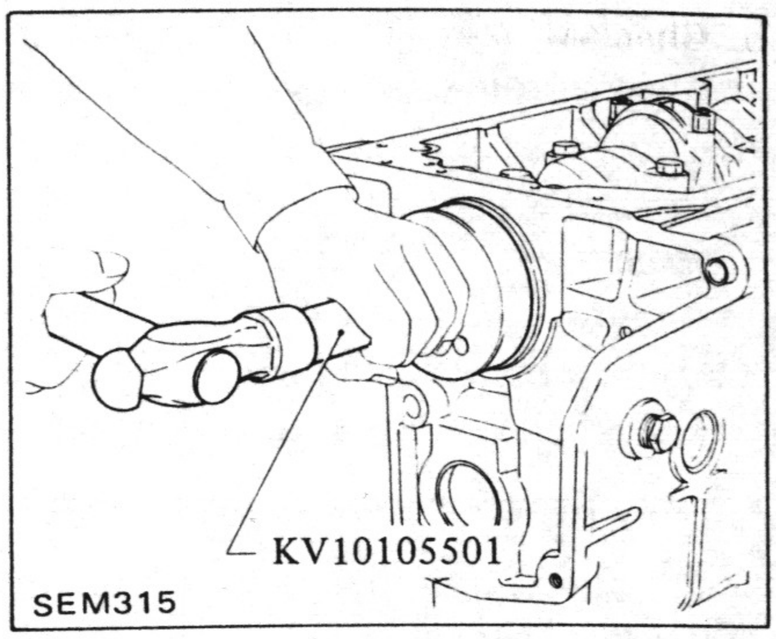
(5) Make sure that there exists proper end play at crankshaft.



2. Side oil seals. Apply sealant to these seals. Then install them into main bearing cap.

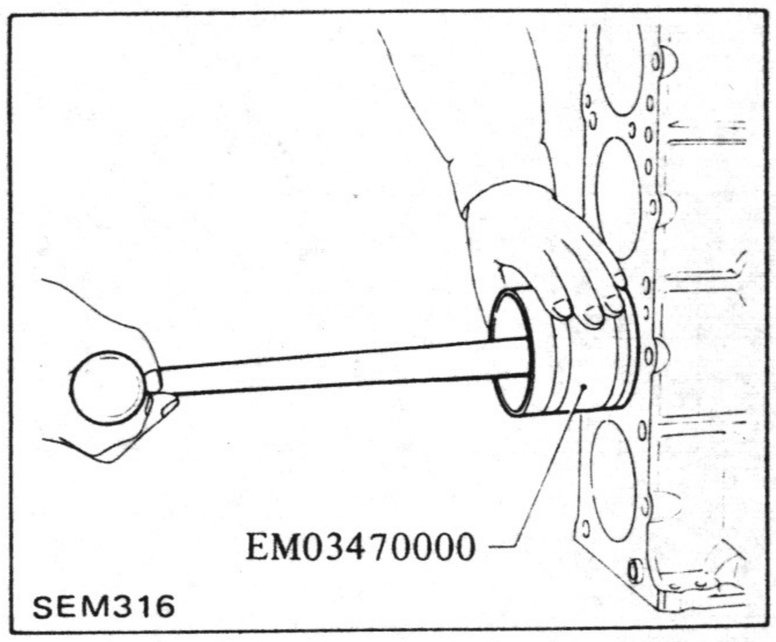


3. Rear oil seal. Install rear oil seal by using Tool.

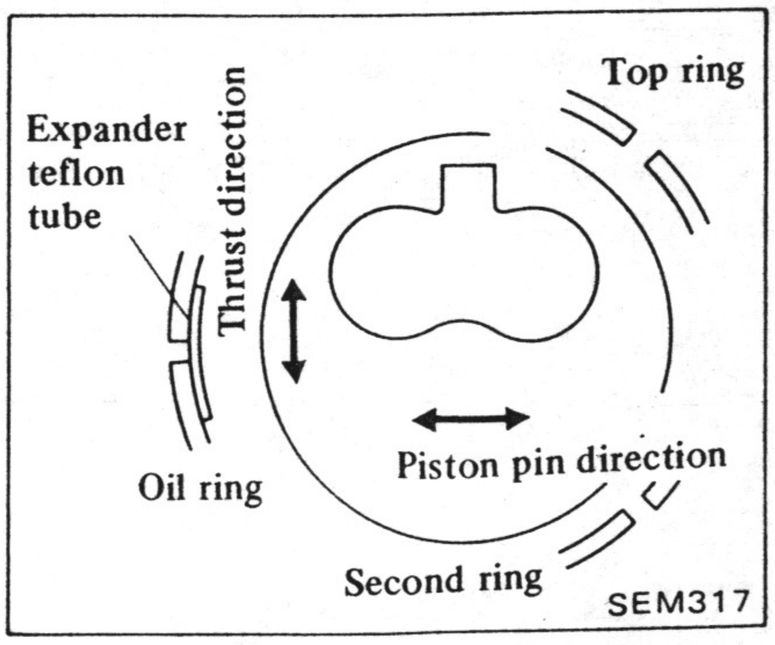


a. When installing oil seal, give coating of engine oil to mating shaft to prevent scratches and folded lip. Also apply coating of oil to periphery of oil seal.
b. Install oil seal in the direction that dust seal lip faces to the outside of crankcase.

4. Piston with connecting rod
(1) Install them into corresponding cylinders using Tool.

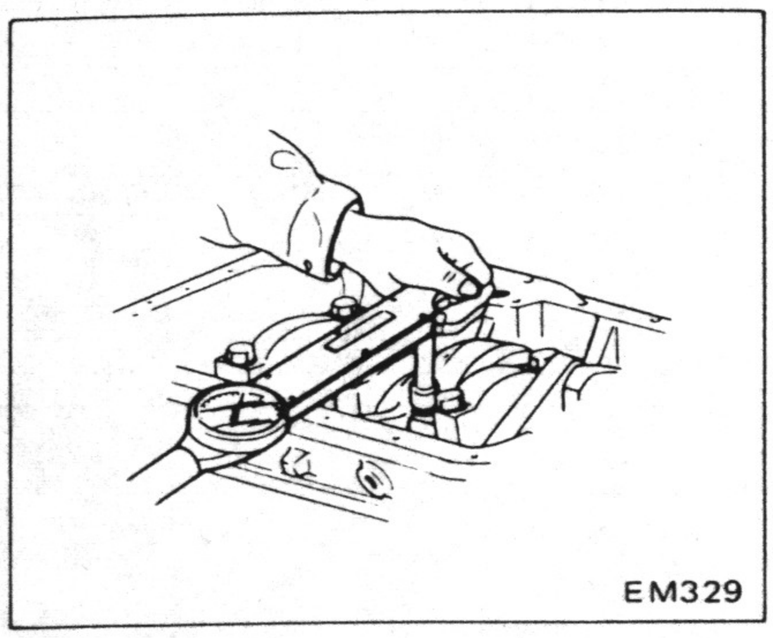


a. Apply engine oil to sliding parts.
b. Arrange so that the grade mark on piston head faces the front of engine.
c. Set piston rings as shown below.



(2) Install connecting rod caps.

Ⓣ : **Connecting rod big end nuts**
44 - 54 N·m
(4.5 - 5.5 kg-m,
33 - 40 ft-lb)

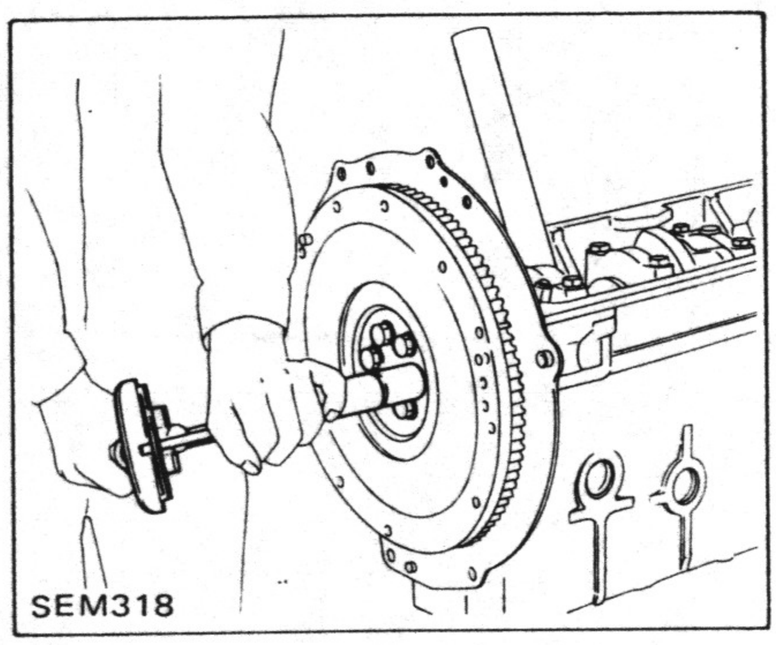

EM329

Arrange connecting rod and connecting rod caps so that the cylinder numbers face in the same direction.

(3) Make sure that there is sufficient play at the large end of the connecting rod. Refer to Inspection and Repair.

5. Install rear plate and flywheel or drive plate.

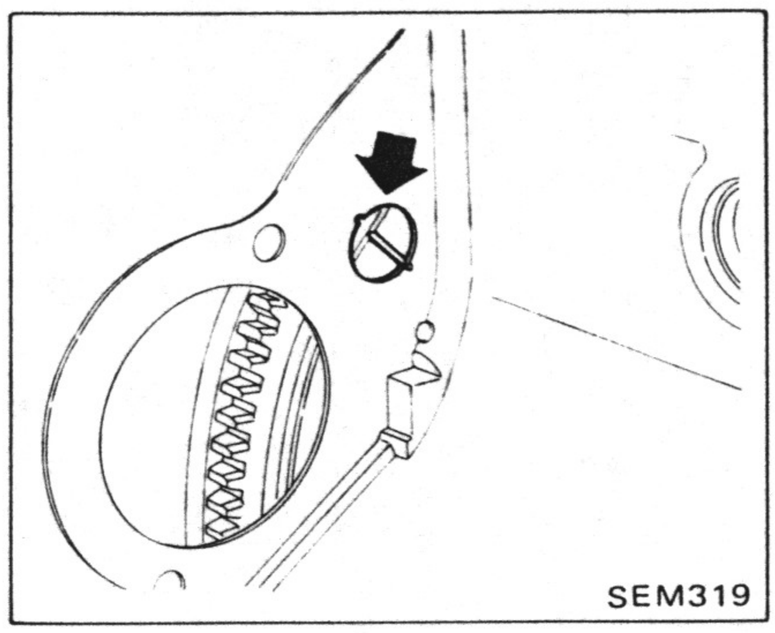
Ⓣ : **Flywheel or drive plate fixing bolts**
137 - 157 N·m
(14 - 16 kg-m,
101 - 116 ft-lb)


SEM318

6. Cylinder head assembly. Install it through gasket by accommodating knock pin of cylinder block as follows:

(1) Thoroughly clean cylinder block and head surface. Do not apply sealant to any other part of cylinder block or head surface.

(2) Rotate crankshaft until timing marks on flywheel and rear plate are properly aligned. Make sure that No.1 piston is at T.D.C. on its compression stroke.


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(3) When installing cylinder head, set intake and exhaust valve for No. 1 piston its compression stroke by turning camshaft.

(4) Temporarily tighten two center bolts.

a. **Final tightening should be carried out after installing chain and front cover.**
b. **Do not rotate crankshaft and camshaft separately, because valves will hit piston heads.**
c. **Always use new cylinder head gasket.**
d. **There are two kinds of cylinder head bolts with different length.**

INSTALLING TIMING CHAIN

1. Install crankshaft sprocket, oil pump drive gear and oil thrower.

(1) Make sure that the mating marks of crankshaft sprocket face front.

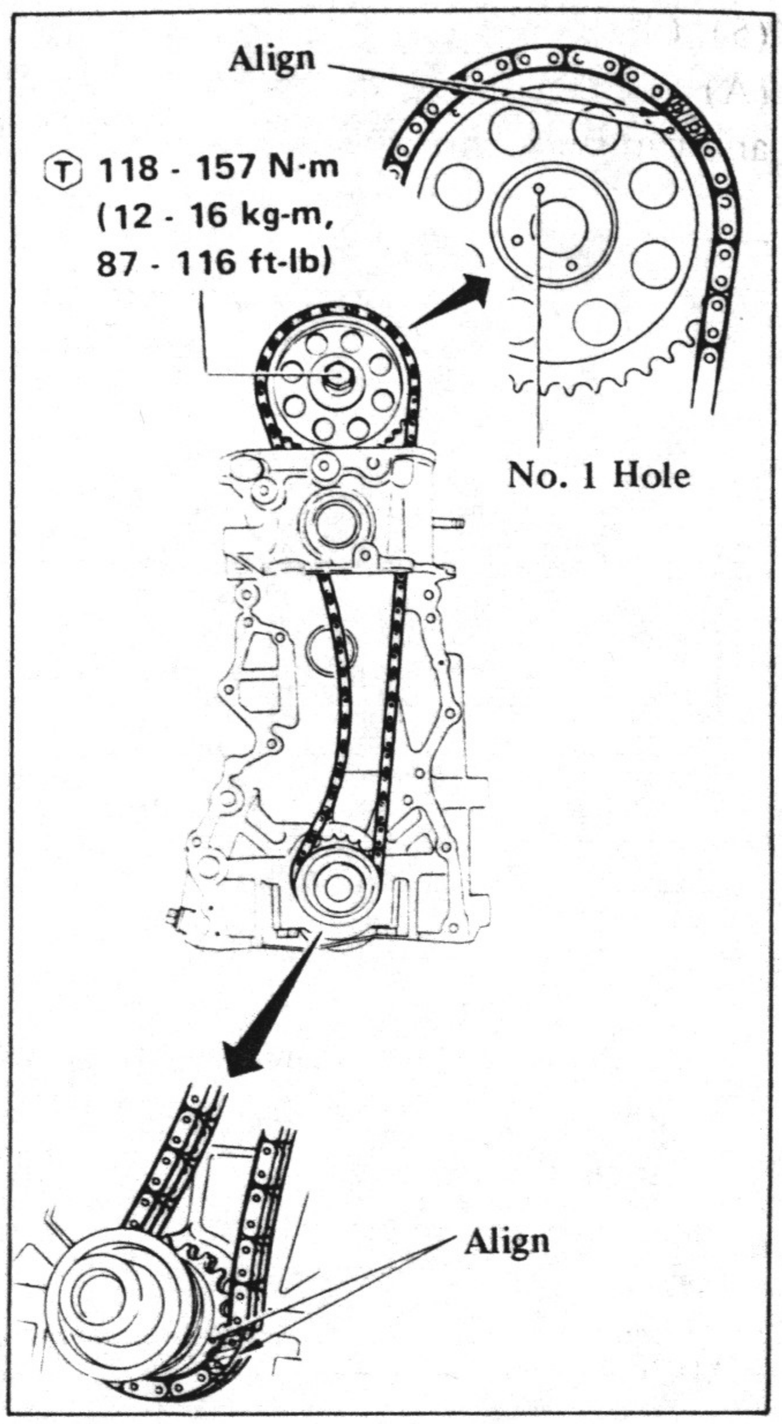
(2) Install oil pump drive gear so that large chamfered inner side faces rearward.

2. Install timing chain.

(1) Align timing marks on chain and crankshaft sprocket properly.

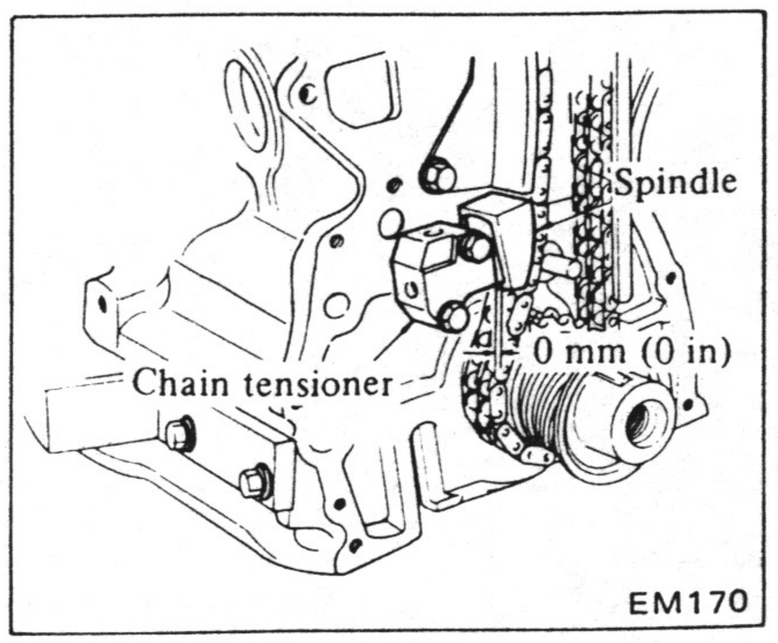
(2) Align No. 1 mark on camshaft sprocket with timing mark on chain.

(3) Insert camshaft dowel pin into No. 1 hole in camshaft sprocket, and install camshaft sprocket bolt.



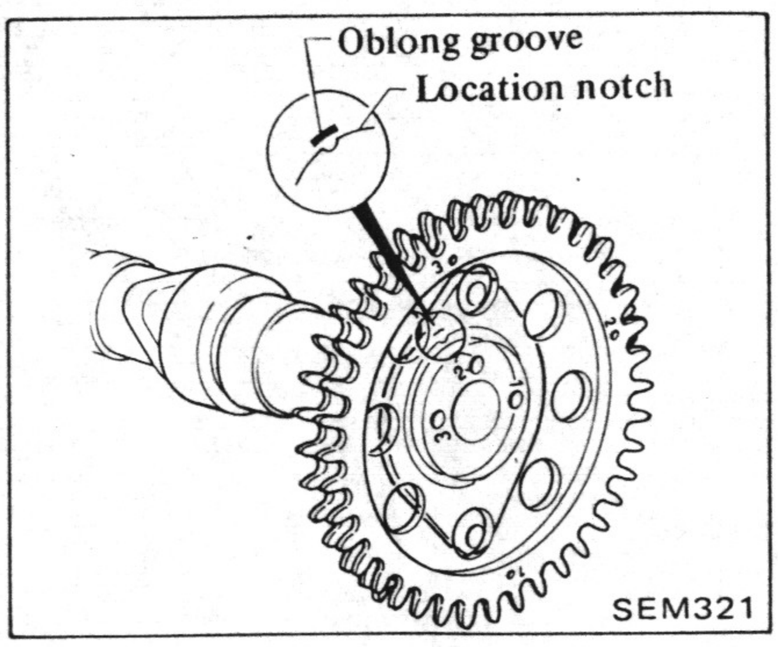
(4) Install chain guide and chain tensioner. Then tighten slack side chain guide mounting bolt so that protrusion of chain tensioner spindle is 0 mm (0 in).

Ⓣ : **Chain guide and chain tensioner mounting bolt**
6 - 10 N·m
(0.6 - 1.0 kg-m,
4.3 - 7.2 ft-lb)

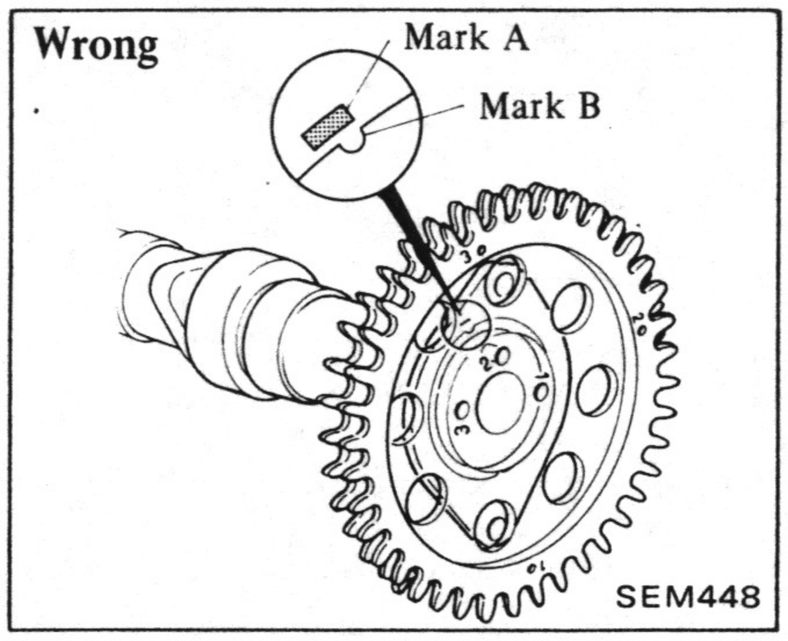


EM170

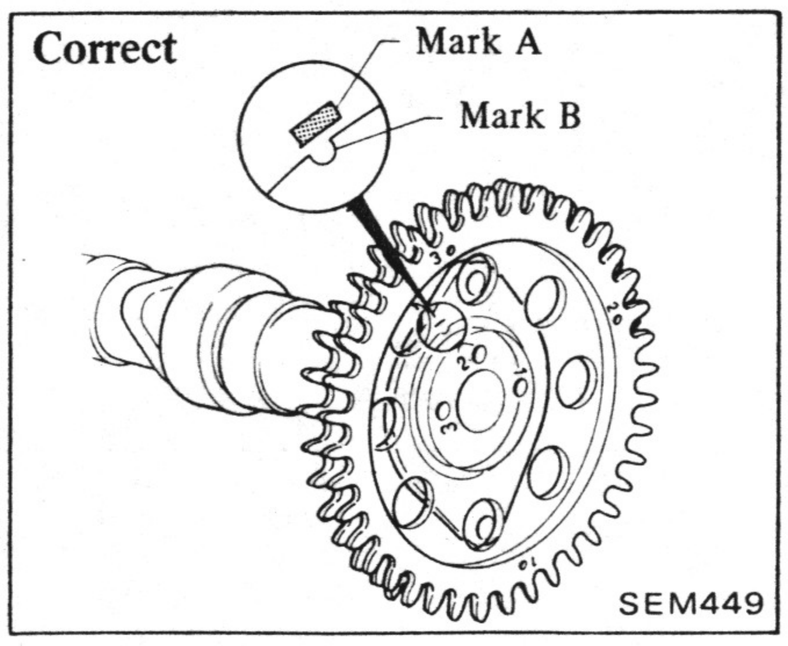
(5) Check relative positions of marks (A) and (B) on camshaft locating plate and camshaft sprocket.



If relative positions of these two marks are as shown in figure below, change the position of dowel hole in camshaft sprocket and reinstall sprocket.



After reinstalling camshaft sprocket, check marks (A) and (B) to ensure that they are in correct position, as shown in figure below.

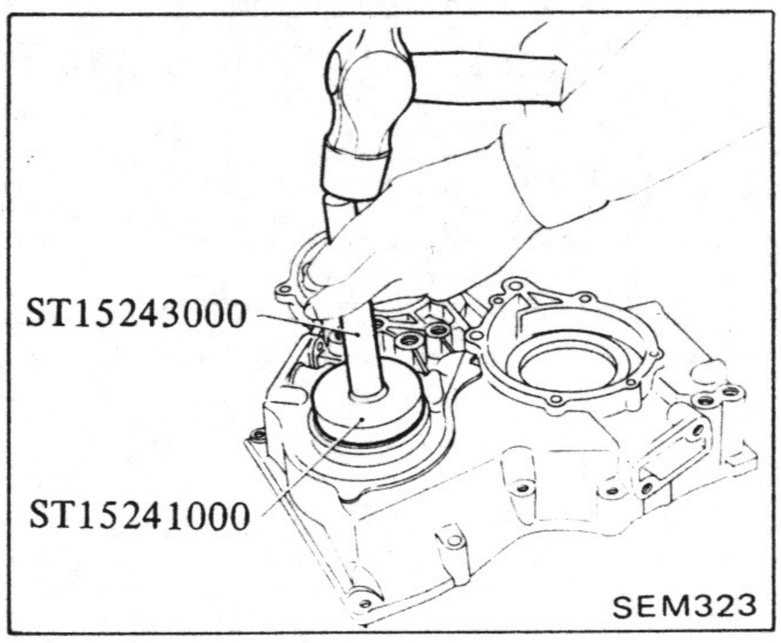


a. **Align No. 2 mark on camshaft sprocket with mark on chain.**
b. **Camshaft sprocket should be installed by accommodating its No. 2 hole to camshaft knock pin.**
c. **Make sure both marks on locating plate and camshaft sprocket are on right side.**
d. **If mark is displaced to left side, utilize No. 3 hole in camshaft sprocket and adjust.**
e. **If mark is still on left side although adjustment is made at No. 3 hole in camshaft sprocket, replace chain.**

INSTALLING FRONT SIDE PARTS

1. Install front cover with gasket in place observing the following:

a. **Before installing front cover, using Tool new oil seal in front cover in the direction that dust seal lip faces to the outside of front cover.**



b. **Apply sealant to gaskets and sealing portions designated. Refer to Precautions.**
c. **Apply coating of engine oil to periphery of oil seal.**

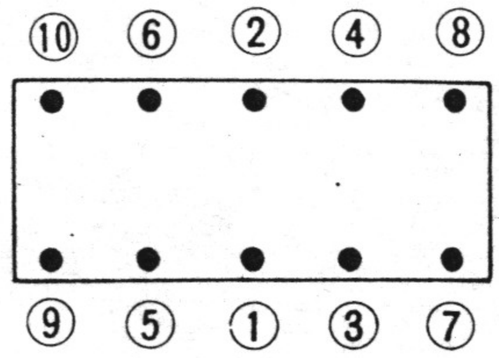
2. Tighten temporarily front cover to cylinder block bolts and cylinder head to front cover bolts.

Check the height difference between cylinder block upper face and front cover upper face. Its difference must be less than 0.15 mm (0.0059 in).

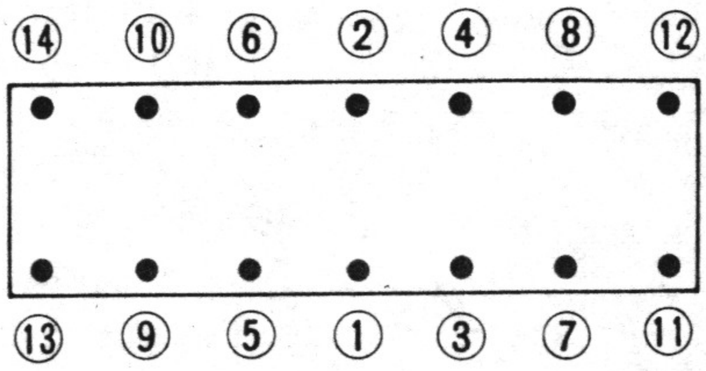
3. Tighten cylinder head bolts to the specified torque in several steps in the sequence as follows.

Ⓣ : **Cylinder head bolt**
118 - 127 N·m
(12 - 13 kg-m,
87 - 94 ft-lb)

LD20 engine



LD28 engine



4. Finally tighten front cover to cylinder block bolts and cylinder head to front cover bolts.

Ⓣ : **Front cover bolts**

	N·m	kg-m	ft-lb
M8 (4T)	9 - 12	0.9 - 1.2	6.5 - 8.7
M6 (4T)	4 - 5	0.4 - 0.5	2.9 - 3.6

Ⓣ : **Cylinder head to front cover bolts**
5.3 - 7.3 N·m
(0.54 - 0.74 kg-m,
3.9 - 5.4 ft-lb)

5. Injection pump

For details concerning injection pump, refer to Section EF.

(1) Install injection pump.

Ⓣ : **Nut**
16 - 21 N·m
(1.6 - 2.1 kg-m,
12 - 15 ft-lb)
Bracket bolt
30 - 35 N·m
(3.1 - 3.6 kg-m,
22 - 26 ft-lb)

(2) Install injection pump drive gear.

Ⓣ : **Drive gear nut**
59 - 69 N·m
(6.0 - 7.0 kg-m,
43 - 51 ft-lb)

(3) Install injection pump drive crank pulley.

Ⓣ : **Crank pulley bolt**
137 - 157 N·m
(14.0 - 16.0 kg-m,
101 - 116 ft-lb)

(4) Install tensioner pulley.

Ⓣ : **Tensioner shaft**
30 - 40 N·m
(3.1 - 4.1 kg-m,
22 - 30 ft-lb)

Spring set pin
30 - 40 N·m
(3.1 - 4.1 kg-m,
22 - 30 ft-lb)

(5) Install drive belt.

6. Install dust cover.

Ⓣ : **Dust cover bolt**
4 - 5 N·m
(0.4 - 0.5 kg-m,
2.9 - 3.6 ft-lb)

7. Install crank pulley.

Ⓣ : **Crank damper pulley bolt**
22 - 27 N·m
(2.2 - 2.8 kg-m,
16 - 20 ft-lb)

8. Install water pump assembly.

Ⓣ : **Water pump bolt**

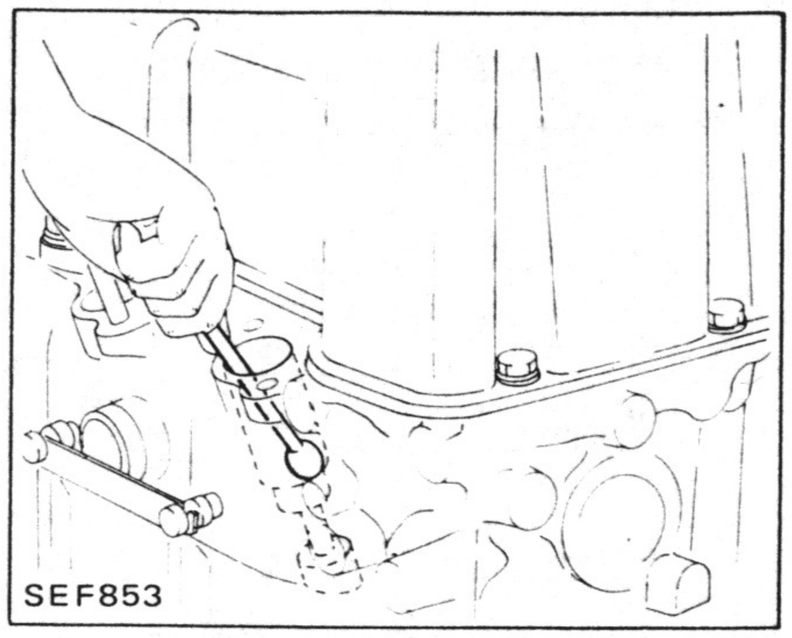
	N·m	kg-m	ft-lb
M8	9 - 12	0.9 - 1.2	6.5 - 8.7
M6	4 - 5	0.4 - 0.5	2.9 - 3.6

9. Install fan pulley, fan coupling and fan.
10. Install idler pulley for power steering (If so equipped).

INSTALLING SIDE PARTS AND OIL PAN

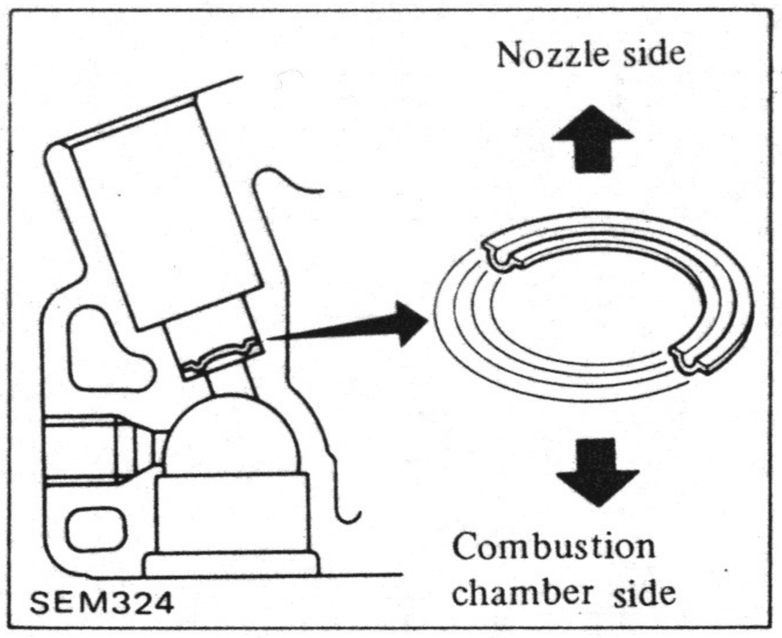
1. Install engine right side parts.
- Nozzle washers and nozzle assembly.

a. Always clean nozzle holes.


SEF853

b. Do not reuse nozzle washers after removal, but rather install new ones.

c. Install nozzle washers as follows:



SEM324

Ⓣ : **Nozzle to cylinder head**
16 - 21 N·m
(1.6 - 2.1 kg-m,
12 - 15 ft-lb)

- Injection tubes

Ⓣ : **Flare nut**
22 - 25 N·m
(2.2 - 2.5 kg-m,
16 - 18 ft-lb)

- Spill tube

15 - 18 N·m
(1.5 - 1.8 kg-m,
11 - 13 ft-lb)

Replace spill tube washers with new ones.

- Fuel return hose
- Oil cooler and coolant hoses with oil filter

Ⓣ : **Oil cooler bracket bolt**
16 - 21 N·m
(1.6 - 2.1 kg-m,
12 - 15 ft-lb)

- Engine mounting brackets

Ⓣ : **Bracket bolt**
20 - 29 N·m
(2.0 - 3.0 kg-m,
14 - 22 ft-lb)

- Oil level dipstick

2. Install left side engine parts.
- Oil feed pipe

Ⓣ : **Feed pipe bolt**
19 - 25 N·m
(1.9 - 2.5 kg-m,
14 - 18 ft-lb)

Always install a new manifold gasket.

- Intake, exhaust manifold and engine slinger

Always install a new manifold gasket.

Ⓣ : **Manifold upper (M10)**
32 - 36 N·m
(3.3 - 3.7 kg-m,
24 - 27 ft-lb)
Lower nut & bolt (M8)
17 - 21 N·m
(1.7 - 2.1 kg-m,
12 - 15 ft-lb)

- Thermostat housing and bottom bypass inlet with hose

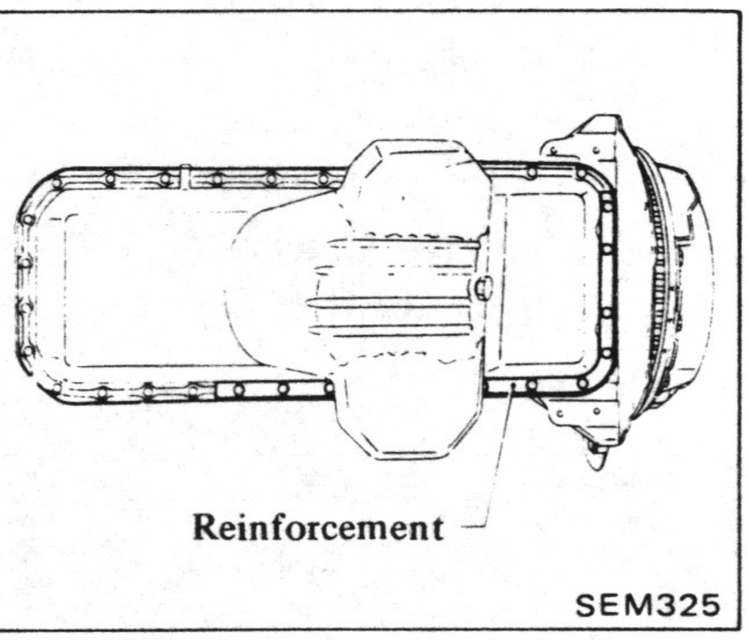
Always install a new gasket.

Ⓣ : **Thermostat housing bolt**
16 - 21 N·m
(1.6 - 2.1 kg-m,
12 - 15 ft-lb)
Bottom bypass inlet
10 - 12 N·m
(1.0 - 1.2 kg-m,
7 - 9 ft-lb)

3. Install oil strainer and oil pan with new gasket.

Ⓣ : **Oil strainer bolts**
9 - 12 N·m
(0.9 - 1.2 kg-m,
6.5 - 8.7 ft-lb)
Oil pan bolts
6 - 9 N·m
(0.6 - 0.9 kg-m,
4.3 - 6.5 ft-lb)

a. **Apply sealant to the designated portions. Refer to Precautions.**
b. **Oil pan should be tightened in a criss-cross pattern. Do not overtighten.**
c. **Always use new oil pan gasket.**
d. **Always install reinforcement on rear side of oil pan.**



4. Dismount engine from work stand and remove engine attachment.
5. Install following parts.
- Alternator bracket with oil feed pipe.

Ⓣ : **Alternator bracket bolt**
44 - 54 N·m
(4.5 - 5.5 kg-m,
33 - 40 ft-lb)

- Alternator assembly

Ⓣ : **Alternator to bracket**
29 - 39 N·m
(3 - 4 kg-m,
22 - 29 ft-lb)

- Fan belt

For details concerning clutch assembly (torque converter) and transmission, refer to Section MT of consolidated Service Manual for applied model.

6. After installing engine to vehicle, tune up engine. Refer to Section ET.
- Fill engine oil and coolant to the specified level.
- Adjust fan belt deflection.
- Adjust idle speed.
- Adjust valve clearance.
- Retighten cylinder head bolt.
- Bleeding fuel system. Refer to Section EF.

SERVICE DATA AND SPECIFICATIONS

GENERAL SPECIFICATIONS

Engine model		LD20	LD28
Cylinder arrangement		4, in-line	6, in-line
Displacement cm³ (cu in)		1,952 (119.11)	2,793 (170.43)
Bore and Stroke mm (in)		85.0 x 86.0 (3.346 x 3.386)	84.5 x 83.0 (3.327 - 3.268)
Valve arrangement		O.H.C.	
Firing order		1-3-4-2	1-5-3-6-2-4
Number of piston rings	Compression	2	
	Oil	1	
Number of main bearings		5	7
Compression ratio		22.2	22

INSPECTION AND ADJUSTMENT

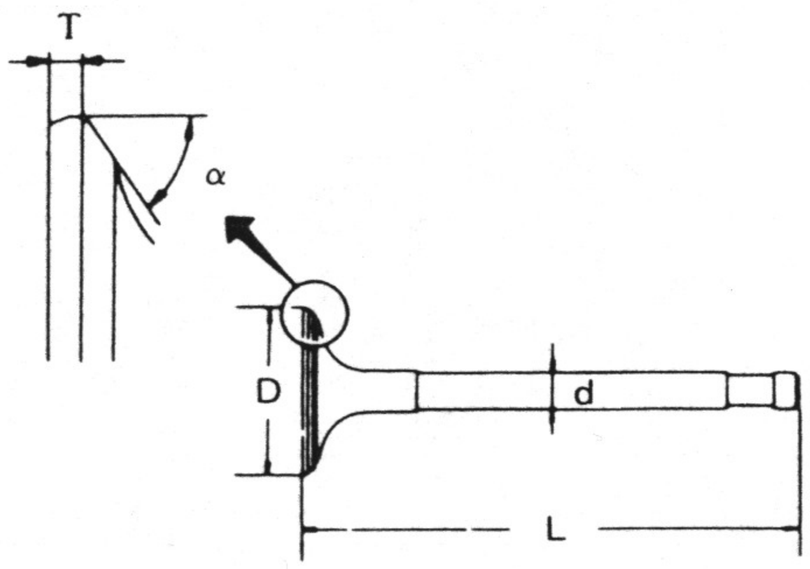
CYLINDER HEAD

Unit: mm (in)

	Standard	Limit
Head surface flatness	Less than 0.05 (0.0020)	0.1 (0.004)
Nominal height	89.5±0.1 (3.524±0.004)	

VALVE

Unit: mm (in)



SEM188

		LD28
Valve head diameter "D"	Intake	39.0 (1.535)
	Exhaust	32.0 (1.260)
Valve length "L"	Intake	116.83 - 117.27 (4.5996 - 4.6169)
	Exhaust	117.03 - 117.47 (4.6075 - 4.6248)
Valve stem diameter "d"	Intake	7.965 - 7.980 (0.3136 - 0.3142)
	Exhaust	7.945 - 7.960 (0.3128 - 0.3134)
Valve seat angle "α"		45° 30'
Valve margin "T" Limit		0.5 (0.020)
Valve stem end surface grinding limit		0.5 (0.020)
Valve clearance Hot	Intake	0.25 (0.010)
	Exhaust	0.30 (0.012)
Valve clearance Cold	Intake	0.18 (0.007)
	Exhaust	0.25 (0.010)

Valve spring

Free height mm (in)	49.77 (1.9594)
Pressure height mm/N (mm/kg, in/lb)	30.0/512.9 (30.0/52.3, 1.181/115.3)
Assembled height mm/N (mm/kg, in/lb)	40.0/226 (40.0/23, 1.575/51)
Out of square ("S") mm (in)	2.2 (0.087)

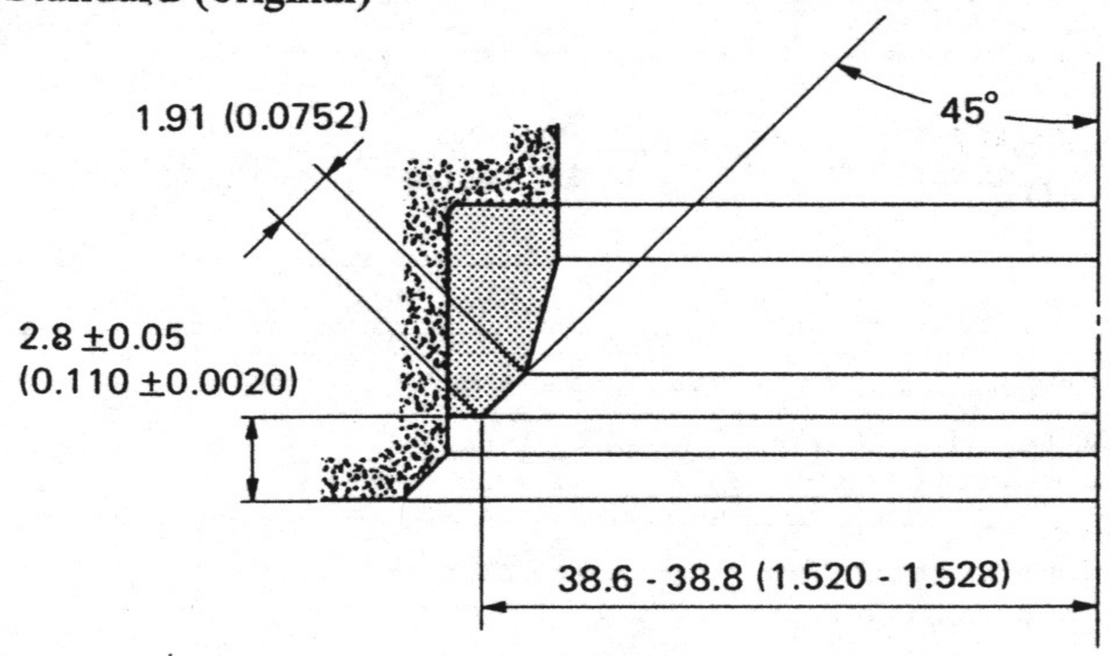
Valve guide

Unit: mm (in)

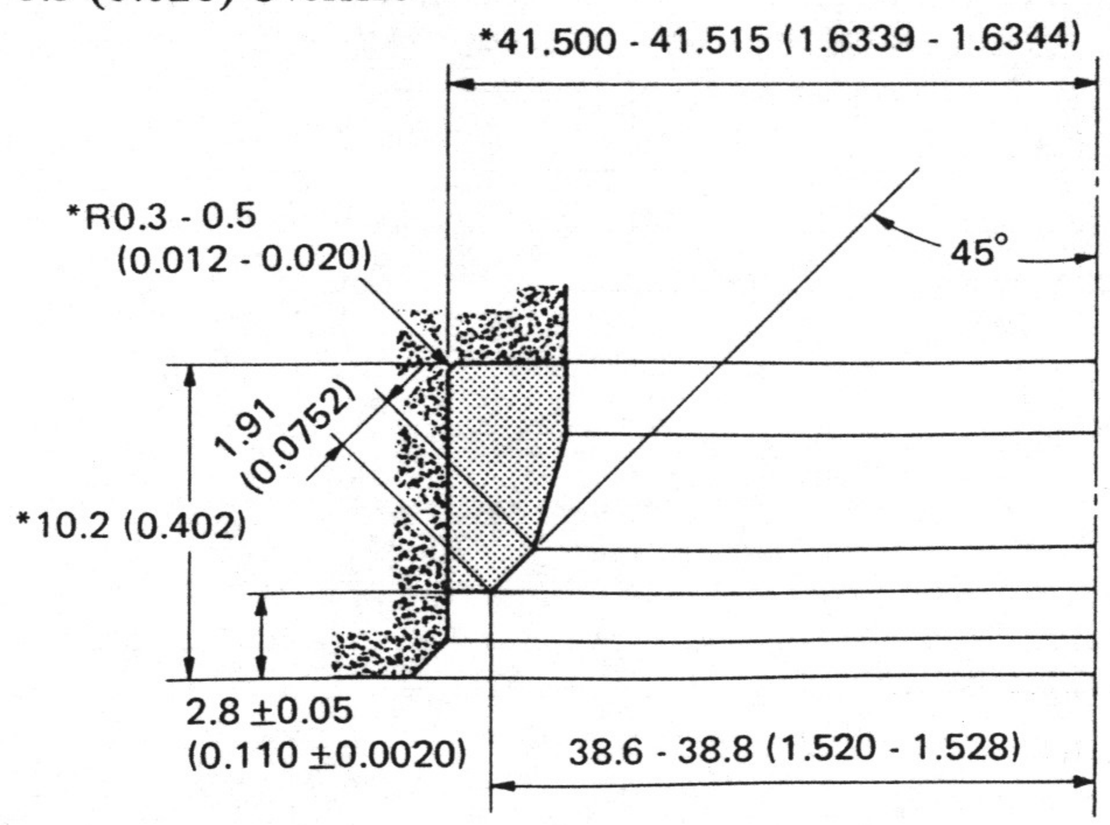
		Standard	Service
Valve guide Outer diameter		12.023 - 12.034 (0.4733 - 0.4738)	12.223 - 12.234 (0.4812 - 0.4817)
Valve guide Inner diameter [Finished size]		8.000 - 8.018 (0.3150 - 0.3157)	
Cylinder head valve guide hole diameter		11.985 - 11.996 (0.4718 - 0.4723)	12.185 - 12.196 (0.4797 - 0.4802)
Interference fit of valve guide		0.027 - 0.049 (0.0011 - 0.0019)	
		Standard	Max. tolerance
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.1 (0.004)
	Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	
Valve deflection limit		0.2 (0.008)	

Intake valve seat

Standard (original)



0.5 (0.020) Oversize



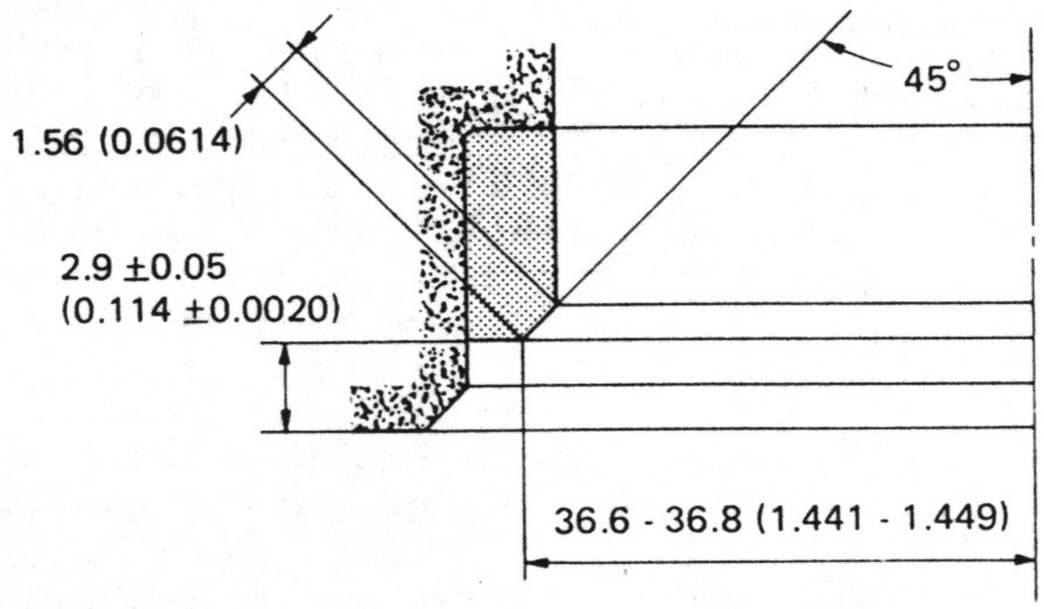
*Cylinder head machining data

Unit: mm (in)

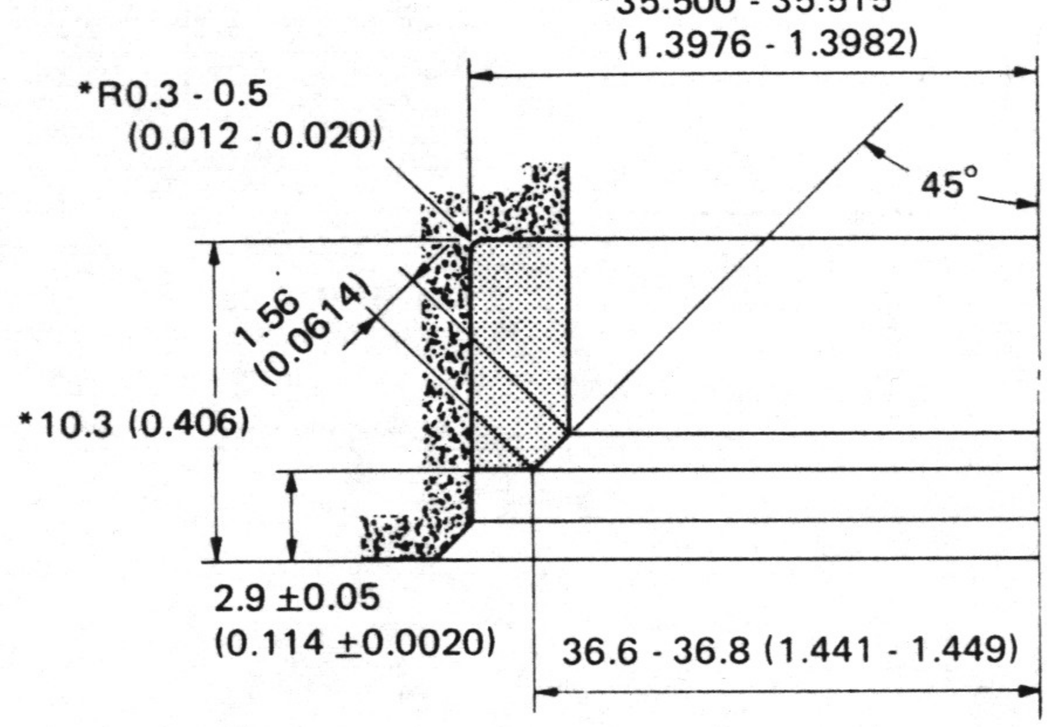
SEM334

Exhaust valve seat

Standard (original)



0.5 (0.020) Oversize



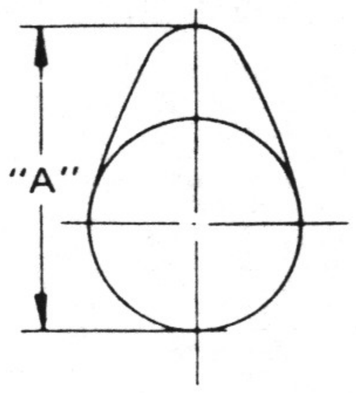
*Cylinder head machining data

Unit: mm (in)

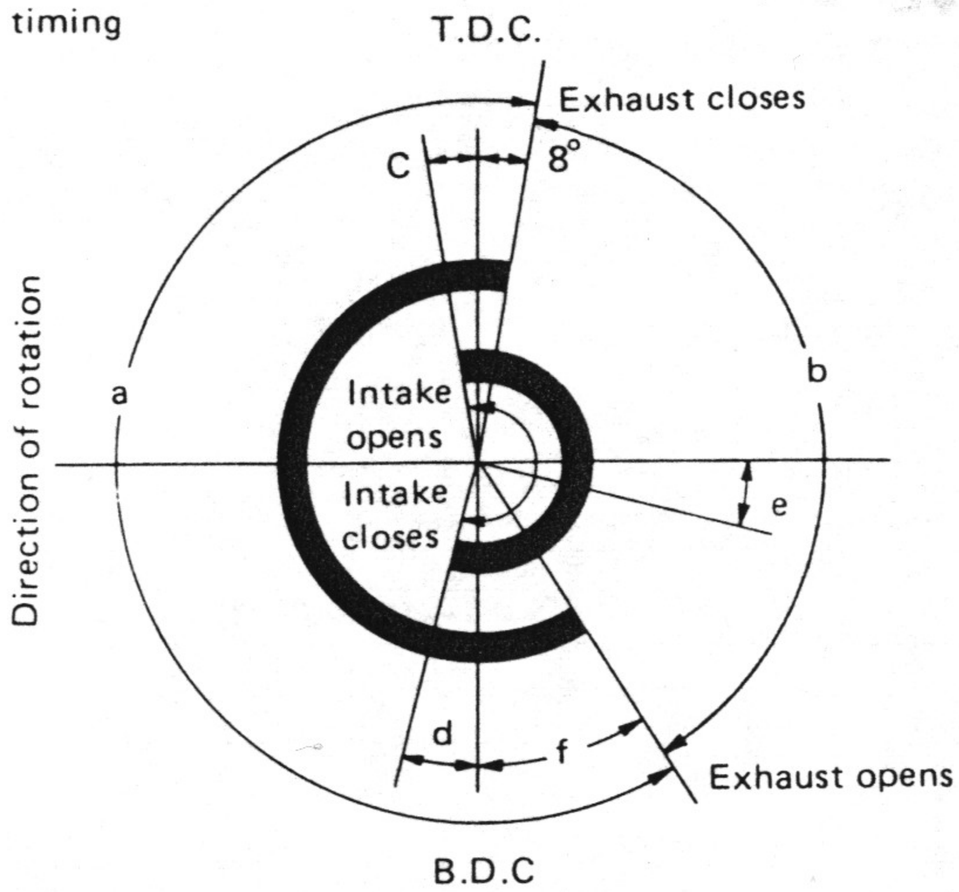
SEM335

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

		Standard	Max. tolerance
Camshaft journal to bearing clearance		0.038 - 0.067 (0.0015 - 0.0026)	0.1 (0.004)
Inner diameter of camshaft bearing		48.000 - 48.016 (1.8898 - 1.8904)	–
Outer diameter of camshaft journal		47.949 - 47.962 (1.8878 - 1.8883)	–
Camshaft bend [T.I.R.]		Less than 0.02 (0.0008)	0.05 (0.0020)
Camshaft end play		0.08 - 0.38 (0.0031 - 0.0150)	
 EM671			
Cam height "A"	Intake	39.95 - 40.00 (1.5728 - 1.5748)	
	Exhaust	40.30 - 40.35 (1.5866 - 1.5886)	
Wear limit of cam height		0.15 (0.0059)	

Valve timing

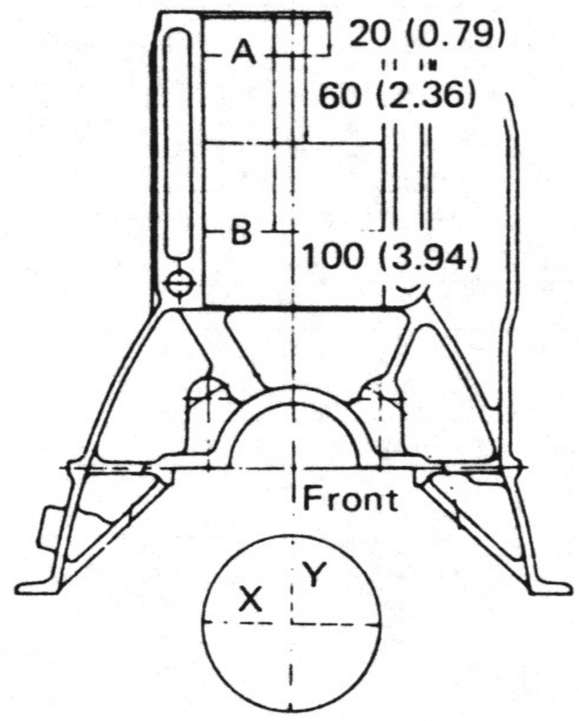


SEM332

a	b	c	d	e	f
248	232	14	38	12	60

CYLINDER BLOCK

Unit: mm (in)



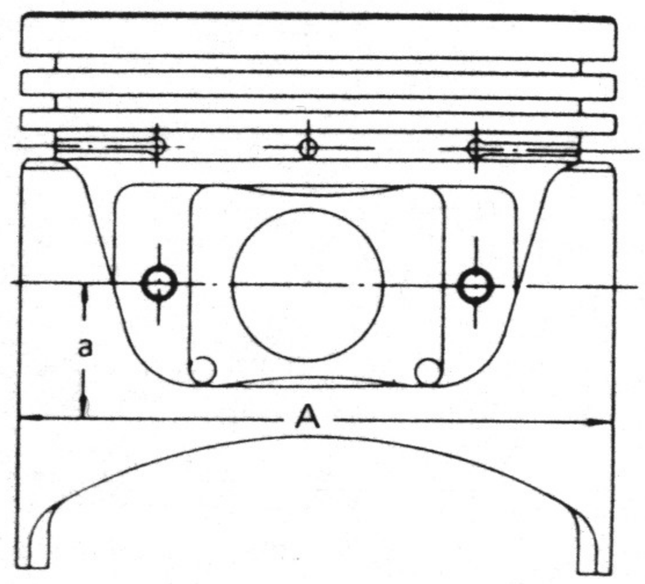
EM125

			Standard	Wear limit
Surface flatness			Less than 0.05 (0.0020)	0.10 (0.0039)
Cylinder bore	Inner diameter	LD20	85.000 - 85.050 (3.3465 - 3.3484)	–
		LD28	84.500 - 84.550 (3.3268 - 3.3287)	
	Out-of-round (X-Y)		Less than 0.02 (0.0008)	–
	Taper (A-B)		Less than 0.02 (0.0008)	–
Difference in inner diameter between cylinders			Less than 0.05 (0.0020)	–
Piston to cylinder clearance			0.05 - 0.07 (0.0020 - 0.0028)	–
Nominal height (From crankshaft center)			227.45±0.05 (8.9547±0.0020)	

PISTON, PISTON RING AND PISTON PIN

Piston

Unit: mm (in)



EM714

Piston skirt diameter "A"	Standard		LD20	84.94 - 84.99 (3.3441 - 3.3461)
			LD28	84.44 - 84.49 (3.3244 - 3.3264)
	Oversize	0.5 (0.020)	LD20	85.44 - 85.49 (3.3638 - 3.3657)
			LD28	84.94 - 84.99 (3.3441 - 3.3461)
		1.0 (0.039)	LD20	85.94 - 85.99 (3.3835 - 3.3854)
			LD28	85.44 - 85.49 (3.3638 - 3.3657)
"a" dimension				About 20 (0.79)
Piston pin hole diameter				24.991 - 24.999 (0.9839 - 0.9842)
Piston clearance to cylinder block				0.05 - 0.07 (0.0020 - 0.0028)

Piston ring

Unit: mm (in)

			Standard	Limit
Side clearance	Top		0.060 - 0.100 (0.0024 - 0.0039)	0.2 (0.008)
	2nd		0.040 - 0.080 (0.0016 - 0.0031)	0.15 (0.0059)
	Oil		0.030 - 0.070 (0.0012 - 0.0028)	0.1 (0.004)
Ring gap	Top	Without mark	0.20 - 0.29 (0.0079 - 0.0114)	0.6 (0.024)
		With mark	0.14 - 0.22 (0.0055 - 0.0087)	
	2nd		0.20 - 0.35 (0.0079 - 0.0138)	0.8 (0.031)
	Oil (rail ring)		0.30 - 0.45 (0.0118 - 0.0177)	1.0 (0.039)

Piston pin

Unit: mm (in)

Piston pin outer diameter	24.994 - 25.000 (0.9840 - 0.9843)
Piston pin to piston clearance	0 - 0.004 (0 - 0.0002)
Interference fit of piston pin to connecting rod	0.025 - 0.044 (0.0010 - 0.0017)

CONNECTING ROD

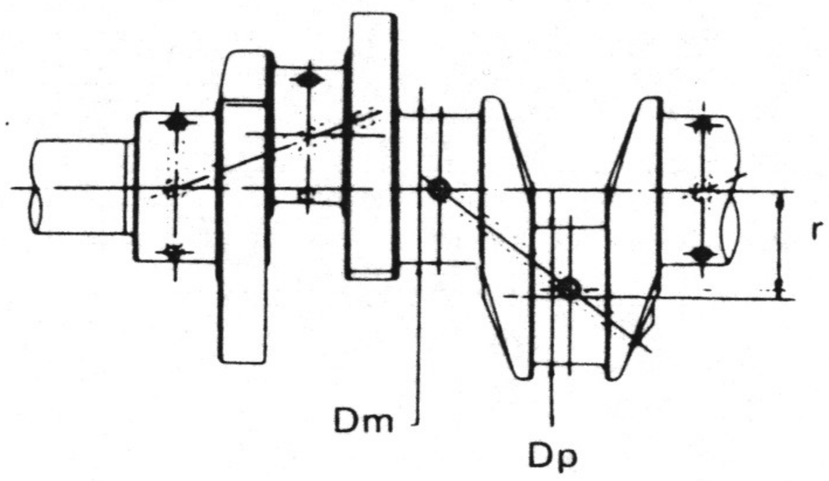
Unit: mm (in)

Center distance		LD20	138.5 (5.4527)
		LD28	140 (5.5118)
Bend, Torsion [per 100 mm (3.94 in)]	Std.	Less than 0.025 (0.0010)	
	Limit	0.05 (0.0020)	
Piston pin bore dia.		25.025 - 25.038 (0.9852 - 0.9857)	
Big end play	Std.	0.2 - 0.3 (0.008 - 0.012)	
	Limit	0.6 (0.024)	

CRANKSHAFT

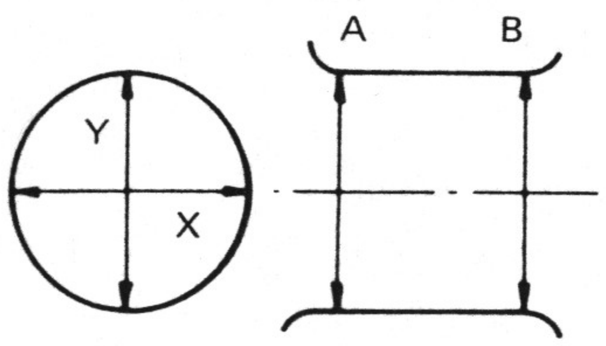
Unit: mm (in)

Main journal dia. "Dm"		LD20	59.942 - 59.955 (2.3599 - 2.3604)
		LD28	54.942 - 54.955 (2.1631 - 2.1636)
Pin journal dia. "Dp"		49.961 - 49.974 (1.9670 - 1.9675)	
Center distance "r"		LD20	43.00 (1.6929)
		LD28	41.5 (1.6339)
Out-of-round (X-Y) and taper (A-B)	Std.	Less than 0.01 (0.0004)	
	Limit	0.03 (0.0012)	
Bend [T.I.R.]	Std.	Less than 0.05 (0.0020)	
	Limit	0.10 (0.0039)	
Free end play	Std.	0.05 - 0.18 (0.0020 - 0.0071)	
	Limit	0.30 (0.0118)	
Pilot bushing insert distance		Approximately 4.0 (0.157)	



EM737

Out-of-round X-Y
Taper A-B



EM715

Main bearing undersize

Unit: mm (in)

	Crank journal diameter	
	LD20	LD28
STD	59.942 - 59.955 (2.3599 - 2.3604)	54.942 - 54.955 (2.1631 - 2.1636)
0.25 (0.0098) Undersize	59.692 - 59.705 (2.3501 - 2.3506)	54.692 - 54.705 (2.1532 - 2.1537)
0.50 (0.0197) Undersize	59.442 - 59.455 (2.3402 - 2.3407)	54.442 - 54.455 (2.1434 - 2.1439)
0.75 (0.0295) Undersize	59.192 - 59.205 (2.3304 - 2.3309)	54.192 - 54.205 (2.1335 - 2.1341)
1.00 (0.0394) Undersize	58.942 - 58.955 (2.3205 - 2.3211)	53.942 - 53.955 (2.1237 - 2.1242)

Connecting rod bearing undersize

Unit: mm (in)

	Crank pin diameter
STD	49.961 - 49.974 (1.9670 - 1.9675)
0.06 (0.0024) Undersize	49.901 - 49.914 (1.9646 - 1.9651)
0.12 (0.0047) Undersize	49.841 - 49.854 (1.9622 - 1.9628)
0.25 (0.0098) Undersize	49.711 - 49.724 (1.9571 - 1.9576)
0.50 (0.0197) Undersize	49.461 - 49.474 (1.9473 - 1.9478)
0.75 (0.0295) Undersize	49.211 - 49.224 (1.9374 - 1.9379)
1.00 (0.0394) Undersize	48.961 - 48.974 (1.9276 - 1.9281)

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Camshaft sprocket Runout [T.I.R.]	Less than 0.1 (0.004)
Flywheel Runout [T.I.R.]	Less than 0.15 (0.0059)

BEARING

Bearing clearance

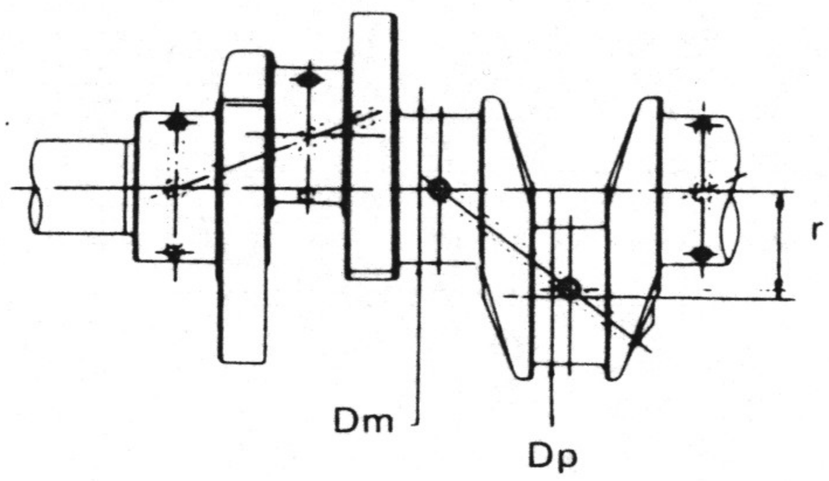
Unit: mm (in)

	Standard	Limit
Main bearing clearance	0.020 - 0.062 (0.0008 - 0.0024)	0.12 (0.0047)
Connecting rod bearing clearance	0.020 - 0.062 (0.0008 - 0.0024)	0.12 (0.0047)

CRANKSHAFT

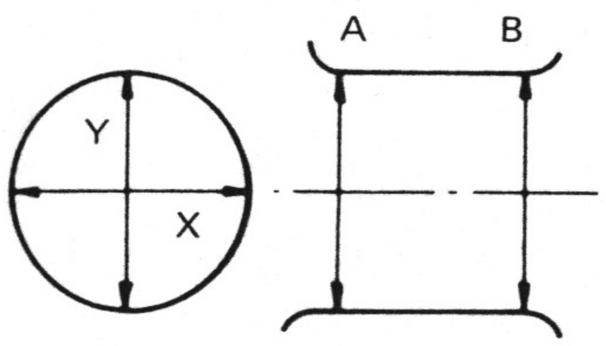
Unit: mm (in)

Main journal dia. "Dm"		LD20	59.942 - 59.955 (2.3599 - 2.3604)
		LD28	54.942 - 54.955 (2.1631 - 2.1636)
Pin journal dia. "Dp"		49.961 - 49.974 (1.9670 - 1.9675)	
Center distance "r"		LD20	43.00 (1.6929)
		LD28	41.5 (1.6339)
Out-of-round (X-Y) and taper (A-B)	Std.	Less than 0.01 (0.0004)	
	Limit	0.03 (0.0012)	
Bend [T.I.R.]	Std.	Less than 0.05 (0.0020)	
	Limit	0.10 (0.0039)	
Free end play	Std.	0.05 - 0.18 (0.0020 - 0.0071)	
	Limit	0.30 (0.0118)	
Pilot bushing insert distance		Approximately 4.0 (0.157)	



EM737

Out-of-round X-Y
Taper A-B



EM715

Main bearing undersize

Unit: mm (in)

	Crank journal diameter	
	LD20	LD28
STD	59.942 - 59.955 (2.3599 - 2.3604)	54.942 - 54.955 (2.1631 - 2.1636)
0.25 (0.0098) Undersize	59.692 - 59.705 (2.3501 - 2.3506)	54.692 - 54.705 (2.1532 - 2.1537)
0.50 (0.0197) Undersize	59.442 - 59.455 (2.3402 - 2.3407)	54.442 - 54.455 (2.1434 - 2.1439)
0.75 (0.0295) Undersize	59.192 - 59.205 (2.3304 - 2.3309)	54.192 - 54.205 (2.1335 - 2.1341)
1.00 (0.0394) Undersize	58.942 - 58.955 (2.3205 - 2.3211)	53.942 - 53.955 (2.1237 - 2.1242)

Connecting rod bearing undersize

Unit: mm (in)

	Crank pin diameter
STD	49.961 - 49.974 (1.9670 - 1.9675)
0.06 (0.0024) Undersize	49.901 - 49.914 (1.9646 - 1.9651)
0.12 (0.0047) Undersize	49.841 - 49.854 (1.9622 - 1.9628)
0.25 (0.0098) Undersize	49.711 - 49.724 (1.9571 - 1.9576)
0.50 (0.0197) Undersize	49.461 - 49.474 (1.9473 - 1.9478)
0.75 (0.0295) Undersize	49.211 - 49.224 (1.9374 - 1.9379)
1.00 (0.0394) Undersize	48.961 - 48.974 (1.9276 - 1.9281)

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Camshaft sprocket Runout [T.I.R.]	Less than 0.1 (0.004)
Flywheel Runout [T.I.R.]	Less than 0.15 (0.0059)

BEARING

Bearing clearance

Unit: mm (in)

	Standard	Limit
Main bearing clearance	0.020 - 0.062 (0.0008 - 0.0024)	0.12 (0.0047)
Connecting rod bearing clearance	0.020 - 0.062 (0.0008 - 0.0024)	0.12 (0.0047)

TIGHTENING TORQUE

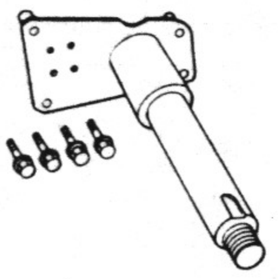
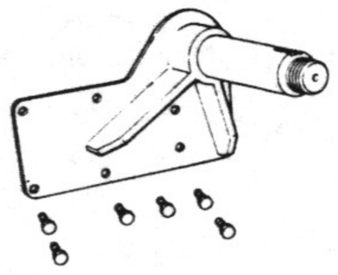
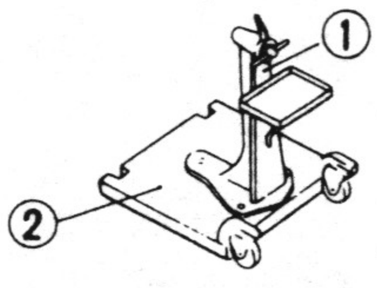
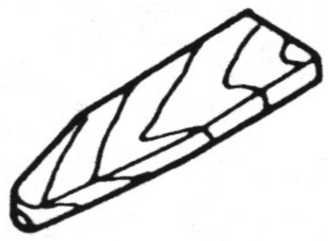
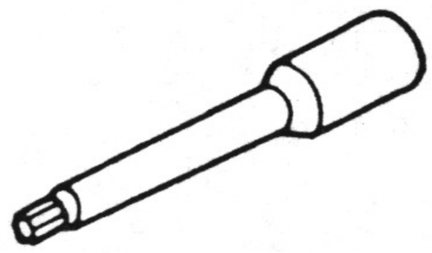
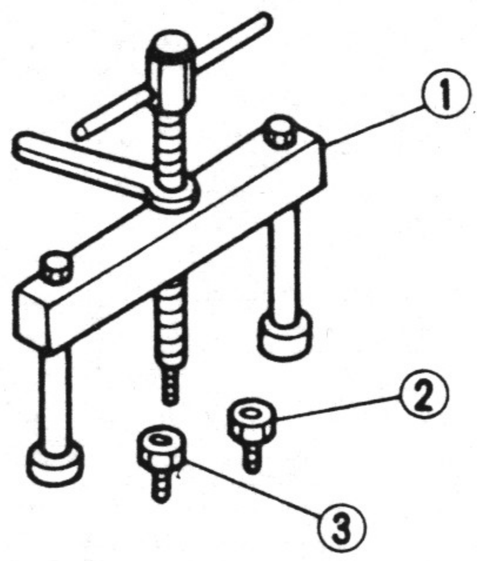
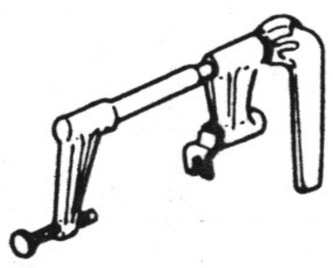
Engine outer parts

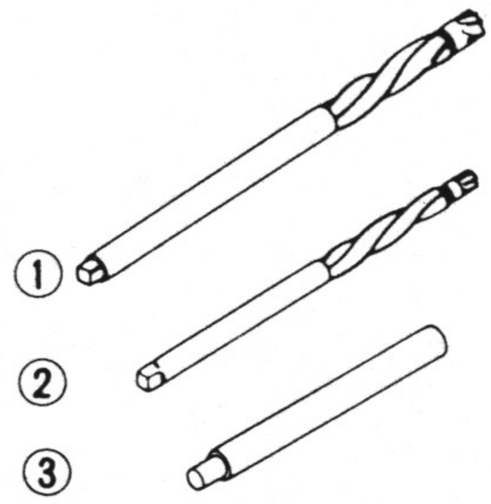
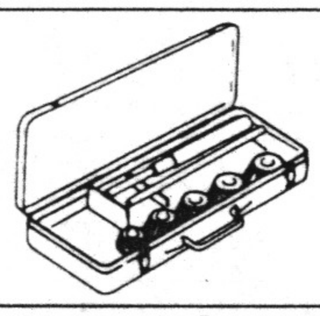
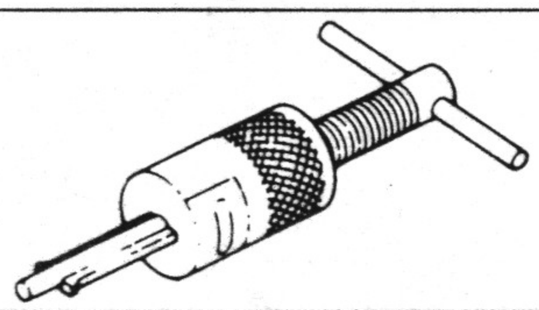
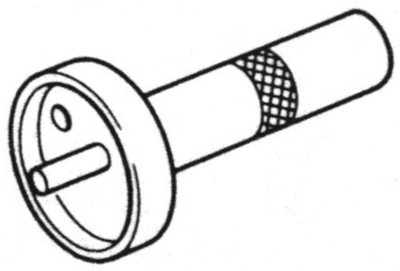
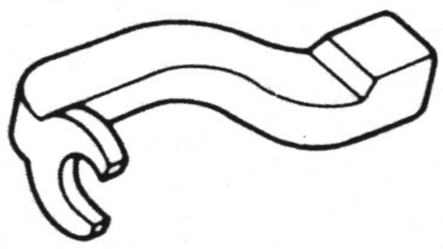
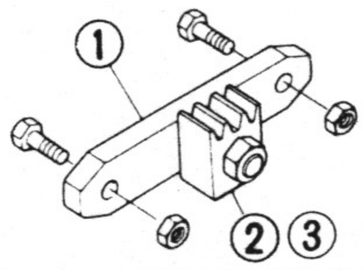
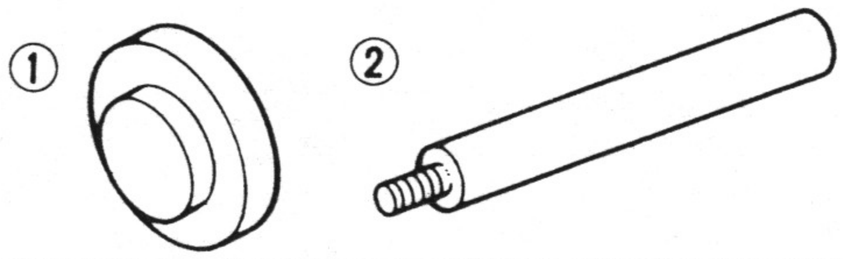
Unit		N·m	kg-m	ft-lb
Alternator bracket		44 - 54	4.5 - 5.5	33 - 40
Alternator to adjusting bar bolt		16 - 21	1.6 - 2.1	12 - 15
Alternator to bracket		29 - 39	3 - 4	22 - 29
Bottom bypass inlet		10 - 12	1.0 - 1.2	7 - 9
Crank damper pulley bolt		22 - 27	2.2 - 2.8	16 - 20
Crank pulley bolt		137 - 157	14.0 - 16.0	101 - 116
Dust cover bolt		4 - 5	0.4 - 0.5	2.9 - 3.6
Engine mounting bracket		20 - 29	2.0 - 3.0	14 - 22
Glow plug		20 - 25	2.0 - 2.5	14 - 18
Glow plug connecting plate		1.0 - 1.5	0.1 - 0.15	0.7 - 1.1
Injection pump bracket		30 - 35	3.1 - 3.6	22 - 26
Injection pump drive gear nut		59 - 69	6.0 - 7.0	43 - 51
Injection pump nut		16 - 21	1.6 - 2.1	12 - 15
Injection tube flare nut		22 - 25	2.2 - 2.5	16 - 18
Manifold Bolt and Nut	Upper bolt (M10)	32 - 36	3.3 - 3.7	24 - 27
	Lower nut & bolt (M8)	17 - 21	1.7 - 2.1	12 - 15
Nozzle holder to cylinder head nut		16 - 21	1.6 - 2.1	12 - 15
Oil cooler bracket bolt		16 - 21	1.6 - 2.1	12 - 15
Oil feed pipe bolt		19 - 25	1.9 - 2.5	14 - 18
Oil pump bolt		11 - 15	1.1 - 1.5	8 - 11
Power steering pump bracket bolt		22 - 29	2.2 - 3.0	16 - 22
Spill tube bolt		15 - 18	1.5 - 1.8	11 - 13
Spring set pin		30 - 40	3.1 - 4.1	22 - 30
Tensioner shaft		30 - 40	3.1 - 4.1	22 - 30
Thermostat housing		16 - 21	1.6 - 2.1	12 - 15
Vacuum pump pipe bolt		26 - 32	2.7 - 3.3	20 - 24
Water inlet bolt		10 - 12	1.0 - 1.2	7 - 9
Water outlet bolt		16 - 21	1.6 - 2.1	12 - 15
Water pump bolt	M6	4 - 5	0.4 - 0.5	2.9 - 3.6
	M8	9 - 12	0.9 - 1.2	6.5 - 8.7

Engine body parts

Unit		N·m	kg-m	ft-lb
Camshaft sprocket bolt		118 - 157	12 - 16	87 - 116
Camshaft thrust plate bolt		6 - 10	0.6 - 1.0	4.3 - 7.2
Chain guide bolt		6 - 10	0.6 - 1.0	4.3 - 7.2
Chain tensioner bolt		6 - 10	0.6 - 1.0	4.3 - 7.2
Connecting rod big end nut		44 - 54	4.5 - 5.5	33 - 40
Cylinder head bolt		118 - 127	12 - 13	87 - 94
Cylinder head to front cover bolt		5.3 - 7.3	0.54 - 0.74	3.9 - 5.4
Drive plate bolt (A/T)		137 - 157	14 - 16	101 - 116
Flywheel bolt (M/T)		137 - 157	14 - 16	101 - 116
Front cover bolt	M6	4 - 5	0.4 - 0.5	2.9 - 3.6
	M8	9 - 12	0.9 - 1.2	6.5 - 8.7
Main bearing cap bolt		69 - 83	7.0 - 8.5	51 - 61
Oil pan bolt		6 - 9	0.6 - 0.9	4.3 - 6.5
Oil pan drain plug		20 - 29	2.0 - 3.0	14 - 22
Oil strainer bolt		9 - 12	0.9 - 1.2	6.5 - 8.7
Pivot bushing bolt		78 - 118	8.0 - 12.0	58 - 87
Pivot lock nut		49 - 59	5.0 - 6.0	36 - 43
Rocker cover bolt		6 - 9	0.6 - 0.9	4.3 - 6.5

SPECIAL SERVICE TOOLS

Tool number	Tool name
ST19320000	Oil filter wrench 
KV11101900 (LD20 engine)	Engine attachment 
KV11101400 (LD28 engine)	Engine attachment 
ST0501S000 ① ST05011000 ② ST05012000	Engine stand assembly Engine stand Base 
KV10105800	Chain stopper 
ST10120000	Cylinder head bolt wrench 
KV101041S0 ① ST16511000 ② ST16512001 ③ ST16701001	Crankshaft main bearing cap puller Crankshaft main bearing puller Adapter Adapter 
ST12070000	Valve lifter 

Tool number	Tool name
KV101039S0 ① ST11081000 ② ST11032000 ③ ST11320000	Valve guide reamer set Reamer [12.2 mm (0.480 in) dia.] Reamer [8.0 mm (0.315 in) dia.] Drift 
ST11650001	Valve seat cutter set 
ST16610001	Pilot bushing puller 
KV10105501	Crankshaft rear oil seal drift 
EM03470000	Piston ring compressor 
ST10640001	Pivot adjuster 
KV30100100	Clutch aligning bar 
KV101056S0 ① KV10105610 ② KV10105630 ③ KV10105620	Engine stopper Plate and bolt Stopper B Stopper A (Useless) 
① ST15241000 ② ST15243000	Front oil seal drift Seal drift Bar 

ENGINE TUNE-UP

SECTION ET

ET

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TROUBLE DIAGNOSES AND CORRECTIONS ET-13

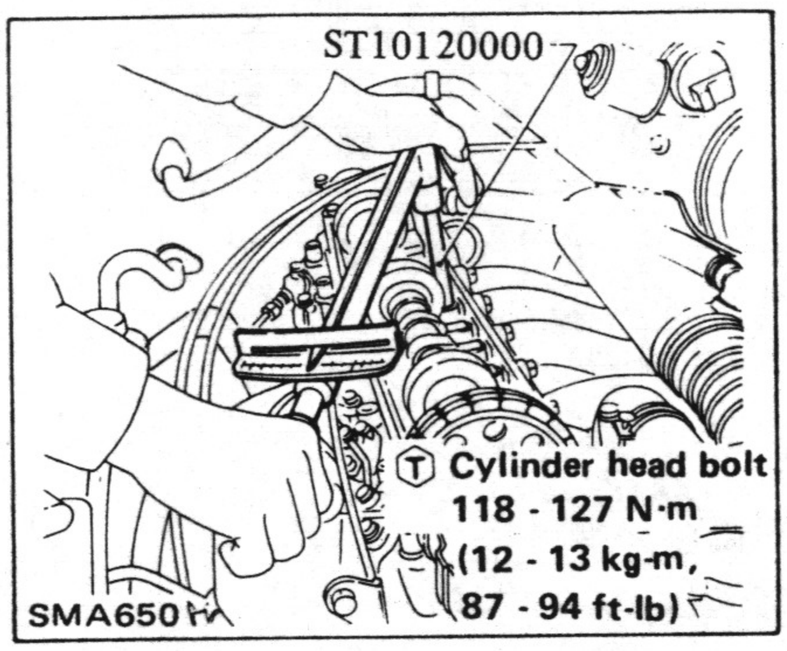
SPECIAL SERVICE TOOLS ET-25

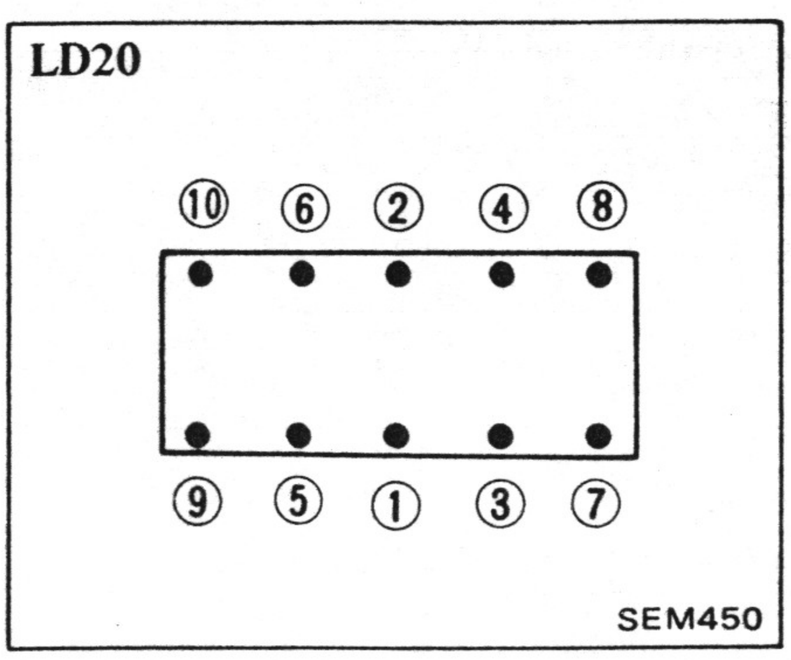
BASIC MECHANICAL SYSTEM

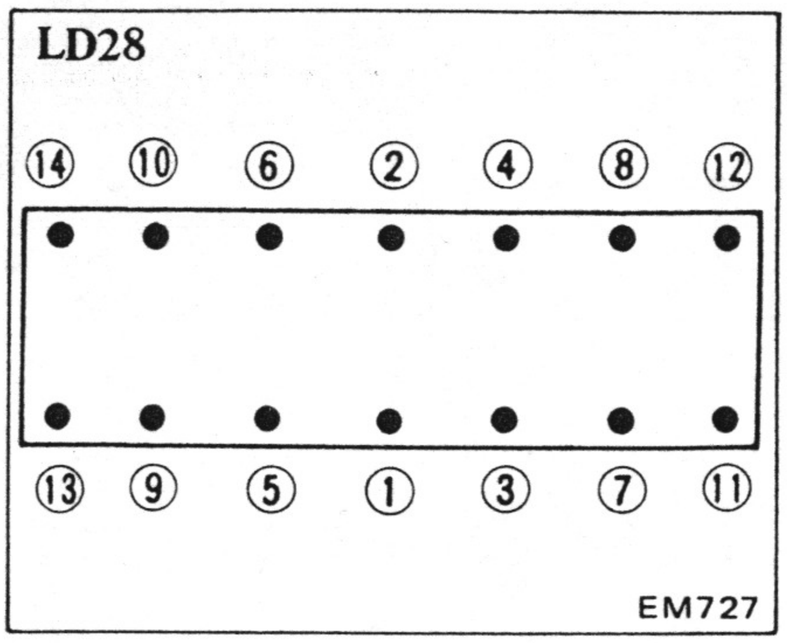
RETIGHTENING CYLINDER HEAD BOLTS, MANIFOLD NUTS

CYLINDER HEAD BOLTS

1. Run engine until coolant temperture indicator points to the middle of gauge, then stop engine.
2. Remove valve rocker cover.
3. Using Tool, tighten cylinder head bolts according to the order shown in figure, starting with the center and moving toward the ends.







4. Install valve rocker cover.

Ⓣ : **Valve rocker cover bolt**
6 - 9 N·m
(0.6 - 0.9 kg-m,
4.3 - 6.5 ft-lb)

MANIFOLD AND EXHAUST TUBE NUTS

WARNING:
Do not check the exhaust system until it has cooled off. Otherwise, you may burn yourself.

TIGHTENING TORQUE:

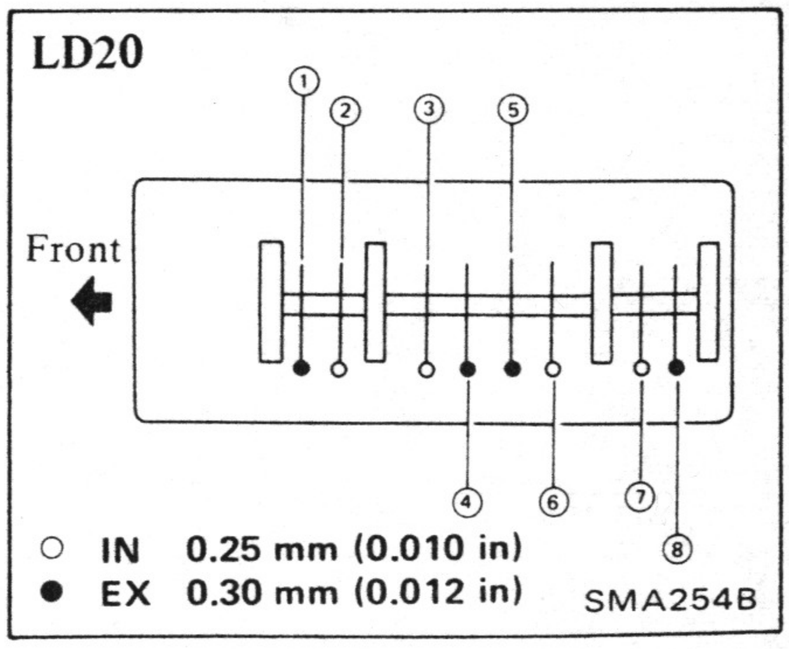
Unit		N·m	kg-m	ft-lb
Manifold	Bolt (M10)	32 - 36	3.3 - 3.7	24 - 27
	Bolt (M8)	17 - 21	1.7 - 2.1	12 - 15
	Nut	17 - 21	1.7 - 2.1	12 - 15
Exhaust tube		26 - 36	2.7 - 3.7	20 - 27

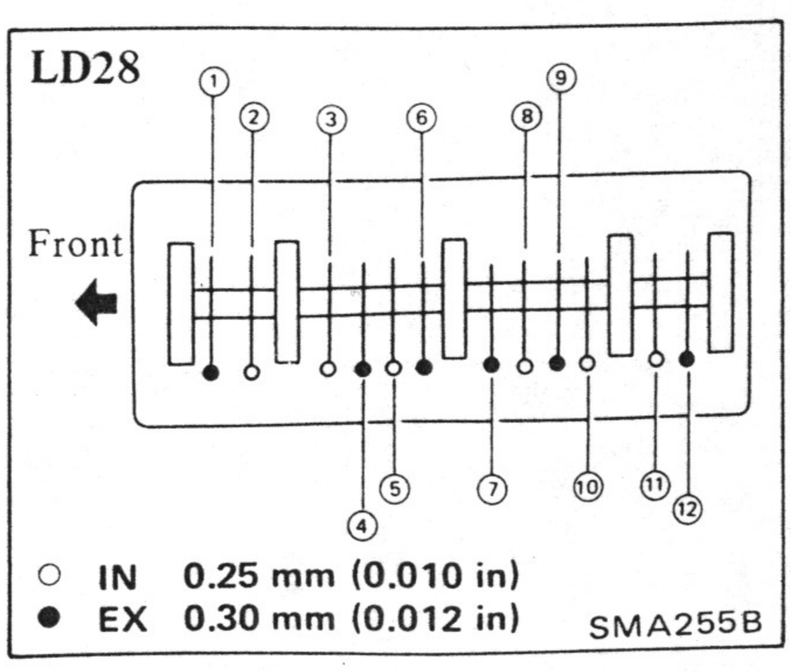
Never disassemble the intake manifold.

ADJUSTING INTAKE AND EXHAUST VALVE CLEARANCE

a. Adjustment should be made while engine is hot.
b. Adustment cannot be made while engine is in operation.
c. When rocker cover is removed to adjust intake and exhaust valve clearance, check elongation of timing chain. For details, refer to INSTALLING TIMING CHAIN in EM section.

To adjust, proceed as follows:
1. Remove valve rocker cover.
2. Set No. 1 cylinder at Top Dead Center on its compression stroke.
3. For LD20 engine, adjust clearance of half of the valves. Adjust ①, ②, ③ and ⑤ valves.
For LD28 engine, adjust ①, ②, ③, ⑥, ⑧ and ⑨ valves.
4. Set No. 4 (for LD20) or No. 6 (for LD28) cylinder at Top Dead Center on its compression stroke.
5. For LD20 engine, adjust ④, ⑥, ⑦ and ⑧ valves.





For LD28 engine, adjust ④ , ⑤ , ⑦ , ⑩ , ⑪ and ⑫ valves.

Valve clearance (Hot):

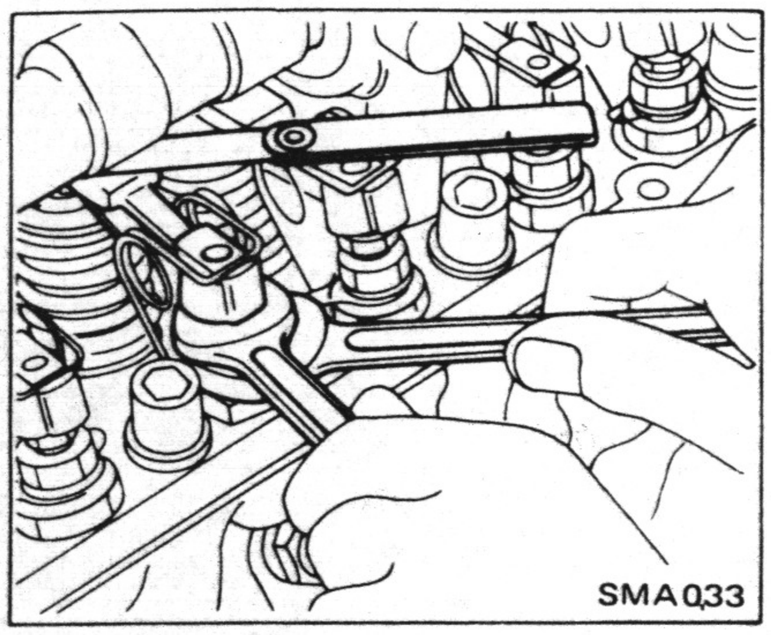
Intake

0.25 mm (0.010 in)

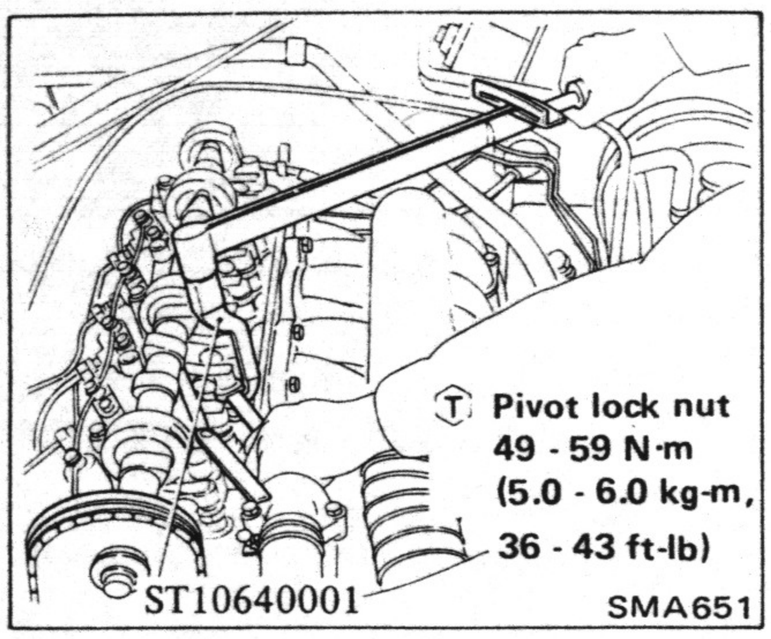
Exhaust

0.30 mm (0.012 in)

(1) If the clearance is not specified value, loosen pivot lock nut and turn valve rocker pivot to provide proper clearance.



(2) Hold valve rocker pivot and tighten pivot lock nut using Tool.



6. Install valve rocker cover.

Ⓣ : **Valve rocker cover bolt**

6 - 9 N·m

(0.6 - 0.9 kg-m,

4.3 - 6.5 ft-lb)

CHECKING AND ADJUSTING DRIVE BELT

1. Visually inspect for cracks or damage.

The belts should not touch the bottom of the pulley groove.

2. Check belt tension by pushing it.

The belts should deflect by the specified amount.

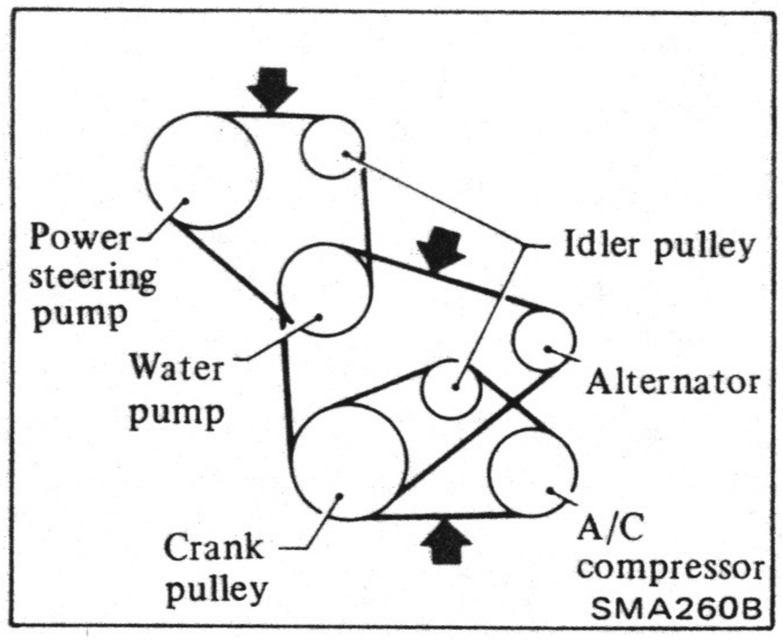
Drive belt deflection mm (in)

	Used belt deflection		Set deflection of new belt
	Limit	Adjust deflection	
Alternator	15 (0.59)	11 - 13* (0.43 - 0.51)	8 - 12 (0.31 - 0.47)
		12 - 14** (0.47 - 0.55)	10 - 12 (0.39 - 0.47)
A/C compressor	14 (0.55)	12 - 13 (0.47 - 0.51)	9 - 11 (0.35 - 0.43)
P/S oil pump	9 (0.35)	8 - 8.5 (0.315 - 0.335)	7 - 8 (0.28 - 0.31)

Pushing force: 98 N (10 kg, 22 lb)

* For 430 and C31 models equipped with LD28

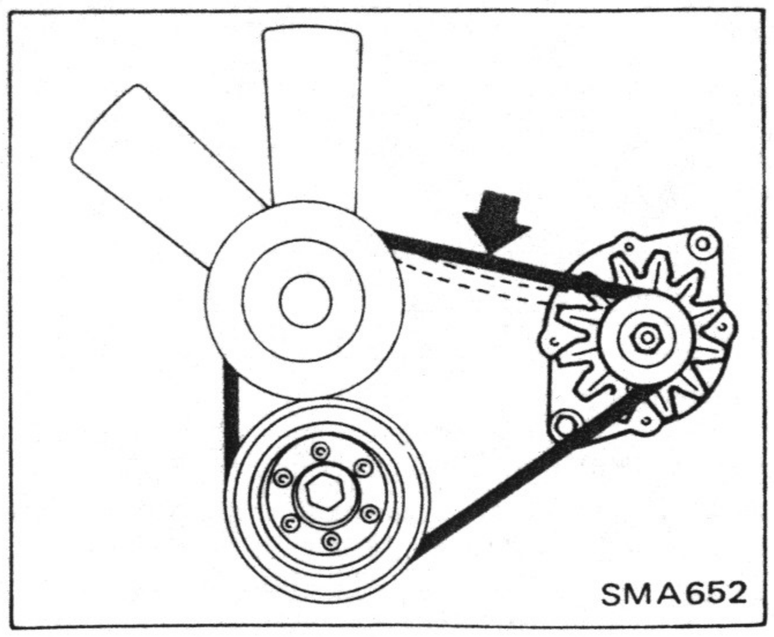
** For 910 and C120 models equipped with LD20



3. Adjust belt tension as follows:

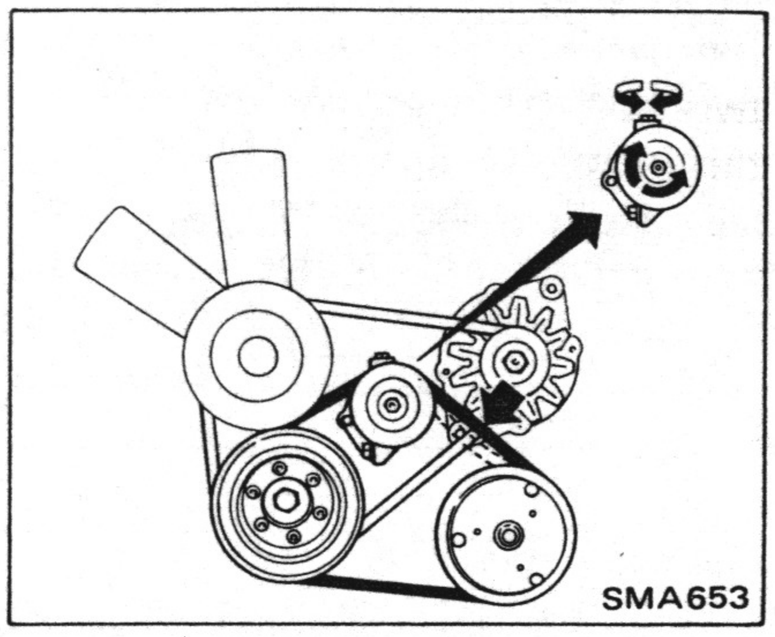
FAN BELT

1. Loosen alternator bracket bolts and adjusting bar bolt.
2. Move alternator until fan belt tension is within the specified range. Then tighten bracket bolts and adjusting bar bolt.



AIR CONDITIONER COMPRESSOR BELT

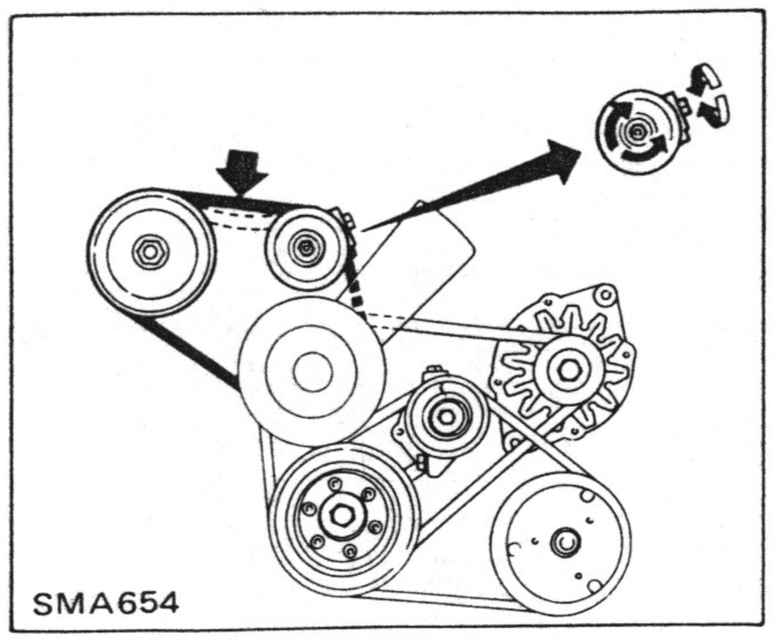
1. Loosen idler pulley lock nut.
2. Turn idler pulley adjusting bolt in either direction until air conditioner compressor belt's tension is within specified range.



3. Tighten idler pulley lock nut.

POWER STEERING PUMP BELT

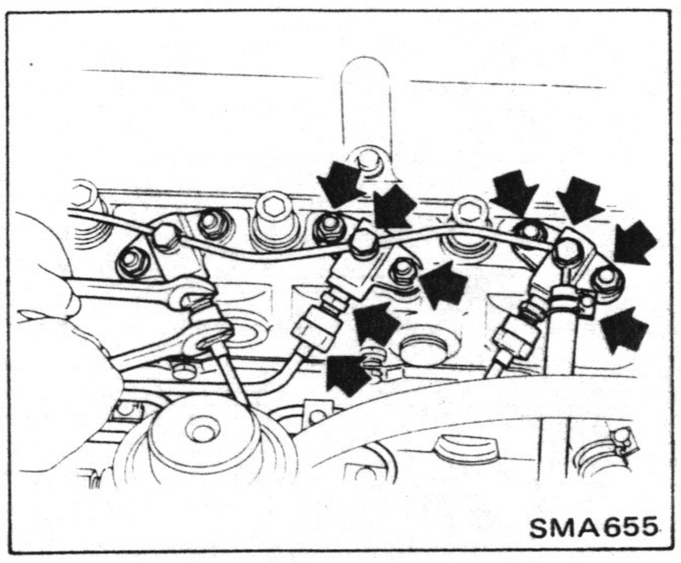
1. Loosen idler pully lock nut.
2. Turn idler pulley adjusting bolt in either direction until power steering pump belt's tension is within specified range.



3. Tighten idler pulley lock nut.

CHECKING ENGINE COMPRESSION

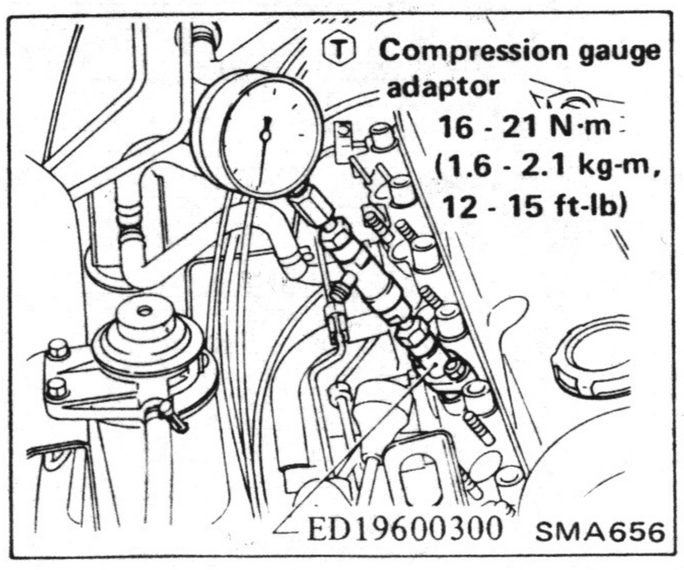
1. Run engine until water temperture indicator points to the middle of gauge, then stop engine.
2. Remove following parts:
- Spill tube assembly
- Injection tubes on nozzle side
- Nozzle assemblies


SMA655

CAUTION:
Remove nozzle washer with a pair of tweezers. Do not forget to remove this washer; otherwise, it may get lost when the engine is cranked.

3. Fit compression gauge adapter to cylinder head.

Make sure bleeder screw of gauge is closed.



4. Crank engine and read gauge indication.
- Run engine at about 200 rpm.
- Engine compression measurement should be made as quickly as possible.

Compression pressure:

Unit: kPa (bar, kg/cm², psi)/200 rpm

Standard	3,138 (31.4, 32, 455)
Minimum	2,452 (24.5, 25, 356)
Differential limit between cylinders	490 (4.9, 5, 71)

5. Cylinder compression in cylinders should not be less than 80% of the highest reading.

If cylinder compression in one or more cylinders is low, pour a small quantity of engine oil into cylinders through the nozzle holes and retest compression.

- **If adding oil helps the compression pressure,** chances are that piston rings are worn or damaged.
- **If pressure stays low,** valve may be sticking or seating improperly.
- **If cylinder compression in any two adjacent cylinders is low, and if adding oil does not help the compression,** there is leakage past the gasketed surface.

Oil and water in combustion chambers can result from this problem.

CHANGING TIMING BELT

1. Remove fan shroud.
2. Remove the following belts.
- Alternator drive belt
- Air conditioner compressor drive belt
- Power steering oil pump drive belt

3. Set No. 1 cylinder at T.D.C. on its compression stroke.

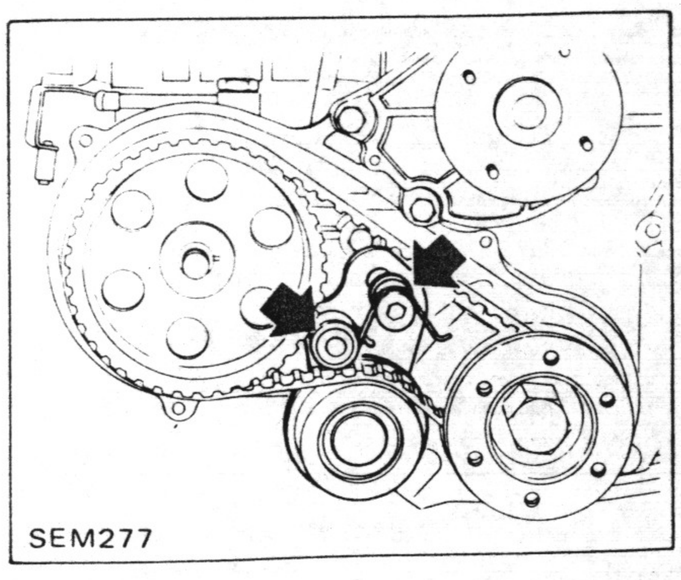
Make sure that grooves in rear plate and drive plates are aligned with each other.

SEF548

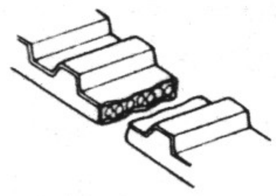
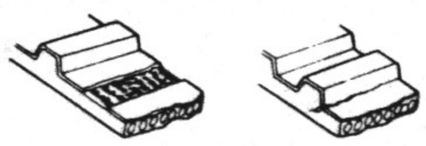
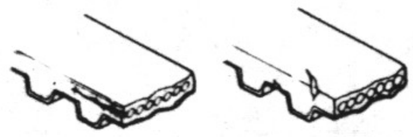
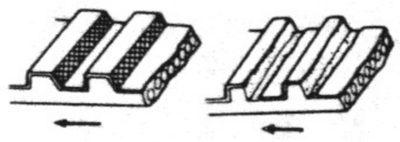
Make sure that No. 1 cam of camshaft is in the position as shown.

4. Remove front side engine parts.
- Fan, Tem-coupling and fan pulley
- Remove crank damper pulley by lightly tapping around it. **If it is difficult to remove, use a puller.**
- Front dust cover

5. Remove tensioner shaft and spring set pin, then remove tensioner pulley. (Tensioner pulley is fastened with a tensioner shaft and spring pin.)


SEM277

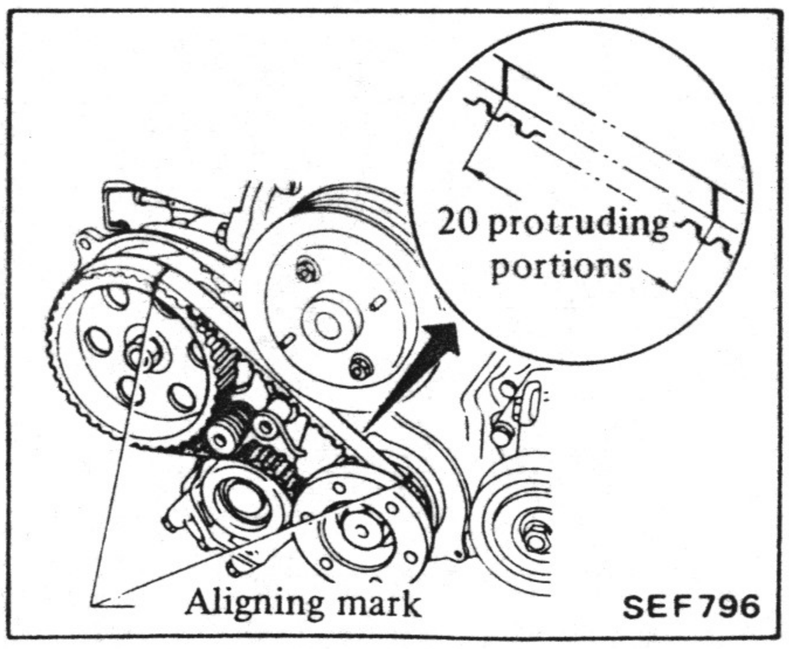
6. Remove timing belt.
7. Visually check the condition of the timing belt. If any abnormalities are noted, check and correct.

Item to check	Problem	Cause
Belt is broken.	 SEM393A	• Improper handling • Poor belt cover sealing • Coolant leakage at water pump
Tooth is broken/ tooth root is cracked.	 SEM394A	• Injection pump jamming • Damaged crankshaft oil seal
Back surface is cracked/worn.	 SEM395A	• Tensioner jamming • Overheated engine • Interference with belt cover
Side surface is worn.	 • Side surface of belt is worn to such an extent that there is no trace of cutoff performed during manufacturing process. • Belt corners are worn and round. • Wicks are frayed and coming out. SEM396A	• Improper installation of belt • Malfunctioning crank pulley plate/ timing belt plate
Teeth are worn.	 • Canvas on tooth face is worn down. • Canvas on tooth is fluffy, rubber layer is worn down and faded white, or weft is worn down and invisible. SEM397A	• Poor belt cover sealing • Coolant leakage at water pump • Injection pump not functioning properly • Excessive belt tension
Oil/Coolant or water is stuck to belt.		• Poor oil sealing of each oil seal • Coolant leakage at water pump • Poor belt cover sealing

8. Confirm that No. 1 cylinder is set at T.D.C. on its compression stroke.
9. Confirm that tensioner pulley can be rotated smoothly.
10. Install the tensioner in "free" position.
11. Install timing belt.

(1) Align both timing marks of timing belt and crank pulley.

(2) Properly align timing mark of pump pulley with that of timing belt.



Ensure timing belt is clean and free from oil or water. Do not bend it.

12. Loosen spring set pin and tensioner so that belt is automatically set to "tension" position.
13. Tighten spring set pin.

Ⓣ: Tensioner shaft and spring set pin
30 - 40 N·m
(3.1 - 4.1 kg-m,
22 - 30 ft-lb)

INJECTION AND FUEL SYSTEM

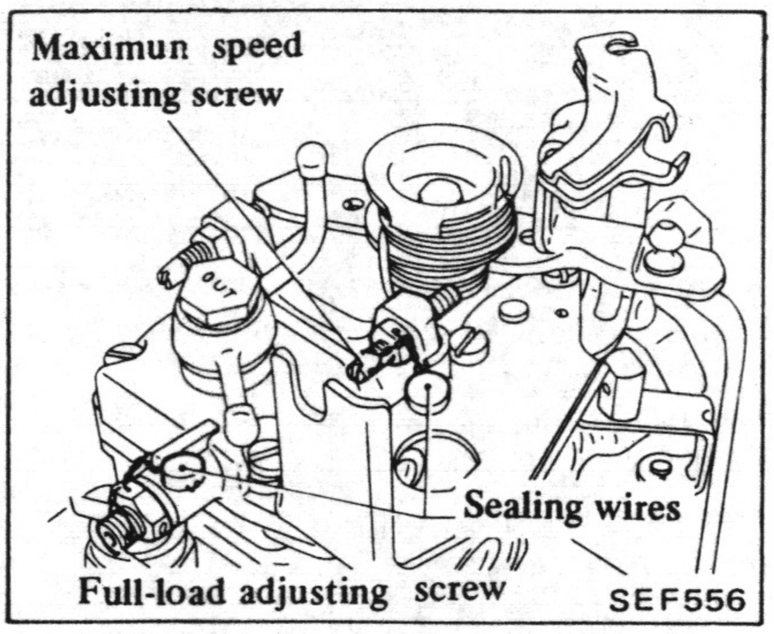
CHECKING AND ADJUSTING INJECTION TIMING

Refer to installation of injective pump in Section EF.

CHECKING AND ADJUSTING IDLE AND MAXIMUM SPEED

CAUTION:

a. Do not remove sealing wires unless absolutely necessary.

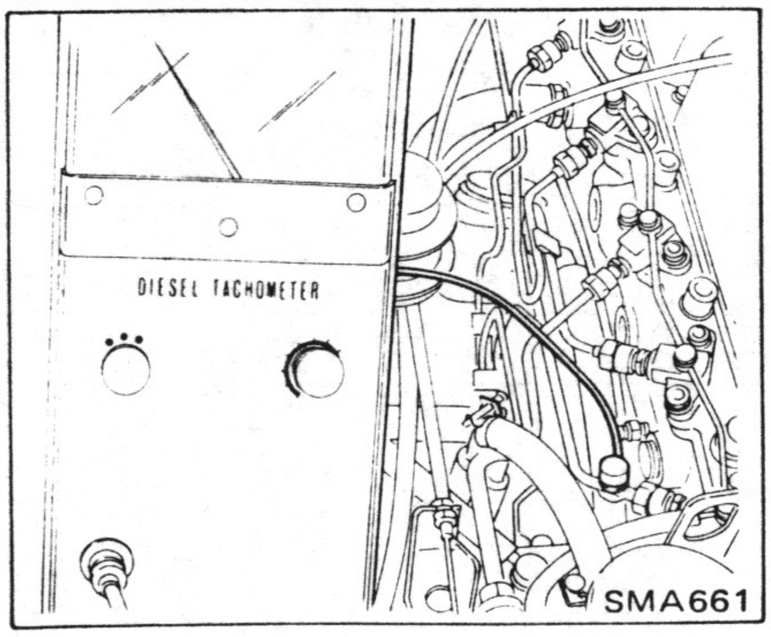


b. Disturbing full-load adjusting screw adjustment will change fuel flow characteristics, resulting in an improperly adjusted engine. Readjustment of fuel injection pump should be done using a pump tester.

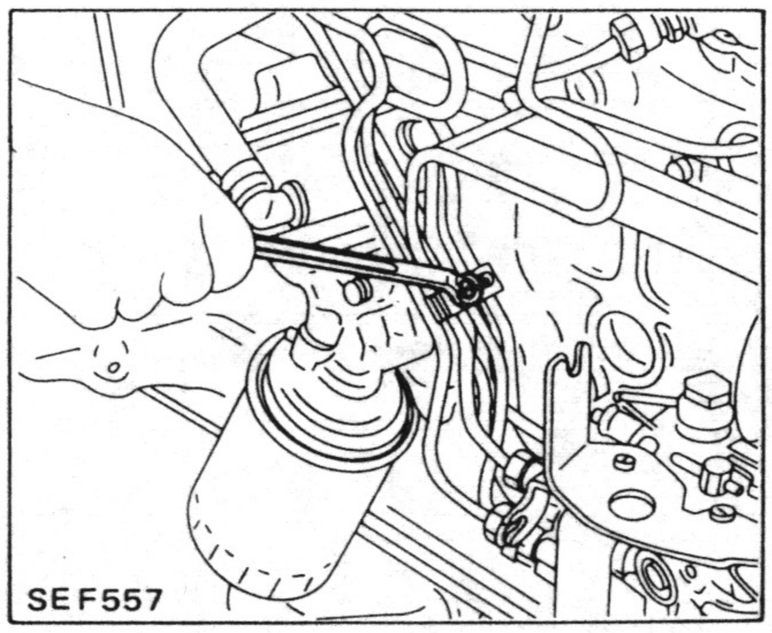
c. If maximum speed adjusting screw is turned in direction that increases control lever angle, engine damage may result.

IDLE ADJUSTMENT

1. Start engine and warm it up until coolant temperature indicator points to middle of gauge.
2. Attach tachometer's pickup to No. 1 fuel injection tube.



In order to take accurate reading of engine rpm, remove clamp that secures No. 1 fuel injection tube.

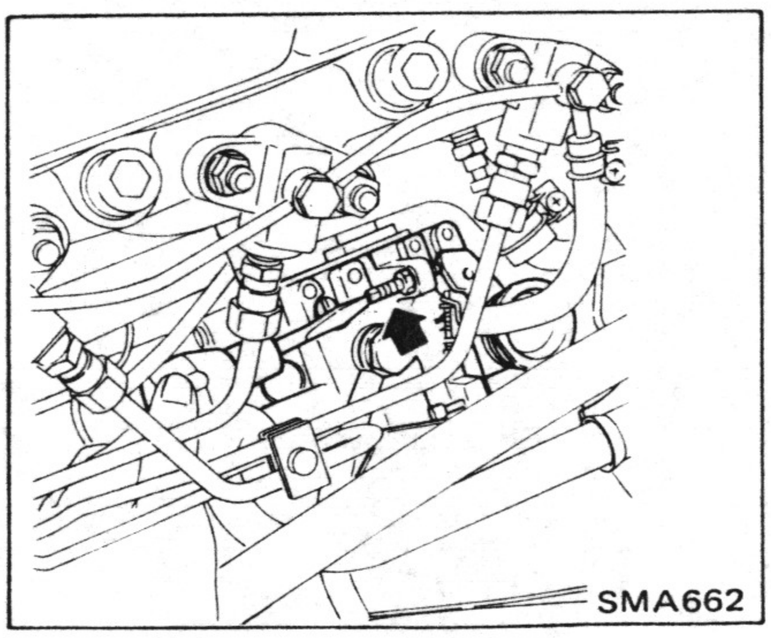


3. Start engine and check engine idle speed.

At this time, make sure the accelerator wire and throttle control wire are removed.

	Idle speed (rpm)
M/T	650
A/T	700

4. If engine idle speed is not within the specified value, proceed as follows.
(1) Loosen idle adjust screw lock nut.
(2) Turn idle adjust screw in either direction until the specified engine idle speed is obtained.



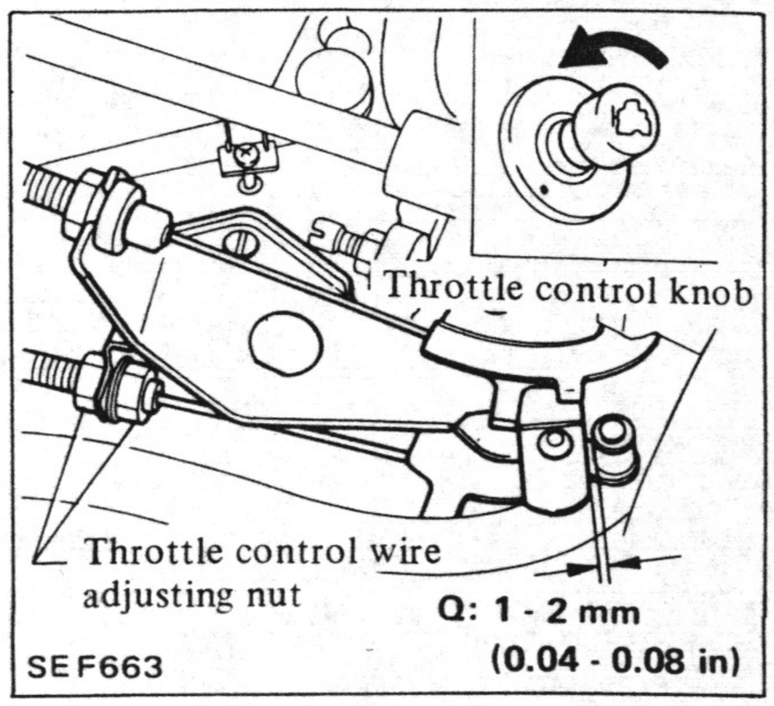
(3) Tighten idle adjust screw lock nut.
5. Fix the accelerator wire and throttle control wire.

Do not stretch wires too tightly.

THROTTLE CONTROL WIRE ADJUSTMENT

1. Turn throttle control knob fully counterclockwise.
2. Make sure that clearance between idle control lever pin and fuel injection pump control lever is within specified range.

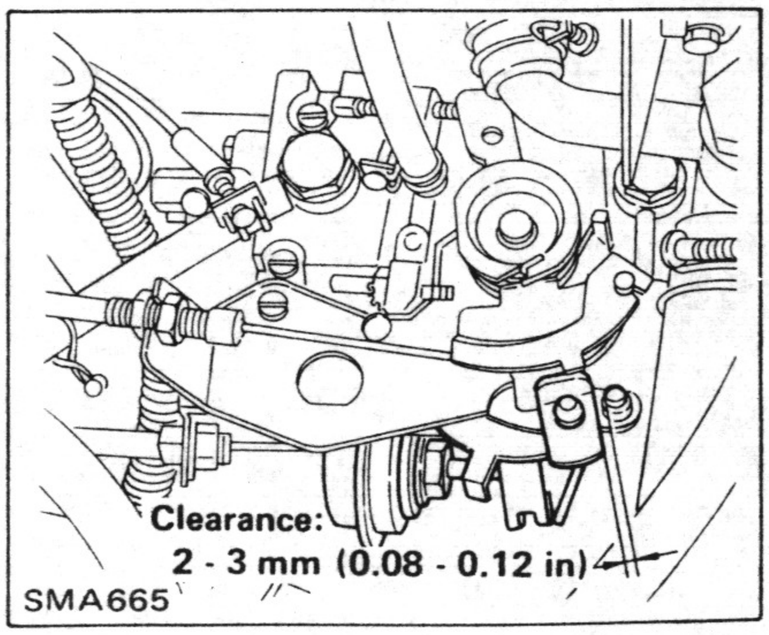
Clearance:
1 - 2 mm (0.04 - 0.08 in)



3. If not within specified range, adjust with throttle control wire adjusting nut.
4. After adjusting clearance properly, tighten lock nut.

F.I.C.D. ADJUSTMENT

1. Make certain that the clearance between the idle control lever pin and the injection pump control lever is within the specified limits.

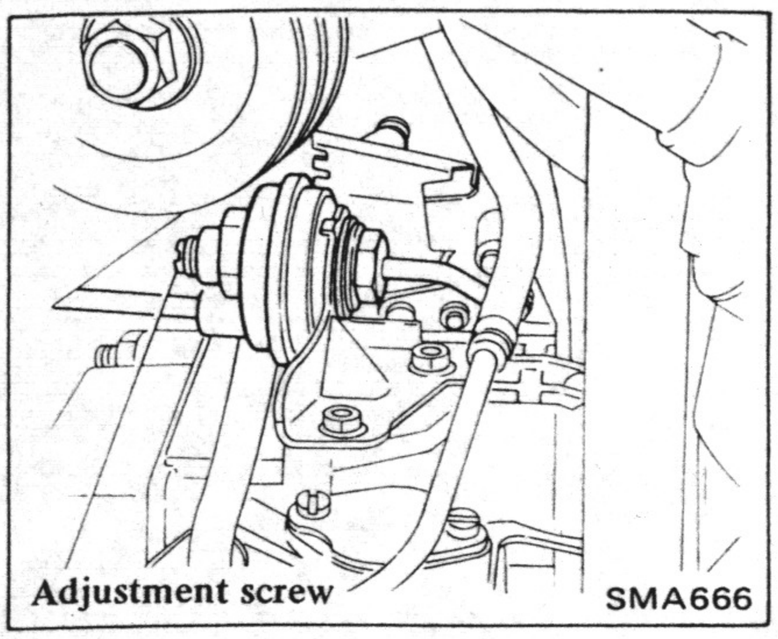


2. Adjust idle speed to specified rpm without the air conditioner operating.
3. Then check the idle speed when the air conditioner is operating and make sure it is correct.

Unit: rpm

Idle speed (Air conditioner "ON")	800

If not, adjust it by turning F.I.C.D. actuator stroke adjusting screw.


Adjustment screw SMA666

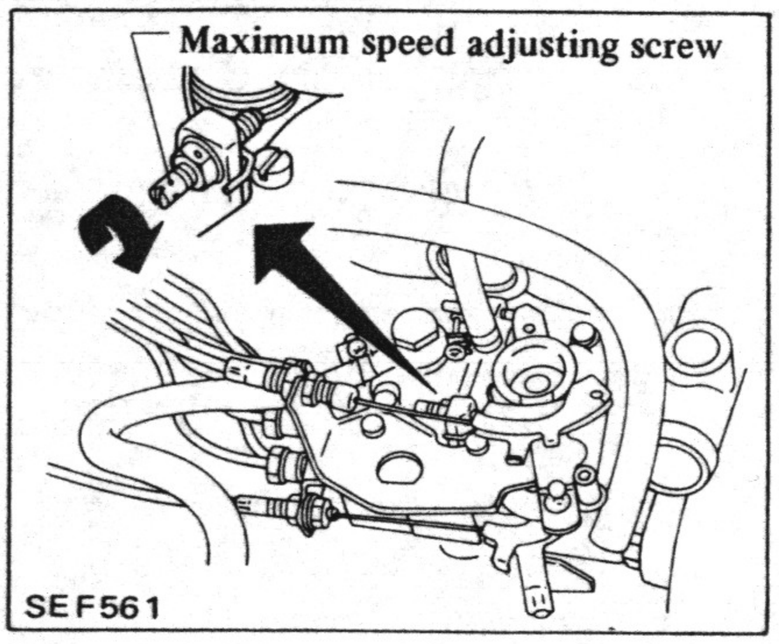
MAXIMUM SPEED ADJUSTMENT

Maximum speed adjusting wire is retained by sealing wire and need not be adjusted under normal circumstances. However, if it should become necessary to adjust it, the following procedure should be followed:

1. Start engine and warm it up until coolant temperature indicator points to middle of gauge.
2. Connect tachometer's pickup to No. 1 fuel injection tube.

To obtain accurate reading of engine rpm, remove clamp that secures No. 1 fuel injection tube.

3. Turn maximum speed adjusting screw fully clockwise.

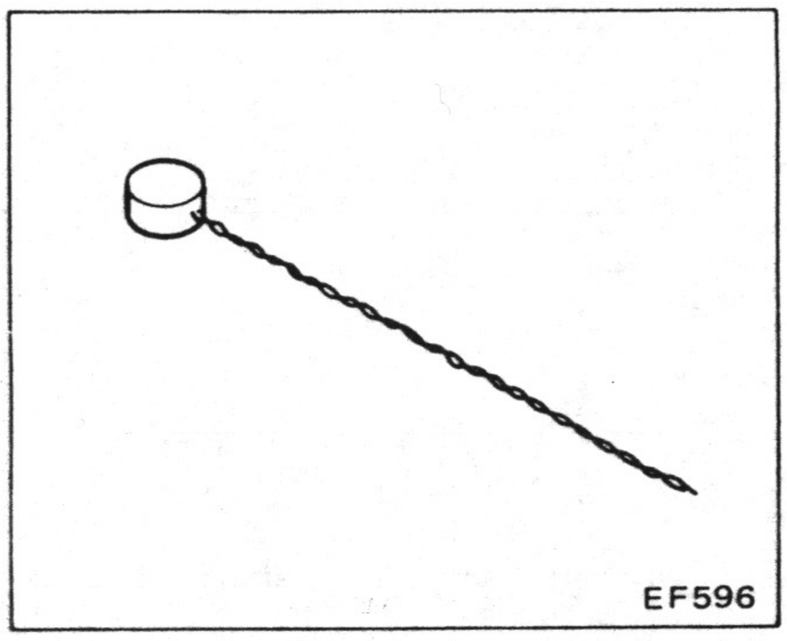


SEF561

4. Depress the accelerator pedal fully under no load and, at this point, read engine speed indication.

Specified maximum engine speed (Under no-load):
5,300 rpm

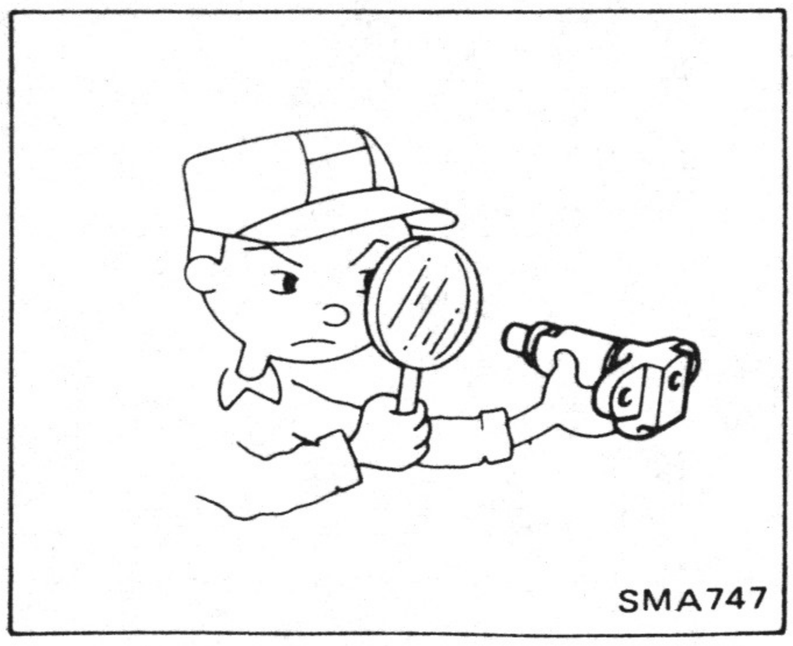
5. If indication is lower than specified maximum engine speed, turn maximum speed adjusting screw counterclockwise 1 or 2 rotations. Then depress accelerator pedal to floor under no load and, at this point, read indication.
6. If indication is still lower than specified speed, repeat step 5 above until specified engine speed is reached.
7. After adjustment, tighten lock nut securely.
8. Slide a sealing sleeve over max. speed adjusting screw, and wind up with a wire.


EF596

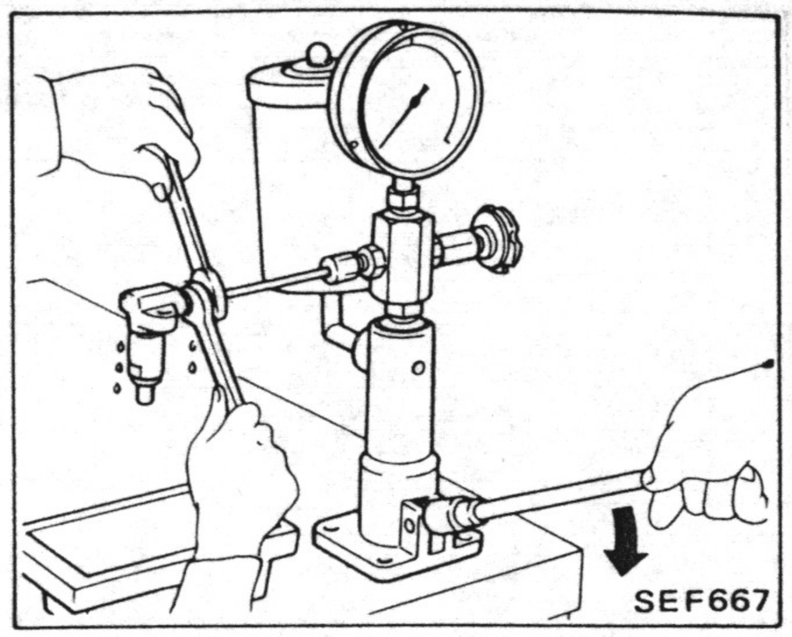
TESTING AND ADJUSTING INJECTION NOZZLES

WARNING:
When using nozzle tester, be careful not to allow diesel fuel sprayed from nozzle to come into contact with your hand or body, and make sure that your eyes are properly protected.

1. Clean and check nozzles.


SMA747

2. Install nozzle to injection nozzle tester and **bleed air from flare nut.**

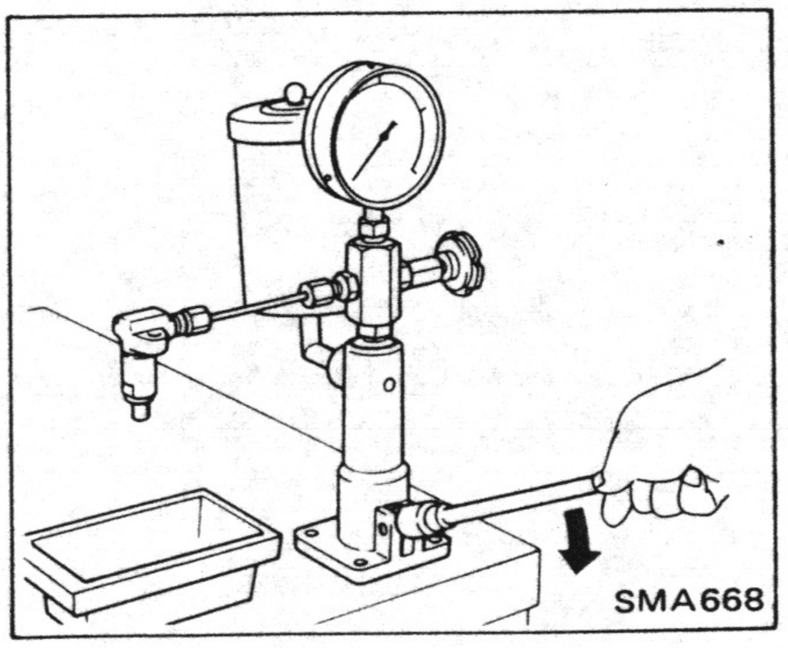

SEF667

3. Check initial injection pressure by pumping tester handle one time per second.

Initial injection pressure:
12,259 - 13,239 kPa
(122.6 - 132.4 bar,
125 - 135 kg/cm^2,
1,778 - 1,920 psi)

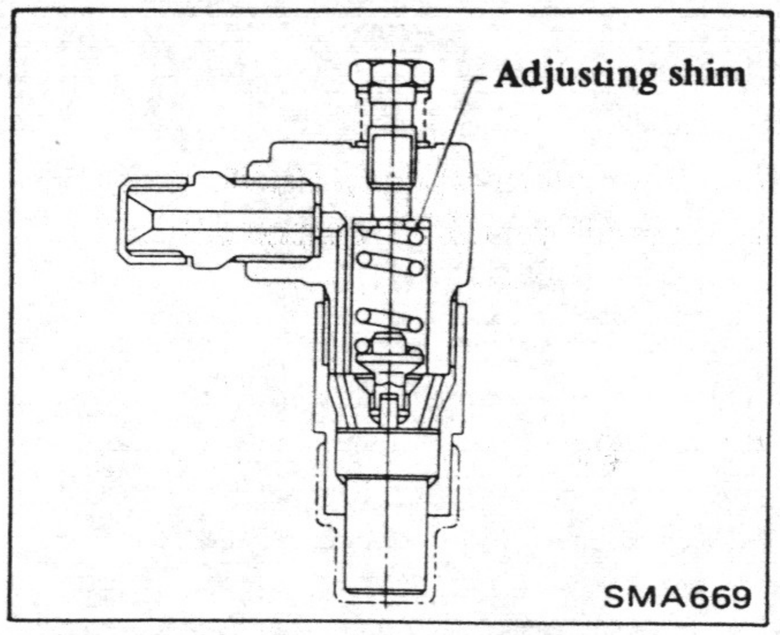
New nozzle initial injection pressure:
13,239 - 14,024 kPa
(132.4 - 140.2 bar,
135 - 143 kg/cm^2,
1,920 - 2,033 psi)

The new nozzle is not required to adjust initial injection pressure.

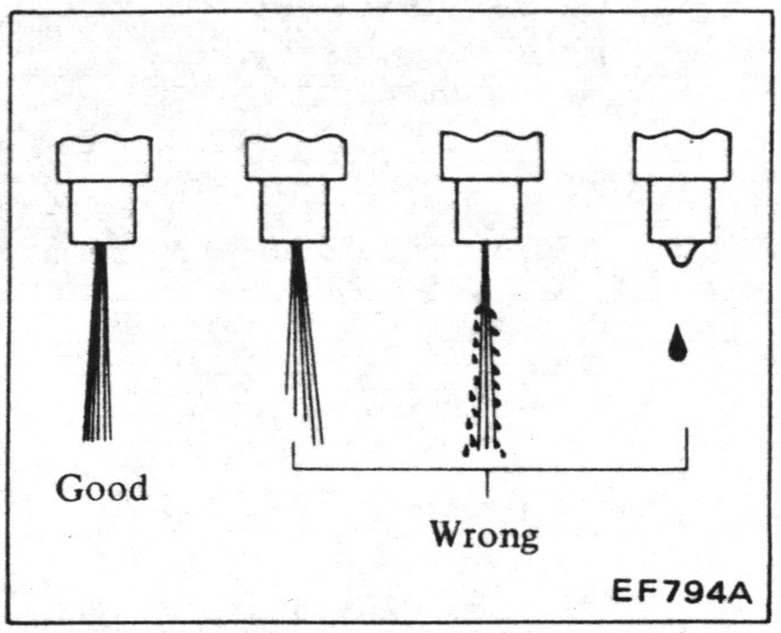

SMA668

4. To adjust injection pressure, change adjusting shims.

a. **Increasing the thickness of adjusting shims increases initial injection pressure. Decreasing shim thickness reduces initial injection pressure.**
b. **A shim thickness of 0.04 mm (0.0016 in) corresponds approximately to a difference of 471 kPa (4.71 bar, 4.8 kg/cm^2, 68 psi) in initial injection pressure.**



5. Check spray pattern by pumping tester handle one time per second.

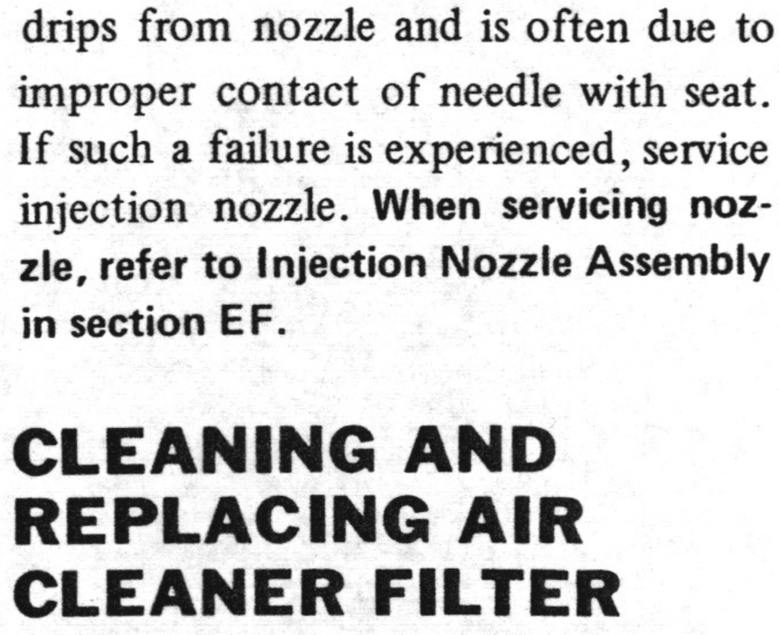


6. Inadequate fuel spray pattern or drips from nozzle and is often due to improper contact of needle with seat. If such a failure is experienced, service injection nozzle. **When servicing nozzle, refer to Injection Nozzle Assembly in section EF.**

CLEANING AND REPLACING AIR CLEANER FILTER AND RESONATOR

AIR CLEANER

1. Remove air cleaner cover and filter element.

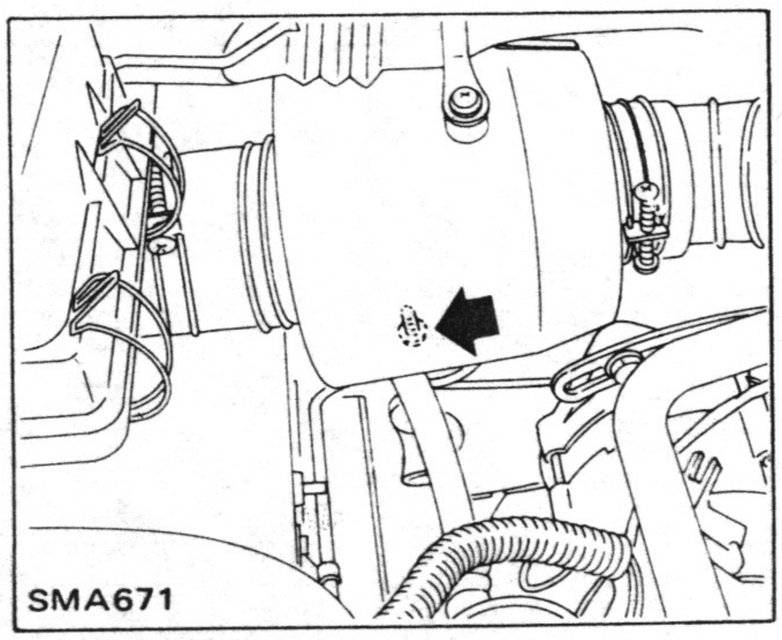


2. Wipe inside of air cleaner housing and cover with a damp cloth.

3. Install filter element and air cleaner cover.

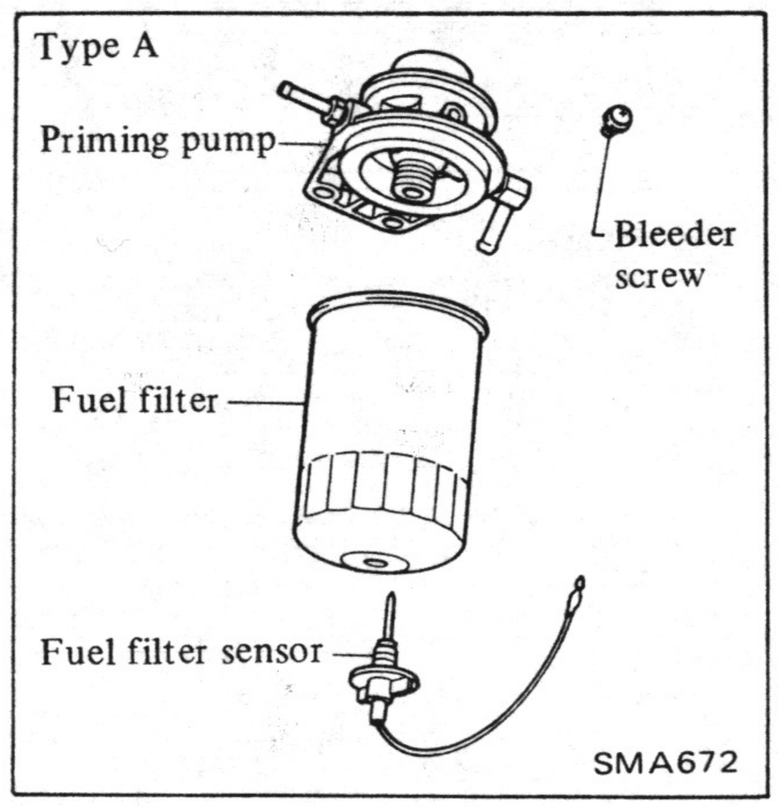
RESONATOR (For LD28)

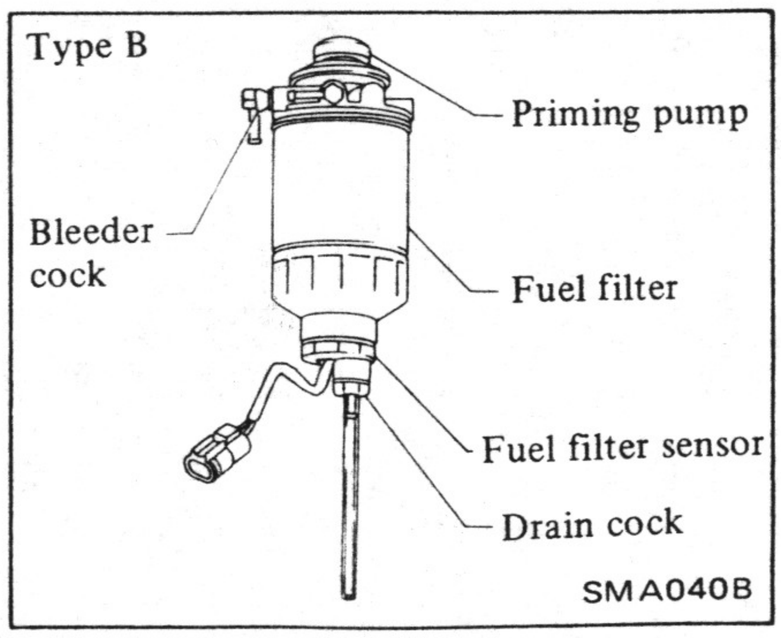
If resonator makes noise, drain water by loosening resonator bottom screw.



CHECKING FUEL FILTER, DRAIN WATER AND REPLACING FILTER

This filter includes priming pump and fuel filter sensor.

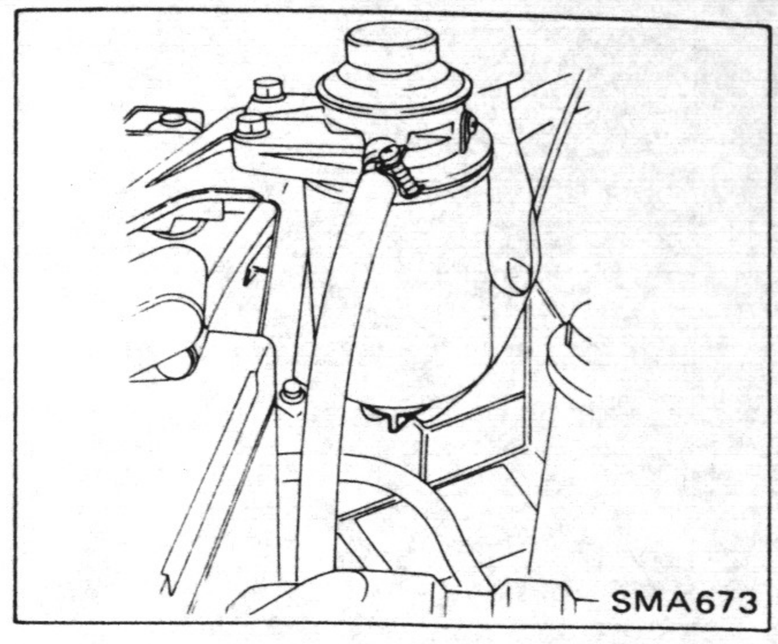




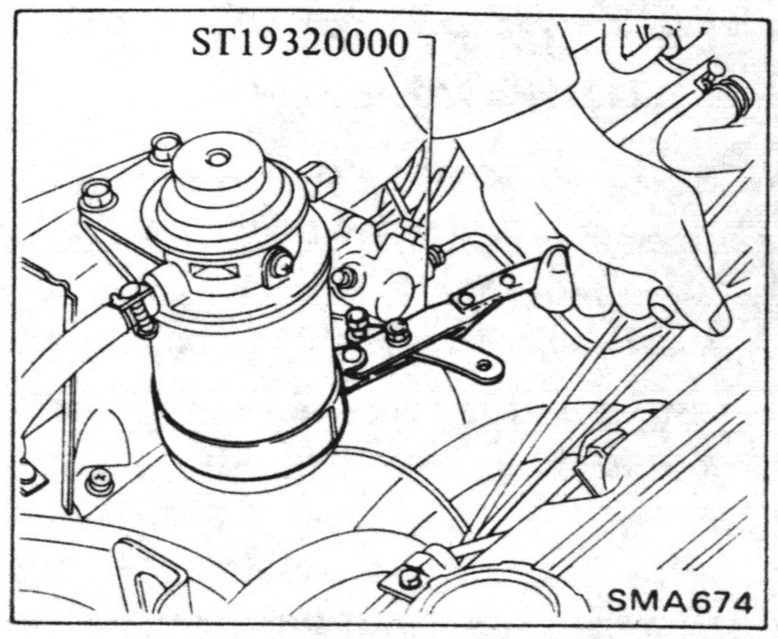
Reuse the fuel filter sensor.

Replacing fuel filter

1. Remove fuel filter sensor and drain fuel.



2. Remove fuel filter, using Tool.



3. Install fuel filter sensor to new fuel filter.
4. Install fuel filter to priming pump.
5. Bleed air.

Refer to Section EF for fuel system bleeding instructions.

Start engine and check for leaks.

Drain water

1. Set a container under fuel filter.
2. For type A, loosen bleeder screw and remove fuel detector senosor and drain water.
3. For type B, loosen drain cock and drain water.
4. Bleed air.

Refer to section EF for bleeding fuel system.

For type B, bleeder screw or cock does not need to be loosened because air automatically enters from the drain passage. Loosening drain cock 4 to 5 turns causes water to start draining. Do not remove drain cock by loosening it excessively.

CHECKING FUEL LINES (Hoses, piping, connectors, etc.) FOR LEAKS

Check fuel lines for loose connections, cracks and deterioration. Retighten loose connections; if necessary, replace any damaged or faulty parts.

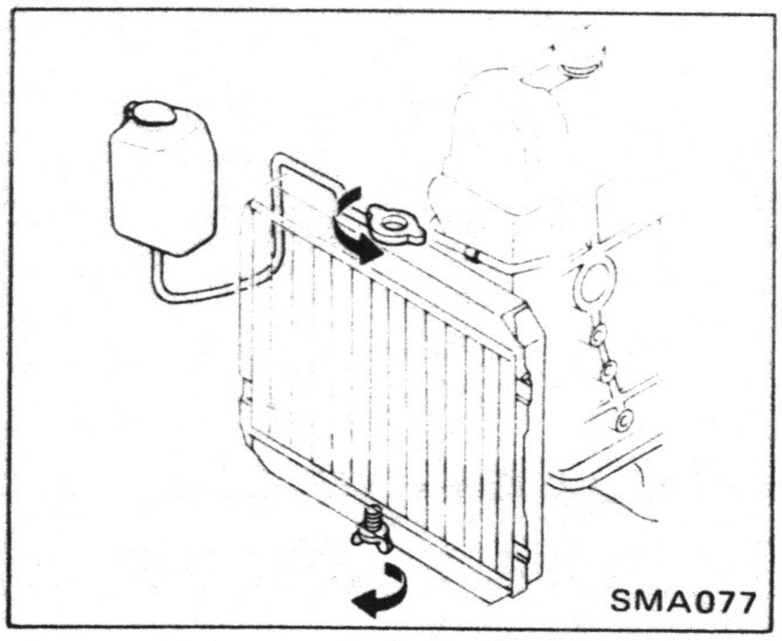
COOLING AND LUBRICATION SYSTEM

CHANGING ENGINE COOLANT

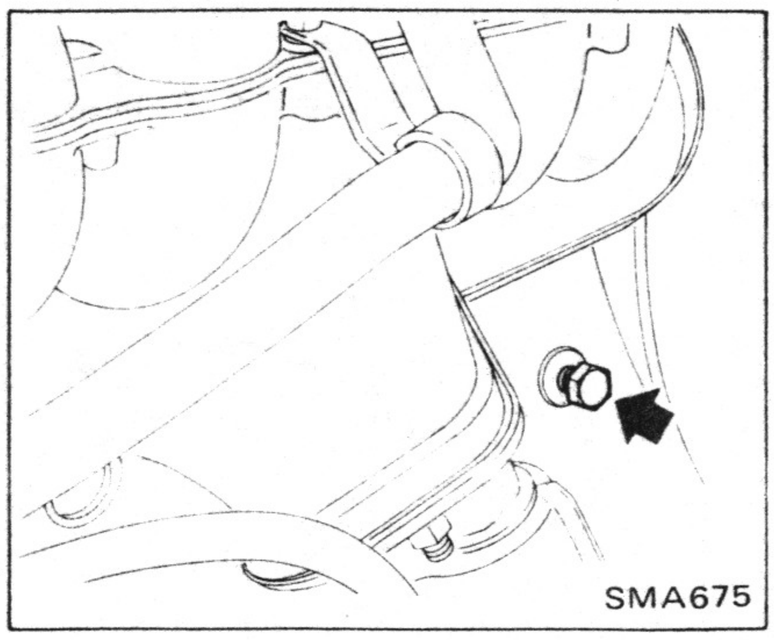
WARNING:
To avoid being scalded, never attempt to change the coolant when engine is hot.

When changing engine coolant, on heater-equipped models, set heater "TEMP" control lever at fully "HOT" position.

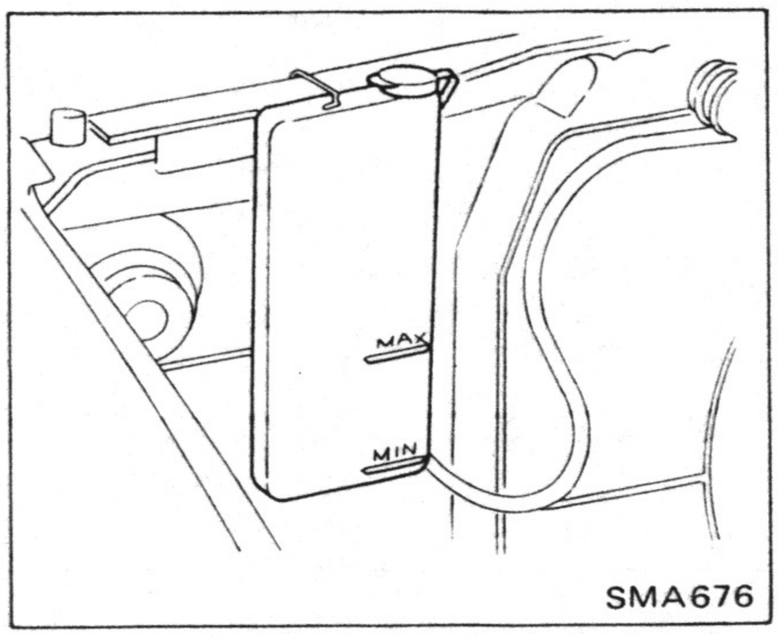
1. Open drain cock at bottom of radiator, and remove radiator cap.


SMA077

2. Remove cylinder block drain plug located at left rear of cylinder block.


SMA675

3. Drain coolant completely. Then flush cooling system.
4. Close drain cock and plug.
5. Fill radiator and reservoir tank with coolant to the specified level. When using anti-freeze coolant, mix the anti-freeze coolant with water, observing instructions attached to anti-freeze container.



SMA676

6. Run engine for a few minutes. Then stop engine, and check coolant level. If necessary, add coolant.

Check for coolant leaks.

CHECKING COOLING SYSTEM HOSES AND CONNECTIONS FOR LEAKS

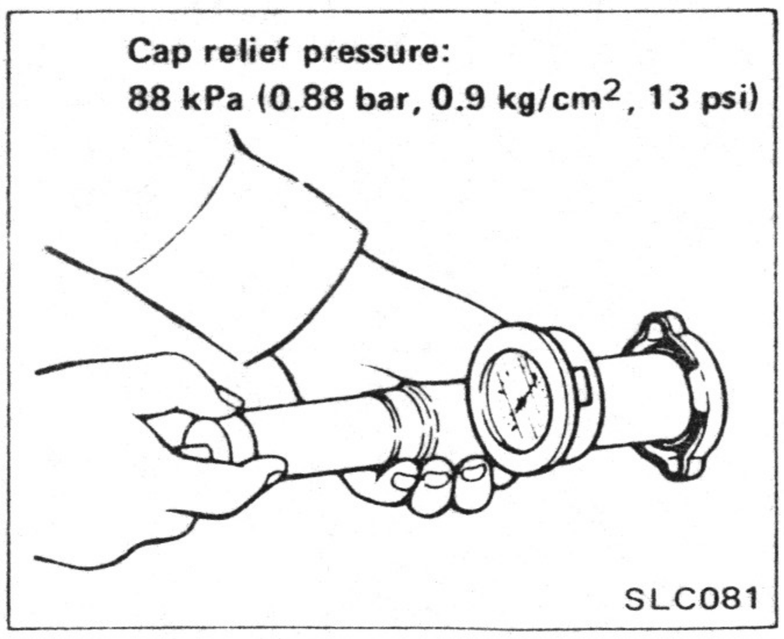
Check hoses and fittings for loose connections or deterioration.

Retighten or replace if necessary.

CHECKING RADIATOR CAP

Using cap tester, check the radiator cap relief pressure.

If the pressure gauge drops rapidly and excessively, replace the radiator cap.

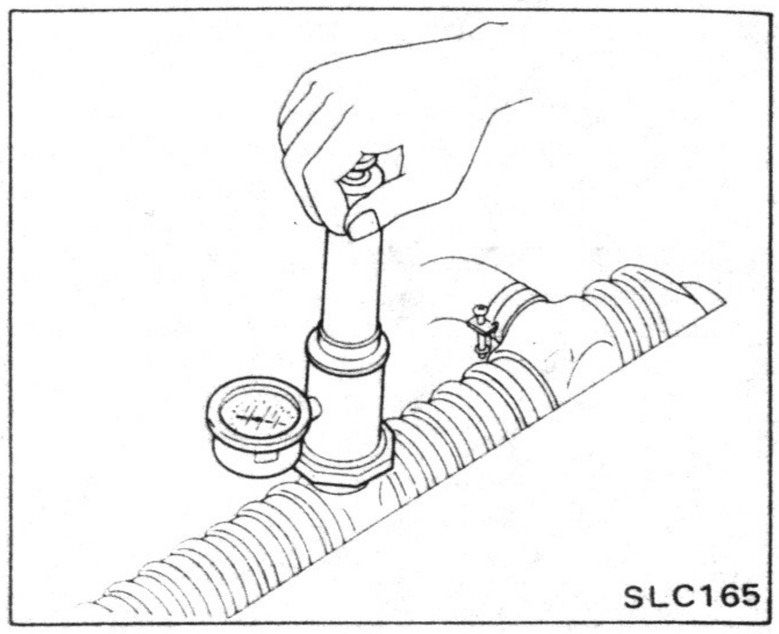


SLC081

CHECKING COOLING SYSTEM FOR LEAKS

Attach pressure tester and pump tester, and apply specified pressure. Check for drop in pressure.

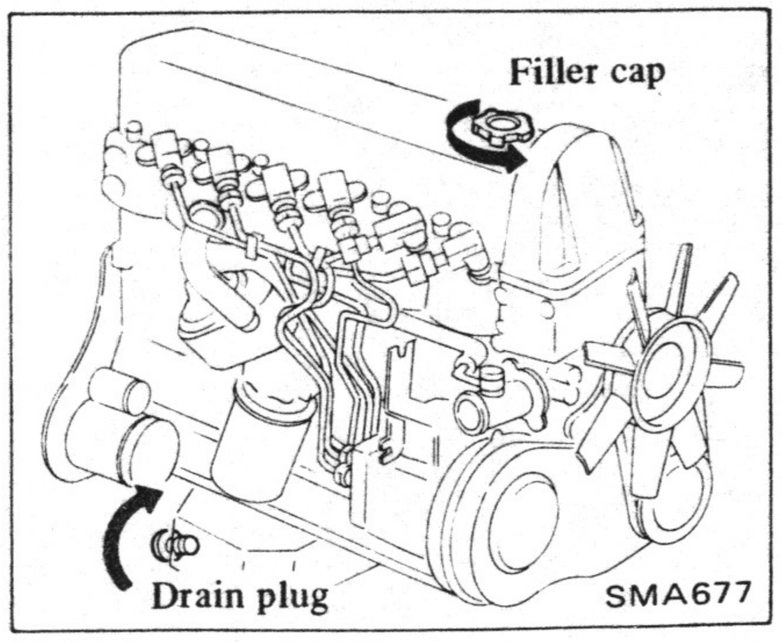
If pressure drops, check for leaks from hoses, radiator, or water pump. If no external leaks are found, check heater core, block and head.


SLC165

CHANGING ENGINE OIL AND FILTER

1. Run engine until water temperature indicator points to the middle of gauge, then stop engine.
2. Remove oil filler cap and oil pan drain plug, and allow oil to drain.

WARNING:
Be careful not to burn yourself, as the engine oil may still be hot.



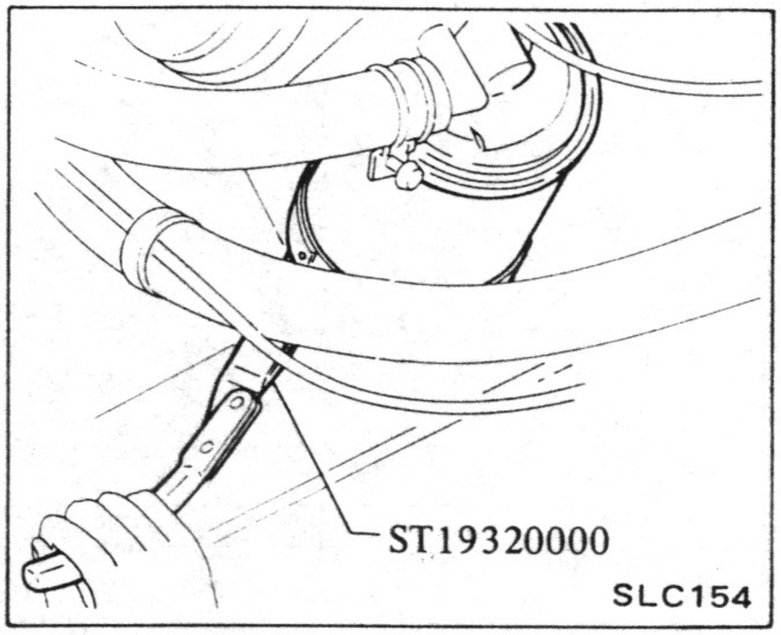
SMA677

- **A milky oil indicates the presence of cooling water. Isolate the cause and take corrective measures.**
- **An oil with extremely low viscosity indicates the presence of gasoline.**

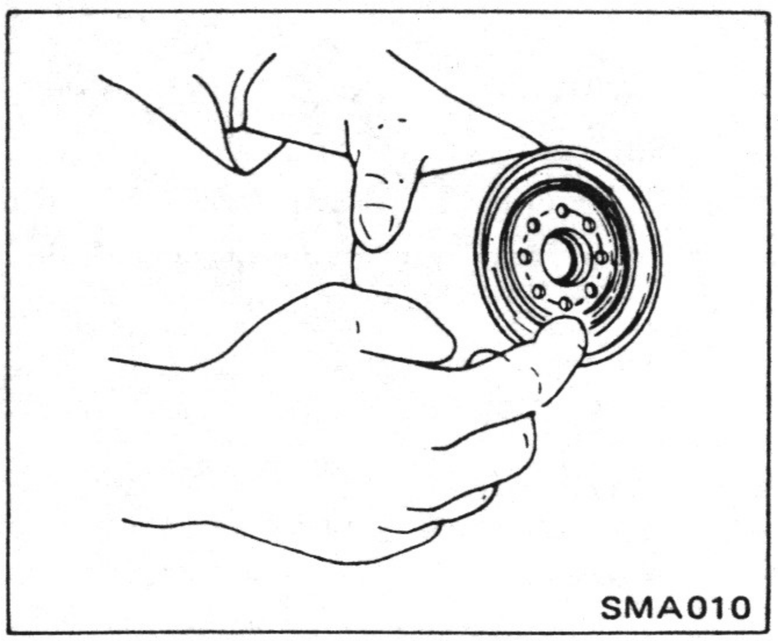
3. Clean and install oil pan drain plug with washer.

Ⓣ : **Oil pan drain plug**
20 - 29 N·m
(2.0 - 3.0 kg-m,
14 - 22 ft-lb)

4. Using Tool, remove oil filter.



5. Wipe oil filter mounting surface with a clean rag.
6. Smear a little engine oil on rubber lip of new oil filter.



7. Install new oil filter.

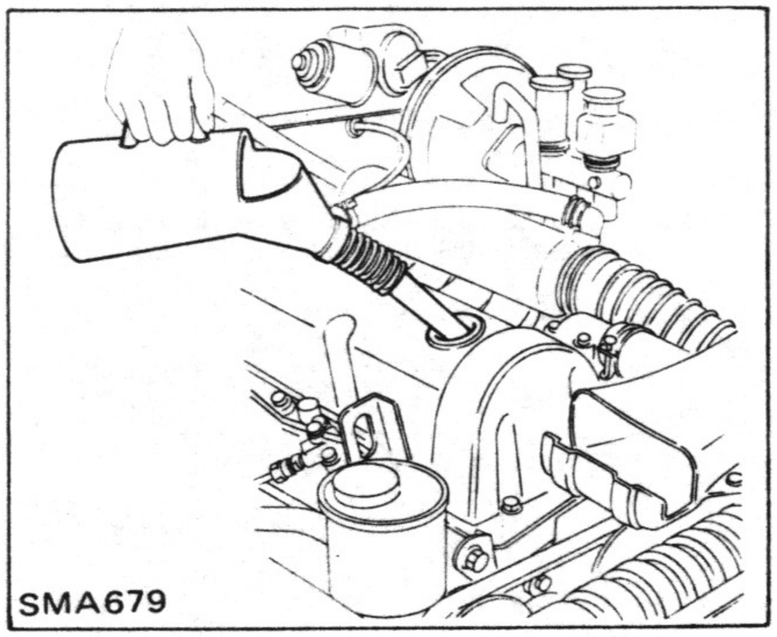
Screw in oil filter until a slight resistance is felt, then tighten additional 2/3 of a turn.

8. Refill engine with new engine oil, referring to Recommended Lubricants.

Approximate oil refill capacity

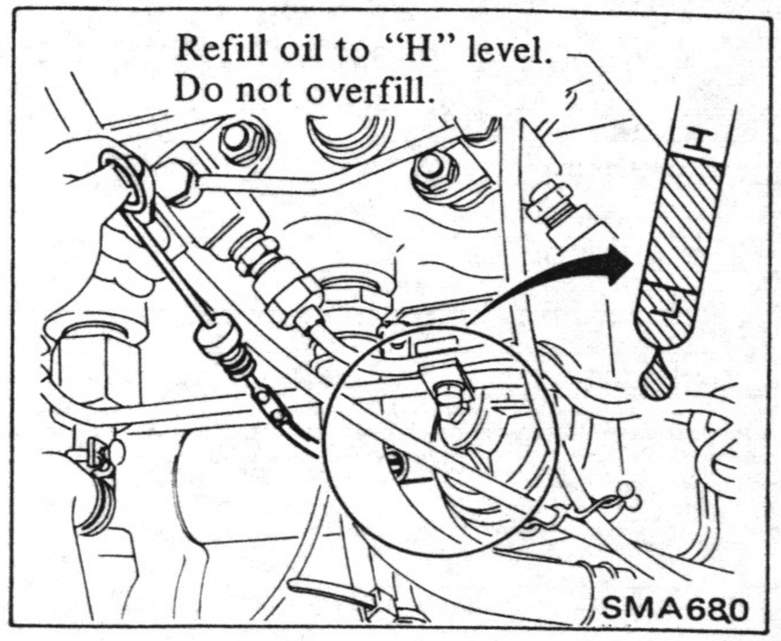
Unit: liter (Imp qt)

		Without oil filter chage	With oil filter change
LD20	910	3.8 (3-3/8)	4.5 (4)
	C120	3.6 (3-1/8)	4.3 (3-3/4)
LD28	430	4.3 (3-3/4)	5.0 (4-3/8)
	C31	4.3 (3-3/4)	5.0 (4-3/8)



a. **Start engine. Check area around drain plug and oil filter for any sign of oil leakage.**
If any leakage is evident, these parts have not been properly installed.

b. **Run engine until water temperature indicator points to the middle of gauge. Then stop engine and check oil level with dipstick. If necessary, add engine oil.**
c. **When checking oil level, park the car on a level surface.**



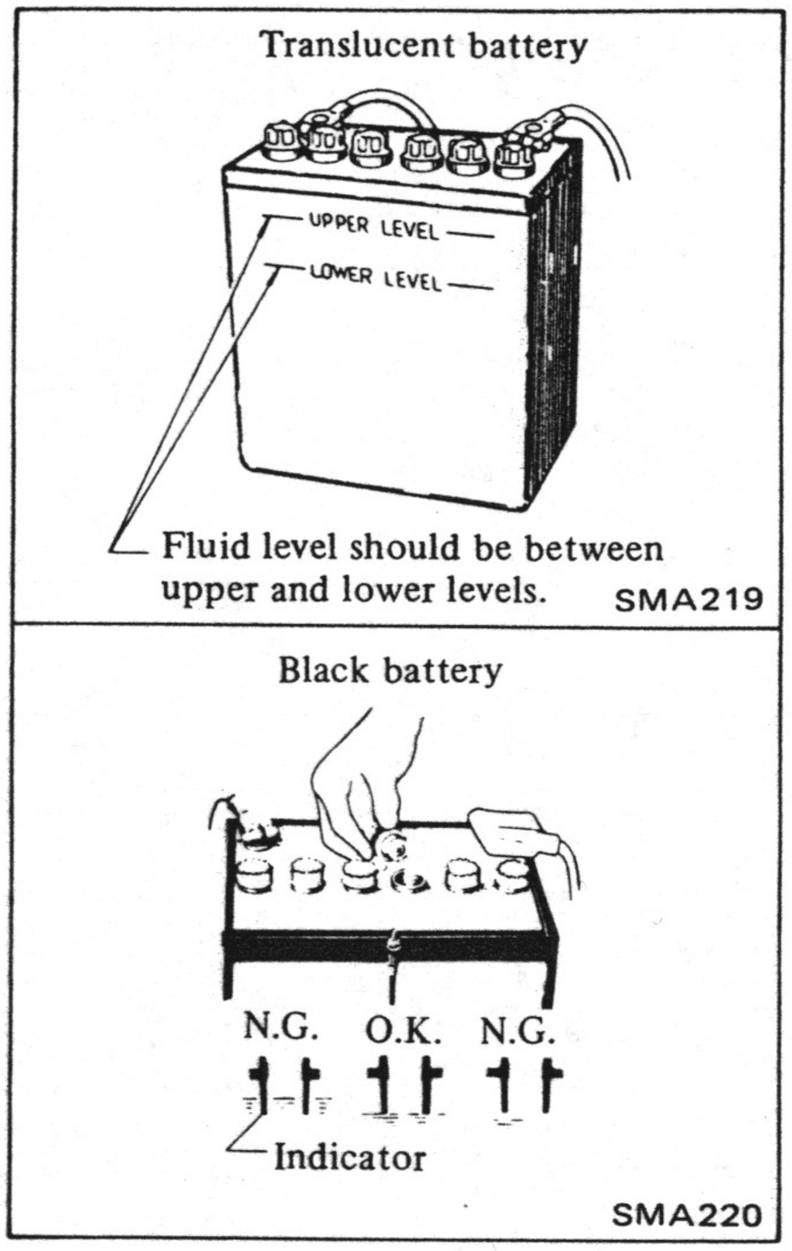
CHECKING ENGINE OIL FOR LEAKS

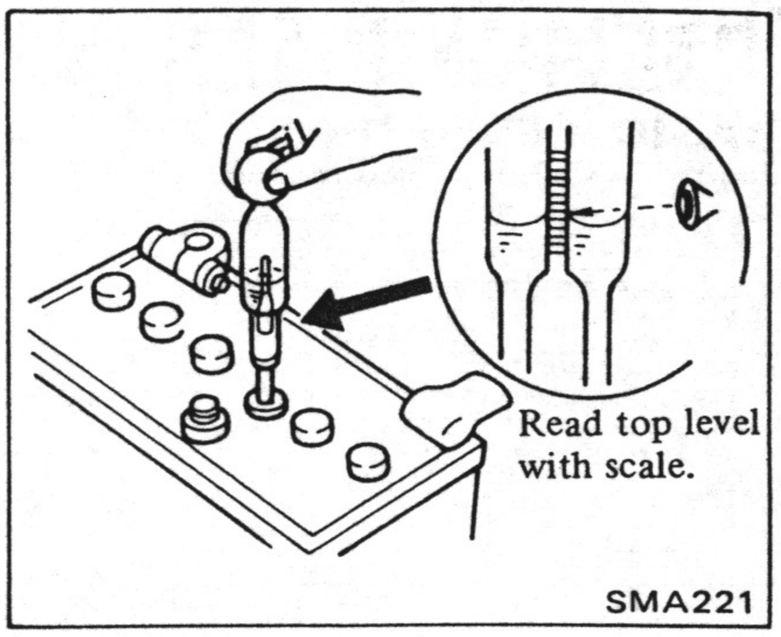
Check cylinder head, front engine cover, oil pan, oil pump, oil filter gasket, etc. or other parts for sign of leaks past their gasketed surfaces. If necessary, replace gaskets or faulty parts. After maintenance has been done, check replaced parts to see if any leaks occur.

ELECTRICAL SYSTEM

CHECKING BATTERY

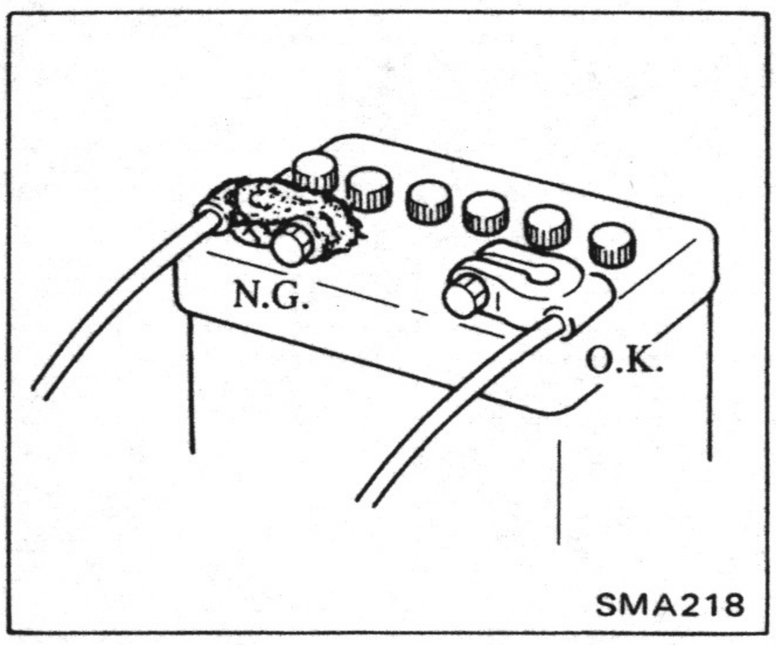
WARNING:
Do not expose the battery to flames or electrical sparks. Hydrogen gas generated by battery action is explosive. Do not allow battety fluid to come in contact with skin, eyes, fabrics, or painted surfaces. If the acid contacts the eyes, skin or clothing, immediately flush with water for 15 minutes and seek medical attention. In freezing weather, run the engine for while after adding distilled water, to make sure that the water mixes properly with the fluid. Otherwise the water may freeze and damage the battery.





VISUAL CHECK

1. Rusted battery support.
2. Loose terminal connections.
3. Rusted or deteriorated terminals.
4. Damaged or leaking battery.



CHECK ELECTROLYTE LEVEL

Check the fluid level in each cell. If necessary, add only distilled water.

CHECK ELECTROLYTE GRAVITY

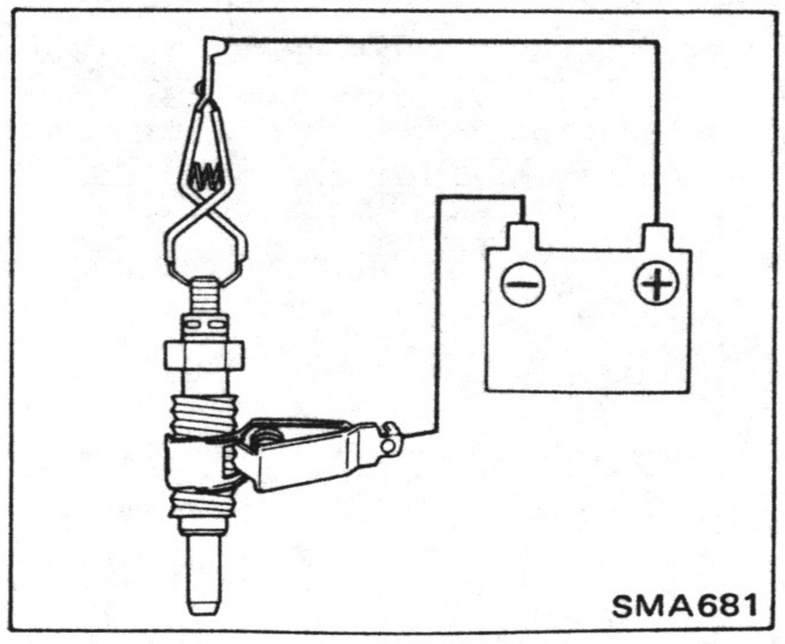
1. Place the hydrometer in the cell. Be sure the float is not in contact with the cylinder wall.
2. Take enough electrolyte into the hydrometer to allow the float to suspend freely between the top and bottom of the cylinder.
3. Read indication.

	Permissible value	Fully charged value [at 20°C (68°F)]
Frigid climate	Over 1.22	1.28
Tropical climate	Over 1.18	1.24
Other climates	Over 1.20	1.26

CHECKING GLOW PLUGS

1. Remove glow plugs from cylinder head.
2. Apply battery voltage (over 10V) to glow plug and see if it will turn red within 15 seconds.

If it takes too much time to turn red, replace it.



SERVICE DATA AND SPECIFICATIONS

INSPECTION AND ADJUSTMENT

BASIC MECHANICAL SYSTEM

Valve clearance Hot mm (in)	Intake	0.25 (0.010)
	Exhaust	0.30 (0.012)
Compression pressure kPa (bar, kg/cm^2, psi)	Standard	3,138 (31.4, 32, 455)
	Minimum	2,452 (24.5, 25, 356)
	Differential limit	490 (4.9, 5, 71)

Drive belt deflection

mm (in)

	Used belt deflection		Set deflection of new belt
	Limit	Adjust deflection	
Alternator	15 (0.59)	11 - 13* (0.43 - 0.51)	8 - 12 (0.31 - 0.47)
		12 - 14** (0.47 - 0.55)	10 - 12 (0.39 - 0.47)
A/C compressor	14 (0.55)	12 - 13 (0.47 - 0.51)	9 - 11 (0.35 - 0.43)
P/S oil pump	9 (0.35)	8 - 8.5 (0.315 - 0.335)	7 - 8 (0.28 - 0.31)

Pushing force: 98 N (10 kg, 22 lb)

* For 430 and C31 models equipped with LD28
** For 910 and C120 models equipped with LD20

INJECTION AND FUEL SYSTEM

Item	Trans-mission	LD28	LD20
Injection timing and idle speed degree/rpm	M/T	B.T.D.C. 5°/650	B.T.D.C. 7°/650
	A/T	B.T.D.C. 5°/700	B.T.D.C. 7°/700
Idle speed of air conditioner "ON" rpm	M/T A/T	800	
Initial injection pressure kPa (bar, kg/cm^2, psi) 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)	

COOLING SYSTEM AND LUBRICATION SYSTEM

Radiator cap relief pressure kPa (bar, kg/cm^2, psi)	88 (0.88, 0.9, 13)
Cooling system leakage testing pressure kPa (bar, kg/cm^2, psi)	157 (1.57, 1.6, 23)

Approximate oil refill capacity Unit: liter (Imp qt)

		Without oil filter change	With oil filter change
LD20	910	3.8 (3-3/8)	4.5 (4)
	C120	3.6 (3-1/8)	4.3 (3-3/4)
LD28	430	4.3 (3-3/4)	5.0 (4-3/8)
	C31	4.3 (3-3/4)	5.0 (4-3/8)

ELECTRICAL SYSTEM

Item \ Climate		Frigid climate	Tropical climate	Other climate
BATTERY	Permissible valve	Over 1.22	Over 1.18	Over 1.20
	Fully charged value [at 20°C (68°F)]	1.28	1.24	1.26

TIGHTENING TORQUE

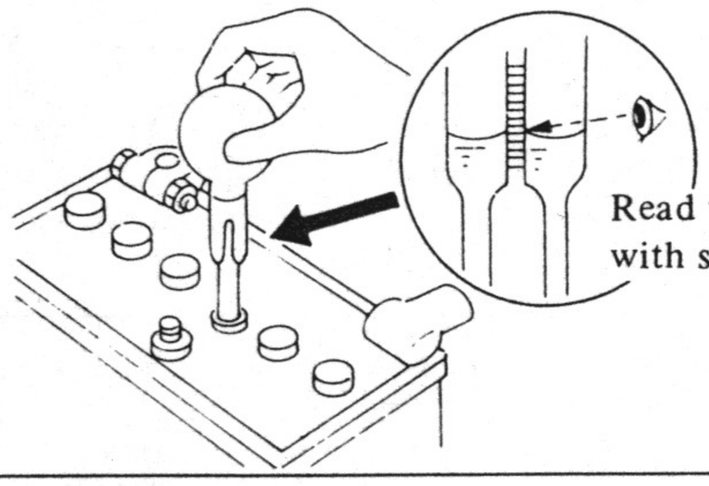
Unit		N·m	kg-m	ft-lb
Cylinder head bolt		118 - 127	12 - 13	87 - 94
Rocker cover		6 - 9	0.6 - 0.9	4.3 - 6.5
Manifold	M10	32 - 36	3.3 - 3.7	24 - 27
	M8	17 - 21	1.7 - 2.1	12 - 15
Alternator		43 - 58	4.4 - 5.9	32 - 43
Injection pump fixing nut and bolt		16 - 21	1.6 - 2.1	12 - 15
Injection tube		22 - 25	2.2 - 2.5	16 - 18
Spill tube		15 - 18	1.5 - 1.8	11 - 13
Nozzle fixing nut		16 - 21	1.6 - 2.1	12 - 15
Oil pan drain plug		20 - 29	2.0 - 3.0	14 - 22
Glow plug		20 - 25	2.0 - 2.5	14 - 18
Glow plug connecting plate		1.0 - 1.5	0.1 - 0.15	0.7 - 1.1
Tensioner shaft		30 - 40	3.1 - 4.1	22 - 30
Spring set pin		30 - 40	3.1 - 4.1	22 - 30

TROUBLE DIAGNOSES AND CORRECTIONS

: Condition
: Check points
: Action
: Probable cause system

Engine fails or is difficult to start.

Are battery electrolyte and fuel levels O.K.?





O.K.

ELECTRICAL SYSTEM

Will starter motor rotate?

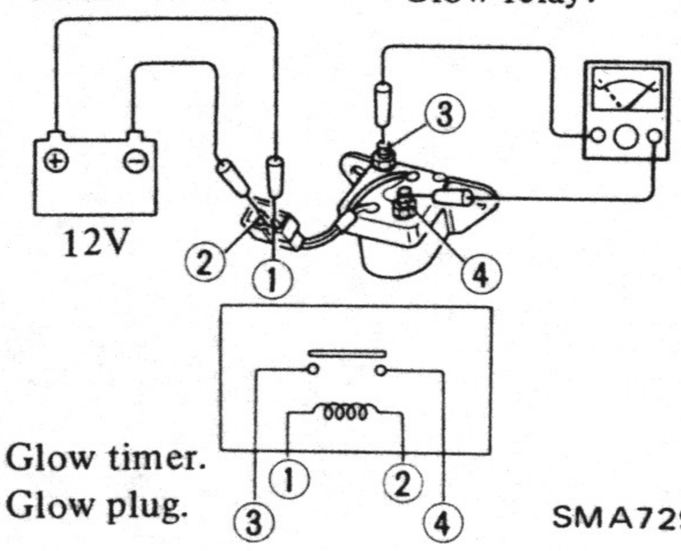
Check points.
- Connections.
- Ignition switch.
- Starting circuit.
- Starter motor.

O.K. / NOT O.K.

Repair or replace.

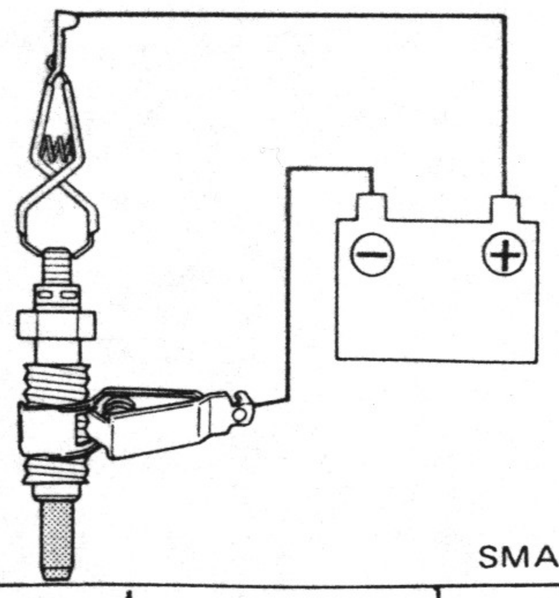
Check glow system.

Check points.
- Connections.
- Glow circuit.
- Glow relay.



- Glow timer.
- Glow plug.

SMA729



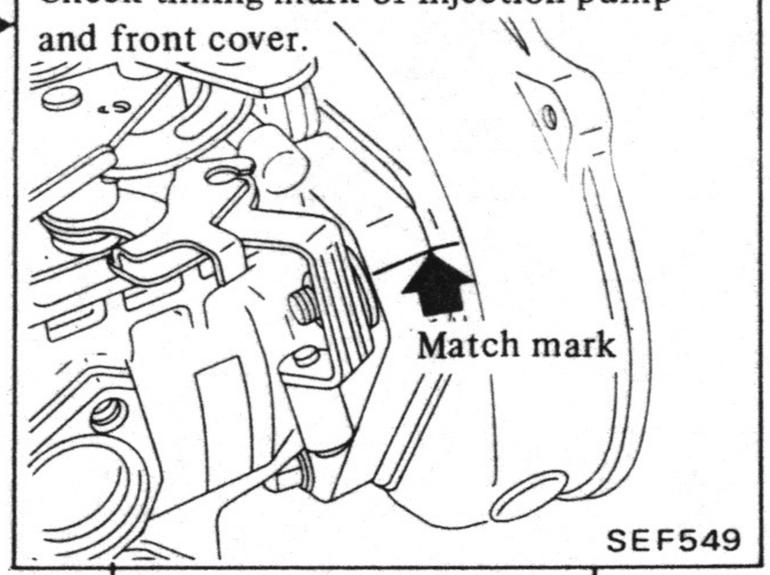
SMA681

NOT O.K. / O.K.

Repair or replace.

FUEL SYSTEM

Check timing mark of injection pump and front cover.

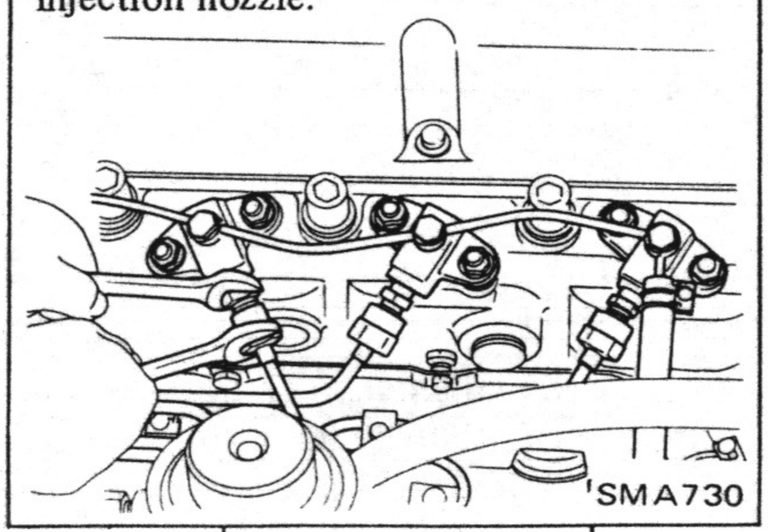


SEF549

O.K. / NOT O.K.

Adjust.

Crank engine to make sure fuel reaches injection nozzle.

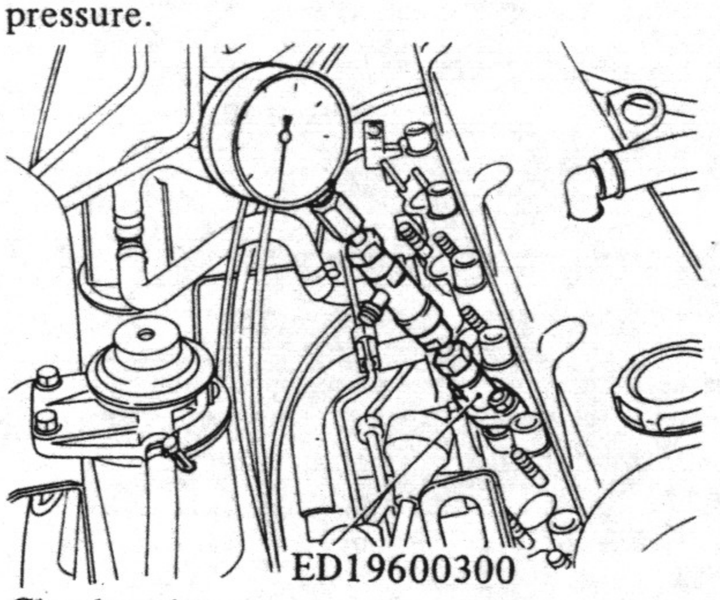


SMA730

NOT O.K. / O.K.

MECHANICAL SYSTEM

Crank engine and check compression pressure.



ED19600300

Check points. SMA656
- Valve lip seal worn.
- Piston or piston ring worn.
- Valve stem or valve seat worn.
- Cylinder gasket damaged.

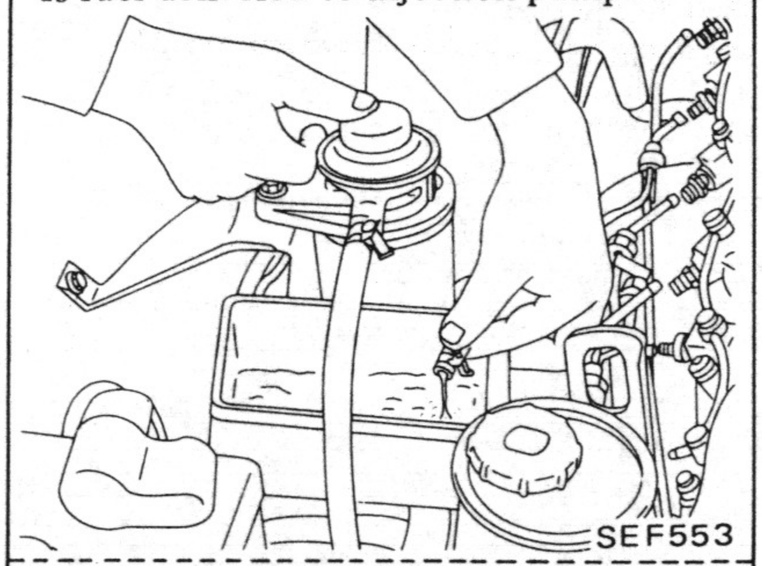
O.K. / NOT O.K.

Repair or replace.

Ⓐ Ⓑ

Ⓐ

Is fuel delivered to injection pump?



Check points.
- Fuel line twisted or clogged.
- Fuel filter clogged.

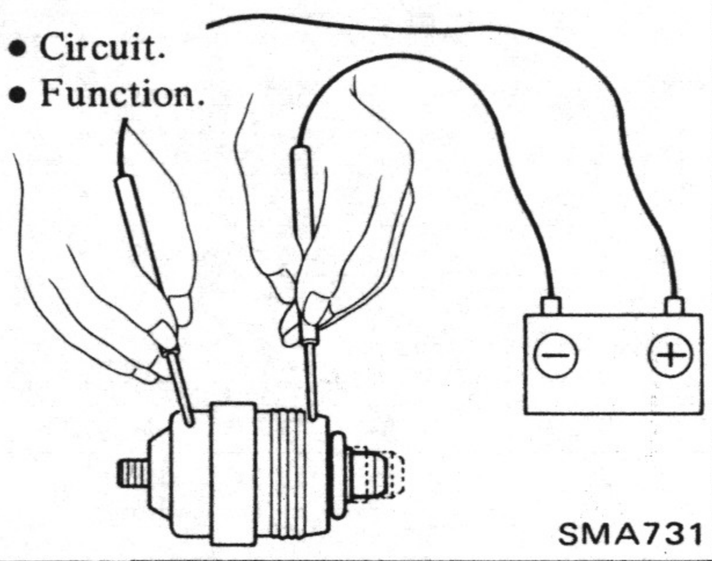
O.K.

NOT O.K.

Repair or replace.

Check fuel cut solenoid valve.

Check points.
- Circuit.
- Function.



O.K.

NOT O.K.

Replace.

Does delivery valve stick?

O.K.

NOT O.K.

Replace.

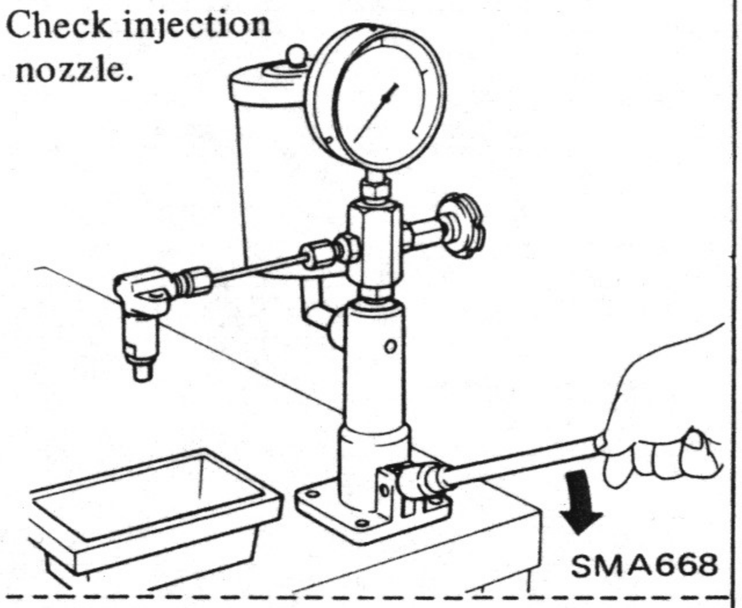
Overhaul injection pump.

Inspection points.
- Rusted or tardy movement of feed pump vane.
- Weak, broken, worn or rusted plunger spring.
- Abnormal wear on cam disc.

Ⓑ

O.K.

Check injection nozzle.



Check points.
- Fuel injection pattern.
- Clogging.
- Sticking
- Injection pressure.

NOT O.K.

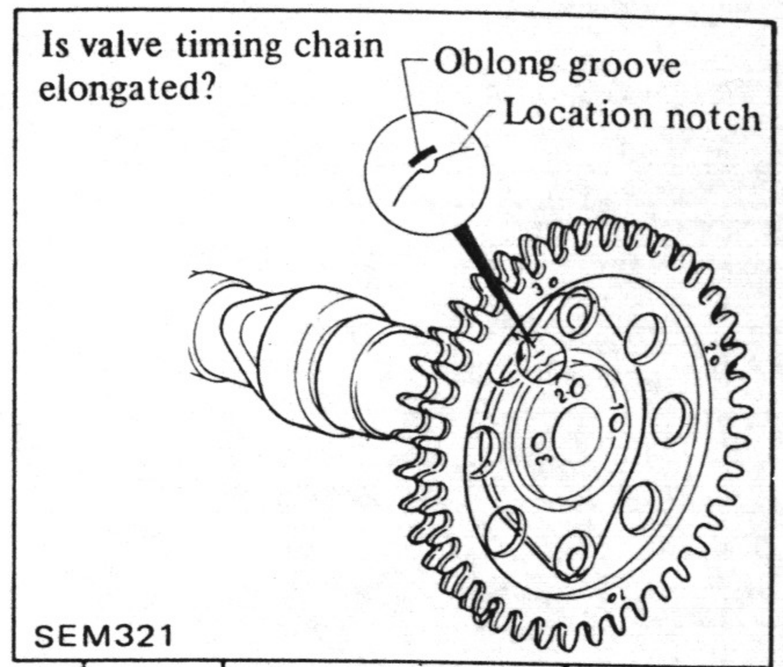
Adjust, repair or replace.

O.K.

Overhaul injection pump.

Inspection points.
- Rusted or tardy movement of feed pump vane.
- Weak, broken, or rusted regulating valve spring.
- Low setting pressure of regulating valve.
- Weak or broken delivery valve spring.
- Poor seating at delivery valve seat
- Weak, broken, worn, or rusted plunger spring.
- Malfunction of governor lever.
- Broken or weak timer spring.
- Rusted or tardy movement of timer piston.
- Weak or broken governor spring.
- Maladjusted injection quantity..
- Abnormal wear on cam disc.

Is valve timing chain elongated?



NO.

YES.

Adjust or replace chain.

Check valve clearance.

O.K.

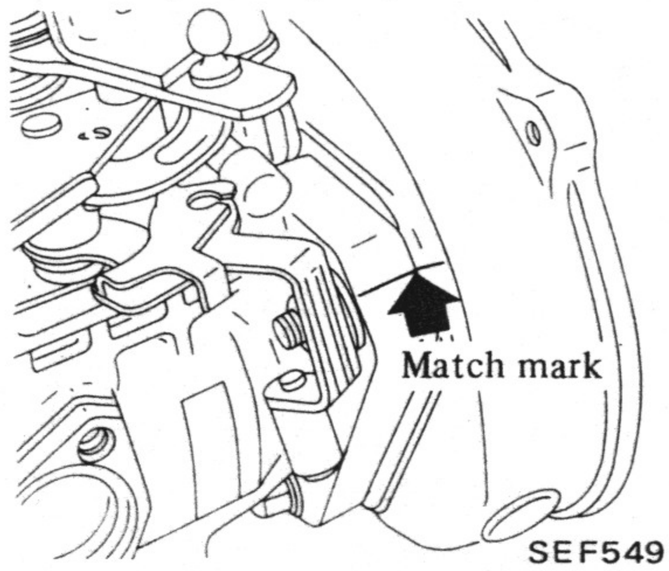
NOT O.K.

Adjust.

UNSTABLE IDLING SPEED

FUEL SYSTEM

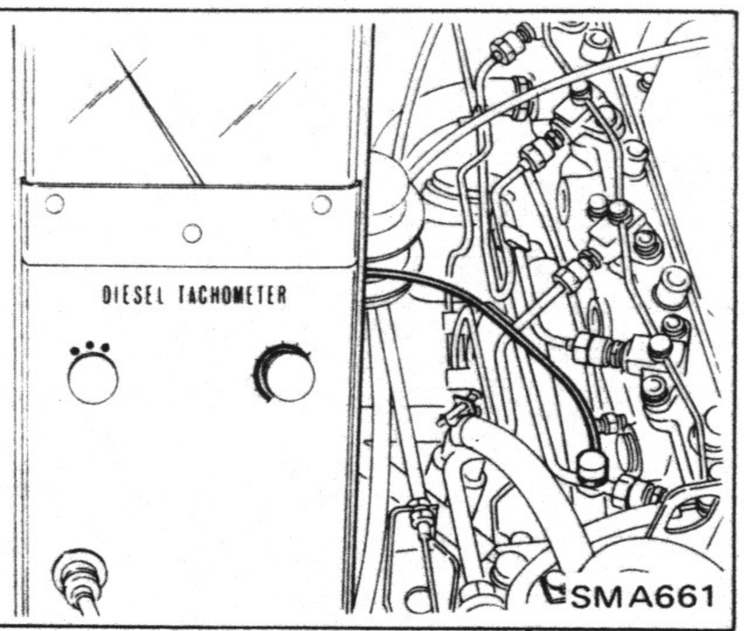
Check timing mark of injection pump and front cover.



O.K.

NOT O.K. → Adjust.

Check idle speed.



O.K.

NOT O.K. → Adjust.

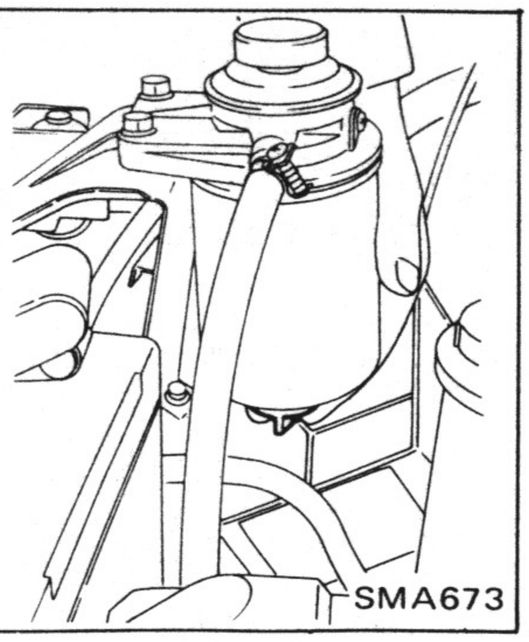
Check fuel line.

Check points.
- Fuel line twisted or clogged.
- Fuel filter clogged.
- Leaks or loose.

O.K.

NOT O.K. → Repair, retighten or replace.

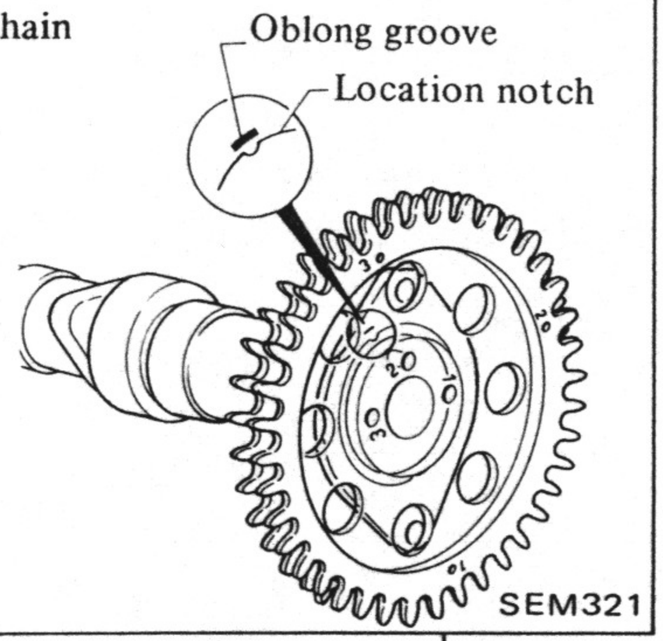
Purge air and drain water.



O.K.

MECHANICAL SYSTEM

Is valve timing chain elongated?



NO.

YES. → Adjust or replace chain.

Check valve clearance.

O.K.

NOT O.K. → Adjust.

Check engine mounting.

Check points.
- Cracked.
- Loose.

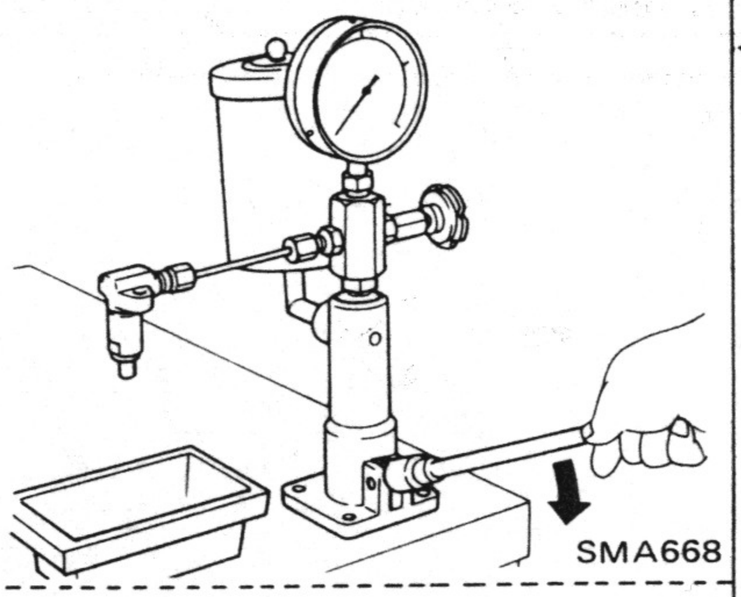
O.K.

NOT O.K. → Replace or retighten.

Ⓐ

Ⓐ

Check injection nozzle.

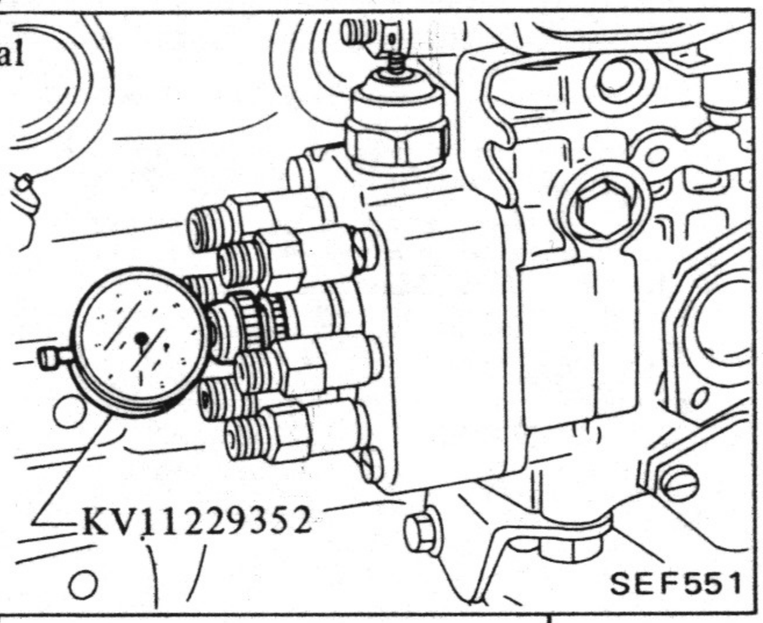


Check points.
- Fuel injection pattern.
- Clogging.
- Sticking.

O.K.

NOT O.K. → Adjust, repair or replace.

Check initial timing.



O.K.

NOT O.K. → Adjust or replace.

Does delivery valve stick?

NO.

YES. → Replace.

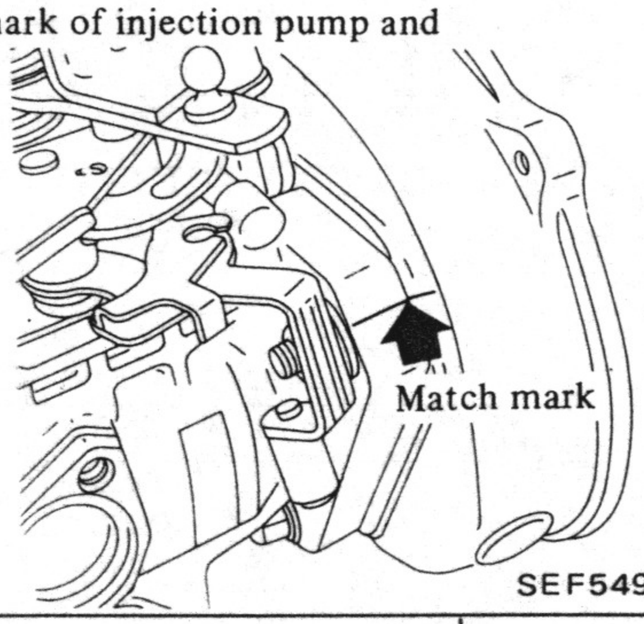
Overhaul injection pump.

Inspection points.
- Rusted or tardy movement of feed pump vane.
- Weak, broken, or rusted regulating valve spring.
- Low setting pressure of regulating valve.
- Weak or broken delivery valve spring.
- Poor seating at delivery valve seat.
- Weak, broken, worn, or rusted plunger spring.
- Malfunction of governor lever.
- Broken or weak timer spring.
- Rusted or tardy movement of timer piston.
- Weak or broken governor spring.
- Maladjusted injection quantity.
- Abnormal wear on cam disc.

EXCESSIVE WHITE or BLACK SMOKE

FUEL SYSTEM

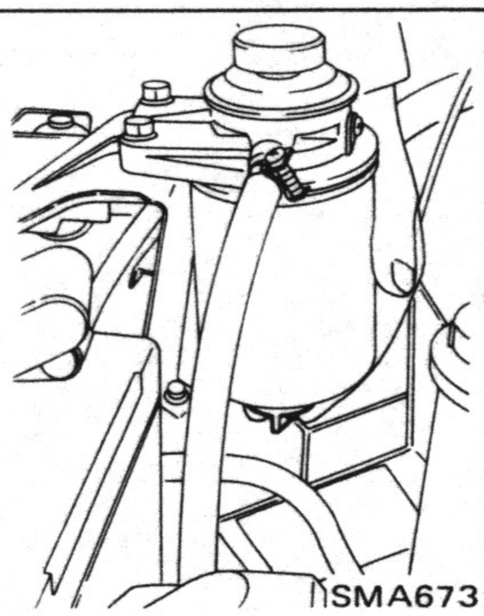
Check timing mark of injection pump and front cover.



NOT O.K. → Adjust.

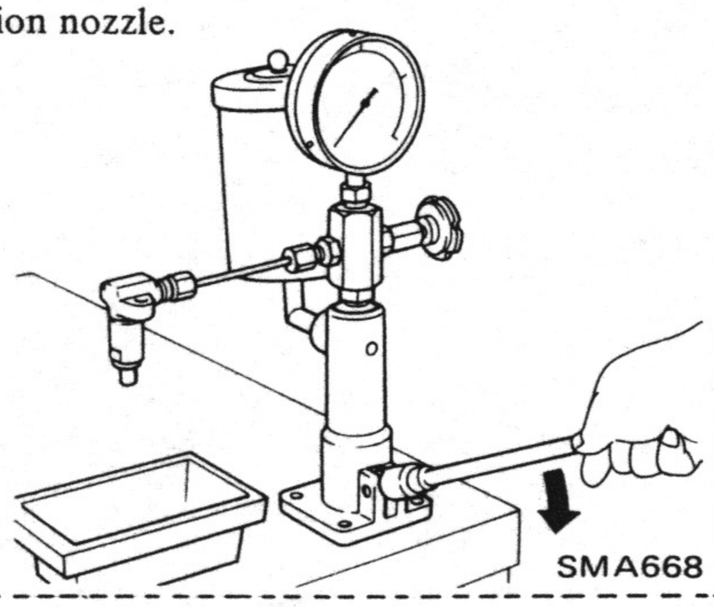
O.K. (White smoke)

Purge air and drain water.



O.K. (Black smoke)

Check injection nozzle.



Check points
- Nozzle worn.
- Spring worn.
- Injection pressure.

NOT O.K. → Adjust, repair or replace.

Does delivery valve stick?

YES. → Replace.

→ (A)

MECHANICAL SYSTEM

Black smoke or white smoke?

(Black smoke) / (White smoke)

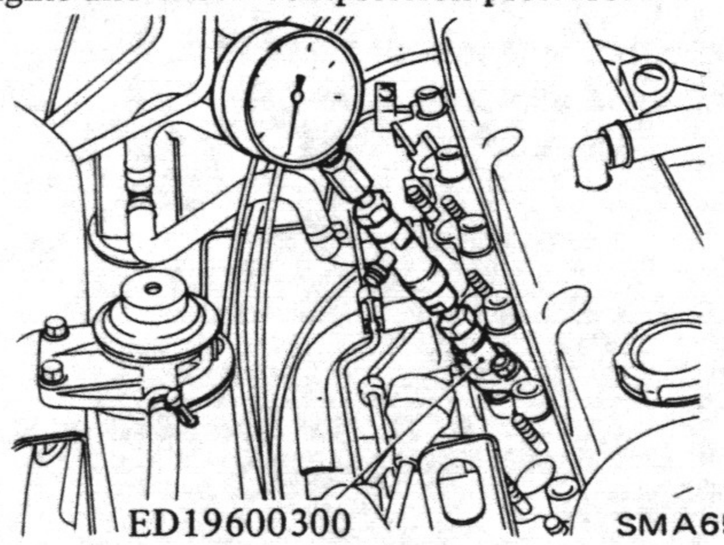
NO. → Is air cleaner element clogged?

YES. → Replace.

NO. → Check for oil or similar material in or on tail pipe.

YES.

Crank engine and check compression pressure.



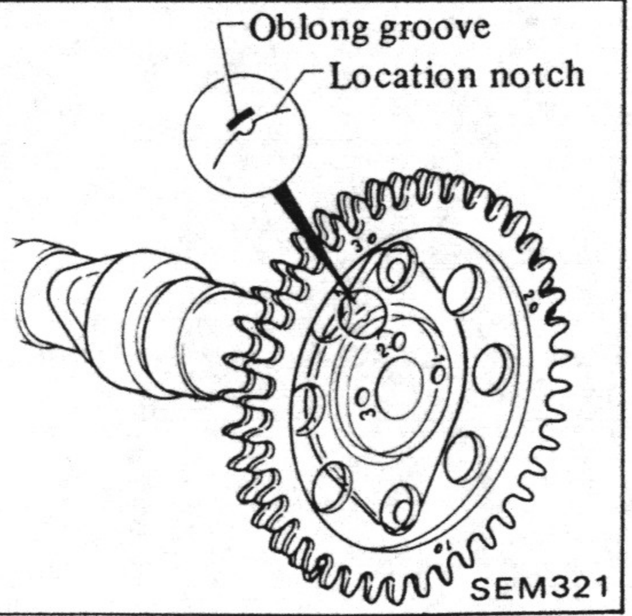
Check points.
- Cylinder head gasket damaged.
- Piston or piston ring worn.
- Valve stem or valve seat worn.
- Valve lip seal worn.

O.K. (Black smoke) → (Black smoke)

O.K. (White smoke) → (White smoke)

NOT O.K. → Repair or replace.

Is valve timing chain elongated?



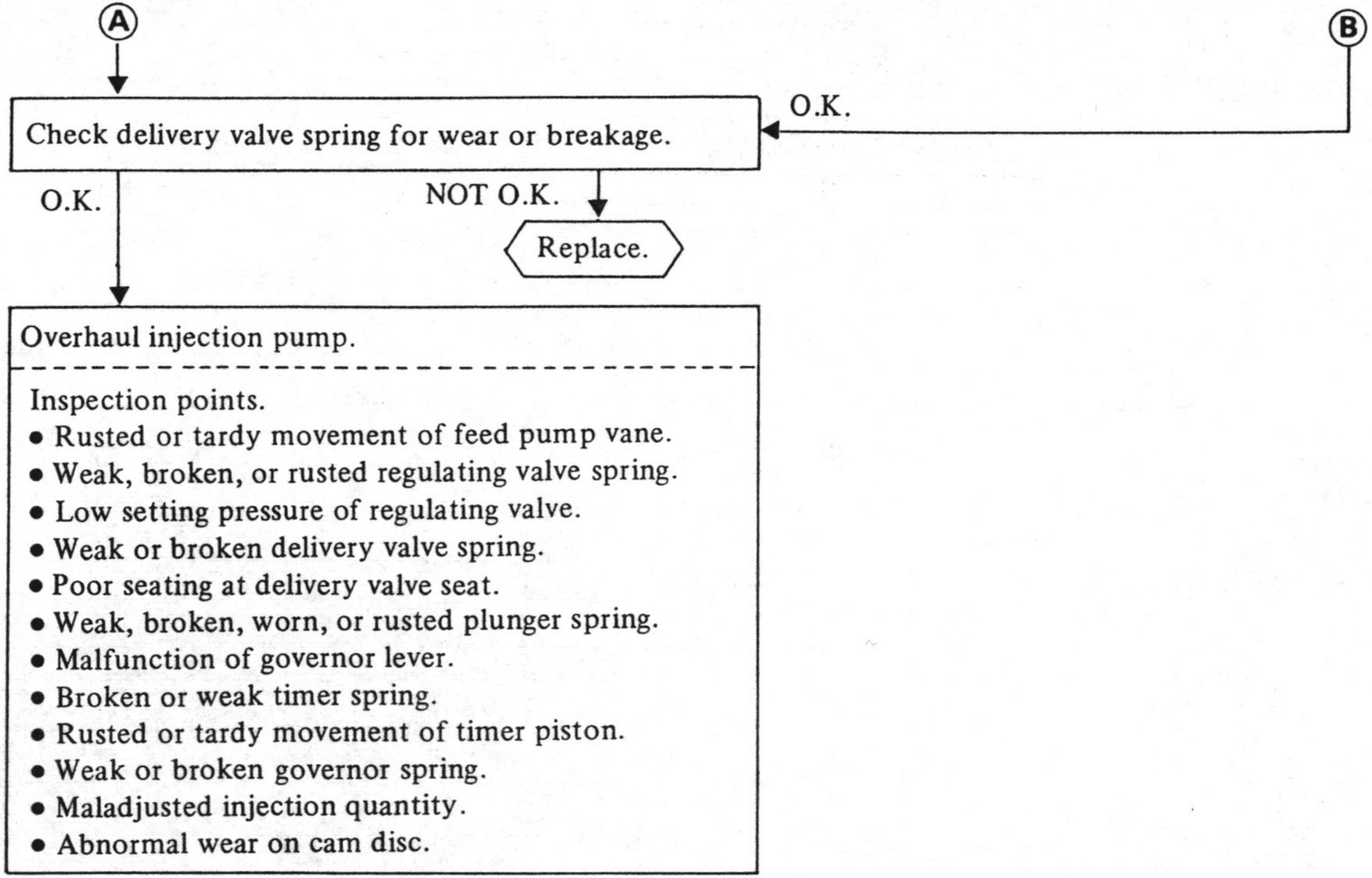
NO. → (B)

YES. → Adjust or replace chain.

(White smoke) → Does delivery valve stick?

YES. → Replace.

→ (A)


A
B
Check delivery valve spring for wear or breakage.
O.K.
NOT O.K.
O.K.
Replace.
Overhaul injection pump.
Inspection points.
• Rusted or tardy movement of feed pump vane.
• Weak, broken, or rusted regulating valve spring.
• Low setting pressure of regulating valve.
• Weak or broken delivery valve spring.
• Poor seating at delivery valve seat.
• Weak, broken, worn, or rusted plunger spring.
• Malfunction of governor lever.
• Broken or weak timer spring.
• Rusted or tardy movement of timer piston.
• Weak or broken governor spring.
• Maladjusted injection quantity.
• Abnormal wear on cam disc.

NOISY ENGINE

ENGINE KNOCKING

- Check engine warm-up.
  - NOT O.K. → Warm-up.
  - O.K. ↓
- Check injection timing.
  - NOT O.K. → Adjust.
  - O.K. ↓
- Check compression pressure.
  - Check piston and piston ring for wear.
  - Check valve seat and valve stem for wear.
  - NOT O.K. → Repair or replace.
  - O.K. ↓
- Check injection nozzle.
  - Fuel injection pattern.
  - Clogging nozzle.
  - Damage gasket.
  - Injection pressure.
  - NOT O.K. → Clean or replace.
  - O.K. ↓
- Check injection pump. Refer to EF section.

FROM CYLINDER HEAD

- Check cylinder head bolt.
  - NOT O.K. → Retighten.
  - O.K. ↓
- Check for gas leakage.
  - NOT O.K. → Replace head gasket.
  - O.K. ↓
- Check valve clearance.
  - NOT O.K. → Adjust.
  - O.K. ↓
- END.

AT INJECTION PUMP SIDE OF ENGINE

- Check injection pump. Refer to EF section.

AT FAN

- Check fan for cracks.
  - NOT O.K. → Replace.
  - O.K. ↓
- Check for loose fan belt.
  - NOT O.K. → Adjust.
  - O.K. ↓
- Is fan pulley cracked?
  - YES. → Replace.
  - NO. ↓
- Check alternator for bearing play.
  - NOT O.K. → Replace bearing or armature shaft.
  - O.K. ↓
- Check water pump.
  - Check body assembly and vane for rust formation or corrosion.
  - Check end play or roughness of bearing in operation.
  - NOT O.K. → Replace water pump assembly.
  - O.K. ↓
- END.

FROM ENGINE ITSELF (CYLINDER BLOCK)

- Check points.
  - Piston worn.
  - Connecting rod bent or worn.
  - Crankshaft bent or worn.
  - Loose bolts.

OIL LEAKAGE

OIL PUMP

Check mating areas of oil pump and front cover.
- O.K.
- NOT O.K. → Retighten or replace.

Check regulator valve.
- O.K.
- NOT O.K. → Retighten or replace.

Check oil pump body for cracks or damage.
- O.K.
- NOT O.K. → Replace.

Check oil pump cover mounting area.
- NOT O.K. → Retighten or replace.
- O.K.

ENGINE COMPONENT

Check rocker cover.
- O.K.
- NOT O.K. → Retighten or replace gasket.

Check mating areas of cylinder block and cylinder head.
- O.K.
- NOT O.K. → Replace gasket.

Check areas around blind plug at cylinder block's oil gallery.
- O.K.
- NOT O.K. → Replace blind plug.

Check oil cooler mounting area.
- O.K.
- NOT O.K. → Retighten or replace O-ring.

Check mating areas of oil pan and cylinder block.
- O.K.
- NOT O.K. → Retighten or replace gasket.

Check oil pan drain plug.
- O.K.
- NOT O.K. → Retighten or replace gasket.

Check areas around rear plate.
- O.K.
- NOT O.K. → Replace oil seal.

Check areas around front cover.
- O.K.
- NOT O.K. → Replace oil seal and gasket.

Check oil leaks around transmission.
- O.K. → END
- NOT O.K. → Replace oil seal.

WATER LEAKAGE

RADIATOR

Check drain cock.

- NOT O.K. → Replace packing or retighten.
- O.K. →

Check radiator for cracks.

- NOT O.K. → Repair or replace.
- O.K. →

Radiator hoses for cracks.

- NOT O.K. → Retighten or replace.
- O.K. → (to OIL COOLER)

OIL COOLER

Oil cooler for cracks.

- NOT O.K. → Repair or replace.
- O.K. →

Check oil cooler hoses for cracks and loose joints.

- NOT O.K. → Retighten or replace.
- O.K. → (to ENGINE COMPONENT)

ENGINE COMPONENT

Check mating areas of cylinder block and head.

- NOT O.K. → Retighten or replace gasket.
- O.K. →

Check areas around blind plug at cylinder block's water gallery.

- NOT O.K. → Replace blind plug.
- O.K. →

Check water pumps.

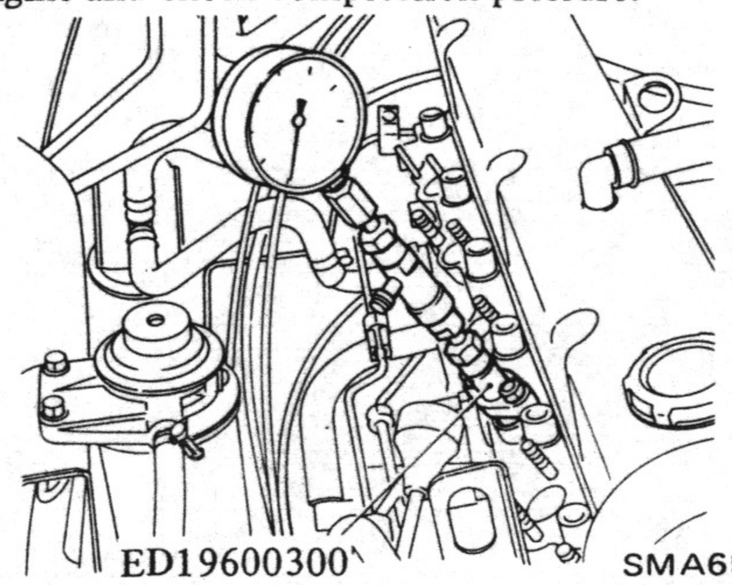
- NOT O.K. → Retighten or replace gasket.

END

HIGH OIL CONSUMPTION

Oil leakage.
Refer to OIL LEAKAGE.

Crank engine and check compression pressure.

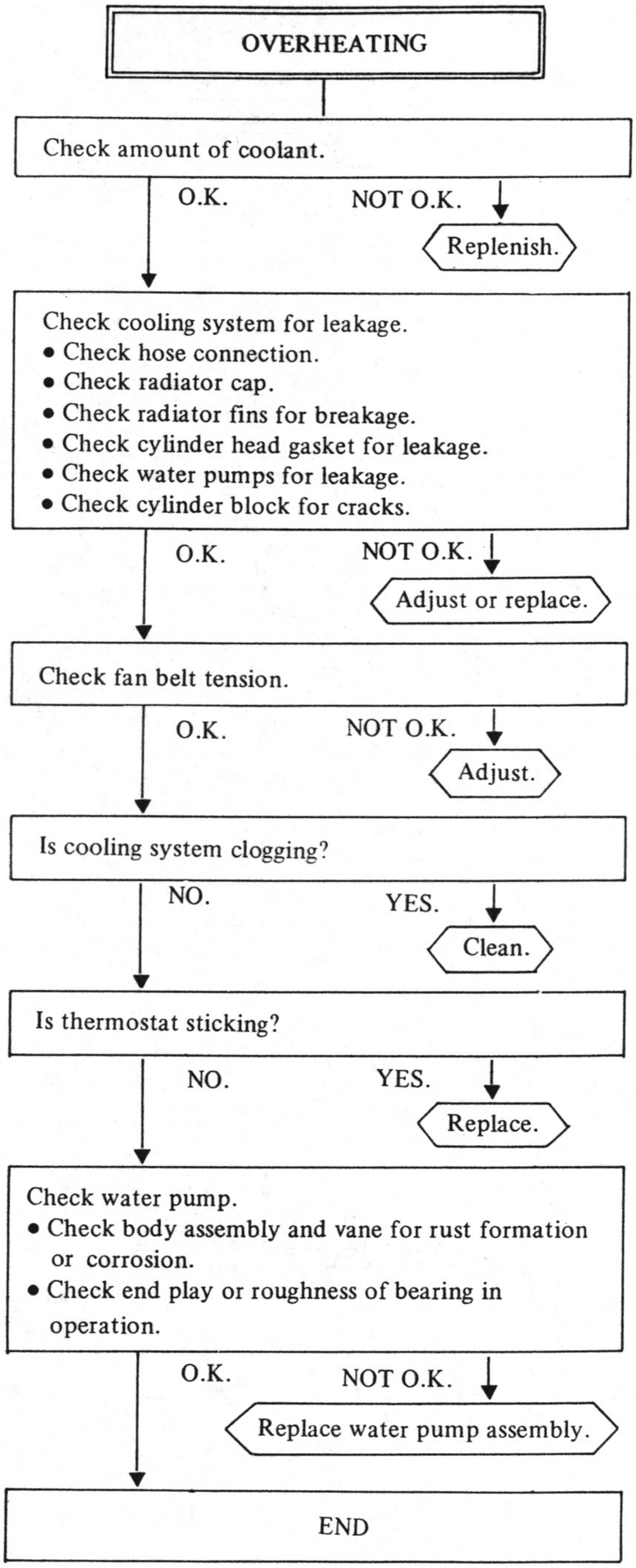


ED19600300 SMA656

Check points.
- Cylinder gasket damaged.
- Piston or piston ring worn.
- Valve stem or valve seat worn.
- Valve lip seal worn.

- NOT O.K. → Repair or replace.
- O.K. →

END


OVERHEATING
Check amount of coolant.
O.K.
NOT O.K.
Replenish.
Check cooling system for leakage.
• Check hose connection.
• Check radiator cap.
• Check radiator fins for breakage.
• Check cylinder head gasket for leakage.
• Check water pumps for leakage.
• Check cylinder block for cracks.
O.K.
NOT O.K.
Adjust or replace.
Check fan belt tension.
O.K.
NOT O.K.
Adjust.
Is cooling system clogging?
NO.
YES.
Clean.
Is thermostat sticking?
NO.
YES.
Replace.
Check water pump.
• Check body assembly and vane for rust formation or corrosion.
• Check end play or roughness of bearing in operation.
O.K.
NOT O.K.
Replace water pump assembly.
END

INSUFFICIENT OUTPUT

FUEL SYSTEM

Fuel quality is normal.

O.K.

NOT O.K. → Replace.

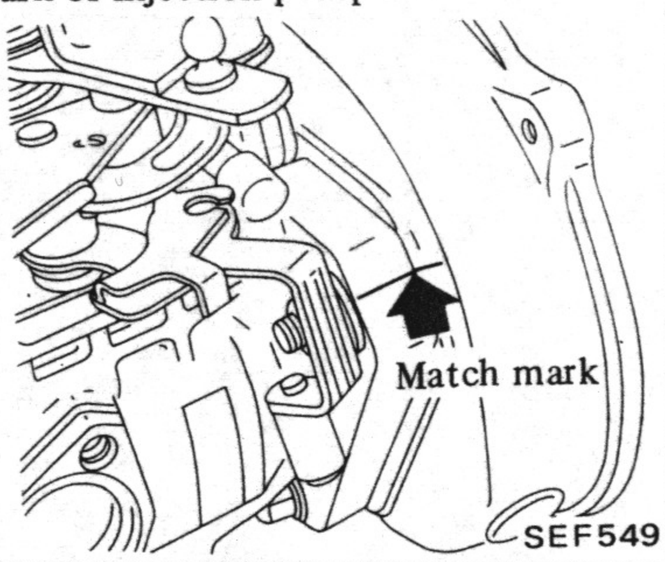
Does control lever contact maximum speed adjusting screw?

Check points.
- Accelerator pedal stroke.
- Accelerator wire elongated.
- Accelerator linkage stuck.

O.K.

NOT O.K. → Adjust or repair.

Check timing mark of injection pump and front cover.



O.K.

NOT O.K. → Adjust.

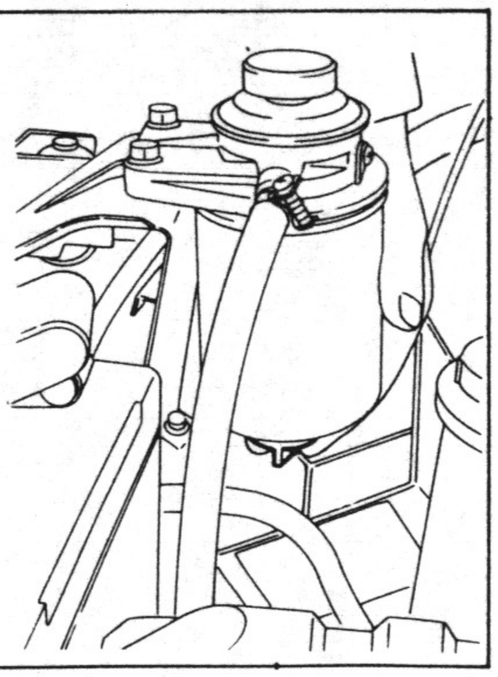
Check fuel line.

Check points.
- Fuel line twisted or clogged.
- Fuel filter clogged.
- Leaks or loose.

O.K.

NOT O.K. → Repair, retighten or replace.

Purge air and drain water.



O.K.

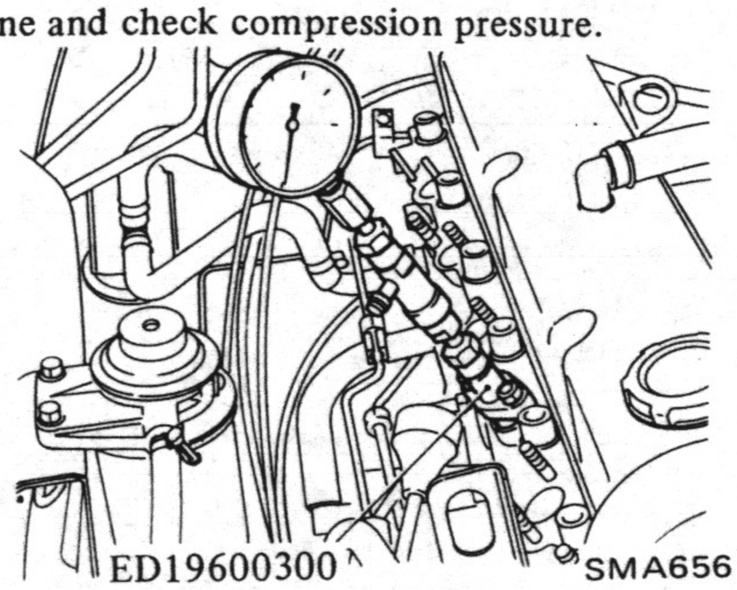
MECHANICAL SYSTEM

Check air cleaner element for clogs.

O.K.

NOT O.K. → Replace.

Crank engine and check compression pressure.



Check points.
- Valve lip seal worn.
- Piston or piston ring worn.
- Valve stem or valve seal worn.
- Cylinder gasket damaged.

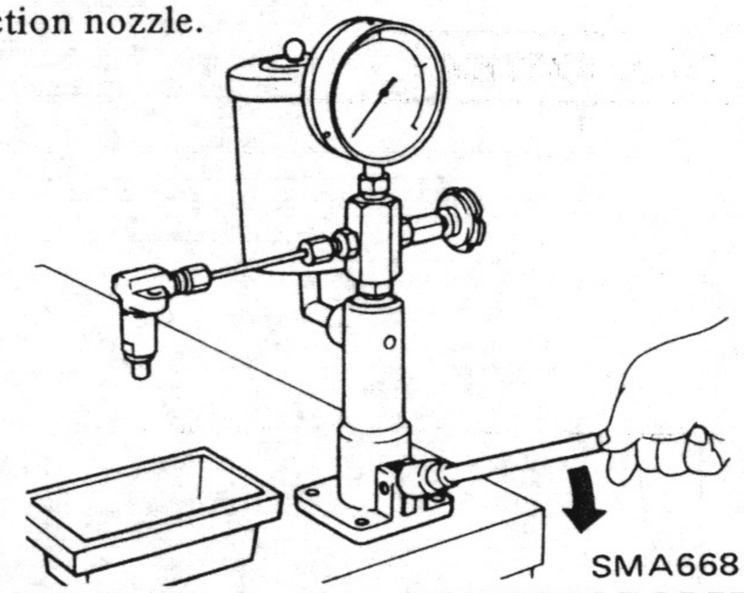
O.K.

NOT O.K. → Repair or replace.

Ⓐ

Ⓐ O.K.

Check injection nozzle.



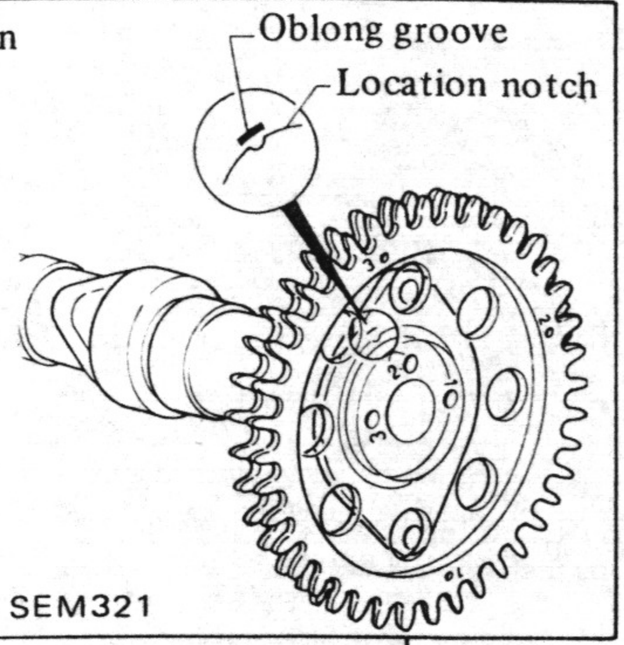
SMA668

Check points.
- Fuel injection pattern.
- Clogging.
- Sticking.
- Injection pressure.

NOT O.K. → Adjust, repair or replace.

O.K.

Is valve timing chain elongated?



SEM321

YES. → Adjust or replace chain.

NO.

Check valve clearance.

O.K.

NOT O.K. → Adjust.

Does delivery valve stick?

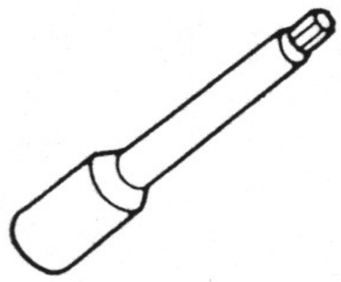
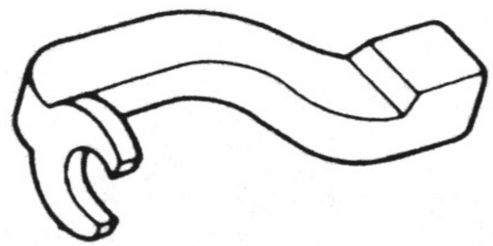
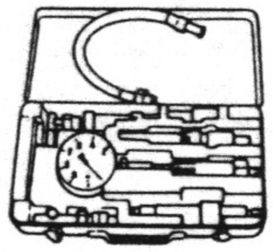
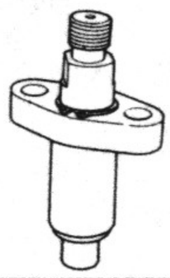
NO.

YES. → Replace.

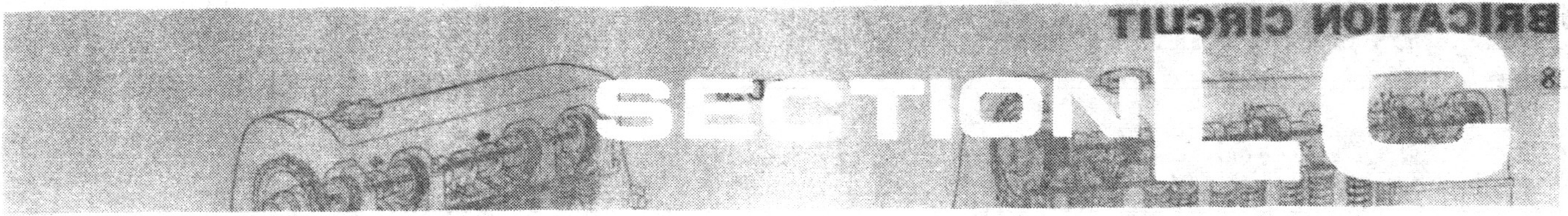
Overhaul injection pump.

Inspection points.
- Rusted or tardy movement of feed pump vane.
- Weak, broken, or rusted regulating valve spring.
- Low setting pressure of regulating valve.
- Weak or broken delivery valve spring.
- Poor seating at delivery valve seat.
- Weak, broken, worn, or rusted plunger spring.
- Malfunction of governor lever.
- Broken or weak timer spring.
- Rusted or tardy movement of timer piston.
- Weak or broken governor spring.
- Maladjusted injection quantity.
- Abnormal wear on cam disc.

SPECIAL SERVICE TOOLS

Tool number	Tool name
ST10120000	Cylinder head bolt wrench 
ST10640001	Pivot adjuster 
ST19320000	Oil filter wrench 
ED19600000	Compression gauge set 
ED19600300	Compression gauge adapter 

ENGINE LUBRICATION & COOLING SYSTEMS



CONTENTS

ENGINE LUBRICATION SYSTEM ..... LC- 2
- LUBRICATION CIRCUIT ..... LC- 2
- OIL PUMP ..... LC- 3
- OIL COOLER ..... LC- 5

ENGINE COOLING SYSTEM ..... LC- 6
- COOLING CIRCUIT ..... LC- 6
- WATER PUMP ..... LC- 6
- THERMOSTAT ..... LC- 8
- RADIATOR ..... LC- 9

SERVICE DATA AND SPECIFICATIONS LC-10
- ENGINE LUBRICATION SYSTEM LC-10
- ENGINE COOLING SYSTEM LC-10

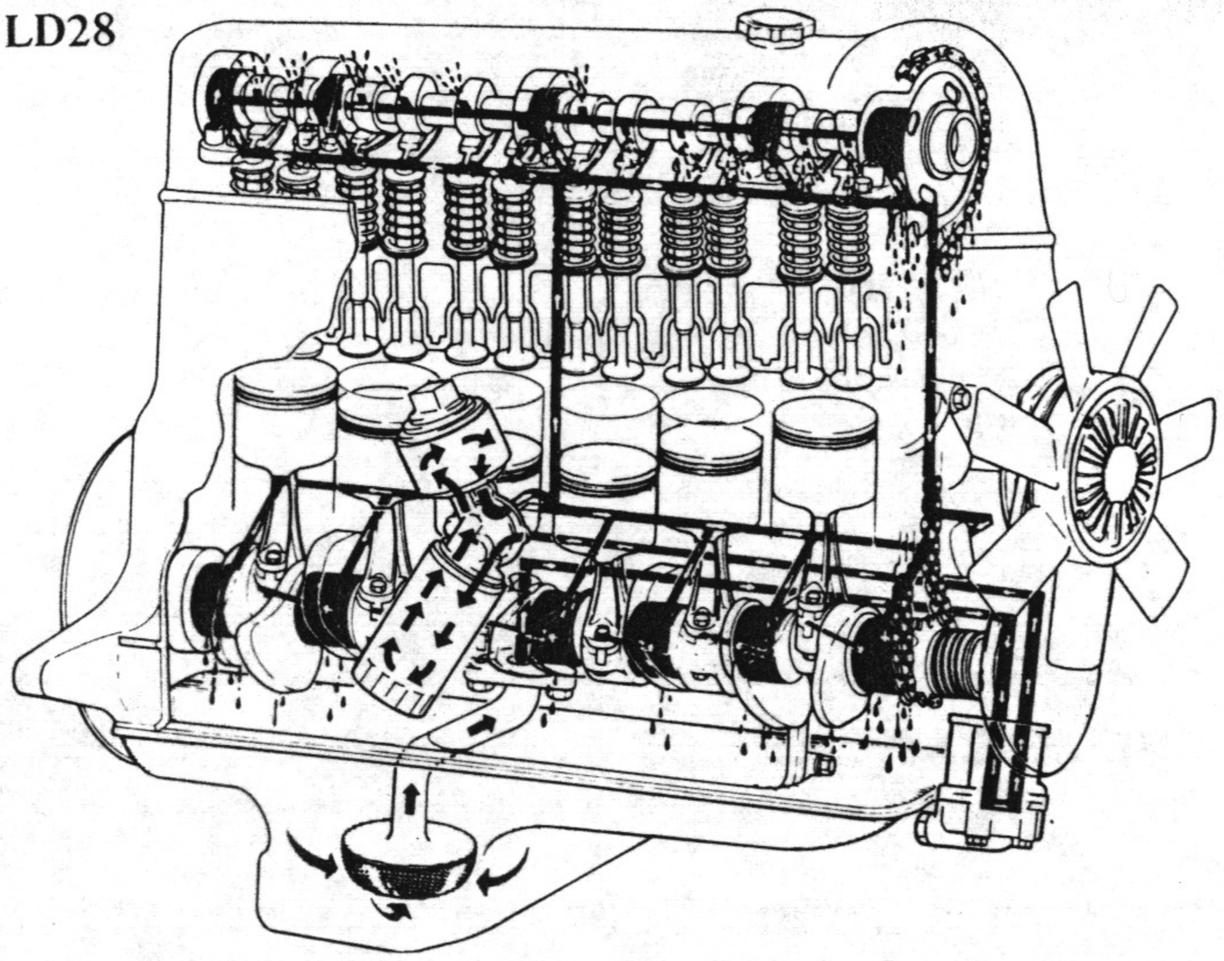
SPECIAL SERVICE TOOL LC-11

LC

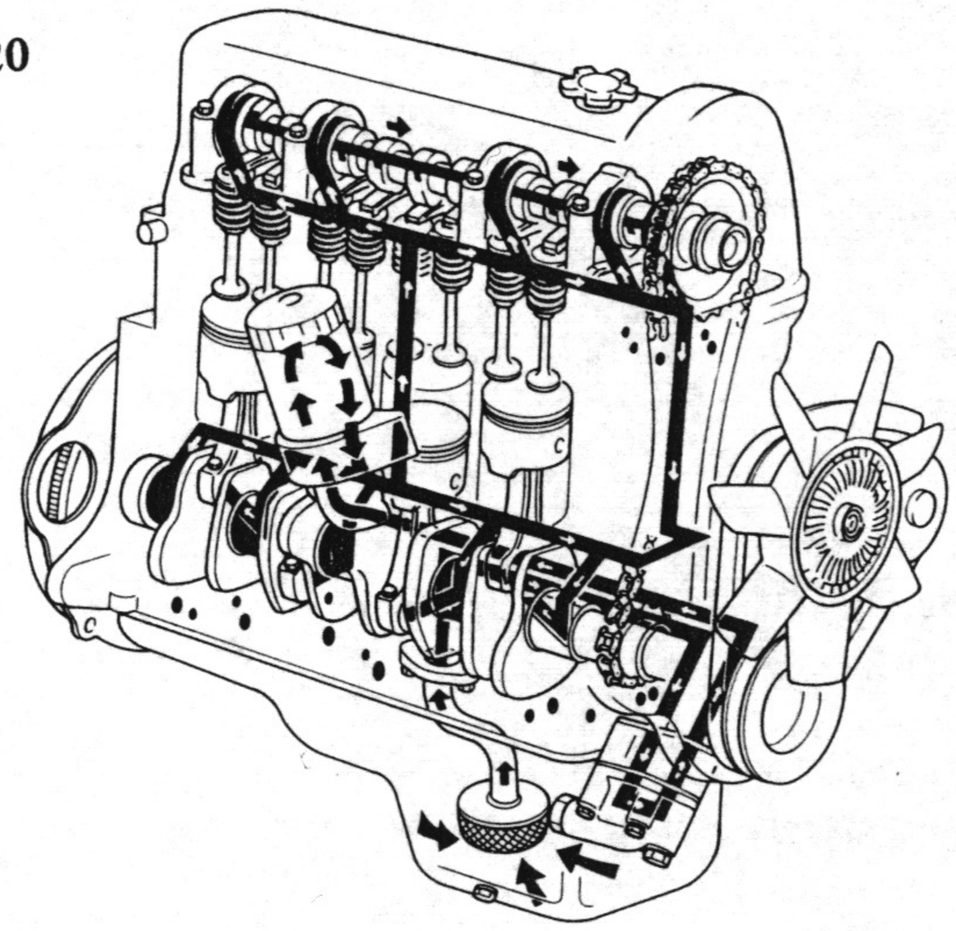
ENGINE LUBRICATION SYSTEM

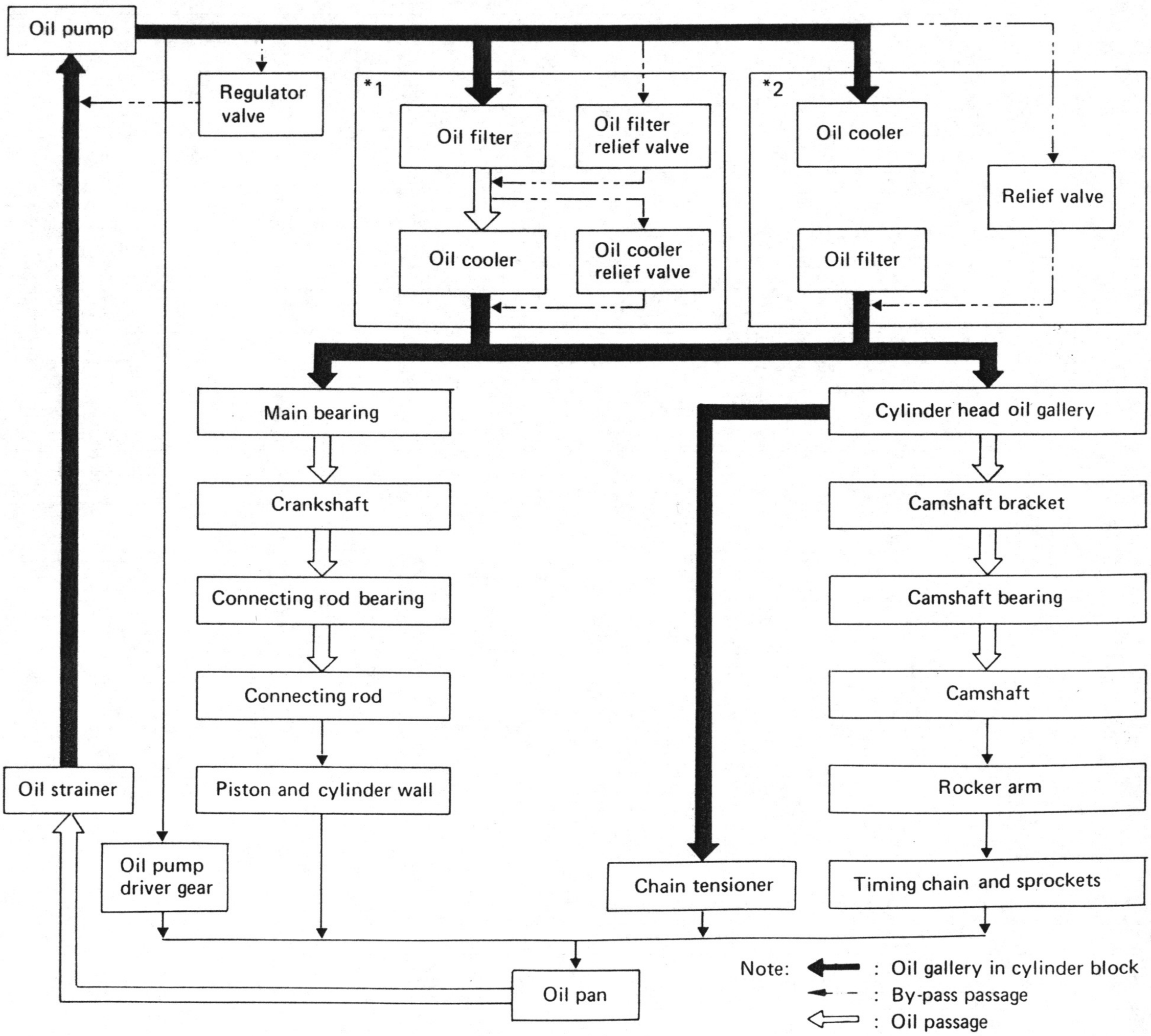
LUBRICATION CIRCUIT

LD28



LD20



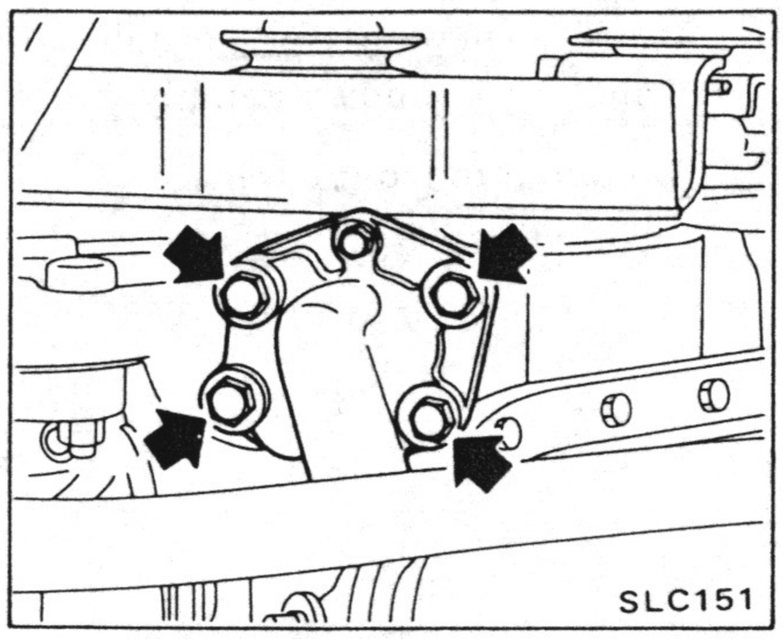


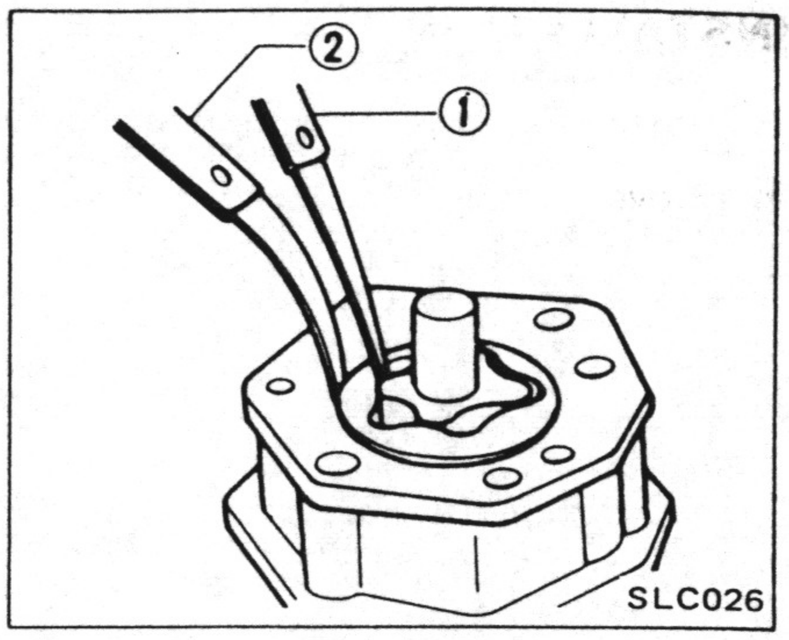
SLC235

OIL PUMP

REMOVAL

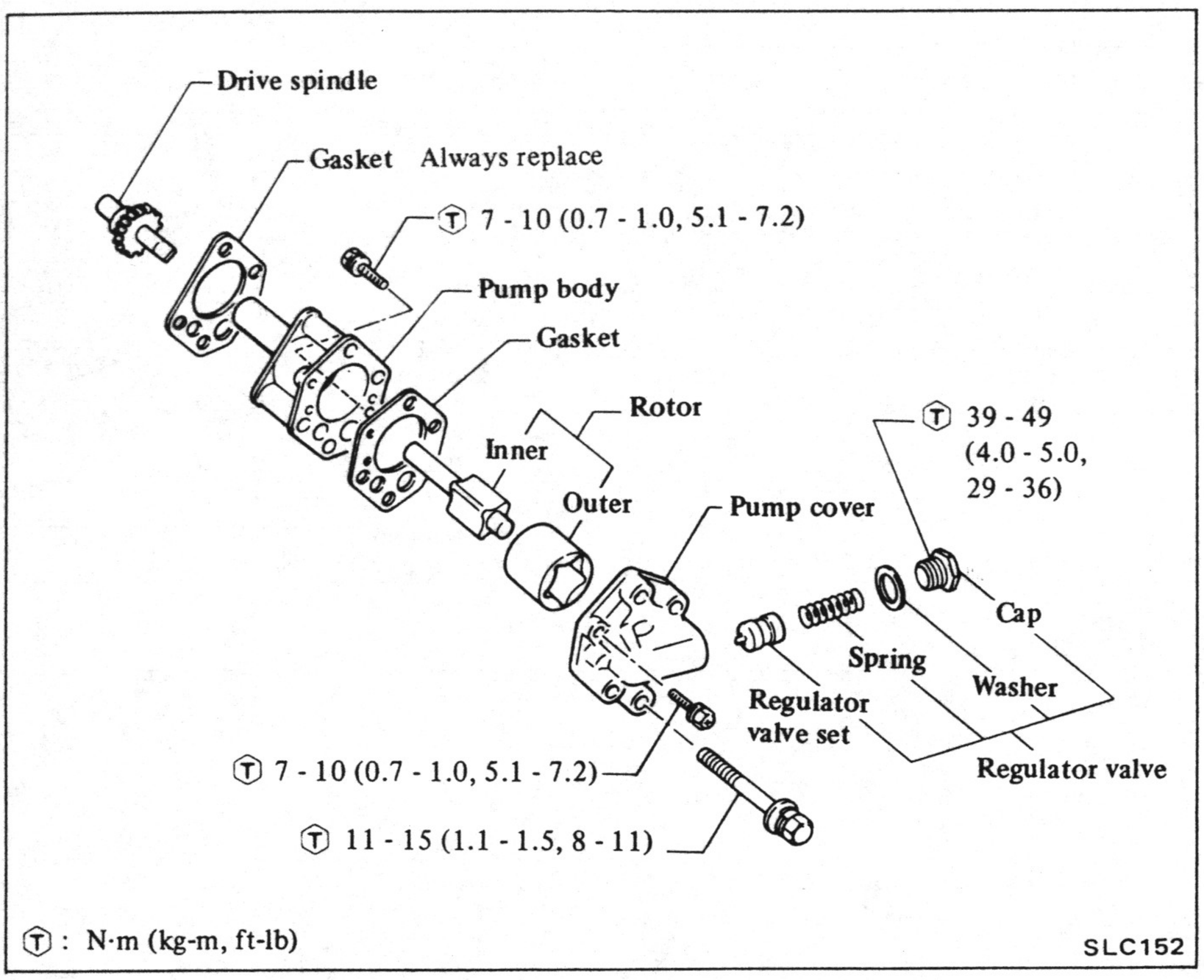
1. Remove engine undercover.
2. Remove oil pump and drive spindle as an assembly.


SLC151



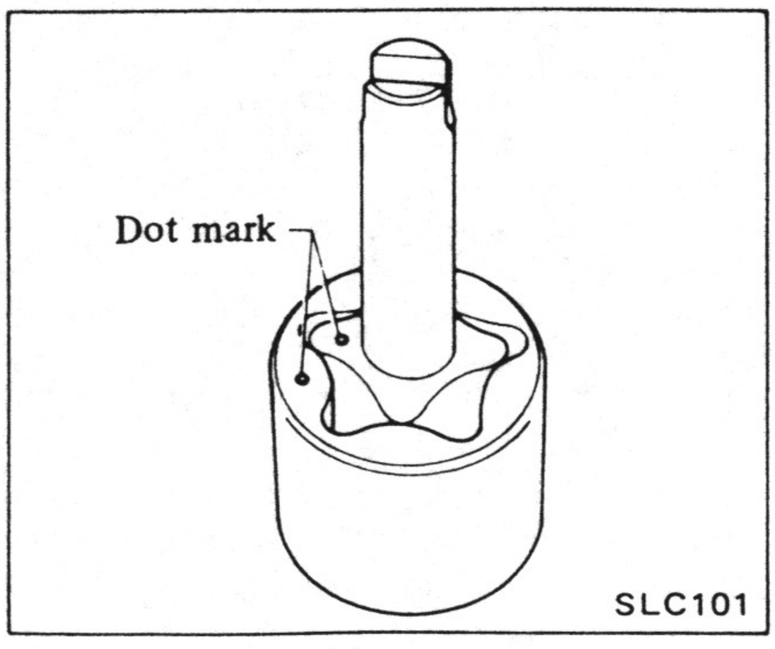
SLC026

DISASSEMBLY AND ASSEMBLY



Ⓣ : N·m (kg-m, ft-lb)
SLC152

The dot on outer and inner rotor should face toward oil pump body.



SLC101

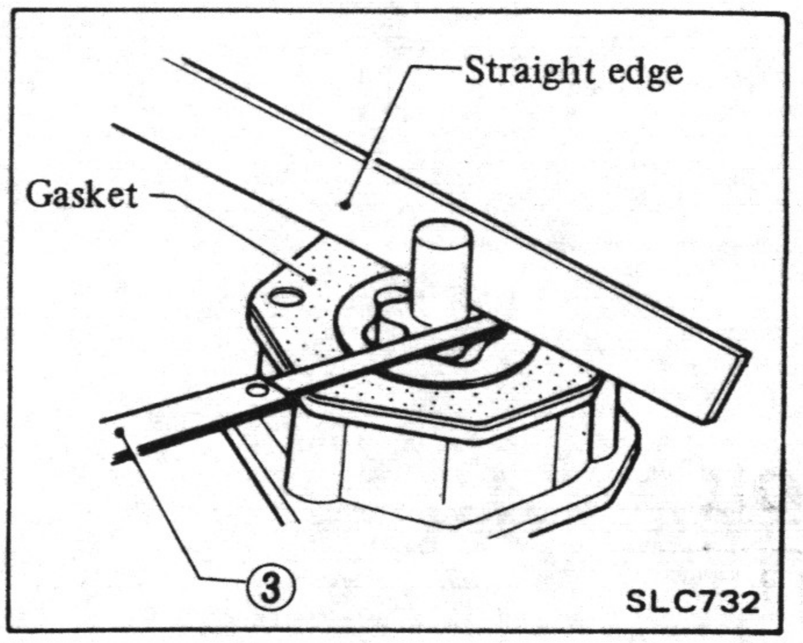
INSPECTION

1. Using a feeler gauge, check the following clearance.

If it exceeds limit, replace rotor set or entire oil pump assembly.

Rotor tip clearance ①:
Less than 0.12 mm (0.0047 in)
Outer rotor to body clearance ②:
0.15 - 0.21 mm
(0.0059 - 0.0083 in)

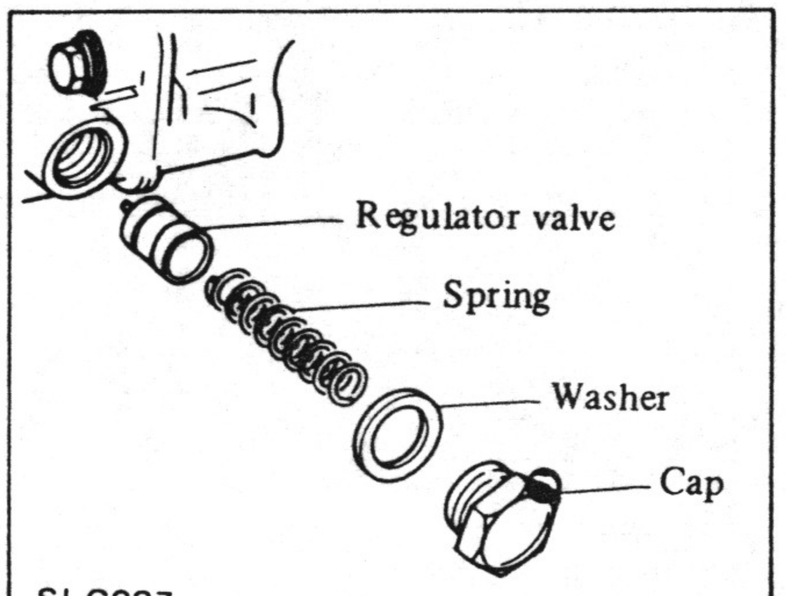
Outer and inner rotor side clearance (with gasket) ③:
0.04 - 0.08 mm
(0.0016 - 0.0031 in)



SLC732

2. Check oil pressure regulator valve sliding surface and valve spring.

If damaged, replace valve set or pump assembly.



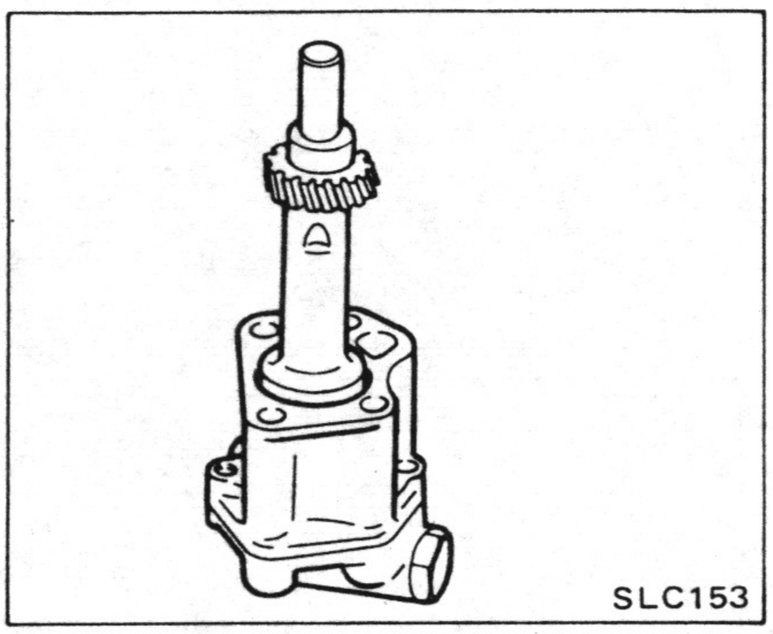
SLC087

INSTALLATION

1. Install pump cover with gasket.

Ⓣ : **Cover bolt**
7 - 10 N·m
(0.7 - 1.0 kg-m,
5.1 - 7.2 ft-lb)

2. Fill pump housing with engine oil, then install drive spindle.



3. Using a new gasket, install oil pump and drive spindle assembly.

Ⓣ : **Oil pump to front cover**
11 - 15 N·m
(1.1 - 1.5 kg-m,
8 - 11 ft-lb)

4. Refill engine with oil.

Approximate oil refill capacity

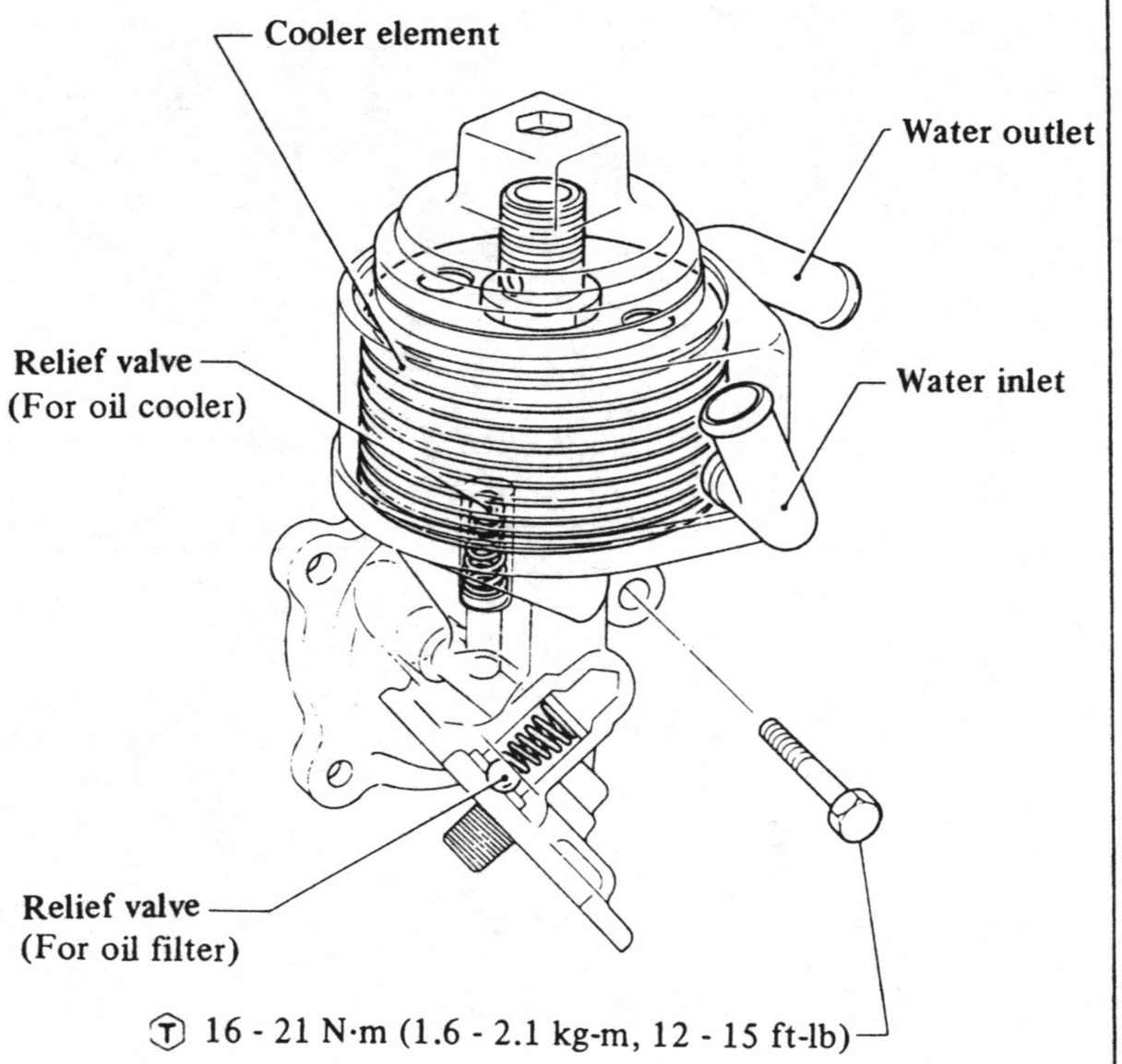
Unit: liter (Imp qt)

		Without oil filter change	With oil filter change
LD20	910	3.8 (3-3/8)	4.5 (4)
	C120	3.6 (3-1/8)	4.3 (3-3/4)
LD28	430	4.3 (3-3/4)	5.0 (4-3/8)
	C31	4.3 (3-3/4)	5.0 (4-3/8)

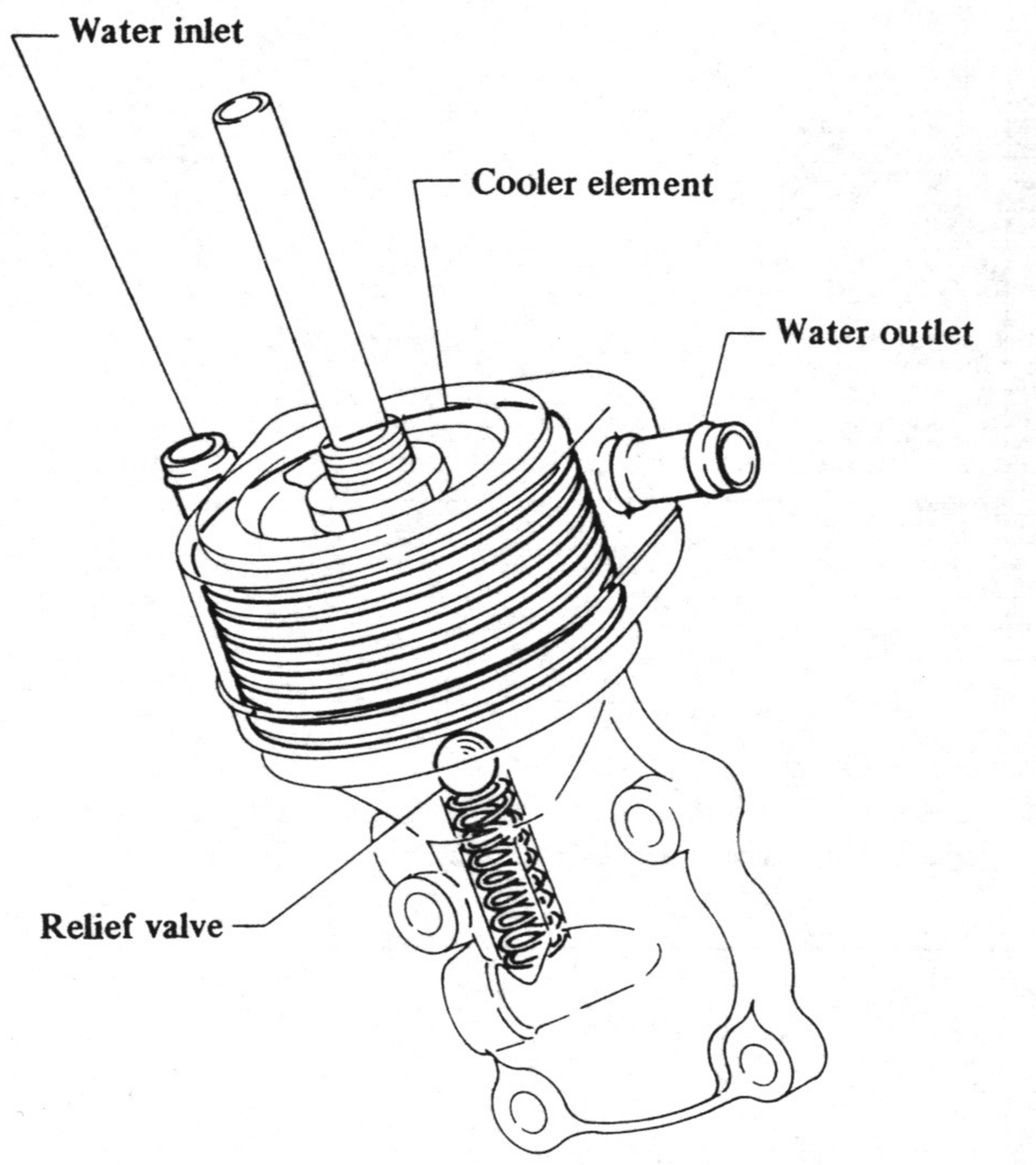
After installing, run engine for a few minutes, and check for leaks.

OIL COOLER

LD28



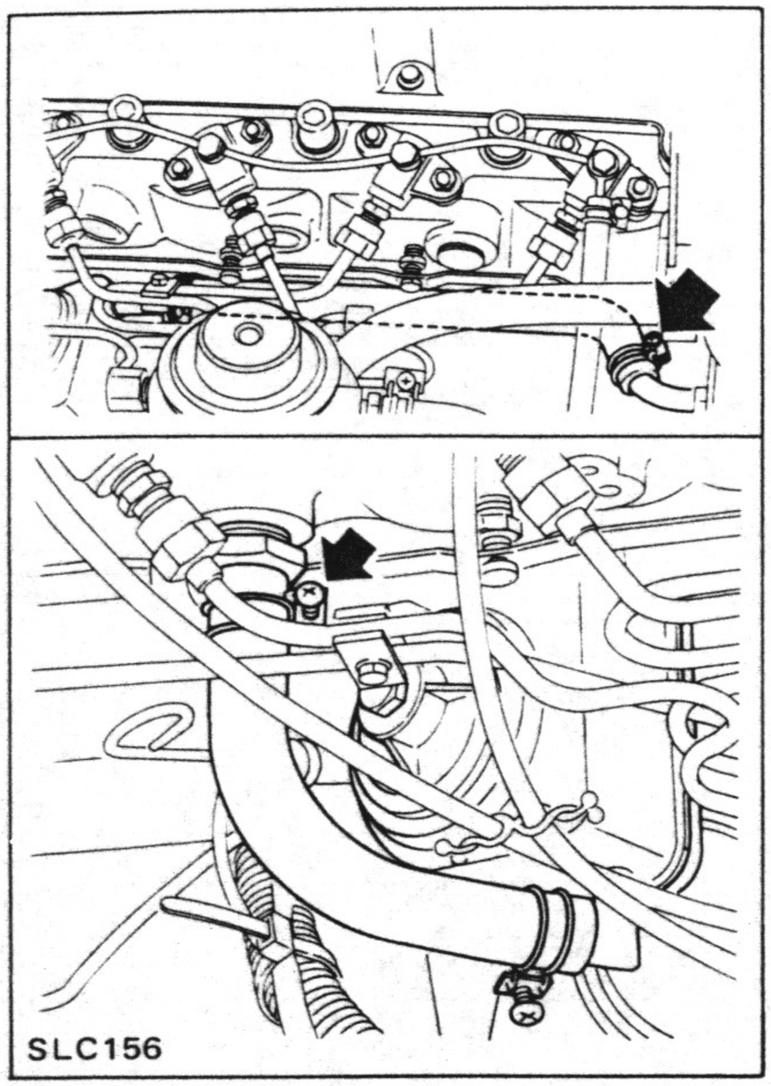
LD20



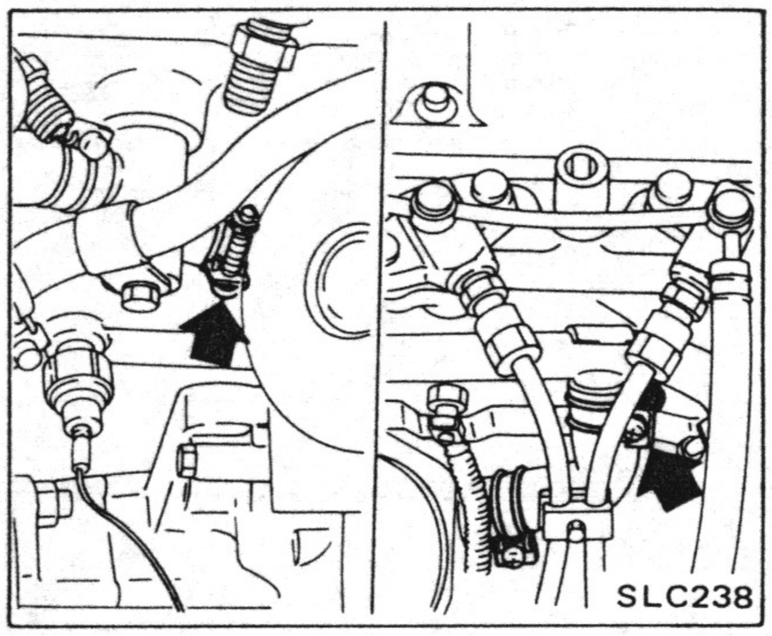
REMOVAL

1. Remove radiator drain plug and radiator cap, and drain coolant.
2. Remove coolant hoses.

LD28



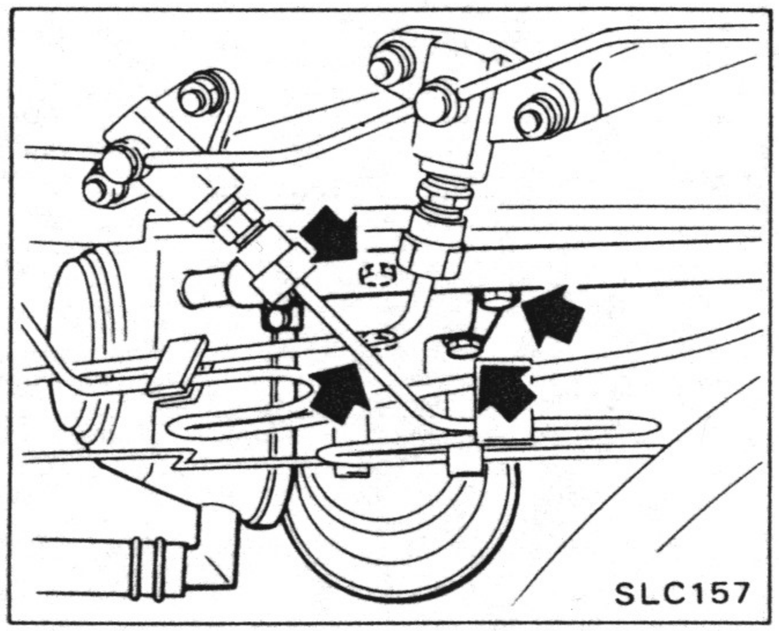
LD20



3.

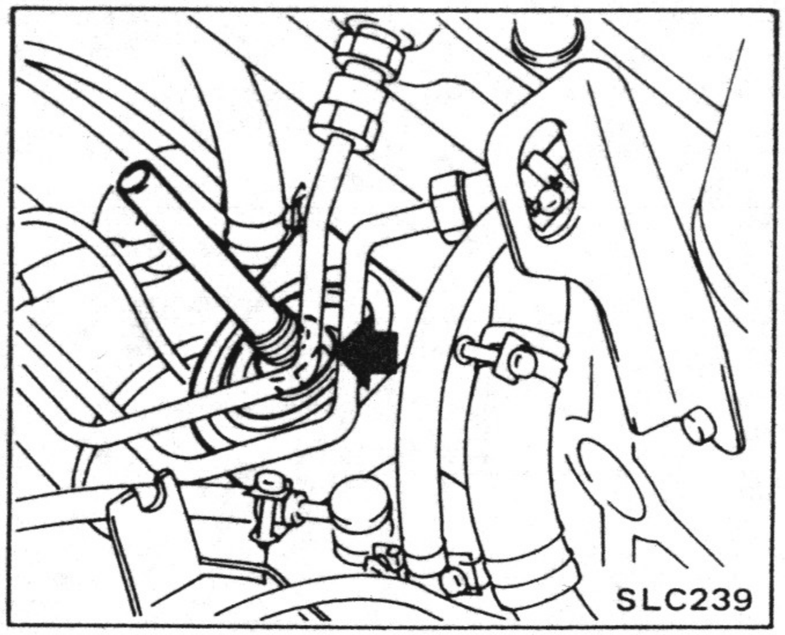
LD28

- Remove oil cooler assembly with oil filter and hoses.

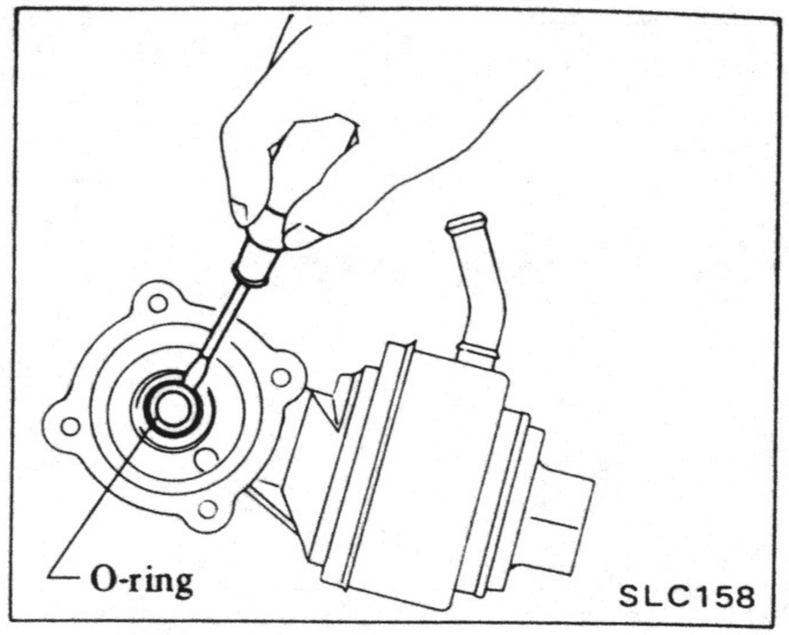


LD20

- Remove oil filter and nut, then take out oil cooler.



4. Remove O-ring from bracket (LD28).



INSTALLATION

Install oil cooler in the reverse order of removal.

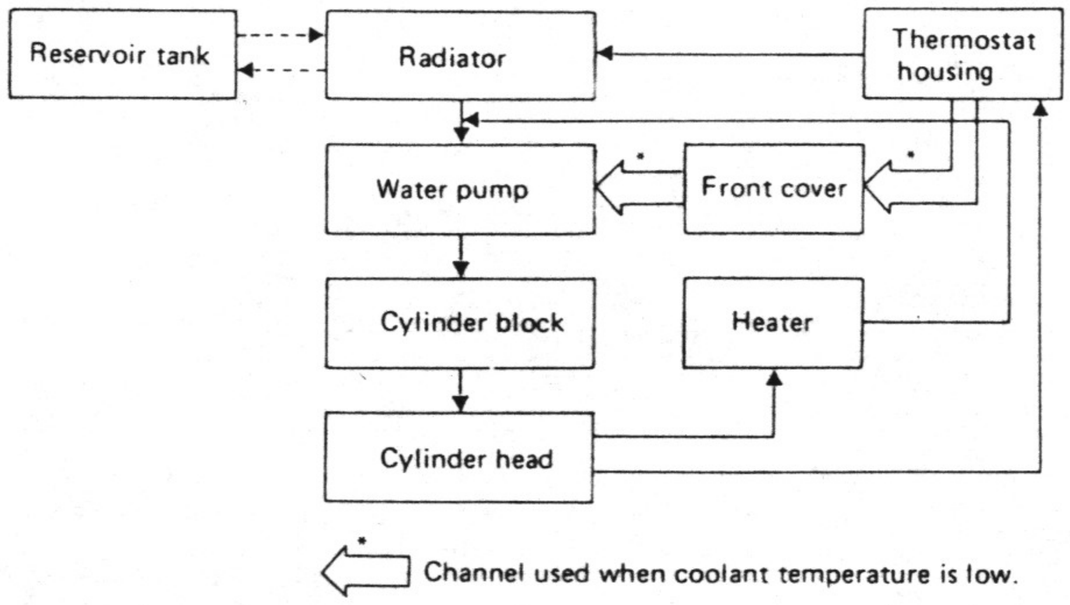
Always use new gasket.

Ⓣ : Oil cooler fixing bolt
16 - 21 N·m
(1.6 - 2.1 kg-m,
12 - 15 ft-lb)

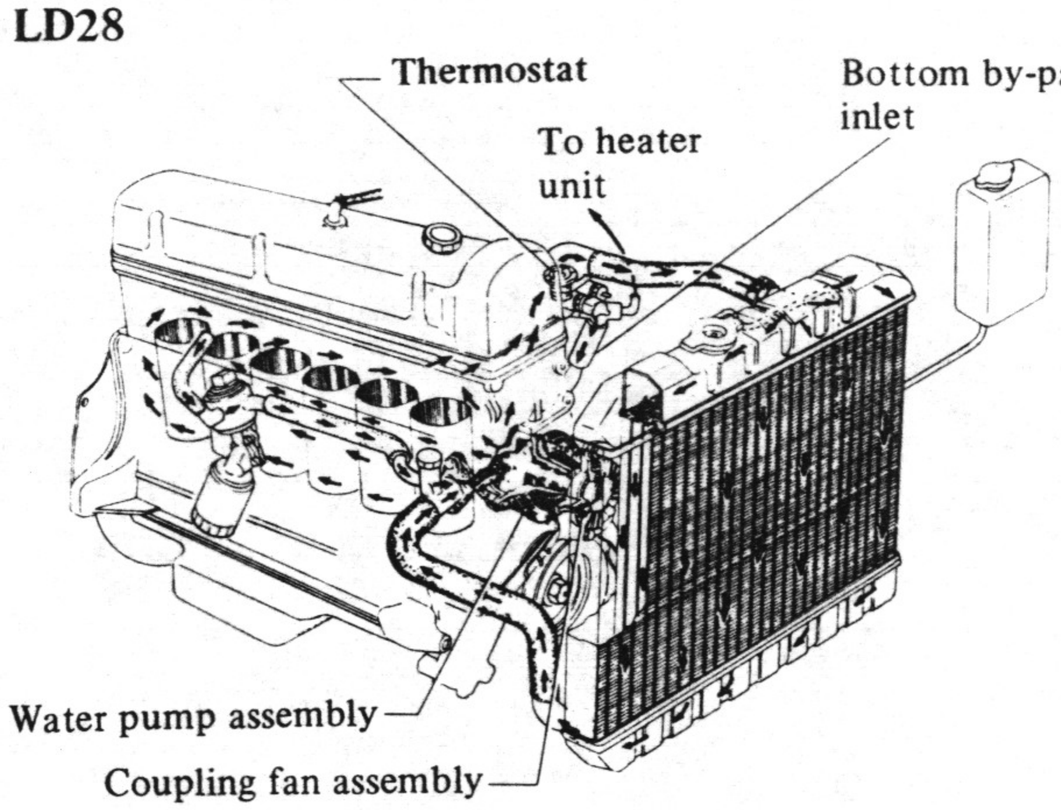
After installing, run engine for a few minutes, and check for leaks.

ENGINE COOLING SYSTEM

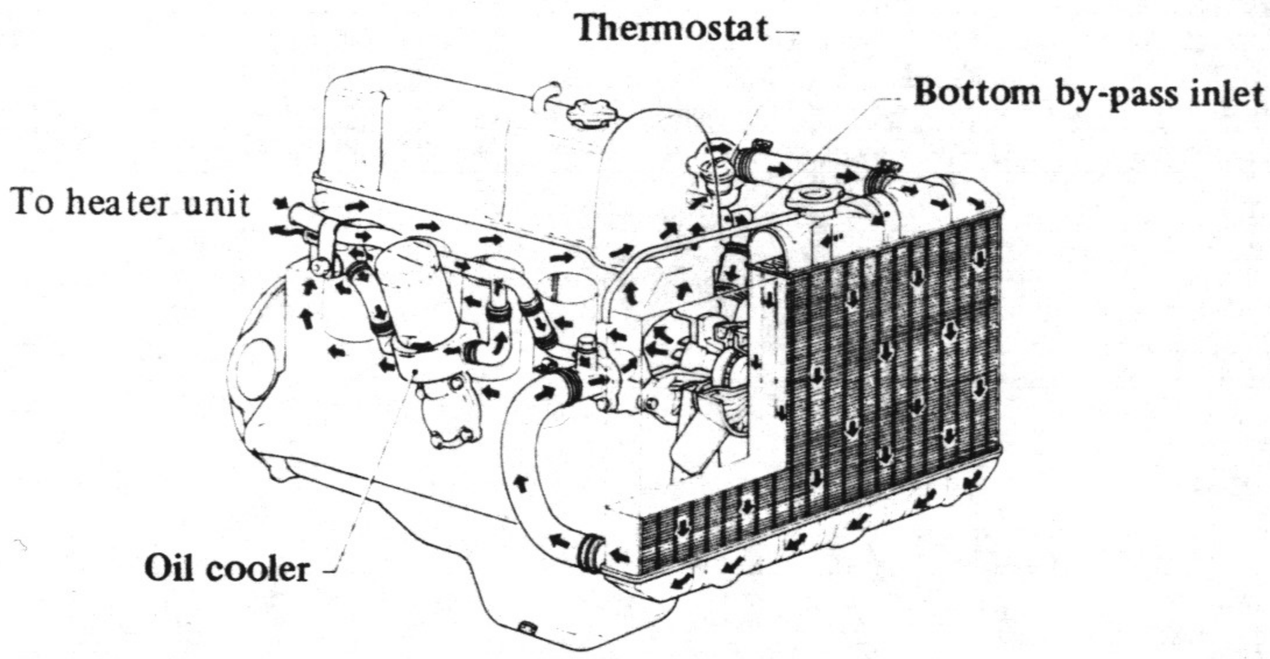
COOLING CIRCUIT



LD28



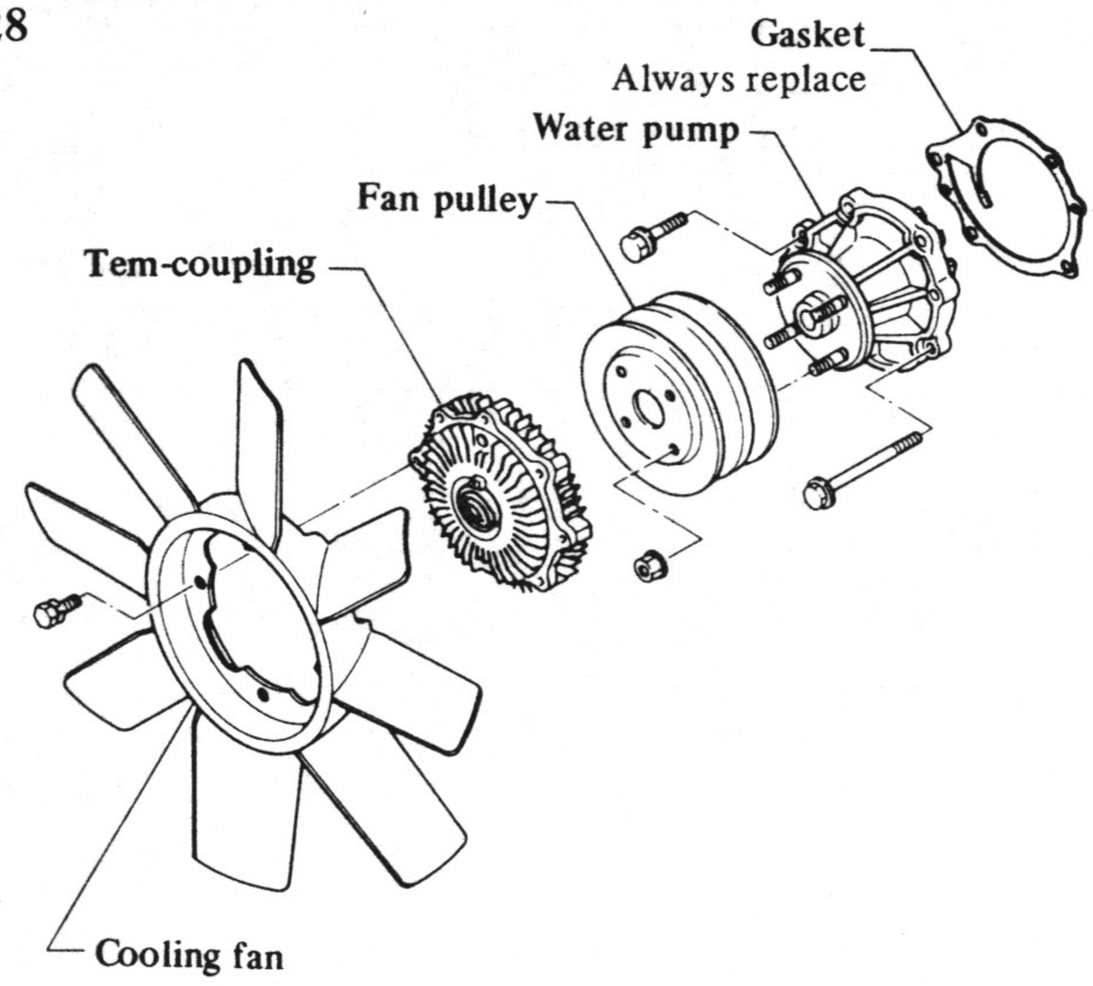
LD20



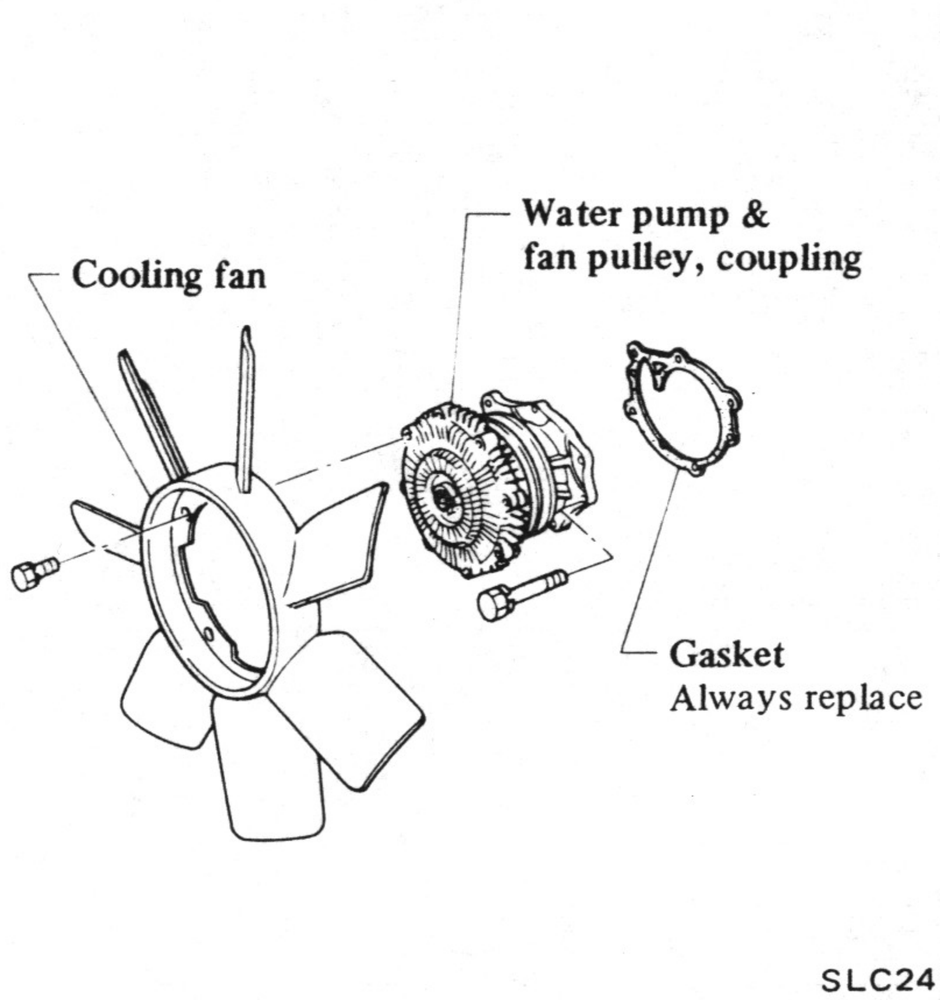
SLC240

WATER PUMP

LD28



LD20



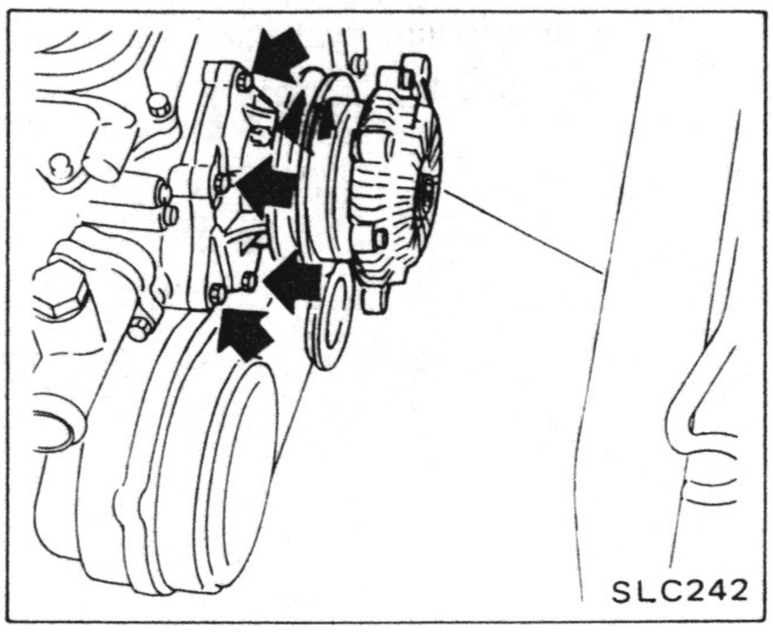
SLC241

REMOVAL

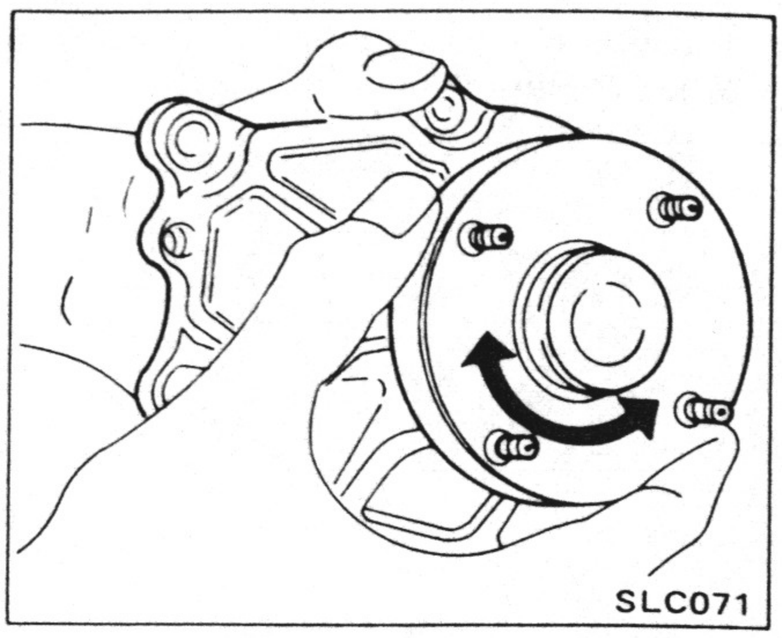
1. Open radiator drain cock and radiator cap, and drain coolant.

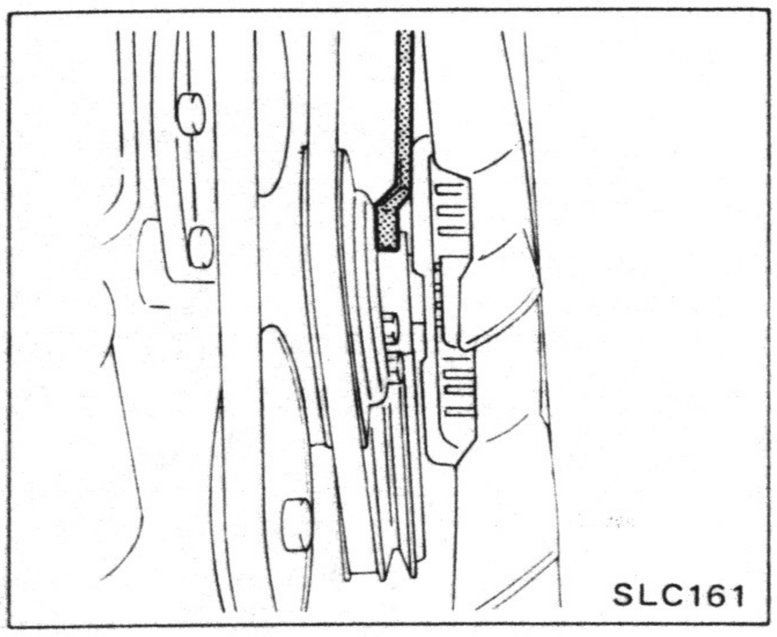
WARNING:
To avoid the danger of being scalded, never attempt to drain the coolant when the engine is hot.

2. Remove radiator shroud.
3. Loosen fan pulley nuts (LD28).


SLC242

LD28


SLC071

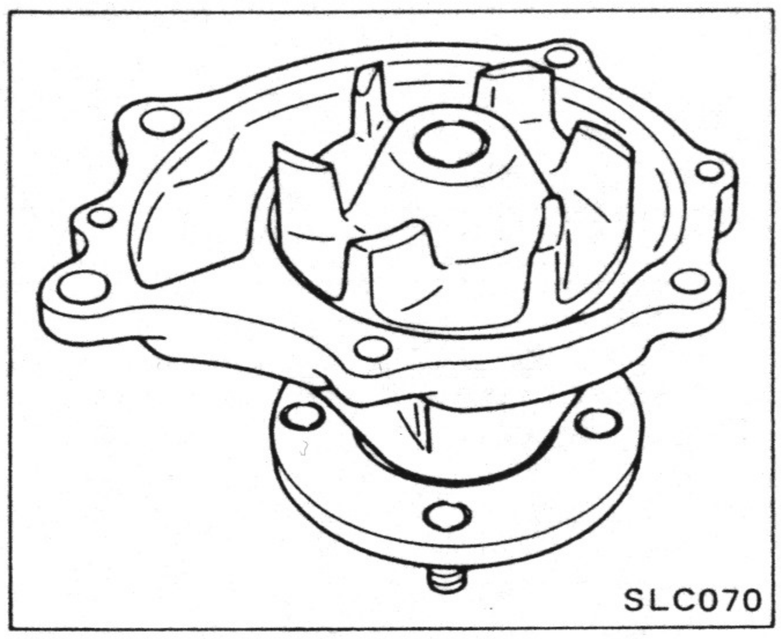

SLC161

INSPECTION

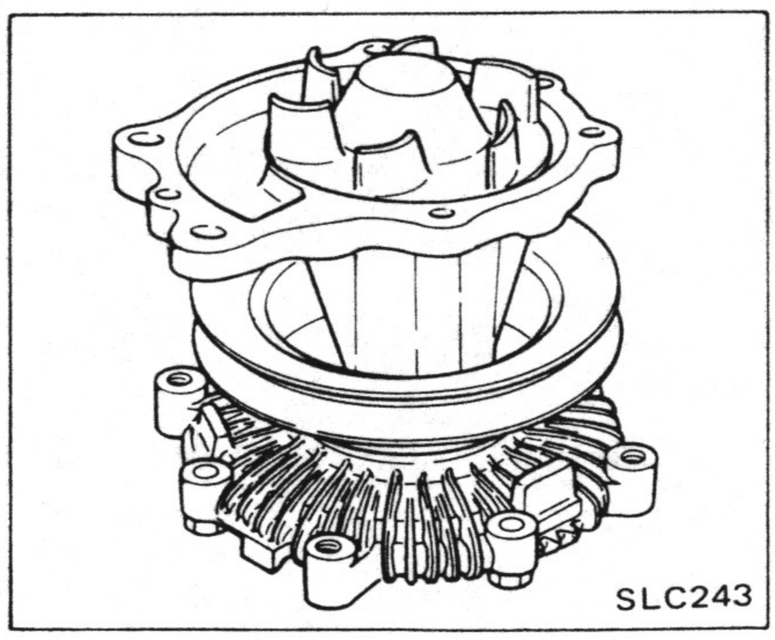
The water pump and fan coupling cannot be disassembled and should be replaced as a unit.

1. Inspect water pump body and vane for rust or corrosion.

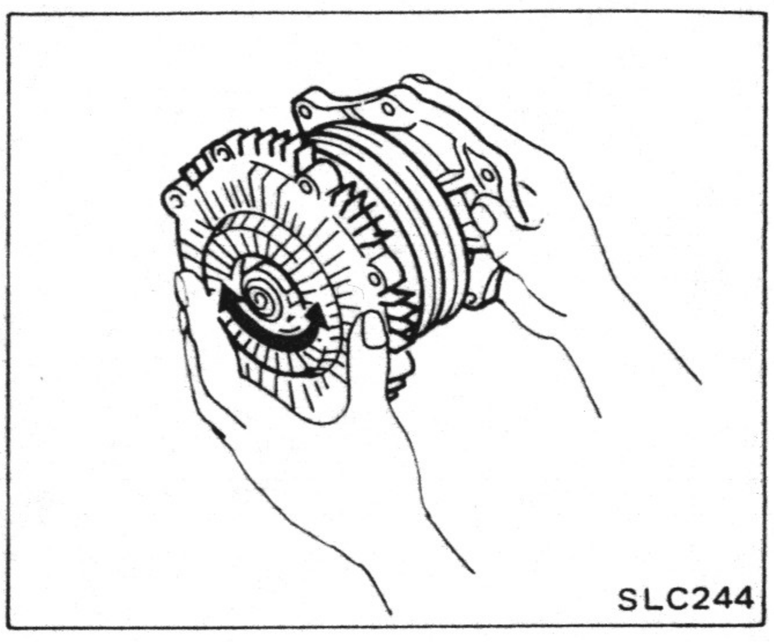
LD28


SLC070

LD20


SLC243

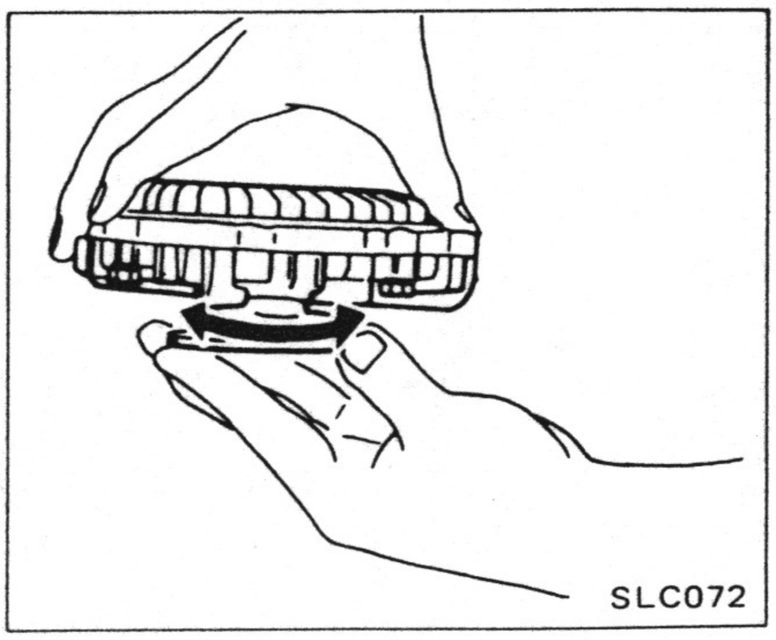
LD20


SLC244

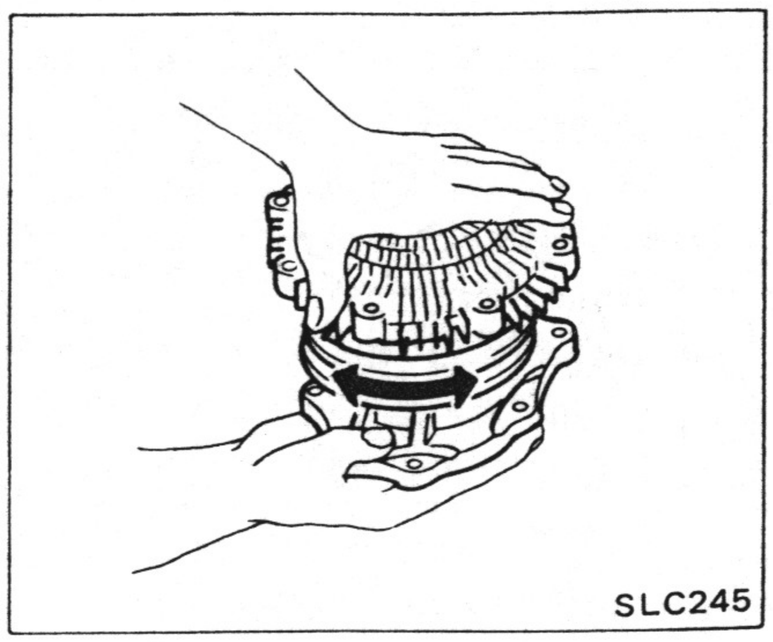
3. Inspect fan coupling.

Check the coupling for oil leakage or bent bimetal.

LD28

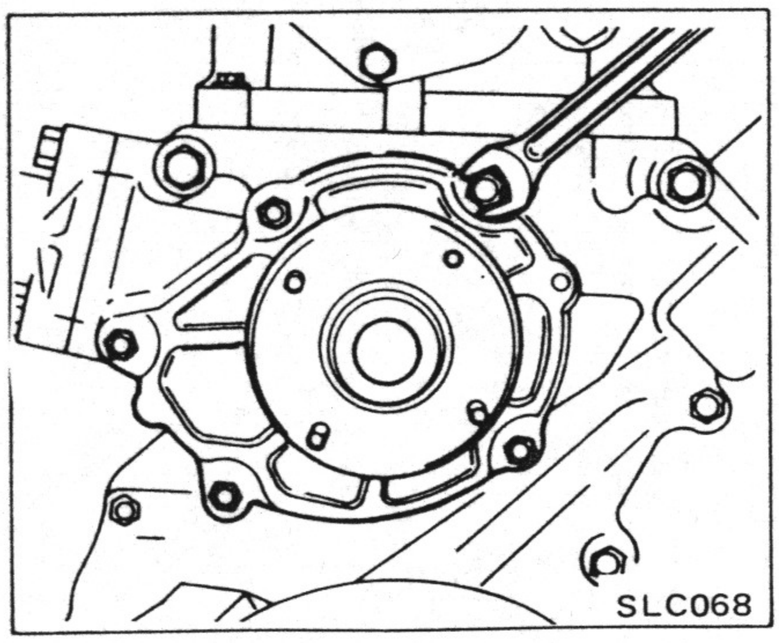

SLC072

LD20


SLC245

4. Loosen fan belt.
(1) Loosen alternator securing bolts.
(2) Move the alternator toward the engine.
5. Remove fan pulley with fan coupling and fan (LD28).
6. Remove fan (LD20).
7.

- Remove water pump with gasket (LD28).


SLC068

- Remove water pump with fan pulley, fan coupling and gasket (LD20).

2. Inspect water pump bearing.

Check for excessive end play or rough operation.

INSTALLATION

1. Install water pump in the reverse order of removal.

Always use new gasket.

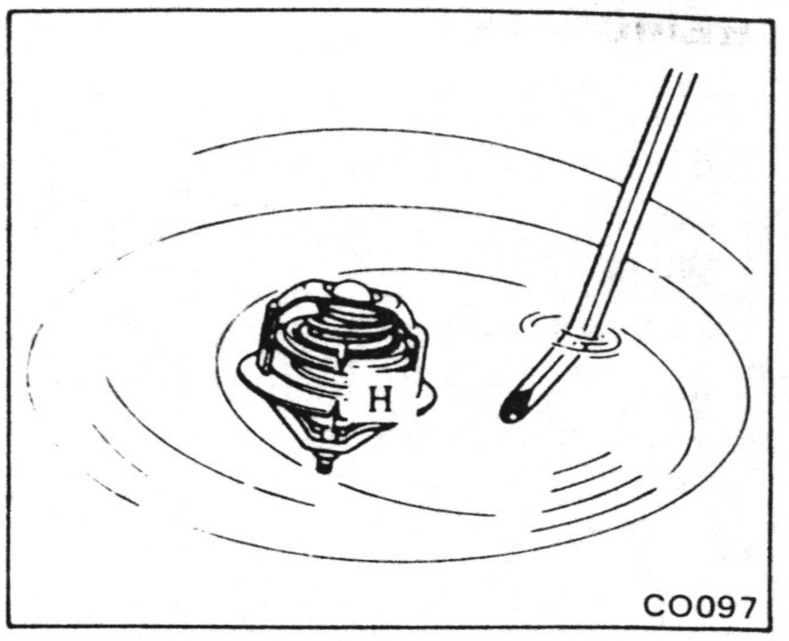
2. Adjust fan belt tension.

Fan belt deflection:
8 - 12 mm (0.31 - 0.47 in)

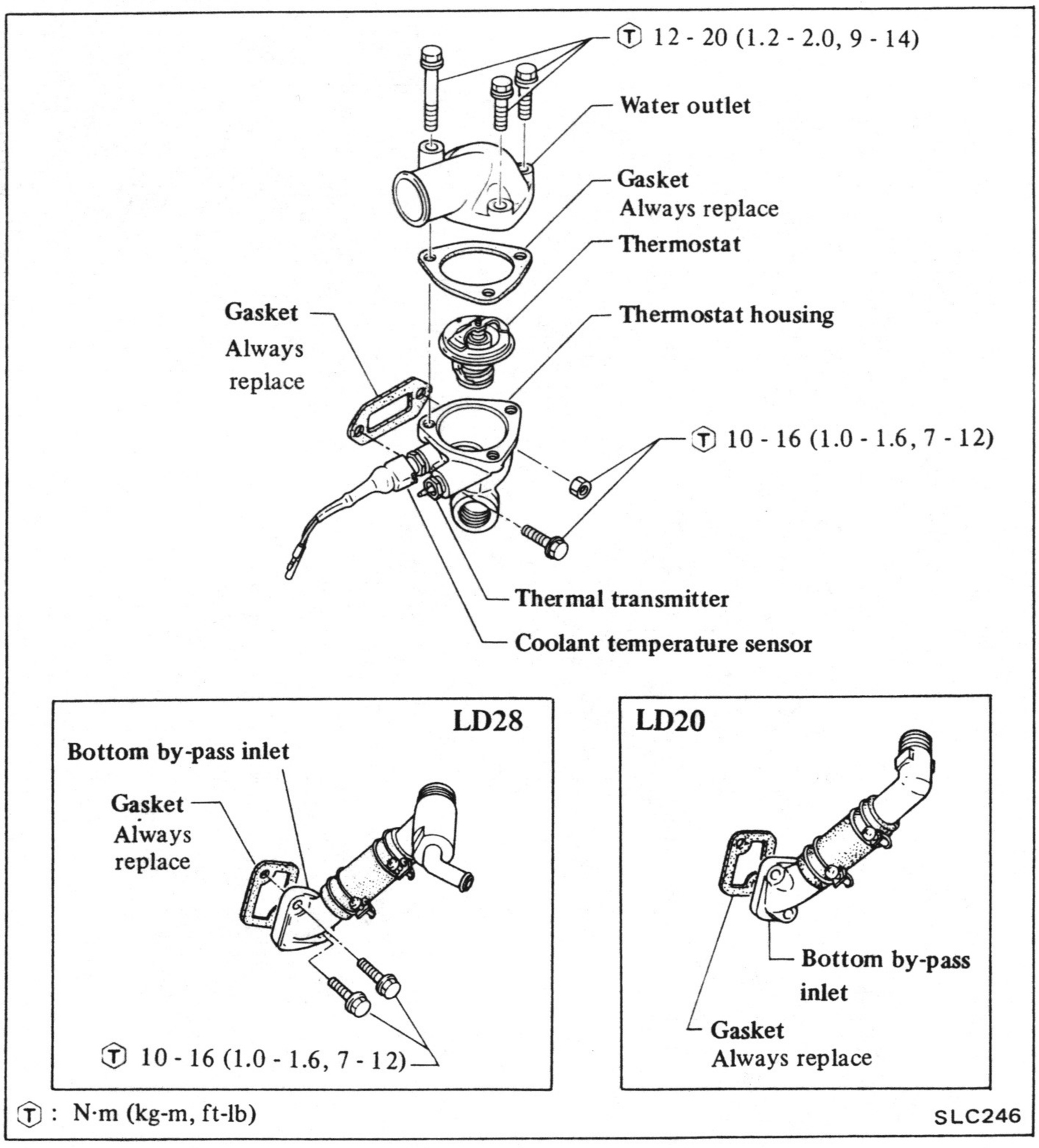
Pushing force:
98 N (10 kg, 22 lb)

3. Fill radiator with coolant.

After installing, run engine for a few minutes and check for leaks.



THERMOSTAT



REMOVAL

1. Drain a small amount of coolant partially and disconnect radiator upper hose at water outlet.

WARNING:
To avoid the danger of being scalded, never attempt to drain the coolant when the engine is hot.

2. Remove water outlet and then remove thermostat.

INSPECTION

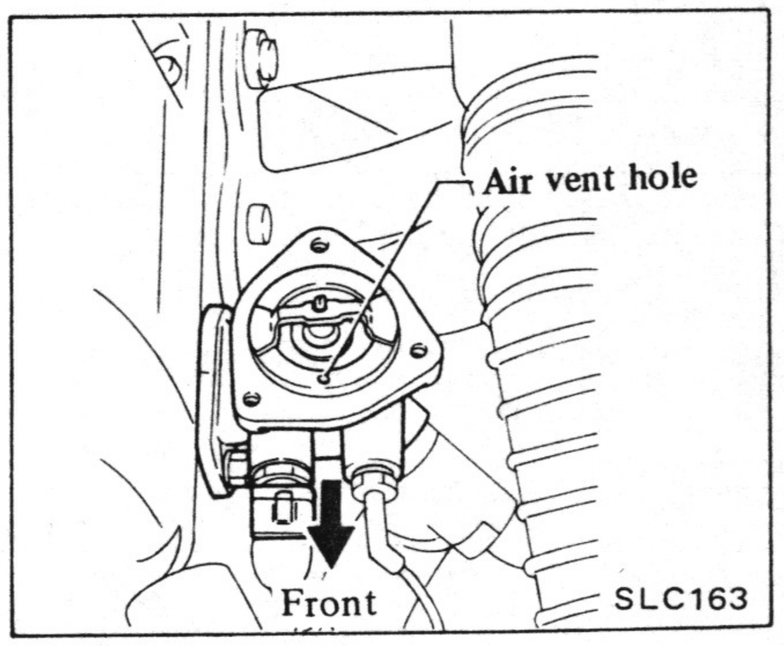
Inspect thermostat for the following and replace if necessary.

1. Valve seating condition at ordinary temperature. It should seat tightly.
2. Valve opening temperature and maximum valve lift. (Refer to S.D.S.)
3. Then check if valve closes at 5°C (9°F) below valve opening temperature.

It is necessary to check the new thermostat before installing it.

INSTALLATION

1. Position thermostat on thermostat housing with the air vent hole facing the front side of the engine.



2. Install water outlet with new gasket.

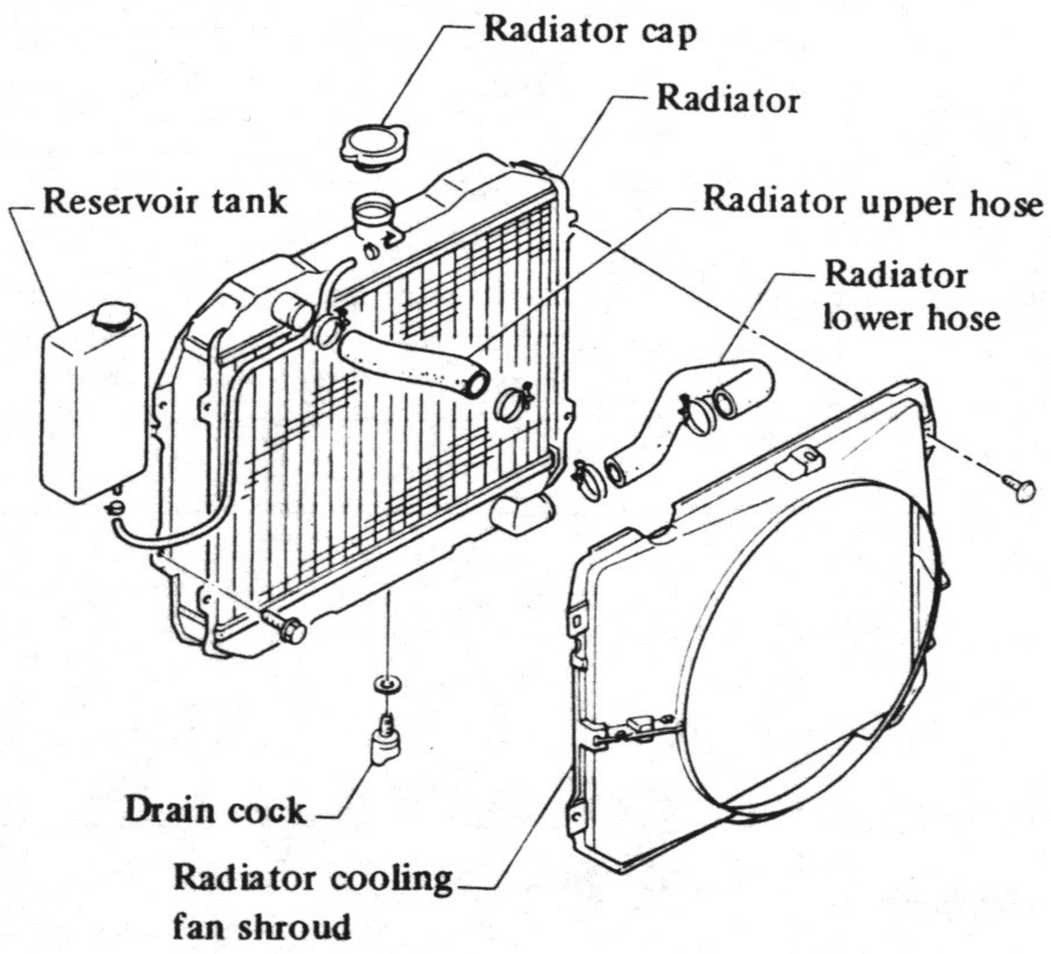
Ⓣ : Attaching bolt
12 - 20 N·m
(1.2 - 2.0 kg-m,
9 - 14 ft-lb)

3. Connect radiator upper hose and fill radiator with coolant.

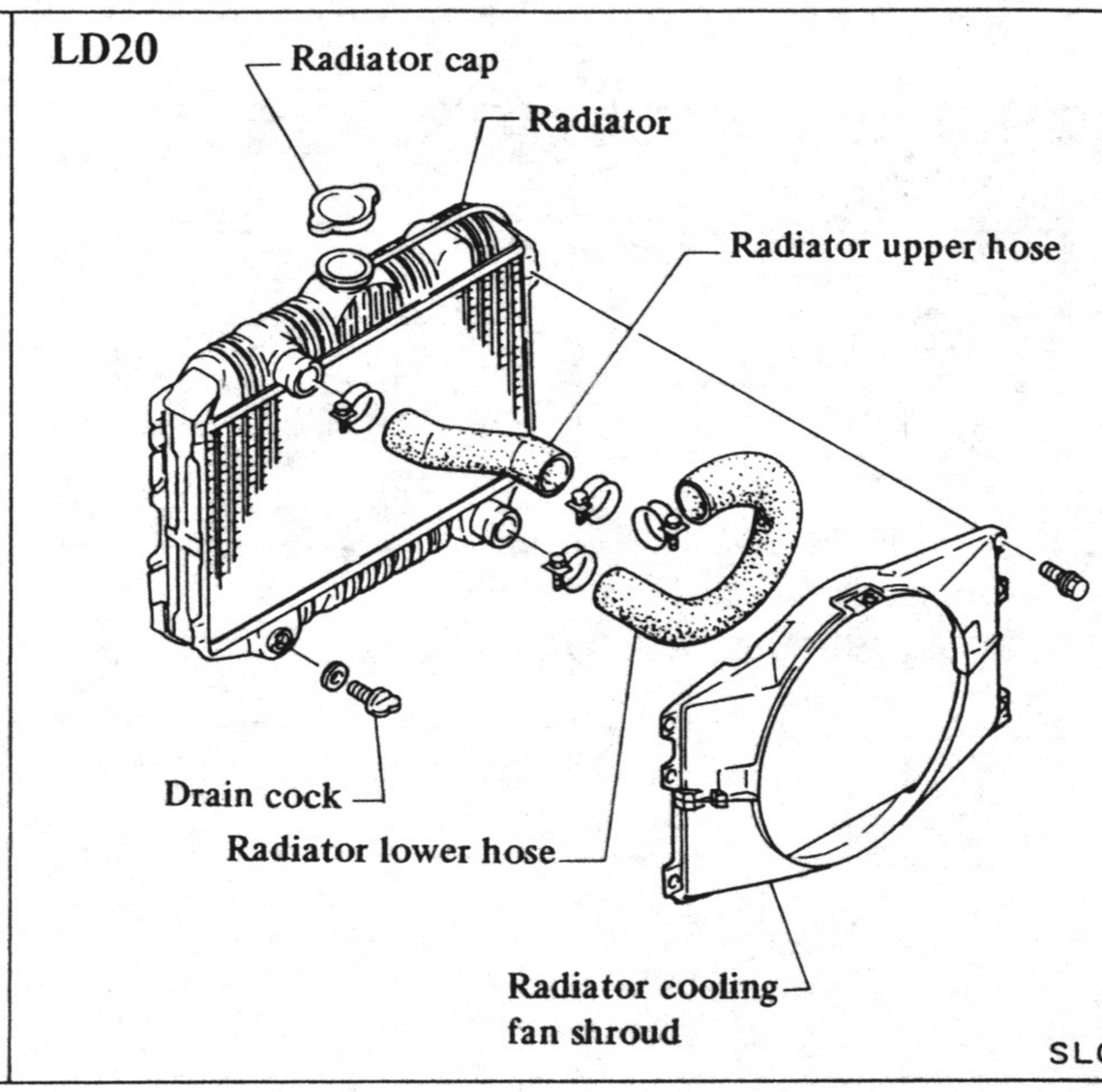
After installing, run engine for a few minutes, and check for leaks.

RADIATOR

LD28



LD20



SLC247

WARNING:
Never remove the radiator cap when the engine is hot; serious burns can be caused by high pressure fluid escaping from the radiator, wrap a thick cloth around cap and carefully remove the cap by turning it a quarter turn to allow built-up pressure to escape, and then turn the cap all the way off.

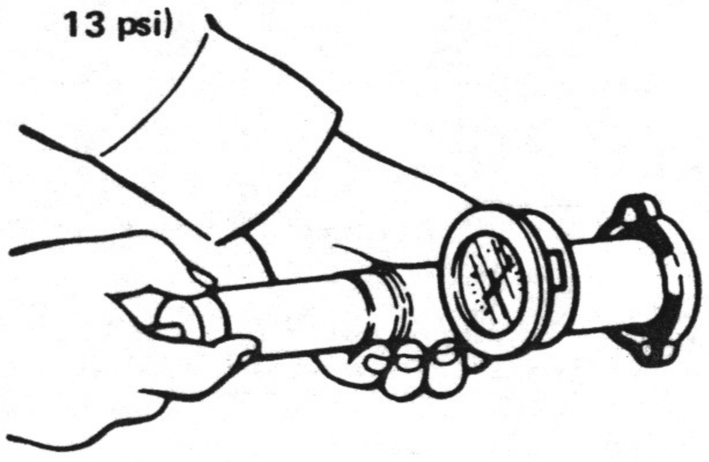
INSPECTION

Checking radiator cap

Using cap tester, check the radiator cap relief pressure.

If the pressure gauge drops rapidly and excessively, replace the radiator cap.

Cap relief pressure
88 kPa (0.88 bar, 0.9 kg/cm², 13 psi)

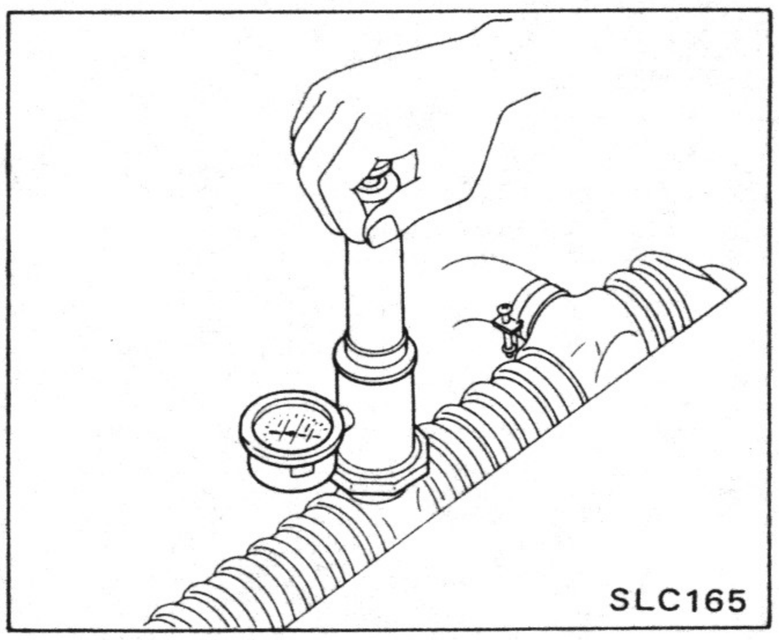


SLC081

Checking cooling system for leaks

Attach pressure tester, pump tester to the specified pressure.

Check for drop in pressure.



SLC165

If the pressure drops, check for leaks from hoses, radiator, or water pump.

If no external leaks are found, check heater core, block and head.

REMOVAL AND INSTALLATION

1. Open radiator drain cock and remove radiator cap. Drain coolant into a suitable container.

WARNING:
To avoid the danger of being scalded, never attempt to drain the coolant when the engine is hot.

2. Remove radiator shroud attaching screws and place radiator shroud close to engine. (Radiator shroud can be removed after removing radiator.)
3. Disconnect radiator upper and lower hoses, and reservoir tank hose.
4. On a car with automatic transmission, disconnect cooler inlet and outlet lines from radiator.
5. Remove radiator.
6. Install radiator in the reverse order of removal.
7. Fill radiator with coolant to specified quantity.

After installing, run engine for a few minutes, and check for leaks.

SERVICE DATA AND SPECIFICATIONS

ENGINE LUBRICATION SYSTEM

GENERAL SPECIFICATIONS

Lubrication method	Pressed feed flow
Oil pump type	Trochoid type
Oil filter type	Full flow and cartridge type

Approximate oil refill capacity

Unit: liter (Imp qt)

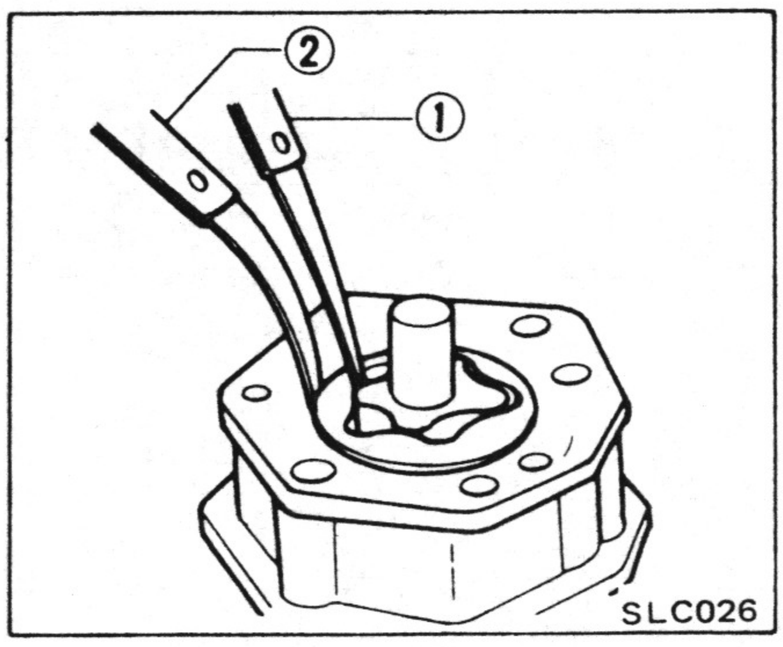
		Without oil filter change	With oil filter change
LD20	910	3.8 (3-3/8)	4.5 (4)
	C120	3.6 (3-1/8)	4.3 (3-3/4)
LD28	430	4.3 (3-3/4)	5.0 (4-3/8)
	C31	4.3 (3-3/4)	5.0 (4-3/8)

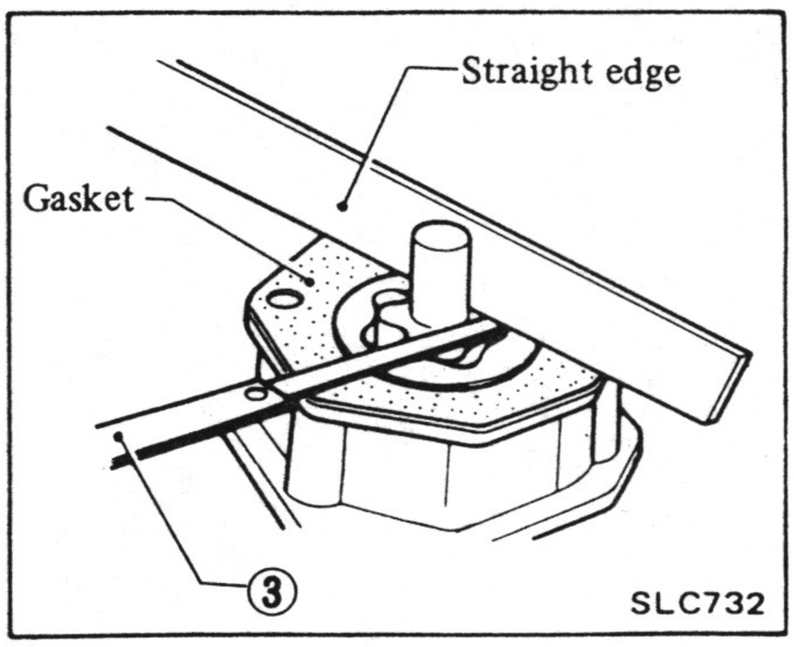
INSPECTION AND ADJUSTMENT

Oil pump

Unit: mm (in)

Rotor tip clearance ①	Less than 0.12 (0.0047)
Outer rotor to body clearance ②	0.15 - 0.21 (0.0059 - 0.0083)
Outer and inner rotor side clearance (with gasket) ③	0.04 - 0.08 (0.0016 - 0.0031)





TIGHTENING TORQUE

Unit	N·m	kg-m	ft-lb
Oil pump mounting bolts	11 - 15	1.1 - 1.5	8 - 11
Oil pump cover bolt	7 - 10	0.7 - 1.0	5.1 - 7.2
Regulator valve cap	39 - 49	4.0 - 5.0	29 - 36
Oil pan drain plug	20 - 29	2.0 - 3.0	14 - 22
Oil cooler fixing bolt	16 - 21	1.6 - 2.1	12 - 15

ENGINE COOLING SYSTEM

GENERAL SPECIFICATIONS

Cooling method	Water cooling, forced circulation
Water pump type	Centrifugal
Thermostat type	Wax-pellet
Radiator type	Corrugated fin and tube
Fan coupling method	Temperature coupling

INSPECTION AND ADJUSTMENT

Water pump

Fan belt deflection [Applied force 98 N (10 kg, 22lb)] mm (in)	8 - 12 (0.31 - 0.47)

Thermostat

	Frigid type	Standard type	Tropical type
Valve opening temperature °C (°F)	88 (190)	82 (180)	76.5 (170)
Max. valve lift mm/°C (in/°F)	8/100 (0.31/212)	8/95 (0.31/203)	8/90 (0.31/194)

Radiator

kPa (bar, kg/cm^2, psi)

Cap relief pressure	88 (0.88, 0.9, 13)
Leakage test pressure	157 (1.57, 1.6, 23)

TIGHTENING TORQUE

Unit		N·m	kg-m	ft-lb
Water pump bolt	M6	4 - 10	0.4 - 1.0	2.9 - 7.2
	M8	10 - 16	1.0 - 1.6	7 - 12
Water pump pulley stud		6 - 10	0.6 - 1.0	4.3 - 7.2
Thermostat housing		10 - 16	1.0 - 1.6	7 - 12
Water outlet bolt		12 - 20	1.2 - 2.0	9 - 14

SPECIAL SERVICE TOOL

Tool number	Tool name
ST19320000	Oil filter wrench  SLC036