

NISSAN

SD33T ***Diesel Engine***

FOREWORD

This supplement contains information concerning necessary service procedures and relevant data for the SD33T diesel engine used in vehicles.

All information, illustrations and specifications contained in this supplement are based on the latest product information available at the time of publication. If your NISSAN model differs from the specifications contained in this supplement, consult your NISSAN dealer for information.

The right is reserved to make changes in specifications and methods at any time without notice.

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QUICK REFERENCE INDEX

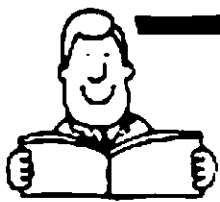
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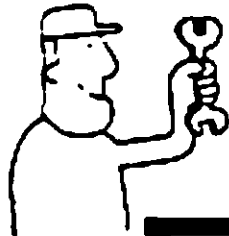
**ENGINE LUBRICATION &
COOLING SYSTEMS** **LC**

ENGINE FUEL **EF**



HOW TO USE THIS MANUAL

- ▶ This manual is designed to give you the new service procedures, service data and specifications of the SD33T diesel engine used in vehicles.
- ▶ This manual, however, does not contain some items which are the same as those for the SD33 diesel engine.
Please use this manual in conjunction with the Service Manual "Model SD Series Diesel Engine" (Pub. No.: SM3E-00SDG0).



IMPORTANT SAFETY NOTICE

The proper performance of service is essential for both the safety of the mechanic and the efficient functioning of the engine.

The service methods in this Service Manual are described in such a manner that the service may be performed safely and accurately.

Special service tools have been designed to permit safe and proper performance of service. Be sure to use them.

Service varies with the procedures used, the skills of the mechanic and the tools and parts available. Accordingly, anyone using service procedures, tools or parts which are not specifically recommended by NISSAN must first completely satisfy himself that neither his safety nor the engine's safety will be jeopardized by the service method selected.

GENERAL INFORMATION



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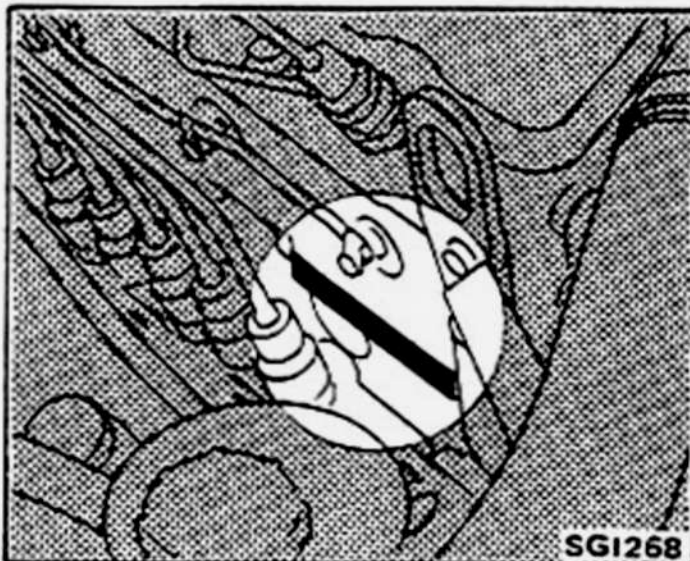
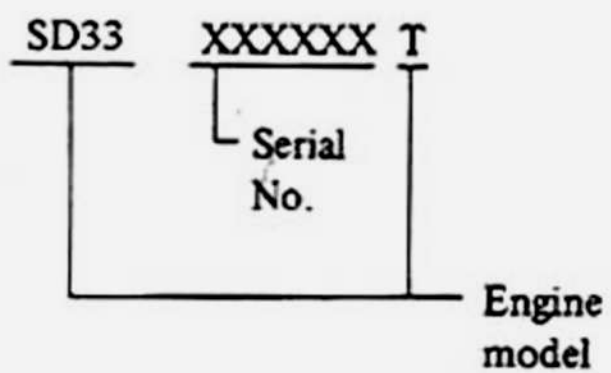
SPECIFICATIONS / ENGINE SERIAL NUMBER LOCATION

SPECIFICATIONS

Engine model	SD33T	
Cylinder arrangement	In-line	
Number of cylinders	6	
Valve arrangement	O.H.V.	
Bore x Stroke	mm (in)	83 x 100 (3.27 x 3.94)
Displacement	cm ³ (cu in)	3,246 (198.07)
Firing order	1-4-2-6-3-5	
Number of piston rings		
Compression	2	
Oil	1	
Number of main bearings	4	
Compression ratio	21.6	
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.



MAINTENANCE



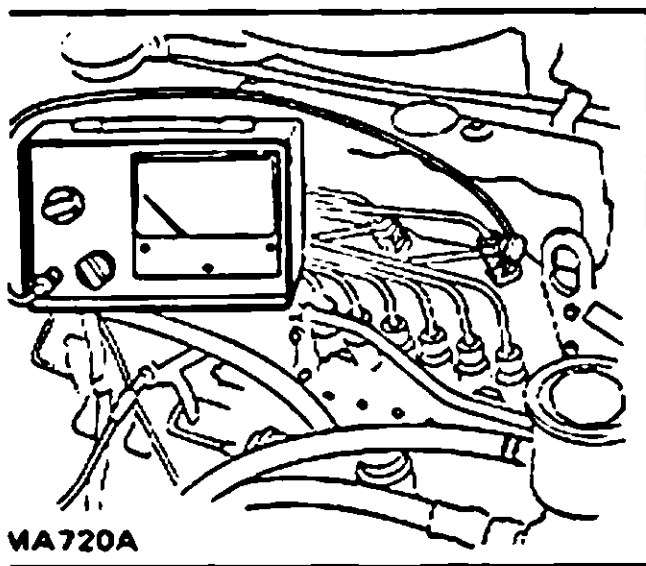
INJECTION AND FUEL SYSTEM

IDLE SPEED ADJUSTMENT

Turn idle control knob fully counterclockwise.

Start engine and warm it up until coolant temperature indicator points middle of gauge.

Attach tachometer's pick-up to fuel injection nozzle.



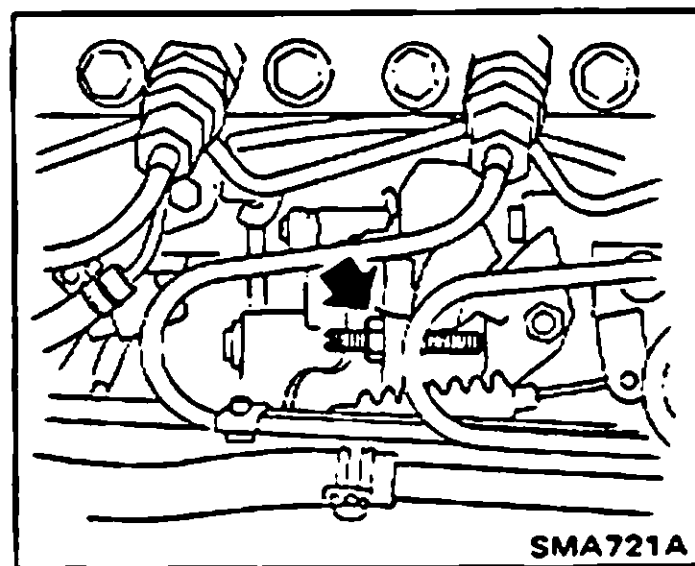
4. Adjust engine to specified idle speed with idle speed adjusting screw.

Idle speed:

600 - 650 rpm

700 - 750 rpm

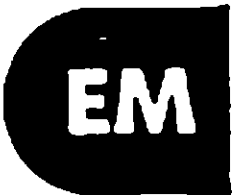
(Equipped with power steering)



5. After adjusting idle speed properly, tighten lock nut.

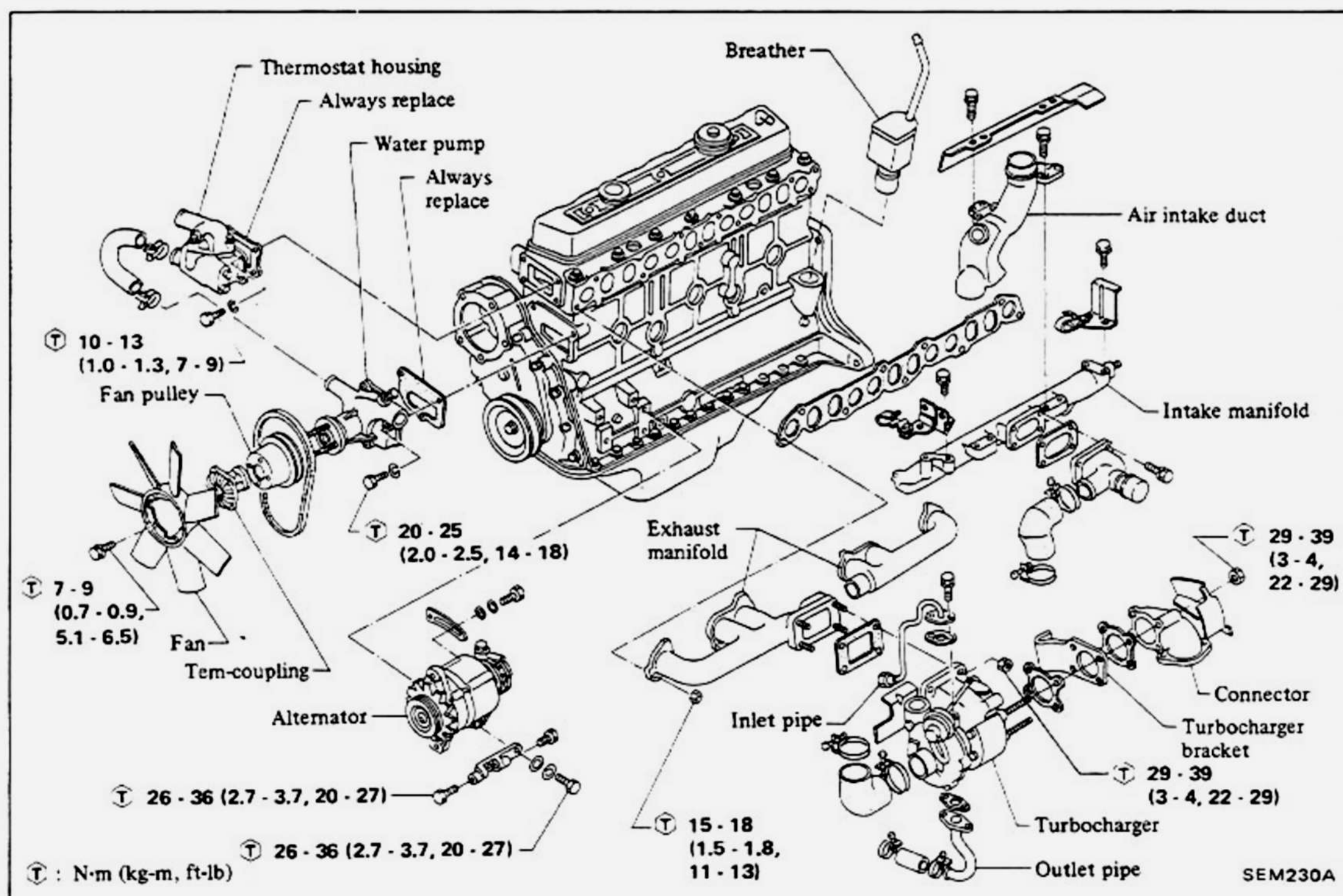
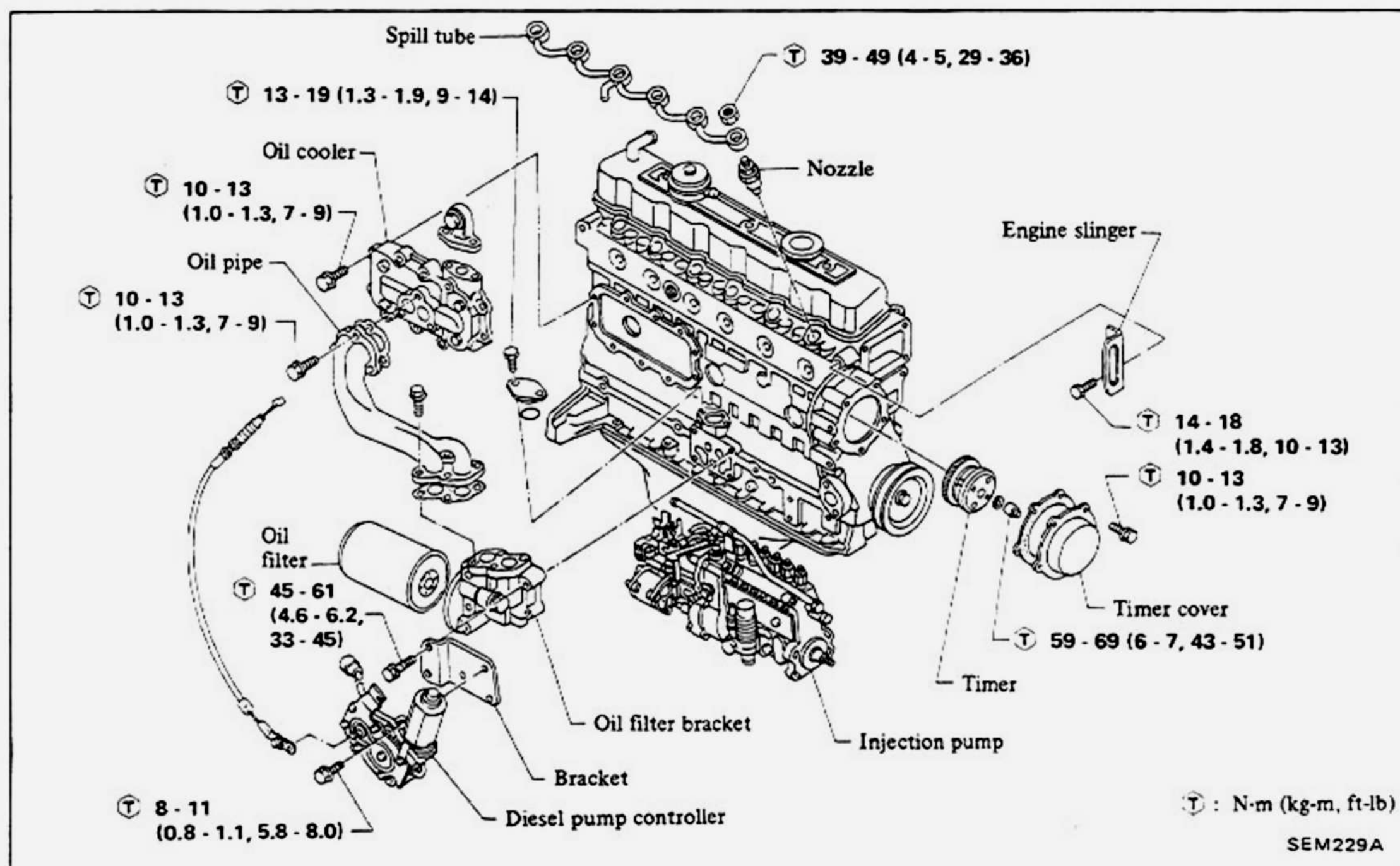
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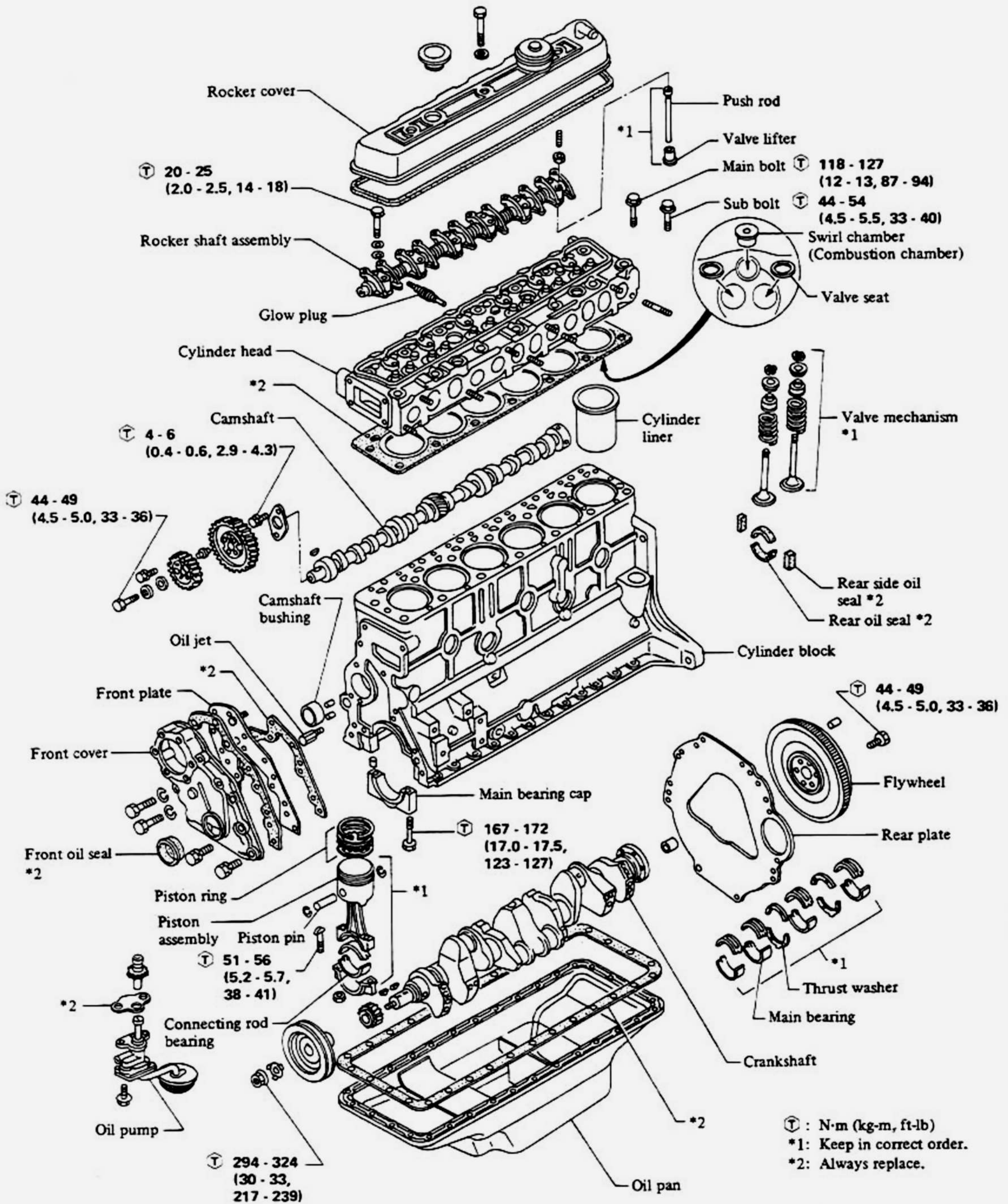


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ENGINE COMPONENTS (Outer parts)



ENGINE COMPONENTS (Internal parts)



SEM231A

SERVICE DATA AND SPECIFICATIONS

SERVICE DATA AND SPECIFICATIONS

INSPECTION AND ADJUSTMENT

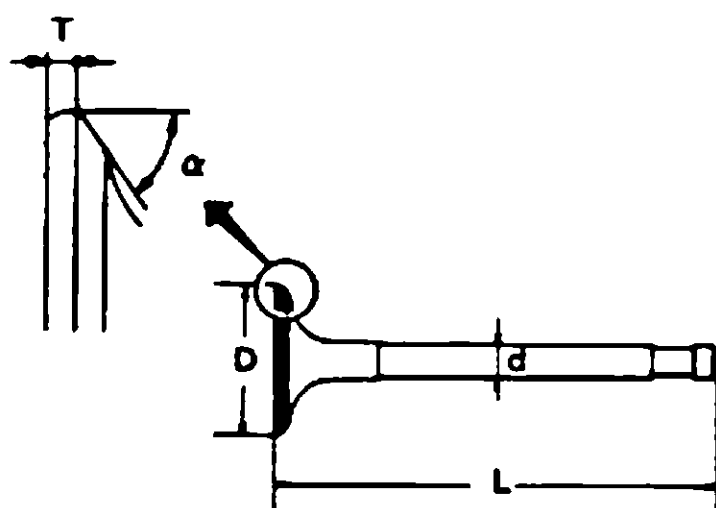
CYLINDER HEAD

Unit: mm (in)

	Standard	Limit
Longitudinal direction	Less than 0.10 (0.0039)	0.20 (0.0079)
Transverse direction	Less than 0.05 (0.0020)	

VALVE

Unit: mm (in)



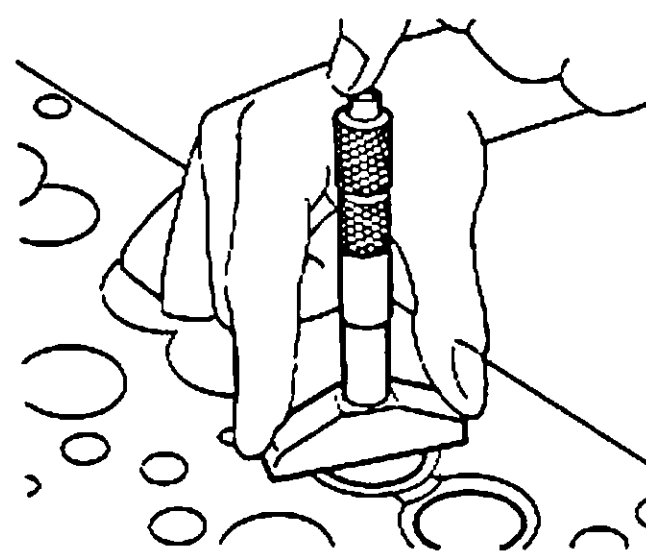
SEM188

	Standard	Service	
Valve head diameter "D"			
Intake		38.0 (1.496)	
Exhaust		32.0 (1.260)	
Valve length "L"			
Intake		117 (4.61)	
Exhaust			
Valve stem diameter "d"			
Intake	7.970 - 7.985 (0.3138 - 0.3144)	8.170 - 8.185 (0.3217 - 0.3222)	8.370 - 8.385 (0.3295 - 0.3301)
Exhaust	7.945 - 7.960 (0.3128 - 0.3134)	8.145 - 8.160 (0.3207 - 0.3213)	8.345 - 8.360 (0.3285 - 0.3291)
Valve seat angle "α"	45° - 45°30'		
Valve margin "T" limit	1.0 (0.039)		
Valve stem and surface grinding limit	0.2 (0.008)		
Valve clearance (Hot)			
Intake	0.35 (0.014)		
Exhaust			

Valve spring

Free length	mm (in)	Painted red 50.35 (1.982)
Pressure height	mm/N (mm/kg, in/lb)	30.6/677 (30.6/69, 1.205/152)
Assembled height	mm/N (mm/kg, in/lb)	39.7/324 (39.7/33, 1.563/73)
Out of square	mm (in)	2.2 (0.087)

Valve to head distance



SEM026

Unit: mm (in)

	Standard	Limit
Intake	0.225 - 0.675 (0.0089 - 0.0266)	1.25 (0.0492)
Exhaust	0.255 - 0.745 (0.0100 - 0.0293)	

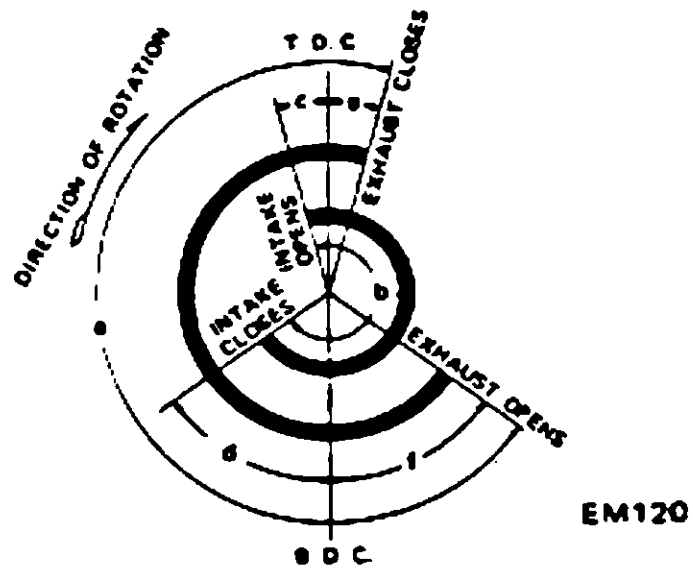
Valve stem hole (Cylinder head)

Unit: mm (in)

Valve stem hole inner diameter	8.000 - 8.015 (0.3150 - 0.3156)	
	Standard	Max. tolerance
Stem to stem hole clearance		
Intake	0.015 - 0.045 (0.0006 - 0.0018)	0.15 (0.0059)
Exhaust	0.04 - 0.07 (0.0016 - 0.0028)	0.20 (0.0079)
Valve deflection limit	0.15 (0.0059)	

SERVICE DATA AND SPECIFICATIONS

Valve timing

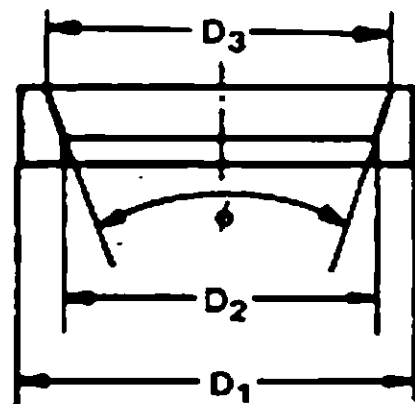


Unit: degree

a	b	c	d	e	f
275	275	28	67	67	28

Valve seat

Unit: mm (in)



EM733

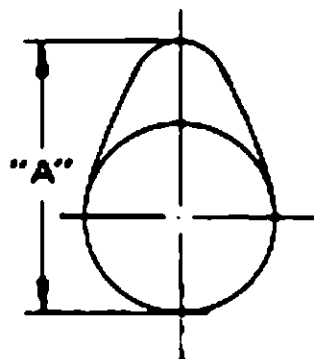
	Standard	Service	
Intake			
Outer diameter "D1"	39.035 - 39.045 (1.5368 - 1.5372)	—	
Inner diameter "D2"	32.9 - 33.1 (1.295 - 1.303)	—	
Diameter of seat "D3"	36.95 - 37.05 (1.4547 - 1.4587)	—	
Valve seat face angle "φ"	89° - 90°	—	
Exhaust			
Outer diameter "D1"	35.035 - 35.045 (1.3793 - 1.3797)	35.235 - 35.245 (1.3872 - 1.3876)	35.435 - 35.445 (1.3951 - 1.3955)
Inner diameter "D2"	28.4 - 28.6 (1.118 - 1.126)	28.4 - 28.6 (1.118 - 1.126)	28.4 - 28.6 (1.118 - 1.126)
Diameter of seat "D3"	30.95 - 31.05 (1.2185 - 1.2224)	30.95 - 31.05 (1.2185 - 1.2224)	30.95 - 31.05 (1.2185 - 1.2224)
Cylinder head valve seat diameter	34.995 - 35.01 (1.3778 - 1.3783)	35.195 - 35.21 (1.3856 - 1.3862)	35.395 - 35.41 (1.3935 - 1.3941)
Valve seat face angle "φ"	89° - 90°	—	

SERVICE DATA AND SPECIFICATIONS

CAMSHAFT AND CAMSHAFT BUSHING

Unit: mm (in)

	Standard	Limit
Camshaft journal to bushing clearance [Oil clearance]		
Front	0.024 - 0.102 (0.0009 - 0.0040)	0.15 (0.0059)
Center	0.037 - 0.115 (0.0015 - 0.0045)	
Rear	0.024 - 0.102 (0.0009 - 0.0040)	
Camshaft journal diameter		
Front	45.434 - 45.447 (1.7887 - 1.7892)	—
Center	43.897 - 43.910 (1.7282 - 1.7287)	—
Rear	41.218 - 41.231 (1.6228 - 1.6233)	—
Camshaft bend (Total indicator reading)	Less than 0.03 (0.0012)	0.06 (0.0024)
Camshaft end play	0.08 - 0.28 (0.0031 - 0.0110)	0.50 (0.0197)

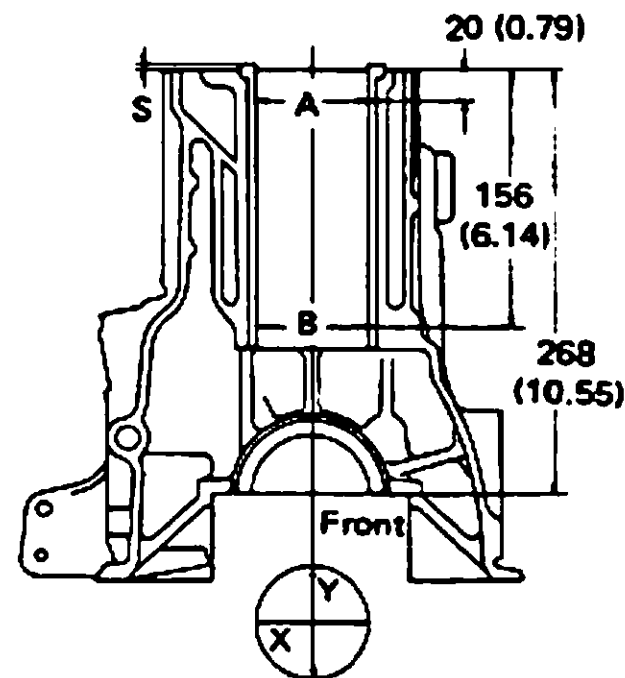


EM671

Cam height "A"	37.28 - 37.32 (1.4677 - 1.4693)
Cam height limit	36.8 (1.449)

CYLINDER BLOCK AND CYLINDER LINER

Unit: mm (in)

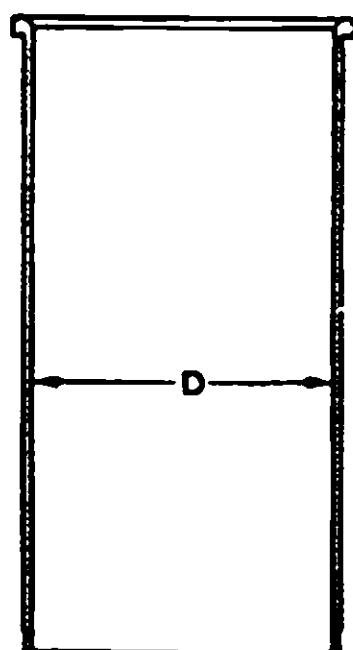


SEM251

	Standard	Wear limit
Surface flatness (Without cylinder liner)	Less than 0.10 (0.0039) (Shaft direction) Less than 0.02 (0.0008) (Right angle direction)	0.3 (0.012)
Cylinder bore (With cylinder liner)		
Inner diameter	82.995 - 83.025 (3.2675 - 3.2687)	0.3 (0.012)
Out-of-round (X-Y)	Less than 0.02 (0.0008)	—
Taper (A-B)	Less than 0.02 (0.0008)	—
Projection "S"	0.02 - 0.09 (0.0008 - 0.0035)	—
Division of each cylinder "S"	Less than 0.05 (0.0020)	—
Piston to cylinder liner clearance	0.05 - 0.07 (0.0020 - 0.0028)	
Interference fit cylinder liner to block	0.01 - 0.03 (0.0004 - 0.0012)	

SERVICE DATA AND SPECIFICATIONS

Unit: mm (in)



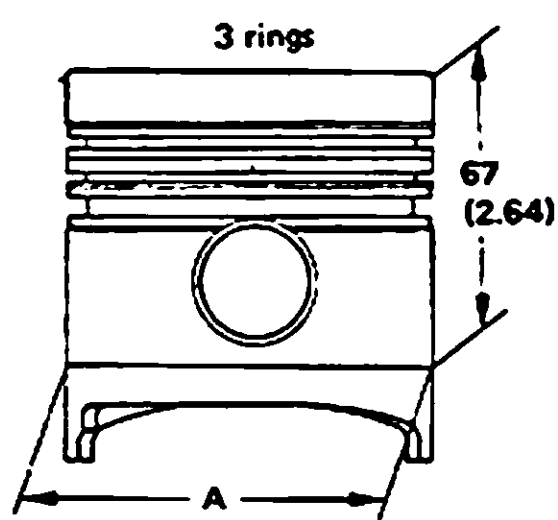
SEM427

	Standard	Service
Cylinder liner inner diameter "D"	82.995 - 83.025 (3.2675 - 3.2687)	83.03 - 83.05 (3.2689 - 3.2697)

PISTON, PISTON RING AND PISTON PIN

Piston

Unit: mm (in)



SEM778A

Piston skirt diameter "A"	82.935 - 82.965 (3.2652 - 3.2663)
Piston pin hole diameter	25.992 - 26.00 (1.0233 - 1.0236)

Piston ring

Unit: mm (in)

	Standard	Limit
Side clearance		
No. 1	0.06 - 0.10 (0.0024 - 0.0039)	0.5 (0.020)
No. 2	0.05 - 0.09 (0.0020 - 0.0035)	0.3 (0.012)
No. 3	0.02 - 0.06 (0.0008 - 0.0024)	0.15 (0.0059)
Ring gap		
No. 1	0.30 - 0.45 (0.0118 - 0.0177)	1.5 (0.059)
No. 2	0.20 - 0.35 (0.0079 - 0.0138)	
No. 3	0.15 - 0.30 (0.0059 - 0.0118)	

Piston pin

Unit: mm (in)

Piston pin outer diameter	25.993 - 26.000 (1.0233 - 1.0236)
Interference fit of piston pin to piston	-0.007 - 0.008 (-0.00028 - 0.00031)
Piston pin to connecting rod clearance	0.025 - 0.045 (0.0010 - 0.0018)

CONNECTING ROD

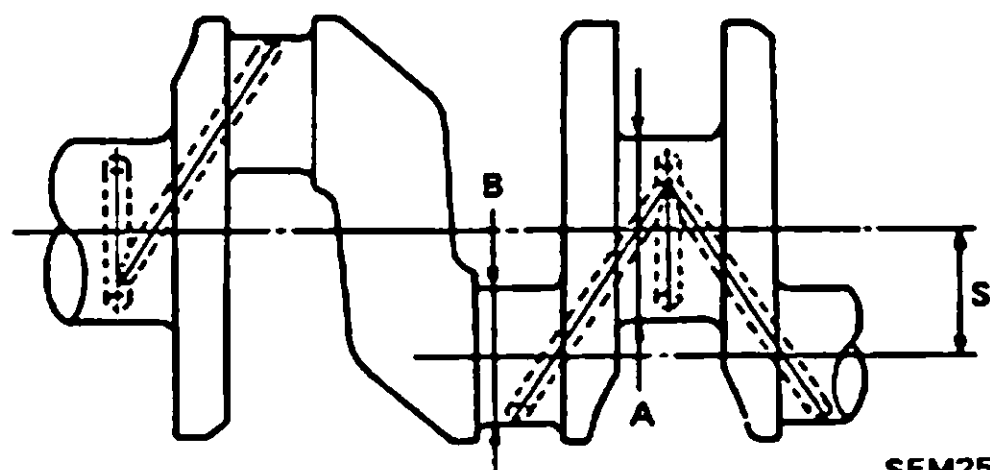
Unit: mm (in)

Center distance	170.0 (6.69)
Connecting rod bend or torsion [Per 100 mm (3.94 in) length]	
Standard	0 - 0.05 (0 - 0.0020)
Limit	0.05 (0.0020)
Piston pin bore diameter	26.025 - 26.038 (1.0246 - 1.0251)
Big end play	
Standard	0.1 - 0.2 (0.004 - 0.008)
Limit	0.2 (0.008)

SERVICE DATA AND SPECIFICATIONS

CRANKSHAFT

Unit: mm (in)

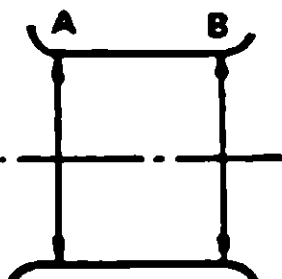
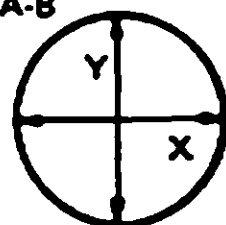


SEM253

Journal diameter "A"	70.907 - 70.920 (2.7916 - 2.7921)
Pin diameter "B"	52.913 - 52.926 (2.0832 - 2.0837)
"S"	50.00 (1.9685)

Out-of-round
Taper

X-Y
A-B



EM715

Taper of journal and pin "A-B"	
Standard	0.01 (0.0004)
Limit	0.02 (0.0008)
Out-of-round of journal and pin "X-Y"	
Standard	0.01 (0.0004)
Limit	0.02 (0.0008)
Crankshaft bend	
Standard	0 - 0.03 (0 - 0.0012)
Limit	0.10 (0.0039)
Crankshaft end play	
Standard	0.06 - 0.14 (0.0024 - 0.0055)
Limit	0.40 (0.0157)

BEARING

Bearing clearance

Unit: mm (in)

	Standard	Limit
Main bearing clearance	0.035 - 0.087 (0.0014 - 0.0034)	0.15 (0.0059)
Connecting rod bearing clearance	0.035 - 0.081 (0.0014 - 0.0032)	0.15 (0.0059)

Main bearing undersize

Unit: mm (in)

	Crank journal diameter
Standard	70.907 - 70.920 (2.7916 - 2.7921)
Undersize	
0.25 (0.0098)	70.657 - 70.670 (2.7818 - 2.7823)
0.50 (0.0197)	70.407 - 70.420 (2.7719 - 2.7724)
0.75 (0.0295)	70.157 - 70.170 (2.7621 - 2.7626)
1.00 (0.0394)	69.907 - 69.920 (2.7522 - 2.7528)

Connecting rod bearing undersize

Unit: mm (in)

	Crank pin diameter
Standard	52.913 - 52.926 (2.0832 - 2.0837)
Undersize	
0.25 (0.0098)	52.663 - 52.676 (2.0733 - 2.0739)
0.50 (0.0197)	52.413 - 52.426 (2.0635 - 2.0640)
0.75 (0.0295)	52.163 - 52.176 (2.0537 - 2.0542)
1.00 (0.0394)	51.913 - 51.926 (2.0438 - 2.0443)

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Gear train Backlash of each gear	0.07 - 0.11 (0.0028 - 0.0043)
Flywheel Runout (Total indicator reading)	Less than 0.15 (0.0059)

SERVICE DATA AND SPECIFICATIONS

TIGHTENING TORQUE

Engine outer parts

	N·m	kg-m	ft-lb
Water outlet bolt	10 - 13	1.0 - 1.3	7 - 9
Water pump bolt			
M8	10 - 13	1.0 - 1.3	7 - 9
M10	20 - 25	2.0 - 2.5	14 - 18
Manifold bolt and nut	15 - 18	1.5 - 1.8	11 - 13
Injection pump nut	20 - 25	2.0 - 2.5	14 - 18
Injection nozzle to cylinder head	59 - 69	6.0 - 7.0	43 - 51
Oil cooler bolt	10 - 13	1.0 - 1.3	7 - 9
Oil cooler pipe nut	10 - 13	1.0 - 1.3	7 - 9
Timing gear cover bolt	10 - 13	1.0 - 1.3	7 - 9
Injection pump timer nut	59 - 69	6 - 7	43 - 51
Injection tube flare nut	29 - 34	3.0 - 3.5	22 - 25
Spill tube with cap nut	39 - 49	4 - 5	29 - 36
Oil filter bracket bolt	26 - 36	2.7 - 3.7	20 - 27
Alternator bracket bolt	26 - 36	2.7 - 3.7	20 - 27
Alternator to adjusting bar bolt	11 - 14	1.1 - 1.4	8 - 10
Diesel pump controller bolt	10 - 13	1.0 - 1.3	7 - 9
Thermostat housing	10 - 13	1.0 - 1.3	7 - 9
Turbocharger to exhaust manifold	29 - 39	3 - 4	22 - 29
Turbocharger to connector	29 - 39	3 - 4	22 - 29

Engine internal parts

	N·m	kg-m	ft-lb
Main bearing cap bolt	167 - 172	17.0 - 17.5	123 - 127
Crank pulley nut	294 - 324	30 - 33	217 - 239
Flywheel bolt	44 - 49	4.5 - 5.0	33 - 36
Front cover bolt			
M6	4 - 6	0.4 - 0.6	2.9 - 4.3
M8	10 - 13	1.0 - 1.3	7 - 9
Front end plate bolt	10 - 13	1.0 - 1.3	7 - 9
Camshaft gear bolt	44 - 49	4.5 - 5.0	33 - 36
Oil pump bolt	13 - 19	1.3 - 1.9	9 - 14
Oil pan bolt	7 - 10	0.7 - 1.0	5.1 - 7.2
Cylinder head bolt			
Sub	44 - 54	4.5 - 5.5	33 - 40
Main	118 - 127	12 - 13	87 - 94
Rocker arm shaft bolt	20 - 25	2.0 - 2.5	14 - 18
Rocker arm lock nut	20 - 25	2.0 - 2.5	14 - 18
Camshaft thrust plate bolt	4 - 6	0.4 - 0.6	2.9 - 4.3
Connecting rod big end nut	51 - 56	5.2 - 5.7	38 - 41
Rocker cover bolt	10 - 13	1.0 - 1.3	7 - 9
Oil jet (for piston)	29 - 39	3 - 4	22 - 29

ENGINE LUBRICATION & COOLING SYSTEMS

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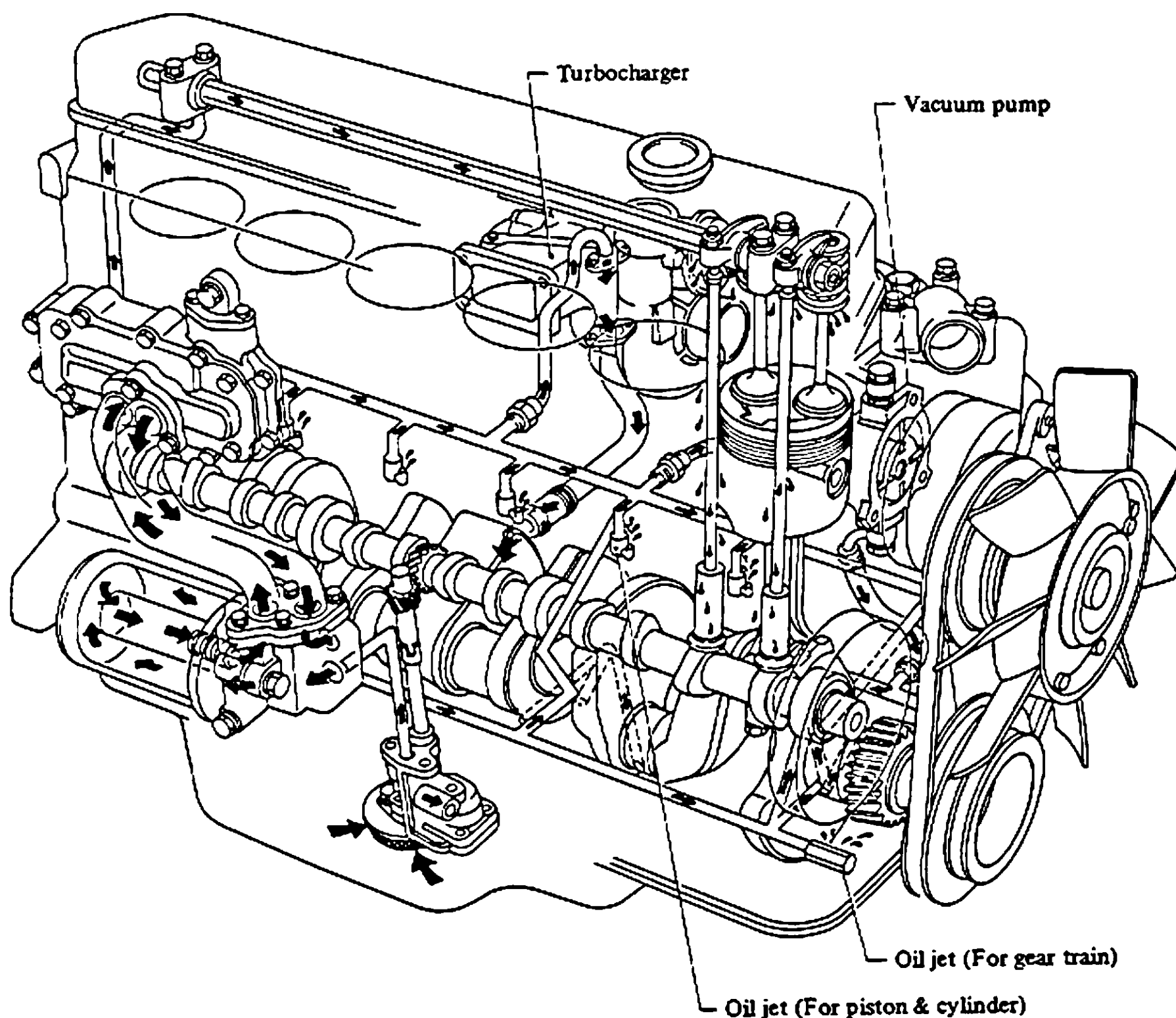
ENGINE LUBRICATION SYSTEM	LC-2
Lubrication circuit	LC-2



ENGINE LUBRICATION SYSTEM

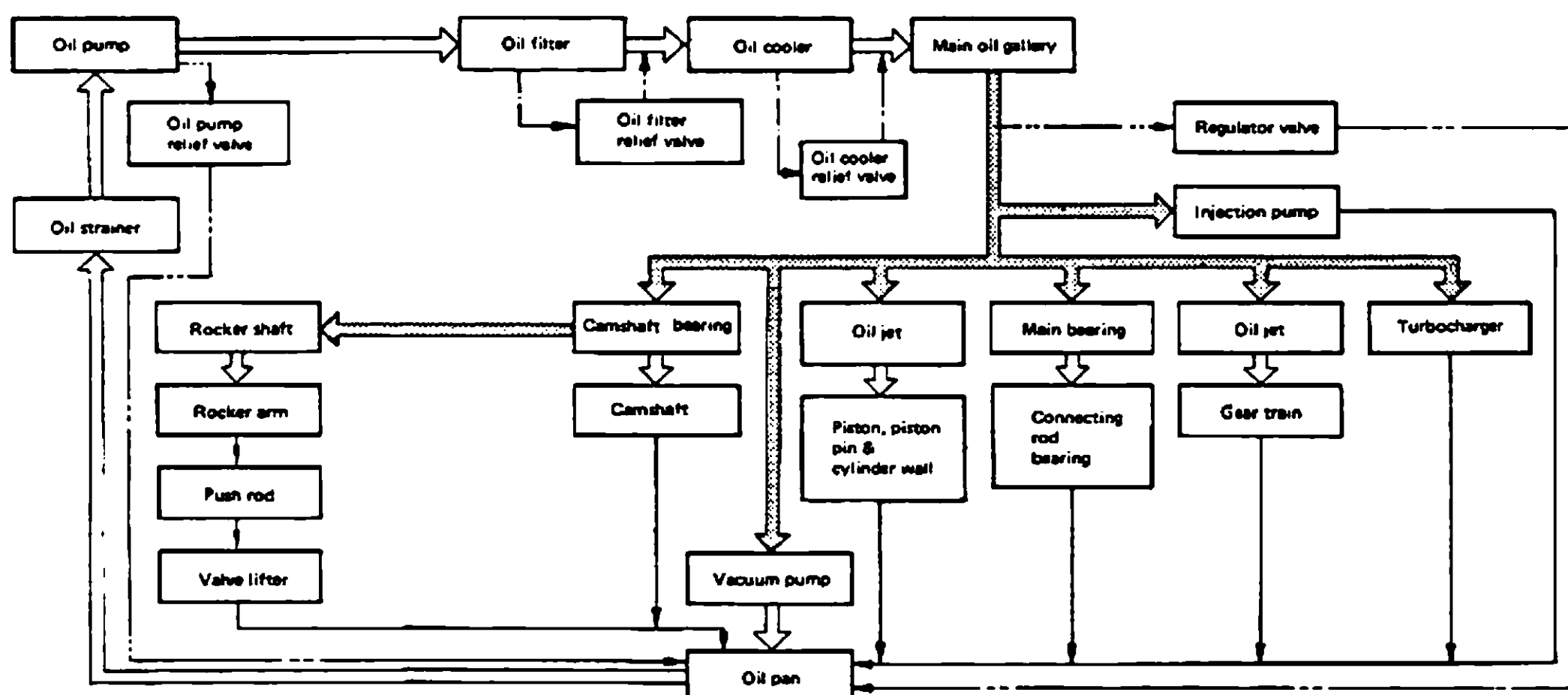
ENGINE LUBRICATION SYSTEM

LUBRICATION CIRCUIT



Note

- Oil gallery in cylinder block
- By-pass passage
- Oil passage



SLC563

ENGINE FUEL

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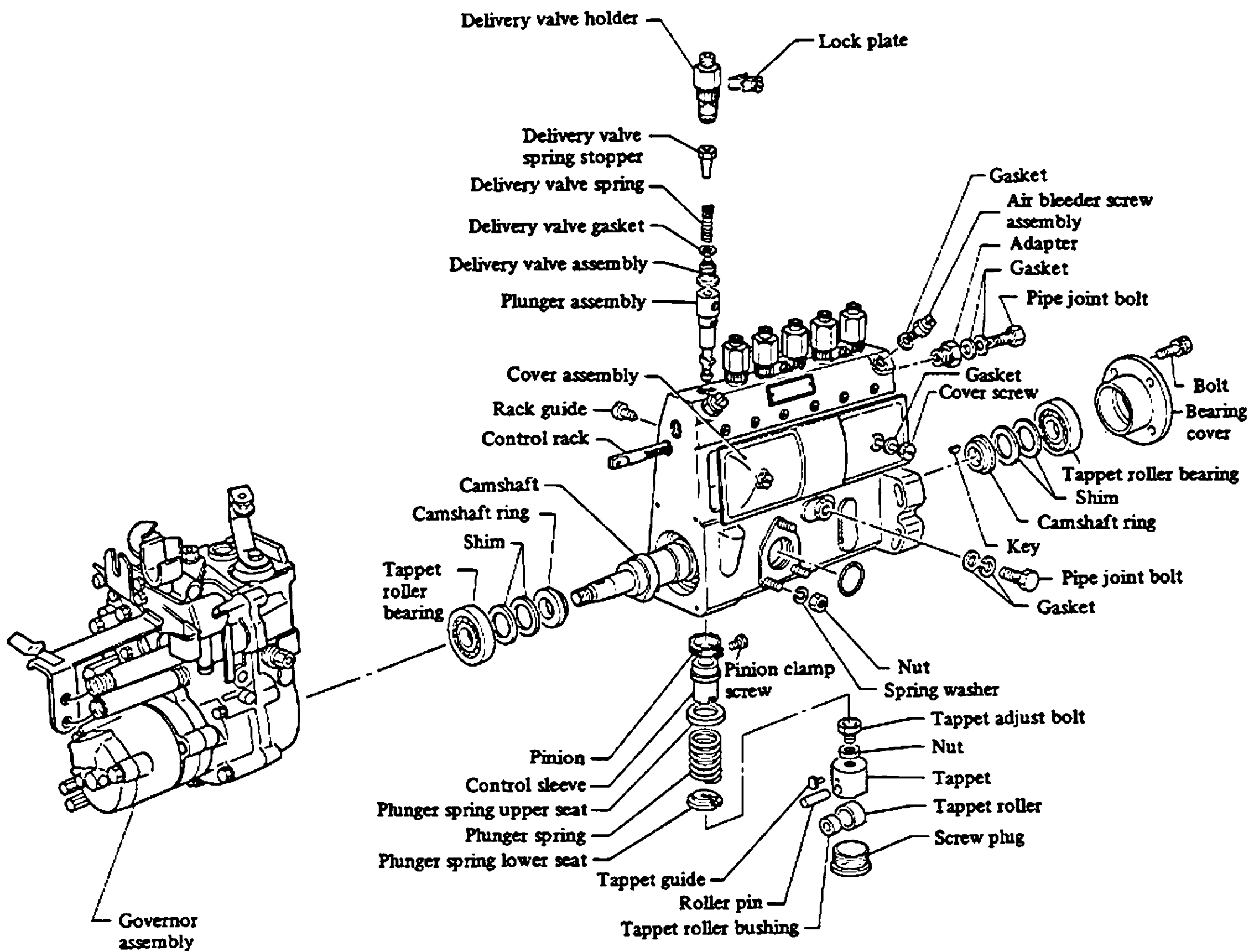


INJECTION PUMP ASSEMBLY

INJECTION PUMP ASSEMBLY

- CAUTION:**
- Disassembly and assembly of the all injection pumps should be done only in service shops authorized by NISSAN/DATSUN or by the pump manufacturer.
 - The pump tester is required for servicing the pump.
 - Before removing fuel injection pump from vehicle, check closely to make sure that it is apparently malfunctioning.
- Refer to Trouble-shooting in MA section in SD series SERVICE MANUAL.

DISASSEMBLY



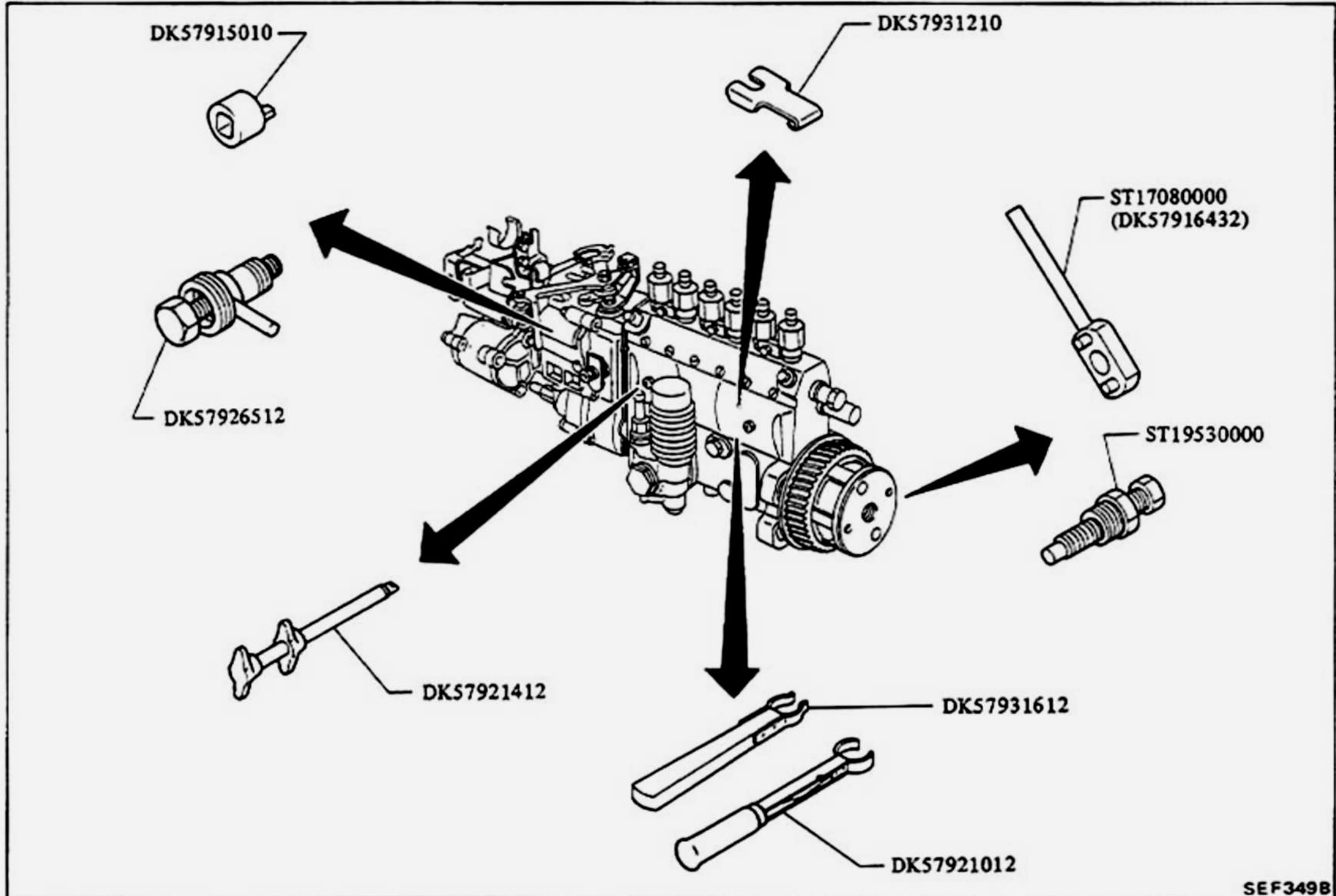
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INJECTION PUMP ASSEMBLY

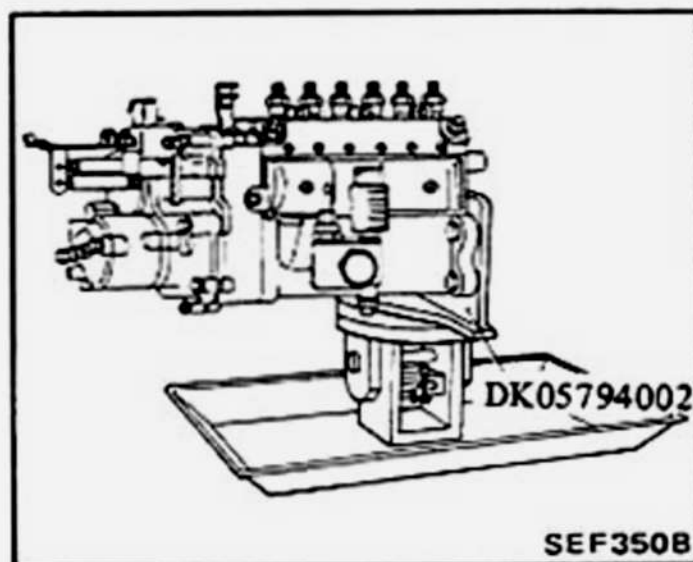
PREPARATION

- 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.
- Clean work bench completely, removing all foreign matter.
- Collect only those service tools necessary for disassembling and reassembling.
- Be careful not to bend or scratch any parts.
- Be careful not to mix parts of different cylinders.

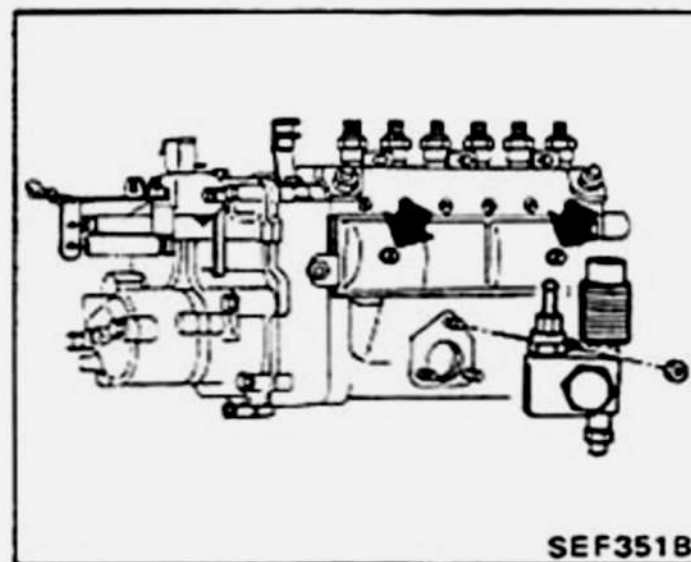
Special tools for disassembling and reassembling fuel injection pump



1. Drain injection pump oil.
2. Attach injection pump with Tool.



3. Remove feed pump and cover plate.



4. Check backlash between control rack and control pinion.

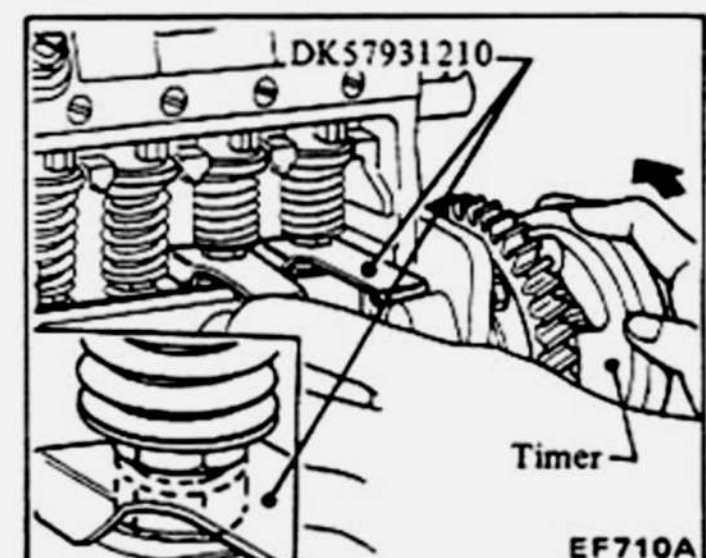
Refer to Inspection.

5. (1) Temporarily install timer to injection pump.

tion pump.

(2) Turn timer until tappet is raised to T.D.C. for each cylinder and then install Tool between tappet adjusting bolt and nut.

If Tool cannot be installed, loosen tappet adjusting bolt.



INJECTION PUMP ASSEMBLY

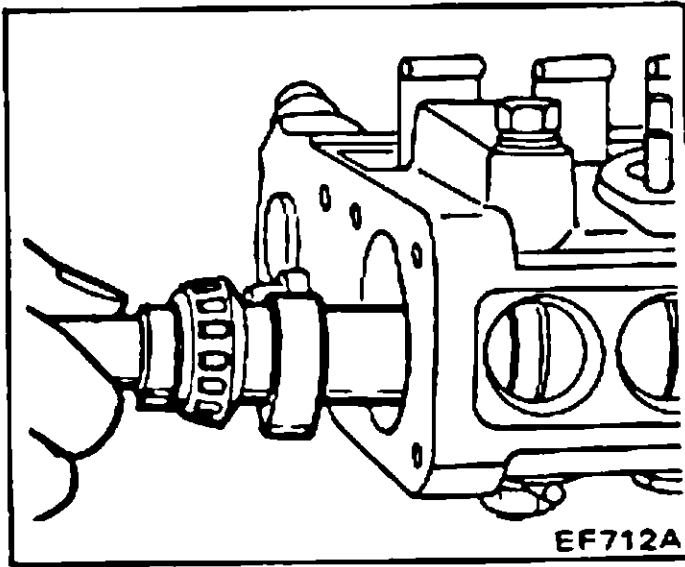
6. Check camshaft end play.

Refer to Inspection.

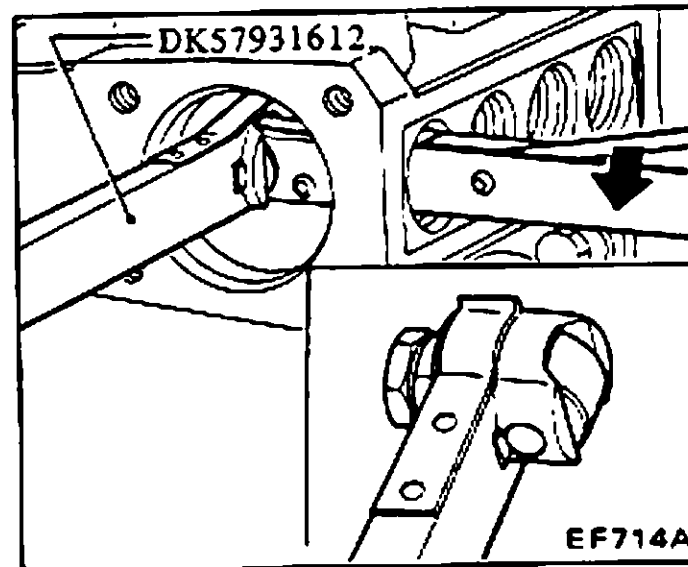
7. Remove boost compensator, governor cover, flyweight and governor housing.

Refer to Governor for removal.

8. Draw out camshaft.

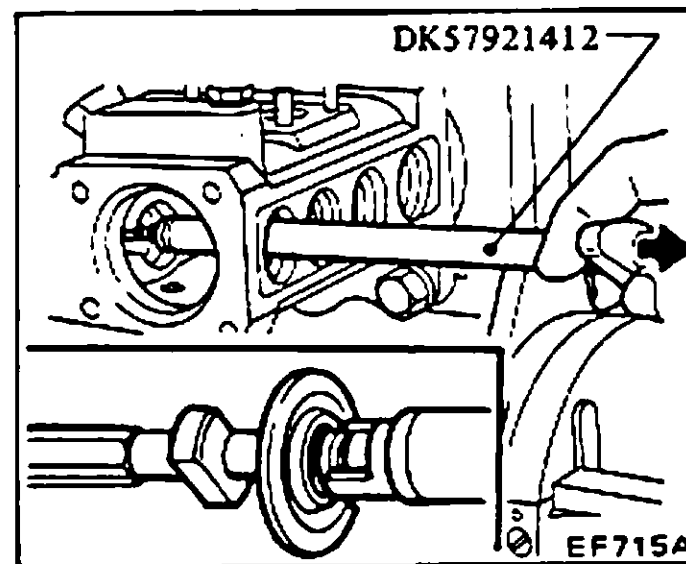


11. Withdraw tappet assembly with Tool from camshaft chamber by loosening Tool.

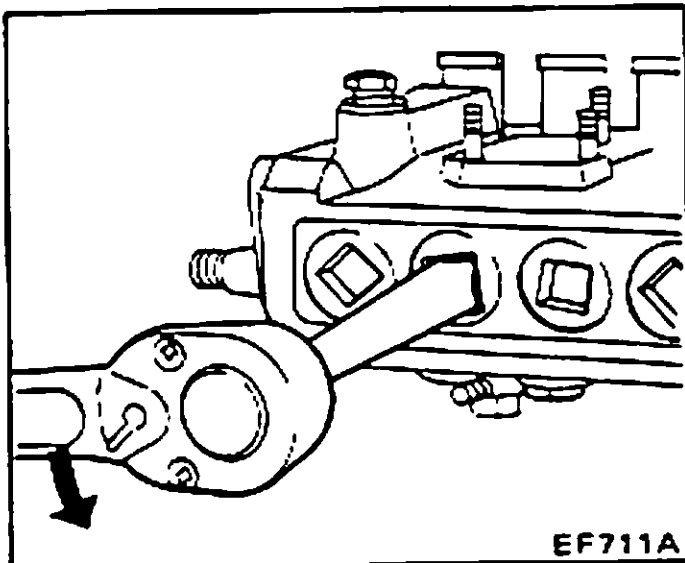


12. Remove plungers together with lower spring seat with Tool.

CAUTION:
Lay out plunger and plunger barrel in order in a pan of kerosene or solvent. Do not touch plunger with hand.

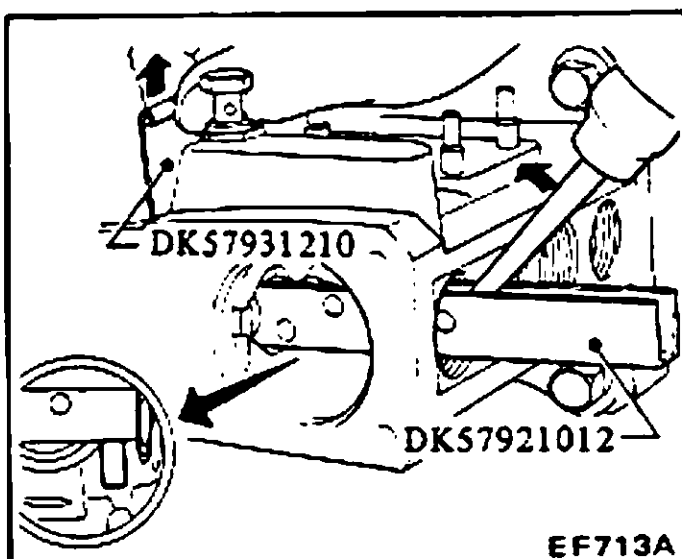


9. Remove plug.



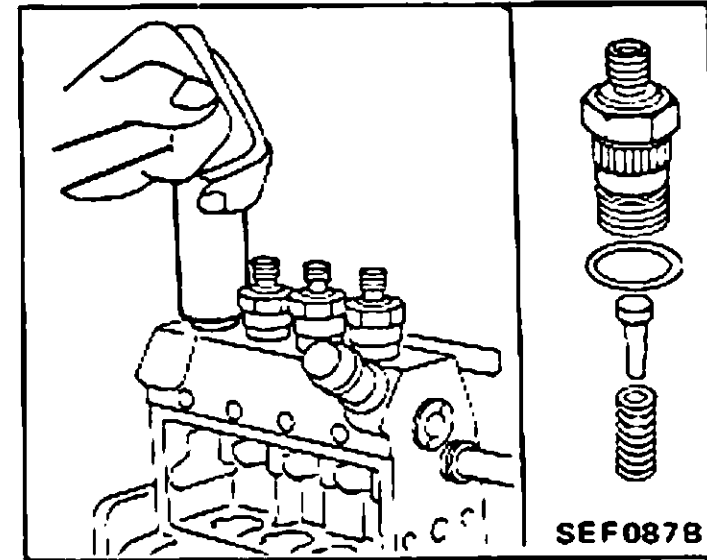
10. Remove tappet holder by pushing tappet with Tool.

CAUTION:
Be careful not to damage housing plug hole threads.



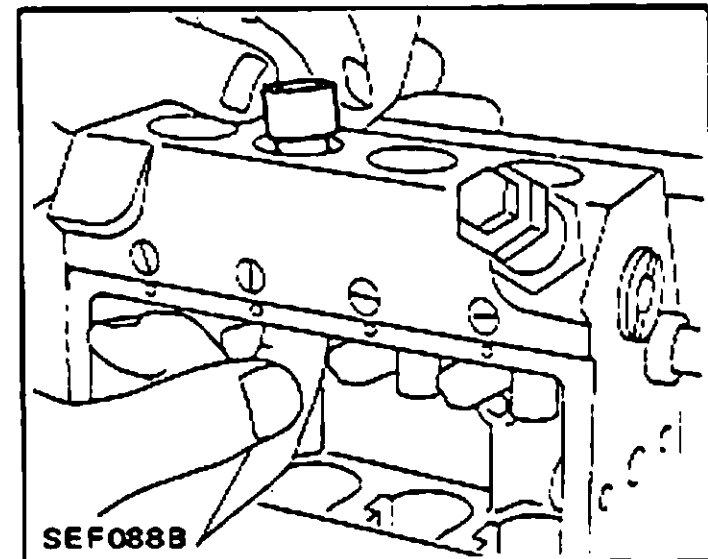
14. Remove lock plate.

15. Remove delivery valve holder and then remove delivery holder spring, and delivery valve stopper.

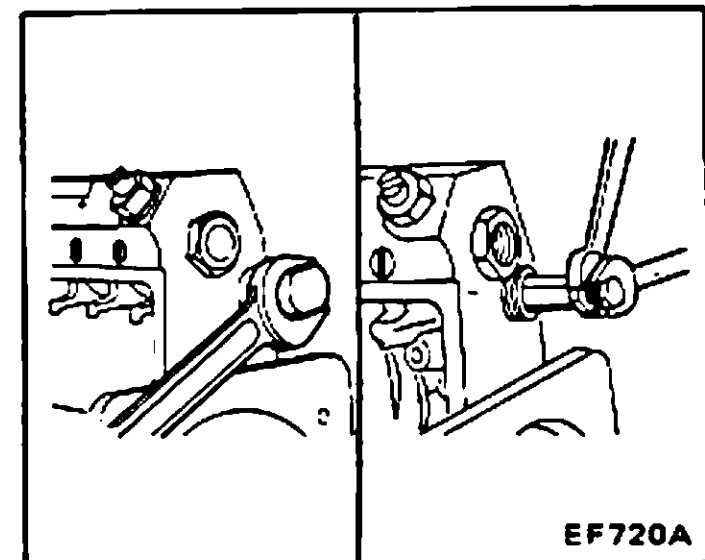


16. Remove delivery valve.

17. Remove plunger barrel by pushing it from below.

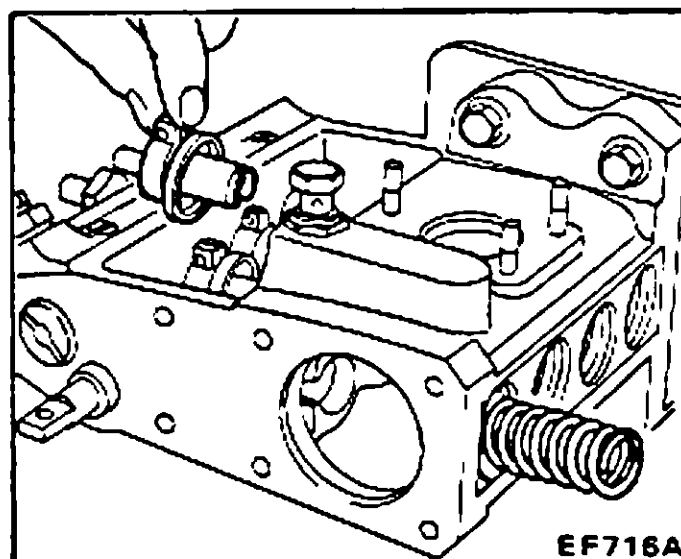


18. Remove cap and bolt and nut on control rack.



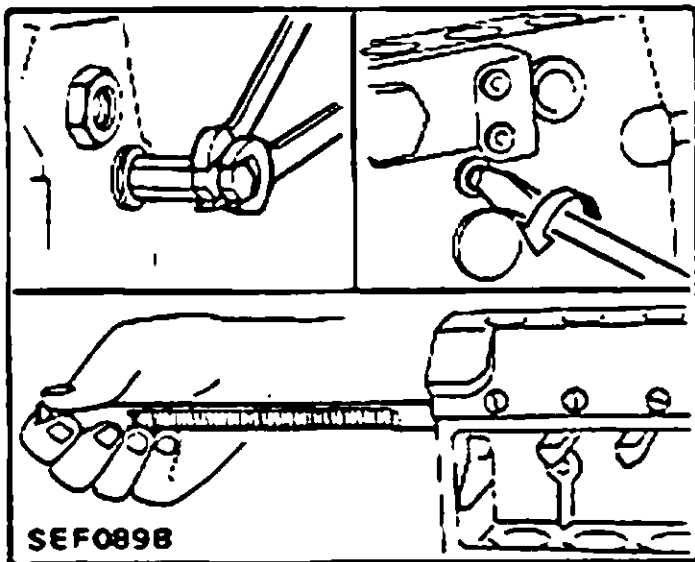
13. Remove plunger spring, upper spring seat and control sleeve assembly.

When disassembling control sleeve assembly, put matching mark.



INJECTION PUMP ASSEMBLY

19. Remove control rack guide screw and then draw out control rack.



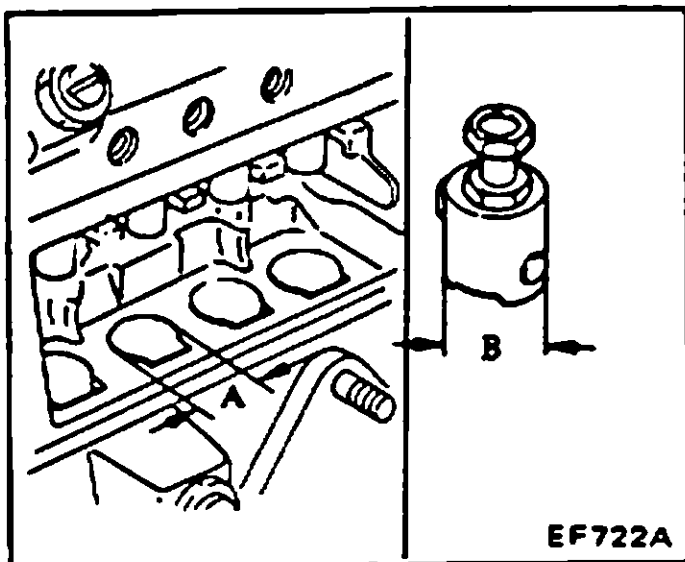
INSPECTION PUMP HOUSING

1. Inspect for damage, cracks, etc.
If excessively damaged, replace it with a new housing.
2. Check plunger barrel drum surface for proper contact with plunger barrel seating hole. Also, check for damage or cracks.

If faulty, replace with a new plunger and plunger barrel.

3. Measure tappet to housing clearance. If worn beyond wear limit, replace tappet or housing.

Tappet to housing clearance (A-B):
Limit
0.2 mm (0.008 in)



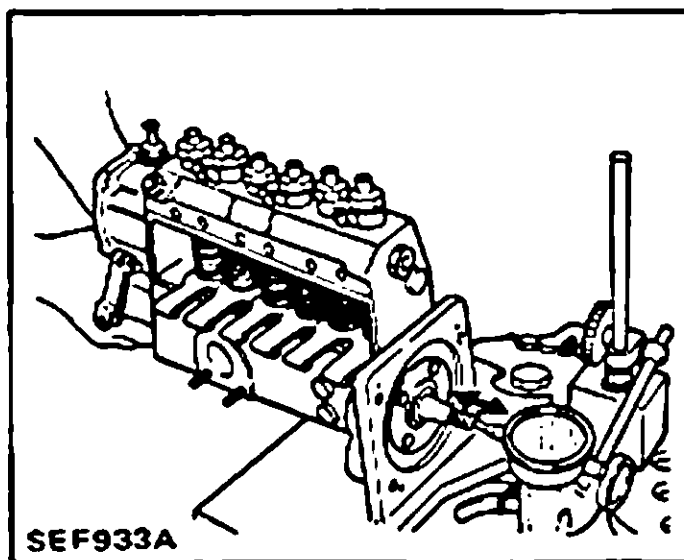
CAMSHAFT

1. Measure cam profile for uneven or excessive wear. If excessively or unevenly worn, replace camshaft with a new one.
2. Check for damage, cracks, etc.

If excessively damaged, replace it with a new one.

3. Measure camshaft end play by pushing camshaft from timer end so as to move camshaft in shaft direction.

Camshaft end play
Standard:
0 - 0.03 mm (0 - 0.0012 in)
Limit:
0.10 mm (0.0039 in)



If camshaft end play is over limit, adjust as follows:

- (1) Remove bearing inner race from camshaft.
- (2) Based upon end play measurement, increase or decrease adjusting shims.

Use the same shim thickness on each end.

- (3) Re-install bearing inner race on camshaft.

BEARINGS

Check for wear or discoloration. If faulty, replace with a new one.

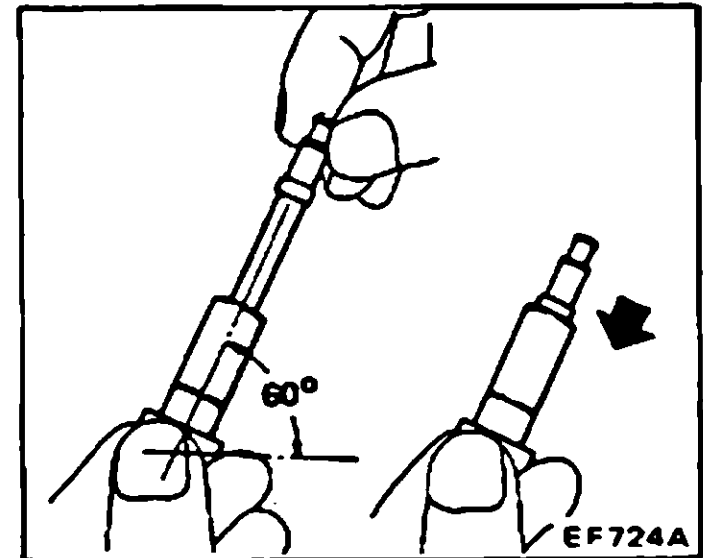
PLUNGER AND PLUNGER BARREL

The operation of the plunger should be checked based on the results of fuel injection volume measurement.

Oil-tightness check

1. Thoroughly clean plunger barrel in clear kerosene or solvent.
2. Tilt it to approximately 60°. Then, let plunger slide down through barrel, making sure that plunger slides smoothly. Repeat this procedure by turning plunger to various positions,

making sure that plunger slides smoothly in any of the positions.



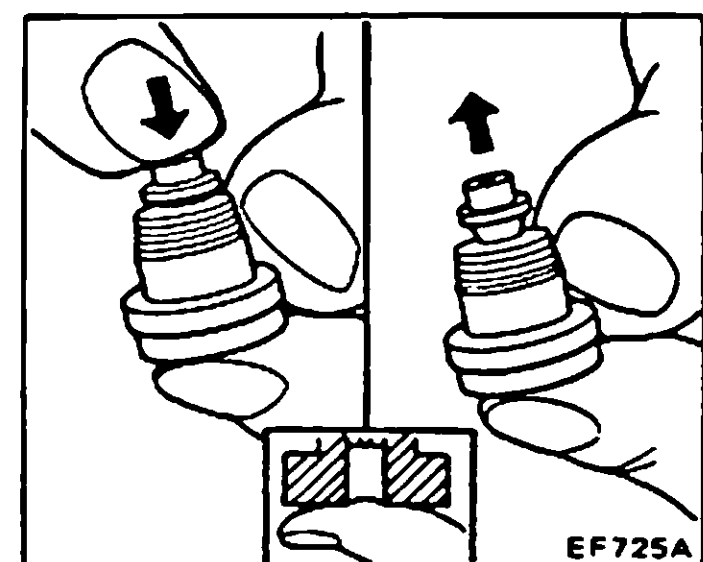
When replacement is required, replace both the plunger and plunger barrel as a set.

DELIVERY VALVE

Air-tightness check

1. Thoroughly clean delivery valve and delivery valve seat in clear kerosene or solvent.
2. Place finger over lower part of valve seat, lightly depress delivery valve with your finger tip, and make sure that valve springs back when released.

If valve falls to valve seat, it is not operating properly due to excessive piston wear. If faulty, replace with a new valve and valve seat assembly.



TAPPET

Inspect tappet, roller, roller bushing, and pin for wear or damage. If faulty, replace with new components, as required.

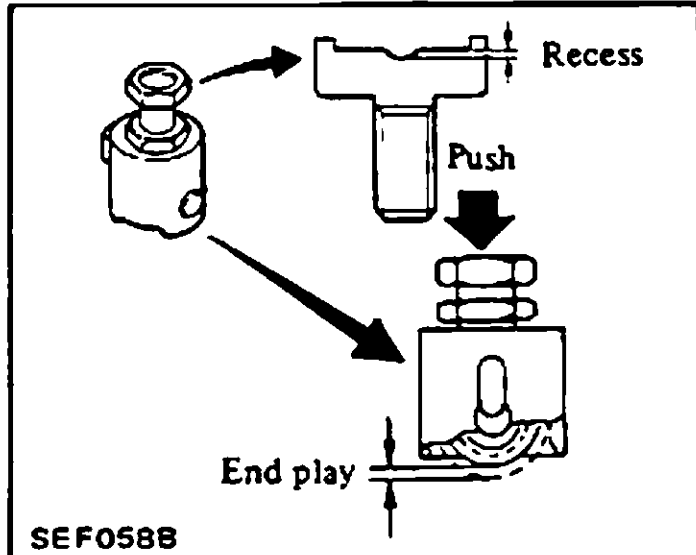
INJECTION PUMP ASSEMBLY

Adjusting bolt head recess wear limit:

0.20 mm (0.0079 in)

Roller end play limit:

0.20 mm (0.0079 in)



CONTROL RACK AND CONTROL SLEEVE ASSEMBLY

1. Inspect control rack for bending and damage.

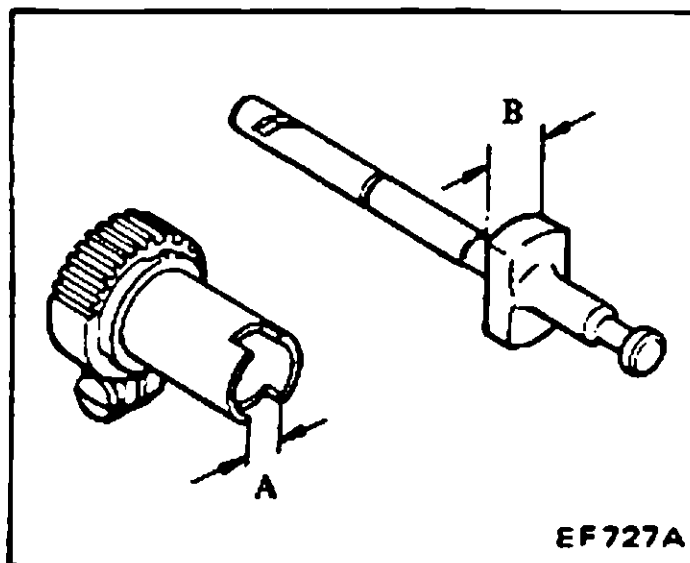
If faulty, repair or replace with a new control rack, as required.

2. Measure control sleeve to plunger lug clearance. If worn excessively, replace control sleeve or plunger, as required.

Control sleeve to plunger lug clearance (A-B):

Limit

0.12 mm (0.0047 in)

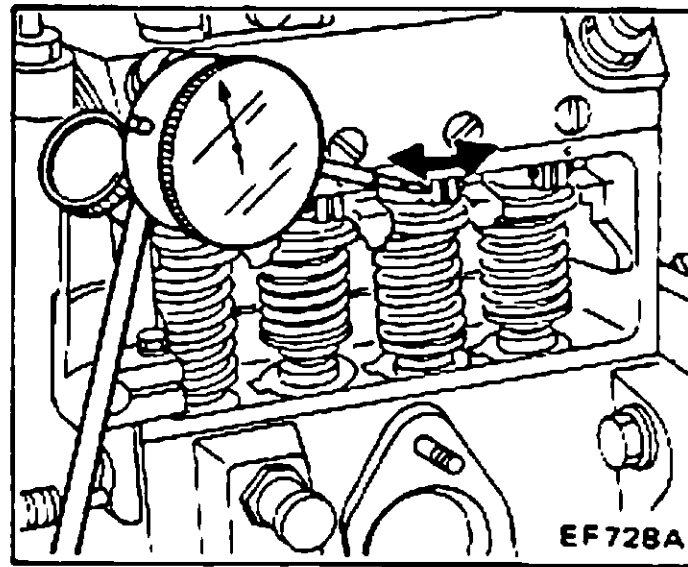


3. Measure backlash between control rack and control pinion.

Backlash between control rack and control pinion:

Limit

0.30 mm (0.0118 in)



SPRING

Inspect plunger and delivery valve springs for damage and squareness.

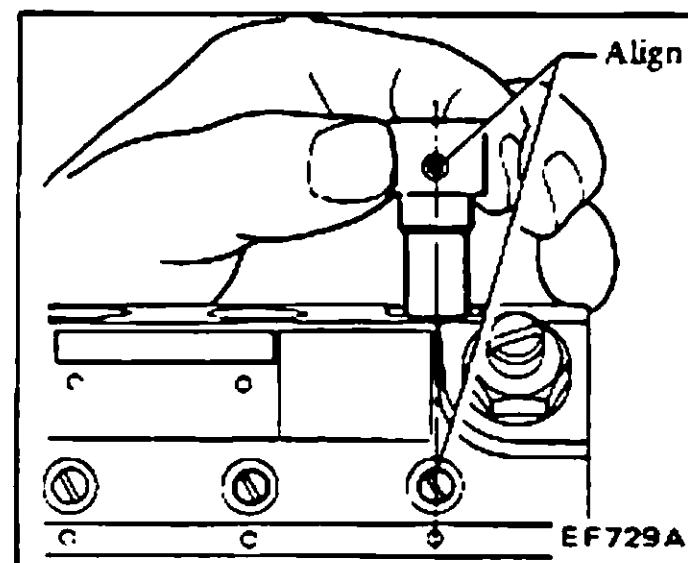
ASSEMBLY

Clean parts thoroughly and apply a thin coat of engine oil to rotating and sliding parts.

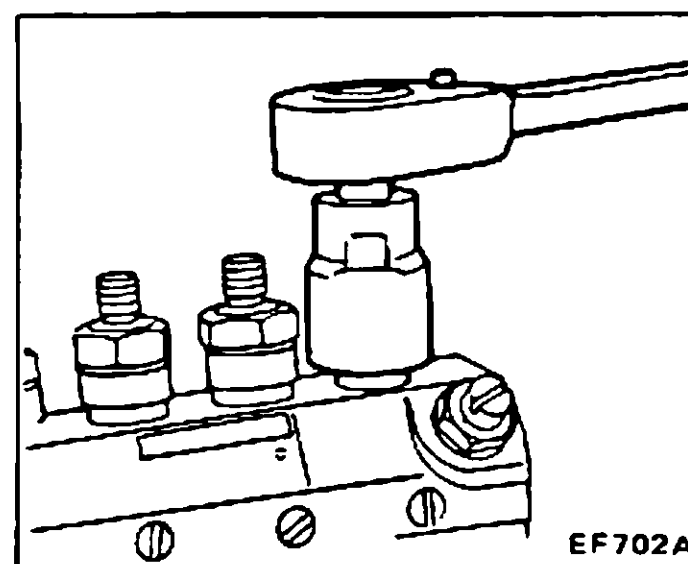
Assemble injection pump in the reverse order of disassembly.

Note the following items.

1. Set plunger barrel in position, with hole in barrel aligned with dowel pin of housing.



2. Install delivery valve.
3. Install delivery valve spring delivery valve stopper and delivery valve holder.



① : Delivery valve holder
39 - 44 N·m
(4.0 - 4.5 kg-m,
29 - 33 ft-lb)

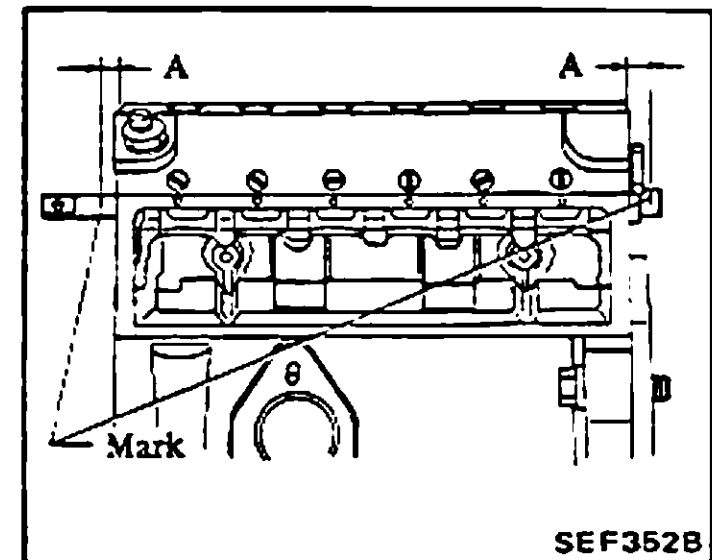
4. Install lock plates.

5.

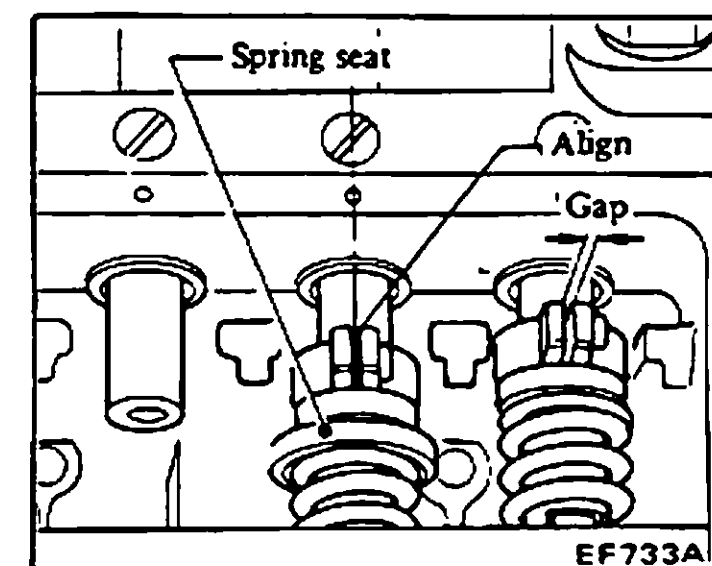
(1) Set the control rack so that marks on both sides are same distance "A" from each end of pump housing.

(2) Adjust bolt length and tighten lock nut.

(3) Then install control rack guide screw.



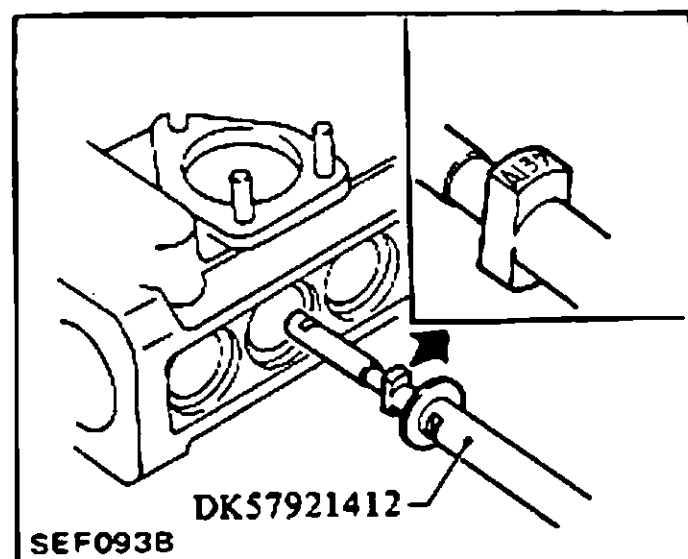
6. Install control sleeve assembly with gap of control sleeve facing straight up. Then install upper spring seats and plunger springs.



7. Install plunger together with lower spring seat by using Tool with plunger alignment mark facing upward (cover side of pump housing).

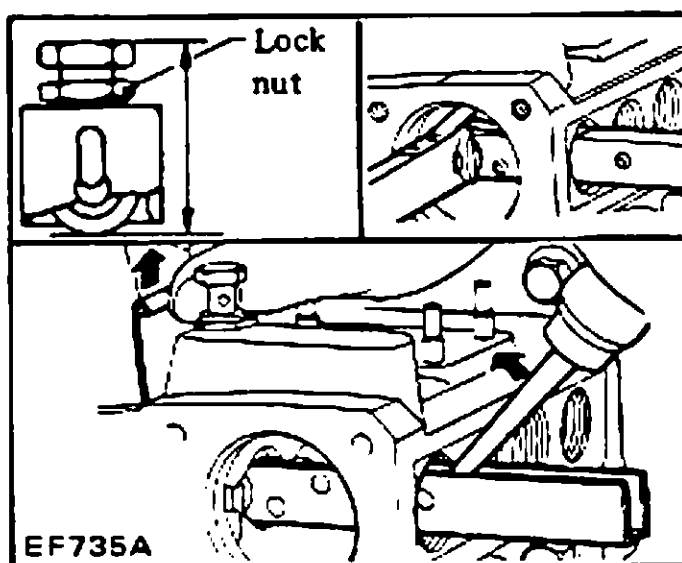
INJECTION PUMP ASSEMBLY

Do not use plunger with a barrel from a different cylinder.

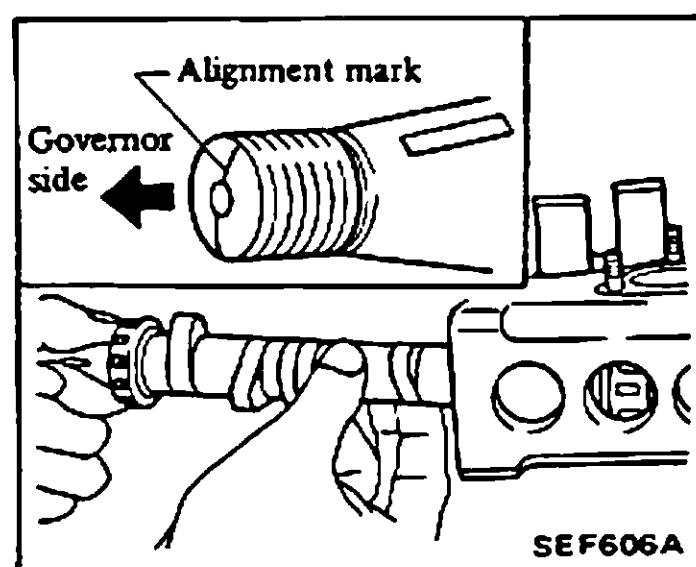


8. After adjusting tappet height to 34.5 to 35.0 mm (1.358 to 1.378 in), install tappet assembly by reversing the removal procedure.

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



9. Install camshaft so that its alignment mark is toward governor.



10. Install governor housing and then adjust camshaft end play.

Refer to Inspection.

11. Install screw plug on bottom of pump housing.

Seal the plug with sealant.

Ⓣ: Screw plug
54 - 74 N·m
(5.5 - 7.5 kg-m,
40 - 54 ft-lb)

12. Temporarily install timer and remove Tool (Plunger spring holder) while turning timer.

13. Install flyweight, governor cover and boost compensator in that order.

Refer to Governor for installation.

14. Install control rack cap, cover plate and feed pump.

15. Install pump bracket.

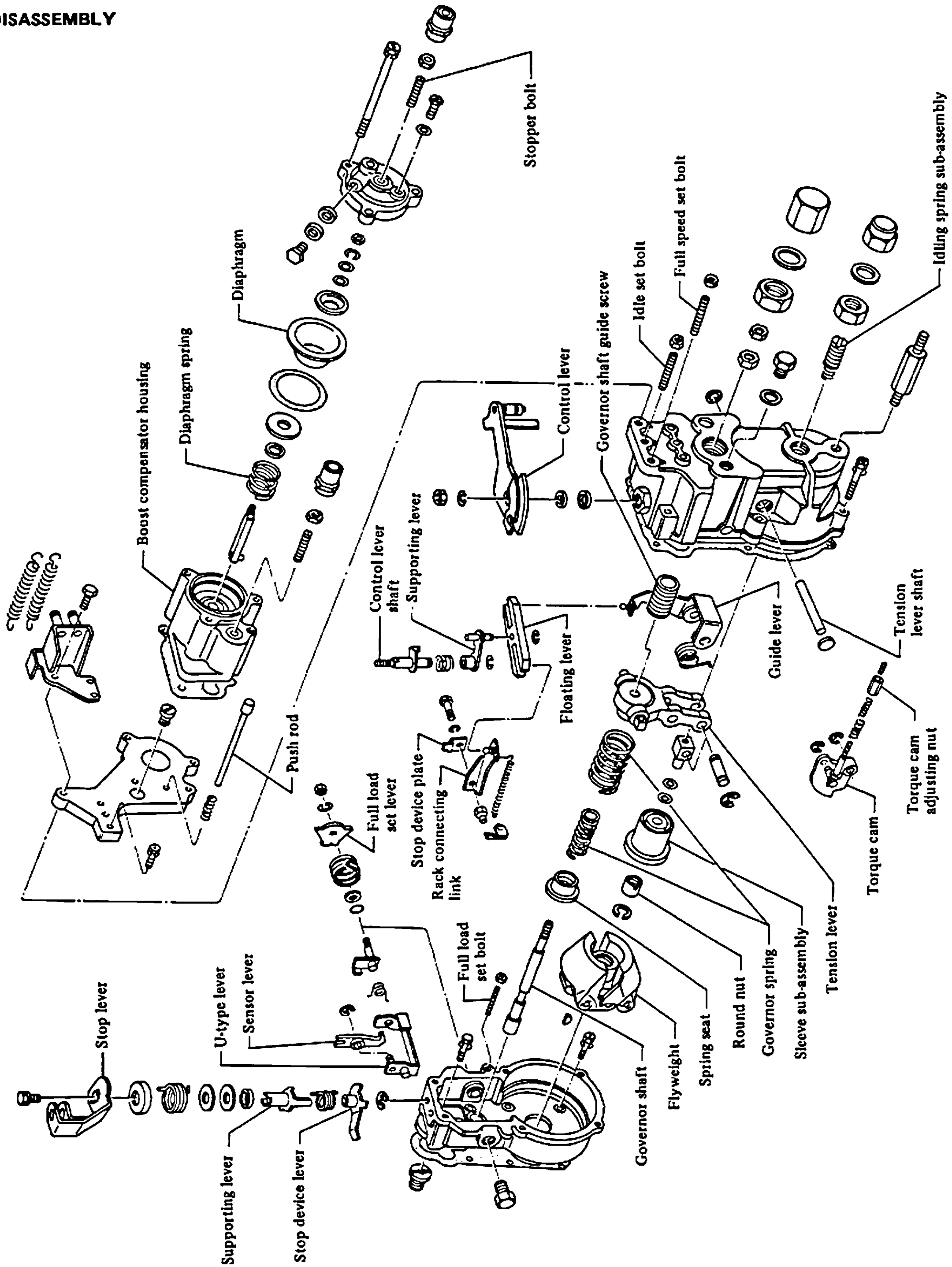
16. Install timer.

Ⓢ: Round nut
59 - 69 N·m
(6 - 7 kg-m,
43 - 51 ft-lb)

INJECTION PUMP ASSEMBLY

GOVERNOR (RLD-K type)

DISASSEMBLY



SEF353B

INJECTION PUMP ASSEMBLY

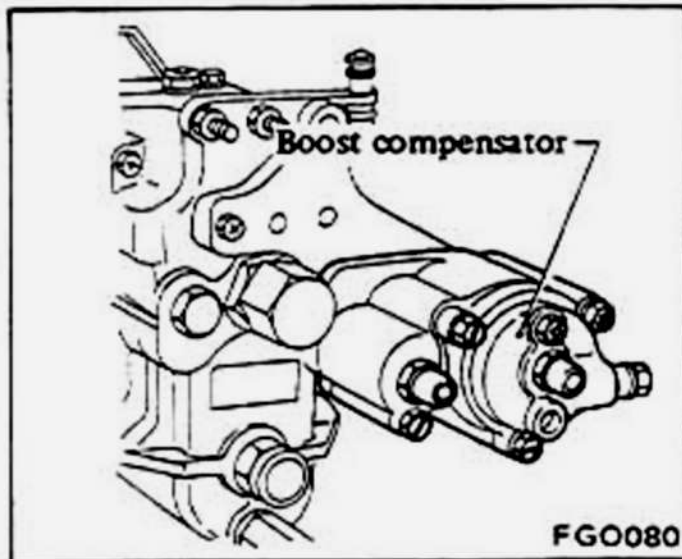
Preparation

Work with the disassembling table and keep the work room clean. Prior to disassembling, if you record the governor performance and the degree of screwing the screws at the adjusting points, and if you arrange the parts on the work table during the disassembling work, assembling and adjustment can be made quickly with ease.

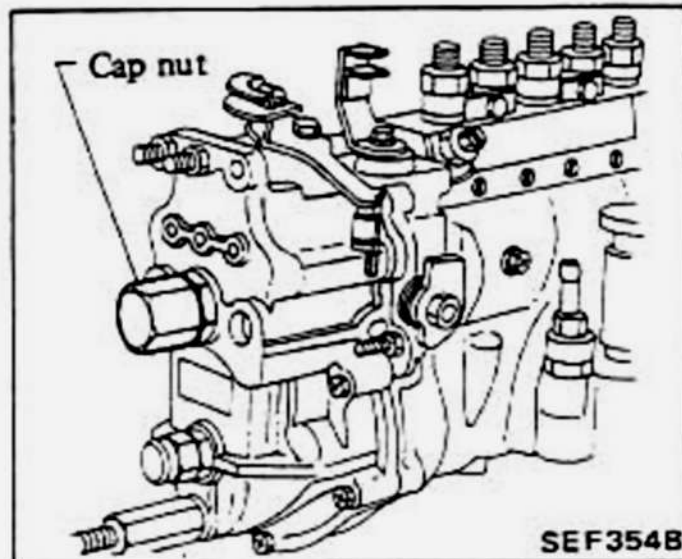
If there is extreme error in the adjustment or there are parts of poor function, the cause of poor functioning can be known by comparing the adjustment values before and after disassembly.

Prior to disassembling the governor, remove dust adhered to the external surface and extract the lubricating oil (engine oil) stored in cam chamber of the injection pump and the governor chamber.

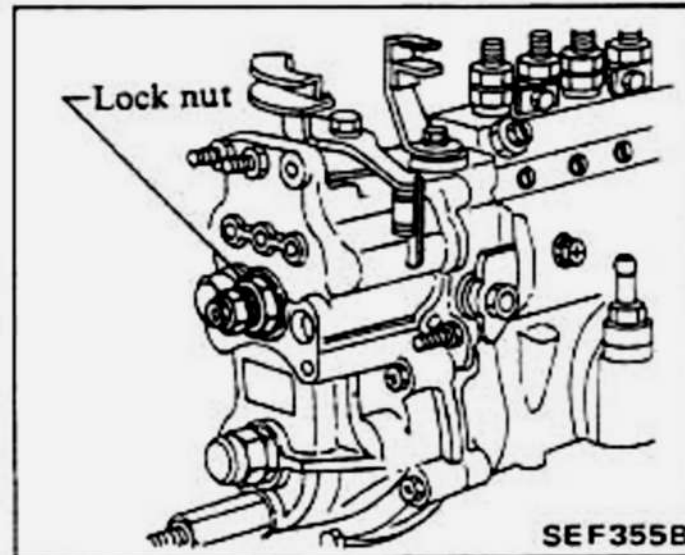
1. Install injection pump to universal vice.
2. Install tappet holder after removing feed pump and cover plate.
3. Remove control lever return spring and spring bracket.
4. Remove boost compensator assembly and draw push rod.



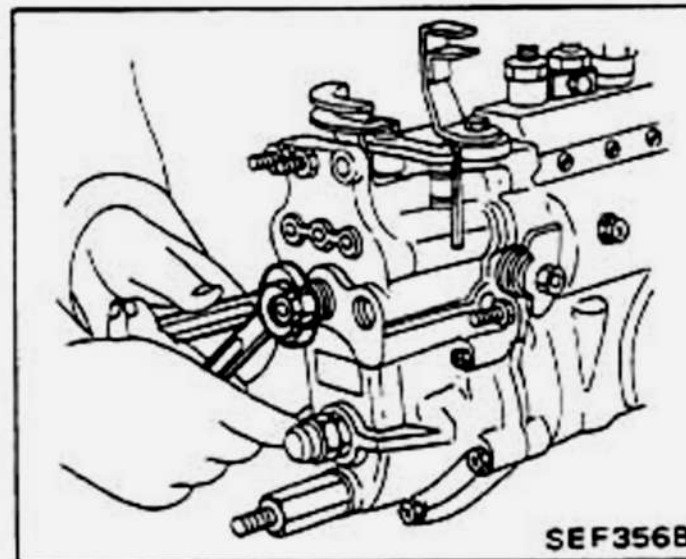
5. Remove guide screw cap nut on governor shaft.



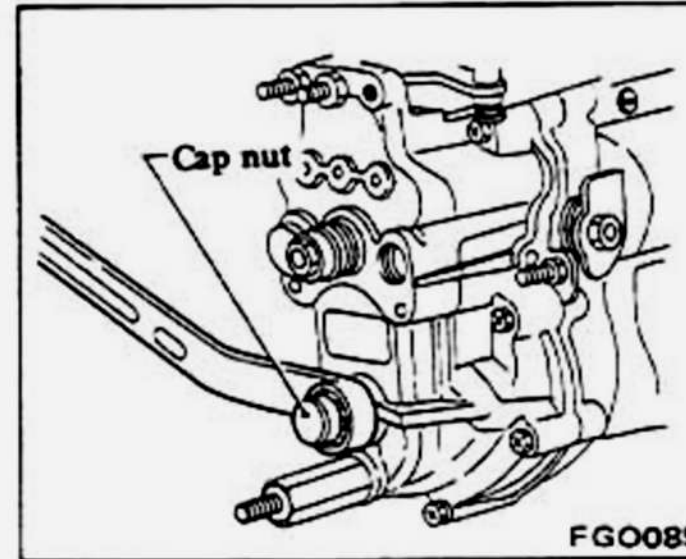
6. Remove governor shaft lock nut.



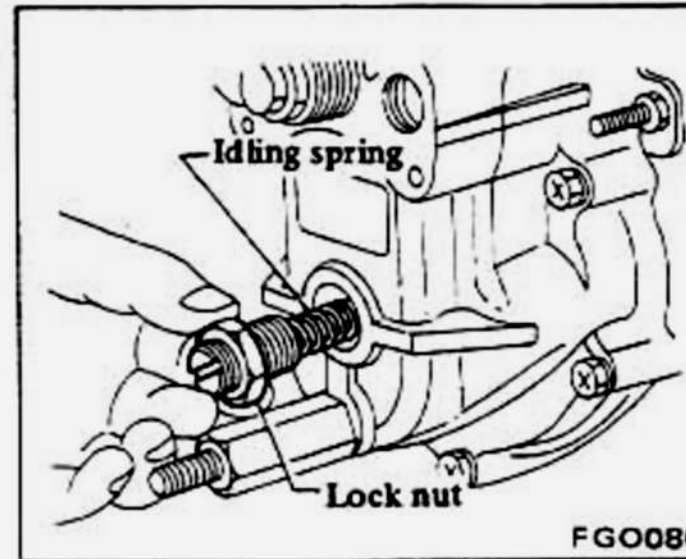
7. Remove guide screw nut.



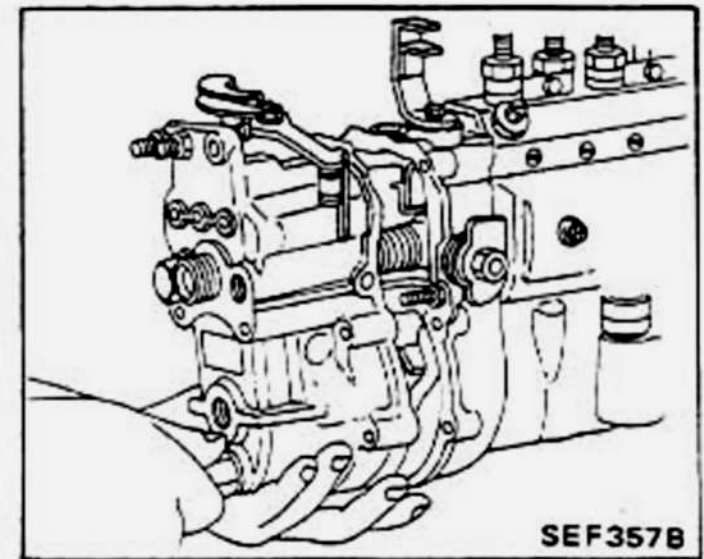
8. Remove cap nut fastening idling spring assembly.



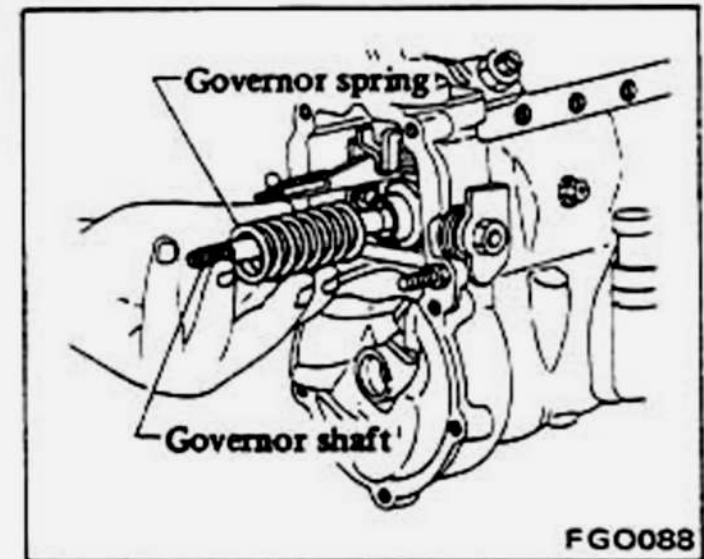
9. Loosen lock nut fastening idling spring assembly and remove idling spring assembly with screwdriver.



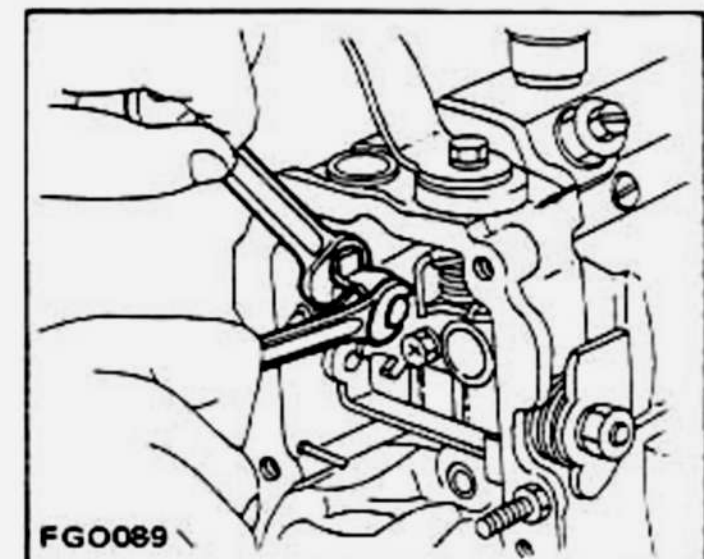
10. Loosen control lever nut slightly.
11. Loosen plug for hole for adjusting torque cam.
12. Remove seven bolts fastening governor cover and remove governor cover.



13. Extract governor spring and governor shaft together with spring sheet from governor housing.



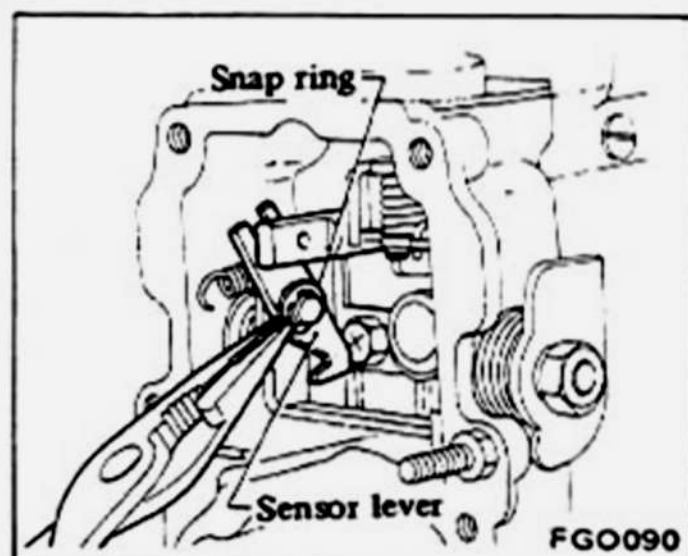
14. Remove start spring from rack connecting link.
15. Remove rack connecting link bolt from control rack.



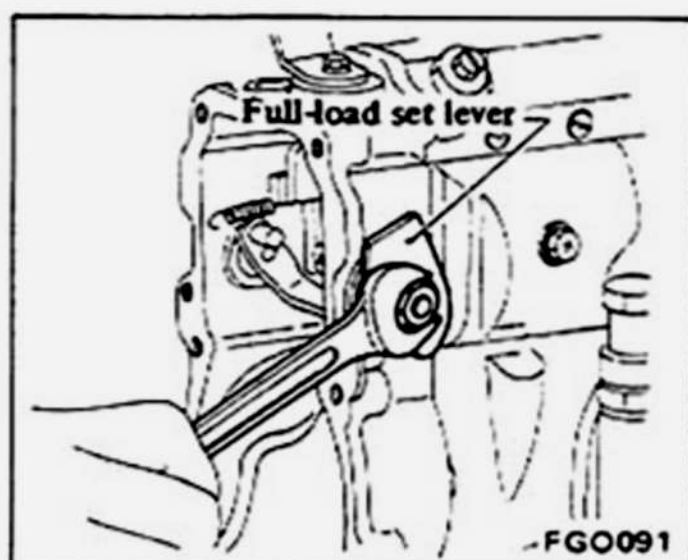
16. Remove snap ring fastening sensor lever.

INJECTION PUMP ASSEMBLY

17. Take out sensor lever

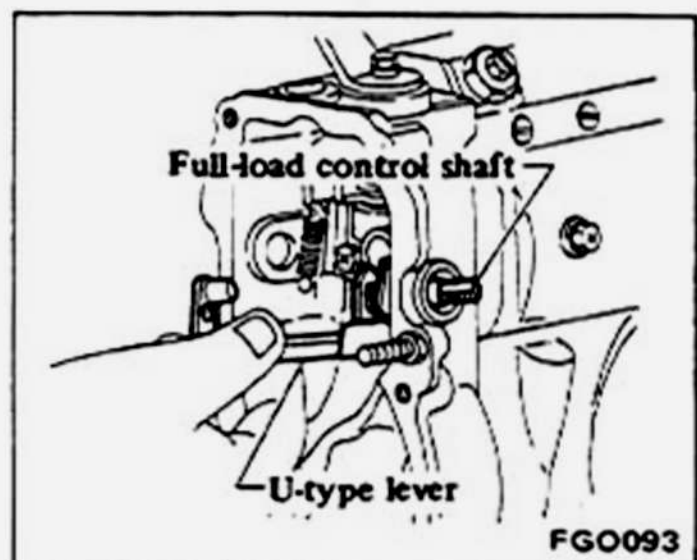


18. Remove full-load set lever.

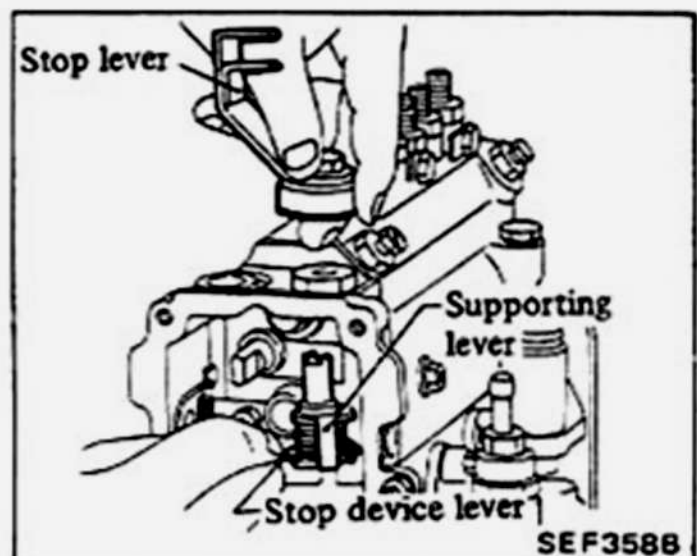


19. Remove guide plug on opposite side of full-load set lever.

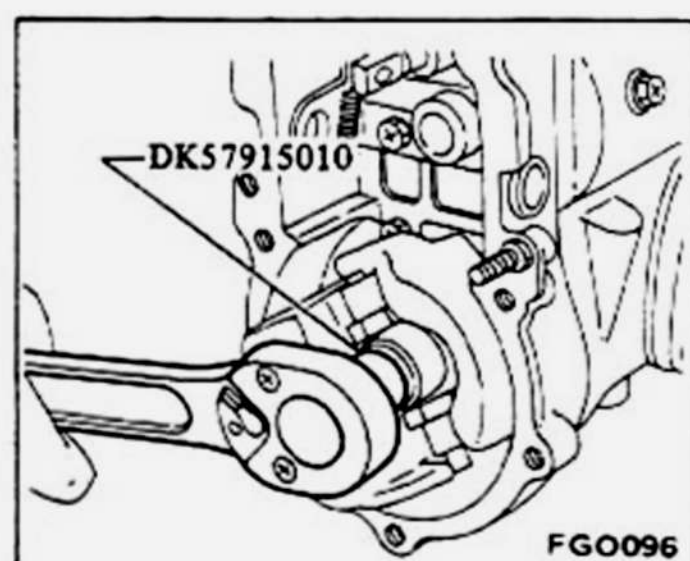
20. Remove U-type lever and full-load control shaft together with spring.



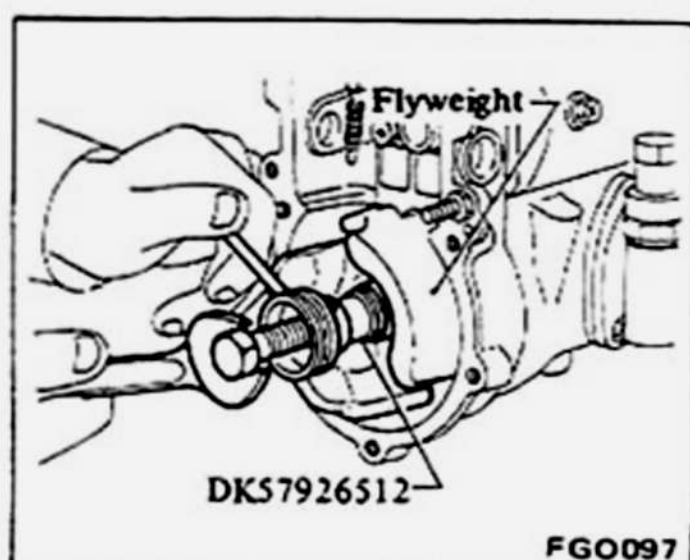
21. Remove bolt fastening stop lever and remove stop lever.



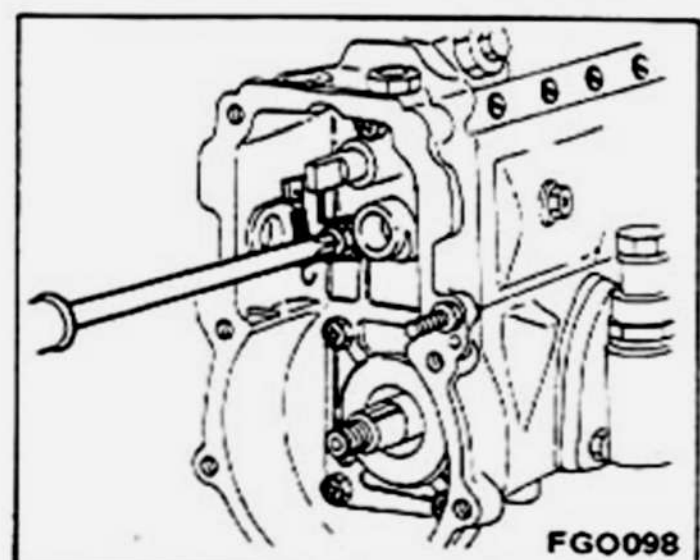
22. Remove round nut fastening flyweight with Tools. At this time, stop turning of camshaft with Tool.



23. Extract flyweight from camshaft with Tool.



24. Remove bolt and screw fastening governor housing to pump housing. Remove spring eye at the same time.

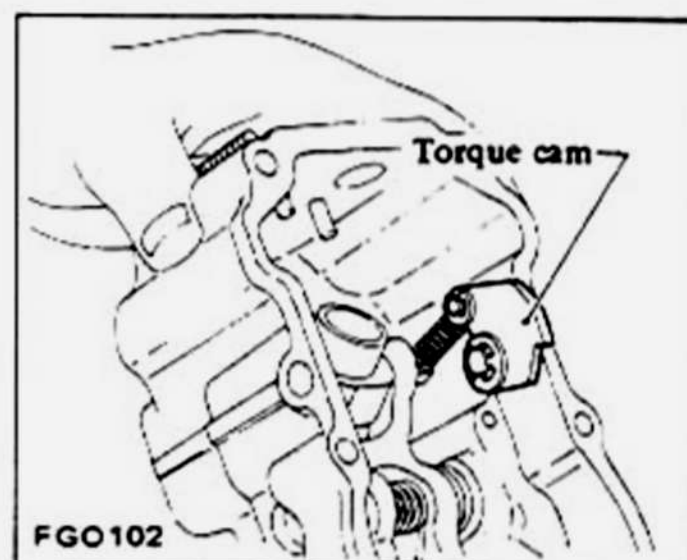


25. Remove governor housing from pump housing by lightly tapping governor housing with mallet or plastic hammer.

26. Remove plug, which has been loosened before, from governor cover.

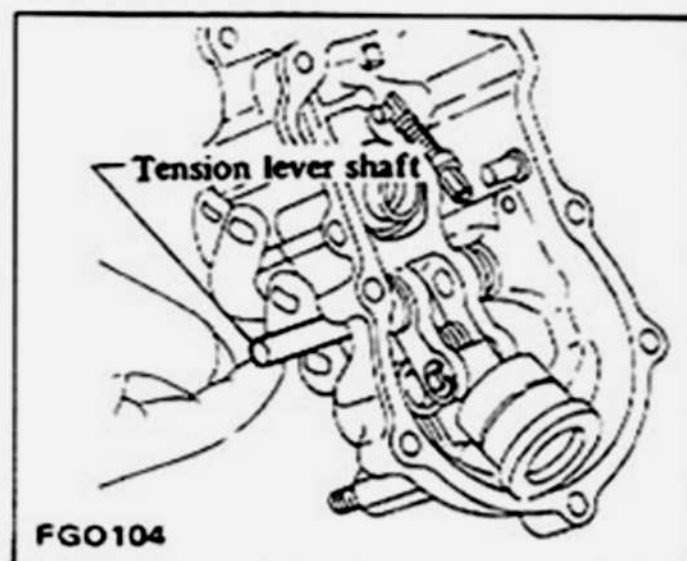
27. Remove guide screw together with lock nut from governor cover.

28. Remove snap rings connecting torque cam and remove torque cam.



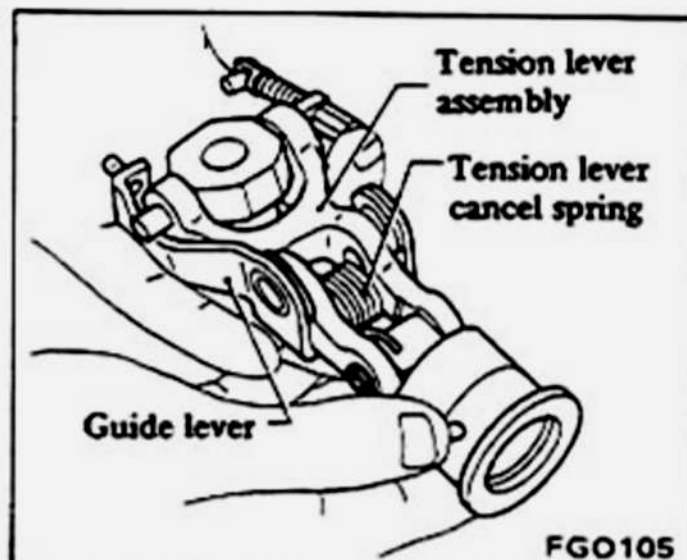
29. Remove plug which holds in place the shaft supporting the tension lever assembly.

30. Extract shaft.

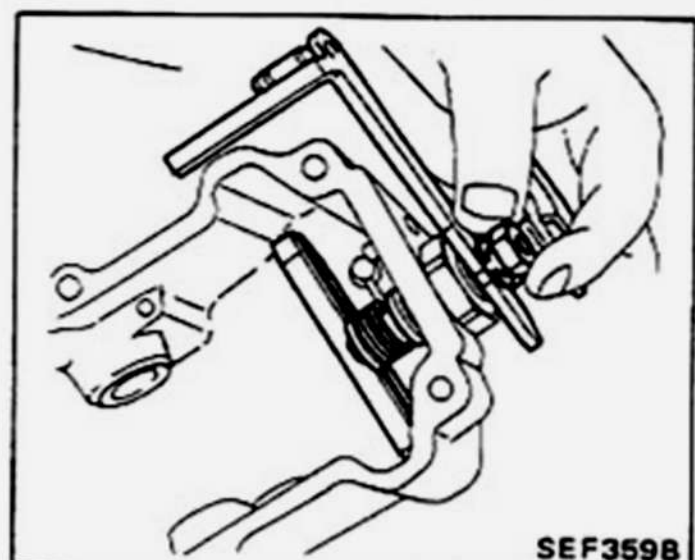


31. Extract tension lever assembly.

32. Extract guide lever together with collar. Extract cancel spring at the same time.

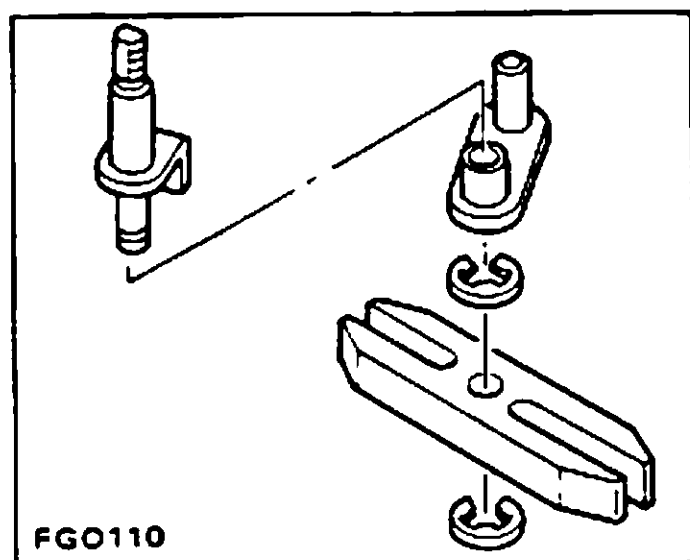


33. Remove nut fastening control lever and remove control lever.



INJECTION PUMP ASSEMBLY

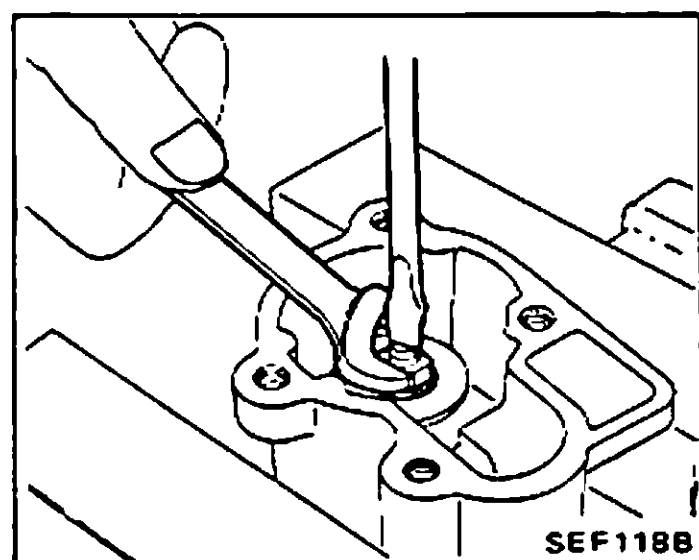
34. The lever assembly consists of parts as shown below, and is connected by a snap ring.



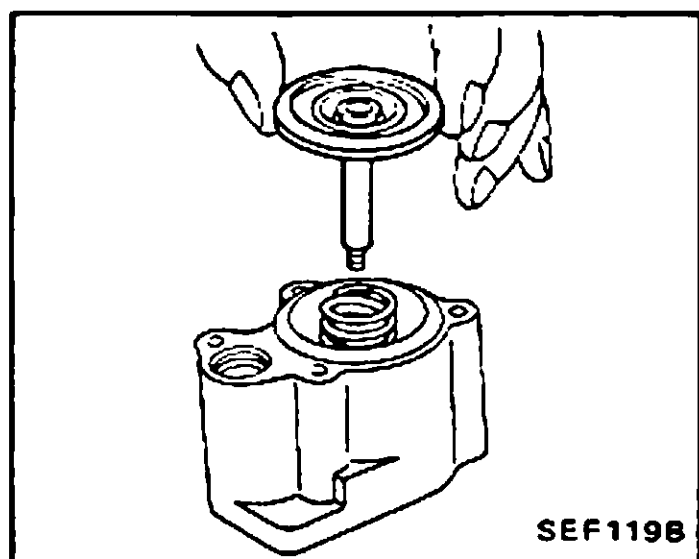
Disassembly of boost compensator

1. Fix boost compensator in vise.
2. Remove spring washer and disc by removing push rod nut.

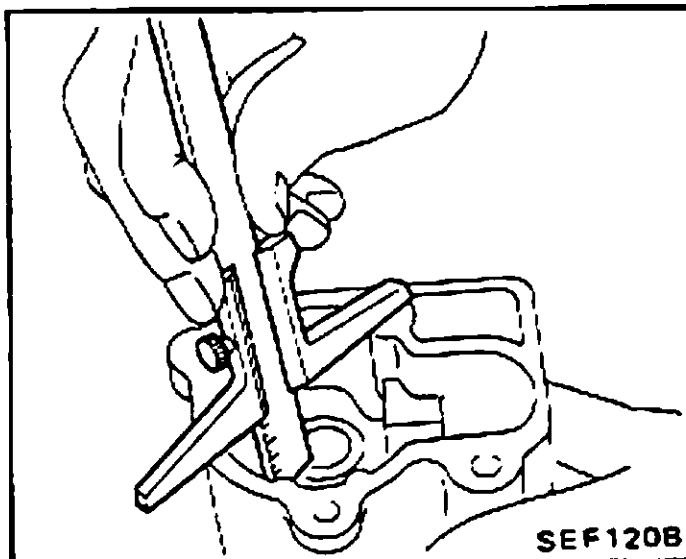
Stop rotating push rod with screwdriver to prevent it from being damaged by diaphragm.



3. Remove boost compensator cover.
4. Extract diaphragm and spring.



5. Measure and record distance between upper surface of guide screw and surface of housing.



INSPECTION

1. Flyweight

- Check pin and holder bushing for wear. If worn excessively, replace with a new one.
- Check slider for uneven wear or charring. If necessary, replace with a new one.
- Remove burrs from contact surface of flyweight at spring washer location.
- Check screw threads for damage. If necessary, repair or replace damaged parts.

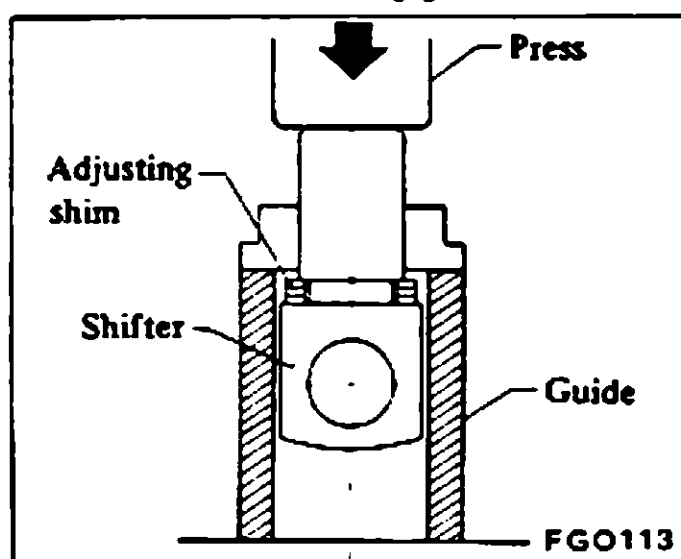
2. Tension lever assembly

- Check tension lever shaft for abnormal wear or charring.
- Check governor spring seat pin for wear.
- Check torque cam rod for bending and screw threads for damage.
- Check shifter pin for abnormal wear and bearing for charring or wear.

Replace damaged parts as needed.

To disassemble tension lever assembly for parts replacement, proceed as follows:

- a. Remove left and right snap rings from shifter pin and withdraw shifter pin.
- b. Remove snap ring which holds sleeve to bearing.
- c. Press shifter bearing guide out.



3. Guide lever, rack connecting link and floating lever

Check guide lever, rack connecting link and groove width of floating lever for excessive play or wear. Replace worn or damaged parts.

4. Governor housing and cover

• "Pressed-in" locks

Check pins for bending or damage. Repair or replace damaged parts or entire assembly.

• Check tension lever shaft bushing for wear.

• Check screw threads for abnormalities. If necessary, repair or replace with new ones.

5. Sensor lever and torque cam

• Check for abnormal wear on pawl at tip end of sensor lever and surface of torque cam. Replace sensor and/or torque cam as required.

• Check sensor lever fork for uneven wear.

• Check torque cam rod pin and pin hole for wear. Replace worn parts.

6. Governor shaft

Check for proper operation of governor shaft, governor housing, spring seat, guide screw, etc.

7. Control lever assembly

Check control lever shaft, bushing and supporting lever for abnormalities.

8. Springs

Check springs for bending, rust formation or damage. If necessary, replace with new ones.

ASSEMBLY

Assembly is in the reverse order of disassembly. Observe the following:

Do not reuse old gaskets, oil seals, O-rings and snap E-rings. Always install new ones.

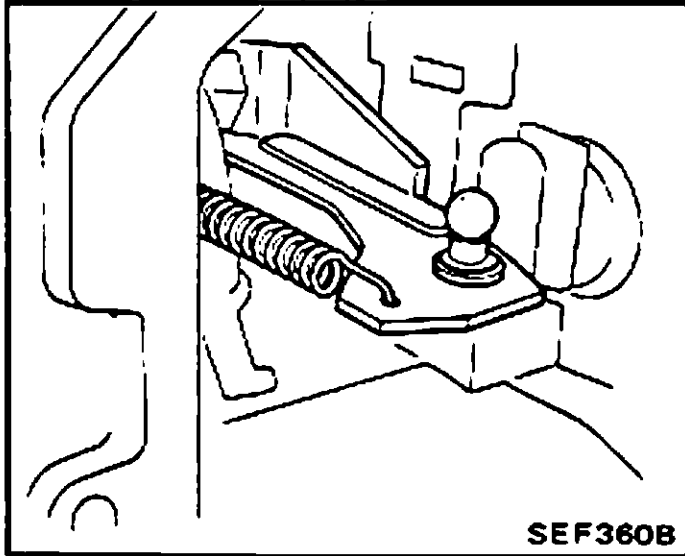
1. Governor housing and flyweight

(1) Place gasket between governor and pump housings and then install spring eye. Tighten all seven bolts equally in a crisscross fashion.

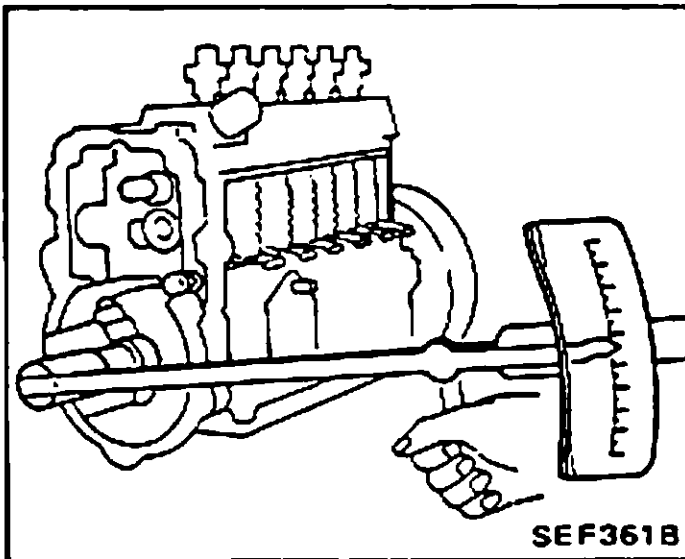
(2) Install full-load set lever, U-type lever, sensor lever and connecting link in that order.

INJECTION PUMP ASSEMBLY

(3) Insert hook of start spring into hole on upper side of connecting rod. If spring is installed backwards, its hook will enter fork groove on floating lever and not operate properly.



(4) Insert key into groove on camshaft, install flyweight and tighten nuts.



Ⓙ : Flyweight
49 - 59 N·m
(5 - 6 kg·m,
36 - 43 ft·lb)

2. Governor cover assembly

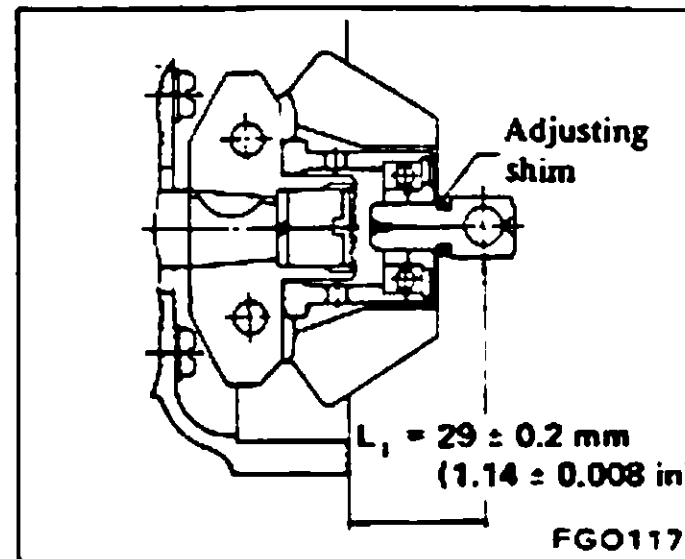
(1) Shifter

When shifter is assembled to sleeve assembly, the sleeve is pressed against the flyweight holder so that the lift of the flyweight becomes the state of 0 and it is so adjusted that size L_1 from the governor cover adhered surface to the center of the pin hole of the shifter may be 29 ± 0.2 mm (1.14 ± 0.008 in) by using an adjusting shim. A functional difficulty will occur if the dimension L_1 is not within specifications:

a. Too large a value of L_1 causes the flyweights to open too wide, allowing the slide to come off the sleeve and wear on the contacting surface of the sleeve. This wear is evidenced by a surface offset.

b. Too small a value of L_1 prevents the flyweight from moving and making maximum lift.

Part No.	mm (in)
16826-99008	0.1 (0.004)
16826-99009	0.5 (0.020)



(2) Assemble shifter assembly to tension lever.

3. Governor cover internal parts

(1) Installation of control lever and floating lever

a. Insert control lever assembly into place on inside of governor cover. To facilitate insertion, apply a coat of grease to upper oil seal and surface of lever shaft.

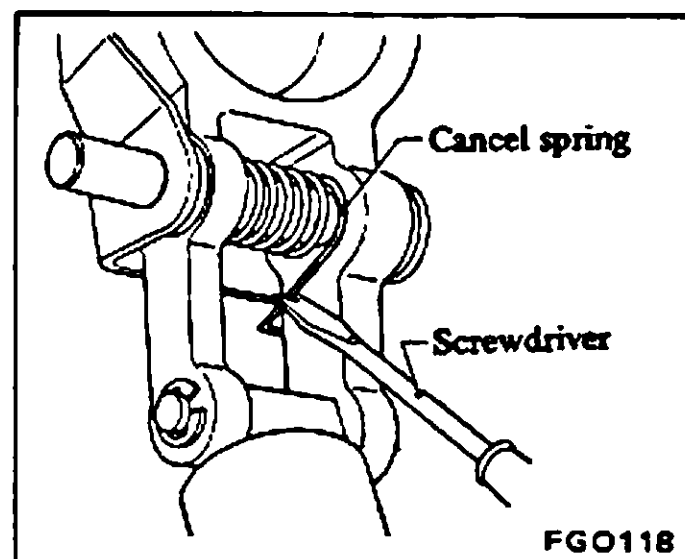
b. Install floating lever on supporting lever with chamfered side (mark "⊙") of fork facing down.

(2) Installation of tension lever and guide lever

a. Connect upper rod of tension lever to torque cam. Tighten lock screw.

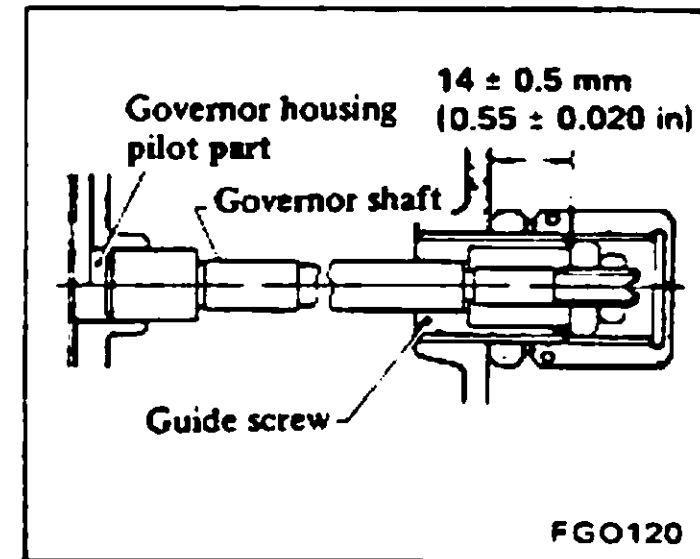
b. Place left and right collars between tension lever and guide lever, and insert tension lever shaft into collars.

(3) When cancel spring for integrating the guide lever with the tension lever is built in, it is convenient to use screwdriver with a grooved blade.



4. Governor shaft

(1) Screw guide screw into governor cover until its end is aligned with inner wall of cover. Tighten lock nut. Ensure that length " L_2 " measures 14 ± 0.5 mm (0.55 ± 0.020 in).



(2) Install spring seat and governor spring onto governor shaft. Then insert governor shaft into spring seat on upper end of tension lever.

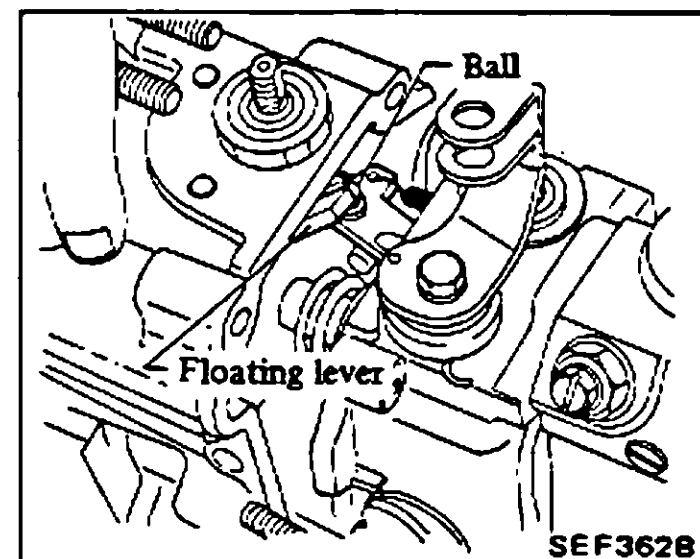
Spring seat on each side of governor spring should be installed with its graded portion facing the spring.

(3) Temporarily tighten the nut on end face of governor shaft located outside governor cover.

(4) After plug of tension lever shaft is pressed in governor cover, coat screw lock in periphery of plug. Unless screw lock is coated, lubricating oil may leak out.

5. Fitting governor to pump

(1) Have control rod side of supporting lever pulled out toward governor housing, and then mount sleeve. Next, insert ball joint (on control rod side) into slot of floating lever. This sequence makes it easier to attach governor cover assembly to pump.



INJECTION PUMP ASSEMBLY

(2) When governor cover is to be built into governor housing upon completion of the shim adjustment of shifter, fasten guide screw after confirming that governor shaft is inserted in the faucet portion of housing so as to slide and rotate smoothly. If governor shaft does not rotate smoothly, loosen governor cover fastening bolt and re-

build governor.

(3) Confirm that the following control rod position can be obtained after governor cover is attached and idling and set of governor spring are loosened. Manipulated control lever to full speed side in such state that control lever and full load stop lever are not

limited by stopper bolt. Insert control rod in non-injection direction from pump driving side. Then, confirm that control rod reaches the following maximum position smoothly when control rod is released.

Shift volume of control rod: 9.5 to 21 mm (0.374 to 0.83 in).

TESTING OF INJECTION PUMP

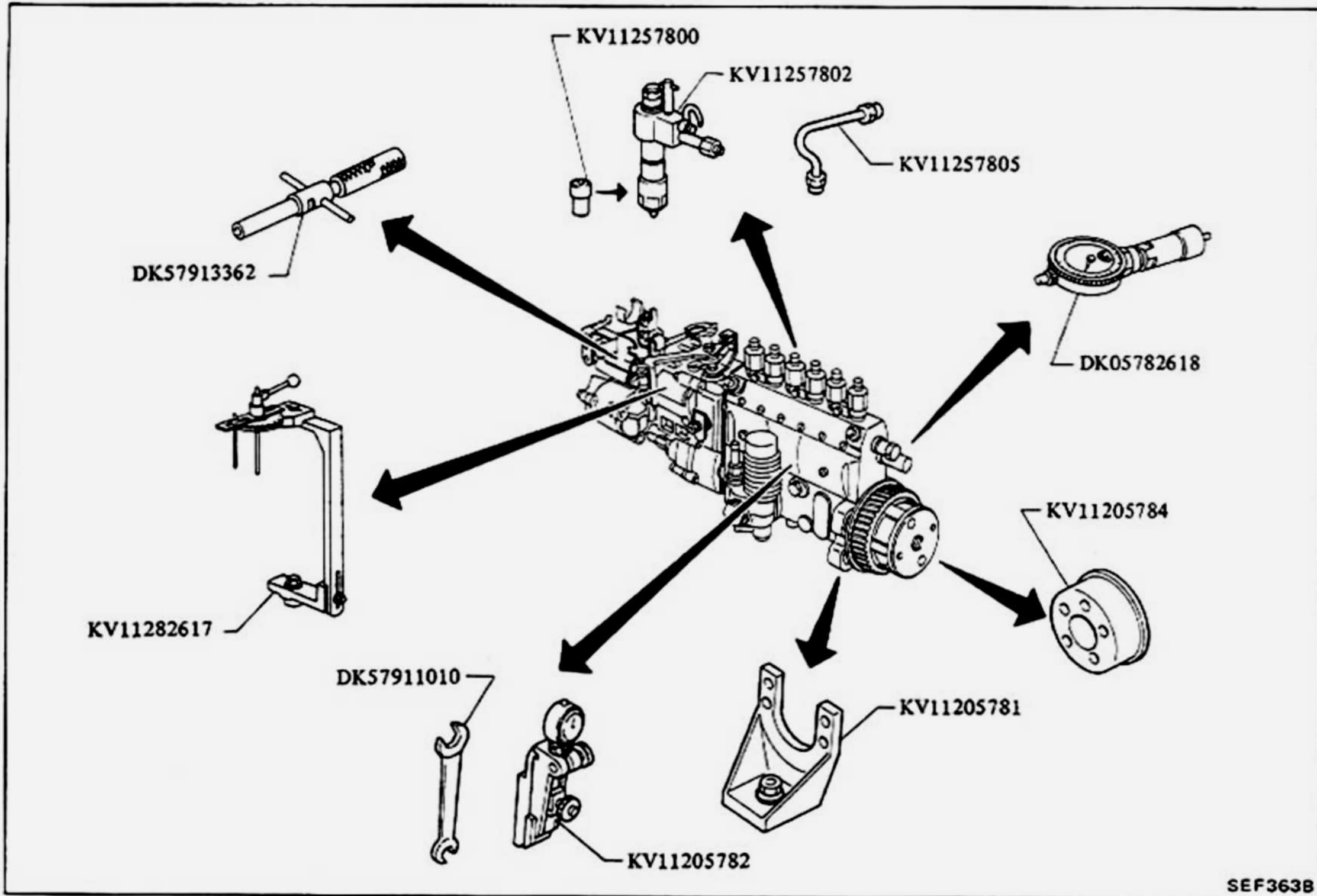
PREPARATION

Injection pump test conditions

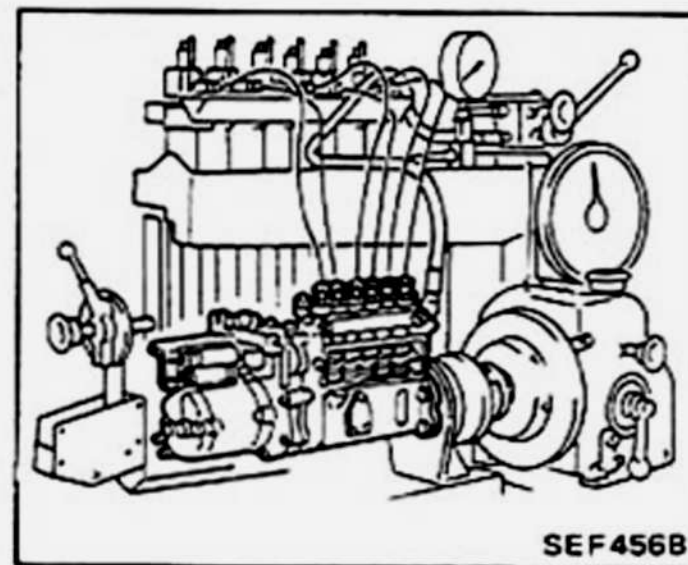
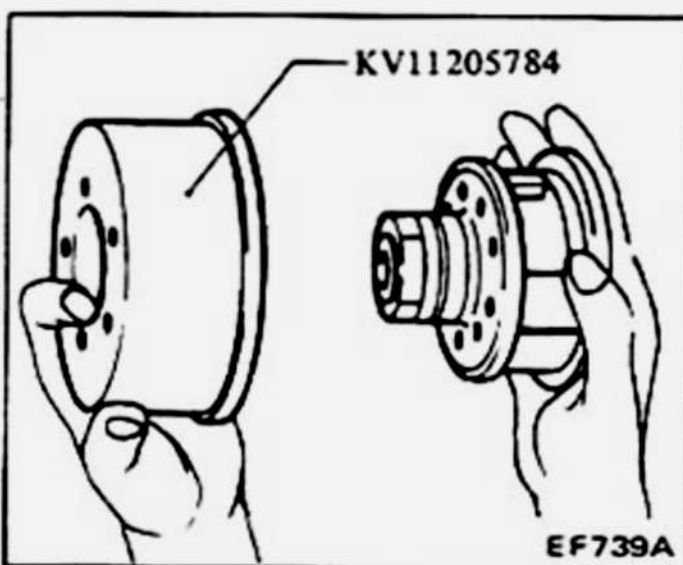
Nozzle	KV11257800
Nozzle holder	KV11257802
Nozzle starting pressure kPa (bar, kg/cm ² , psi)	17,162 (171.6, 175, 2,489)
Nozzle tube Inner dia. x outer dia. x length mm (in)	KV11257805 2.0 x 6.0 x 600 (0.079 x 0.236 x 23.62)
Fuel feed pressure kPa (bar, kg/cm ² , psi)	147 - 157 (1.47 - 1.57, 1.5 - 1.6, 21 - 23)
Fuel (test oil)	ISO 4113 or SAE Standard Test Oil (SAE J967d)
Fuel temperature °C (°F)	40 - 45 (104 - 113)
Rotating direction	Right (observed from the drive shaft)
Injection sequence	1-4-2-6-3-5

INJECTION PUMP ASSEMBLY

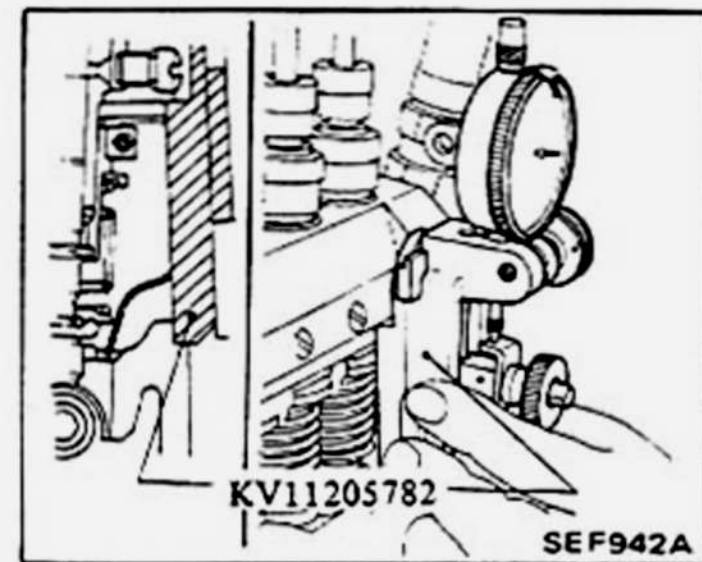
1. Prepare necessary service tools.



2. Remove fuel feed pump and cover plate.
3. Remove timer drive gear and attach coupling.



- (1) Set a Tool to No. 1 cylinder tappet.



7. Remove cap and apply tester dial to camshaft for measurement of rotating angle.
8. Bleed air from injection pump.

ADJUSTMENT

Adjusting injection timing

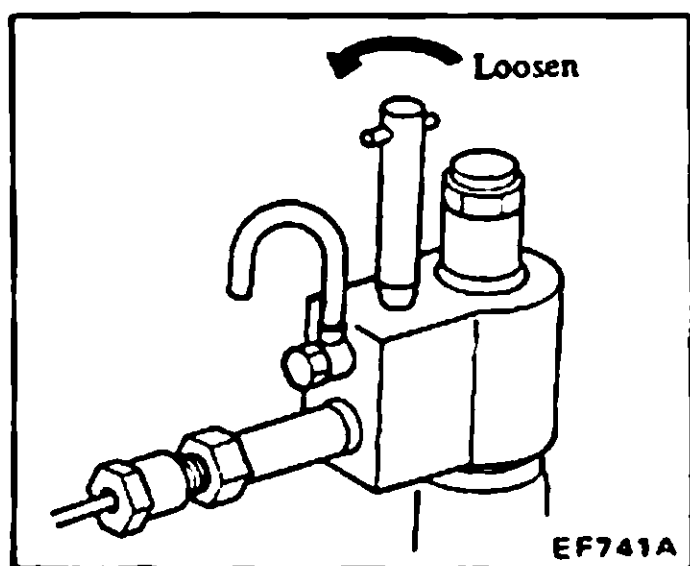
1. Adjust No. 1 injection timing.

- (2) Set No. 1 tappet to bottom dead center (B.D.C.) position and set dial gauge at "0".

4. Install fuel injection pump on the bed of tester with Tool. Then attach pump to timer.
5. Connect coupling to tester drive shaft with coupling disc.
6. Connect flexible hose from tester to nozzle tube on pump.

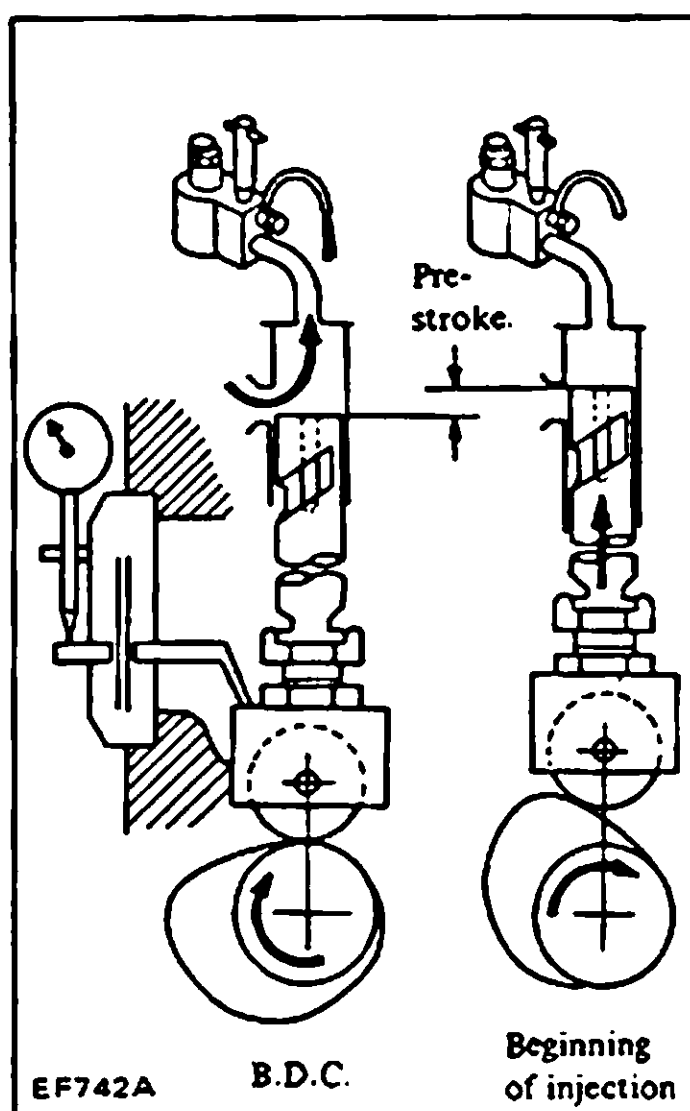
INJECTION PUMP ASSEMBLY

(3) Loosen valve of nozzle holder for testing.



(4) Rotate camshaft (pump tester) clockwise, and measure the lift of 1st plunger when fuel flow from test nozzle stops.

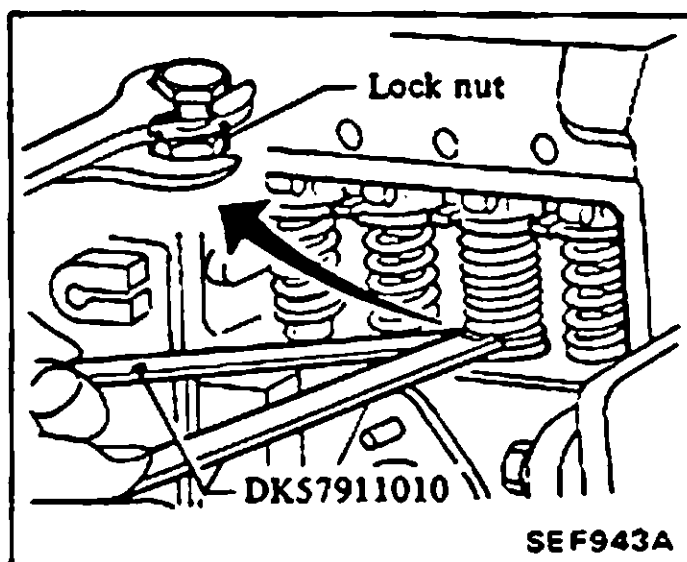
Pre-stroke:
Refer to S.D.S.



2. If pre-stroke is not within specification, adjust injection timing.

- (1) Loosen lock nut of tappet.
- (2) Adjust tappet height by turning adjusting bolt.

- If the pre-stroke is greater than S.D.S., turn adjusting bolt counter-clockwise.
- If the pre-stroke is less than S.D.S., turn adjusting bolt clockwise.



(3) Tighten adjusting bolt lock nut.

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

3. Adjust No. 2 to No. 6 cylinder injection timing.

- (1) Set No. 1 cylinder to injection start timing position, and set angle scale on tester flywheel at "0°".
- (2) Turn tester flywheel to the angle shown below, and make sure that fuel flow from test nozzle stops.

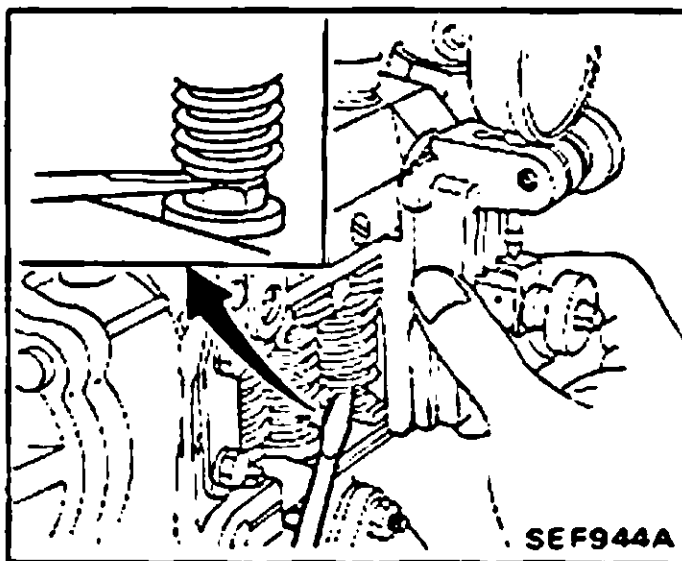
If pre-stroke (injection timing) is incorrect, adjust the timing by following step 2.

Cylinder No.	1	4	2	6	3	5
Injection Starting angle	0	59°30' 60°30'	119°30' 120°30'	179°30' 180°30'	239°30' 240°30'	299°30' 300°30'

4. Check tappet clearance.

- (1) Set camshaft to T.D.C. with setting tool on tappet and then set gauge scale at "0".
- (2) Lift the tappet with a screwdriver and measure tappet top clearance (stroke until the plunger contacts the end of the plunger barrel).

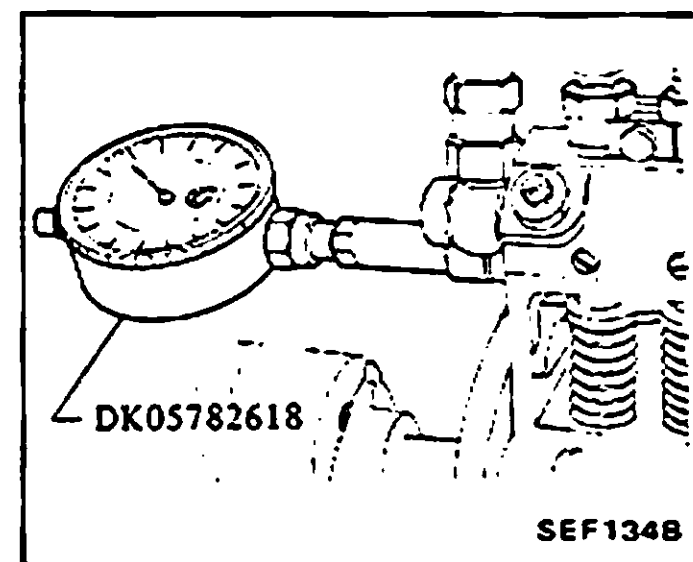
Tappet clearance:
More than
0.30 mm (0.0118 in)



(3) If specified tappet clearance is not obtained, recheck and adjust pre-stroke.

Adjusting injection volume

1. Attach measuring device to driven side of control rack.



2. Bring control lever to idling position and hold it there with adjusting device.

3. Push governor shaft all the way, forward until its forward end touches wall of pump housing. Raise speed to 1,000 pump rpm or slightly above this level. Under this condition determine zero point position of rack.

a. Unless injection pump is rotated at above rotation rate, "0" position cannot be obtained even if front end of control rack is pressed strongly.

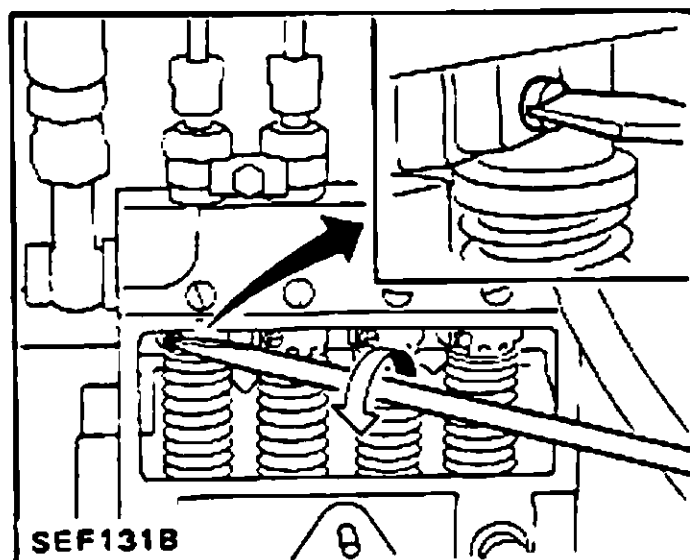
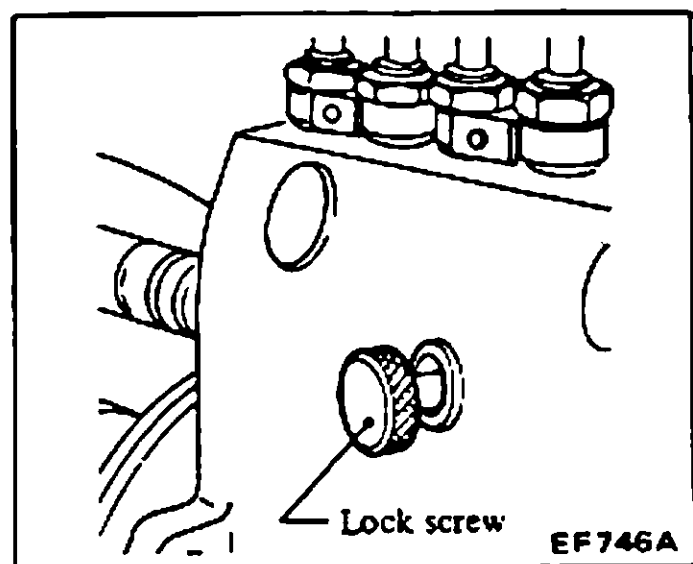
b. if front end of control rack is pushed without rotating injection pump, this may cause damage to links.

INJECTION PUMP ASSEMBLY

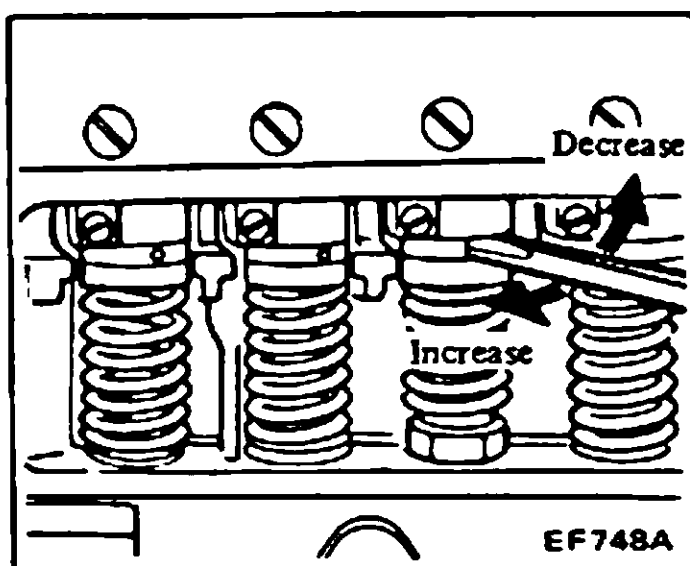
4. Remove control rack guide screw and install lock screw to fix control rack on pump housing.

CAUTION:

Tighten lock screw by hand.



- (2) Place suitable tool into hole in control sleeve and adjust by rotating control sleeve.



- (3) After adjustment is completed, tightly secure pinion set screw.
- (4) Remove lock screw from control rack and reinstall guide screw.

GOVERNOR

Adjustment

The following adjustment tests must be carried out.

1. Adjustment of injection timing and injection quantity of the injection pump
2. Setting the ZERO point of control rack
3. Idling adjustment
4. Adjustment of governor spring contact
5. Setting the full-load position of control rack
6. Checking the maximum controlled speed
7. Checking the idling speed limit for warm-up run

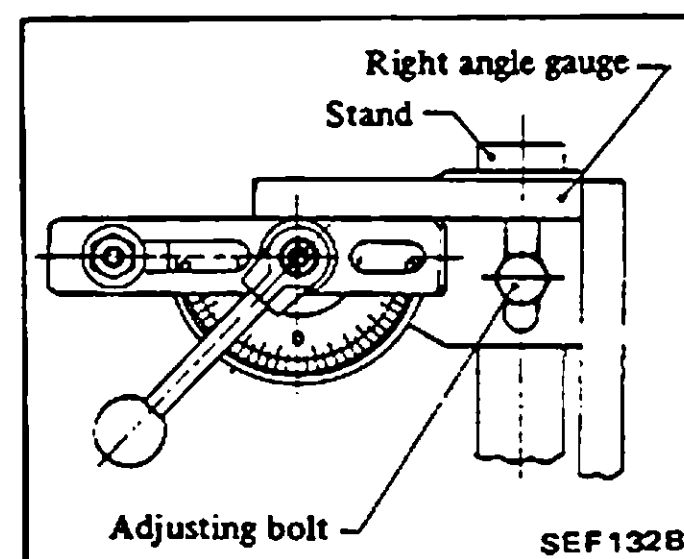
PREPARATION

Before adjusting the governor, the following preparations must be made:

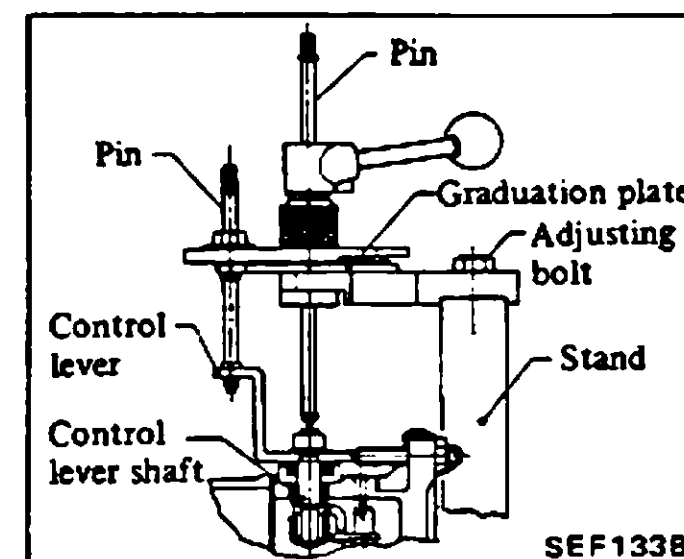
1. Add a prescribed amount of lubricating oil to governor room and cam room of injection pump.
2. Run in tester. After run-in operation, check to be sure that governor operates satisfactorily.
3. Before adjustment, lock nuts for idling spring and governor shaft are removed.
4. Full speed set bolt, idle set bolt and full load set bolt are loosened beforehand.
5. Remove boost compensator.

Setting the zero degree point of adjusting device

1. Referring to figure showing the top view of the adjusting device, set the angular scale in the position shown, truing it with the square, and tighten the lock nut below the lever.



2. Align the center pin of the adjusting device to the axis of control lever shaft. This is accomplished by displacing the scale-carrying top part of the device.



5. Set fuel feed pressure.

Fuel feed pressure:

147 - 157 kPa (1.47 - 1.57 bar,
1.5 - 1.6 kg/cm², 21 - 23 psi)

6. (1) Measure injection volume for each cylinder at rated pump speed and control rack position.

Injection volume:

Refer to S.D.S.

- (2) Compute allowable unbalance of fuel injection volume.

Allowable unbalance =

$$\frac{\left(\begin{array}{c} \text{Max. or min.} \\ \text{injection vol-} \\ \text{ume for each} \\ \text{plunger} \end{array} \right) - \left(\begin{array}{c} \text{Main} \\ \text{injection} \\ \text{volume} \end{array} \right)}{\text{Mean injection volume}} \times 100$$

Allowable unbalance:

Refer to S.D.S.

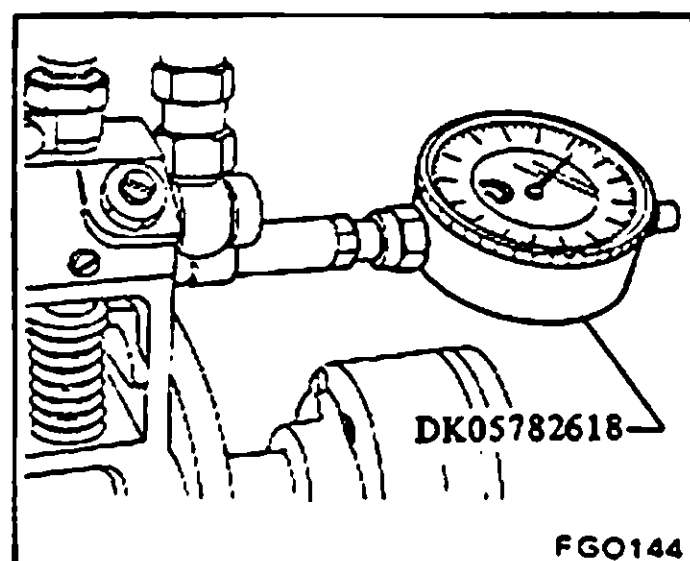
7. Adjust injection volume so that specified injection volume and allowable unbalance is obtained.

- (1) Loosen control pinion clamp screw.

INJECTION PUMP ASSEMBLY

Setting zero point position of control rack

1. Attach measuring device to driven side of control rack.



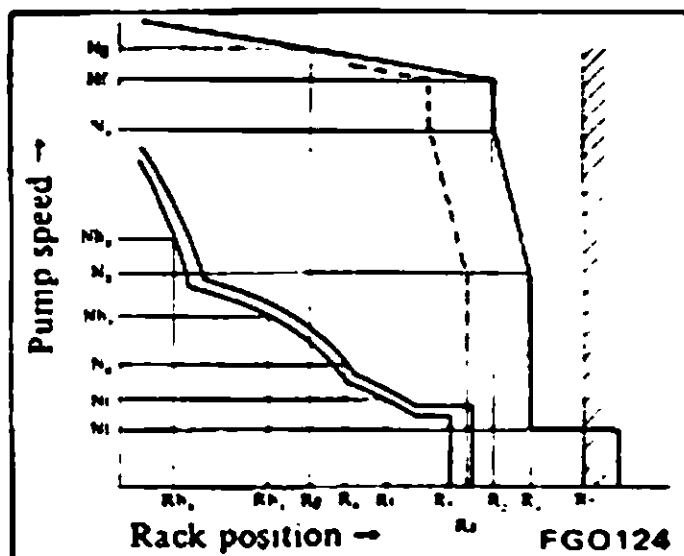
2. Bring control lever to idling position and hold it there with adjusting device.
3. Push governor shaft all the way, forward until its forward end touches wall of pump housing. Raise speed to 1,000 pump rpm or slightly above this level. Under this condition determine zero point position of rack.

- a. Unless injection pump is rotated at above rotation rate, "0" position cannot be obtained even if front end of control rack is pressed strongly.
- b. If front end of control rack is pushed without rotating injection pump, this may cause damage to links.

Precaution for adjustment of governor

1. Fixing control rack

In fixing control rack when adjusting injection quantity of injection pump, control lever is fixed to the idling position, injection pump is accelerated to above 500 rpm, control lever is manipulated to the full speed position, the control rack position is assigned to the full-load position + about 3 mm (0.12 in) by full-load stopper, and control rack is controlled, to be fixed to each control rack position to obtain injection quantity.

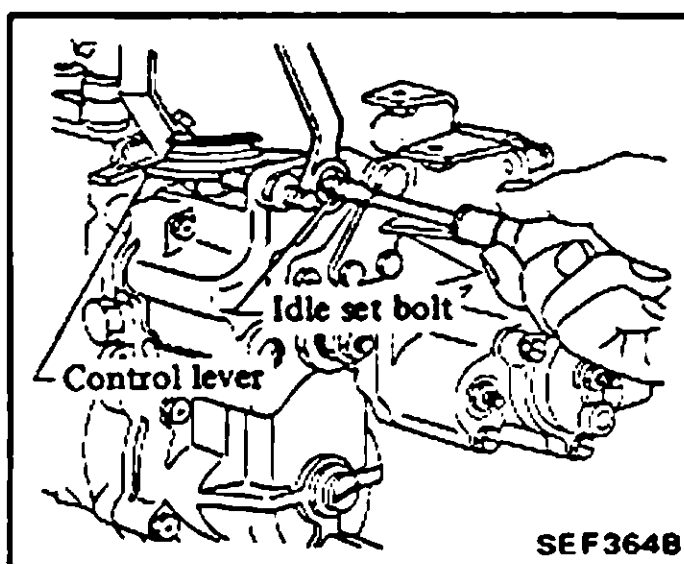
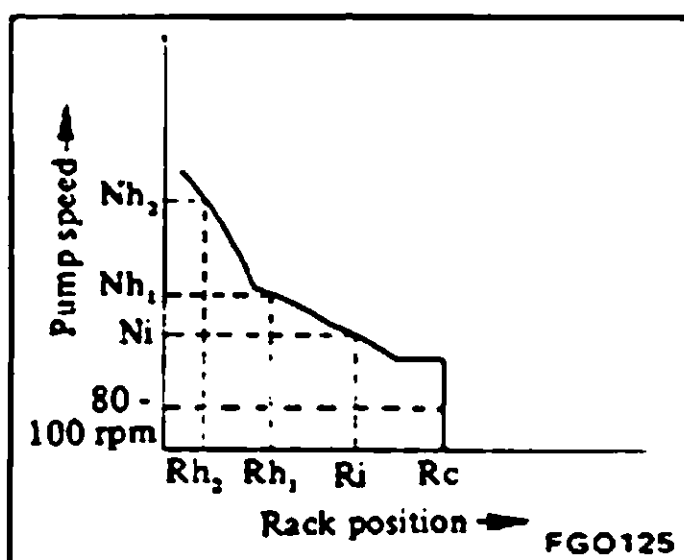


2. Method of operating control lever
In operating control lever to the full speed position, this operation should be conducted after pump speed is increased to above 500 rpm at the idling lever position.
3. Always fix adjusting nut for adjusting torque cam with lock screw.

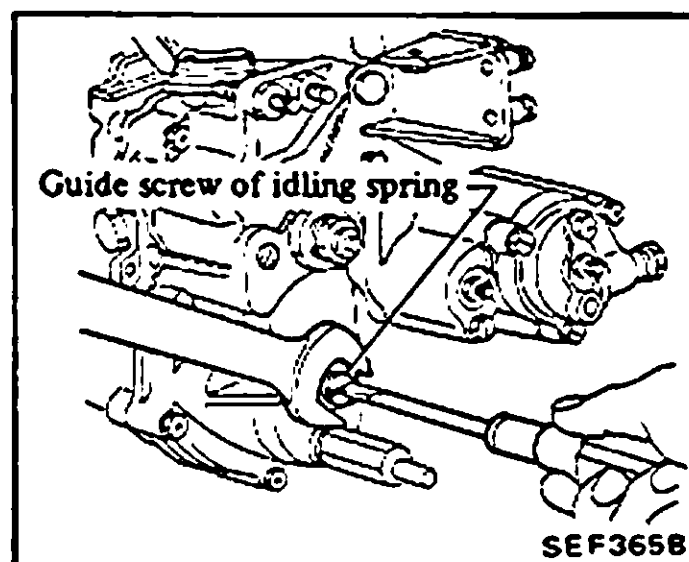
Adjustment of idling spring

1. Adjustment of idling lever position

Control lever is fixed to the position where it comes in contact with idle stopper bolt, and length of projection of idle stopper bolt is adjusted so that control rack position R_c may be obtained at a pump speed of $N = 80$ to 100 rpm, and this length is fixed.



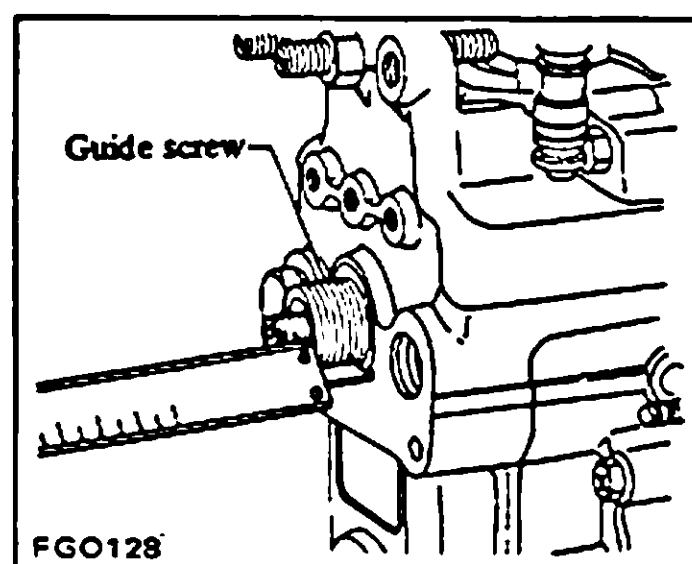
2. Adjustment of idling rack position
Guide screw of idling spring is adjusted so that the control rack position R_i may be obtained at the prescribed pump speed N_i in such state that control lever is fixed to the idling stopper bolt position. Then, guide screw of idling spring is fixed.



In case the specified control rack position can not be obtained, idle spring assembly must be replaced.

Adjustment of governor spring contact

1. Projection L_2 from governor cover end surface to guide screw of governor shaft is adjusted so as to be 14 ± 0.5 mm (0.55 ± 0.020 in) and guide screw is fixed by lock nut.



If this L_2 is out of specification, following inconvenience may arise.

If L_2 is too large: -

Governor shaft will extend too little, and will prevent double nut from performing its adjusting purpose easily.

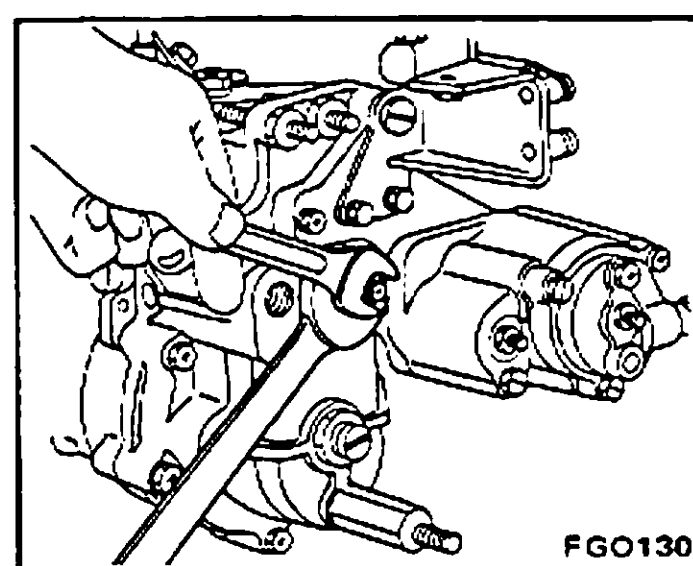
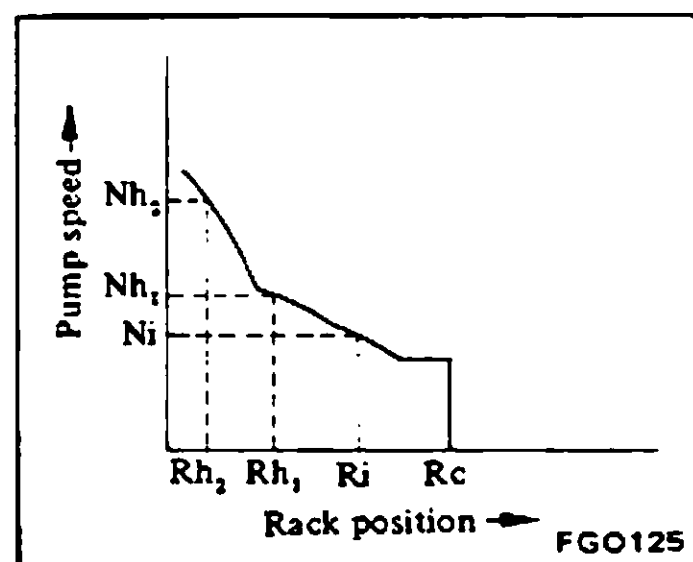
If L_2 is too small:

Guide screw will push on spring seat too hard, and will prevent flyweight from running to full-lift position.

INJECTION PUMP ASSEMBLY

2. Control lever is fixed to the position where it comes in contact with idle stopper bolt with adjusting device, and double nut of governor shaft is adjusted so that control rack positions R_{h1} and R_{h2} may be obtained in N_{h1} and N_{h2} , and the double nut is fixed.

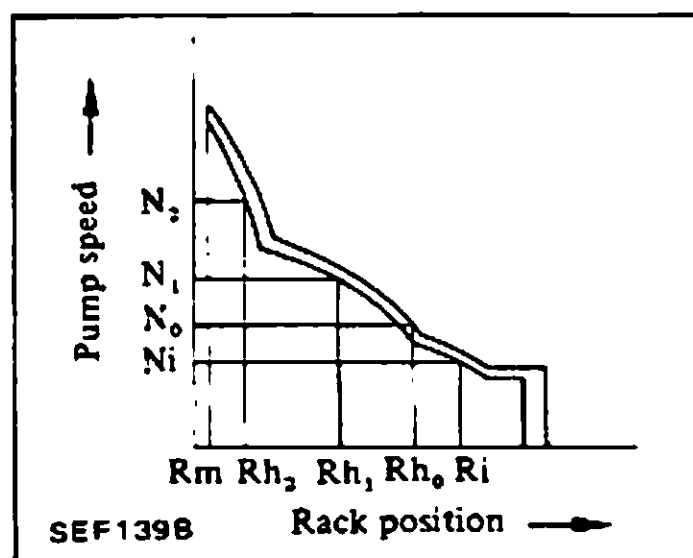
After adjusting double nut, increase the pump speed and confirm that control rack is at "0" position.



3. After adjusting contact of governor spring, mount gasket and cap nut to guide screw.

Idle adjustment

1. Fix control lever at the position where it comes in contact with idle set bolt so that control rack position R_0 may be obtained at pump speed N_0 .

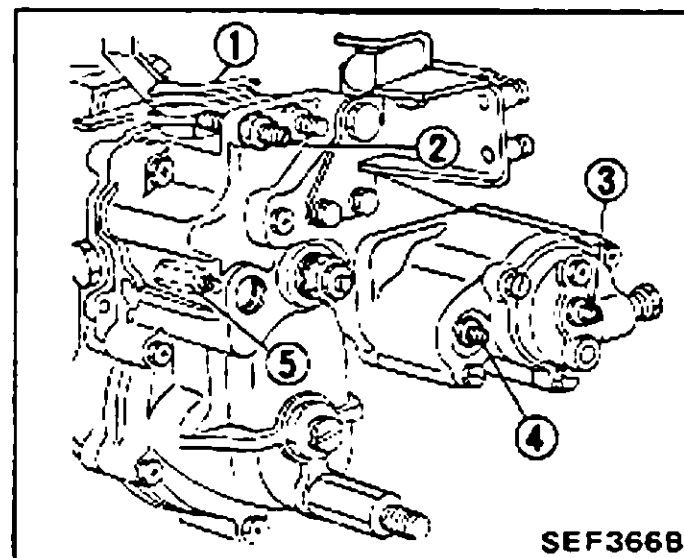
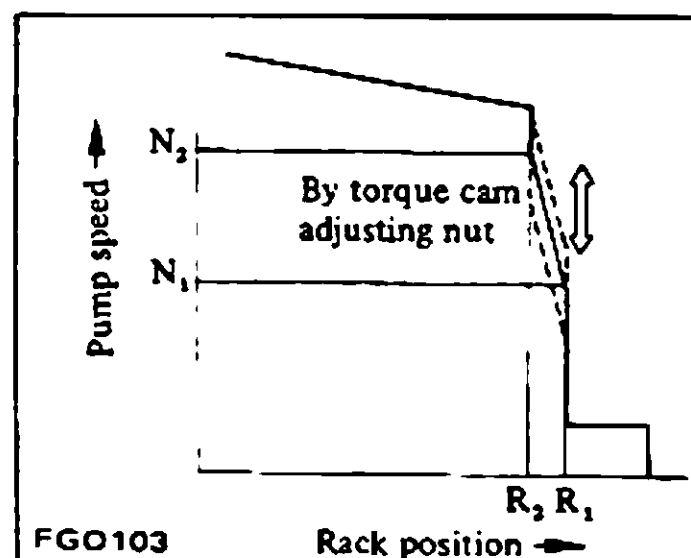
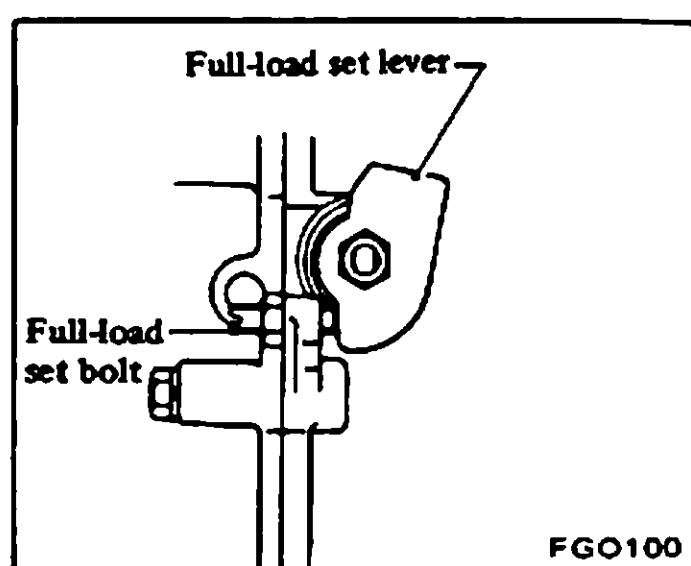
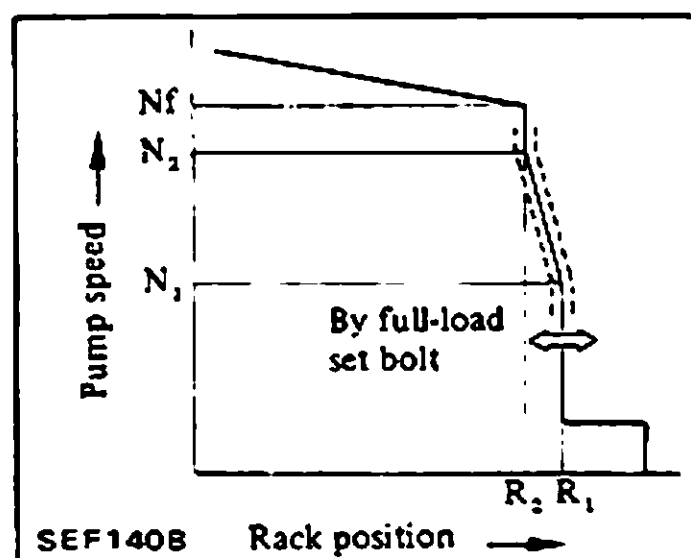


2. Increase the pump speed and confirm that control rack position R_m is obtained.

Adjustment of full-load rack position

1. Adjust control lever until it contacts full-speed stopper bolt. With pump running at specified rpm " N_f ", temporarily adjust full-speed stopper bolt so that pump speed is before the "governing" range.

Adjust full-load setscrew and torque cam adjusting nut using Tool DK57913362 so that control rack positions " R_1 " and " R_2 " are reached with pump running at speeds " N_1 " and " N_2 ", respectively.



- 1 Control lever
- 2 Full speed set bolt
- 3 Full load set bolt
- 4 Setscrew
- 5 Torque cam adjusting nut

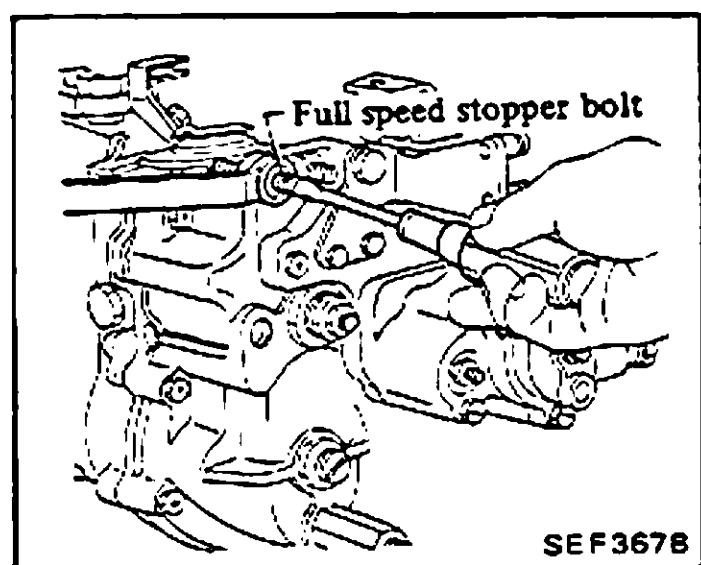
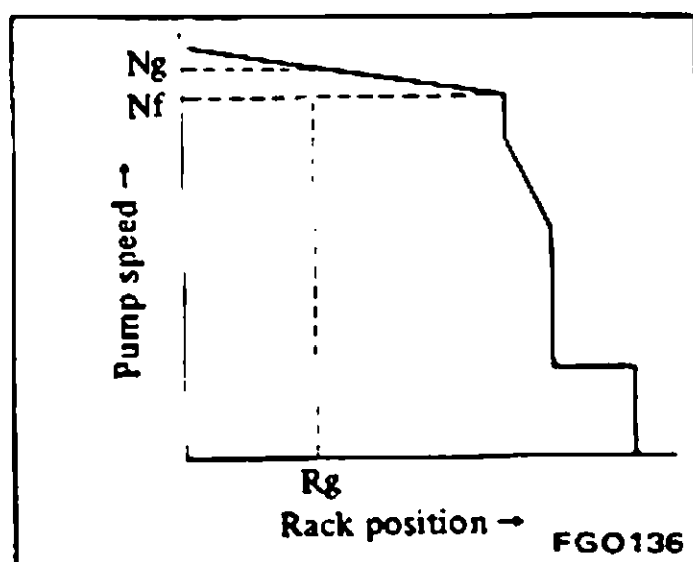
2. The works of the above step 1 are alternately carried out in order to obtain the prescribed governor performance characteristic diagram, by adjusting the torque cam and the full load stopper bolt.

If the above adjustment is not conducted completely, the prescribed injection volume cannot be obtained and this may cause the deficit in the output of the engine or the emission of black smoke.

INJECTION PUMP ASSEMBLY

HIGH SPEED CONTROL ADJUSTMENT

1. Fix control lever to position where it comes in contact with full speed stopper bolt and adjust full speed stopper bolt so that high speed governor control may start at prescribed pump speed N_f , and fix full speed stopper bolt.



2. Confirm that operating angle of control lever is in the prescribed range using the adjusting device.

3. Increase pump speed and confirm that control rack position R_g is obtained at the prescribed speed N_g .

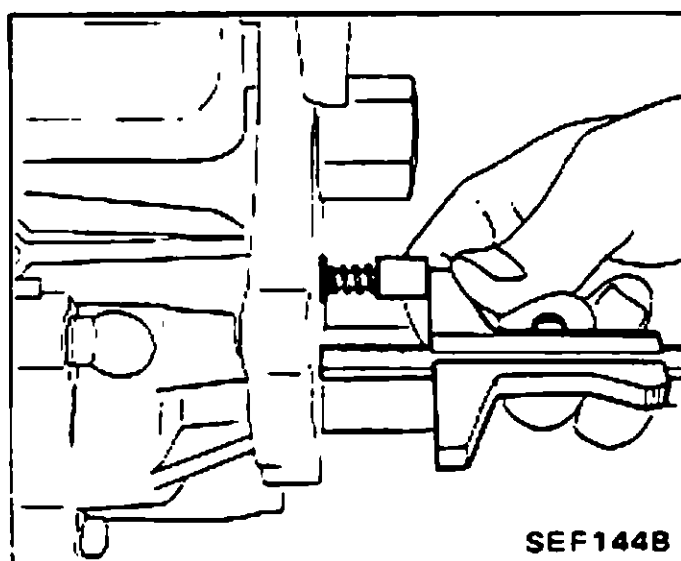
4. Increase pump speed further and confirm that control rack position R_n is obtained.

If the speed droop does not reach governor performance curve, replace governor spring because governor spring is considered to have deteriorated.

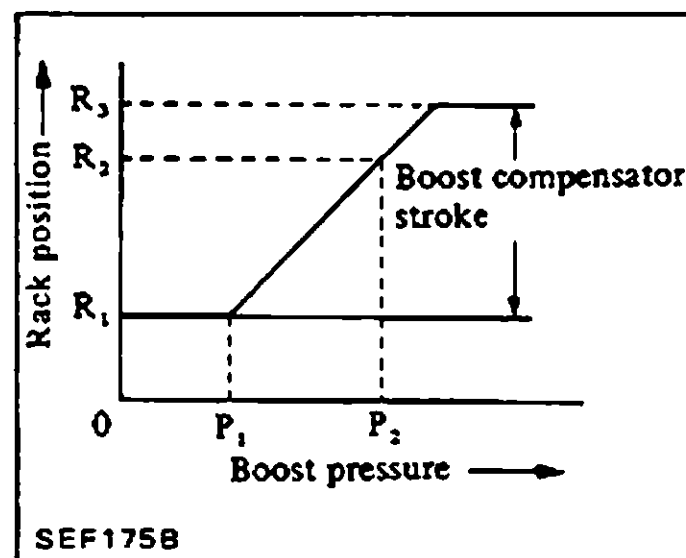
ADJUSTMENT OF BOOST COMPENSATOR

1. Run injection pump at 500 rpm and set control lever at the full position.

2. When specified control rack position is obtained, confirm that distance "L" between tip end of push rod B and end face of spacer is 19.5 ± 0.1 mm (0.768 ± 0.004 in). If it is outside specified range, governor cannot be adjusted properly or push rod B may not be of proper specifications.



3. Install boost compensator assembly while there is no booster pressure, and adjust setscrew so that specified rack position is obtained. In other words, move rack position from R_3 to R_1 .



4. Gradually increase (do not decrease) boost pressure inside boost compensator chamber. Check to make sure that when boost pressure reaches specified pressure indicated on performance curve, the specified rack position is obtained. If it is not, remove boost compensator assembly and disassemble it and adjust amount of guide screw's stroke length.

When viewed from boost compensator lever side, guide screw can be tightened two and a half (2-1/2) rotations from its fully back-off position.

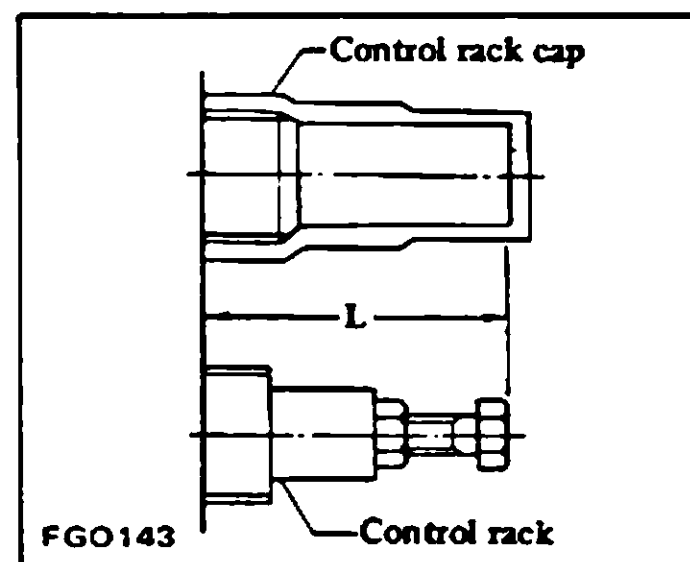
Do not attempt to tighten guide screw more than two and a half rotations because this results in a reduction in engagement with lock nut.

After rack position adjustment, confirm that rack position is correct as described in step 2. above.

ADJUSTING CONTROL RACK LIMITER

Stop the pump and fix the control rack at the rack limit position. Then remove the control rack measuring device.

After that, adjust the distance between the pump end surface and the bolt head end so that it is the same as the depth of the control rack cap, then fix the lock nut.



FEED PUMP

After installing feed pump, bleed air from system.

TEST

Standard fuel feed volume

The volume of fuel displaced by the feed pump is more than 300 ml (10.6 Imp fl oz) for each 15 seconds at 1,000 rpm.

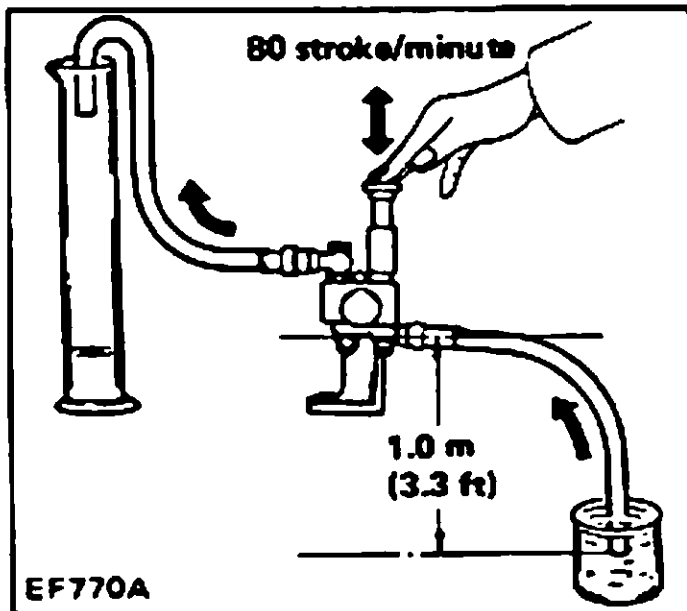
The discharge pressure is more than 157 kPa (1.57 bar, 1.6 kg/cm², 23 psi) per 30 seconds at 600 rpm.

Pump performance test

1. Connect a pipe to intake side of feed pump, and set pump so that fuel can be sucked up from fuel level 1.0 m (3.3 ft) below the pump.

INJECTION PUMP ASSEMBLY

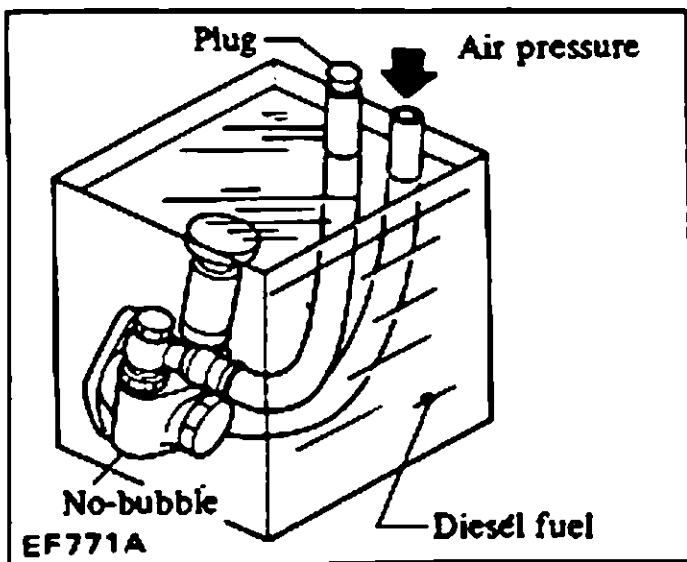
2. Operate priming pump at 80 strokes per minute, and make sure that fuel can be sucked up within 1 minute.



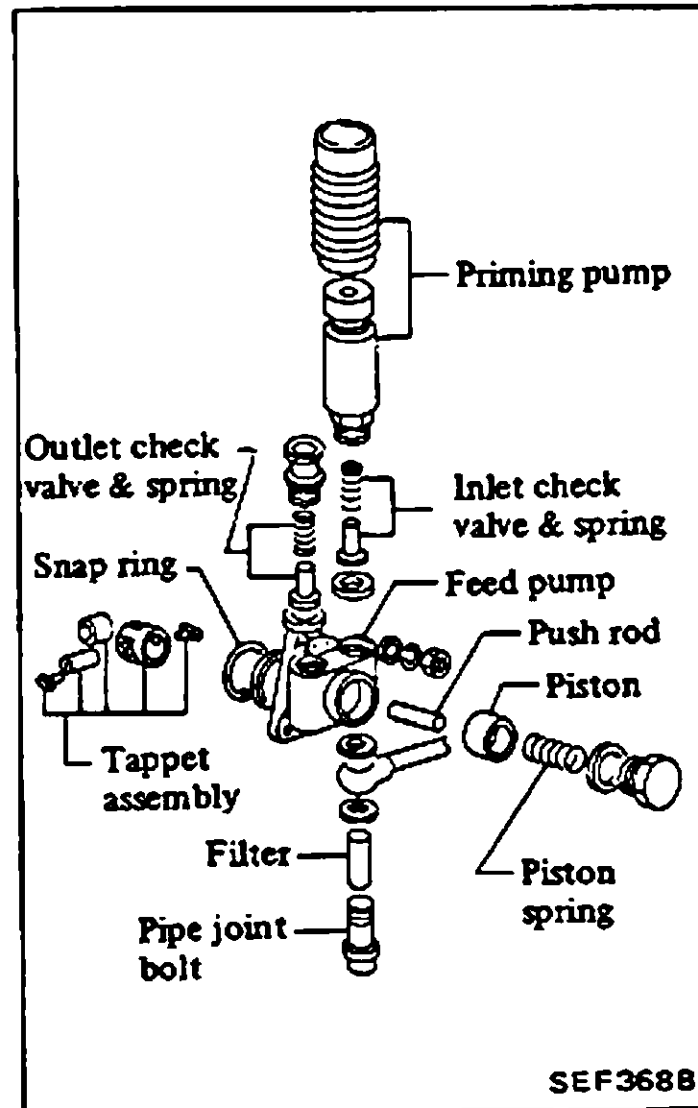
Air-tightness test

1. Stop up fuel feed pump discharge port and apply 147 to 196 kPa (1.47 to 1.96 bar, 1.5 to 2.0 kg/cm², 21 to 28 psi) of air pressure to intake side of pump.
2. Immerse pump in kerosene (light oil) and make sure that no air leaks from any of pump connections. If bubbles larger than one grain come from fuel feed pump housing or push rod joint continuously, replace oil seal at push rod or push rod.

Replace feed pump assembly, if necessary.



INSPECTION



Feed pump housing

1. Check check valve seats. If they are damaged or excessively worn, replace housing.
2. Check push rod hole. If hole is excessively worn, replace housing.

Check valve and check valve spring

1. If seat of check valve is excessively worn or scarred, replace check valve with a new one.
2. If check valve spring is damaged or permanently stressed, replace valve spring.

Piston and piston spring

1. If periphery of piston is excessively worn or scarred, replace piston with a new one.
2. If piston spring is damaged or weakened, replace valve spring.

Tappet assembly

1. Tappet

If periphery of tappet is worn or scarred, replace it with a new one.

2. Tappet roller

If periphery of tappet roller is excessively worn or scarred, replace it with a new one.

Roller to pin clearance:

Limit

0.30 mm (0.0118 in)

Tappet roller outside diameter:

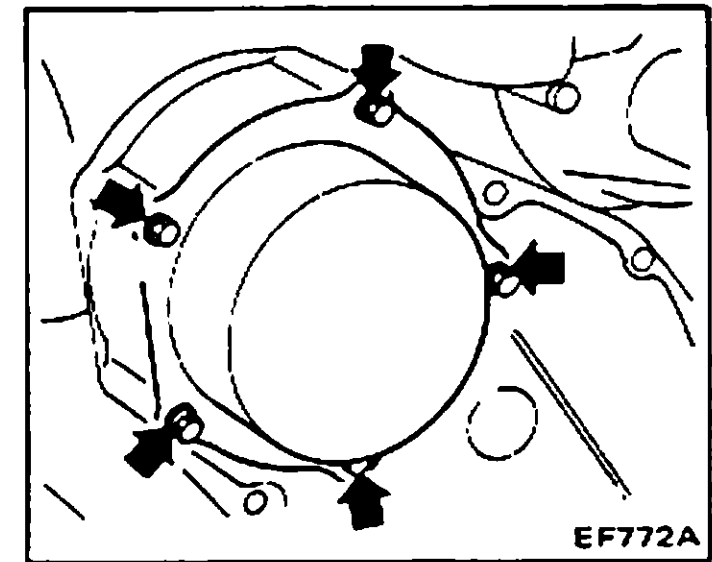
Wear limit

14.9 mm (0.587 in)

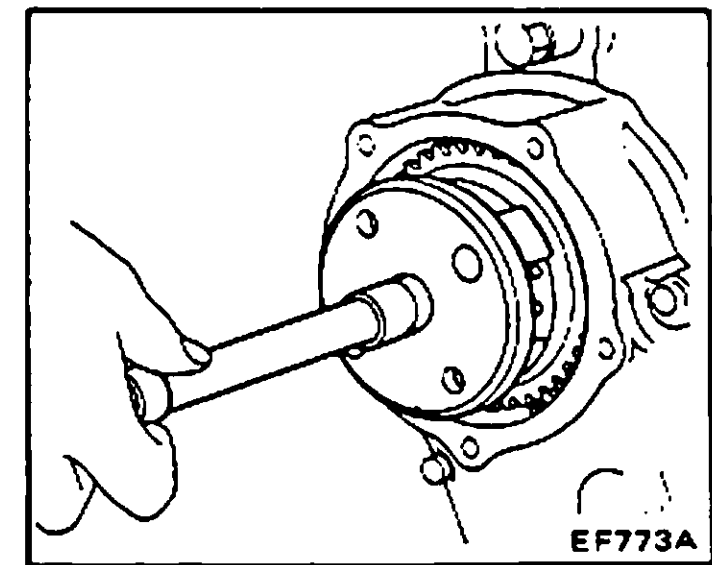
TIMER

REMOVAL

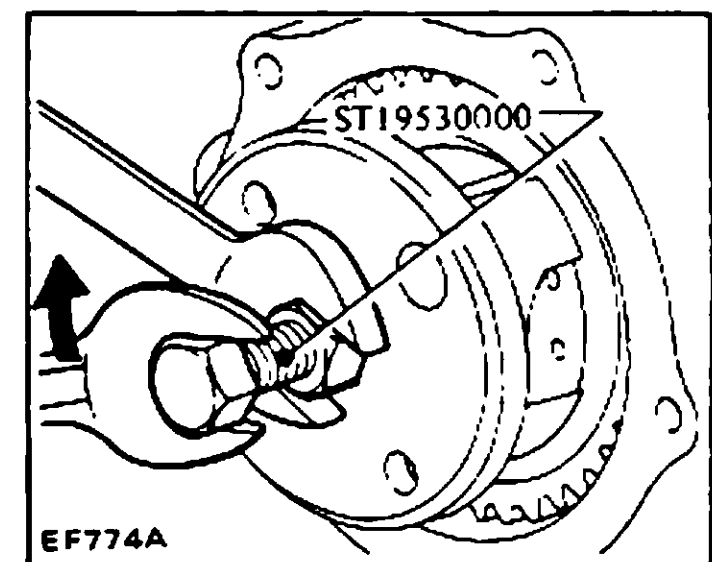
1. Remove timing gear cover.



2. Remove timer round nut.



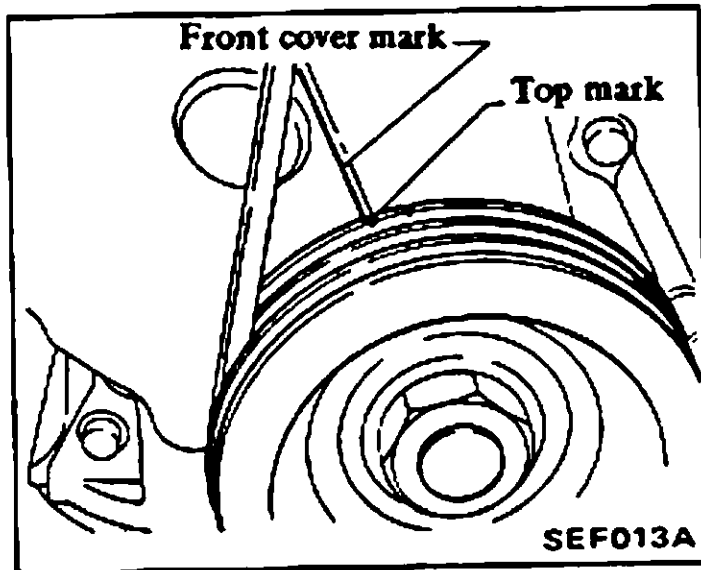
3. Remove timer assembly by threading in Tool.



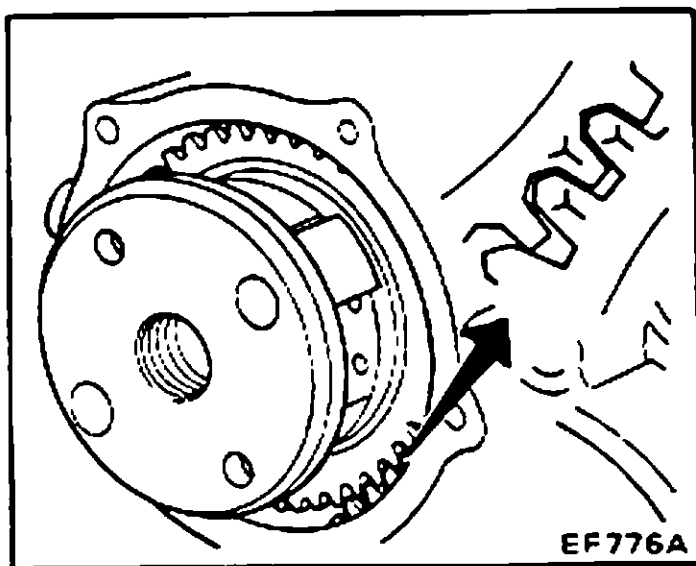
INJECTION PUMP ASSEMBLY

INSTALLATION

1. Align crank pulley and front cover marks so that No. 1 piston is at top dead center.



2. Mesh injection pump drive gear with idler gear at Y-mark, and then align gear to key way of injection pump camshaft while turning crank pulley.



3. Secure timer assembly with lock washer and round nut.

Ⓓ : Round nut:

59 - 69 N·m

(6 - 7 kg-m, 43 - 51 ft-lb)

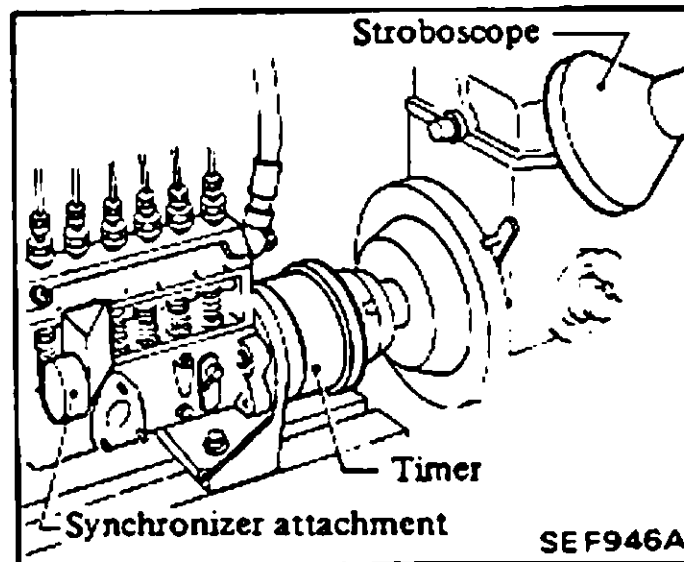
4. Install timing gear cover with new gasket sealed.

ADJUSTMENT

1. Install stroboscope, using cover plate bolts, so that synchronizer lever attachment is applied to tappet.
2. Operate fuel injection pump, turn "ON" switch of stroboscope illuminating dial (angle scale) on flywheel, and measure angular change based on variations in pump speed.

If tester does not have a dial (angle scale):

- (1) Attach a dial to timer coupling and mount a pointer on tester drive shaft.
- (2) Operate fuel injection pump and turn stroboscope "ON" so as to illuminate dial.

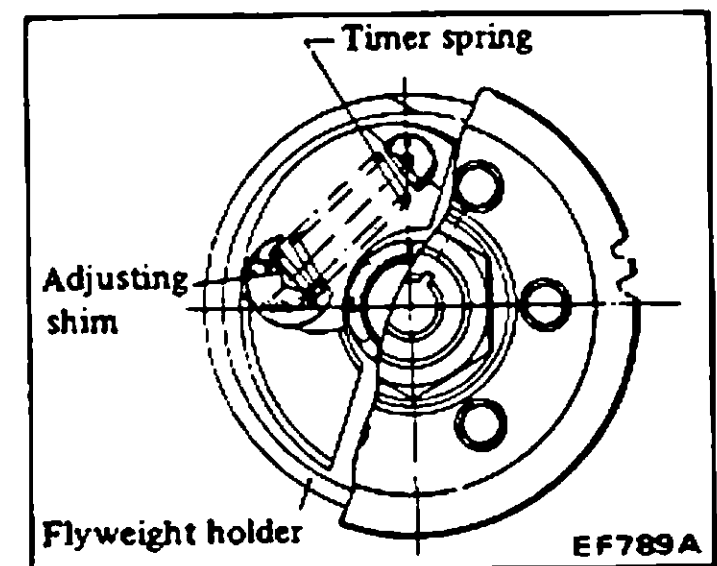


3. If advance angle is not within specified range, adjust by changing timer spring shims.

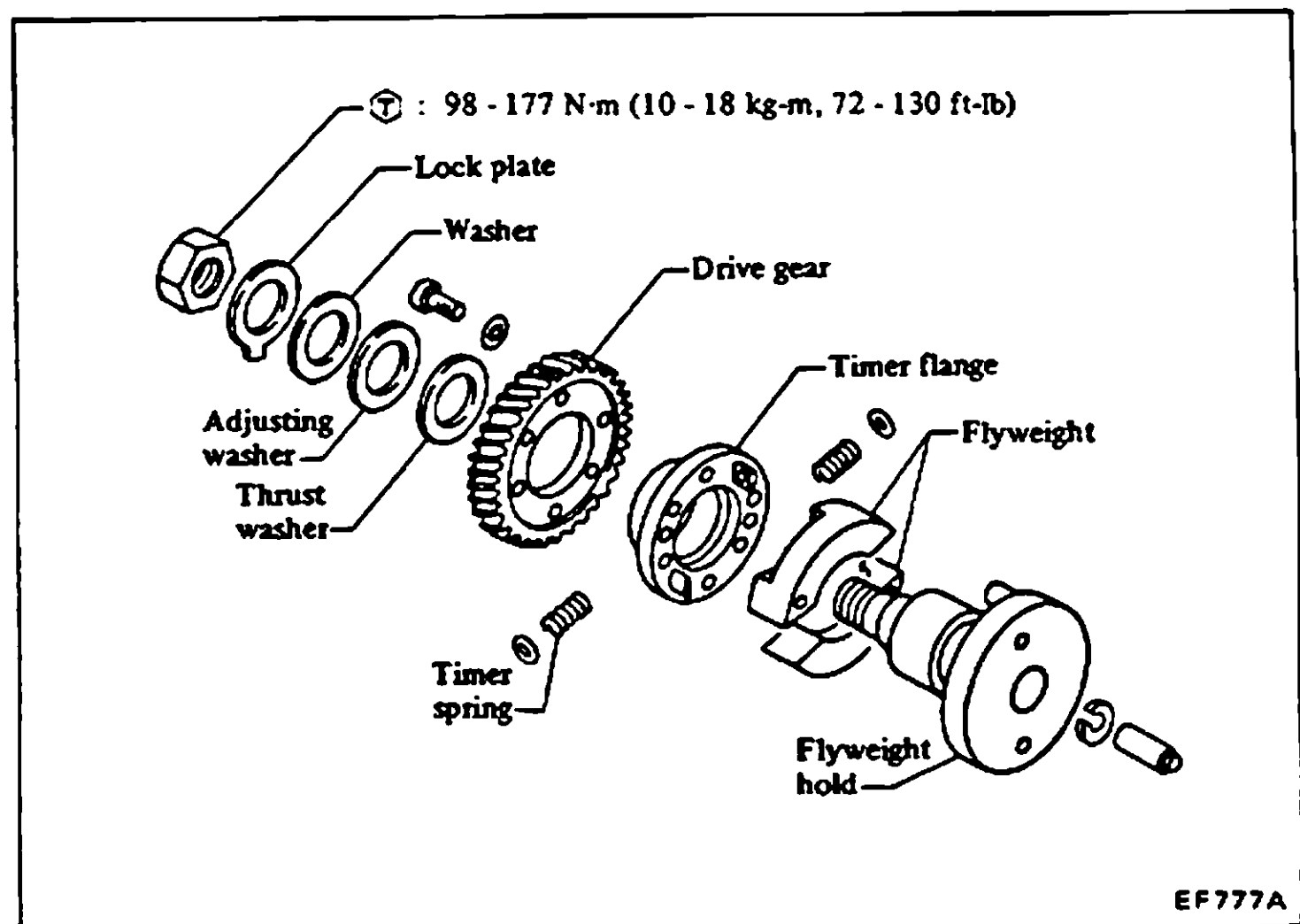
- a. When injection timing is retarded, decrease shim thickness.
- b. When injection timing is advanced, increase shim thickness.

Timer advance curve:

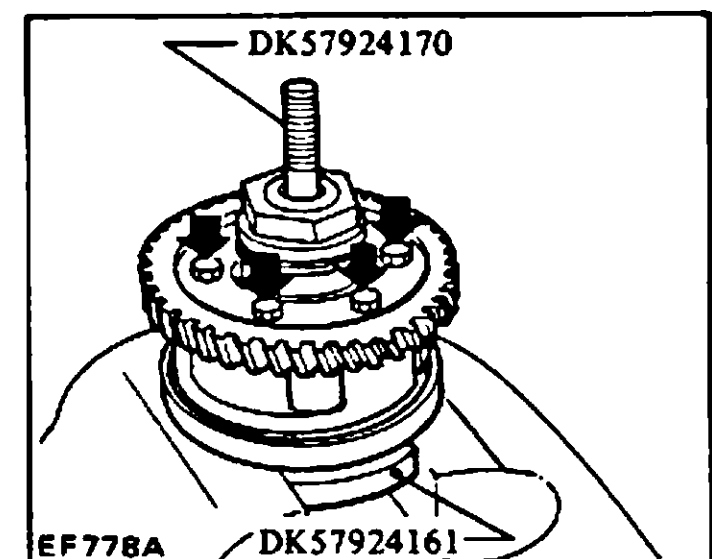
Refer to S.D.S.



DISASSEMBLY

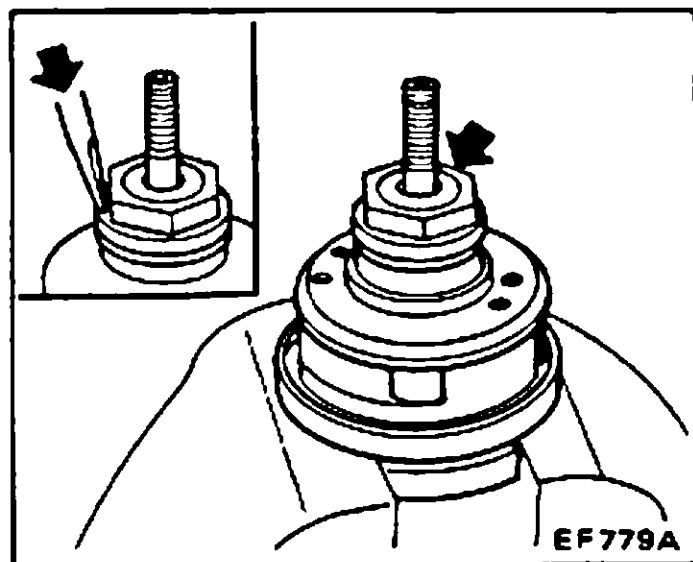


1. Place timer assembly on Tools with flyweight holder hole positioned on base pin.
2. Remove injection pump drive gear.

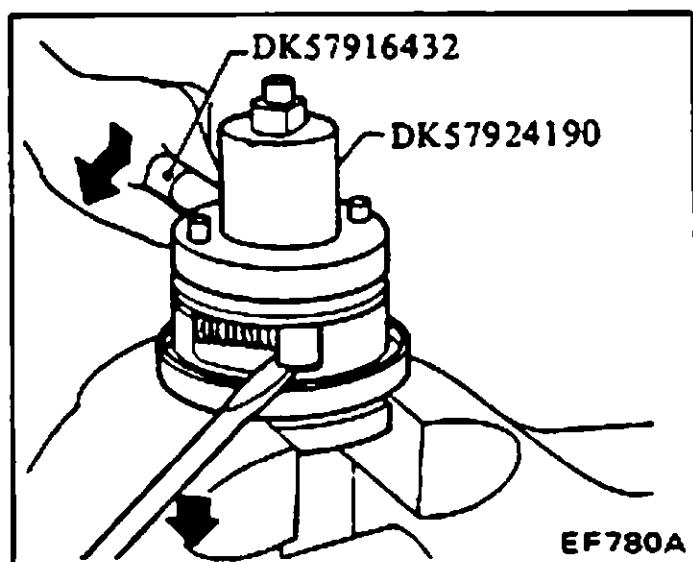


INJECTION PUMP ASSEMBLY

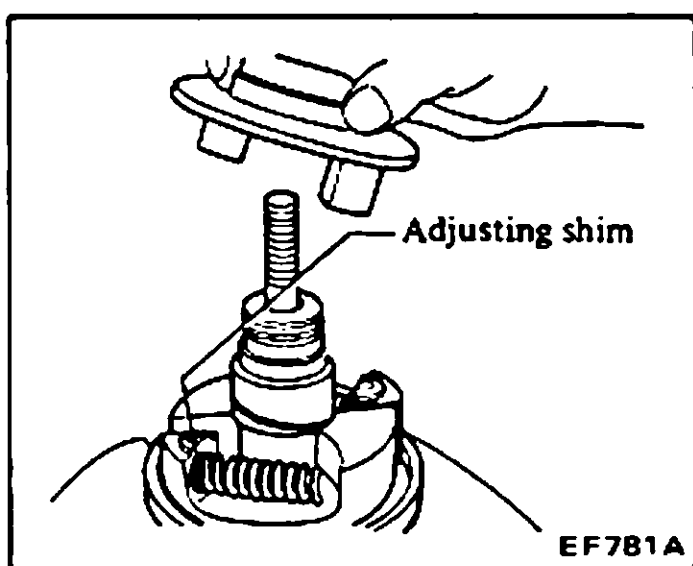
3. Remove nut, lock washer, lock plate, adjusting shim and thrust washer after unbending lock washer.



4. Remove timer flange by prying with lever while pressing spring with Tool DK57916432.



5. Remove timer spring, adjusting shim and flyweight.

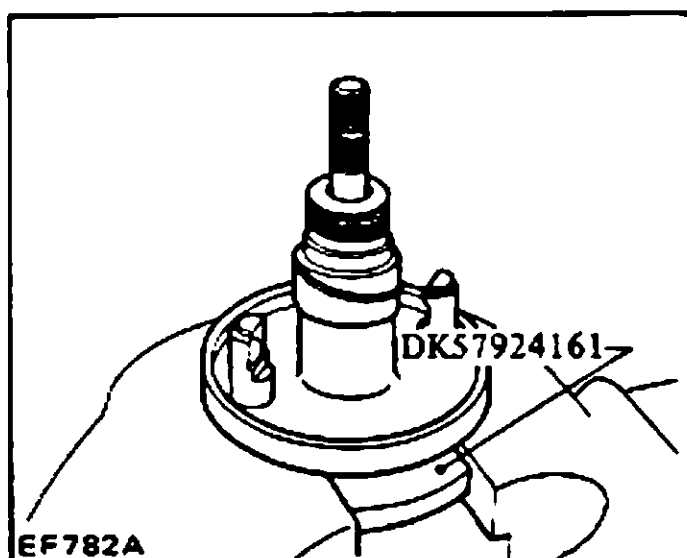


INSPECTION

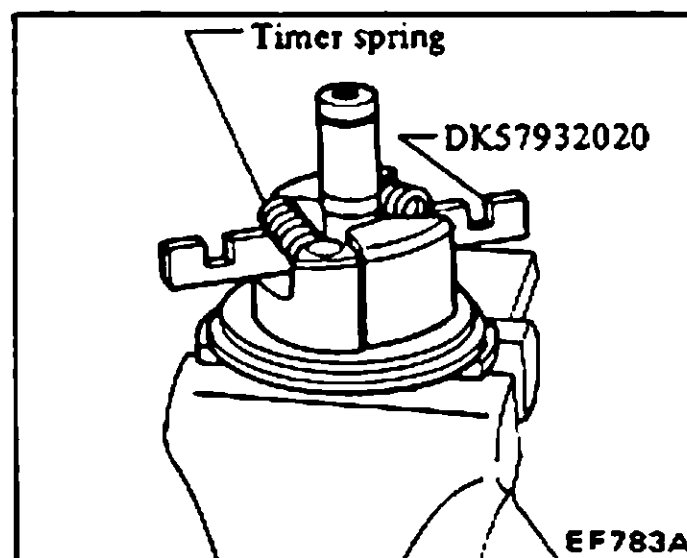
Check all parts for wear or damage.

ASSEMBLY

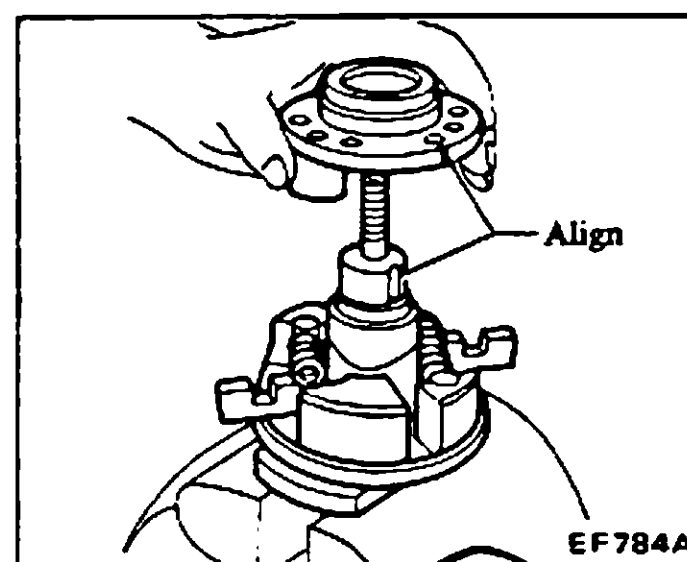
1. Set flyweight holder on Tools with flyweight holder pin hole positioned on base pin.



2. Apply grease to flyweight holder pin and flyweight holder hole.
3. Install flyweight and insert Tool under timer spring, positioning spring on flyweight.

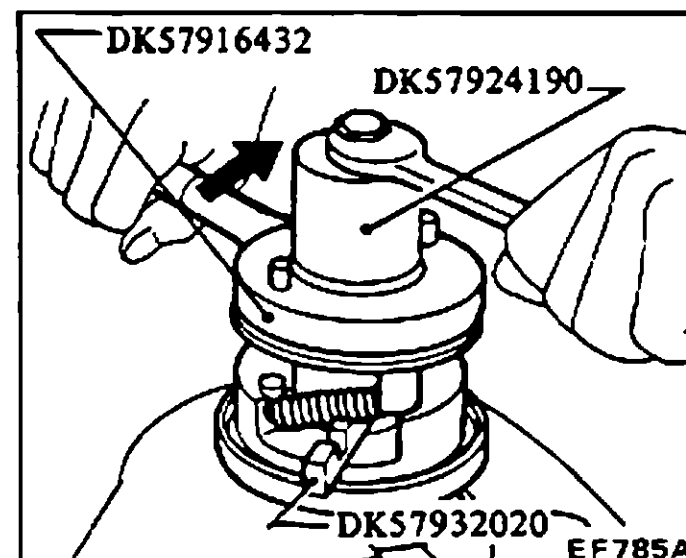


4. Insert suitable adjusting shim into hole at pin part of timer flange.
5. Cover timer flange to flyweight holder by matching notch of flange and key groove of flyweight holder.



6.

- (1) Turn Tool DK57916432 in direction to compress timer spring, thread in Tool DK57924190, and then remove Tool DK57932020.



- (2) Using a lever, insert timer spring into flange hole, thread in Tool DK57924190 all the way and install flange in its proper position.

Make sure that spring is fully seated in holes in flange and flyweight holder.

7. Adjust flyweight holder and flange clearance.

- (1) Install thrust washer, lock plate and adjusting shims, and completely tighten them with nut.

Ⓙ : Nut

98 - 177 N·m

(10 - 18 kg-m,

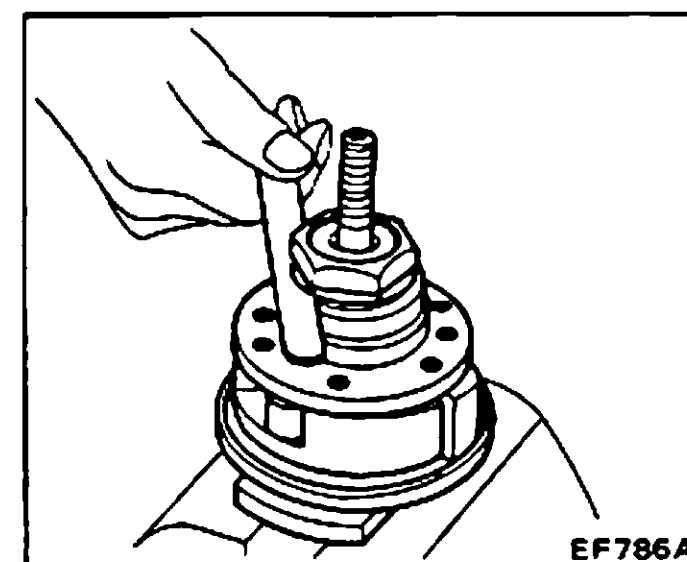
72 - 130 ft-lb)

Lock plate and thrust washer clearance:

0.02 - 0.10 mm

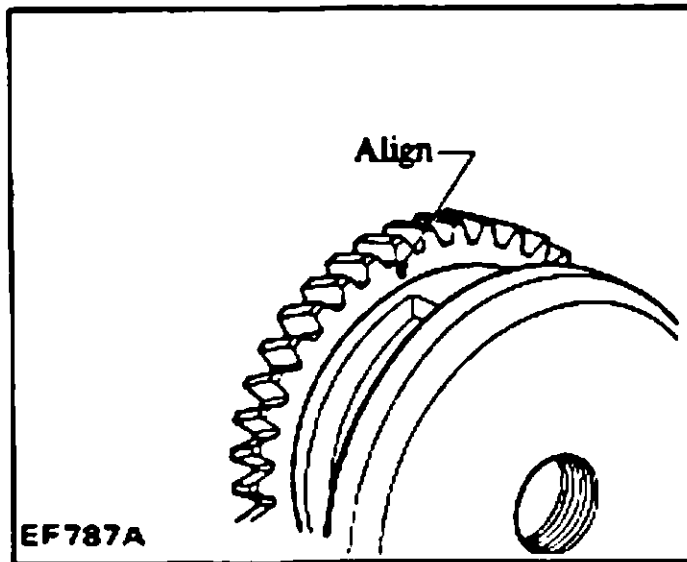
(0.0008 - 0.0039 in)

- (2) Measure lock plate and thrust washer clearance. If the clearance is not within specifications, adjust with adjusting shim.



INJECTION PUMP ASSEMBLY

8. Align "O" mark on drive gear with notch in timer flange, and install drive gear.



FUEL FILTER

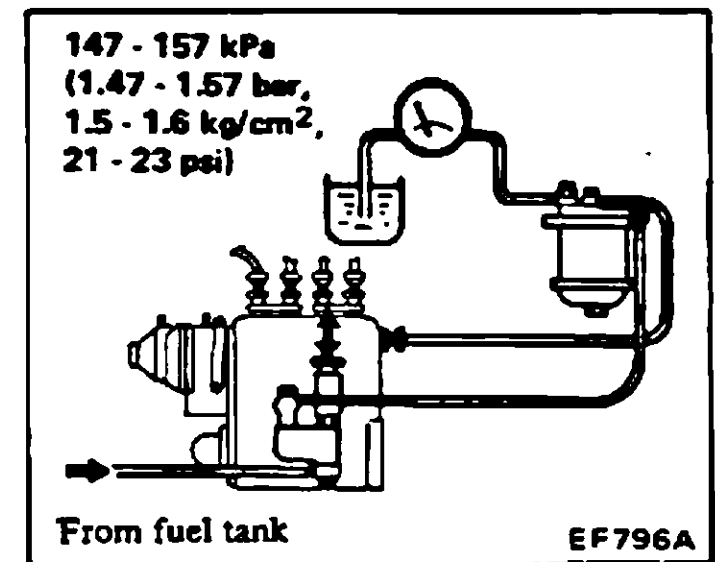
Bleed air from fuel system after installing fuel filter.

TEST

Overflow valve

Attach a pressure gauge to fuel filter discharge port, and check valve opening pressure by operating priming

pump. If pressure is not within range of 147 to 157 kPa (1.47 to 1.57 bar, 1.5 to 1.6 kg/cm², 21 to 23 psi), replace overflow valve.



SERVICE DATA AND SPECIFICATIONS

TABLE OF MODELS AND CORRESPONDING PUMP NUMBERS

Model	Engine	Part number	Pump number
160	SD33T	16700-C8700 16700-C8701 16700-C8702	

INSPECTION AND ADJUSTMENT

Injection pump

Unit: mm (in)

	Standard	Limit
Pump housing to tappet clearance	0.02 - 0.062 (0.0008 - 0.0024)	0.20 (0.0079)
Tappet adjusting bolt head recess	—	0.20 (0.0079)
Control sleeve to plunger trunnion shaft clearance	0.02 - 0.08 (0.0008 - 0.0031)	0.12 (0.0047)
Camshaft end play	0 - 0.03 (0 - 0.0012)	0.10 (0.0039)
Control rack to pinion backlash	0.15 (0.0059)	0.30 (0.0118)
Injection internal (cam angle)	59° 30' - 60° 30'	—
Injection starting timing (pre-stroke: plunger lift from B.D.C.)	2.25 - 2.35 (0.0886 - 0.0925)	—
Tappet clearance at cam T.D.C.)	More than 0.30 (0.0118)	—
Camshaft end play adjusting shim	Thickness	Parts number
	0.10 (0.0039)	16741-37500
	0.12 (0.0047)	16741-37501
	0.14 (0.0055)	16741-37502
	0.16 (0.0063)	16741-37503
	0.18 (0.0071)	16741-37504
	0.30 (0.0118)	16741-37505
	0.50 (0.0197)	16741-37506

INJECTION PUMP ASSEMBLY

Feed pump

	Standard mm (in)	Wear limit mm (in)
Roller to pin clearance	0.04 - 0.08 (0.0016 - 0.0031)	0.30 (0.0118)
Roller outer diameter	15.0 (0.591)	14.9 (0.587)
Oil feed rate	300 ml (10.6 imp fl-oz) or more within 15 seconds at a pump speed of 1,000 rpm.	
Pumping capacity	Discharge should occur within one minute (60 seconds) with a pump speed of 100 rpm and intake head of 1.0 meter (3.3 ft).	
Oil feed pressure	The time required to develop an oil feed pressure of 157 kPa (1.57 bar, 1.6 kg/cm ² , 23 psi) with a feed pump speed of 600 rpm should be within 30 seconds.	
Pumping capacity (priming pump)	Operate the priming pump at a rate of 60 to 100 strokes per minute and verify that pumping is started within 30 strokes.	

Timer

Flyweight holder to flange clearance (Lock plate to thrust washer clearance) mm (in)	0.02 - 0.10 (0.0008 - 0.0039)	
	Thickness mm (in)	Part number
Timer spring adjusting shim	0.1 (0.004)	16822 37500
	0.3 (0.012)	16822 37501
	0.5 (0.020)	16822 37502
Timer plate bearing adjusting shim	0.10 (0.0039)	16826 99007
	0.12 (0.0047)	16826 99000
	0.14 (0.0055)	16826 99001
	0.16 (0.0063)	16826 99002
	0.18 (0.0071)	16826 99003
	0.20 (0.0079)	16826 99005
	0.30 (0.0118)	16826 99006
	0.50 (0.0197)	16826 99004

Fuel filter

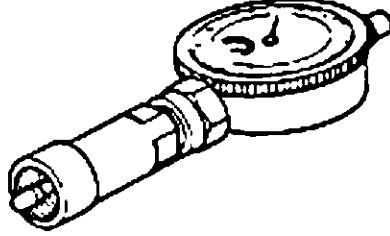
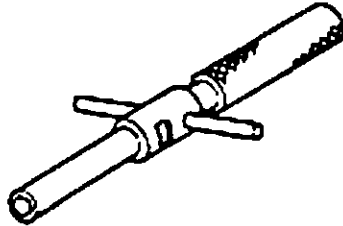
Type	Full-flow, paper type filter
Overflow valve opening pressure kPa (bar, kg/cm ² , psi)	147 - 157 (1.47 - 1.57, - 1.5 - 1.6, 21 - 23)

TIGHTENING TORQUE

	N-m	kg-m	ft-lb
Injection pump			
Injection pump to engine front plate	20 - 25	2.0 - 2.5	14 - 18
Delivery valve holder	29 - 34	3.0 - 3.5	22 - 25
Screw plug	54 - 74	5.5 - 7.5	40 - 54
Tappet adjusting bolt lock nut	25 - 29	2.5 - 3.0	18 - 22
Governor			
Flyweight round nut	49 - 59	5.0 - 6.0	36 - 43
Timer			
Round nut	59 - 69	6.0 - 7.0	43 - 51
Lock nut	98 - 177	10 - 18	72 - 130
Injection nozzle assembly			
Nozzle holder to nozzle nut	78 - 98	8.0 - 10.0	58 - 72
Injection nozzle assembly to engine	59 - 69	6.0 - 7.0	43 - 51
Injection tube flare nut	29 - 34	3.0 - 3.5	22 - 25
Overflow nut	39 - 49	4.0 - 5.0	29 - 36
Spill tube nut	39 - 49	4.0 - 5.0	29 - 36

TURBOCHARGER

SPECIAL SERVICE TOOLS

Tool number	Tool name
DK05782618	Measuring device 
DK57913362	Special wrench 
KV11282617	Adjusting device 

TURBOCHARGER

DESCRIPTION

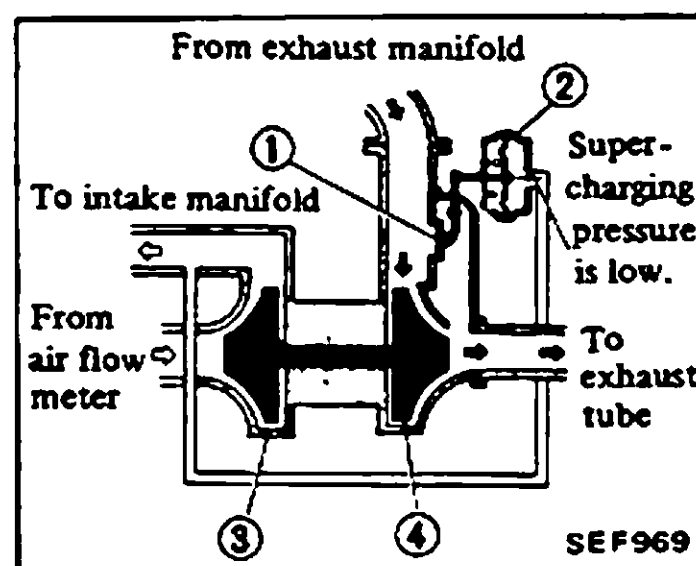
The turbocharger is installed on the exhaust manifold. This system utilizes exhaust gas energy to rotate the turbine wheel which drives the compressor turbine installed on the other end of the turbine wheel shaft. The compressor supplies compressed air to the engine to increase the charging efficiency so as to improve engine output and torque.

To prevent an excessive rise in the supercharging pressure, a system is adopted which maintains the turbine speed within a certain range by controlling the quantity of exhaust gas that passes through the turbine. This system consists of a by-pass valve controller which detects the supercharged pressure and activates a by-pass valve that allows a part of exhaust gas to be discharged without passing through the turbine.

To prevent an abnormal rise in supercharging pressure and possible engine damage in case of a malfunction, an emergency relief valve is provided as a safety device in the intake manifold.

OPERATION

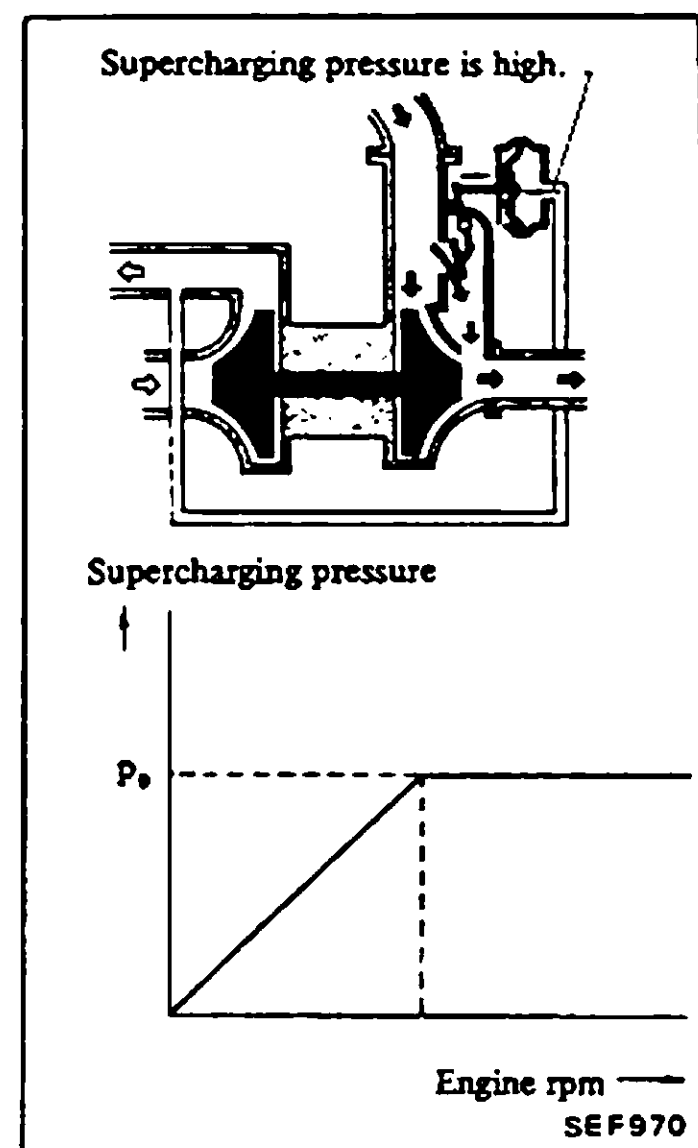
The by-pass valve controller normally detects the supercharging pressure at the outlet of the compressor housing. All exhaust gas flows through the turbine when the supercharging pressure is below the specified pressure P_0 .



- 1 By-pass valve
- 2 By-pass valve controller
- 3 Compressor
- 4 Turbine

As the engine speed increases and the supercharging pressure approaches the specified pressure value P_0 , it exerts a force on the diaphragm of the by-pass valve controller, thereby opening the by-pass valve.

As the valve opens, part of the exhaust gas by-passes the turbine and goes directly to the exhaust tube. As a result, the turbine speed is kept constant and the supercharging pressure maintained at the specified pressure level.

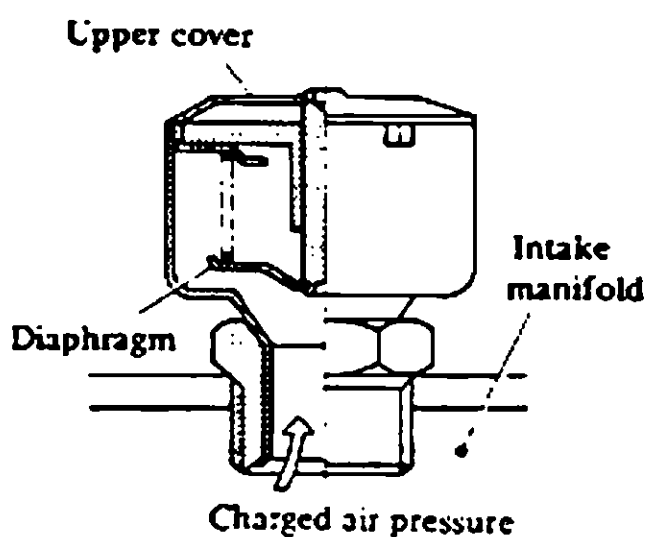


TURBOCHARGER

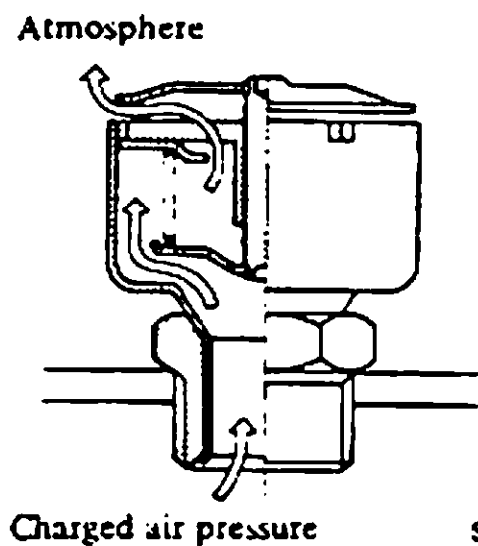
The emergency relief valve operates as follows:

When the pressure in the intake manifold exceeds P_{max} , it exerts a force on diaphragm. Then the upper cover, connected to the diaphragm by a shaft, is pushed open, and the excess pressure in the intake manifold is released into the atmosphere.

When the pressure in the intake manifold is below P_{max} .



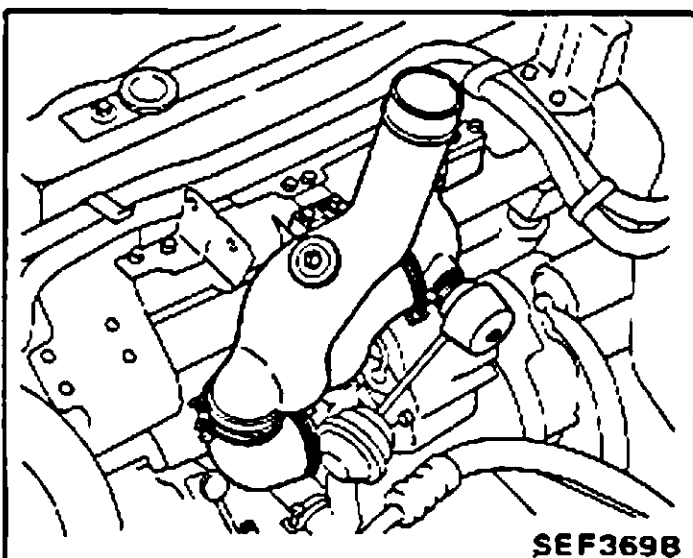
When the pressure in the intake manifold is above P_{max} .



SEF971

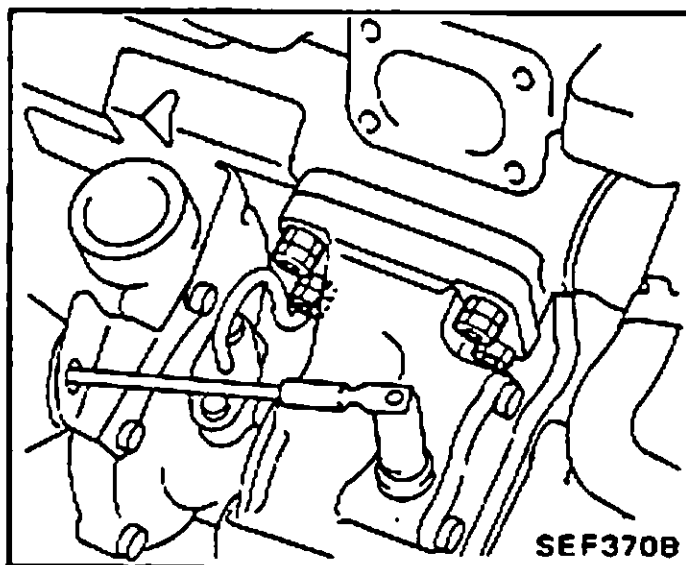
REMOVAL AND INSTALLATION

1. Remove air cleaner.
2. Remove air intake duct.



3. Remove oil inlet pipe for turbocharger.
4. Remove turbocharger oil drain tube bolts on turbocharger side.
5. Remove exhaust manifold connector.
6. Remove turbocharger bracket.
7. Remove turbocharger.
8. Install in the reverse order of removal.

Use double nuts when tightening except for the bolts at lower rear side.



- Ⓙ : Turbocharger to exhaust manifold
29 - 39 N·m
(3 - 4 kg-m, 22 - 29 ft-lb)
- Turbocharger to connector
29 - 39 N·m
(3 - 4 kg-m, 22 - 29 ft-lb)

DISASSEMBLY AND ASSEMBLY

Turbocharger should not be disassembled.

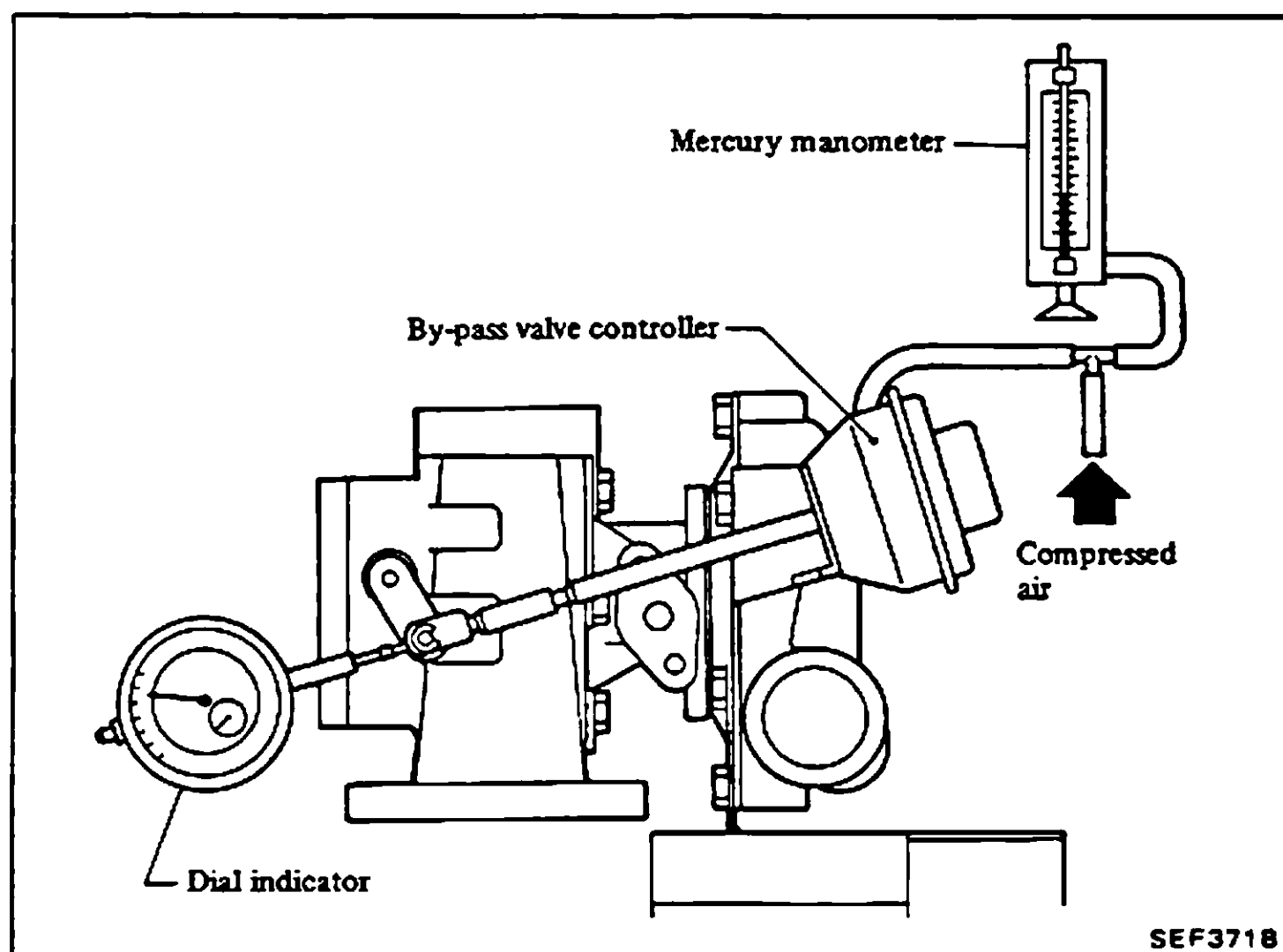
Inspection

1. Inspect turbine and compressor wheels for cracks, clogging, deformity or other damage.
2. Revolve wheels to make sure that they turn freely without any abnormal noise.
3. Check operation of by-pass valve controller.

Do not apply more than 66.7 kPa (667 mbar, 500 mmHg, 19.69 inHg) pressure to controller diaphragm.

By-pass valve controller stroke/pressure:

1.5 mm (0.059 in)/
48.7 - 52.7 kPa
(487 - 527 mbar,
365 - 395 mmHg,
14.37 - 15.55 inHg)



4. Move by-pass valve to make sure that it is not stuck or scratched.

5. Always replace turbocharger as an assembly if any of the above items shows abnormalities.

CRANKCASE EMISSION CONTROL SYSTEM

DESCRIPTION

The closed-type crankcase ventilation system is utilized as a crankcase emission control system.

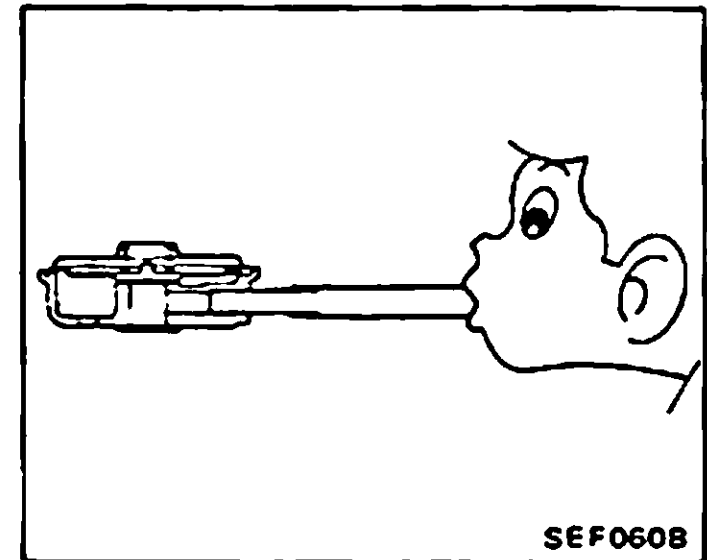
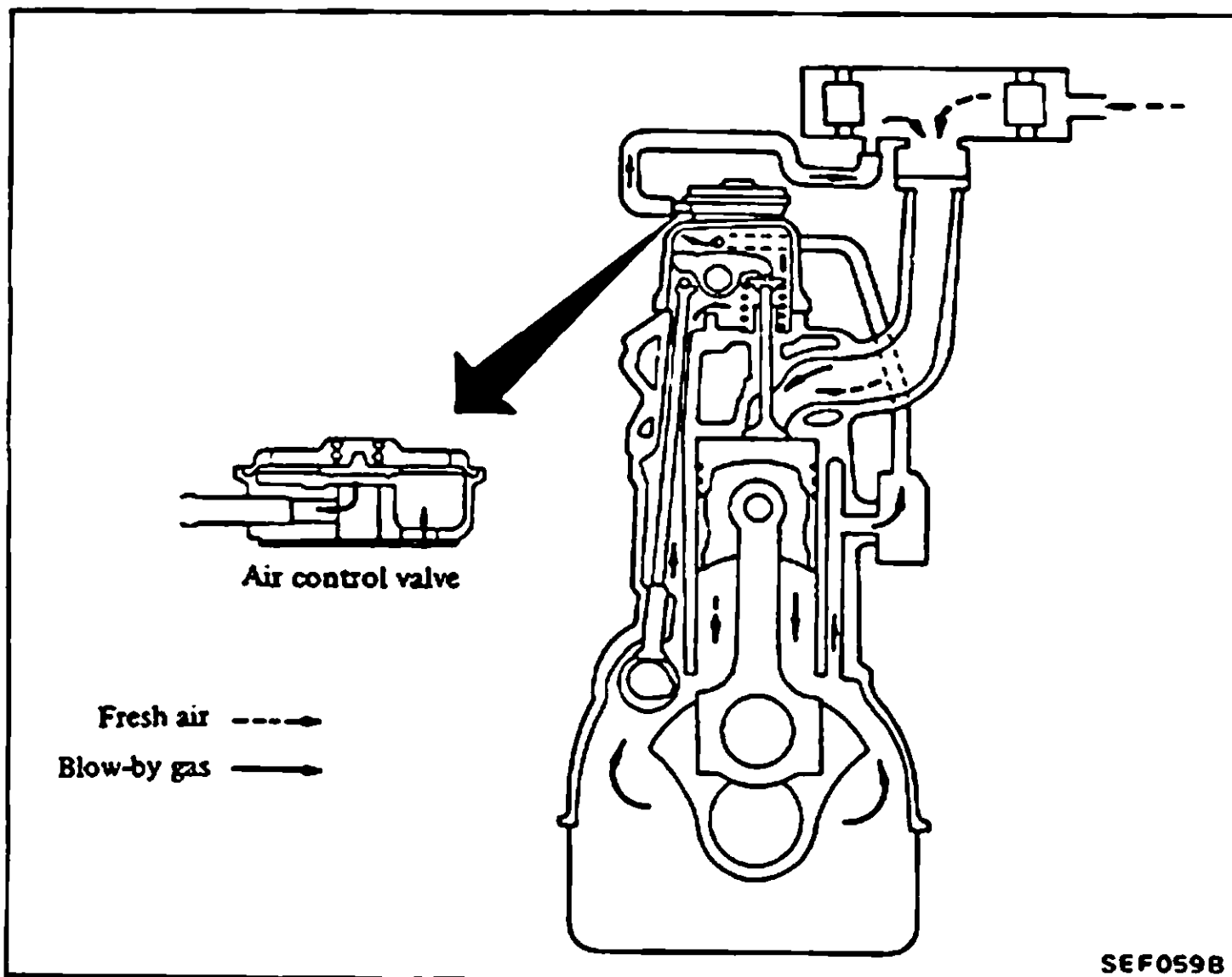
The closed-type crankcase emission control system prevents blow-by gas from entering the atmosphere and keeps the internal crankcase pressure constant.

During the valve operation, the blow-

by gas is fed into the intake manifold by the air control valve.

This is activated by the internal rocker cover pressure. When the intake air flow is restricted by the throttle chamber, the internal rocker cover pressure decreases. At this point, the crankcase emission control valve keeps the internal rocker cover pressure constant so that air or dust is not sucked in around the crankshaft oil seal.

3. After plugging the center hole with adhesive tape, check that air flows from inlet by orally sending air from outlet and that air does not flow sucking in air.



VENTILATION HOSE

1. Check hoses and hose connections for leaks.
2. Disconnect all hoses and clean with compressed air.

If any hose cannot be free of obstructions, replace.

INSPECTION

Air control valve

1. Remove rocker cover.
2. Remove control valve from rocker cover.

