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DIESEL ENGINE FOR MARINE USE

metemar
concessionaria motori marini

Viale Rimembranze 54
20099 Sesto San Giovanni • Milano
tel. 0222478015 • fax 022427970 • e-mail info@ufin.com

WORKSHOP MANUAL

W06D-TI, W06D-TI-II

Hino Motors, Ltd.

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FOREWORD

This workshop manual has been prepared to provide information covering repair procedures on Hino Marine Engine.

Applicable models: W06D-TI and W06D-TI-II engine

When making any repair on your vehicle, be careful not to be injured through improper procedures.
As for maintenance items, refer to the Operation Hand Book.
All information and specifications in this manual are based upon the latest product information available at the time of printing.
Hino Motors reserves the right to make changes at any time without prior notice.

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Hino

WORKSHOP MANUAL

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GENERAL INTRODUCTION

ENGINE

ELECTRICAL EQUIPMENT

TURBOCHARGER

INJECTION PUMP

INJECTION PUMP GOVERNOR

GENERATOR

STARTER

INJECTION PUMP CALIBRATION

HINO MOTORS, LTD.

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GI-S166E-02

CHAPTER GI

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GENERAL PRECAUTIONS

Some recommended and standard maintenance services for your engine are mentioned in this section.
When performing maintenance on your engine be careful not to get injured by improper work.
Improper or incomplete work can cause a malfunction of the engine which may result in personal injury and/or property damage.

WARNING

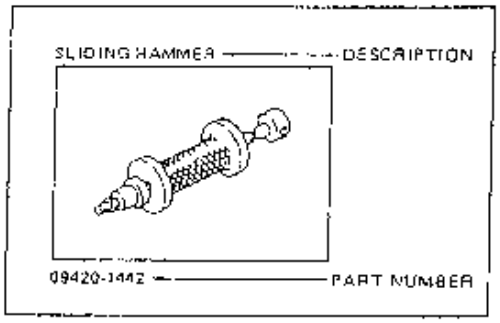
When working on your engine, observe the following general precautions to prevent personal injury and/or property damage in addition to the particular NOTES or WARNINGS in the each chapter.
Most threaded fasteners are metric.
Be careful not to mix with threaded fasteners using the inch system.

- Always wear safety glasses or goggles to protect your eyes.
- Remove rings, watches, ties, loose hanging jewelry and loose clothing before starting work on the engine.
- Bind long hair securely behind the head.
- To avoid serious burns, keep yourself away from hot metal parts such as the engine, exhaust manifold, radiator, muffler, exhaust pipe and tail pipe.
- Do not smoke while working on the engine since fuel and gases from the battery are flammable.
- Take utmost care when working on the battery. It contains corrosive sulfuric acid.
- Large electric current flows through the battery cable and starter cable. Be careful not to cause a short which can result in personal injury and/or property damage.
- Always stop the engine and turn off the starter switch, unless the operation requires the engine running. Removing the key from the switch is recommended.
- Run the engine only in a well-ventilated area to avoid inhaling of carbon monoxide.
- Keep yourself, your clothing and your tools away from moving parts such as the cooling fan and V-belts when the engine is running.
- Be careful not to leave any tool in the engine compartment. The tool may be hit by moving parts and can cause personal injury.

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HOW TO USE THIS WORKSHOP MANUAL.

This workshop manual is designed as a guide for servicing engine.
An INDEX is provided on the first page of each chapter.
TROUBLESHOOTING is dealt with each chapter.
When beginning operations, refer to the sections on for guide to appropriate diagnoses.



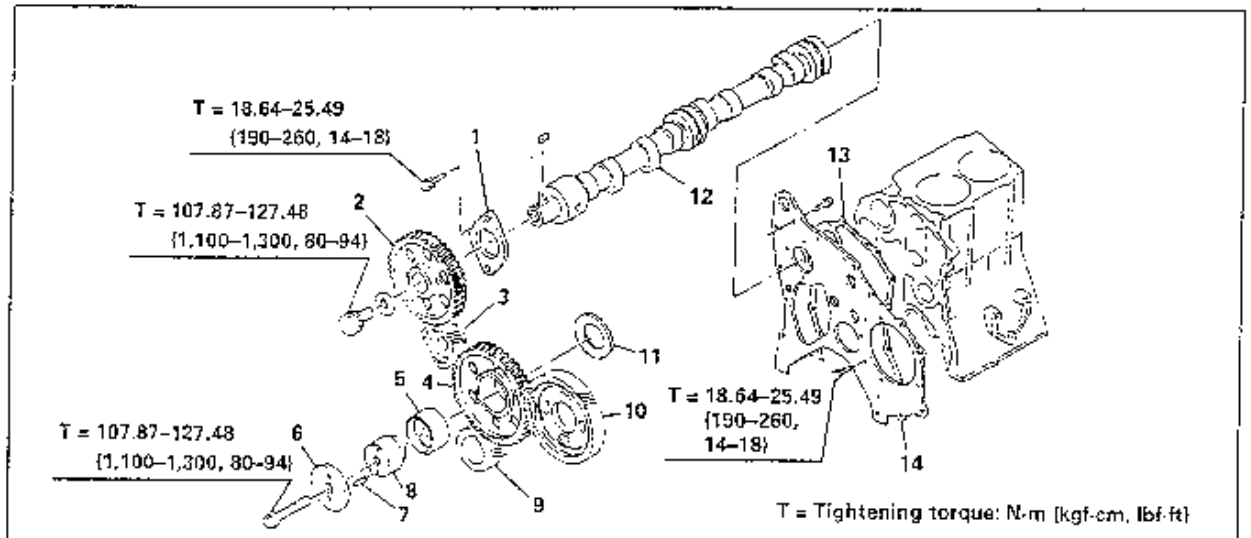
SPECIAL TOOLS are dealt with in each chapter.
When ordering a special tool, confirm the parts number with the applicable parts catalog.

REPAIR PROCEDURES

Repair procedures which are self-explanatory such as simple installation and removal of parts have been omitted. Illustrations such as the one below have been provided to make such simple procedures clear. Only essential procedures requiring directions have been dealt with explicitly.

EXAMPLE:

TIMING GEAR AND CAMSHAFT



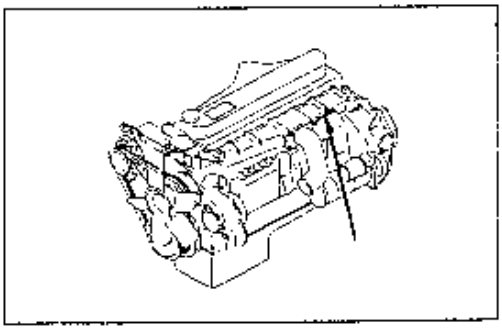
T = Tightening torque: N·m {kgf-cm, lbf-ft}

1. Thrust bearing
2. Camshaft gear
3. Oil pump drive gear
4. Idler gear
5. Bushing
6. Idler gear thrust plate
7. Straight pin
8. Idler gear shaft
9. Crankshaft gear
10. Injection pump drive gear
11. Idler gear thrust plate
12. Camshaft
13. Front end plate gasket
14. Front end plate

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In some cases, illustrations may be of parts which differ in some nonessential way from the parts found on your particular engine. In such cases, however, the principale or procedure being illustrated applies regardless of such nonessential differences.



IDENTIFICATION INFORMATION

ENGINE SERIAL NUMBERS

Please quote these numbers when ordering spare parts or reporting technical matter as they will give you prompt service attention.

The engine serial number is engraved on the engine cylinder block.

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SPECIFICATIONS

DIESEL ENGINE FOR MARINE USE

HINO W06D-TI

5.759 liters, 4-cycle,
6-cyl., water-cooled,
turbocharged and intercooled

● ENGINE DESCRIPTION

1.	Max. output, pleasure craft	187 kW (250 HP)/3,000 r/min
2.	Type	Diesel, 4-cycle, 6-cyl., in-line, over-head valve, water-cooled
3.	Aspiration	Turbocharged and intercooled
4.	Combustion system	Direct injection
5.	Cylinder Bore x Stroke	104 x 113 mm (4.09 x 4.45 in.)
6.	Piston displacement	5.759 liter (351.5 cu.in.)
7.	Compression ratio	16.5
8.	Direction of rotation	Counter-clockwise viewed from flywheel
9.	Dimensions with marine gear (L x W x H)	Approx. 1,401 x 835 x 866 mm (55.2 x 32.9 x 34.1 in.)
10.	Dry weight with marine gear	Approx. 600 kg (1,323 lb)

● FEATURES

1.	Cylinder block	Mono block cast iron with replaceable dry liner
2.	Cylinder head	Single piece cast iron
3.	Crankshaft	Induction hardened die forged special steel with counter weights
4.	Piston and rings	Heat resistance aluminum alloy Two compression rings, chrome plated One oil ring, chrome plated with coil expander
5.	Camshaft	Induction hardened carbon steel
6.	Valves	Heat resistance steel

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● EQUIPMENT

• ENGINE

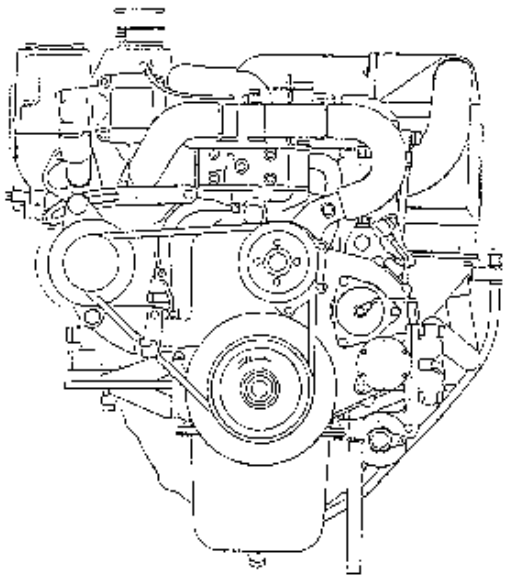
1.	Flywheel housing	SAE No. 3
2.	Flywheel	SAE 11½
3.	Fuel injection pump	BOSCH "A" type with all speed governor
4.	Fuel filter	Paper element type
5.	Water separator	Equipped
6.	Lube oil pump	Full forced pressure feed by gear pump
7.	Lube oil filter	Paper element type (Full flow)
8.	Lube oil cooler	Multi plate type, Fresh water cooled
9.	Fresh water pump	Forced-circulation by volute pump
10.	Raw water pump	Self priming, Rubber impeller type
11.	Intake manifold	Inlet position at rear
12.	Exhaust manifold	Fresh water-cooled exhaust manifold, integrated heat exchanger with expansion tank
13.	Turbocharger	Cooled by fresh water, with air cleaner
14.	Intercooler	Cooled by raw water
15.	Starter	12V, 2.5 KW
16.	Alternator	12V, 80A, with built-in voltage regulator
17.	Engine stop solenoid	Equipped
18.	Emergency stop relay	Equipped
19.	Starter block relay	Equipped
20.	Glow plug	Equipped
21.	Rigid mount bracket	Equipped
22.	Exhaust riser	Cooled by raw water
23.	Marine gear	Equipped

• INSTRUMENT PANEL

1. Battery switch
2. Starter switch with key
3. Instrument panel lamp switch
4. Tachometer with hourmeter
5. Coolant temperature gauge
6. Oil pressure gauge
7. Fuel gauge
8. Volt meter
9. Pre-heater indicator lamp
10. Coolant temperature warning lamp
11. Charge warning lamp
12. Oil pressure warning lamp

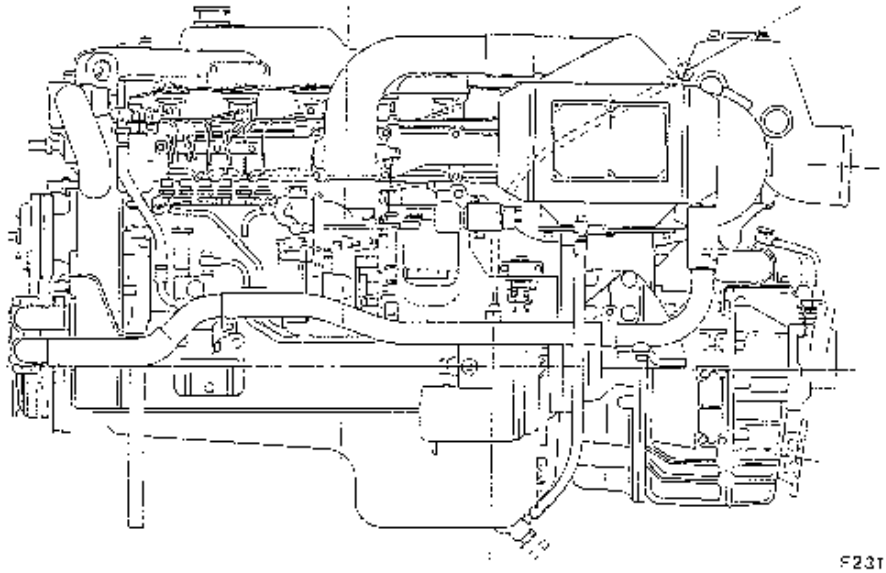
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F230

FRONT VIEW



F231

LEFT SIDE VIEW

NOTE: These specifications are subject to change without notice.

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SPECIFICATIONS

DIESEL ENGINE FOR MARINE USE

HINO W06D-TI-II

5.759 liters, 4-cycle,
6-cyl., water-cooled,
turbocharged and intercooled

● ENGINE DESCRIPTION

1.	Max. output, pleasure craft	231 kW (310 HP)/3,000 r/min
2.	Type	Diesel, 4-cycle, 6-cyl., in-line, over-head valve, water-cooled
3.	Aspiration	Turbocharged and intercooled
4.	Combustion system	Direct injection
5.	Cylinder	
	Bore x Stroke	104 x 113 mm (4.09 x 4.45 in.)
6.	Piston displacement	5.759 liter (351.5 cu.in.)
7.	Compression ratio	16.0
8.	Direction of rotation	Counter-clockwise viewed from flywheel
9.	Dimensions without marine gear (L x W x H)	Approx. 1,448 x 835 x 804 mm (57.0 x 32.9 x 31.6 in.)
10.	Dry weight without marine gear	Approx. 580 kg (1,279 lb)

● FEATURES

1.	Cylinder block	Mono block cast iron with replaceable dry liner
2.	Cylinder head	Single piece cast iron
3.	Crankshaft	Induction hardened die forged special steel with counter weights
4.	Piston and rings	Heat resistance aluminum alloy Two compression rings, chrome plated One oil ring, chrome plated with coil expander
5.	Camshaft	Induction hardened carbon steel
6.	Valves	Heat resistance steel

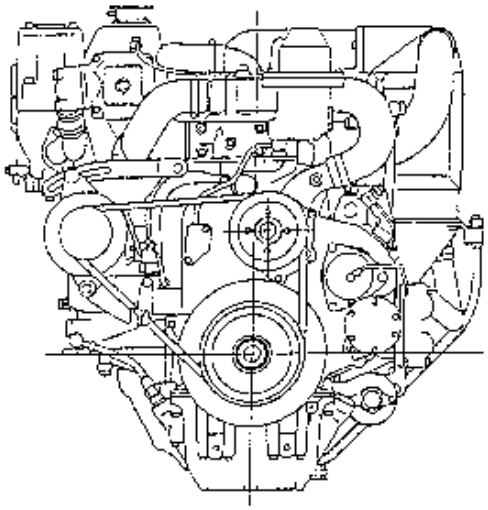
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- EQUIPMENT
- ENGINE

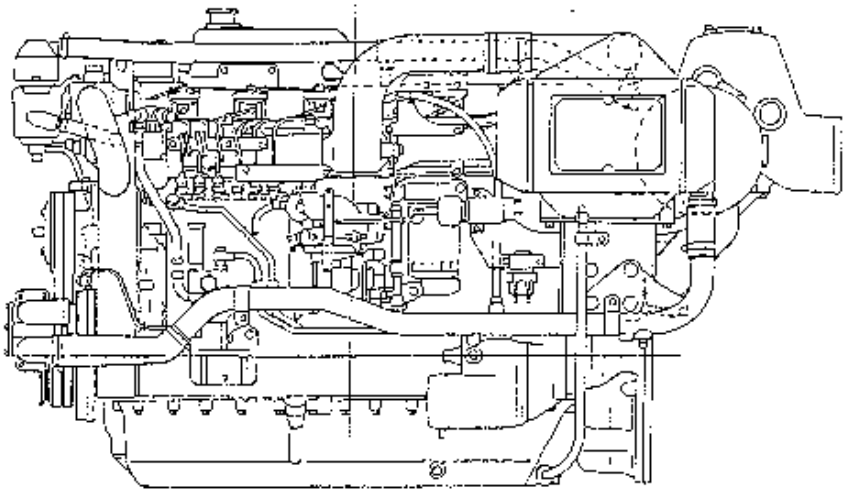
1.	Flywheel housing	SAE No. 3
2.	Flywheel	SAE 11½
3.	Fuel injection pump	BOSCH "AD" type with all speed governor
4.	Fuel filter	Paper element type
5.	Water separator	Equipped
6.	Lube oil pump	Full forced pressure feed by gear pump
7.	Lube oil filter	Paper element type (Full flow)
8.	Lube oil cooler	Multi plate type, Fresh water cooled
9.	Fresh water pump	Forced-circulation by volute pump
10.	Raw water pump	Self priming, Rubber impeller type
11.	Intake manifold	Inlet position at rear
12.	Exhaust manifold	Fresh water-cooled exhaust manifold, integrated heat exchanger with expansion tank
13.	Turbocharger	Cooled by fresh water, with air cleaner
14.	Intercooler	Cooled by raw water
15.	Starter	12V, 2.5 KW
16.	Alternator	12V, 80A, with built-in voltage regulator
17.	Engine stop solenoid	Equipped
18.	Emergency stop relay	Equipped
19.	Starter block relay	Equipped
20.	Glow plug	Equipped
21.	Rigid mount bracket	Equipped
22.	Exhaust riser	Cooled by raw water
23.	Marine gear	Less

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FRONT VIEW



SM3-2374

LEFT SIDE VIEW

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TIGHTENING TORQUE OF STANDARD BOLT

Unit: N·m (kgf·cm / kgf·m)

Bolt identification	Tightening conditions \ Bolt diameter (mm)	4	6	8	10	12	14	16	18	20	22	24
4	Even tightening area. Bolt nut, coating, naked bolt, lubricant, etc. Optimum conditions.	0.59 – 1.47 (6 – 15) (0.6 – 2.0)	3.04 – 5.19 (30 – 53) (2.1 – 3.6)	8.63 – 12.55 (88 – 128) (7 – 9)	17.61 – 25.00 (174 – 255) (13 – 18)	29.02 – 41.63 (300 – 445) (22 – 32)	47.67 – 69.62 (486 – 712) (36 – 51)	74.34 – 108.85 (756 – 1,110) (55 – 80)	101.89 – 150.04 (1,040 – 1,530) (76 – 110)	145.14 – 212.81 (1,480 – 2,170) (108 – 156)	199.08 – 292.23 (2,030 – 2,980) (147 – 215)	251.06 – 367.74 (2,560 – 3,750) (185 – 271)
5	Cast iron or aluminum tightening surface. Washers. Medium conditions.	1.08 – 1.96 (11 – 20) (1.1 – 1.47)	4.71 – 6.96 (48 – 71) (3.5 – 5.1)	11.48 – 16.86 (117 – 172) (9 – 12)	22.36 – 33.34 (232 – 340) (16 – 24)	39.17 – 56.35 (405 – 692) (30 – 42)	63.45 – 93.16 (647 – 950) (47 – 68)	99.05 – 145.13 (1,010 – 1,480) (73 – 107)	136.32 – 200.05 (1,390 – 2,040) (101 – 147)	193.20 – 284.39 (1,970 – 2,900) (143 – 209)	264.78 – 388.32 (2,700 – 3,970) (195 – 287)	334.41 – 490.35 (3,410 – 5,000) (247 – 361)
	Tightening area having black coarse surface. Rusty. Naked bolt or lubricant unavailable. Poor tightening conditions.	1.67 – 2.45 (17 – 25) (1.3 – 1.8)	5.88 – 8.62 (60 – 88) (4.4 – 6.5)	14.32 – 20.98 (146 – 214) (11 – 15)	28.44 – 41.57 (290 – 425) (21 – 30)	48.63 – 72.76 (496 – 742) (37 – 53)	79.34 – 115.71 (809 – 1,180) (59 – 85)	123.57 – 181.42 (1,260 – 1,850) (92 – 133)	170.64 – 249.03 (1,740 – 2,540) (126 – 183)	241.75 – 355.60 (2,460 – 3,620) (178 – 261)	331.47 – 485.42 (3,380 – 4,950) (245 – 358)	427.77 – 612.51 (4,360 – 6,250) (309 – 452)
6	Even tightening area. Bolt nut, coating, naked bolt, lubricant, etc. Optimum conditions.	1.57 – 2.45 (16 – 24) (1.2 – 1.7)	5.88 – 8.13 (58 – 83) (4.2 – 6.0)	13.54 – 19.71 (138 – 201) (10 – 14)	26.78 – 39.22 (273 – 400) (20 – 28)	46.78 – 68.64 (477 – 700) (35 – 50)	74.93 – 109.63 (764 – 1,120) (55 – 81)	116.70 – 171.61 (1,190 – 1,750) (87 – 126)	160.82 – 235.35 (1,640 – 2,400) (119 – 173)	227.52 – 334.46 (2,320 – 3,410) (168 – 246)	311.36 – 456.95 (3,180 – 4,660) (231 – 336)	394.23 – 575.63 (4,020 – 5,870) (291 – 424)
7	Cast iron or aluminum tightening surface. Washers. Medium conditions.	2.16 – 3.13 (22 – 32) (1.6 – 2.3)	7.38 – 10.78 (75 – 110) (5.5 – 7.9)	17.65 – 26.47 (180 – 270) (13 – 19)	35.70 – 52.26 (364 – 533) (27 – 39)	62.38 – 91.39 (636 – 932) (47 – 67)	100.05 – 147.09 (1,020 – 1,500) (74 – 108)	155.93 – 226.95 (1,590 – 2,310) (115 – 168)	213.79 – 313.81 (2,180 – 3,200) (158 – 231)	304.61 – 446.28 (3,100 – 4,550) (225 – 329)	416.79 – 608.99 (4,250 – 6,210) (308 – 449)	525.64 – 759.62 (5,360 – 7,850) (388 – 557)
	Tightening area having black coarse surface. Rusty. Naked bolt or lubricant unavailable. Poor tightening conditions.	2.65 – 3.92 (27 – 40) (2.0 – 2.9)	9.22 – 13.53 (94 – 138) (6.8 – 9.9)	22.46 – 32.95 (229 – 336) (17 – 24)	44.63 – 65.41 (455 – 667) (33 – 48)	77.97 – 114.24 (795 – 1,165) (58 – 84)	124.55 – 183.38 (1,270 – 1,870) (92 – 135)	195.16 – 283.25 (1,990 – 2,890) (144 – 209)	267.73 – 392.26 (2,730 – 4,000) (198 – 289)	379.62 – 557.01 (3,870 – 5,680) (280 – 410)	520.74 – 764.91 (5,310 – 7,800) (385 – 564)	657.05 – 948.05 (6,700 – 9,670) (485 – 712)
8	Even tightening area. Bolt nut, coating, naked bolt, lubricant, etc. Optimum conditions.	2.36 – 3.13 (24 – 32) (1.8 – 2.3)	8.05 – 10.78 (82 – 110) (5.9 – 7.9)	19.62 – 26.16 (200 – 267) (15 – 19)	38.94 – 56.25 (397 – 574) (29 – 41)	68.08 – 90.71 (694 – 925) (51 – 66)	99.05 – 146.13 (1,010 – 1,490) (74 – 107)	155.66 – 226.53 (1,730 – 2,310) (126 – 167)	233.40 – 310.87 (2,380 – 3,170) (173 – 229)	331.47 – 442.27 (3,380 – 4,510) (244 – 326)	454.05 – 605.40 (4,630 – 6,170) (335 – 446)	573.09 – 763.94 (5,850 – 7,790) (424 – 563)
9	Cast iron or aluminum tightening surface. Washers. Medium conditions.	3.14 – 4.11 (32 – 42) (2.4 – 3.0)	10.79 – 14.31 (110 – 146) (8.0 – 10.6)	26.19 – 34.51 (267 – 356) (19 – 25)	51.89 – 69.23 (529 – 706) (39 – 51)	90.72 – 120.62 (925 – 1,230) (67 – 88)	145.14 – 203.19 (1,480 – 1,970) (108 – 142)	226.54 – 302.04 (2,310 – 3,080) (166 – 222)	310.69 – 414.02 (3,170 – 4,220) (230 – 305)	442.28 – 589.37 (4,510 – 6,010) (327 – 434)	605.40 – 807.08 (6,170 – 8,230) (447 – 595)	763.94 – 1,018.91 (7,790 – 10,390) (564 – 751)
10	Tightening area having black coarse surface. Rusty. Naked bolt or lubricant unavailable. Poor tightening conditions.	3.92 – 5.39 (40 – 55) (2.9 – 3.8)	13.44 – 17.94 (137 – 183) (10.0 – 13.2)	32.76 – 43.60 (334 – 445) (25 – 32)	64.93 – 86.49 (662 – 882) (48 – 63)	113.76 – 151.62 (1,160 – 1,540) (84 – 111)	181.43 – 242.22 (1,850 – 2,470) (134 – 178)	283.42 – 377.85 (2,890 – 3,850) (210 – 278)	388.33 – 518.17 (3,960 – 5,280) (286 – 382)	552.18 – 736.47 (5,640 – 7,510) (408 – 543)	757.00 – 1,009.50 (7,720 – 10,290) (558 – 744)	955.12 – 1,273.88 (9,740 – 12,990) (705 – 939)
11												

NOTE: The torque values given in this table should be applied where bolt torque is not specified.

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Hino

RECOMMENDED LUBRICANTS FOR ALL HINO ENGINE

HINO MOTORS, LTD
OVERSEAS OPERATIONS
SERVICE DIV
TOKYO, JAPAN

LUBRICANTS	POSITIONS	ATMOSPHERIC TEMP	S.A.E NO	BP	CALTEX	CASTROL	ESSO	GULF	MOBIL	SHELL	TOTAL
ENGINE OIL (A.P.I. CC) Previous Classification (A.P.I. DG) Item C 2104C (MIL-L-2104B)	Cylinder Block Injection Pump Air Cleaner	Above 32°C (90°F)	40	Vanellus C 3 40	RPM Delo 400 Oil SAE 40 or 15W-40 RPM Delo 3000 Oil SAE 40	Castrol or Castrol CRD 40 Turbomax Castrol or Castrol RX Super 40 15W-40	Esso Extra D 3 40 XD 3 40	Gulf Super Duty Motor Oil 40 15W-40	Mobil Delvac 1340 Mobil Delvac Super 15W-40	Myrina Oil 40 20W-40 15W-40 Rimula X Oil 40 Rimula CT 40	TOTAL Rubia S 40 TOTAL Rubia TX 15W40
		0 ~ 32°C (32 ~ 90°F)	30	Vanellus C 3 10	RPM Delo 400 Oil SAE 30 or 15W-40 RPM Delo 3000 Oil SAE 30	Castrol or Castrol CRD 30 Castrol or Castrol RX Super 30 15W-40	Esso Extra D 3 30 XD 3 30	Gulf Super Duty Motor Oil 30 15W-40	Mobil Delvac 1330 Mobil Delvac Super 15W-40	Myrina Oil 30 20W-40 15W-40 Rimula X Oil 30 10W-30 Rimula CT 30	TOTAL Rubia S 30 TOTAL Rubia TX 15W40
		-20 ~ 0°C (-4 ~ 32°F)	20	Vanellus C 3 20W	RPM Delo 400 Oil SAE 20W-20W or 15W-40 RPM Delo 3000 Oil SAE 20 20W	Castrol or Castrol CRD 20W-20 Castrol or Castrol RX Super 20W-20, 15W-40	Esso Extra D 3 20W XD 3 15W-40	Gulf Super Duty Motor Oil 20 15W-40	Mobil Delvac 1310 Mobil Delvac Super 15W-40	Myrina Oil 20 20W-40 15W-40 Rimula X Oil 20 Rimula CT 20	TOTAL Rubia S 20 TOTAL Rubia TX 15W40
		Above -10°C (14°F)	40	Vanellus M 40	RPM Delo 200 Oil SAE 40 RPM Delo 400 Oil SAE 40	Castrol or Diesel LMX 40 Castrol or Diesel RX Super 40 15W-40	Esso Extra HDX 40 HDX Plus 40	Gulftone Motor Oil HD 40 15W-40	Mobil Delvac 1240 Mobil Delvac 1140	Rimula X 40 20W-50 Rotella SX 40	TOTAL Rubia H 40
ENGINE OIL (A.P.I. CC) Previous Classification (A.P.I. DM) Item C 4633 (MIL-L-2104B)		-20 ~ 10°C (-4 ~ 50°F)	30	Vanellus M 30	RPM Delo 200 Oil SAE 30 RPM Delo 400 Oil SAE 30	Castrol or Diesel CRX 30 Castrol or Diesel RX Super 30 15W-40	Esso Extra HDX 30 HDX Plus 30	Gulftone Motor Oil HD 30 15W-40	Mobil Delvac 1230 Mobil Delvac 1130	Rimula X 30 20W-50 Rotella SX 30 Rimula CT 30	TOTAL Rubia H 30
		0 ~ 32°C (32 ~ 90°F)	20	Vanellus M 20W	RPM Delo 200 Oil SAE 20 20W RPM Delo 400 Oil SAE 20 20W	Castrol or Diesel CRX 20W-20 Castrol or Diesel RX Super 20W-20 15W-40	Esso Extra HDX 20 HDX Plus 20W-20	Gulftone Motor Oil HD 20 15W-40	Mobil Delvac 1220 Mobil Delvac 1120	Rimula X 20 20W-50 Rotella SX 20 Rimula CT 20	TOTAL Rubia H 20
COOLANT PUMP BEARING GREASE (MIL-G-10924a)	Coolant Pump Bearing			Energrease LT 2	Starter Multipurpose 2 or Starter All Purpose 2	Castrol LM Grease	Esso Multipurpose Grease	Gulftex Poly	Mobilgrease MP 77 MS	Retinax A Alvania Grease R2	TOTAL Gadrella 2
STARTER GREASE	Bushing, Clutch Drive Shaft Pinion Shaft Lever & Reduction Gear			———	Molytex Grease EP2				Mobilgrease 28	Alvania Shell Grease 1?	———
GENERATOR & STARTER BEARING GREASE	Generator Bearing Starter Bearing			Energrease LT 2	BP Vanpex MP 3	———	———	———	Mobilgrease 28	Alvania Shell Grease 2	———
INJECTION PUMP TIMER GREASE (MIL-G-10924a)	Injection Pump Timer			Energrease L 2	Marfak Multipurpose 2 or Marfak All Purpose 2	Castrol LM Grease	Esso Multipurpose Grease	Gulftex Poly	Mobilgrease MP 77 MS	Retinax A Alvania Grease R2	TOTAL Multis EP 2
ANTI-FREEZE (MIL-A-11810)	Engine Radiator			Anti Freeze	AF Engine Coolant	Castrol Anti Freeze Castrol Long Life Coolant	Esso Anti Freeze Coolant	Gulf Motor Anti-freeze Rad Summer Coolant	Mobil Permazone	Shell Donax SA Shell Donax PSBA Glycoshell	TOTAL ANTIGEL

Note: Lubricants were recommended according to new classification by A.P.I. (American Petroleum Institute)

(K.P.)

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EN-S138E-02

CHAPTER EN

ENGINE

Model W06D-TI and W06D-TI-II

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DATA AND SPECIFICATIONS

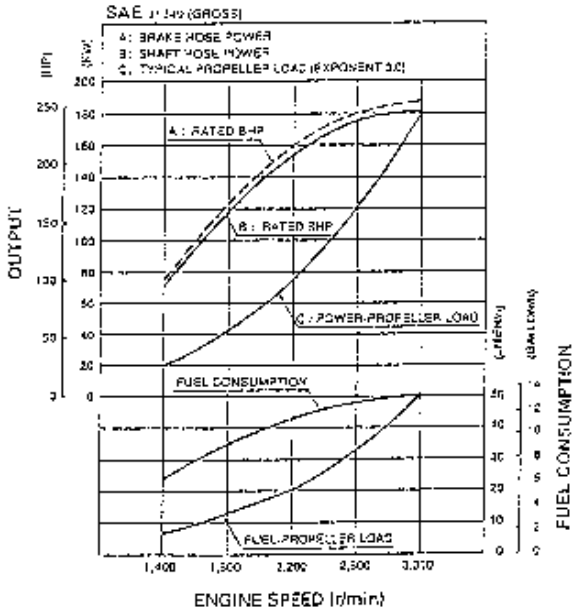
Model		HINO W06D-TI	HINO W06D-TI-II
Type		Diesel, 4-cycle, vertical, 6-cylinder, in-line, overhead valve, water-cooled	
Aspiration		Turbocharged and intercooled	
Combustion system		Direct injection	
Bore and stroke		104 x 113 mm {4.09 x 4.45 in}	
Piston displacement		5.759 L {351.4 cu.in}	
Firin gorder		1 – 4 – 2 – 6 – 3 – 5 (A number of a cylinder is to be counted in order from the timing gear side.)	
Direction of rotation		Counter-clockwise viewed from flywheel	
Compression ratio		16.5 : 1	16.0 : 1
Maximum speed		3,000 r/min	
Idling speed		700 – 750 r/min	
Dry weight	with marine transmission	Approx. 5.844 N {600 kgf, 1,323 lbf}	—
	without marine transmission	—	Approx. 5.688 N {580 kgf, 1,279 lbf}
Valve timing (flywheel travel)	Intake opens	16° before top dead center	
	Intake closes	40° after bottom dead center	
	Exhaust opens	55° before bottom dead center	
	Exhaust closes	13° after top dead center	
Valve clearance (when cold)	Intake	0.35 mm {0.0138 in}	
	Exhaust	0.50 mm {0.0197 in}	
Injection nozzle opening pressure		21.57 MPa {220 kgf/cm^2, 3,129 lbf/in^2}	
Injection timing (A°)		20°	16°
		Before top dead center for No. 1 cylinder on compression stroke	

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PERFORMANCE CURBE (For W06D-TI)

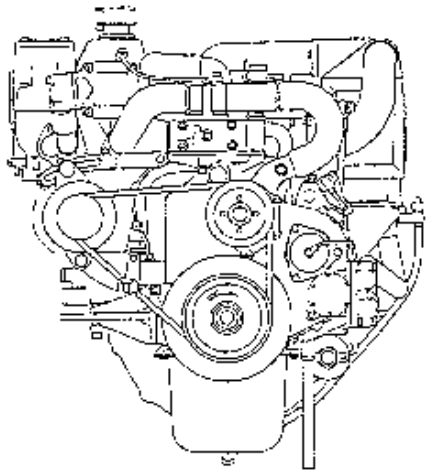
PLEASURE CRAFT RATING



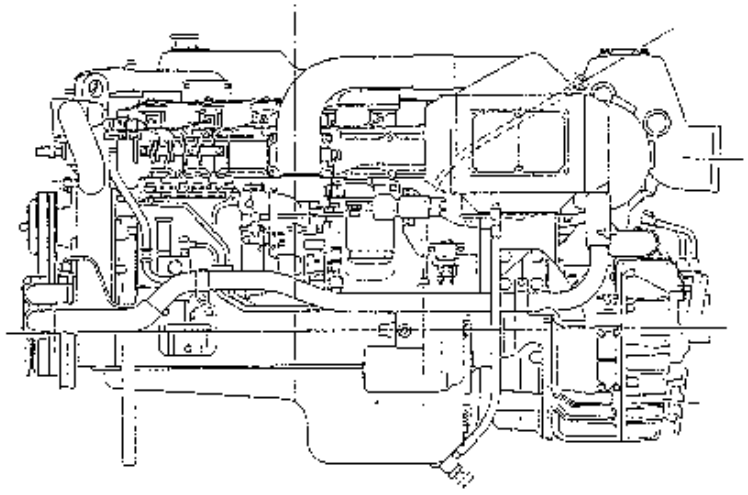
DHF-219

NOTE:
Engine performance at SAE standard J1349 conditions of 90m (300 ft) altitude (100 kPa (29.61 in.Hg) barometric pressure), 25°C (77°F) air intake temperature, and 1 kPa (0.30 in.Hg) water vapor pressure with No.2 diesel fuel will be within 5% of that shown at the time of engine shipment. Actual performance may vary with different ambient conditions.

DESCRIPTION



DHF-230

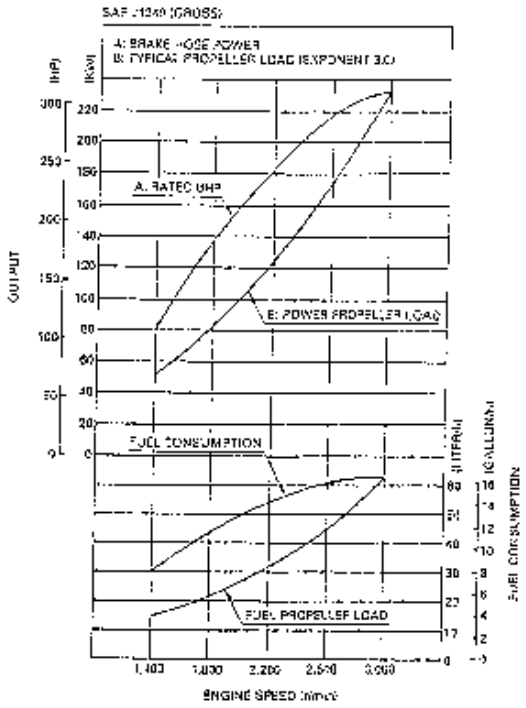


DHF-232

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PERFORMANCE CURBE (For W06D-TI-II)

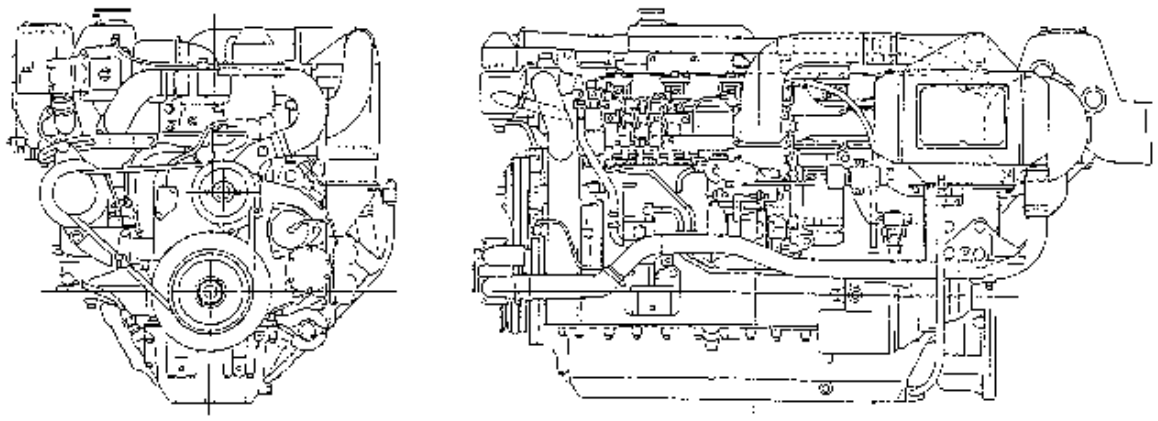
PLEASURE CRAFT RATING



SM3-2373

NOTE:
Engine performance at SAE standard J1349 conditions of 90m (300 ft) altitude (100 kPa (29.61 in.Hg) barometric pressure), 25°C (77°F) air intake temperature, and 1 kPa (0.30 in.Hg) water vapor pressure with No.2 diesel fuel will be within 5% of that shown at the time of engine shipment. Actual performance may vary with different ambient conditions.

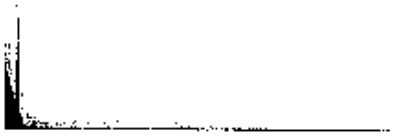
DESCRIPTION



SM3-2374

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TROUBLESHOOTING

Symptom	Possible cause	Remedy/Prevention
Engine overheating	**Coolant**	
	• Insufficient coolant	Add coolant.
	• Defective thermostat	Replace the thermostat.
	• Overflow of coolant due to leakage of exhaust into cooling system	Repair.
	• Coolant leakage from cylinder head gasket	Replace gasket.
	• Defective coolant pump	Repair or replace.
	Heat Exchanger	
	• Clogged with rust and scale	Clean heat exchanger.
	• Clogged with iron oxide due to leakage of exhaust into cooling system	Clean coolant passage and correct exhaust leakage.
	• Clogged or corroded heat exchanger due to mud or other debris	Clean or replace heat exchanger.
	• Defective heat exchanger cap pressure valve	Replace heat exchanger cap.
	Abnormal combustion	
	• Incorrect injection timing	Adjust injection timing.
	• Reduced injection pressure	Adjust injection pressure.
	• Poor fuel	Use good quality fuel.
	• Poor nozzle spray	Adjust or replace nozzle.
	• Unsatisfactory automatic timer advance angle	Repair or replace timer.
	Other problems	
	• Defective or deteriorated engine oil	Change engine oil.
	• Unsatisfactory operation of oil pump	Replace or repair.
	• Insufficient oil	Add oil.
	• Brake drag	Repair or adjust.
	Cooling system	
	• Defective sea water pump	Repair or replace.
	• Loose or slipping V-belt	Adjust V-belt tension or replace.
	• Closed sea water intake valve (Seacock)	Open intake valve.
	• Clogged sea water strainer	Clean strainer.

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Symptom	Possible cause	Remedy/Prevention
Excessive oil consumption	**Pistons, cylinder liners, and piston rings**	
	• Wear of piston ring and cylinder liner	Replace piston rings and cylinder liner.
	• Worn, sticking or broken piston rings	Replace piston rings and cylinder liner.
	• Insufficient tension on piston rings	Replace piston rings and cylinder liner.
	• Unsatisfactory break-in of piston rings	Replace piston rings and cylinder liner.
	• Unsuitable oil (viscosity too low)	Change oil as required and replace piston rings and cylinder liners.
	• Incorrectly fitted piston rings (upside down)	Replace piston rings.
	• Gaps of piston rings in line with each other	Reassemble piston rings.
	Valve and valve guides	
	• Worn valve stem	Replace valve and valve guide.
	• Worn valve guide	Replace valve guide.
	• Incorrectly fitted valve stem seal	Replace the stem seal.
	• Excessive lubricant on rocker arm	Check clearance of rocker arm and shaft.
	Excess oil feed	
	• Defective oil level gauge	Replace oil level gauge.
	• Oil level too high	Drain excess oil.
	Cooling system	
	• Overcooled engine (low temperature wear)	Warm up engine before moving boat. Check cooling system.
	Other problems	
	• Oil leakage from miscellaneous parts	Repair.
Piston seizure	**Operation**	
	• Abrupt stoppage of engine after running at highspeed	Operate engine properly.

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Symptom	Possible cause	Remedy/Prevention
Piston seizure	Oil	
	• Insufficient oil	Add oil.
	• Dirty oil	Change oil.
	• Poor quality oil	Replace with proper engine oil.
	• High oil temperature	Repair.
	• Low oil pressure	Repair.
	• Defective oil pump	Repair oil pump.
	• Reduced performance due to worn oil pump	Replace oil pump.
	• Suction strainer sucking air	Add oil and/or repair strainer.
	Abnormal combustion	See Symptom: "Engine overheating."
	Coolant	See Symptom: "Engine overheating."
Lack of power	Injection pump	Refer to CHAPTER IP, FUEL INJECTION PUMP.
	Intake	
	• Clogged air cleaner	Clean element or replace element.
	Overheating	See Symptom: "Engine overheating."
	Fuel and nozzle	
	• Poor nozzle spray	Adjust or replace injection nozzle.
	• Clogged nozzle with carbon	Clean nozzle.
	• Wear or seizure of nozzle	Replace nozzle.
	• Air in fuel system	Repair and bleed air from fuel system.
	• Clogged fuel filter	Replace element.
	• Use of poor fuel	Use good quality fuel.
	Abnormal combustion	See Symptom: "Engine overheating."
	Piston, cylinder liners, and piston rings	See Symptom "Engine overheating."
	Other problems	
	• Breakage of turbine or blower	Replace the turbine or blower or turbocharger.

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Symptom	Possible cause	Remedy/Prevention
Difficulty starting engine	**Electrical system**	
	• Discharged battery	Charge battery.
	• Defective wiring in starter circuit	Repair wiring of starter.
	• Loose or open-circuit battery cable	Tighten battery terminal connections or replace battery cable.
	• Breakdown of starter	Replace starter.
	• Break of glow plug or intake air heater (If so equipped)	Replace
	Injection pump	Refer to CHAPTER IP, FUEL INJECTION PUMP.
	Air cleaner	
	• Clogged element	Clean the element or replace the element.
	Fuel system	
	• No fuel in tank	Supply fuel and bleed air from fuel system.
	• Clogged fuel line	Clean fuel line.
	• Air sucked into fuel system through fuel line connections	Tighten fuel line connections.
	• Clogged fuel filter	Replace element.
	• Loose connection in high-pressure line	Tighten sleeve nut of high pressure line.
	• Water in fuel	Drain and clean fuel system
Difficulty starting engine	**Nozzles**	
	• Seized nozzle	Replace nozzle.
	• Broken or fatigued nozzle spring	Replace spring.
	Oil system	
	• Oil viscosity too high	Use proper viscosity oil, or install an oil immersion heater and warm up oil.
	Other problems	
	• Seized piston	Replace piston, piston rings, and liner.
	• Seized bearing	Replace bearing and/or crankshaft.
	• Reduced compression pressure	Overhaul engine.
	• Ring gear damaged or worn	Replace the ring gear and/or starter pinion.
	• Improperly adjusted or broken accelerator cable	Adjust or replace the accelerator cable.

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Symptom	Possible cause	Remedy/Prevention
Rough idling	Injection pump	Refer to CHAPTER IP, FUEL INJECTION PUMP.
	Nozzles	
	• Uneven injection pressure	Adjust.
	• Poor nozzle spray	Adjust or replace nozzle.
	• Carbon deposit on nozzle tip	Remove carbon.
	• Seized needle valve	Replace nozzle.
	Engine proper	
	• Improper valve clearance	Adjust valve clearance.
	• Improper contact of valve seat	Replace or repair valve and valve seat.
	• Idling speed too low	Adjust idling speed.
	• Coolant temperature too low	Warm up engine.
	• Compression pressure of cylinders markedly different from one another	Overhaul engine.
Leakage of exhaust	Cylinder head gasket	
	• Fatigued gasket (aging)	Replace gasket.
	• Damage	Replace gasket.
	• Improper installation	Replace gasket.
	Cylinder head bolts	
	• Loose bolts	Tighten bolt.
	• Elongated bolts	Replace bolt.
	• Improper tightening torque or tightening sequence	Tighten properly.
	Cylinder block	
	• Cracking	Replace cylinder block.
	• Surface distortion	Repair or replace.
	• Fretting of cylinder liner insertion portion (insufficient projection of cylinder liner)	Replace cylinder liner or cylinder block.
	Cylinder head	
	• Cracking	Replace cylinder head.
	• Surface distortion	Repair or replace.

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Symptom	Possible cause	Remedy/Prevention
Leakage of exhaust	**Cylinder liners**	
	• Cracking	Replace cylinder liner.
	• Corrosion	Replace cylinder liner.
	• Insufficient projection of cylinder liner	Replace cylinder liner.
	Other problems	
	• Incorrect injection timing	Adjust injection timing.
Seawater discharge is not sufficient	**Seawater pump**	
	• Sucking air	Supply seawater and bleed air from cooling system.
	• Damaged impeller	Replace impeller.
	• Clogging of suction pipe and/or seawater strainer	Clean suction pipe and strainer.
Abnormal noise or vibration	**Seawater pump**	
	• Worn bearing	Replace bearing.
	• Foreign material in the pump	Repair or replace.
	• Incomplete mounting	Mount completely.
Bearing wears frequently	**Seawater pump**	
	• Too tight V-belt tension	Adjust V-belt tension.
Damage of impeller	**Seawater pump**	
	• When it has been operated for a long period	Replace impeller.
	• When it has been operated without seawater	Replace impeller.
	• When it has been operated at higher RPM	Replace impeller and operate at normal RPM.
	• Too high or low water temperature	Replace impeller and operate at normal temperature.
	• When it has not been operated for an extended period	Replace impeller.
	• Foreign material in the pump	Repair or replace.

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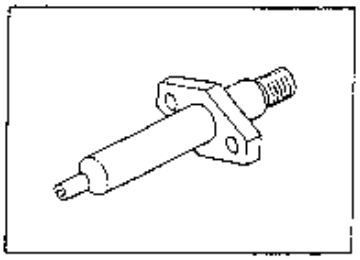
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ENGINE OVERHAUL CRITERIA

SPECIAL TOOL

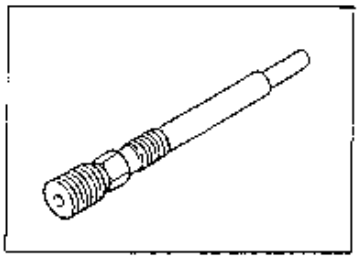
Prior to starting an engine overhaul, it is necessary to have these special tools.

COMPRESSION GAUGE ADAPTOR (NOZZLE HOLDER)



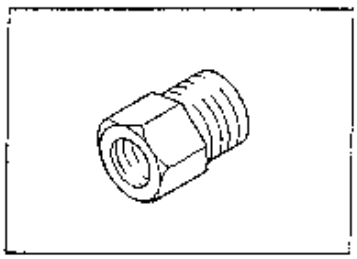
09408-1041

COMPRESSION GAUGE ADAPTOR (GLOW PLUG)

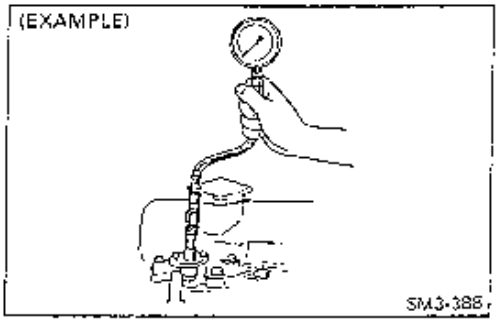


09552-1051

COMPRESSION GAUGE ADAPTOR



09552-1070



FACTORS WHICH DETERMINE WHEN AN ENGINE OVERHAUL IS NEEDED.

1. Lowered compression pressure
2. Before the measurement
   a) Correct the valve clearance.
   b) Warm up engine [Bring the coolant temperature to about 80°C (176°F)].
   c) Charge the battery fully.
   d) Remove the air cleaner.
3. Measurement
   1) Measure at nozzle holder hole.
   a) Remove the nozzle holders.
   b) Install the gauge adapter in the nozzle holder hole.

Special Tool: Compression Gauge Adapter (09408-1041) (09552-1070)

   2) Measure at glow plug hole.
   a) Remove the glow plug.
   b) Install the gauge adapter in the glow plug hole.

Special Tool: Compression Gauge Adapter (09552-1051) (09552-1070)

   c) Connect a compression gauge to the gauge adapter.
   d) Drive the engine with the starter and read the compression pressure.

NOTE: Do not continuously operate the starter for more than 15 seconds at a time.

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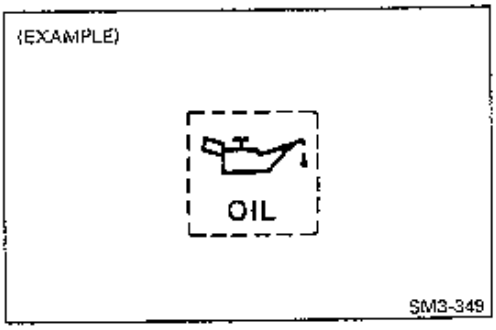
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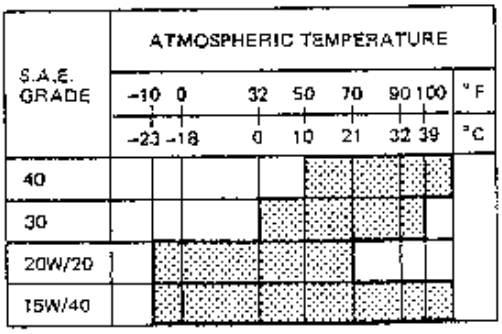
e). Measure the compression pressure for each cylinder. If the compression pressure is low, be sure to repeat the measuring.

NOTE: Be sure not to leak through sealing face.

Unit: MPa {kgf/cm², lbf/in²}

Engine model	Compression pressure		Difference between each cylinder	Engine speed (r/min)
	Standard	Limit		
W04D W04C-T	3.24–3.53 {33–36, 470–511}	2.45 {25, 356}	Less than 0.294 {3, 43}	350
W04C-TI	2.95–3.23 {30–33, 427–469}	2.16 {22, 313}		
W06D W06E	3.24–3.53 {33–36, 470–511}	2.45 {25, 356}		280
W06D-TI	2.75–3.04 {28–31, 399–440}	216 {22, 313}		
W06D-TI-II	2.60–2.89 {26.5–29.5, 379–419}			





3. Decreased oil pressure
Check the oil pressure warning lamp when the oil and coolant temperature is not [about 80°C {176°F}].
a. If the warning lamp is lighted, check the oil level.
b. Check oil deterioration.
If oil quality is poor, replace with a suitable grade oil.
c. Remove the oil pressure switch and install the oil pressure gauge.
d. Measure the oil pressure at coolant temperature 80°C {176°F} or more.

Standard oil pressure: 49–490 kPa {0.5–5.0 kgf/cm², 7.11–71.10 lbf/in²}

Service limit: Less than 49 kPa {0.5 kgf/cm², 7.11 lbf/in²}

3. Other factors
a. The blow-by gas increase.
b. The engine does not start easily.
c. Engine output decreases.
d. Fuel consumption increases.
e. Engine makes greater noise.
f. Excessive oil consumption.

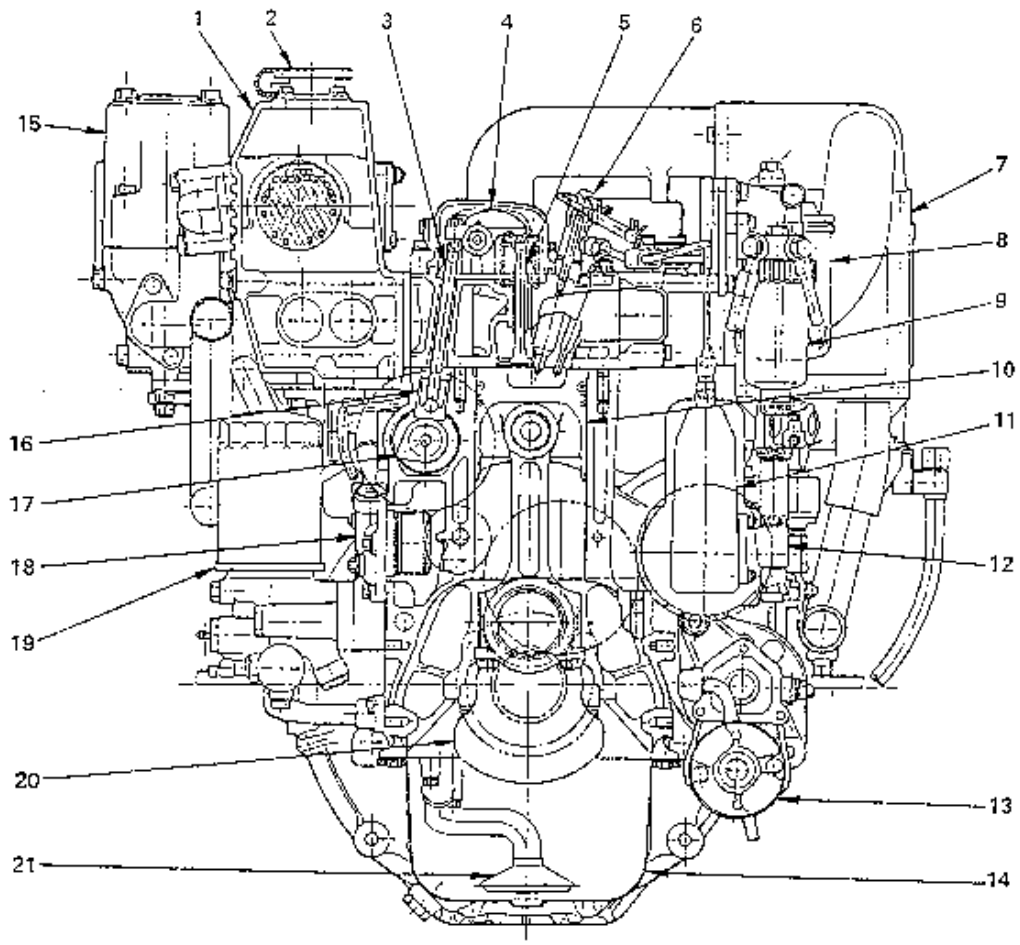
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ENGINE MOVING PARTS

DESCRIPTION

Representative engine model W06D-TI



SM3-1921

1. Heat exchanger (Exhaust manifold)
2. Coolant filler cap
3. Push rod
4. Rocker arm
5. Valve
6. Fuel injection nozzle
7. Intercooler
8. Fuel filter
9. Water separator
10. Piston
11. Fuel injection pump
12. Fuel feed pump
13. Starter
14. Oil pan
15. Exhaust pipe
16. Tappet
17. Camshaft
18. Oil cooler
19. Oil filter
20. Crankshaft
21. Oil strainer

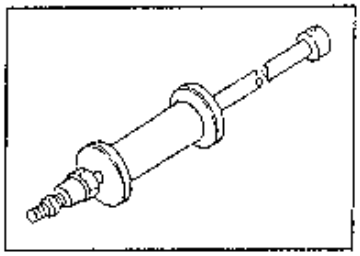
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SPECIAL TOOL

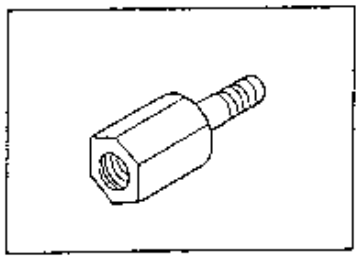
Prior to starting an engine overhaul, it is necessary to have the following.

SLIDING HAMMER
(For nozzle holder)



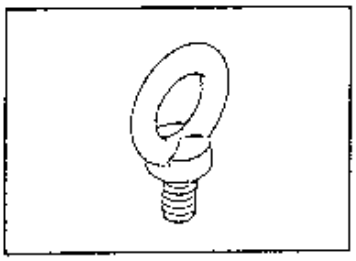
09420-1442

ADAPTOR



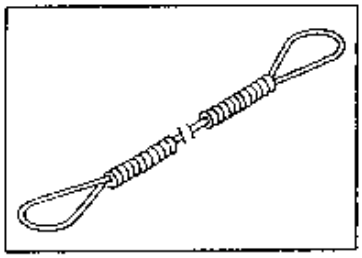
09462-1130
(Used with 09420-1442)

EYE BOLT
(For cylinder head)



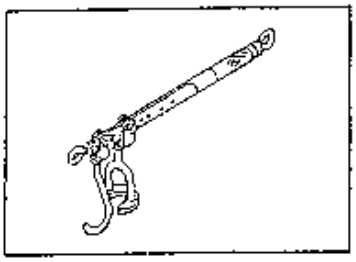
09433-1070
(Used with 09491-1010)

WIRE



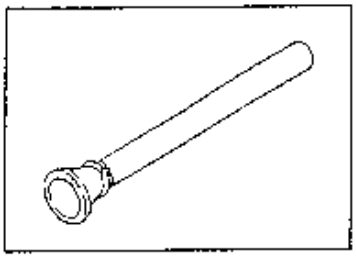
09491-1010

VALVE SPRING PRESS



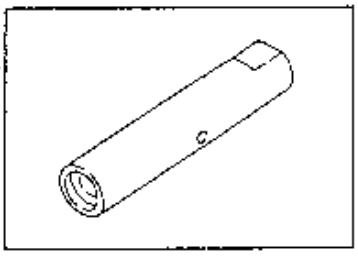
09470-1022

VALVE LAPPING TOOL



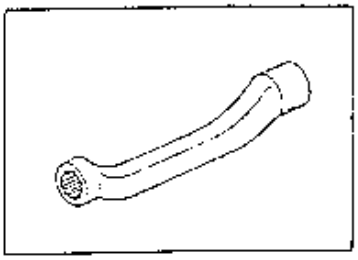
09431-1010

VALVE STEM SEAL PRESS



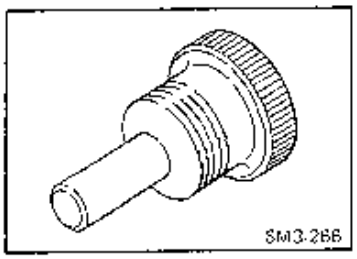
09472-1650

CYLINDER HEAD BOLT WRENCH



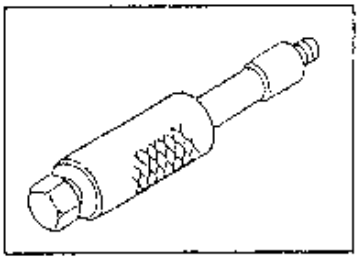
09411-1260

TIMER SETTING TOOL



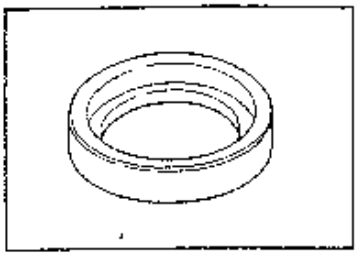
09512-2100

SLIDING HAMMER
(For idle gear shaft)



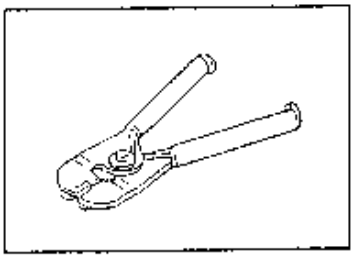
09420-1100

TIMING GEAR CASE OIL SEAL PRESS



09482-1530

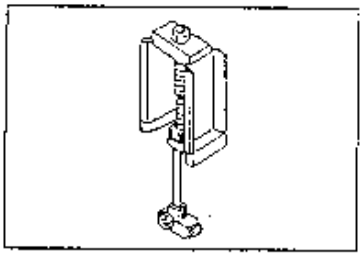
PISTON RING EXPANDER



09442-1180

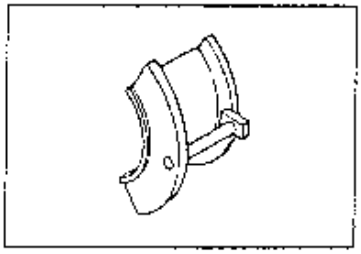
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CYLINDER LINER PULLER



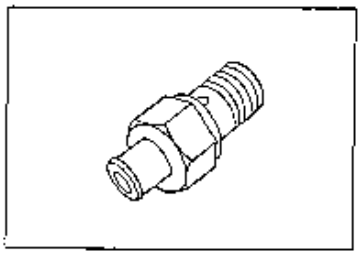
09420-1460

CYLINDER LINER GUIDE



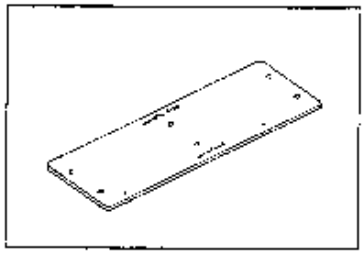
09480-1120

CONNECTOR BOLT
(For piston cooling jet)



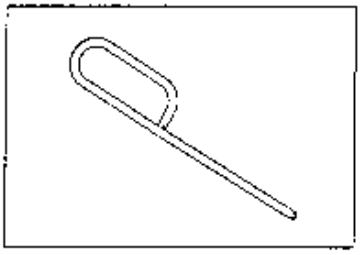
09462-1400 (For W06D-TI-II)

TARGET PLATE
(For piston cooling jet)



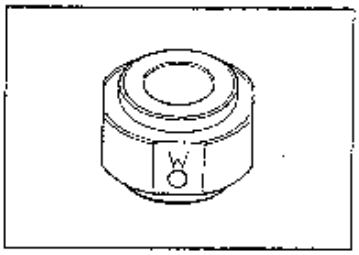
09444-1600 (For W06D-TI-II)

ADJUSTING BAR
(For piston cooling jet)



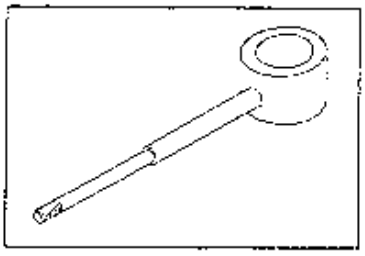
09472-1620 (For W06D-TI-II)

GUIDE
(For piston pin bushing)



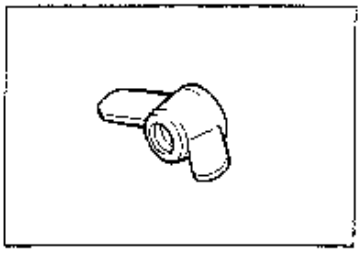
09481-1130

PRESS SUBASSEMBLY
(For piston pin bushing)



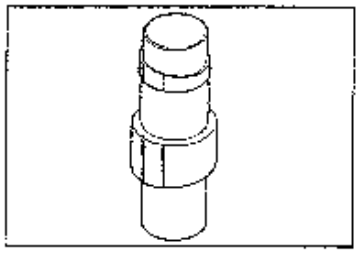
09402-1450

WING NUT
(For piston pin bushing)



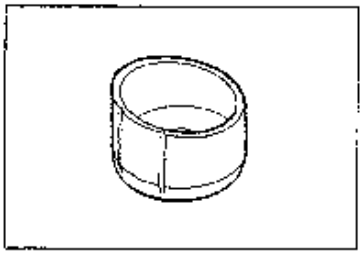
9233-10360

SPINDLE
(For piston pin bushing)



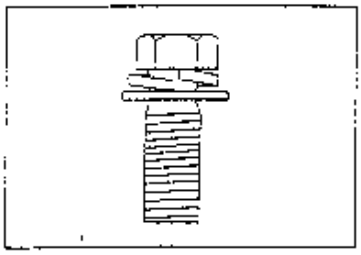
09402-1460

GUIDE
(For piston pin bushing)



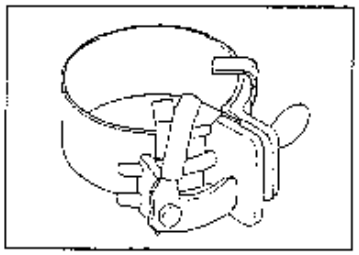
09481-1120

BOLT
(For piston pin bushing)



9191-08252

PISTON RING HOLDER

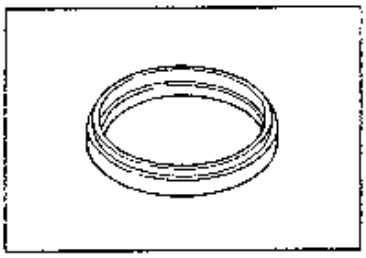


09441-1260

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FLYWHEEL HOUSING OIL SEAL PRESS



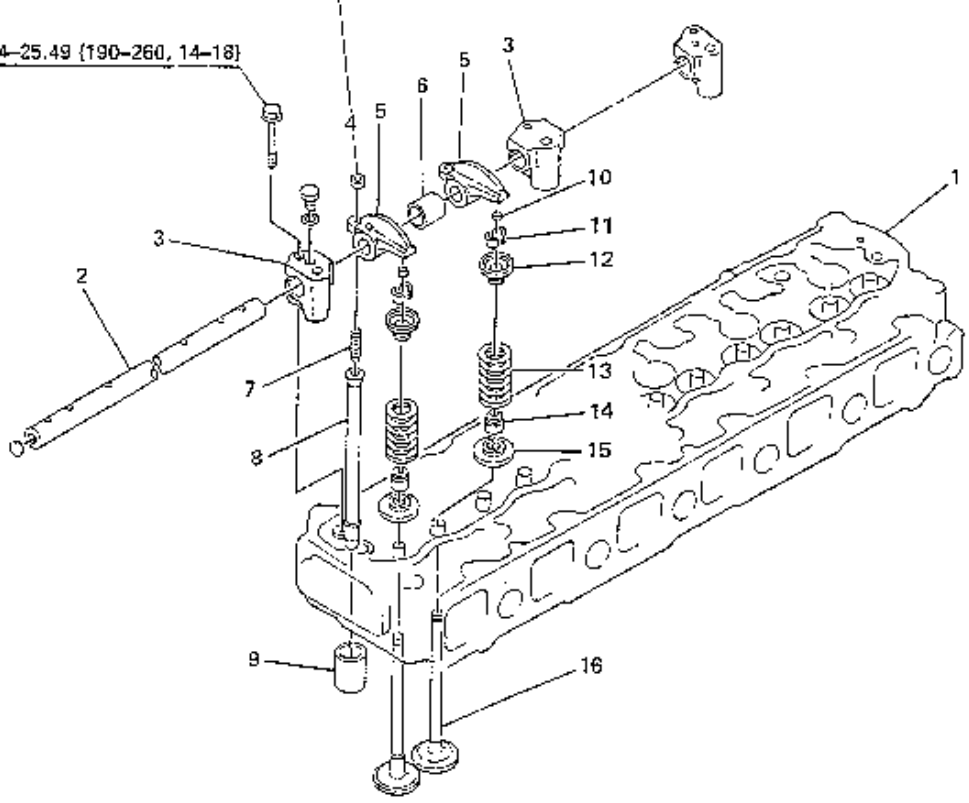
09482-1540

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CYLINDER HEAD

OVERHAUL

HE11–C59–00XC0 (1310)



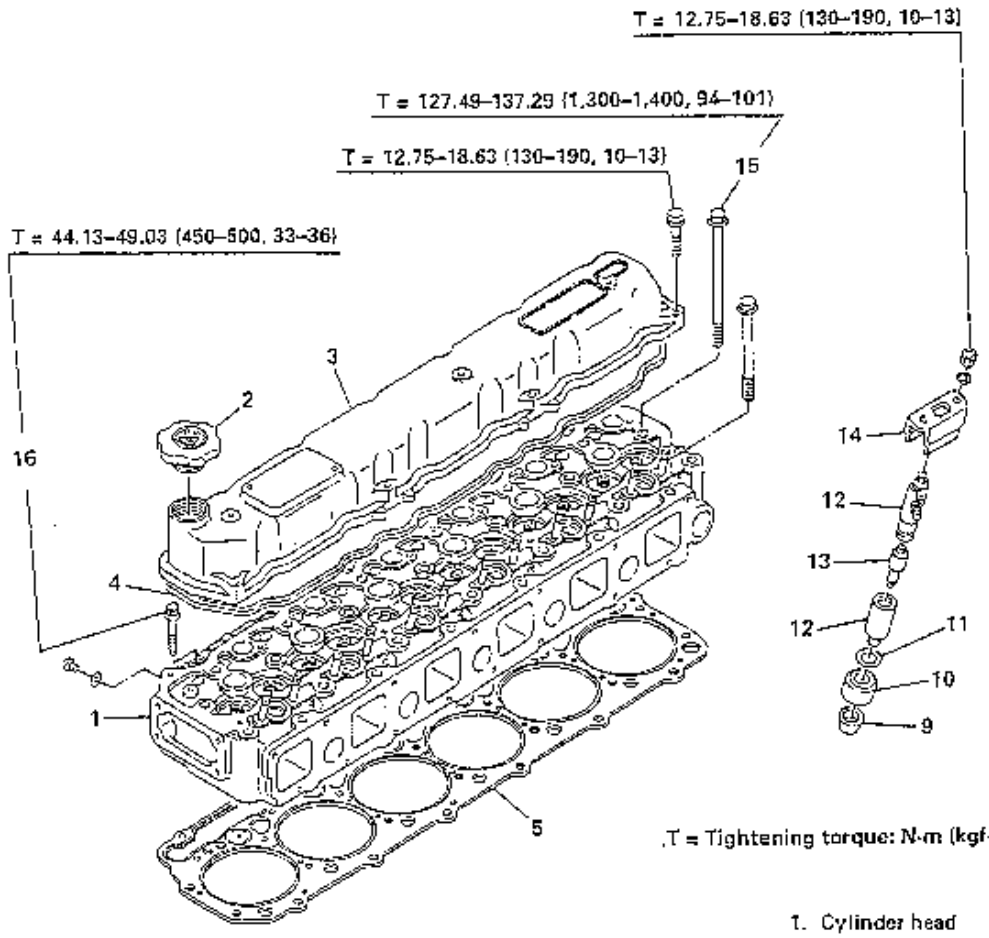
T = Tightening torque: N·m {kgf·cm, lbf·ft}

1. Cylinder head
2. Rocker arm shaft
3. Rocker arm support
4. Adjusting screw lock nut
5. Rocker arm
6. Bushing
7. Valve clearance adjusting screw
8. Push rod
9. Tappet
10. Valve stem cap
11. Cotter key
12. Valve spring upper seat
13. Valve spring
14. Valve stem oil seal
15. Valve spring lower seat
16. Valve

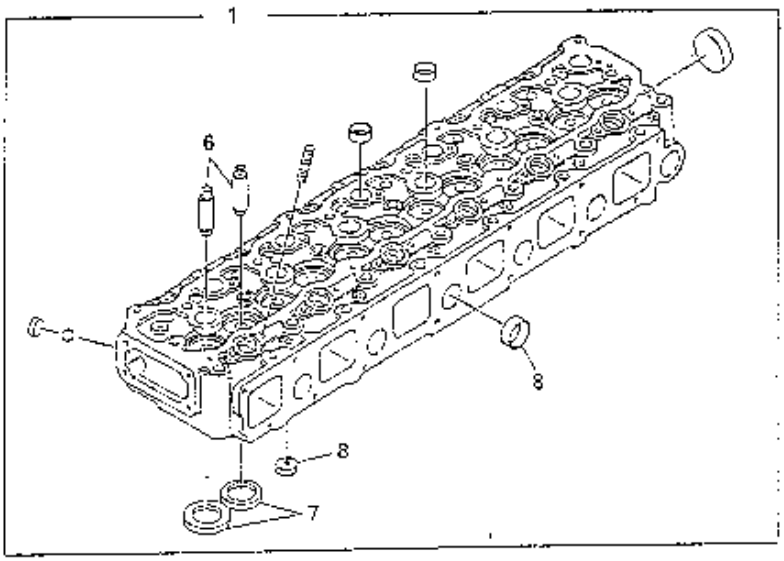
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OVERHAUL



T = Tightening torque: N·m (kgf·cm, lbf·ft)

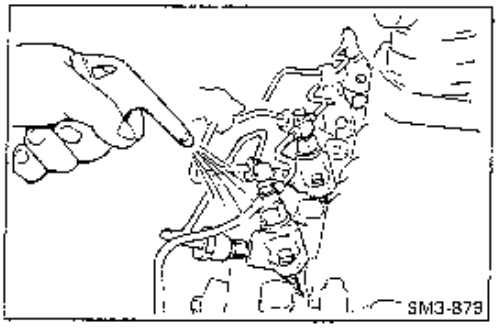


1. Cylinder head
2. Oil filler cap
3. Cylinder head cover
4. Cylinder head cover gasket
5. Cylinder head gasket
6. Valve guide
7. Valve seat
8. Expansion plug
9. Nozzle holder gasket
10. Packing ring
11. Shim
12. Nozzle holder
13. Nozzle
14. Nozzle holder adapter
15. Cylinder head bolt
16. Cylinder head additional bolt

SM3-927

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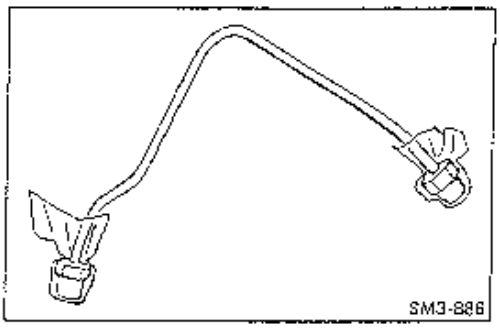
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IMPORTANT POINTS – DISASSEMBLY

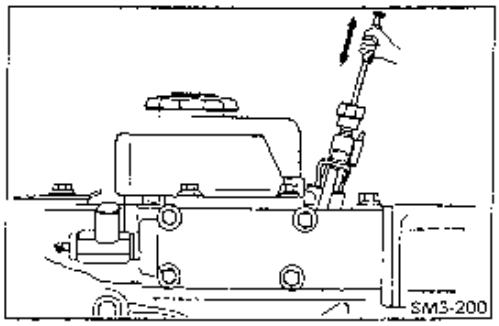
CLEAN OFF SURROUNDING AREA OF THE INJECTION NOZZLE HOLDERS AND THE FUEL LINE CONNECTORS.

NOTE: If foreign matter is allowed to enter the combustion chamber, engine trouble may result.



REMOVE THE INJECTION PIPES.

NOTE: Cover open ends of the pipes and fuel injection pump to prevent entry of dirt.

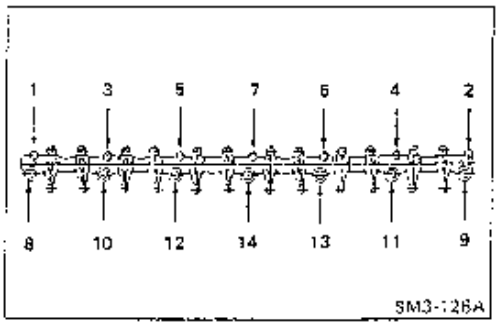


REMOVE THE INJECTION NOZZLE HOLDERS.

Using a special tool, if the nozzle holder is difficult to remove by hand.

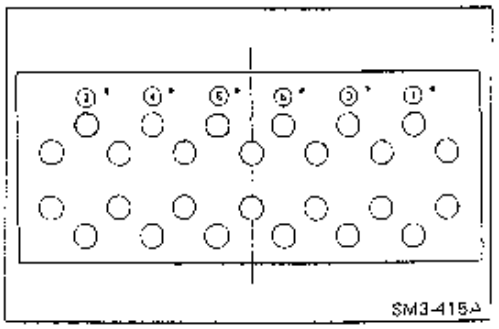
Special Tool: Sliding Hammer (09420-1442)
Adapter (09462-1130)

NOTE: ○ After removal of the nozzle holder, cover the nozzle holder with cloth. Also cover the cylinder head with a cloth to prevent dust from getting in.



REMOVE THE ROCKER ARM ASSEMBLY.

Loosen the rocker arm support bolts and cylinder head bolt little by little in three stages and in the numerical order shown.

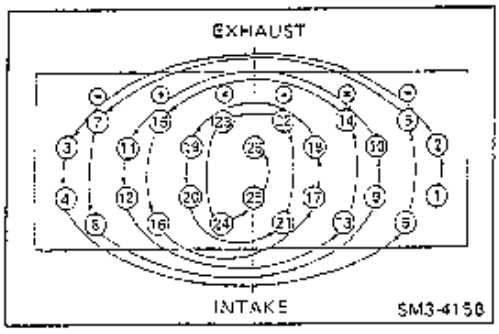


LOOSEN THE CYLINDER HEAD BOLTS AND REMOVE THEM.

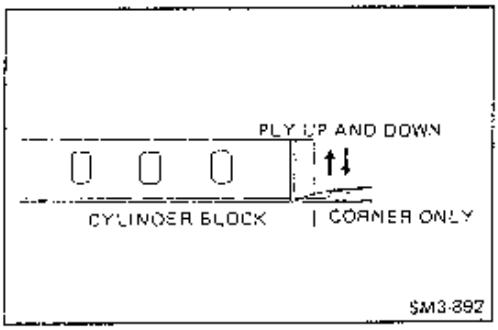
Loosen the cylinder head additional bolts in the numerical order shown.

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Loosen the cylinder head bolts little by little in three stages and in the numerical order shown.

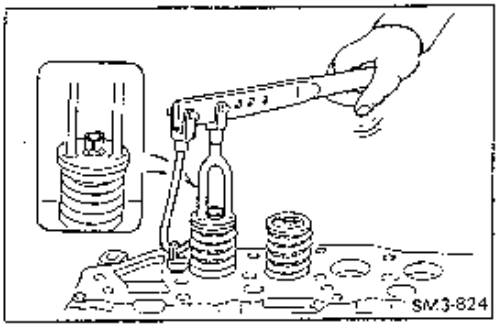


LIFT THE CYLINDER HEAD FROM THE DOWELS ON THE CYLINDER BLOCK AND PLACE IT ON WOODEN BLOCKS.

1. Remove the valve stem cotters, upper valve seats, and valve springs from cylinder head.

NOTE: Do not damage the machined surface of the head or block when removing the cylinder head.

Special Tool: Eye Bolt (09433-1070)
Wire (09491-1010)



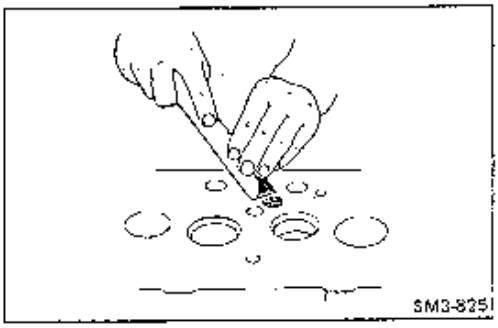
REMOVE THE VALVE SPRINGS.

1. Remove the valve stem cotters, upper valve seats, and valve springs from cylinder head.

Special Tool: Valve Spring Press (09470-1022)

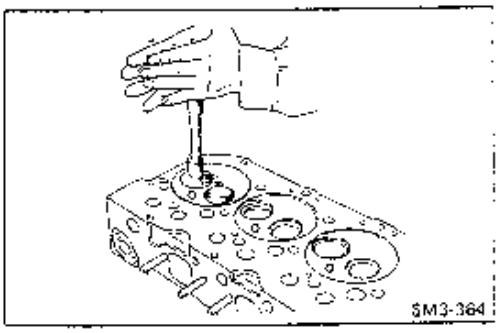
2. Remove the intake and exhaust valves.
3. Tag valves to identify their cylinder numbers and to eliminate valve lapping.

IMPORTANT POINTS – ASSEMBLY



CLEAN THE CYLINDER HEAD THOROUGHLY WITH A SUITABLE SOLVENT.

NOTE: Be careful not to damage the cylinder head surface.



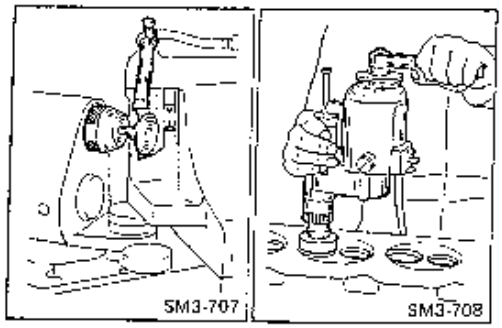
IF NECESSARY, HAND-LAP THE VALVE AND VALVE SEAT.

Lightly apply lapping compound to the valve face. Install the valve with a special tool, tap and rotate the valve against the seat.

Special Tool: Valve Lapping Tool (09431-1010)

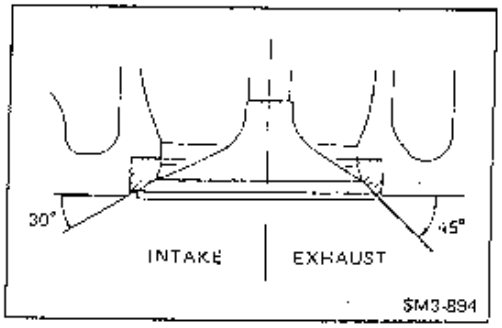
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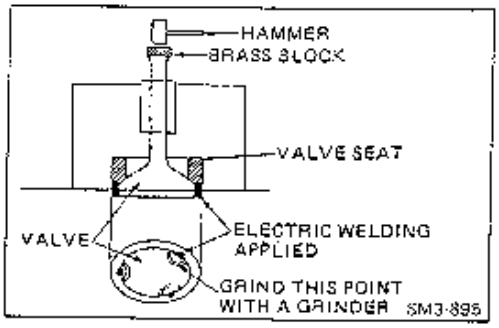
IF NECESSARY, GRIND THE VALVES AND VALVE SEATS.

NOTE: ○ Grinding of valves and valve seats should only be performed when hand-lapping does not result in proper seating.
○ After grinding, always recheck the valve sink.



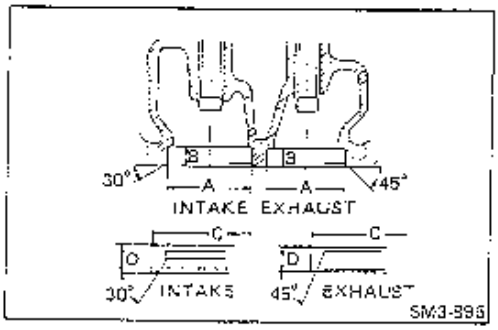
Standard:

Valve Seat (Intake)	:	30° – 30°30′
Valve Face (Intake)	:	29°45′ – 30°15′
Valve Seat (Exhaust)	:	45° – 45°30′
Valve Face (Exhaust)	:	44°45′–45°15′



IF NECESSARY, REPLACE THE VALVE SEAT.

1. Cut the circumference of a valve head at three places with a grinder and install it into the seat as shown and weld the valve to the seat. Then drive the valve and the seat out with a hammer and a brass block.



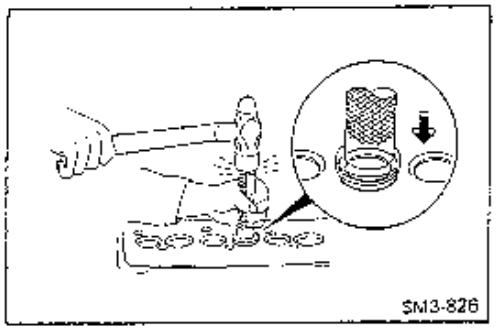
2. Valve seat section machining specifications.

Unit: mm (in)

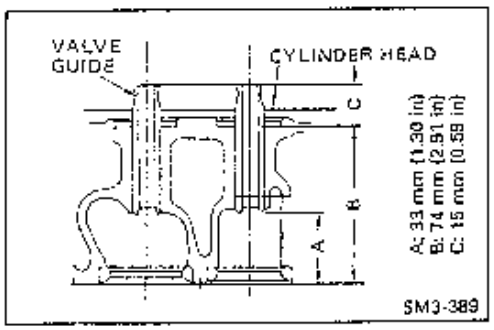
		Intake	Exhaust
Cylinder head dimension	A	46.500–46.516 (1.8308–1.8313)	41.000–41.016 (1.6142–1.6148)
	B	8.8–9.0 (0.3465–0.3543)	7.2–7.4 (0.2835–0.2913)
Valve seat dimension	C	46.585–46.600 (1.8341–1.8346)	41.130–41.145 (1.6193–1.6198)
	D	7.5–7.7 (0.2953–0.3031)	6.0–6.2 (0.2363–0.2440)

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SM3-826

3. Valve seat installation
   Heat the cylinder head to about 80° – 100°C (176 – 212°F) with hot water. On the other hand, cool the valve seat with dry ice or liquid nitrogen for about 30 minutes. Hold the seat with pincers and place it into the heated cylinder head.

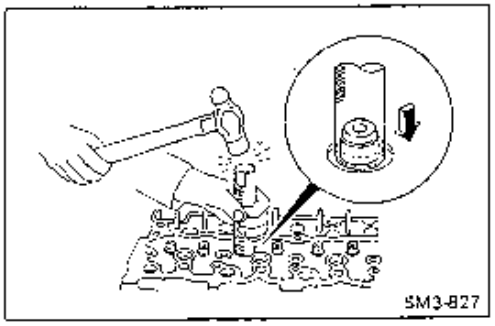


SM3-389

IF NECESSARY, REPLACE THE VALVE GUIDE.

1. Remove the valve stem seal.
2. Using a brass rod and hammer, drive out the valve guide.
3. Install the valve guide.

NOTE: Apply engine oil lightly to the valve guide outer circumference before installation.

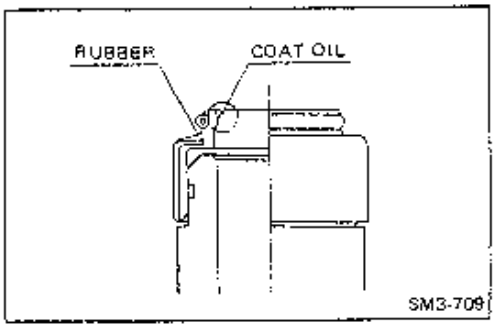

SM3-827

IF NECESSARY, REPLACE THE VALVE STEM SEAL.

1. Remove the valve stem seal.
2. Install the valve stem seal.

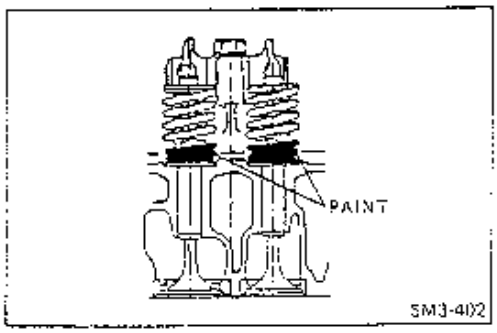
   First, install the lower spring seat (for stopper of special tool) and valve. Then apply engine oil to the lip of the stem seal and drive the special tool until it hits the lower spring seat.

Special Tool: Stem Seal Press (09472-1650)



SM3-709

NOTE:
- After installing stem seal, make sure that check the rubber position for cracks or any other damage.
- Do not use the special tool if its tip (surface contacting lower spring seat) is worn or deformed.



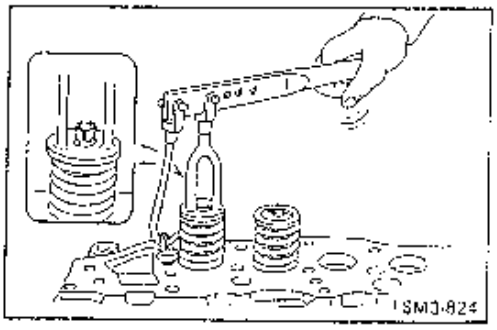
SM3-402

ASSEMBLE THE CYLINDER HEAD.

NOTE:
- Apply engine oil to contact surfaces of all parts.
- Make sure that the valves are installed in the correct cylinders.
- Install the valve springs with their painted side down, since they have variable pitches.

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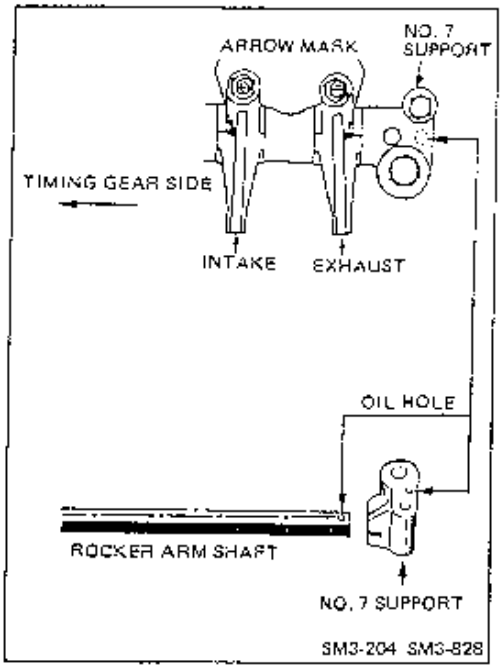
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SM3-824

Press upper spring seats and install the valve stem keys securely in the upper spring seats.

Special Tool: Valve Spring Press (09470-1022)

NOTE: ○ When pressing with the valve spring press, be careful not to damage the stem seals by contacting the upper seats.
○ Drive the valve stem lightly with a hammer to assure proper fit the valve stem key.



SM3-204 SM3-828

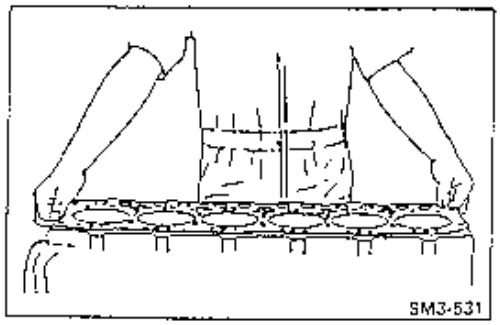
ASSEMBLE THE ROCKER ARM.

Lubricate the rocker arm shaft and bushing.

NOTE: Confirm that oil hole of rocker arm assembly No. 7 support aligns with shaft oil hole. Improper installation will result in burning of the entire valve assembly.

INSTALL THE TAPPETS IN THE CYLINDER BLOCK IN CORRECT ORDER.

NOTE: Apply engine oil to the tappet faces and tappet guide when installing them in the cylinder block.

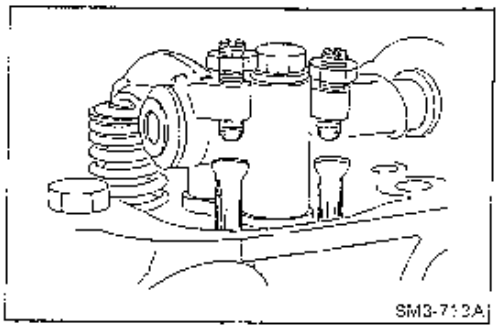

SM3-531

INSTALL THE CYLINDER HEAD AND ROCKER ARM ASSEMBLY.

1. Install the cylinder head gasket.

NOTE: Always use new cylinder head gasket after cleaning the surfaces of the cylinder head, cylinder block and head gasket free of all dirt, water and grease.

2. Install the cylinder head over the dowels on the cylinder block.

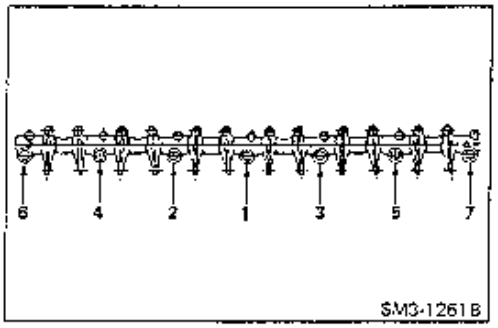

SM3-713A

3. Insert the push rods in correct order, after applying engine oil to both ends.
4. Mount the rocker arm assembly on the cylinder head, make sure that the push rods interlock with the adjusting screws.

NOTE: Always loosen the lock nut and raise the adjusting screws fully to the top.

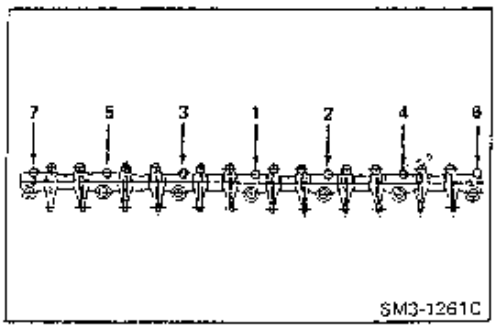
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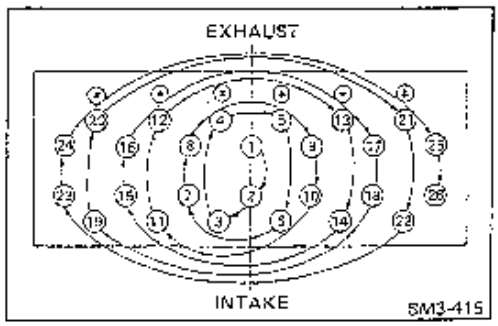


5. Tighten the cylinder head bolts and rocker arm support bolts provisionally.

Tightening order: 1–2–3–4–5–6–7



Tightening order: 1–2–3–4–5–6–7

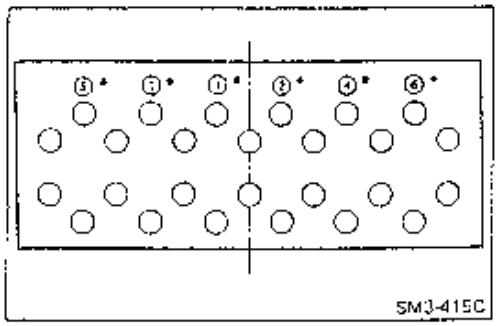


6. Tighten the cylinder head bolts in three stages following the tightening order shown.
Tighten the bolts Ø12 mm (0.47 in) to the specified torque.

NOTE: Apply engine oil to the bolt threads and under the bolt head.

* Mark bolts (cylinder head additional bolt): Ø 10 mm (0.39 in)
No. 1 – No. 26 Bolts (Cylinder head bolt) : Ø 12 mm (0.47 in)

Special tool: Wrench (09411-1260)



7. Tighten the cylinder head additional bolts and rocker arm support bolts in three stages following the tightening order.
Tighten the bolts to the specified torque.

Tightening order: 1–2–3–4–5–6

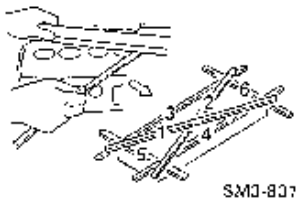
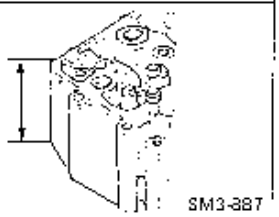
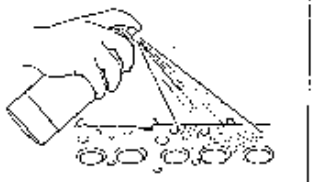
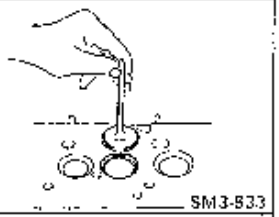
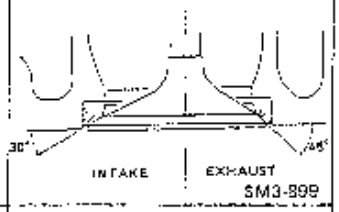
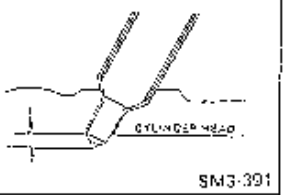
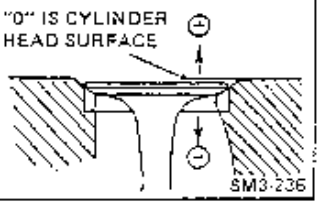
8. Retighten the cylinder head bolts.

NOTE: Refer to section ENGINE TUNE-UP.

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INSPECTION AND REPAIR

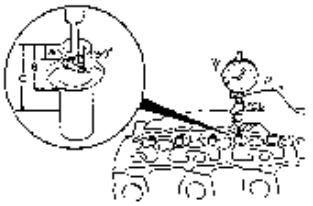
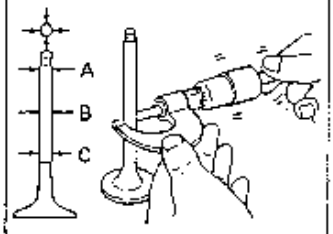
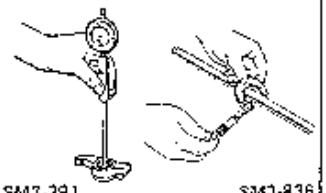
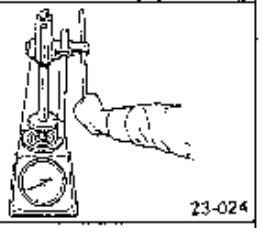
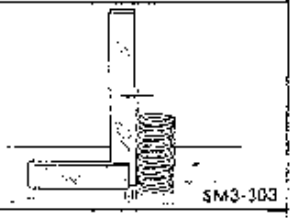
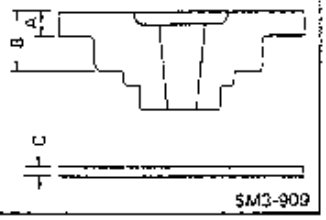
Unit: mm (in)

Inspection Item		Standard	Limit	Remedy	Inspection Procedure
Cylinder Head Flatness		Less than 0.05 (0.0019)	0.1 (0.0039)	Regrind or replace	 SM3-807
Cylinder Head Height		87.0 (3.425)	86.8 (3.417)	Replace	 SM3-887
Cylinder Head Cracks and Damage * Using a Dye Penetrant		–	–	Replace, if necessary	 SM3-832
Valve Seating Condition * Using Red Lead Marking Compound		There should be good contact around entire circumfrence of valve head.	–	Hand-lap with lapping compound	 SM3-833
Valve Seat Angle	Intake	30°–30°30′	–	Regrind or replace valve and/or valve seat	 SM3-899
	Exhaust	45°–45°30′			
Valve Angle	Intake	29°45′–30°15′			
	Exhaust	44°45′–45°15′			
Nozzle Protrution from Cylinder Head Surface		2.75–3.25 (0.1083–0.1279)	–	Replace nozzle gasket	 SM3-391
Intake Valve Sink		-0.05– -0.35 (-0.0020– -0.0138)	-0.55 (-0.0216)	Replace valve and/or valve seat	 SM3-236
Exhaust Valve Sink		-0.47– -0.77 (-0.0185– -0.0303)	-0.87 (-0.0342)		

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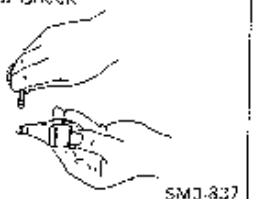
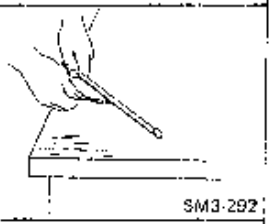
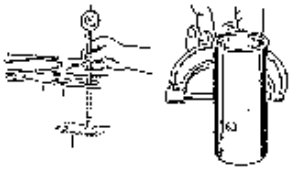
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Unit: mm (in)

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Intake Valve Stem Diameter	8.95–8.97 (0.3524–0.3531)	8.90 (0.3503)	Replace valve guide and/or valve	 A: 5 (0.197) B: 25 (0.984) C: 45 (1.771) SM3-834
Exhaust Valve Stem Diameter	8.93–8.95 (0.3516–0.3524)	8.80 (0.3464)		
Intake and ExhaustValve Guide Diameter	9.000–9.015 (0.3544–0.3549)	A &B: 9.05 (0.3562) C: 9.10 (0.3582)		
Clearance between Valve Stem and Valve Guide (Intake)	0.35–0.068 (0.0014–0.0026)	A & B: 0.10 (0.0040) C: 0.18 (0.0071)		 SM3-835
Clearance between Valve Stem and Valve Guide (Exhaust)	0.050–0.083 (0.0020–0.0032)	A &B: 0.12 (0.0047) C: 0.2 (0.0078)		
Rocker Arm Shaft Diameter	18.97–18.98 (0.7469–0.7472)	18.95 (0.7461)	Replace rocker arm bushing and/or shaft	 SM3-291 SM3-836
Clearance between Rocker Arm Shaft and Rocker Arm Bushing	0.036–0.079 (0.0014–0.0031)	0.1 (0.0039)		
Valve Spring Setting Load	268.7 N (27.4 kgf, 60.4 lbf) at 45.5 (1.79)	250.1 N (25.5 kgf, 56.2 lbf)	Replace	 23-024
Valve Spring Straightness	–	2.0 (0.0787)	Replace	 SM3-303
Valve Spring Seat for Wear	A: 2.5 (0.0984) B: 5.0 (0.1969) C: 1.0 (0.0394)	–	Repalce	 SM3-909

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Unit: mm (in)

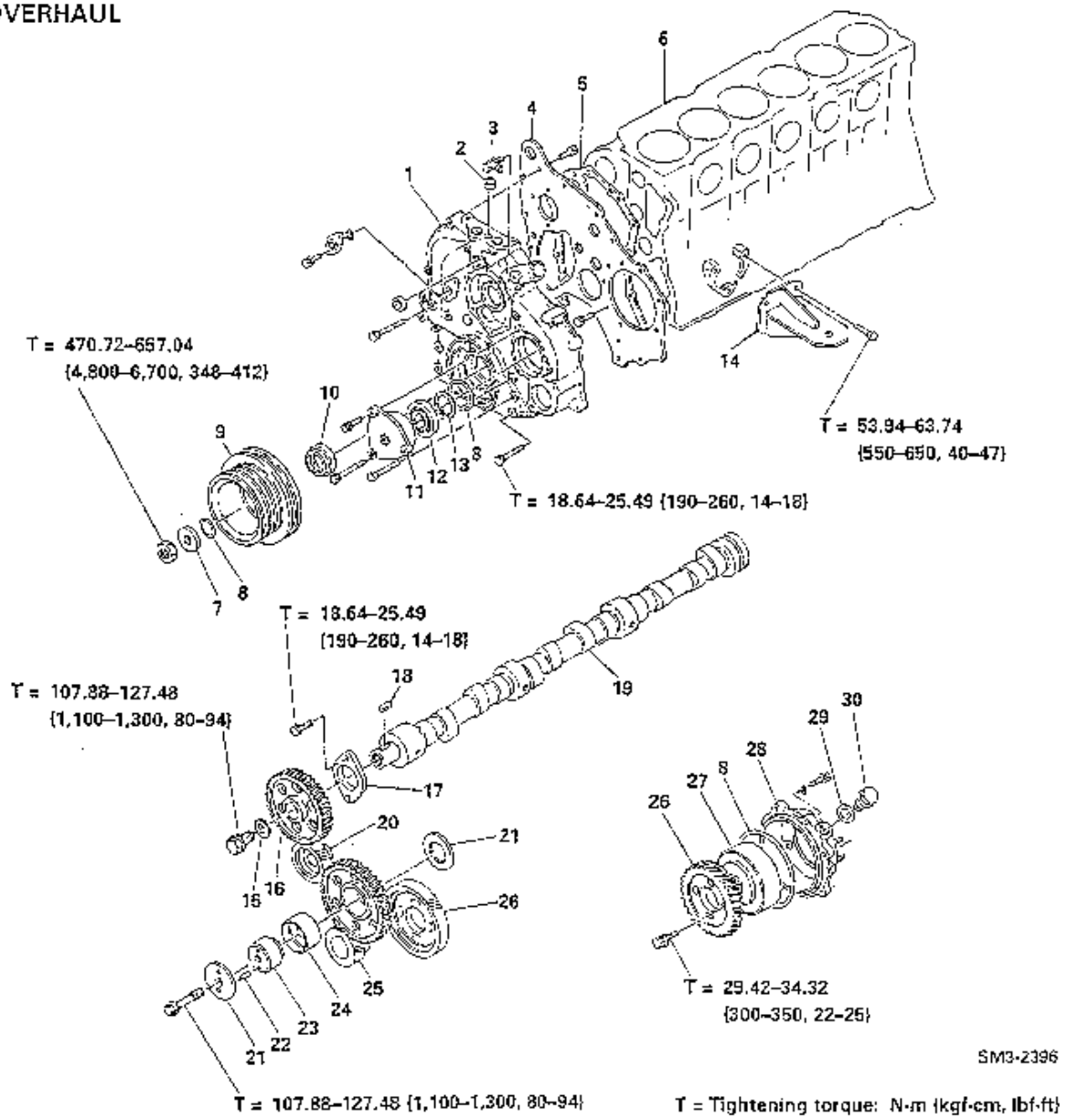
Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Valve Stem Tip Surface for Wear	—	—	Resurface or replace	Visual Check  SM3-327
Valve Stem Contact Surface of Rocker Arm for Wear				
Push Rod Bend	—	0.3 (0.0118)	Replace	 SM3-292
Tappet Diameter	26.95–26.97 (1.0611–1.0618)	—	Replace tappet	 SM3-420 SM3-293
Tappet Guide Inside Diameter	27.00–27.02 (1.0630–1.0637)	—		
Clearance between Tappet and Tappet Guide	0.025–0.071 (0.0010–0.0027)	0.1 (0.0039)		
Tappet for Wear	Should not be worn unevenly.	—	Replace, if necessary	Visual Check

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TIMING GEAR, CAMSHAFT AND OIL PAN

OVERHAUL



T = Tightening torque: N·m {kgf·cm, lbf·ft}

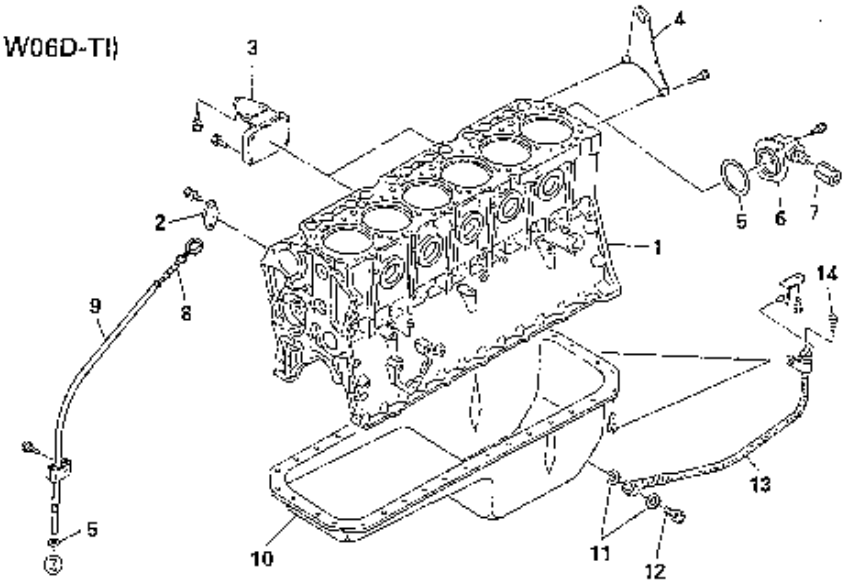
1. Timing gear cover
2. Expansion plug
3. Connector
4. Timing gear plate
5. Gasket
6. Cylinder block
7. Plain washer
8. O-ring
9. Crankshaft pulley
10. Oil seal
11. Bearing holder case
12. Ball bearing
13. Retainer ring
14. Engine mounting bracket
15. Thrust washer
16. Camshaft gear
17. Thrust bearing
18. Key
19. Camshaft
20. Oil pump drive gear
21. Idler gear thrust plate
22. Straight pin
23. Idler gear shaft
24. Bearing
25. Crankshaft gear
26. Injection pump drive gear
27. Coupling flange
28. Timer cover
29. Soft washer
30. Plug

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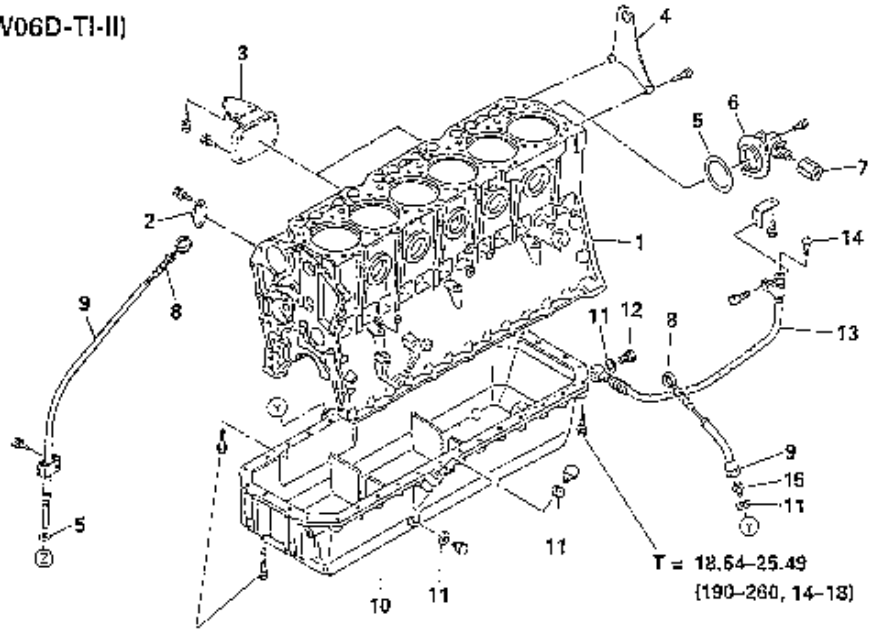
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OVERHAUL

(For W06D-TI)



(For W06D-TI-II)

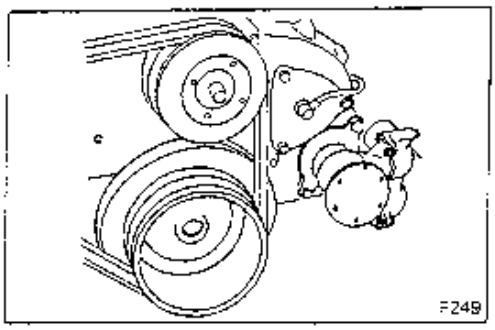


T = Tightening torque: N·m {kgf·cm, lbf·ft}

1. Cylinder block
2. Flange
3. Engine mounting bracket
4. Engine hanger bracket
5. O-ring
6. Tachometer drive assembly
7. Connector
8. Oil level gauge
9. Oil level gauge guide
10. Oil pan
11. Soft washer
12. Connector bolt
13. Oil drain hose
14. Oil drain plug
15. Pipe joint

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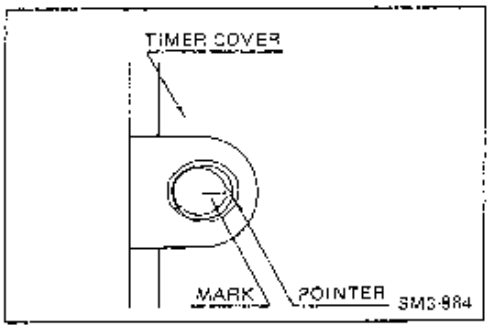


IMPORTANT POINTS – DISASSEMBLY

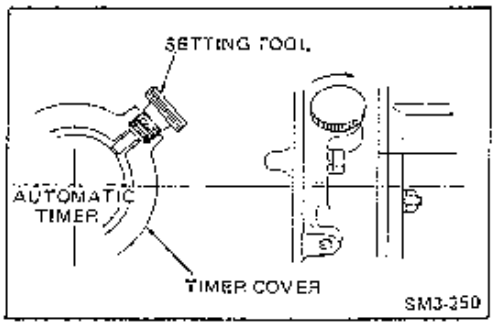
REMOVE THE FUEL INJECTION PUMP ASSEMBLY.

1. Remove the bearing holder case.

NOTE: Do not loosen the injection pump drive gear fitting bolts.



2. Remove the plug of the timer cover.
3. Turn the crankshaft counter-clockwise viewed from the flywheel to align the injection timing mark with pointer.

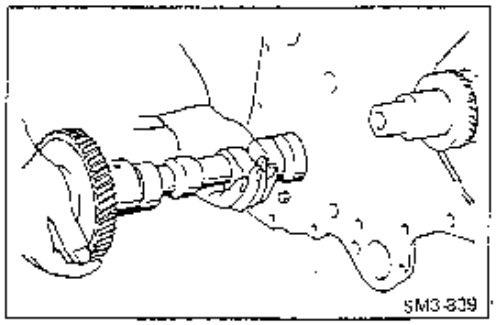


4. Install the setting tool.

Special Tool: Timer Setting Tool (09512-2100)

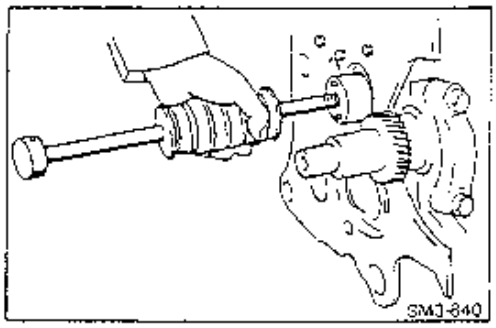
5. Loosen the timer cover fitting bolts and remove the fuel injection pump with timer cover.

NOTE: Do not loosen the fuel injection pump body fitting nuts.



REMOVE THE CAMSHAFT WITH GEAR.

NOTE:
- Remove the tappets above the camshaft.
- Pull out the camshaft, slowly turning it so as not damage the bearings.



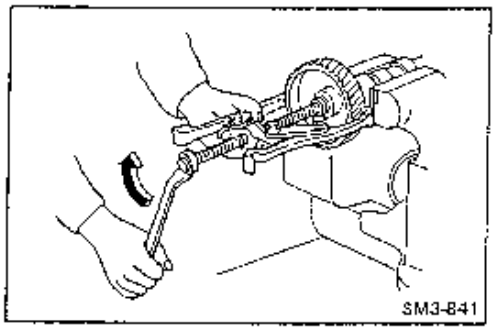
REMOVE THE IDLER GEAR SHAFT.

Using a special tool, remove the idler gear shaft.

Special Tool: Sliding Hammer (09420-1100)

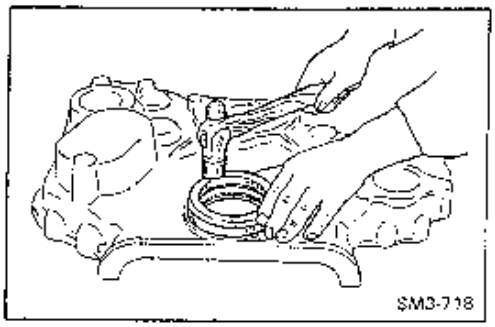
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IF NECESSARY, REMOVE THE CAMSHAFT GEAR.

1. Hold the camshaft with a vice through wooden plates.
2. Remove the bolt and plain washer, then using a gear puller, remove the gear.

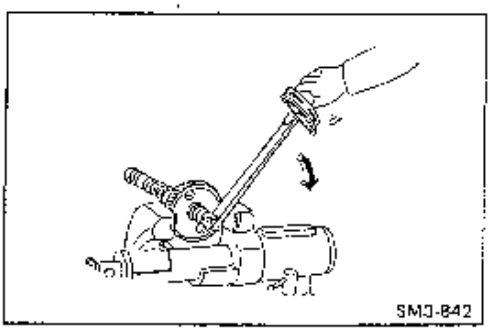


IMPORTANT POINTS – ASSEMBLY

IF NECESSARY, REPLACE THE TIMING GEAR COVER OIL SEAL.

1. Using a screwdriver, remove the oil seal.
2. Using a special tool, install the new oil seal.

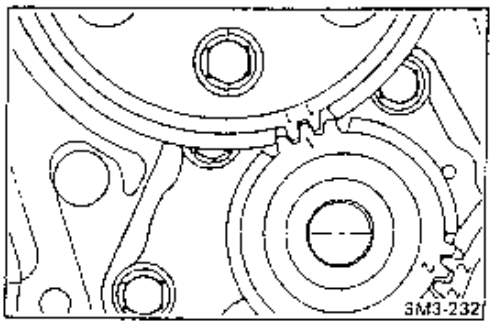
Special Tool: Press (09482-1530)



ASSEMBLE THE CAMSHAFT GEAR AND SHAFT.

Install the camshaft gear with thrust bearing.

NOTE: When installing the gear to the camshaft:
- Heat the gear in hot water [Approx. 100°C (212°F)], then install the gear to the camshaft by using a press.
- When tightening the bolt, apply engine oil to the threads and plate surface of the bolt.



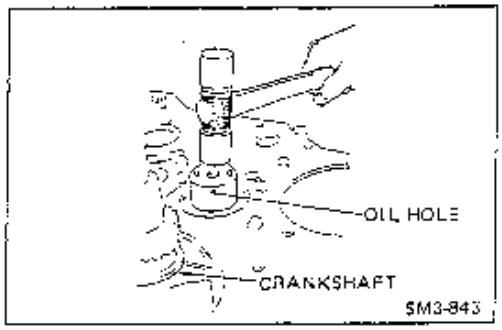
INSTALL THE CAMSHAFT.

Lubricate all journals of the camshaft and insert the camshaft assembly into the cylinder block.

NOTE:
- Insert the camshaft, slowly turning while inserting so that the bearing will not be damaged.
- When installing the camshaft, be sure that the match marks of the oil pump drive gear and camshaft gear are aligned correctly.

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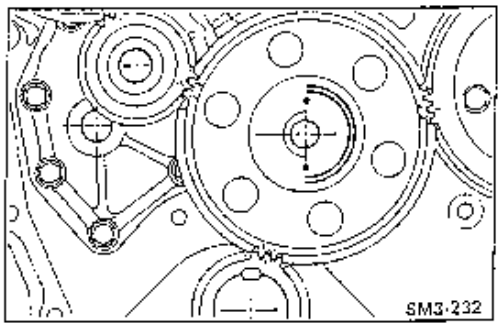
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INSTALL THE IDLER GEAR SHAFT.

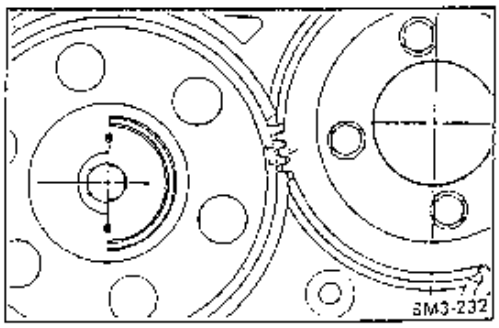
Install the idler gear shaft with thrust plate using a plastic hammer.

NOTE: Be sure that the oil hole is downward, if installed the wrong way, damage to the idler gear shaft and bushing can result.



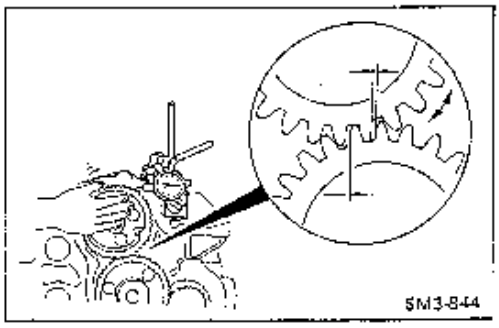
INSTALL THE IDLER GEAR.

NOTE: When installing the idler gear, be sure that the matching marks of the crankshaft gear, oil pump drive gear and idler gear are aligned correctly.



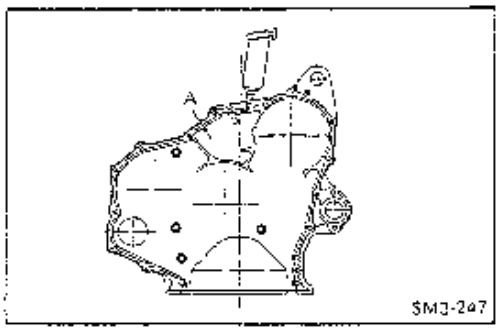
INSTALL THE INJECTION PUMP TEMPORARILY.

NOTE: When installing the injection pump, be sure that the match marks of the idler gear and injection pump drive gear are aligned correctly.



MEASURE THE GEAR BACKLASH.

Measure the backlash of each gear using a dial indicator.
Replace the gear if necessary.
Refer to INSPECTION AND REPAIR.



INSTALL THE TIMING GEAR CASE.

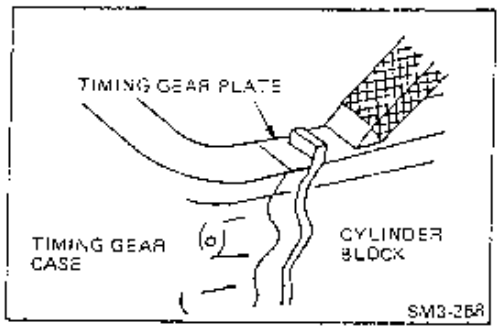
1. Clean the faces.
2. Apply the liquid gasket as shown and install the timing gear cover within 20 minutes.

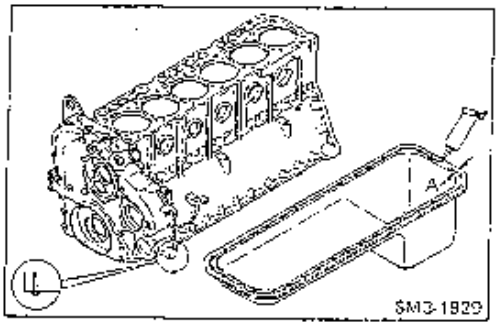
NOTE: If leaving it more than 20 minutes, clean the liquid gasket completely and reapply the liquid gasket.

- **Coating Width [A]: 1.5 – 2.5 mm (0.06 – 0.10 in)**

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INSTALL THE OIL STRAINER.

Refer to Section LUBRICATING SYSTEM.

INSTALL THE OIL PAN.

1. Cut the protrusion of the timing gear plate gasket from the oil pan mounting surface.
2. Clean the faces.
3. Apply the liquid gasket as shown and install the timing gear cover within 20 minutes.

NOTE: If leaving it more than 20 minutes, clean the liquid gasket completely and reapply the liquid gasket.

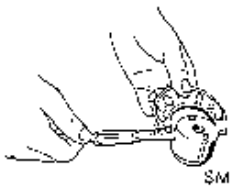
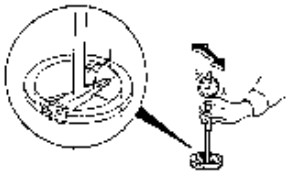
Coating Width (A): Approx. 3 – 4 mm (0.12 – 0.15 in)

TIGHTEN THE CRANKSHAFT PULLY.

NOTE: Apply engine oil to the nut threads.

INSPECTION AND REPAIR

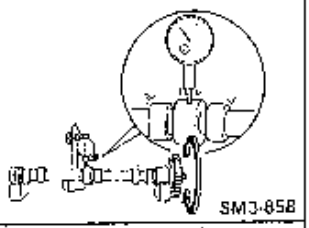
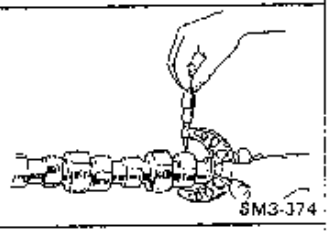
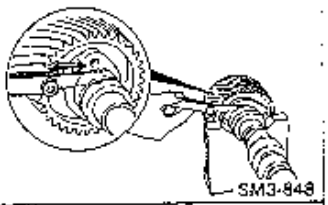
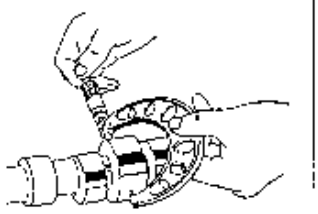
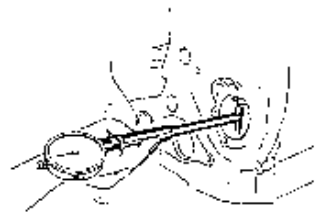
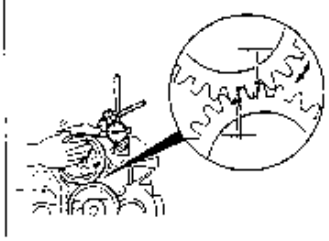
Unit: mm (in)

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Gear Teeth for Pitting or Wear	–	–	Replace, if necessary	Visual check  SM3-845
Idler Gear Shaft Diameter	49.95–49.97 (1.9666–1.9673)	49.93 (1.9657)	Replace bushing and/or shaft	 SM3-846
Idler Gear Bushing Inside Diameter	50.00–50.03 (1.9685–1.9696)	50.05 (1.9705)		
Oil Clearance between Idler Gear Shaft and Gear Bushing	0.03–0.08 (0.0018–0.0031)	0.1 (0.0039)		 SM3-847
Idler Gear end Play	0.04–0.10 (0.0016–0.0039)	0.15 (0.0059)	Replace thrust plate	 SM3-421

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Unit: mm (in)

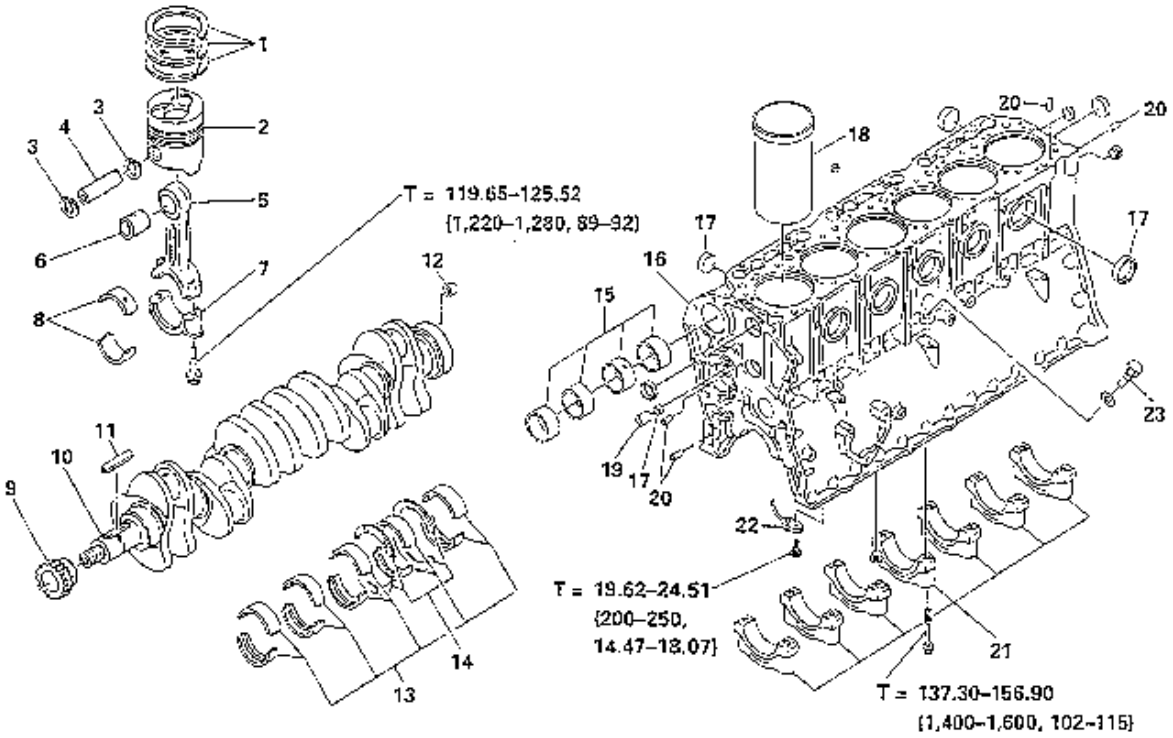
Inspection Item		Standard	Limit	Remedy	Inspection Procedure
Camshaft Bend		—	0.05 (0.0019)	Replace	 SM3-858
Camshaft Cam Height	Intake	49.44 (1.9465)	48.44 (1.9071)	Replace	 SM3-374
	Exhaust	49.50 (1.9488)	48.50 (1.9095)		
Camshaft End Play		0.10–0.18 (0.0040–0.0070)	0.30 (0.0118)	Replace thrust plate	 SM3-848
Camshaft Journal Diameter	No. 1	57.0 (2.2441)	56.85 (2.2383)	Replace shaft and/or bearing	 SM3-849
	No. 2	56.8 (2.2362)	56.65 (2.2303)		
	No. 3	56.6 (2.2283)	56.45 (2.2224)		
	No. 4	56.4 (2.2205)	56.25 (2.2145)		
Camshaft Journal Bearing Inside Diameter	No. 1	57.0 (2.2441)	57.15 (2.2500)		 SM3-850
	No. 2	56.8 (2.2362)	56.95 (2.2421)		
	No. 3	56.6 (2.2283)	56.75 (2.2342)		
	No. 4	56.4 (2.2204)	56.55 (2.2263)		
Oil Clearance between Camshaft Journal and Bearing		0.03–0.12 (0.0012–0.0047)	0.15 (0.0059)		
Timing gear backlash	Crankshaft Gear – Idler Gear	0.068–0.194 (0.0027–0.0076)	0.30 (0.0118)	Replace gear, if necessary.	 SM3-844
	Idler Gear – Oil Pump Gear	0.065–0.182 (0.0026–0.0071)			
	Idler Gear – Injection Pump Gear	0.065–0.182 (0.0026–0.0071)			
	Oil Pump Gear – Camshaft Gear	0.065–0.182 (0.0026–0.0071)			

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PISTON, CRANKSHAFT, CYLINDER BLOCK AND FLYWHEEL HOUSING

OVERHAUL

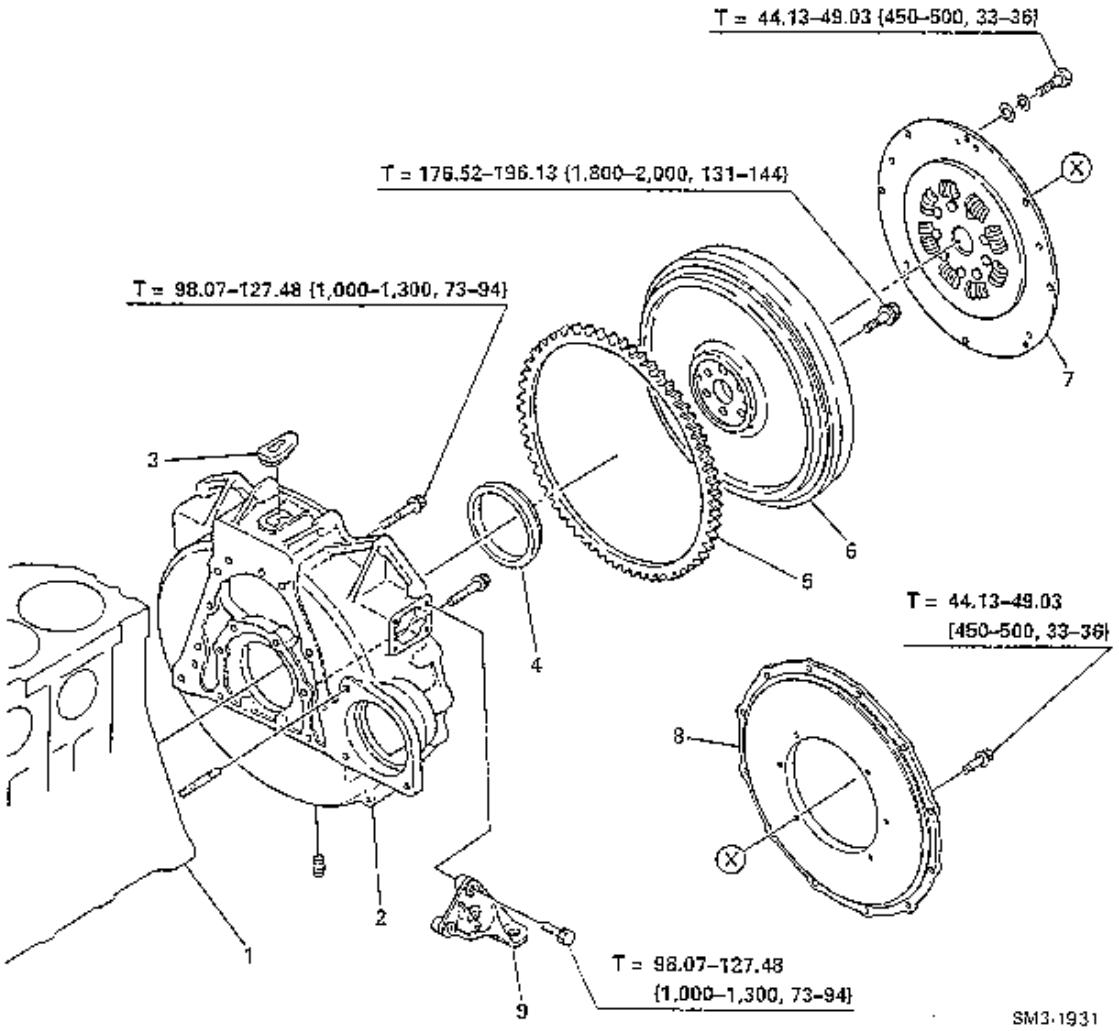


T = Tightening torque: N·m {kgf-cm, lbf-ft}

1. Piston ring
2. Piston
3. Retainer ring
4. Piston pin
5. Connecting rod
6. Piston pin bushing
7. Connecting rod cap
8. Conecting rod bearing
9. Crankshaft gear
10. Crankshaft
11. Key
12. Collar
13. Main bearing
14. Crankshaft thrust bearing
15. Camshaft bearing
16. Cylinder block
17. Expansion plug
18. Cylinder liner
19. Oil pump drive shaft bearing
20. Straight pin
21. Main bearing cap
22. Piston cooling jet
(For W06D-TI-I)
23. Piston cooling valve
(For W06D-TI-I)

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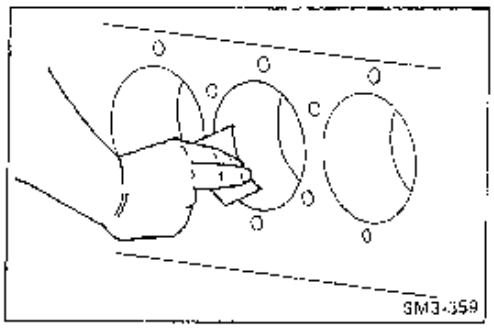
OVERHAUL



T = Tightening torque: N·m {kgf-cm, lbf-ft}

1. Cylinder block
2. Flywheel housing
3. Timing port cover
4. Oil seal
5. Ring gear
6. Flywheel
7. Torsion-elastic coupling (For W06D-TI)
8. Spacer (For W06D-TI)
9. Bracket

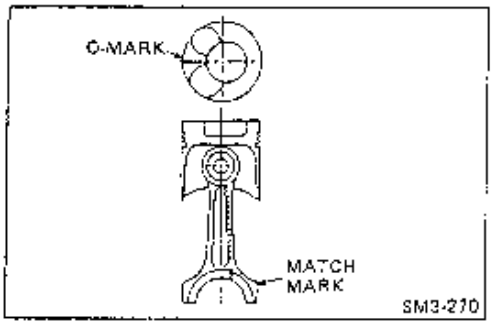
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IMPORTANT POINTS – DISASSEMBLY

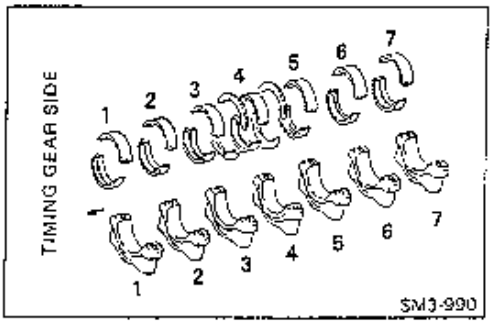
REMOVE THE PISTONS WITH CONNECTING RODS.

1. Remove the carbon from the upper end of the cylinder liner with a scraper or emery paper (recommended: No. 150) in a circular direction.



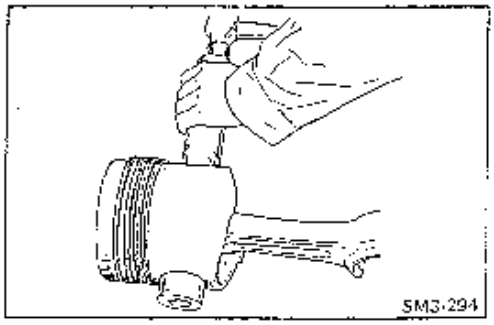
2. Extract the piston and connecting rod assembly out through the top of the cylinder.

NOTE: ○ Arrange the piston and connecting rod caps in order.



REMOVE THE CRANKSHAFT.

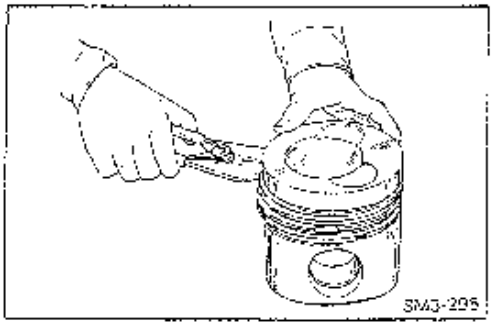
NOTE: Arrange the caps, main bearings and thrust bearings in order.



DISASSEMBLE THE CONNECTING ROD AND PISTON.

1. Remove the retainer ring installed on both ends of the piston pin, by means of retainer ring pliers.
2. Apply a metal pad to the pin and strike out the pin with a hammer.

NOTE: Warm up the piston first in hot water 80–90°C (176–194°F) for about 5 minutes before removing the pin.



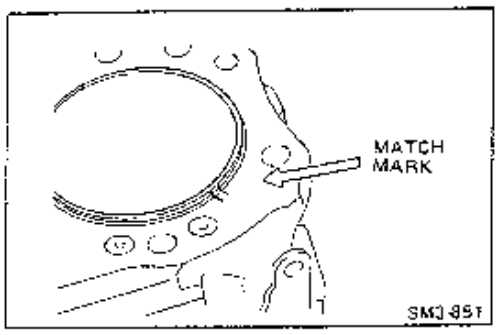
REMOVE THE PISTON RINGS.

Special Tool: Piston Ring Expander (09442-1180)

NOTE: ○ Handle the piston rings carefully because they are made of a special casting which is easily broken.
○ Keep the rings for each cylinder separate.

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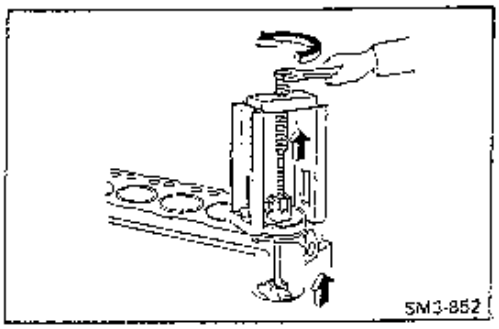
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REMOVE THE CYLINDER LINER.

1. Place the match marks with a pen on the cylinder block and liner flange, before removing the cylinder liners.

NOTE: Do not put the match marks with a punch.



2. Using a special tool, remove the cylinder liners.

Special Tool: Cylinder Liner Puller (09420-1460)

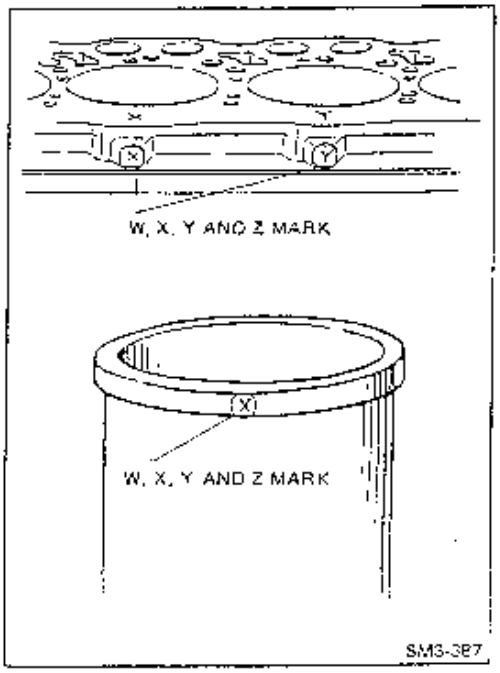
NOTE: After removing the cylinder liners, put numbers on their periphery or arrange them in sequence.

IMPORTANT POINTS – ASSEMBLY

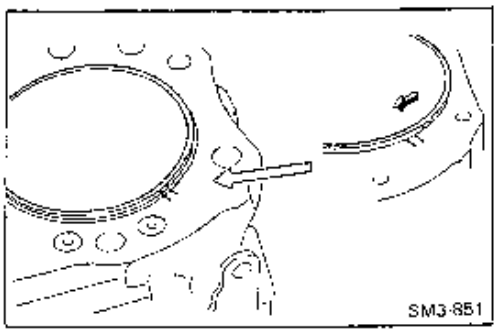
INSERT THE CYLINDER LINER INTO THE CYLINDER BLOCK.

1. When a new cylinder liner is used, make sure that the liner has the same mark as the mark on the cylinder block.

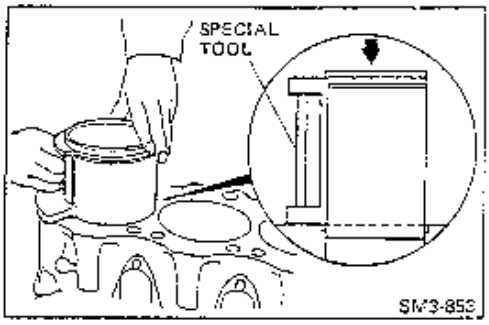
NOTE: ○ There are 4 different liner and cylinder block matches. The flange section of each liner has a marking any, W, X, Y, Z, or indicating the size of the outer diameter of the liner on which it is stamped. The markings W, X, Y and Z, indicating the inner diameter of the cylinder bore supporting the liner on the sides and top of the cylinder block (the boss section for attaching the coolant gallery cover), are inscribed on each cylinder.



2. When reusing a liner, insert the liner its original position aligning the marking marked before disassembly.



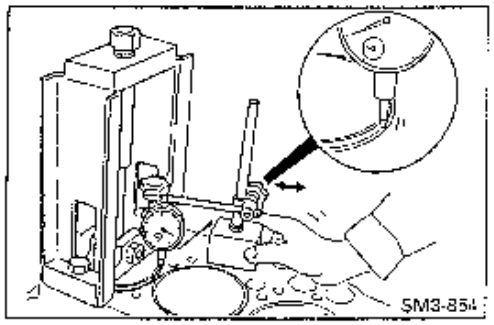
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Apply a small amount of fresh engine oil on the outer periphery of the liner, and apply pressure on the entire flange section of the liner. If insertion by hand is difficult, use a cylinder guide, and the cylinder liner will easily be pushed in.

Special Tool: Cylinder Liner Guide (09480-1120)

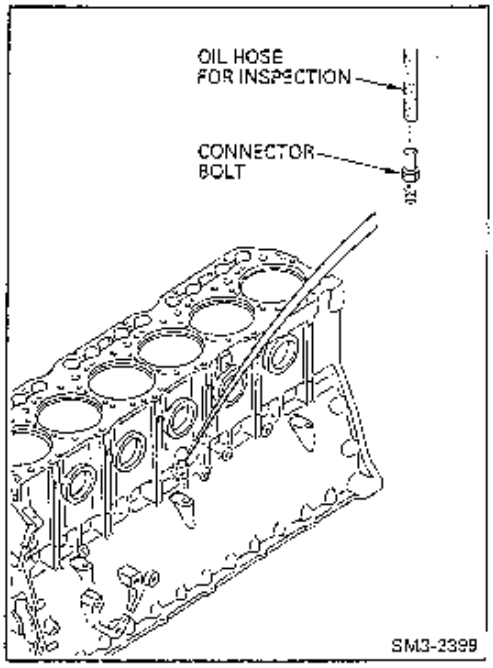
NOTE: ○ **Do not use a liner that has been dropped.**
○ **Take extra care when handling the liner since the liner is easily deformed.**



MEASURE THE PROJECTION OF THE CYLINDER LINER.

Tighten a special tool with a tightening torque of 100 kg-cm (7.23 lbf-ft) and measure the amount of projection of the top end of the liner from the cylinder block with a dial gauge or straight edge and a thickness gauge.

Special Tool: Cylinder Liner Puller (09420-1460)
Tightening Torque: 9.81 N·m {100 kgf·cm, 7.23 lbf-ft}
Assembly Standard: 0.01–0.08 mm {0.0004–0.0031 in}



INSPECT THE PISTON COOLING JET POSITIONING.
(For W06D-TI-II)

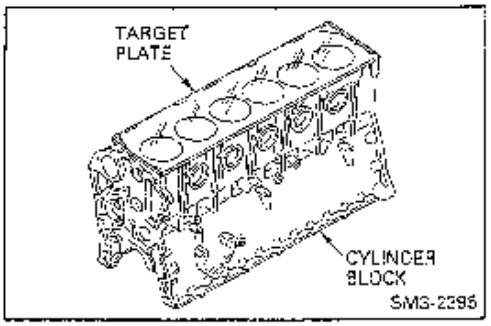
NOTE: ○ **Do not remove the cooling jet except when performing overhauls or when otherwise necessary.**
○ **In the event that the cooling jet is removed, be sure to replace it on the cylinder.**

Inspection of the piston cooling jet positioning procedure are as follows.

1. Remove the piston cooling valve and install a special tool.

Special Tool: Connector Bolt (09462-1400)

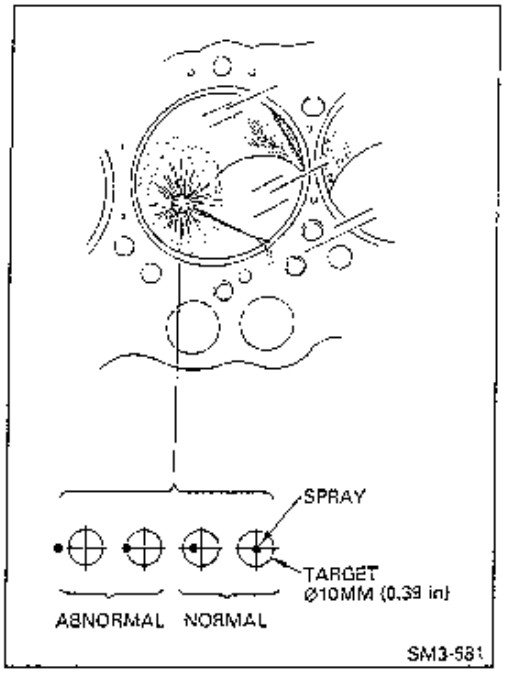
2. Use a commercially available oil pump (pressure about 196 kPa {2 kgf/cm², 28.44 lbf/in²), flow rate about 25 l/min (2.64 US.qts/min)}.
3. Prepare fresh engine oil.
4. Connect the oil lines.
   Connect the oil pump outlet to a special tool (connector bolt).



5. Install a special tool on the cylinder block with locating pins.

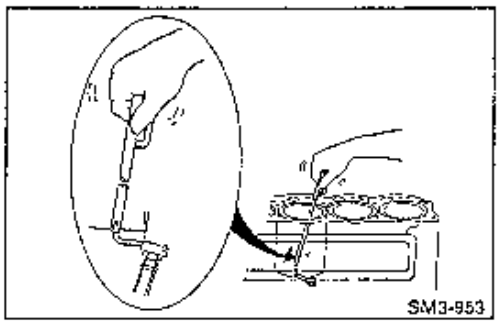
Special Tool: Target plate (09444-1600)

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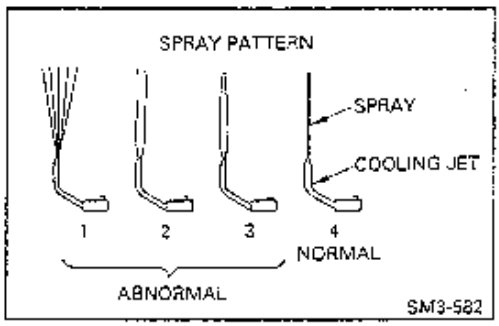
6. Operate the oil pump, and with pressure at about 196 KPa {2 kg/cm², 28.44 lbf/in²}, pump fresh oil from the jet, and perform a spray test. Conditions are normal if the center of stream hits a target plate.

WARNING
Engine oil is flammable.
This spray test should be done in a well ventilated room and away from any open flames or electric sparks.



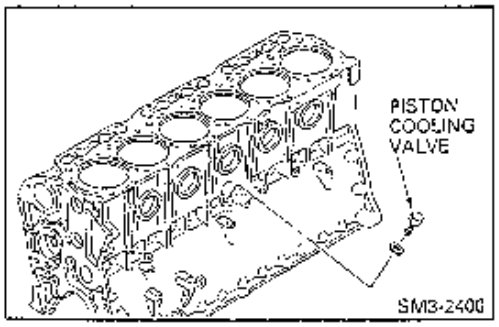
7. If the spray of the cooling jet messes the circle on the target plate, realign then nozzle using a special tool.

Special tool: Adjuster bar (09472-1620)



8. Spray pattern.
When inspecting the piston cooling jet positioning, check that the spray is dispersed as shown in "4" and not as in "1", "2", or "3" in the illustration at left.
Check that the spray is not a thin muddy color.

NOTE: **If the tip of the jet is damaged so that the spray pattern is bad, replace the jet with a new one. When replacing the cooling jet, always inspect the new piston cooling jet's positioning.**



9. After inspecting the piston cooling jet positioning, remove the special tool (connector bolt), then install the piston cooling valve on the cylinder block.

Tightening Torque: 44.13 N·m {450 kgf·cm, 32.54 lbf·ft}

10. After installing the piston, make sure that there is no interference between the cooling jet and the piston when the piston is at bottom dead center.

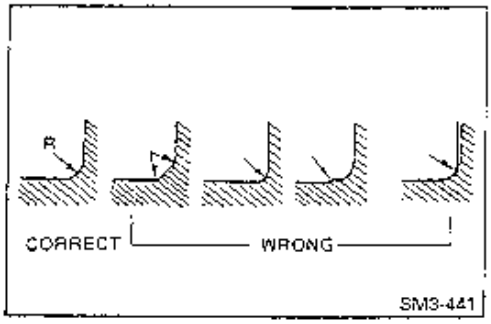
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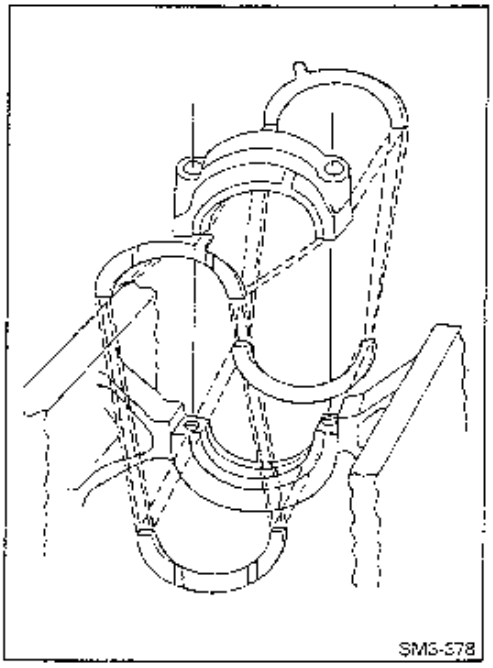
Unit: mm (in)

Under size	Outside diameter	
	Crankpin	Journal
0.25	61.69–61.71 (2.4288–2.4295)	72.69–72.71 (2.8619–2.8625)
0.50	61.44–61.46 (2.4189–2.4196)	72.44–72.46 (2.8520–2.8527)
0.75	61.19–61.21 (2.4091–2.4098)	72.19–72.21 (2.8422–2.8429)
1.00	60.94–60.96 (2.3992–2.4000)	71.94–71.96 (2.823–2.8330)

IF NECESSARY, GRIND THE CRANKSHAFT AND USE UNDER SIZE BEARINGS.



Dimension of Fillet R:
Crank pin : 3.50–4.00 mm (0.1378–0.1574 in)
Journal : 3.05–3.50 mm (0.1201–0.1377 in)



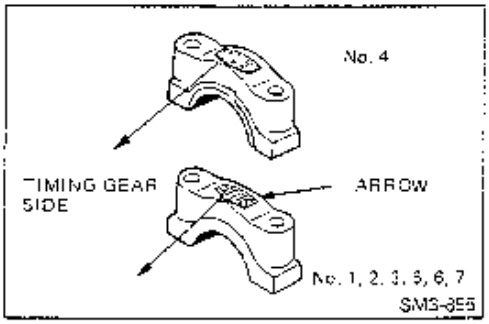
INSTALL THE CRANKSHAFT.

1. Install the crankshaft bearings on the cylinder block and bearing cap.

NOTE: Apply new engine oil to each bearing surface.

2. Install the crankshaft on the cylinder block.
3. Insert the crankshaft thrust bearing along the groove of the cylinder block.
4. Install the thrust bearings on the No.4 bearing cap sides.

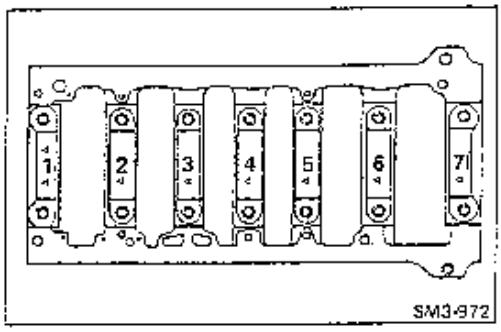
NOTE: Apply new engine oil to each thrust bearing surface.



5. Install the crankshaft bearing caps.
Install the bearing caps in numbered order from timing gear side with the arrow point toward the timing gear side.

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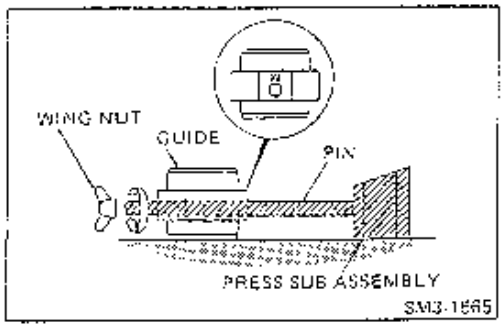


6. Tighten the cap bolts in three stages following the tightening order.

NOTE: Apply engine oil to the bolt threads and under the bolt head.

Tightening order: 4–3–5–2–6–1–7

NOTE: ○ **Make sure that the crankshaft rotates smoothly.**
○ **Inspect the crankshaft end play.**



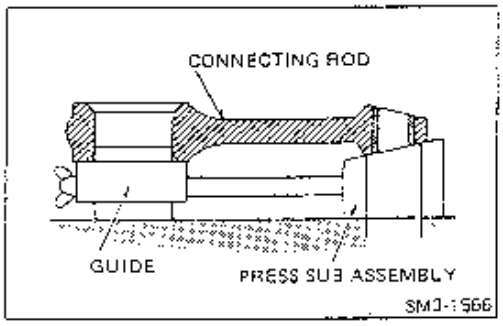
IF NECESSARY, REPLACE THE PISTON PIN BUSHING.

1. Prepare the special tools.

Assemble the guide and press sub assembly inserting its pin into the guide, then secure them with the wing nut.

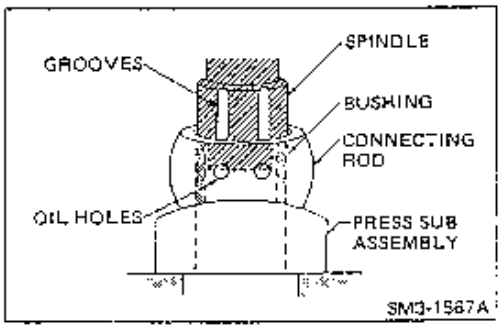
Special tools: Guide (09481-1130)
Press subassembly (09402-1450)
Wing nut (9233-10360)

NOTE: ○ **Bring leter "W" punched on the guide above the pin.**
○ **Make sure to align both supporting surface of the guide and press sub assembly flush on a flat plane.**



2. Using a special tool, remove the piston pin bushing.

a. Set the connecting rod assembled without crank pin bore bearing on the guide and press subassembly.



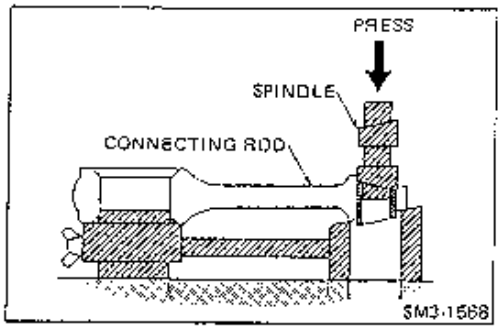
b. Install the spindle on the bushing.

Special tool: Spindle (09402-1460)

NOTE: Align the grooving of the spindle with the oil hole of the bushing.

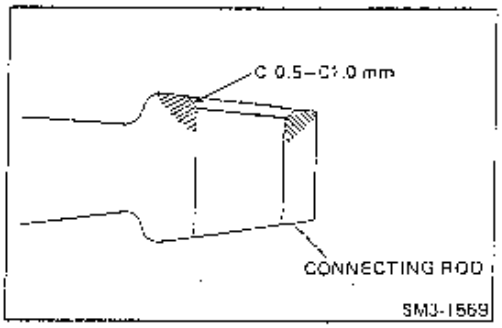
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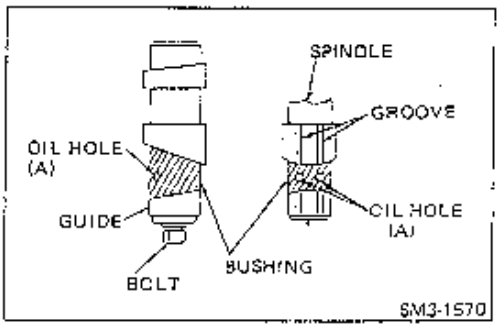
c. Using a hydraulic press, remove the bushing.

NOTE: Always operate the press slowly and smoothly.



3. Assemble the piston pin bushing.
Chamfer one edge of the bushing hole at the small end of the connecting rod uniformly by C 0.5–1.0 mm (0.0196–0.0393 in).

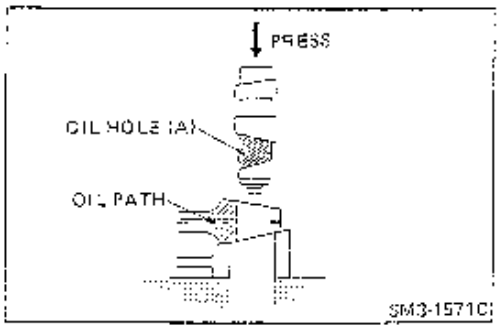
NOTE: ○ Irregular chamfering can cause out-of-roundness of the pressed bushing, which may result in jamming during insertion.
○ Remove dust from the inner surface of the small-end hole.



4. Mount the bushing on the spindle.
a. Set the bushing and guide on the spindle aligning oil hole (A) in the bushing the grooves on the both the spindle and guide.
b. Secure the bushing and guide with the bolt.

Special Tool: Spindle (09402-1460)
Guide (09481-1120)
Bolt (9191-08252)

NOTE: ○ Be sure to slip the bushing over the spindle in the proper direction so that oil hole (A) will later align with the oil path in the connecting rod.
○ Apply fresh engine oil to the bushing and guide.

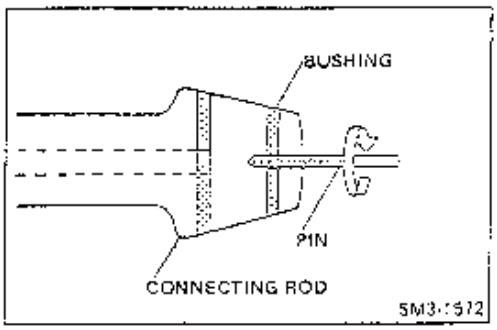


5. Install the bushing in the connecting rod.
Position the bushing–special tool assembly so that oil hole (A) align with the oil path through the connecting rod.

NOTE: ○ Fully coat the bore in the connecting rod with fresh engine oil.
○ Always operate the press slowly and smoothly.

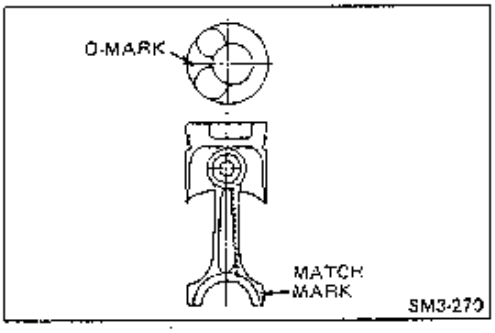
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6. Inspect the bushing position after installation.

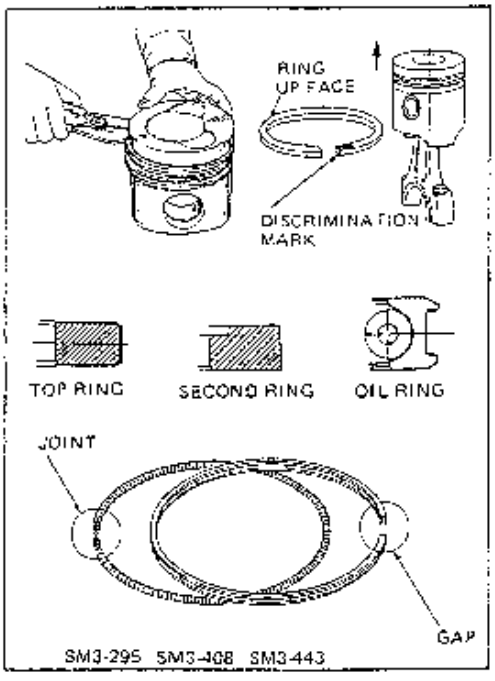
NOTE: ○ Make sure that the oil holes of the bushing and connecting rod are aligned.
○ Insert a pin of 3.0 mm {0.1181 in} dia. into an hole at the end of the connecting rod, and make sure that the pin fully penetrates.
If there is any deviation in the alignment of the oil holes correct it with a drill of 3.0 mm {0.1181 in} dia.
○ Misalignment of the oil holes leads to insufficient lubrication, which may result in seizure.
○ Insert a new piston pin and rotate it slowly to make sure that there is no rattling.



ASSEMBLE THE PISTON AND CONNECTING ROD.

Make sure that the O-mark at the top of the piston and the connecting rod match mark in opposite directions.

NOTE: ○ Use the new retainer rings.
○ Heat the piston to about 80 – 90°C {176 – 194°F} in hot water about 5 minutes.



INSTALL THE PISTON RING.

1. Install the piston rings in the sequence oil ring, second ring and top ring with the identification mark at the top of the ring facing up.

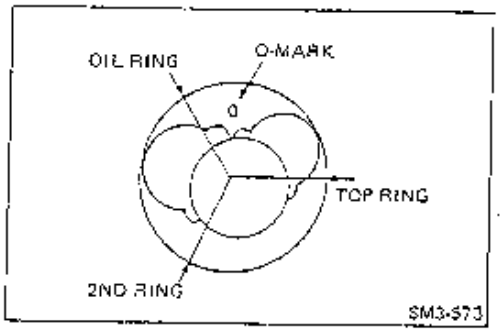
NOTE: ○ Identification mark of second ring and oil ring is applied with gold paint.
○ Apply oil to the piston pin.

Special Tool: Piston Ring Expander (09442-1180)

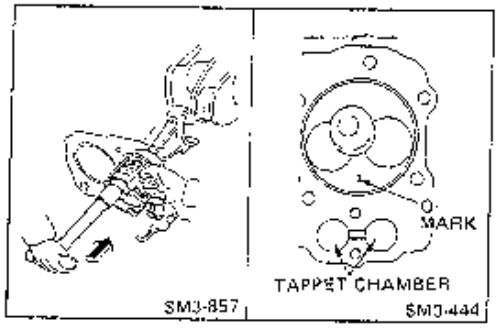
2. Connect the ends of the coil expander and then fit the coil inside the piston ring after ensuring that the gap of the piston ring is 180° away from the joint of the coil.

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3. Arrange the piston rings so that their gaps are equally spaced.

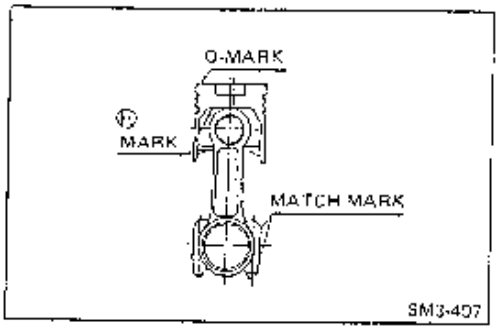


INSTALL THE PISTON IN THE CYLINDER LINER.

Apply engine oil to the piston, cylinder liner and connecting rod bearing surface.

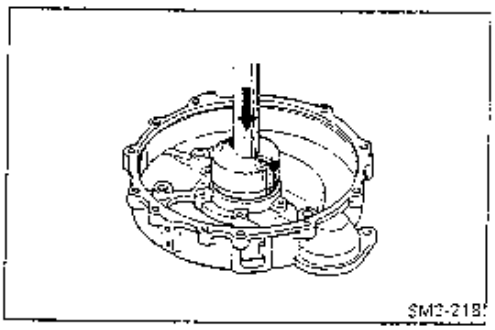
NOTE: Check the piston that the O-mark on the top is on the tappet chamber side.

Special Tool: Piston Ring Holder (09441-1260)



INSTALL THE CONNECTING ROD.

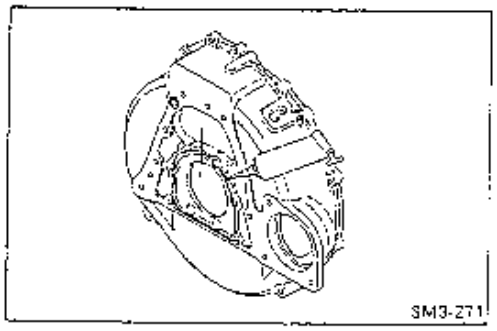
1. Apply engine oil to the cap bearing surface.
2. Align the matching marks on the connecting rod and cap.
3. Apply engine oil to the bolt threads and under the bolt head.
4. Tighten the cap bolt in three stages.



IF NECESSARY, REPLACE THE FLYWHEEL HOUSING OIL SEAL.

1. Using a screwdriver, remove the oil seal.
2. Install the new oil seal.

Special Tool: Flywheel Housing Oil Seal Press (09482-1540)



INSTALL THE FLYWHEEL HOUSING.

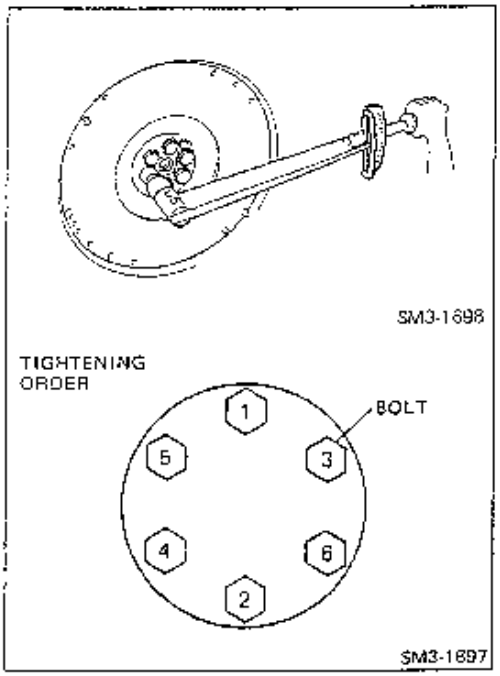
1. Clean the faces.
2. Apply the liquid gasket as shown and install the flywheel housing within 20 minutes.

NOTE: If leaving it more than 20 minutes, clean the liquid gasket completely and reapply the liquid gasket.

Coating Width: 1.5–2.5 mm (0.06–0.10 in)

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INSTALL THE FLYWHEEL.

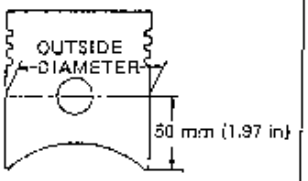
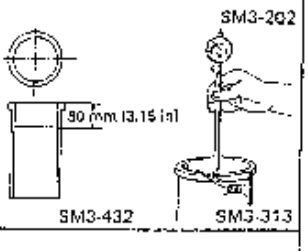
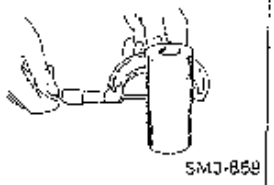
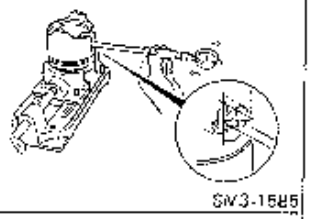
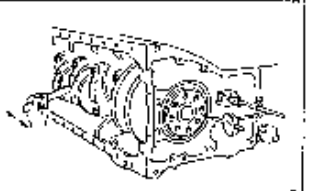
Install the flywheel and tighten the bolts through several repetitions of the tightening order so as to reach specified torque evenly and gradually, then slacken and tighten them one by one to the specified torque.

NOTE: ○ Align the "O" mark on the flywheel and crankshaft collar knock-in.
○ When tightening the bolt, apply engine oil to the threads and flywheel surface of the bolts.

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INSPECTION AND REPAIR

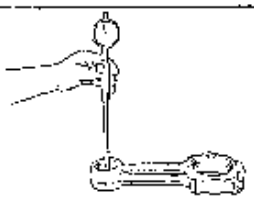
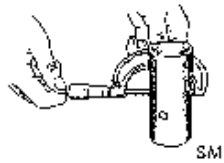
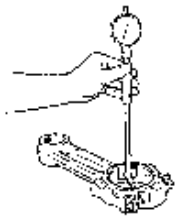
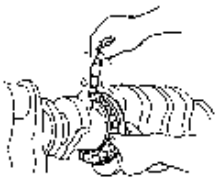
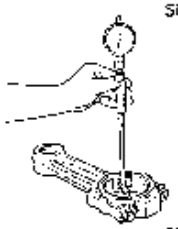
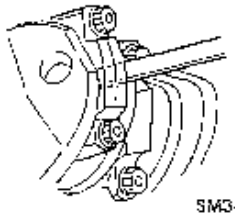
Unit: mm {in}

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Piston Diameter	103.852–103.884 {4.0887–4.0899}	–	Replace piston and/or liner	
Cylinder Liner Inside Diameter	104.008–104.040 {4.0949–4.0960}	104.15 {4.1003}		
Clearance between Piston and Cylinder Liner	0.140–0.172 {0.0056–0.0067}	–		
Piston Pin Diameter	36.987–37.003 {1.4562–1.4568}	36.98 {1.4559}	Replace piston and/or piston pin	
Piston Pin Hole Inside Diameter	36.987–37.003 {1.4562–1.4568}	37.02 {1.4575}		
Clearance between Piston Pin and Piston Pin Hole	0.013T–0.014L {0.00052T–0.00055L} T: Tight, L: Loose	0.03 {0.0011}		
Crankshaft end Play	0.05–0.22 {0.0020–0.0086}	0.4 {0.0157}	Replace thrust bearing	

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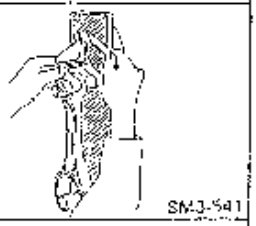
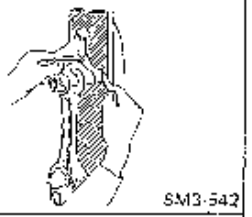
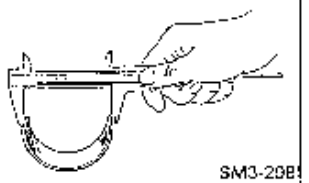
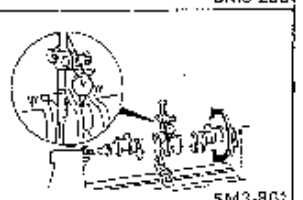
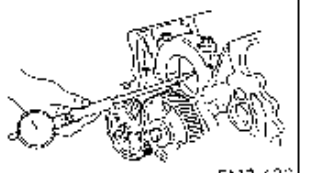
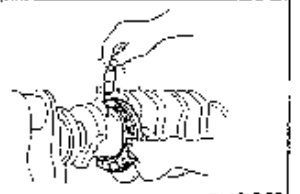
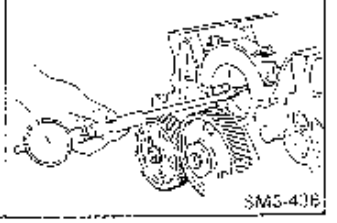
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Unit: mm {in}

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Connecting Rod Small End Bushing Inside Diameter	37.015–37.025 {1.4573–1.4577}	37.07 {1.4594}	Replace bushing and/or piston pin	 SM3-296
Piston Pin Diameter	36.987–37.003 {1.4562–1.4568}	36.98 {1.4559}		
Clearance between Piston Pin And Connecting Rod Small End Bushing	0.015–0.036 {0.0006–0.0014}	0.08 {0.0031}		 SM3-297
Connecting Rod Big end Inside Diameter without Bearing	65.986–66.000 {2.5979–2.5984}	–	Replace connecting rod assembly	 SM3-300
Crank Pin Diameter	61.94–61.96 {2.4386–2.4393}	–0.20 {–0.0078}	Regrind and use undersize bearing	 SM3-860
		60.76 {2.3921}	Replace crankshaft	
Clearance between Connecting Rod and Crank Pin	0.031–0.082 {0.0013–0.0032}	0.12 {0.0047}	Replace bearing	 SM3-300
Connecting Rod end Play	0.20–0.52 {0.0079–0.0204}	0.6 {0.0236}	Replace the connecting rod.	 SM3-862

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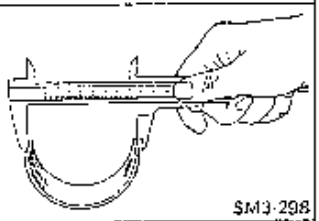
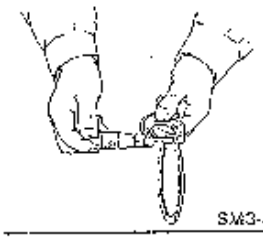
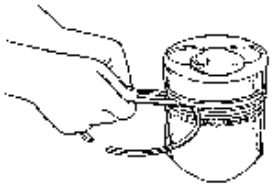
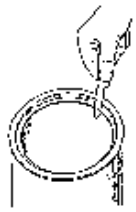
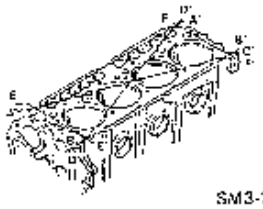
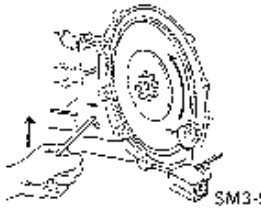
Unit: mm {in}

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Connecting Rod Straightness	—	0.1 {0.0039} Per 200 {7.874}	Replace	 SM3-541
Connecting Rod Twist	—	0.1 {0.0039} Per 200 {7.874}	Replace	 SM3-542
Connecting Rod Bearing Spread Dimention	67.05–67.55 {2.6398–2.6594}	—	Replace	 SM3-298
Crankshaft Bend	—	0.04 {0.0015}	Repair or replace	 SM3-861
Crankshaft Main Bearing Cap Inside Diameter Without Bearing	77.985–78.000 {3.0703–3.0709}	—	Replace	 SM3-436
Crankshaft Journal Diameter	72.94–72.96 {2.8717–2.8724}	–0.20 {–0.0078}	Regrind and use undersize bearing	 SM3-860
		71.76 {2.8252}	Replace crankshaft	
Clearance between Crankshaft Journal and Main Bearing	0.039–0.090 {0.0016–0.0035}	0.13 {0.0051}	Replace bearing	 SM3-406

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Unit: mm (in)

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Crankshaft Main Bearing Spread Dimention	79.00–79.60 {3.1103–3.1338}	–	Replace	 SM3-298
Piston Ring Breadth Ring No.:	Top: Not easily measured		Replace	 SM3-379
	2nd: 2.47–2.49 {0.0972–0.0980}	2.32 {0.0913}		
	Oil: 4.97–4.99 {0.1957–0.1964}	4.95 {0.1949}		
Piston Ring Groove Breadth Ring No.:	Top: Not easily measured		Replace piston ring and/or piston	 SM3-301
	2nd: 2.53–2.55 {0.0996–0.1004}	2.14 {0.0842}		
	Oil: 5.01–5.03 {0.1973–0.1980}	5.08 {0.2000}		
Clearance between Piston Ring and Piston Ring Breadth Ring No.:	Top: Not easily measured			
	2nd: 0.04–0.08 {0.0015–0.0032}	0.30 {0.0118}		
	Oil: 0.02–0.06 {0.0008–0.0023}	0.08 {0.0031}		
Piston Ring Gap All Rings: • Insert the Piston Rings Where the Wear of the Liner is Small.	Top: 0.3–0.45 {0.0119–0.0177}	1.2 {0.0472}	Replace	 SM3-302
	2nd: 0.3–0.45 {0.0119–0.0177}			
	Oil: 0.3–0.45 {0.0119–0.0177}			
Cylinder Block Flatness	Less than 0.05 {0.0019}	0.1 {0.0039}	Regrind and/or replace	 SM3-216
Flywheel Face Alignment	–	0.15 {0.0059}	Regrind and/or replace	 SM3-908

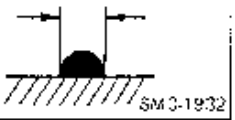
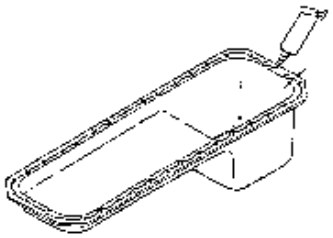
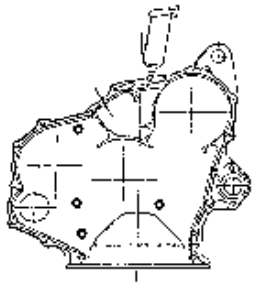
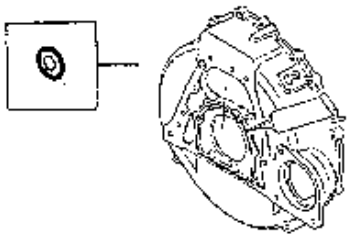
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LIQUID GASKET AND APPLICATION POINTS

The W06D-TI and W06D-TI-II type engines use liquid gasket (Three Bond TB1207C, 04132-1207) instead of conventional sheet gaskets.
Apply liquid gasket, therefore, taking the following items into account.

1. LIQUID GASKET APPLICATION POINTS AND COATING WIDTH

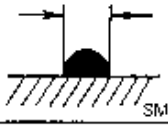
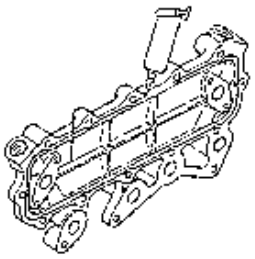
Unit: mm (in)

Parts name	Application point	Coating width  SM3-1932
(a) Oil pan	Flange face which mates with cylinder block and timing gear cover  SM3-1929	3 – 4 (0.12 – 0.16)
(b) Timing gear cover	Face which mates with timing gear plate (flange face, boss face)  SM3-247	1.5 – 2.5 (0.06 – 0.10)
(c) Flywheel housing	Faces which mates with cylinder block (flange face, boss face)  SM3-271	1.5 – 2.5 (0.06 – 0.10)

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Unit: mm (in)

Parts name	Application point	Coating width  SM3-1932
(d) Oil cooler	Flange face which mates with cylinder block  SM3-269	1.5 – 2.5 (0.06 – 0.10)
(e) Coolant pump	Flange face which maters with taming gear cover	1.5 – 2.5 (0.06 – 0.10)
(f) Thermostat case	Flange face which mates with cylinder head	1.5 – 2.5 (0.06 – 0.10)
(g) Intake manifold	Flange face which mates with cylinder head	1.5 – 2.5 (0.06 – 0.10)
(h) Intake pipe	Flange face which mates with intake manifold	1.5 – 2.5 (0.06 – 0.10)

2. COATING LIQUID GASKET AND PARTS ASSEMBLY PROCEDURE

(1) Completely remove old liquid gasket from each part and the respective mating part, and remove oil, water, and dirt using a cloth.

(2) Be careful not to apply excessive or insufficient liquid gasket. Also, be sure to overlap the start and end of each coating.

(3) When assembling coated parts, be careful that there is no misalignment between mating parts. If there is any misalignment, coat the parts again.

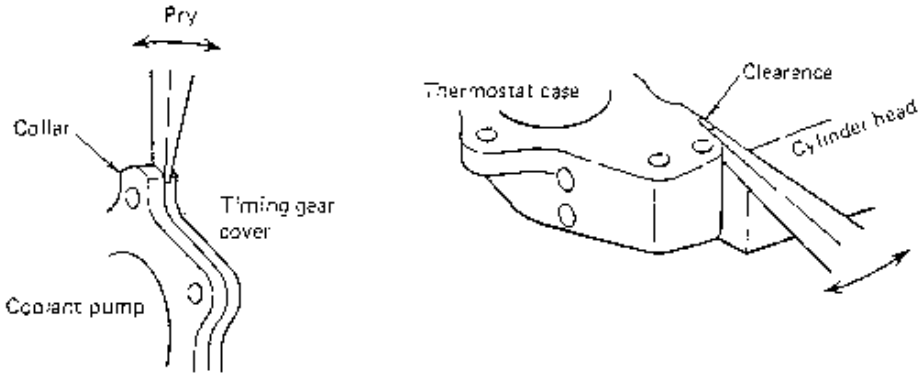
(4) Assemble the various parts within 20 minutes after applying liquid gasket. If more than 20 minutes have elapsed, remove the liquid gasket and apply it again.

(5) After assembling the various parts, wait for at least 15 minutes before starting the engine.

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3. REMOVING PARTS

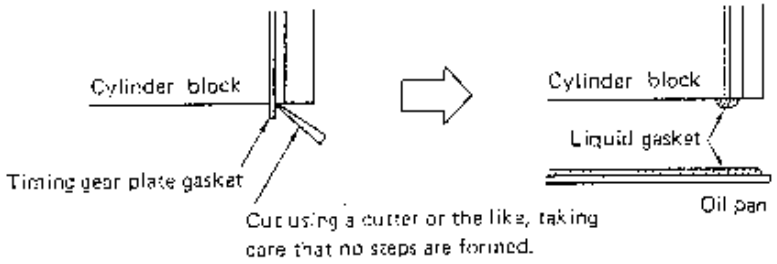
When removing each part, do not attempt to pry one portion of the flange alone but use the flange collar or clearance to pry the flange at several points alternately.



SM3-1933

4. TIMING GEAR PLATE GASKET

When replacing the timing gear plate gasket, cut it so that no steps are formed in it, then liberally apply liquid gasket to the cut face and assembly the oil pan.



SM3-1932

NOTE: The flange of the oil pan may sometimes become deformed preventing it from being reused. To prevent this, therefore, first insert plates with a thin edge at several points around the periphery of the oil pan, then remove the oil pan using a screwdriver.

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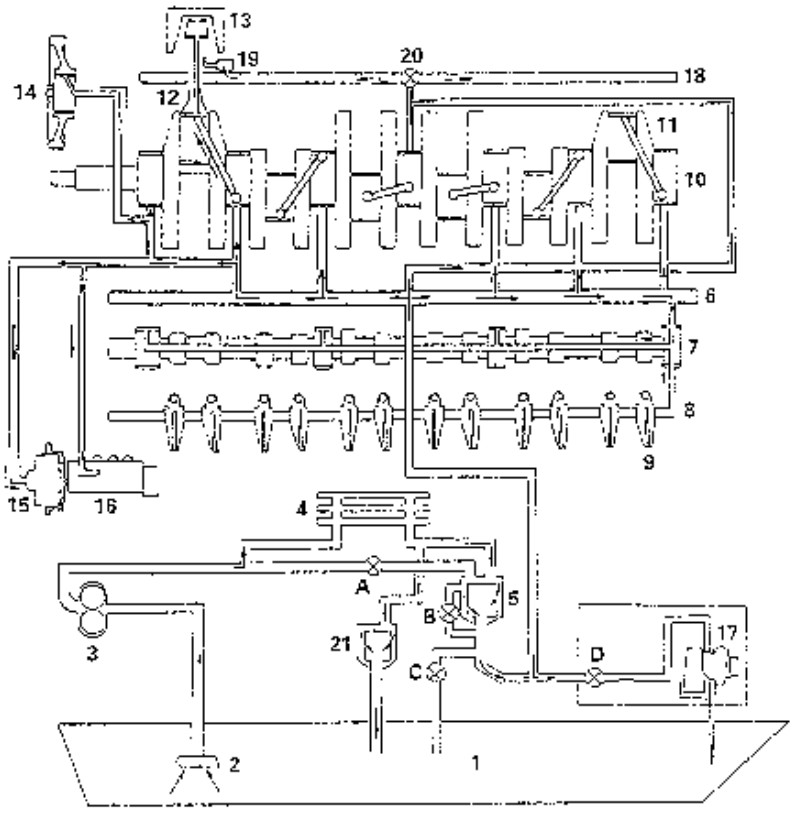
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LUBRICATING SYSTEM

DATA AND SPECIFICATIONS

Oil pump	
Type	Full forced pressure feed by gear pump
Drive	By gear
Oil cooler	
Type	Multi plates type, water-cooled

LUBRICATING SYSTEM DIAGRAM



SM3-2408

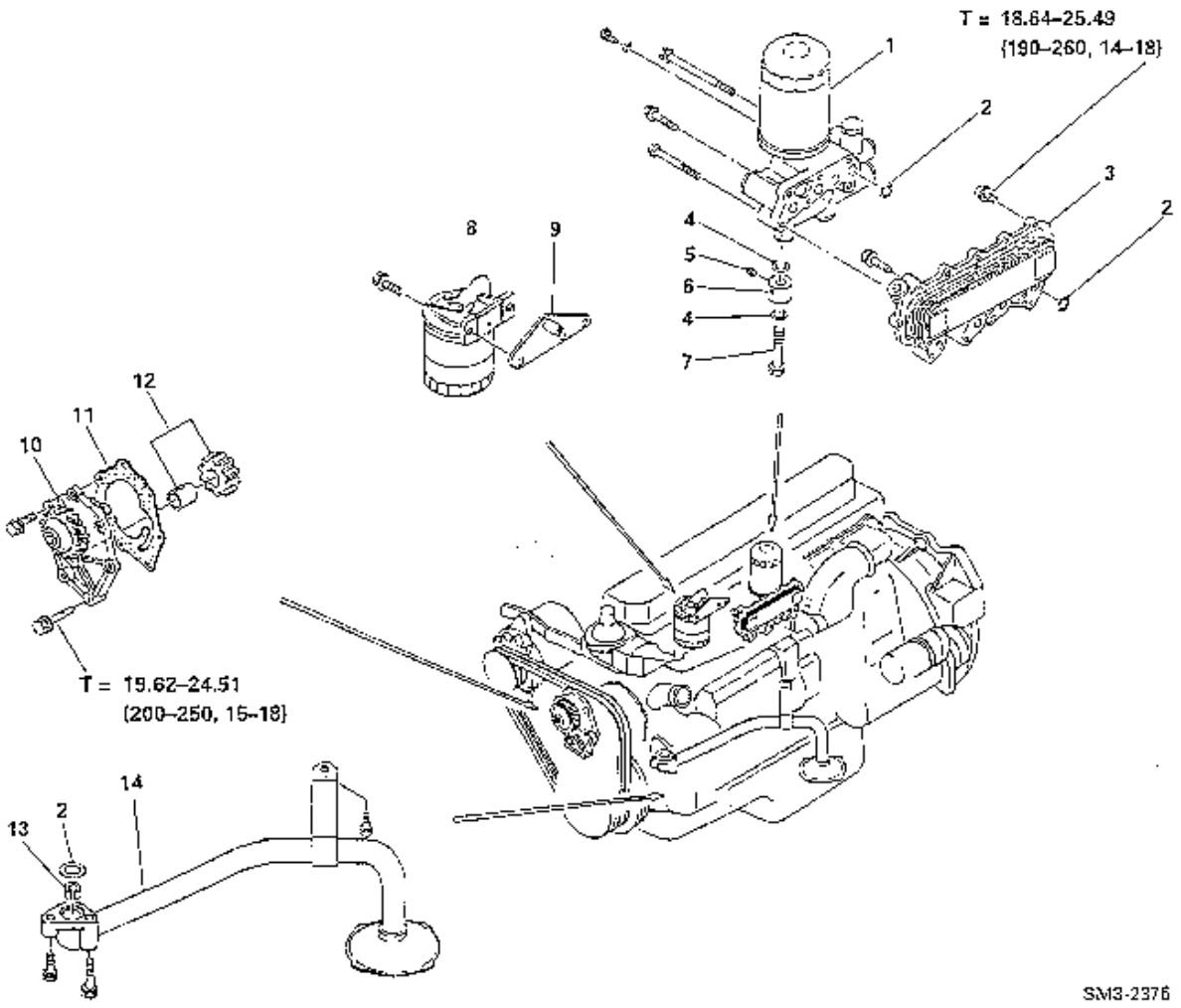
1. Oil pan
2. Oil strainer
3. Oil pump
4. Oil cooler
5. Full flow oil filter
6. Main oil hole
7. Camshaft
8. Rocker arm shaft
9. Rocker arm
10. Crankshaft journal
11. Crankshaft pin
12. Connecting rod
13. Piston
14. Idler gear
15. Fuel injection pump drive gear
16. Fuel injection pump
17. Turbocharger
18. Sub oil hole (For W06D-TI-II)
19. Piston cooling jet (For W06D-TI-II)
20. Check valve (For W06D-TI-II)
21. By pass oil filter (For W06D-TI-II)

A. Oil cooler safety valve
B. Oil filter safety valve
C. Regulator valve
D. Check valve

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OVERHAUL



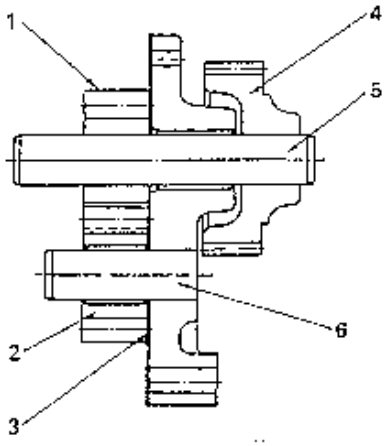
T = Tightening torque: N·m {kgf·cm, lbf·ft}

1. Full flow oil filter
2. O-ring
3. Oil cooler
4. Soft washer
5. Plug
6. Connector pipe
7. Connector bolt
8. By pass oil filter (For W06D-TI-II)
9. Oil filter bracket
10. Oil pump cover subassembly
11. Gasket
12. Oil pump driven gear
13. O-ring guide
14. Oil strainer

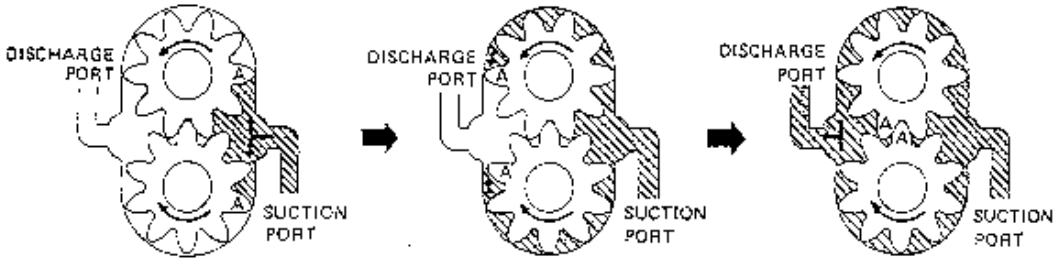
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OIL PUMP

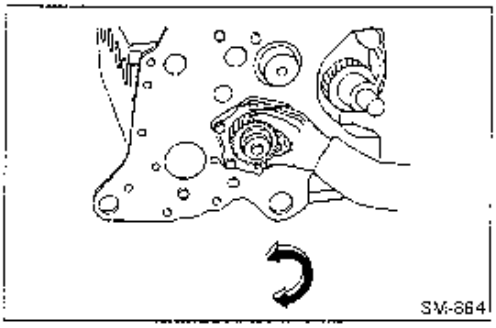
DESCRIPTION



1. Drive gear (Inside)
2. Driven gear
3. Gasket
4. Drive gear (Outside)
5. Drive shaft
6. Driven shaft



[OPERATION]



IMPORTANT POINT – MOUNTING

INSTALL THE OIL PUMP.

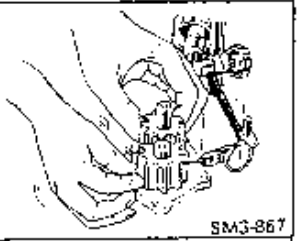
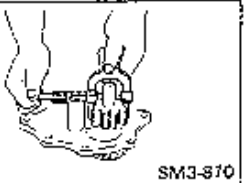
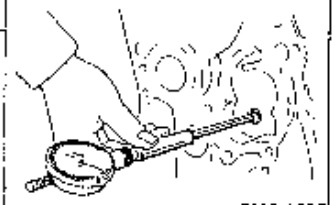
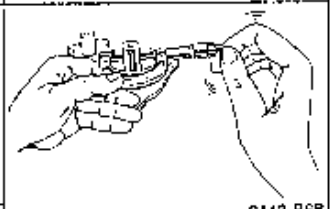
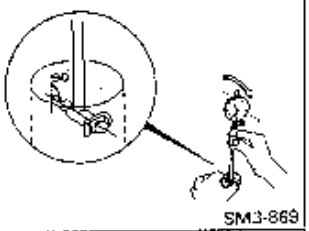
1. Apply oil liberally to cylinder block pump case and bearing before installing oil pump.
2. Confirm smooth rotation of oil pump after tightening bolts.

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INSPECTION AND REPAIR

Unit: mm (in)

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Gear Backlash	0.09–0.21 (0.0036–0.0082)	0.30 (0.0118)	Replace gear	 SM3-867
Drive Gear Shaft Diameter	18.088–18.106 (0.7122–0.7128)	18.060 (0.7110)	Replace	 SM3-870
Drive Shaft Bearing Inside Diameter	18.146–18.173 (0.7145–0.7154)	18.20 (0.7165)	Replace	
Clearance between Drive Shaft and Bearing	0.040–0.085 (0.0080–0.0033)	0.1 (0.0039)	Replace bearing and/or shaft	 SM3-1070
Driven Gear Shaft Diameter	17.979–17.997 (0.7079–0.7085)	17.970 (0.7074)	Replace	 SM3-868
Driven Gear Inside Diameter	18.037–18.054 (0.7102–0.7107)	18.070 (0.7114)	Replace	 SM3-869
Clearance between Driven Gear and Shaft	0.040–0.075 (0.0080–0.0023)	0.1 (0.0039)	Replace bearing and/or shaft	
Gear Teeth Pitting or Wear	–	–	Replace, if necessary	Visual check  SM3-845

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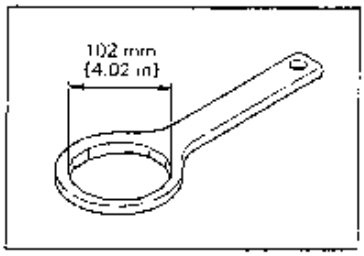
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OIL COOLER AND OIL FILTER

SPECIAL TOOL

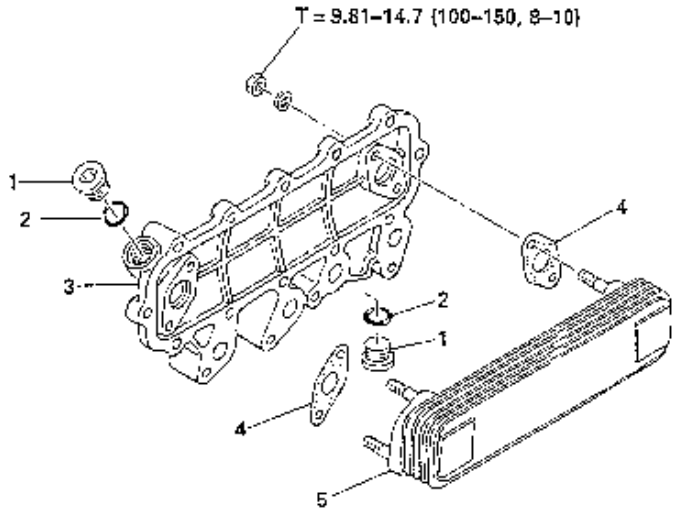
Prior to starting an engine overhaul, it is necessary to have these special tools.

WRENCH



09553-1010
For spin-on type oil filter

OVERHAUL



SM3-2379

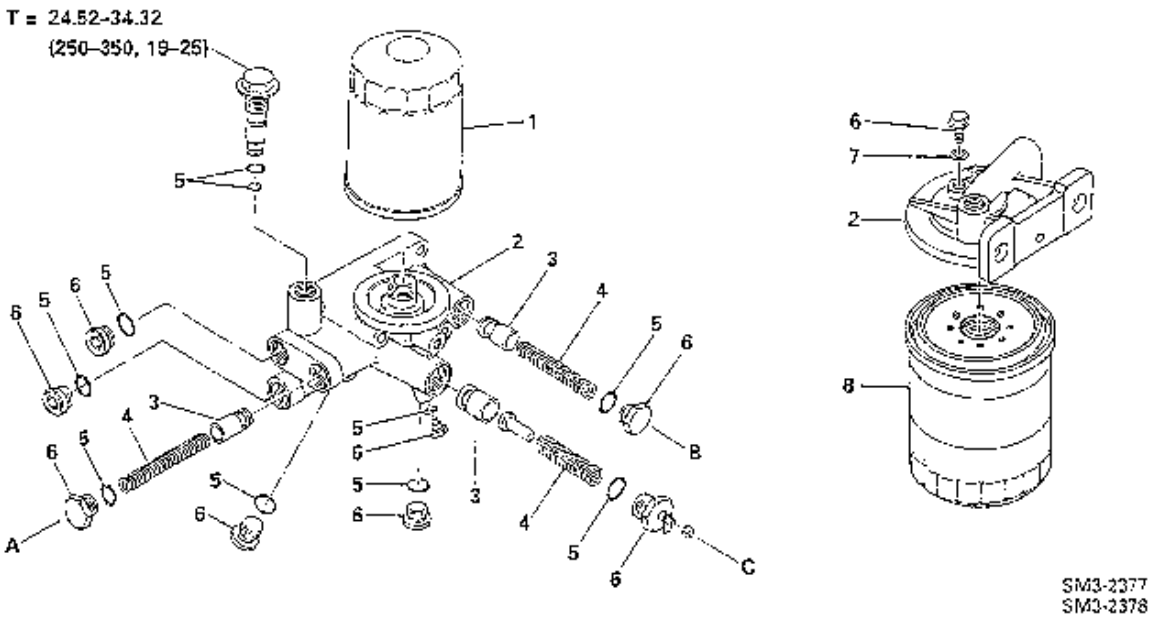
T = Tightening torque: N·m {kgf·cm, lbf·ft}

1. Plug
2. O-ring
3. Oil cooler case
4. Gasket
5. Oil cooler element

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OVERHAUL



SM3-2377
SM3-2378

T = Tightening torque: N·m {kgf·cm, lbf·ft}

1. Full flow oil filter
2. Oil filter cover
3. Valve
4. spring
5. O-ring
6. Plug
7. Soft washer
8. Bypass oil filter
   (For W06D-TI-II)

A. Oil filter safety valve
   127.5 kPa {1.3 kgf/cm², 18.5 lbf/in²}
B. Oil cooler safety valve
   392.3 kPa {4.0 kgf/cm², 56.88 lbf/in²}
C. Regulator valve
   392.3 kPa {4.0 kgf/cm², 56.88 lbf/in²}

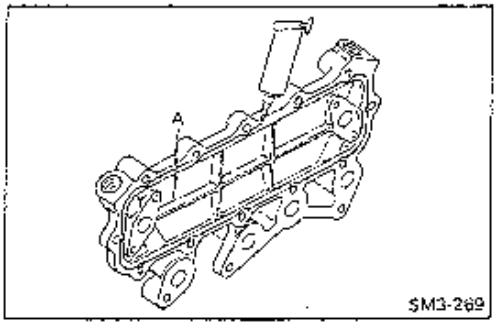
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IMPORTANT POINT – DISMOUNTING

REMOVE THE SPIN-ON TYPE OIL FILTER.

Using a special tool, unscrew the oil filter.

Special Tool: Wrench (09553-1010)



IMPORTANT POINTS – MOUNTING

INSTALL THE OIL COOLER.

1. Clean the faces.
2. Apply the liquid gasket as shown and install the oil cooler within 20 minutes.

NOTE: If leaving it more than 20 minutes, clean the liquid gasket completely and reapply the liquid gasket.

Coating Width (A): 1.5–2.5 mm (0.06–0.10 in)

INSTALL THE SPIN-ON TYPE OIL FILTER.

1. Apply a slight amount of engine oil to the gasket of the new filter.
2. Tighten the new filter by hand until the gasket touches the cover and the tighten another 3/4 to 1 full turn with a special tool.

Special Tool: Wrench (09553-1010)

INSPECTION AND REPAIR

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Valve and Springs of Oil Filter, Wear or Damage.	–	–	Replace, if necessary.	Visual check

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MEMO

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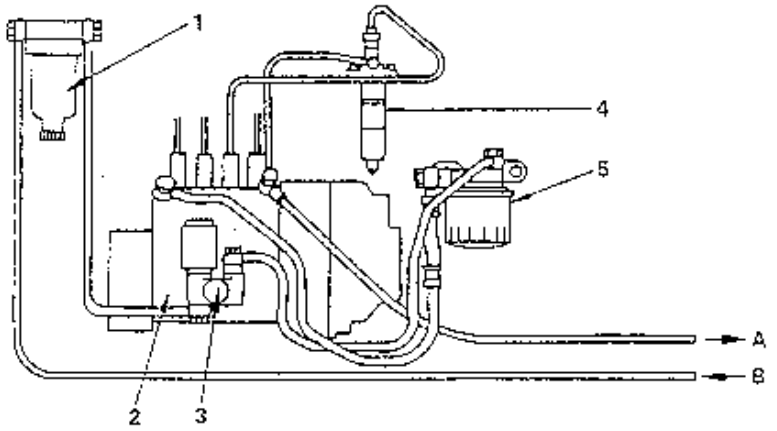
FUEL SYSTEM

DATA AND SPECIFICATIONS

Injection nozzle

Type	Multi-hole nozzle type
Opening pressure	21.57 MPa {220 kbf/cm², 3,129 lbf/in²}

FUEL SYSTEM DIAGRAM

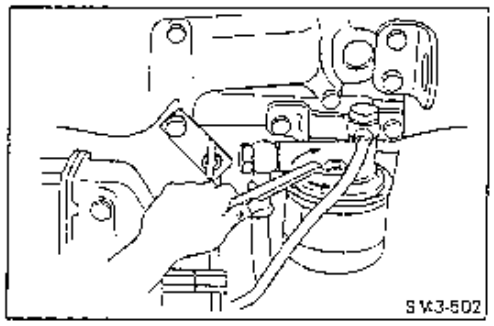


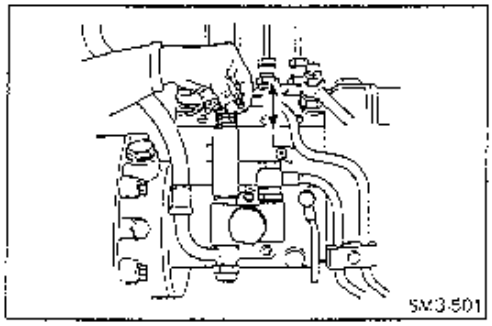
1. Water separator (If so equipped)
2. Fuel injection pump
3. Fuel feed pump
4. Injection nozzle
5. Fuel filter

A. To fuel tank
B. From fuel tank

NOTE: Figure illustrates 4-cylinder engine.

SMJ-227A





AIR BLEEDING FROM FUEL SYSTEM.

1. Loosen the bleeder plug on the fuel filter.
2. Loosen the priming pump knob.
3. Operate the priming pump knob until the air will not come out from the bleeder plug.
4. Tighten the bleeder plug.

Tightening Torque: 3.93–5.88 N·m {40–60 kgf·cm, 3–4 lbf·ft}

NOTE: The bleeder plug should be tightened while the priming pump knob is operated.

5. Once again, operate the priming pump knob several times.
6. Push back the priming pump knob and tighten it.

NOTE: Wipe off any splashed fuel.

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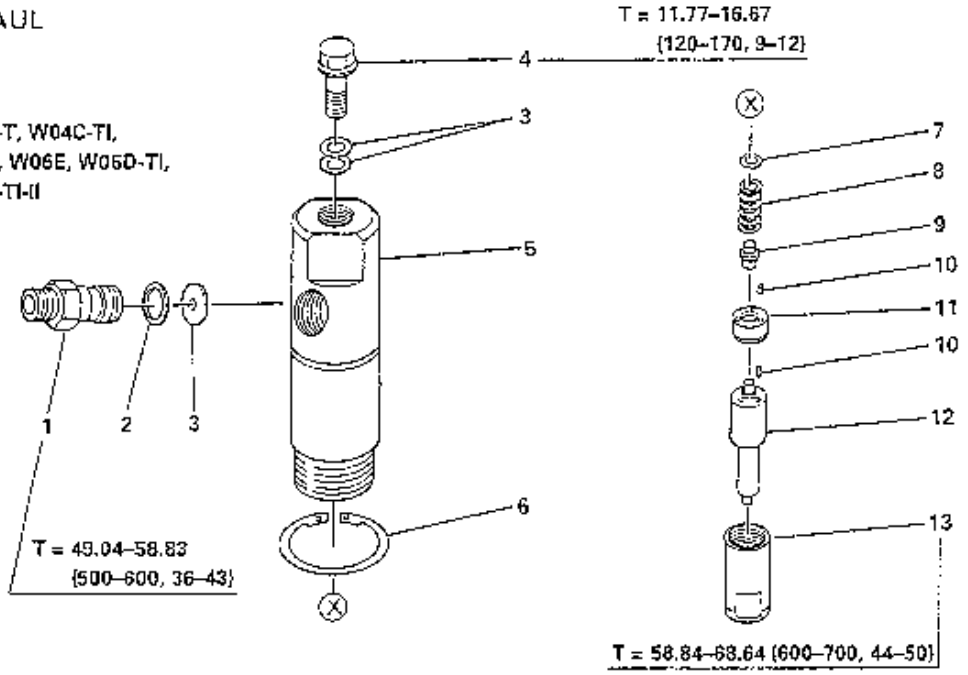
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INJECTION NOZZLE

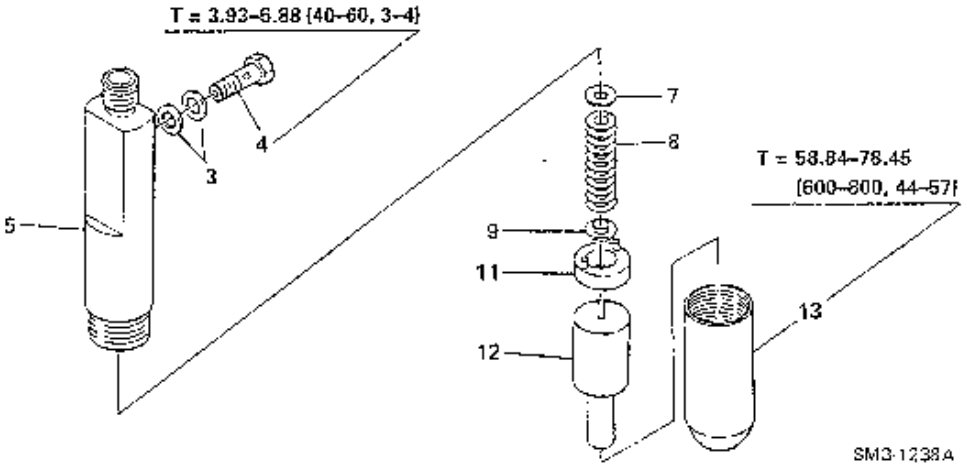
OVERHAUL

1530V
I—No. 20

For W04C-T, W04C-TI,
W06D, W06E, W06D-TI,
W06D-TI-I



For W04D



T = Tightening torque: N·m {kgf-cm, lbf-ft}

1. Connector
2. Packing ring
3. Gasket
4. Joint bolt
5. Nozzle holder
6. Retainer ring
7. Shim
8. Spring
9. Nozzle holder pressure pin
10. Pin
11. Distance piece
12. Nozzle
13. Nozzle retaining nut

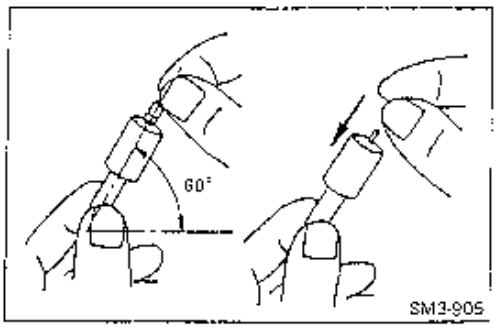
IMPORTANT POINTS – DISMOUNTING

REMOVE THE NOZZLE HOLDER ASSEMBLY.

Refer to Section ENGINE MOVING PARTS.

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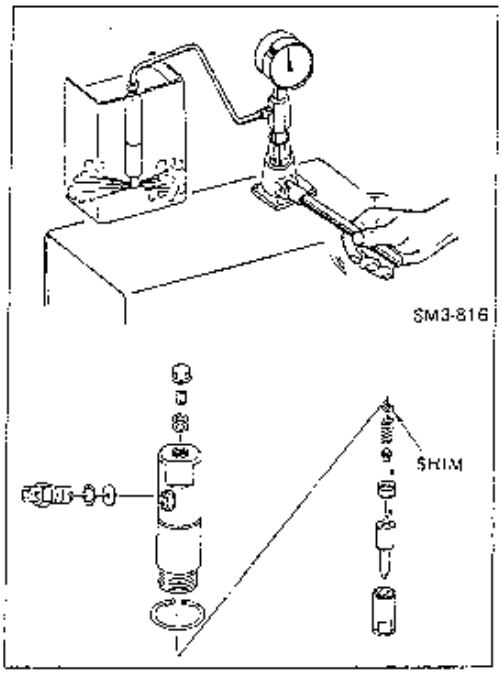


IMPORTANT POINTS — ASSEMBLY

TEST THE NOZZLE SKINKING.

Wash the nozzle proper with diesel fuel oil, then immerse it in diesel fuel oil.

Next slide the needle inside the nozzle proper and ensure that it move smoothly. The needle valve should fall under its own weight when withdrawn vertically about 1/3 and released. If its motion is sluggish, replace the nozzle with a new one.



ADJUST THE INJECTION PRESSURE.

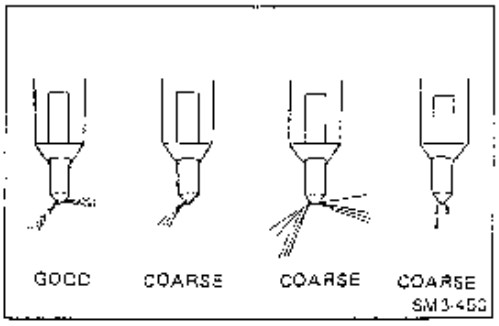
1. Connect the nozzle holder with a nozzle tester and move the lever at the rate of about 50 to 60 times per minute.

Injection Pressure: 21.57 MPa {220 kgf/cm², 3,129 lbf/in²}

WARNING

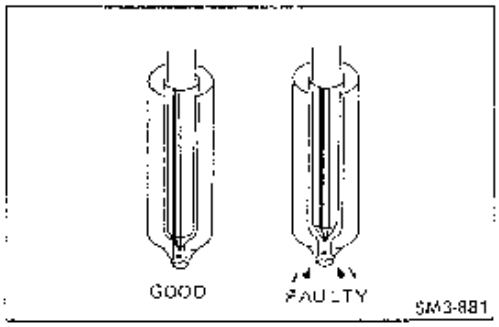
- **Diesel fuel is flammable.**
  This nozzle adjusting should be done a well ventilated room and away from any open flames or electric spark.
- **The spray must always be covered. Keep your face and body away from the spray. This is because of the risk of fuel oil getting in your eyes or passing into your body.**

2. If the injection pressure is not within specification, change the shim.



TEST THE SPRAY PROFILE.

In the case of the new nozzle, operate the lever at the rate of 30 to 60 strokes per minute, and for a used nozzle, operate the lever at the rate of 15 to 60 strokes per minute.



TEST THE FUEL LEAKAGE.

When checking for fuel leakage from the nozzle, apply a pressure of about 0.99–1.96 MPa {10–20 kgf/cm², 142–284 lbf/in²} lower than the correct injection pressure to the nozzle by means of the nozzle tester. If there is no fuel leakage, the nozzle is normal.

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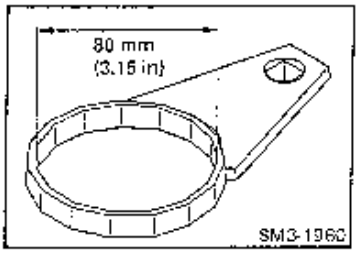
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FUEL FILTER

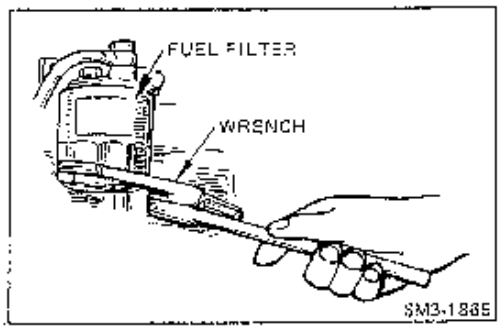
SPECIAL TOOL

Prior to starting an engine overhaul, it is necessary to have these special tools.

WRENCH



09503-1040
For spin-on type fuel filter



IMPORTANT POINT – DISMOUNTING

REMOVE THE SPIN ON TYPE FUEL FILTER.

Using a special tool, unscrew the fuel filter.

NOTE: ○ Be careful not to spill diesel fuel.
○ When removing the fuel filter for W04C-TI,W06D-TI and W06D-TI-II use a suitable wrench.

Special Tool: Wrench (09503-1040) for W04D, W04C-T and W06E

IMPORTANT POINT – MOUNTING

INSTALL THE SPIN-ON TYPE FUEL FILTER.

1. Apply a small amount of diesel fuel to the gasket of a new fuel filter.
2. Manually tighten the new fuel filter until its gasket touches the cover and then tighten another 2/3 turn with a special tool.

NOTE: When installing the fuel filter for W04C-TI, W06D-TI and W06D-TI-II, use a suitable wrench.

Special Tool: Wrench (09503-1040) for W04D, W04C-T and W06E

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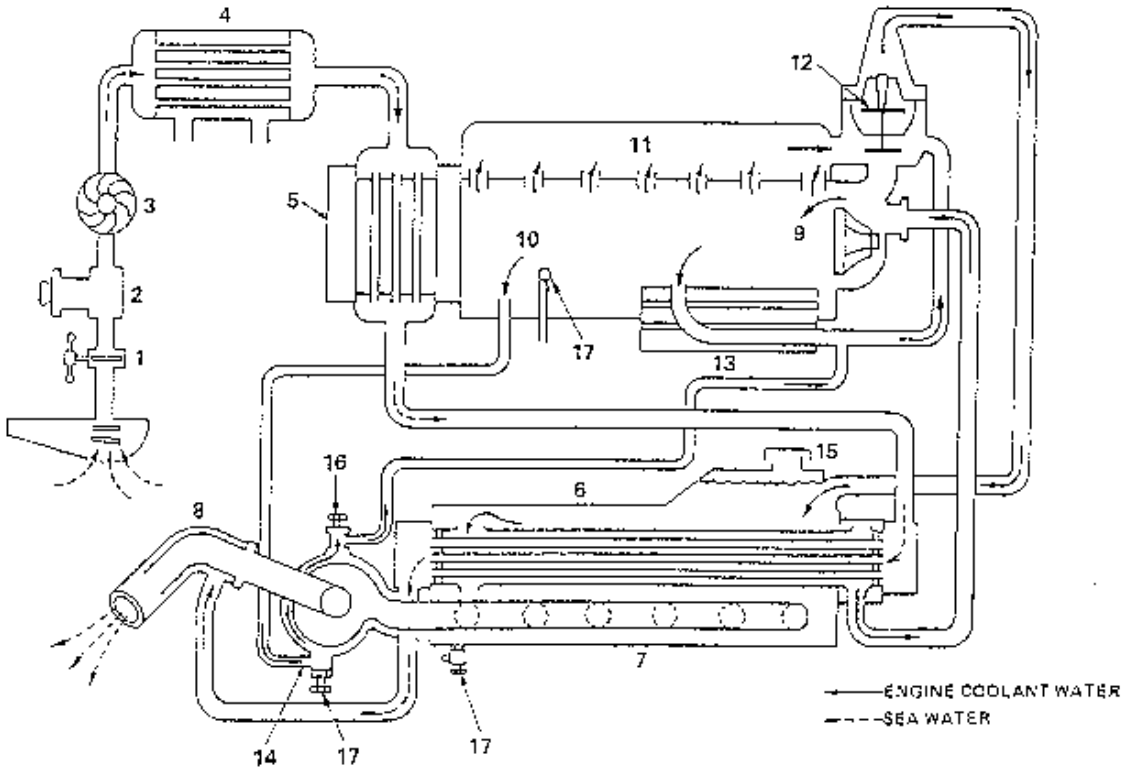
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COOLING SYSTEM

DATA AND SPECIFICATIONS

Coolant pump	
Type	Forced circulation by volute pump
Drive	By V-belt
Seawater pump	
Type	Self priming type (Flexible impeller pump)
Drive	By gear
Thermostat	
Type	Wax type, bottom bypass system
Valve opening temperature	76.5°C (170°F)

COOLING SYSTEM DIAGRAM



SM3-1793

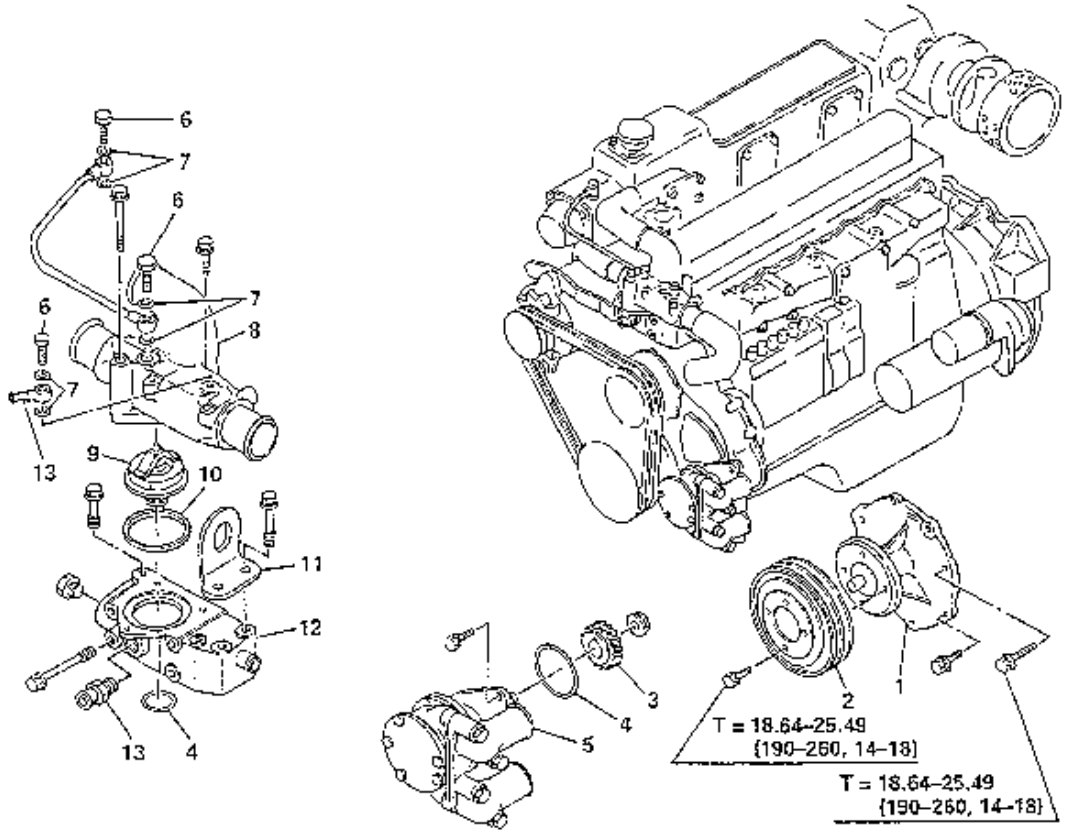
1. Seawater intake valve (Seacock)
2. Seawater filter
3. Seawater pump
4. Intercooler
5. Transmission fluid cooler
6. Heat exchanger
7. Water cooled exhaust manifold
8. Exhaust pipe
9. Coolant pump
10. Cylinder block
11. Cylinder head
12. Thermostat
13. Engine oil cooler
14. Water cooled turbocharger
15. Coolant filler cap
16. Air bleeder plug
17. Coolant drain plug

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OVERHAUL

HE11–C5S–00XD1



5M3-1934

T = Tightening torque: N·m {kgf-cm, lbf-ft}

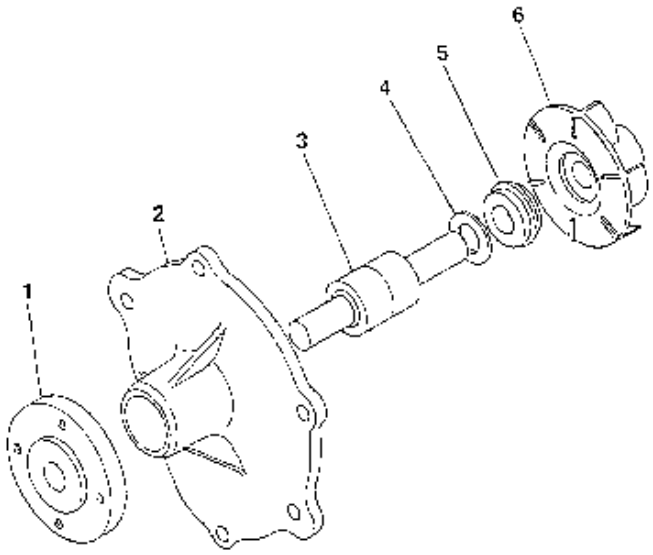
1. Coolant pump
2. Coolant pump pulley
3. Seawater pump drive gear
4. O-ring
5. Seawater pump
6. Connector bolt
7. Soft washer
8. Coolant manifold
9. Thermostat
10. Thermostat gasket
11. Engine hanger
12. Thermostat case
13. Connector

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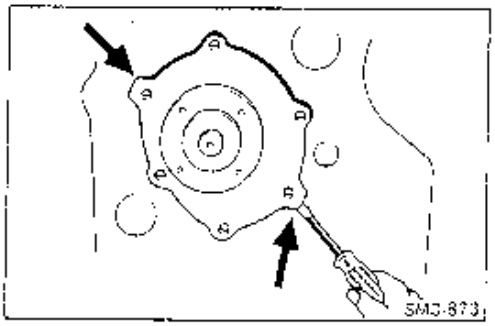
COOLANT PUMP

OVERHAUL

:653N
I—No. 21

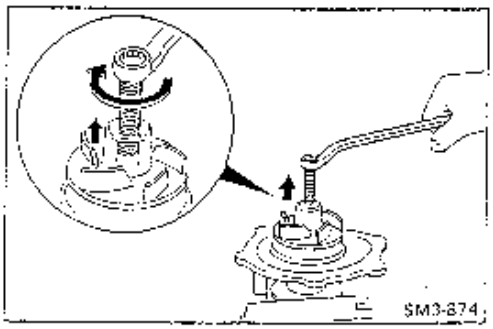


1. Pulley center
2. Pump case
3. Shaft subassembly
4. Slinger
5. Coolant seal
6. Vane



IMPORTANT POINT — DISMOUNTING

REMOVE BY PRYING LOOSE WITH SCREWDRIVER AT THE 2 POINTS ON THE FLANGE.



IMPORTANT POINTS — DISASSEMBLY

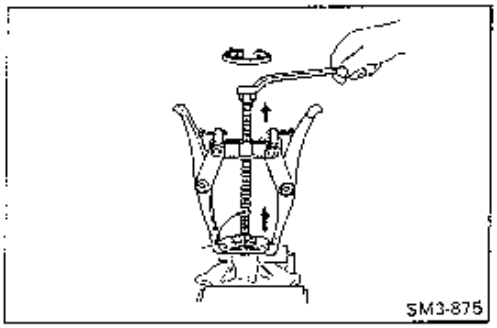
REMOVE VANE FROM SHAFT BY SCREWING IN A BOLT.

Bolt Size;

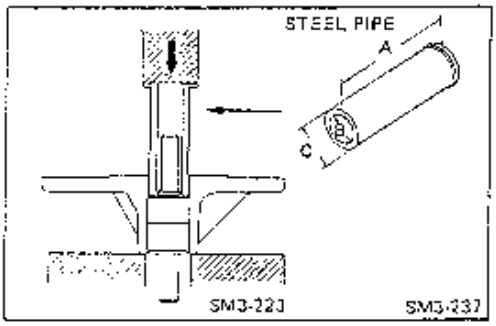
Diameter: 10 mm (0.394 in)
Pitch: 1.5 mm (0.059 in)

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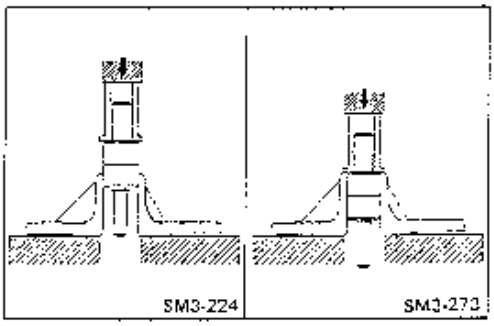
USING A PULLER, REMOVE THE PULLY CENTER FROM THE SHAFT.



USING A STEEL PIPE AND PRESS, REMOVE THE SHAFT FROM BODY.

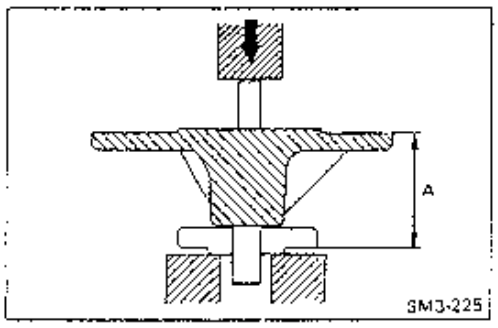
Steel Pipe Dimension: A: More than 57 mm (2.244 in)
B: 18–21 mm (0.7087–0.8267 in)
C: Less than 29.5 mm (1.161 in)

IMPORTANT POINTS – ASSEMBLY



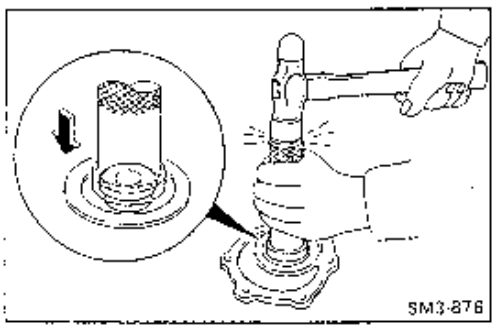
USING A STEEL PIPE AND PRESS, INSTALL THE SHAFT TO THE CASE.

NOTE: Bearing face must be aligned with edge of body.



USING A PRESS, INSTALL THE PULLEY CENTER.

DIMENSION (A): 90 mm (3.543 in)

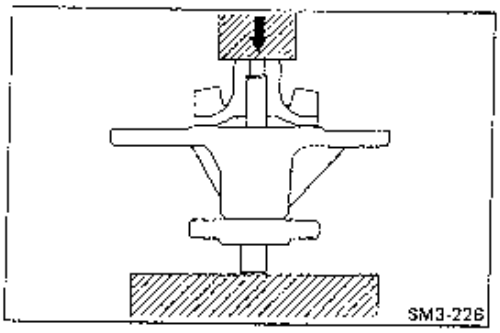


INSTALL THE NEW COOLANT SEAL.

1. Apply a little liquid sealer to the coolant seal outer circumference and coolant pump body.
2. Install the slinger and coolant seal.

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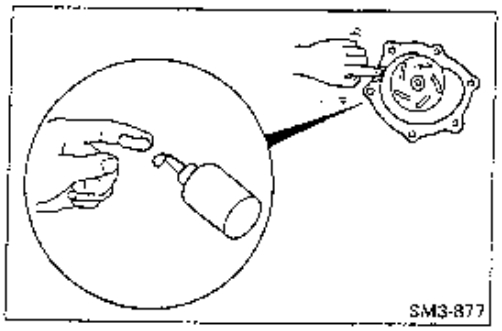
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USING A PRESS, INSTALL THE VANE TO THE SHAFT.

NOTE: Apply a little engine oil to the coolant seal face.

AFTER THE COOLANT PUMP HAS BEEN ASSEMBLED, CHECK THAT THE SHAFT ROTATES SMOOTHLY.



IMPORTANT POINT – MOUNTING

INSTALL THE COOLANT PUMP TO THE TIMING GEAR COVER.

1. Clean the contacting surface of the coolant pump and timing gear cover free of old sealer, water and oil.
2. Apply the liquid gasket as shown and install the coolant pump within 20 minutes.

NOTE: If leaving it more than 20 minutes, clean the liquid gasket completely and reapply the liquid gasket.

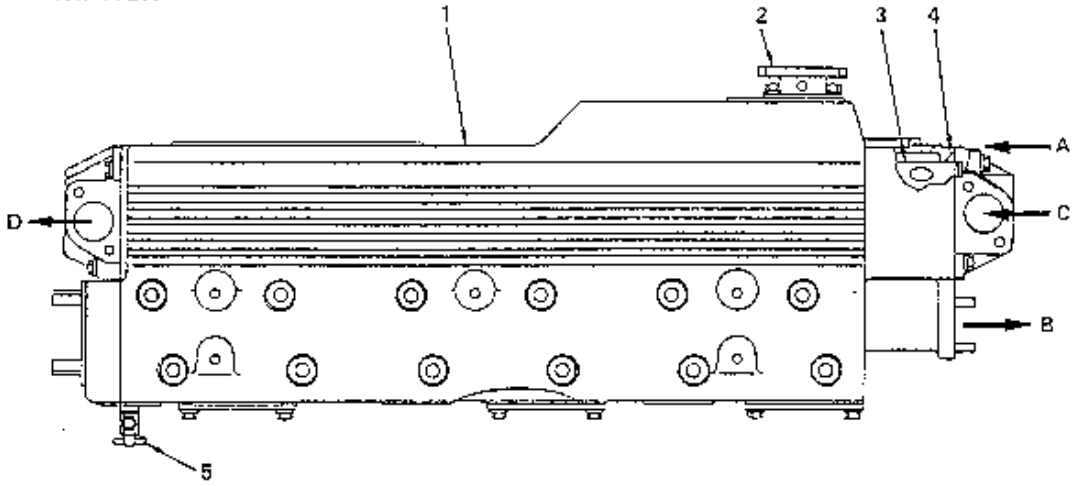
Coating Width: 1.5–2.5 mm {0.06–0.10 in}

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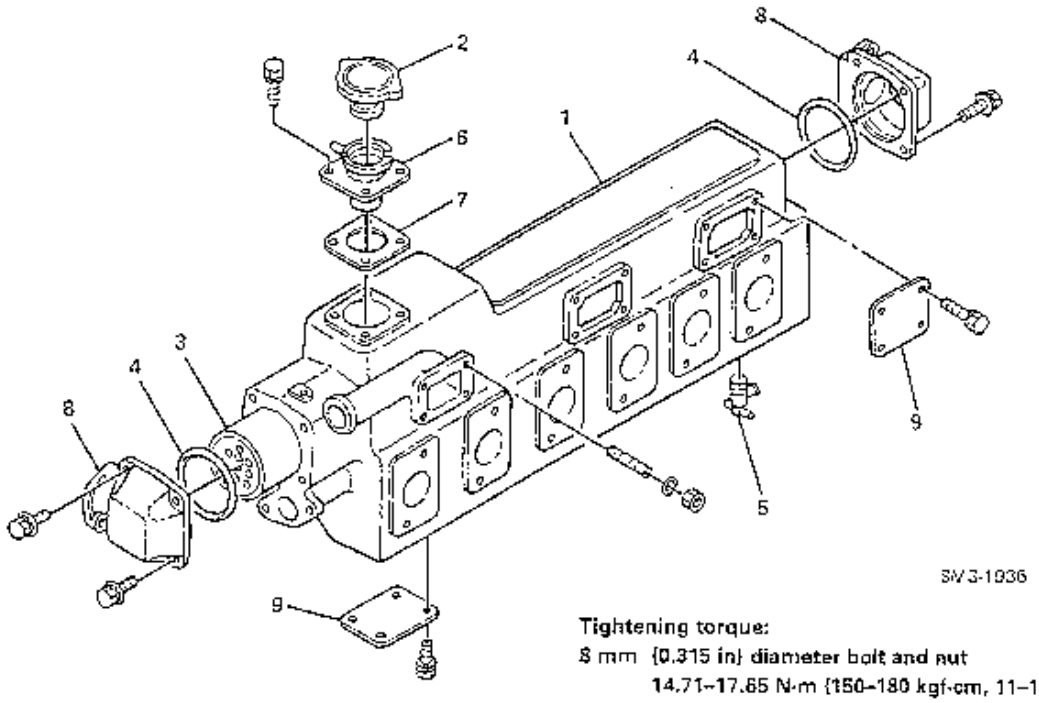
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HEAT EXCHANGER

DESCRIPTION



OVERHAUL



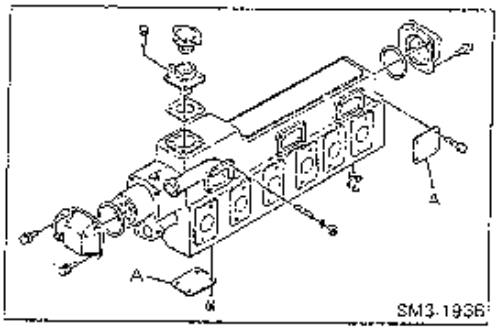
Tightening torque:
8 mm (0.315 in) diameter bolt and nut
14.71–17.65 N·m {150–180 kgf·cm, 11–13 lbf·ft}

1. Housing
2. Coolant filler cap
3. Element
4. O-ring
5. Engine coolant drain cock
6. Filler pipe seat
7. Gasket
8. Water gallery cover
9. Plate

A. Engine coolant inlet
B. Engine coolant outlet
C. Seawater inlet
D. Seawater outlet

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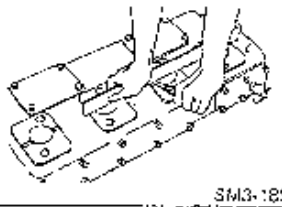
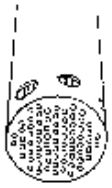
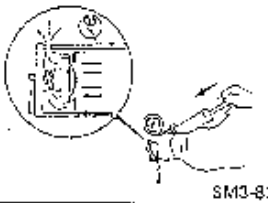
IMPORTANT POINTS – ASSEMBLY

ASSEMBLE THE HEAT EXCHANGER.

NOTE: ○ Replace the O-rings and gasket with new ones.
○ Before installing the plates "A", apply sealing compound (Three Bond No. TB-1207C or equivalent).

INSPECTION AND REPAIR

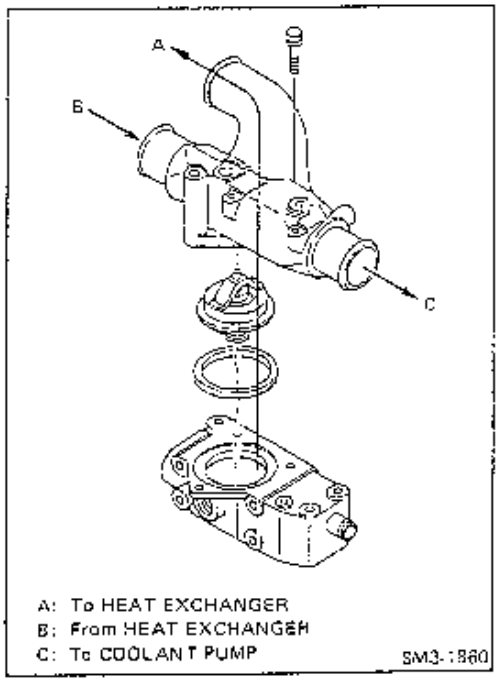
Unit: mm (in)

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Head changer (Exhaust Manifold). Flatness.	Less than 0.1 (0.004)	0.5 (0.019)	Resurface or replace.	 SM3-1858
Element. Clogged.	–	–	Clean with compressed air or sodium hydroxide	Visual check  SM3-2380
Coolant filler cap. Valve opening pressure.	39.23–58.83 KPa {0.4–0.6 kgf/cm², 5.7–8.5 lbf/in²}	–	Replace	 SM3-821

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THERMOSTAT

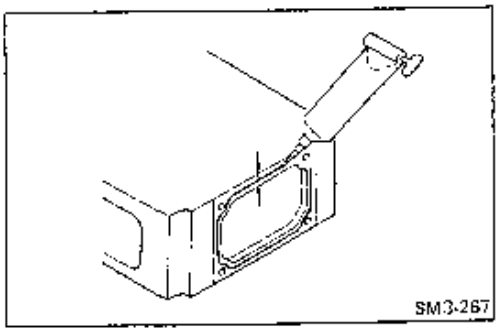


A: To HEAT EXCHANGER
B: From HEAT EXCHANGER
C: To COOLANT PUMP
SM3-1860

IMPORTANT POINT – ASSEMBLY

INSTALL THE THERMOSTAT.

1. Remove water and dirt adhering to the thermostat case.
2. Replace the gasket without fail if it is corroded, damaged or flattened.
3. Before installing the thermostat, apply sealing compound to the hose installation portion of the coolant manifold.
4. Assemble the thermostat, gasket, case and coolant manifold as shown.



IMPORTANT POINT – MOUNTING

INSTALL THE THERMOSTAT CASE.

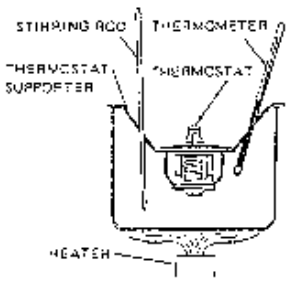
1. Clean the faces.
2. Apply the liquid gasket as shown and install the thermostat case on the cylinder head within 20 minutes.

NOTE: If leaving it more than 20 minutes, clean the liquid gasket completely and reapply the liquid gasket.

Coating Width: 1.5–2.5 mm (0.06–0.10 in)

INSPECTION AND REPAIR

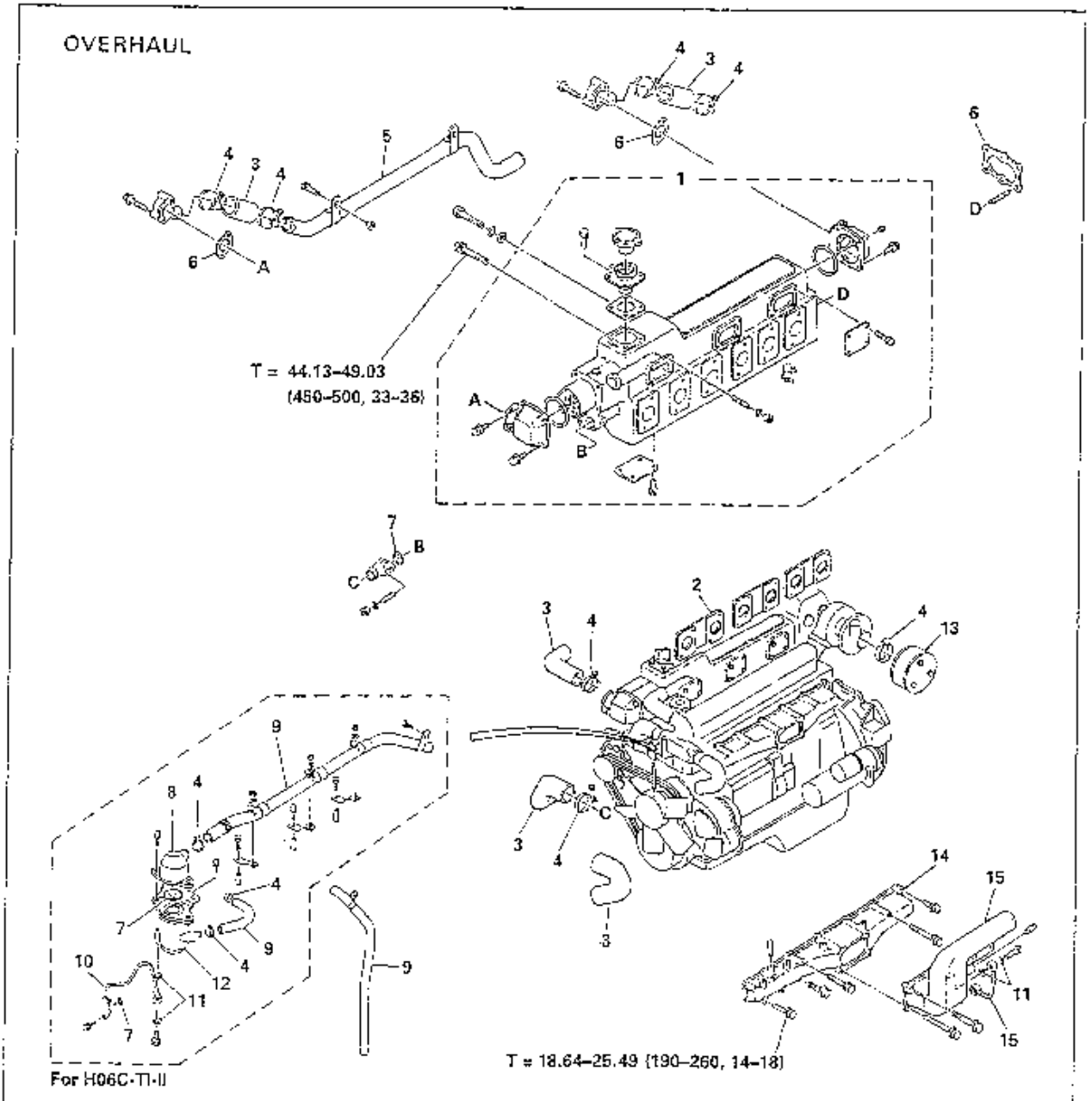
Unit: mm (in)

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Thermostat Valve Opening Temperature	74.5–78.5° (166–173°F)	–	Replace thermostat	
Thermostat Valve Lift	At least 10 (0.4) at 90°C (194°F)	–		
Thermostat Closing Condition	Fully opened valve should close completely within 5 minutes when thermostat is immersed in water of normal temperature.	–		

SM2-889

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AIR INTAKE AND EXHAUST SYSTEM



T = Tightening torque: N·m {kgf·cm, lbf·ft}

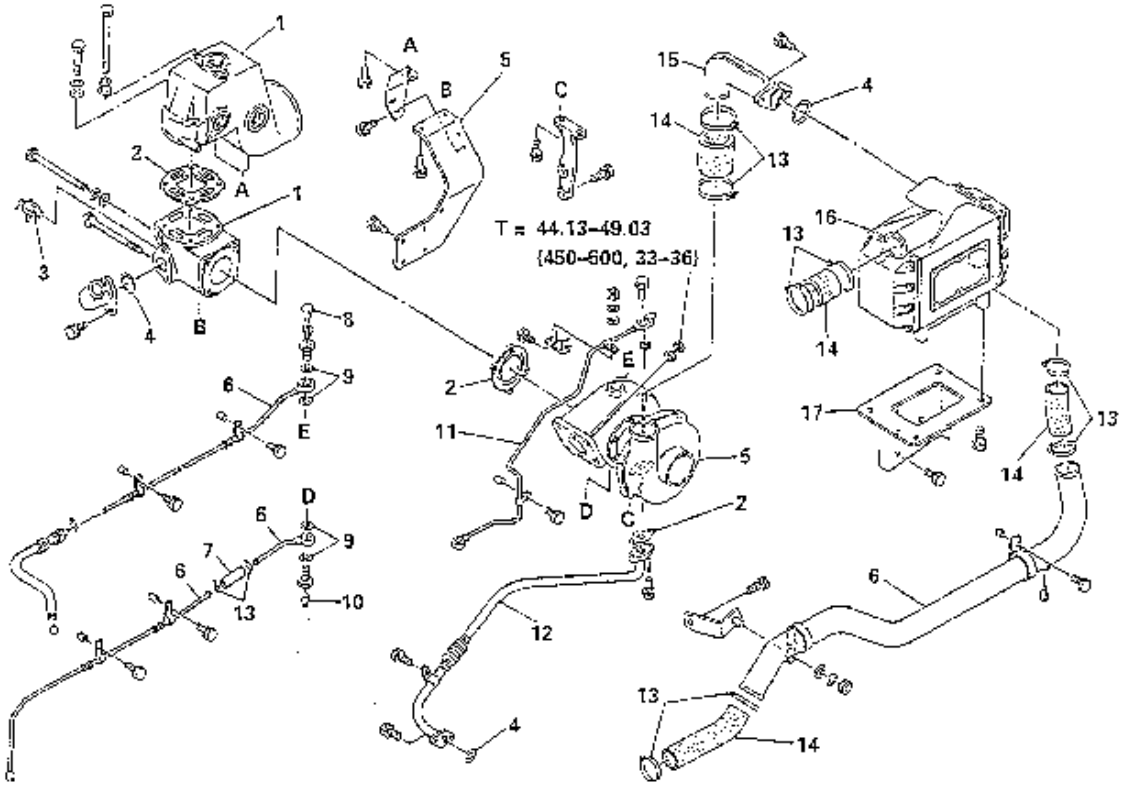
SM3-2404

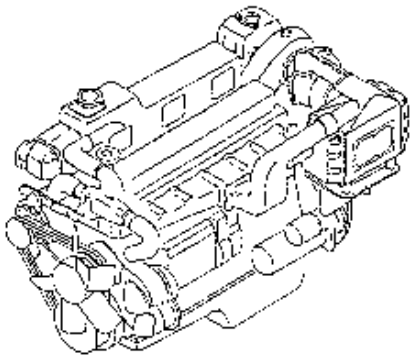
1. Heat exchanger (Exhaust manifold)
2. Exhaust manifold gasket
3. Water hose
4. Clamp
5. Water pipe
6. Gasket
7. O-ring
8. Ventilator
9. Ventilator hose
10. Ventilator pipe
11. Soft washer
12. Ventilator case
13. Air cleaner
14. Intake manifold
15. Intake air pipe

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OVERHAUL





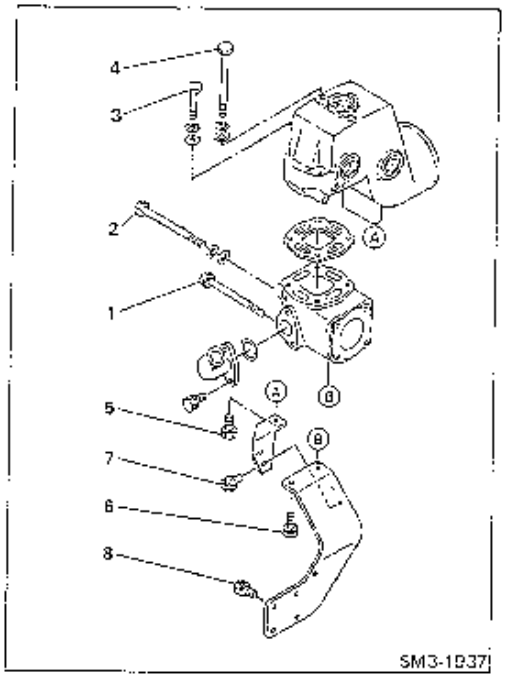
T = Tightening torque: N·m {kgf·cm, lbf·ft}

SM3-2405

1. Exhaust pipe
2. Gasket
3. Seawater drain cock
4. O-ring
5. Turbocharger
6. Water pipe
7. Water hose
8. Air bleeder plug
9. Soft washer
10. Engine coolant drain plug
11. Oil inlet pipe
12. Oil outlet pipe
13. Clamp
14. Air hose
15. Intake air pipe
16. Intercooler
17. Bracket

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IMPORTANT POINTS -- MOUNTING

INSTALL THE EXHAUST PIPES.

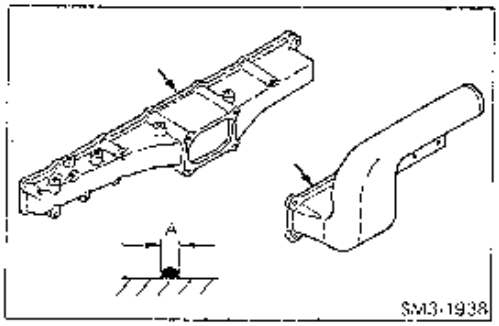
1. Install the turbocharger on the heat exchanger.

Tightening Torque: 44.13–49.03 N (450–500 kgf-cm, 33–36 lbf-ft)

2. Temporarily install the mounting brackets and exhaust pipes.
3. Tighten the bolts to the specified torque in the tightening order as shown.

Tightening Torque:

1 : 49.03–58.83 N.m (500–600 kgf-cm, 37–43 lbf-ft)
2 : 49.03–58.83 N.m (500–600 kgf-cm, 37–43 lbf-ft)
3 : 49.03–58.83 N.m (500–600 kgf-cm, 37–43 lbf-ft)
4 : 49.03–58.83 N.m (500–600 kgf-cm, 37–43 lbf-ft)
5 : 49.03–58.83 N.m (500–600 kgf-cm, 37–43 lbf-ft)
6 : 49.03–58.83 N.m (500–600 kgf-cm, 37–43 lbf-ft)
7 : 49.03–58.83 N.m (500–600 kgf-cm, 37–43 lbf-ft)
8 : 98.07–127.48 N.m (1,000–1,300 kgf-cm, 73–94 lbf-ft)



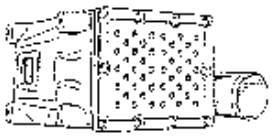
INSTALL THE AIR INTAKE MANIFOLD AND PIPE.

1. Clean the faces.
2. Apply the liquid gasket to the intake manifold flange face and install it on the cylinder head within 20 minutes.
3. Apply the liquid gasket to the pipe flange face and install it on the intake manifold within 20 minutes.

Coating Width (A): 1.5–2.5 mm (0.06–0.10 in)

NOTE: If leaving it more than 20 minutes, clean the liquid gasket completely and reapply the liquid gasket.

INSPECTION AND REPAIR

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Intercooler element. Clogged.	–	–	Clean or replace intercooler assy.	 SM3-1817

NOTE: Do not separate the intercooler housing and element when cleaning.

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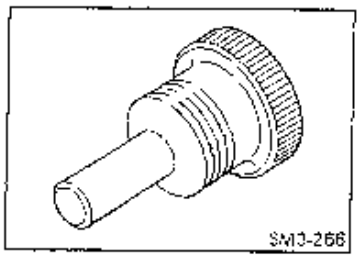
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ENGINE COMPONENT PARTS DISMOUNTING AND MOUNTING

SPECIAL TOOL

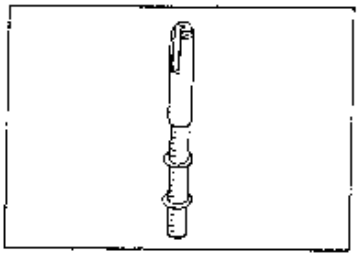
Prior to starting an engine overhaul, it is necessary to have these special tools.

TIMER SETTING TOOL

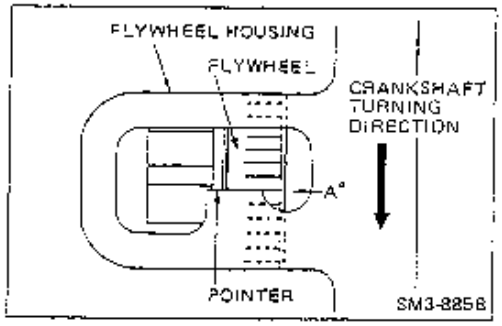


09512-2090 for W04D
09512-2100 for W04C-T,W04C-TI
W06D, W06E, W06D-TI and W06D-TI-II

V-BELT TENSION GAGE



09444-1210



FUEL INJECTION PUMP

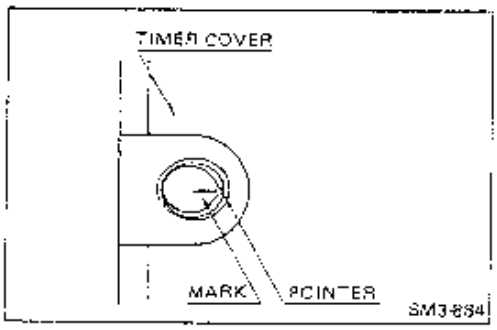
IMPORTANT POINTS – DISMOUNTING

REMOVE THE FUEL INJECTION PUMP.

1. Disconnect the fuel lines, oil lines and engine control lines.
2. Turn the crankshaft counter-clockwise viewed from the flywheel side to align the injection timing mark on the flywheel at A° before top dead center for No.1 cylinder on compression stroke with the pointer on the flywheel housing.

Injection Timing (A°): Refer to SECTION DATA AND SPECIFICATIONS.

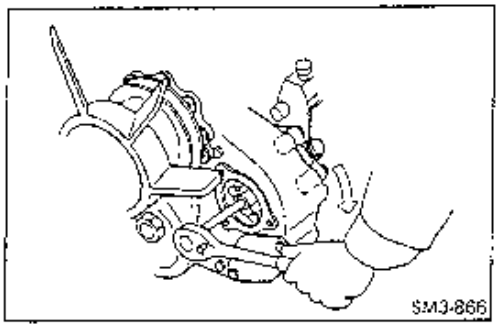
NOTE: In case of marine engine equipped with seawater pump, never rotate crankshaft in reverse direction (Clockwise viewed from the flywheel side).
Reverse rotation may damage impeller in seawater pump.



3. Remove the timing inspection hole plug.
Check that the injection timing mark on the automatic timer is aligned with timer cover pointer.

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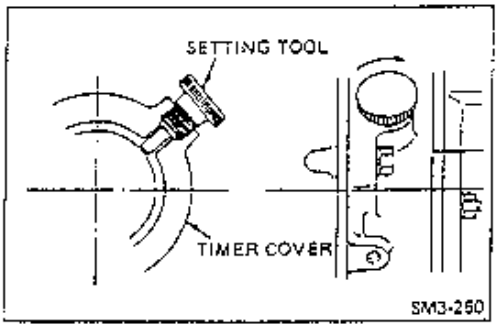


4. If not, remove the timing gear cover and then loosen the drive gear fitting bolts.

NOTE: Do not remove the drive gear fitting bolts.

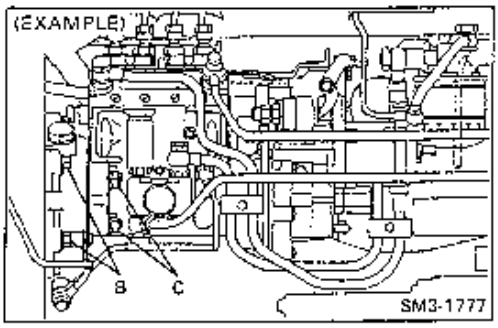
5. Rotate the drive gear clockwise to align the injection timing and then tighten the drive gear fitting bolts.

Tightening Torque: 29.42–34.32 N·m (300–350 kgf·cm, 22–25 lbf·ft)



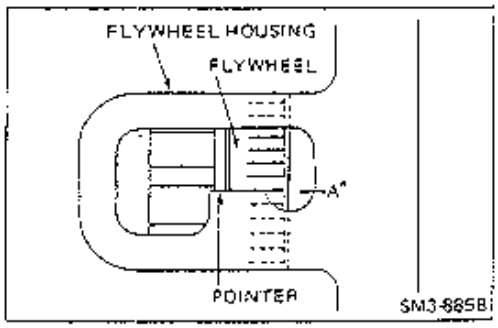
6. Lock the coupling flange with a special tool.

Special Tool:
Timer Setting Tool
(09512-2090) for W04D
(09512-2100) for W04C-T, W04C-TI, W06D, W06E, W06D-TI and W06D-TI-II



7. Loosen the timer cover fitting bolts (B) and then remove the injection pump with timer cover.

NOTE: Do not loosen the injection pump body fitting nuts (C).

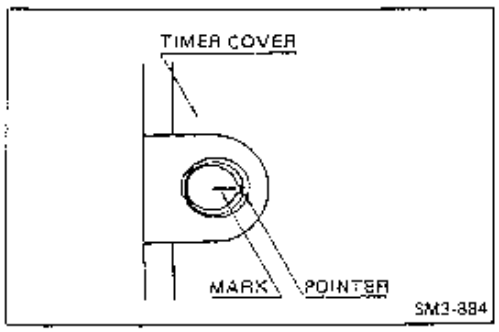


IMPORTANT POINTS – MOUNTING

INSTALL THE INJECTION PUMP.

1. Check that the injection timing mark on the flywheel is aligned with flywheel housing pointer.

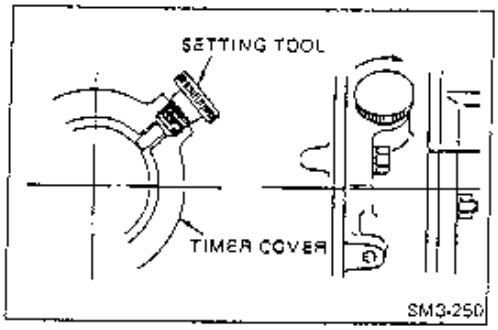
Injection Timing (A°): Refer to SECTION DATA AND SPECIFICATIONS.



2. Check that the injection timing mark on the automatic timer is aligned with timer cover pointer.
If not, adjust the injection timing.

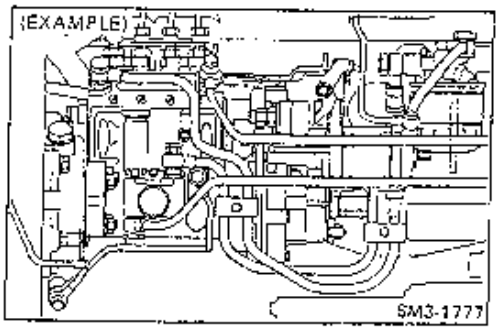
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3. Lock the coupling flange with a special tool.

Special Tool:
Timer Settingtool
(09512-2090) for W04D
(09512-2100) for W04C-T, W04C-TI, W06D, W06E, W06D-TI and W06D-TI-It



4. Install the injection pump with timer cover.

Fitting Bolts Tightening Torque:
18.64–25.49 N·m (190–260 kgf·cm, 14–18 lbf·ft)

5. Remove a special tool and install the timing inspection hole plug.
6. Connect the fuel lines, oil lines and engine control lines.

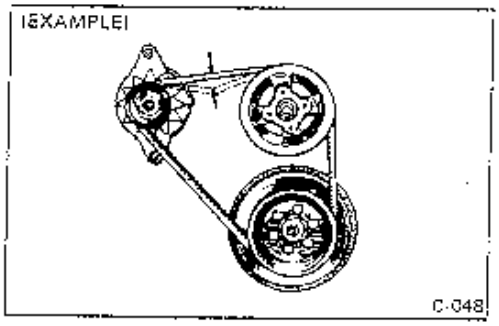
GENERATOR

IMPORTANT POINT – MOUNTING

INSTALL THE GENERATOR ON THE ENGINE.

1. Install the V-belts, and adjust the belt tension.

NOTE: ○ Do not under any circumstances apply the lever directly against the generator body owing to the risk of damaging the generator.
○ When installing a new V-belt or adjusting the tension, be sure to repeat the adjustment two or three times, after running the engine for several minutes each time.



2. V-belt deflection
Apply a load of about 98 N (10 kgf, 22 lbf) by pressing with your finger or a special tool.

Assembly Standard (A): 10–15 mm (0.40–0.59 in)

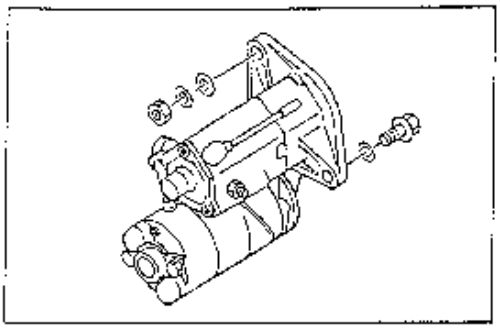
Special Tool: V-belt tension gauge (09444-1210)

NOTE: If the belt is excessively tensioned, there is a risk of damaging the bearings of the generator or coolant pump and also shorting the life of the V-belt.
Conversely, if there is insufficient tension on the V-belt, the belt will slip, unusual noise will be emitted, the battery may run down and the engine may overheat.

Through Bolt Tightening Torque:
44.13–49.03 N·m (450–500 kgf·cm, 33–36 lbf·ft)

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STARTER

IMPORTANT POINT – DISMOUNTING

REMOVE THE STARTER FROM THE ENGINE.

1. Turn off the battery switch (If so equipped).
2. Put the match marks on the harness and starter terminals with a pen and then disconnect the harness.
3. Remove the starter from the engine.

IMPORTANT POINT – MOUNTING

INSTALL THE STARTER ON THE ENGINE.

1. Install the starter on the engine.

Fitting Bolt and Nut Tightening Torque:

12 mm (0.47 in) dia. : 63.75–88.25 N·m (650–900 kgf·cm, 47–65 lbf·ft)

14 mm (0.55 in) dia. : 107.88–147.09 N·m (1,100–1,500 kgf·cm, 80–108 lbf·ft)

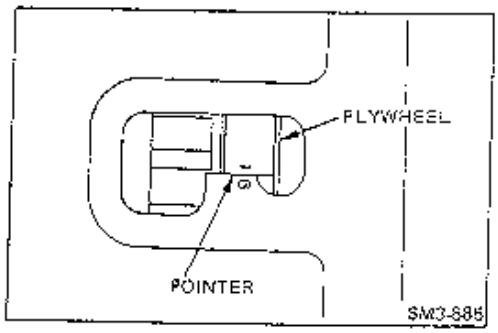
2. Connect the starter harness to match the marks.

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ENGINE TUNE-UP

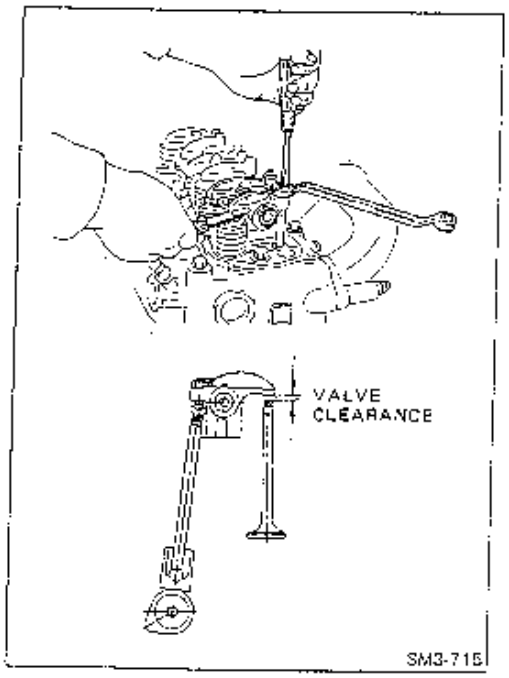
NOTE: In case of marine engine equipped with seawater pump, never rotate the crankshaft in reverse direction (Clockwise viewed from flywheel). Reverse rotation may damage impeller in seawater pump.



VALVE CLEARANCE

INSPECTION AND ADJUSTMENT OF THE VALVE CLEARANCE

1. Set the No.1 piston to top dead center of compression stroke.

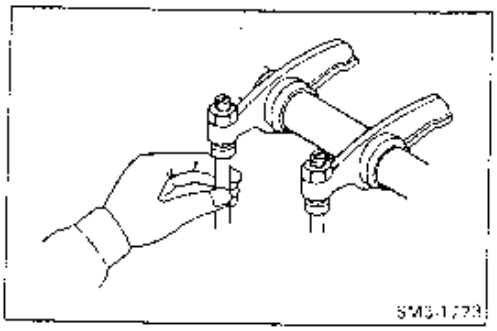


2. With the No. 1 piston positioned at top dead center and of the compression stroke, adjust the No. 1 valve clearance using a thickness gauge.
   The thickness gauge should move with a very slight pull.

Valve Clearance: Refer to SECTION DATA AND SPECIFICATIONS.

3. Adjust the other valves.
   Turn the crankshaft counter-clockwise 120° viewed from flywheel side. Adjust the valve clearance for each cylinder in the firing order.

Firing Order: 1–4–2–6–3–5
(A number of a cylinder is to be counted in order from the timing gear side)

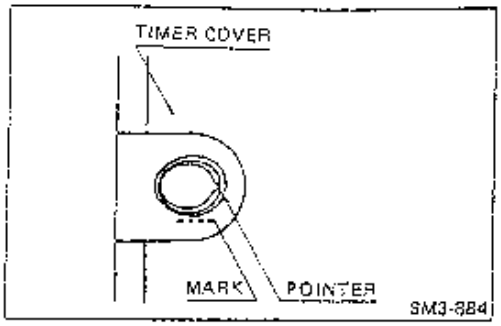


METHOD FOR DETERMINING IF THE NO. 1 OR NO. 6 PISTON IS AT THE TOP DEAD CENTER ON COMPRESSION STROKE.

Turning the crankshaft, align the mark "1-6" on the flywheel with the pointer on the flywheel housing. In this position either the No. 1 or No. 6 piston is at the top dead center on compression stroke.

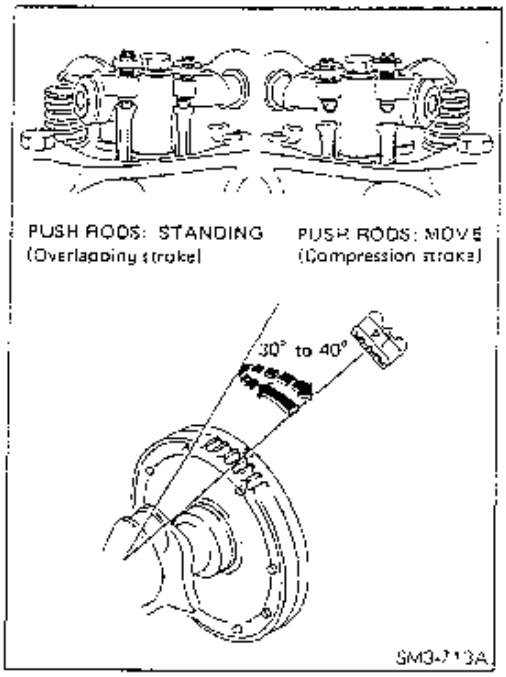
1. If both the No. 1 intake and exhaust rocker arms can be moved easily by hand, the No. 1 piston is at top dead center on compression stroke.

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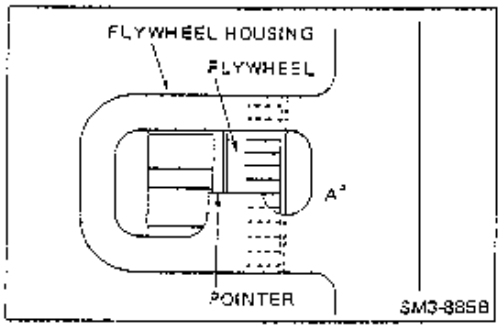
2. If the injection timing mark is nearly aligned with the pointer, the No. 1 piston is at top dead center on the compression stroke.

NOTE: If not, turn the crankshaft one complete revolution and align marks as above.



3. While looking at the push rod of No. 1 and No. 6 pistons. Turn the flywheel counter-clockwise and clockwise about 30° to 40° (see left figure).
If the piston whose exhaust and intake push rods do not move during the interval, it is at the top dead center on the compression stroke.
If the piston whose push rods have moved, it is at the completion of the exhaust and begun of the intake stroke (overlapping stroke).

NOTE: Always loosen the lock nut and raise the adjusting screws fully to the top. If the adjusting screws are too low, the piston and valves may strike each other during valve clearance adjustment.

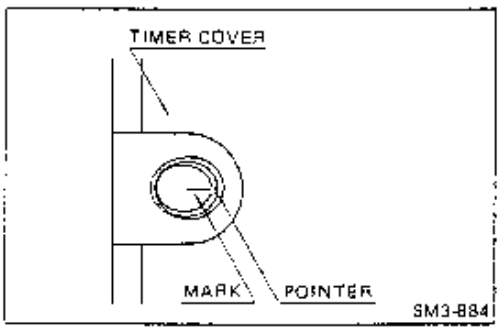


INJECTION TIMING

INSPECT THE INJECTION TIMING.

1. Turn the crankshaft counter-clockwise viewed from the flywheel side to align the injection timing marks on the flywheel at A° before top dead center for No. 1 cylinder on compression stroke with pointer on the flywheel housing.

Injection Timing (A°): Refer to section DADA AND SPECIFICATIONS.

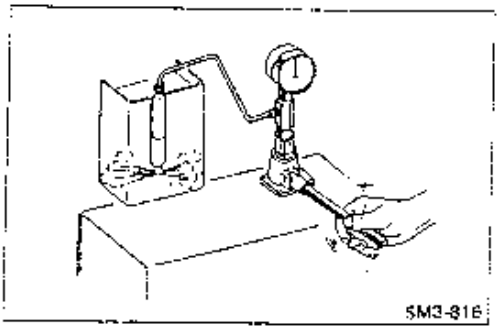


2. Check that the injection timing mark on the automatic timer is aligned with timer cover pointer.
If not, adjust the injection timing.

NOTE: When adjusting the injection timing, refer to "FUEL INJECTION PUMP" in section ENGINE COMPONENT PARTS DISMOUNTING AND MOUNTING for details.

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SM3-816

INJECTION NOZZLE

INSPECT AND ADJUST THE INJECTION PRESSURE.

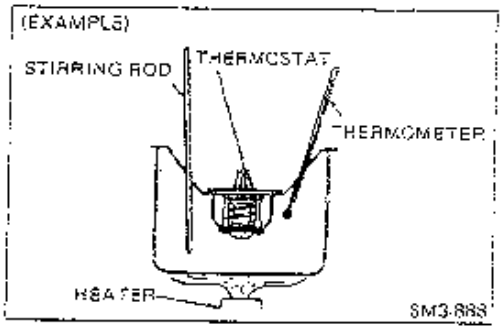
Refer to "INJECTION NOZZLE" in SECTION FUEL SYSTEM.

TEST THE SPRAY PROFILE.

Refer to "INJECTION NOZZLE" in SECTION FUEL SYSTEM.

TEST THE FUEL LEAKAGE.

Refer to "INJECTION NOZZLE" in SECTION FUEL SYSTEM.



SM3-883

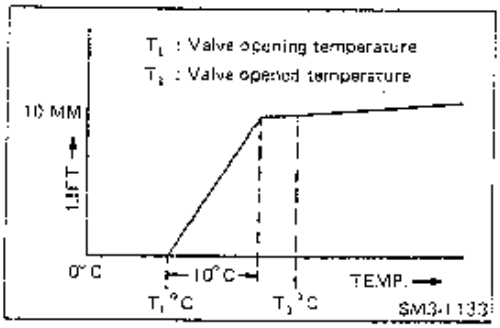
THERMOSTAT

INSPECT THE THERMOSTAT FUNCTION.

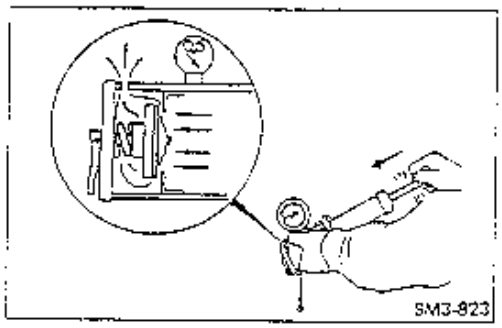
1. Place the thermostat in hot water and check the opening temperature and the lift.
2. Using a thermometer, check to see the thermostat opens at the specified temperature. Refer to "THERMOSTAT" in SECTION COOLING SYSTEM.
3. Immerse the thermostat in hot water and measure the lift of the pellet after a period of 5 minutes using vernier calipers. Measure the position of the bottom of the pellet before and after heating the thermostat.

Valve Lift: Refer to "THERMOSTAT" in SECTION COOLING SYSTEM.

4. Immerse a heated thermostat in water of normal temperature. If it completely closes within 5 minutes it is satisfactory. If it remains even slightly open, it is defective and must be replaced.



SM3-1133


SM3-823

COOLANT FILLER CAP

INSPECT THE FILLER CAP FUNCTION.

Check the filler cap pressure using a cap tester.

0.5 : 39.23–58.83 kPa (0.4–0.6 kgf/cm², 5.7–8.5 lbf/in²)

0.9 : 73.55–102.96 kPa (0.75–1.05 kgf/cm², 10.7–14.9 lbf/in²)

NOTE: ○ The filler cap pressure is shown on the filler cap, and it should be confirmed.

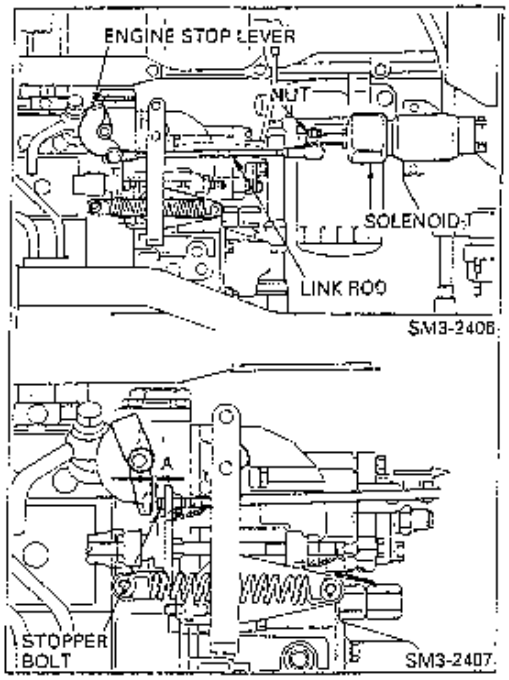
○ If the cap pressure is incorrect, there is a risk of abnormally high pressure being generated in the cooling system, which may cause the hose to drop off or burst and, in turn, damage the engine.

WARNING

The cap should not be removed while the engine and cooling system are hot. This can result personal injury.

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ENGINE CONTROL

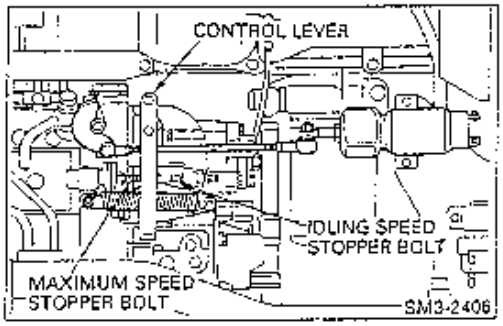
ADJUST THE SOLENOID (ENGINE STOP) LINK ROD.

1. Adjust the link rod length so that the clearance between the stopper of the governor case and the engine stop lever becomes "A" when the solenoid plunger is fully pushed in.

Assembly Standard "A": 2–3 mm (0.08–0.11 in)

NOTE: ○ Install the link rod with the nut(s) at the top.
○ If the clearance adjustment is unsatisfactory or the action of the solenoid is sluggish, solenoid seizure, insufficient output or engine stoppage may result.

2. After the above adjustment is over, move the link rod by hand and make sure that it moves lightly.



ADJUST THE ENGINE IDLING SPEED.

When straight drive navigation is not smoothly made at the time of a sea trial in engine at idle, adjust it according to the following procedures.

1. Disconnect the throttle control cable from engine port (left) side and the starboard (right) side.
2. Loosen the idling speed stopper bolt lock nut.
3. Adjust through varying the engine speed using the idling speed stopper bolt on the injection pump so that straight drive navigation is made.

NOTE:
To increase engine speed: Turn the idling speed stopper bolt clockwise.
To decrease engine speed: Turn the idling speed stopper bolt counter-clockwise.
Engine Idling Speed: Refer to section DATA AND SPECIFICATIONS.

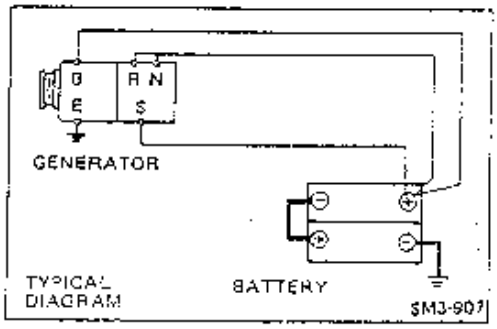
4. Upon completion of adjustment of engine idling speed, lock the stopper bolt with nut and apply paint on the stopper bolt and nut.

NOTE: When adjusting the all adjusting devices on the fuel injection pump governor, except the idling speed stopper bolt, refer to CHAPTER GV, INJECTION PUMP GOVERNOR.

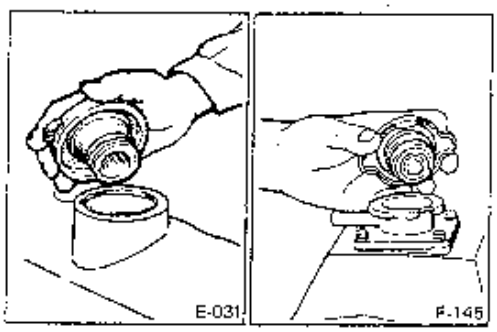
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ENGINE TUNE-UP ON TEST BENCH

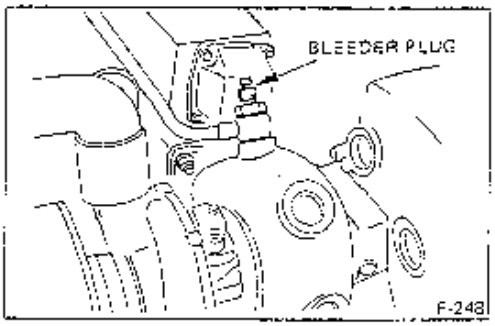


NOTE: In case of marine engine equipped with seawater pump
- Never rotate the crankshaft in reverse direction (Clockwise viewed from flywheel).
  Reverse rotation may damage impeller in seawater pump.
- Do not run engine without water in the seawater cooling system. The seawater pump damage can result.
  Starting the engine when the generator is not connected to the battery may damage the generator. Always connect to the battery.



SET THE ENGINE ASSEMBLY ON A TEST BENCH.

1. Add the proper amount of the specified engine oil through the oil filler cap on the cylinder head cover.
2. Add coolant.



NOTE: In case of engine equipped with water-cooled turbocharger, bleed air from bleeder plug.

BLEED AIR FROM FUEL SYSTEM.

Refer to section FUEL SYSTEM.

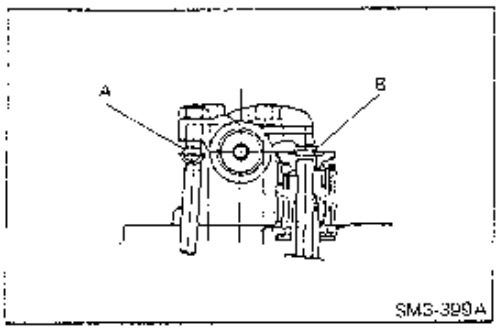
CHECK THE INJECTION TIMING.

Refer to "FUEL INJECTION PUMP" in section ENGINE COMPONENT PARTS DISMOUNTING AND MOUNTING.

CHECK THE VALVE CLEARANCE.

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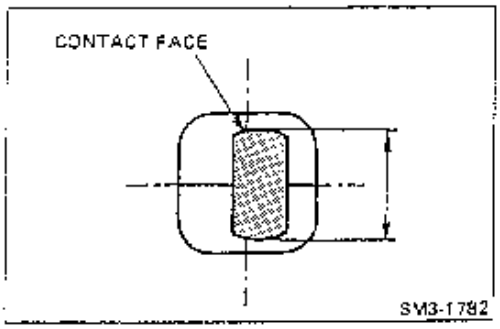
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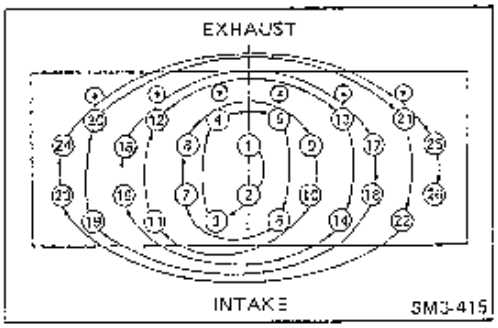


START THE ENGINE.

NOTE: Before starting the engine, mark sure that the fuel cut lever of the fuel injection pump is operating normally.

1. Check the oil feed to rocker arms.
   a. Set the engine speed: Refer to SECTION DATA AND SPECIFICATION.
   b. Within one minute after starting the engine, oil should flow to the head (Face A) of all push rods and the head (Face B) of all valves. If the time required for the oil to flow to the rocker arms is long, various troubles such as seizing, abnormal wear and unusual noize may occur.
2. Check the contact of the rocker arm and valve stem caps.
   After running the engine, a contact of approx. 8 mm (0.315 in) should be obtained at the cap contact face of the rocker arm.
   If the contact face is one sided, the valve will tilt, resulting in valve seizure, breakage, damage, or wear of the rocker arm stem cap.

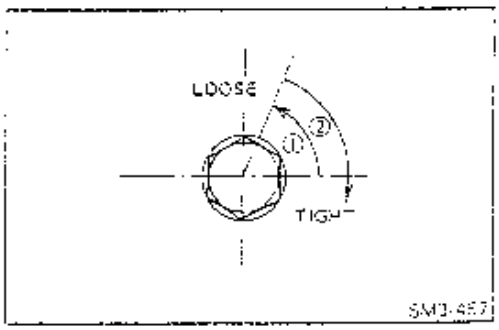


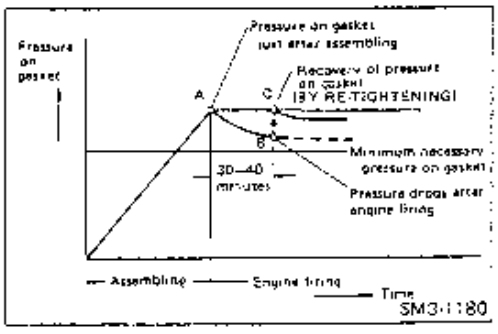


3. Retighten the cylinder head bolts.
   After tightening cylinder head bolt to specified torque, run the engine for about 30 to 40 minutes at a water temperature of about 80°C. Then loosen cylinder each head bolt 1/8–1/4 turn and retighten, in sequence, to specified torque.

Special Tool: Socket wrench (09411-1260)

NOTE:
- In case of marine engine equipped with heat exchanger (exhaust manifold), loosen the heat exchanger bracket fitting bolts before retightening the cylinder head bolts.
- Be sure to loosen one bolt at a time, then retighten it before going on to the next bolt.
- By retightening, face pressure of cylinder head is restored from point B to C as shown.
- Retighten at the first 30 hours following servicing which involves the loosening or removal of any cylinder head bolt. Such servicing includes replacement of the cylinder head gasket, servicing of the valve gear parts, and the like.





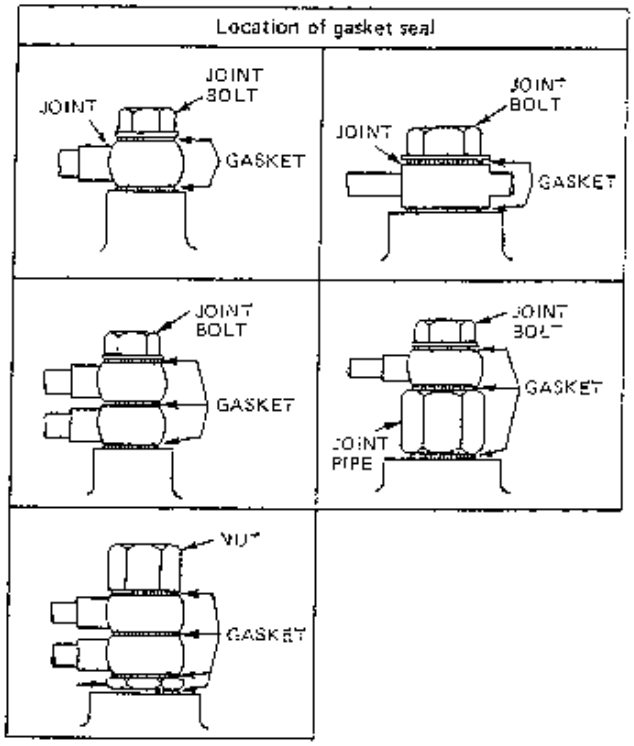
RECHECK THE VALVE CLEARANCE, WHEN ENGINE IS COLD.

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PROCEDURE FOR INSTALLING JOINTS AND GASKETS OF ENGINE PIPES

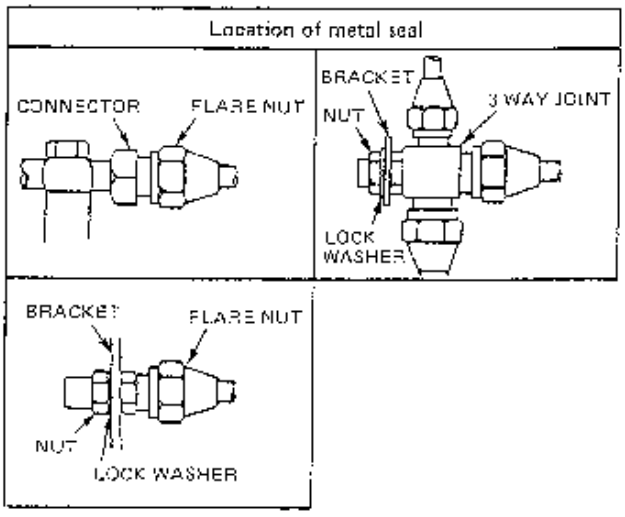
1. Gasket seal type (aluminum + rubber, asbestos or copper).



Tightening torque chart

Clamping screw size (Diameter) mm (in)	Tightening torque N·m (kgf·cm, lbf·ft)
8 (0.315)	11.76–16.67 (120–170, 8.68–12.29)
10 (0.394)	17.66–22.55 (180–230, 13.02–16.63)
12 (0.472)	22.56–27.45 (230–280, 16.64–20.25)
14 (0.551)	22.56–27.45 (230–280, 16.64–20.25)
16 (0.630)	29.42–34.32 (300–350, 21.69–25.30)
18 (0.709)	39.23–44.12 (400–450, 28.94–32.54)
20 (0.787)	39.23–44.12 (400–450, 28.94–32.54)
22 (0.866)	51.98–58.83 (530–600, 38.34–43.39)
24 (0.945)	70.61–78.45 (720–800, 52.08–57.86)
28 (1.102)	127.49–147.09 (1,300–1,500, 94.03–108.49)

2. Metal seal type (Flares connector type).



Tightening torque chart

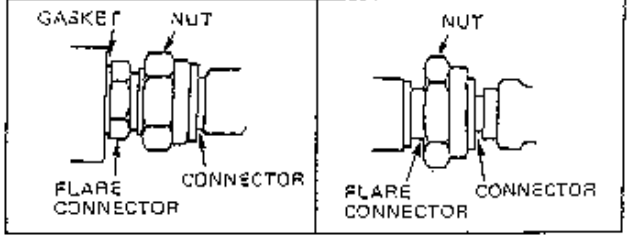
Clamping screw size (Diameter) mm (in)	Tightening torque N·m (kgf·cm, lbf·ft)
12 (0.472)	19.62–22.57 (200–220, 14.47–16.63)
14 (0.551)	32.37–35.30 (330–360, 23.87–26.03)
16 (0.630)	39.23–49.03 (400–500, 28.94–36.16)
18 (0.709)	58.84–68.64 (600–700, 43.39–50.62)
20 (0.787)	63.75–68.64 (650–700, 47.00–50.61)

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3. Metal seal type (Nipples connectors type)

Location of metal seal



Tightening torque chart

Clamping screw size (Diameter) mm (in)	Tightening torque N·m (kgf·cm, lbf·ft)
10 (0.394)	9.81–14.70 (100–150, 7.23–10.84)
20 (0.787)	19.61–24.51 (200–250, 14.47–18.08)

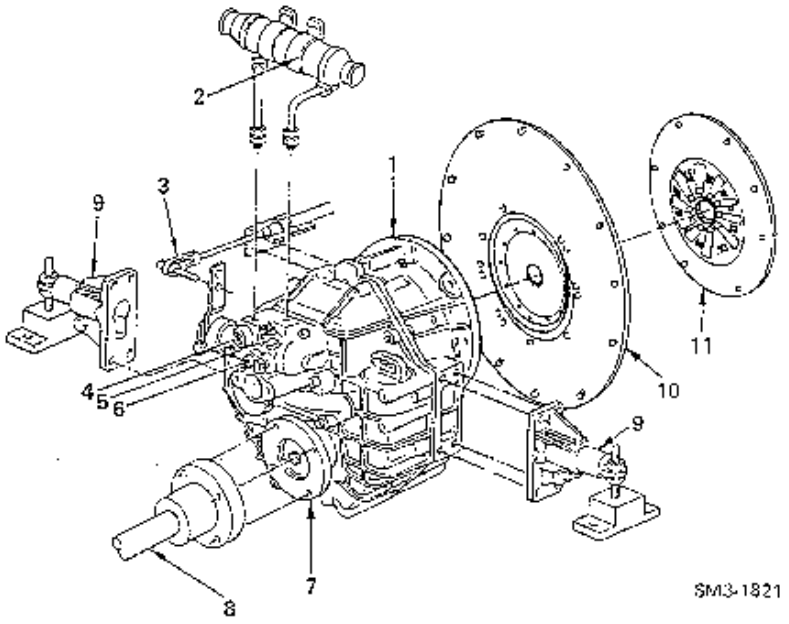
NOTE:
- Before installing the joints, ensure that there is no dirt or burrs adhering to the various seat faces (pipe joints, gaskets, etc.)
- Because the pipes can move relatively free during installation and the seat faces are liable to tilt, first temporarily tighten the pipes, then tighten them to specification and ensure that there is no leakage from them.
- When tightening two pipes together, be very careful that they do not rotate together.
- After installing the pipes, apply the correct pressure to each pipe joint and ensure that there is no leakage.
- Ensure that the various tightening torques conform to the above table.
- If a soft washer ≒4840 FR-N (aluminum + rubber and carbon press fit part) is loosened or removed subsequent to being installed, be sure and replace it with a new one.
  There is no need to replace it, however, for normal retightening.

(K.P.)

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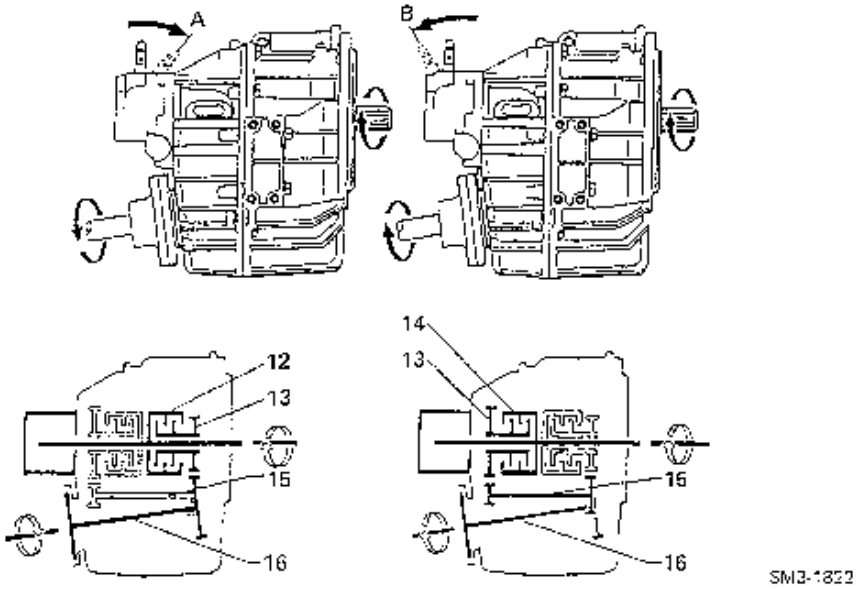
MARINE TRANSMISSION DISMOUNTING AND MOUNTING (For W06D-TI)

OVERHAUL



1. Marine transmission
2. Fluid cooler
3. Remote control
4. Connection for temperature gauge
5. Neutral safety switch
6. Connection for shifting pressure control
7. Marine transmission output flange
8. Propeller shaft
9. Support bracket
10. Intermeidate flange
11. Torsion-elastic coupling
12. Clutch, side A
13. Loose gear
14. Clutch, side B
15. Intermediate shaft
16. Output shaft

OPERATION

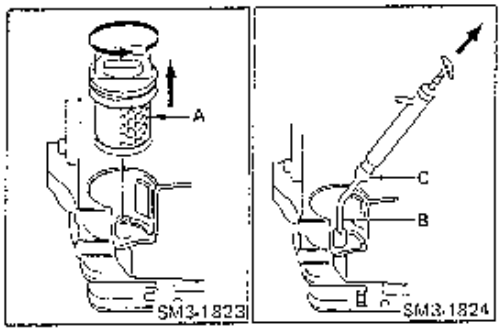


Position of shifting lever when driving forward

Propeller pitch	Propeller ratio	Shifting lever in position
Right hand	Opposite to engine rotation	A
Left hand	As engine rotation	B

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IMPORTANT POINTS – DISMOUNTING

PUMPING OUT MARINE TRANSMISSION FLUID.

1. Turn the filter cover counter-clockwise to loosen the fluid fine filter (Item A).
2. Remove the filter cover complete with fluid fine filter.
3. Pump out old marine transmission fluid through suction pipe (Item B) in the filter compartment.

NOTE: **Max. outside diameter of suction hose is 16 mm (0.625 in) (Item C).**

DISCONNECT THE PROPELLER SHAFT (Item D) FROM THE MARINE TRANSMISSION OUTPUT FLANGE.

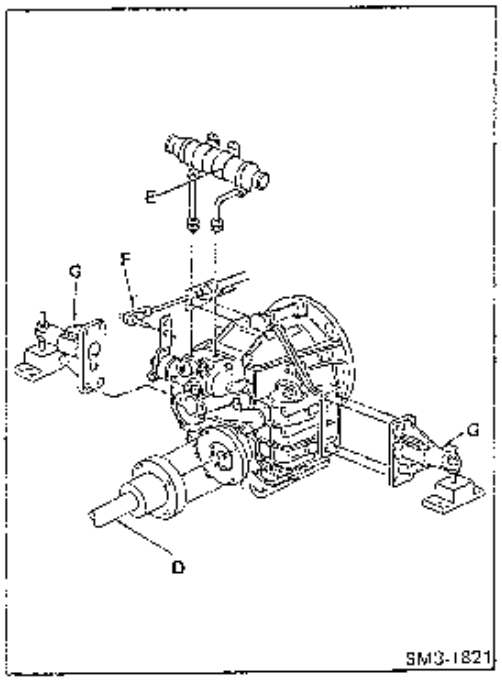
REMOVE THE FLUID COOLER WITH PIPES (Item E).

NOTE: **Plug the openings of the line and marine transmission to prevent dirt entering.**

DISCONNECT THE REMOVE CONTROL (Item F) FROM SHIFTING LEVER.

DISCONNECT THE ELECTRICAL LINE AND FLUID LINES.

REMOVE THE SUPPORT BRACKET (Item G).

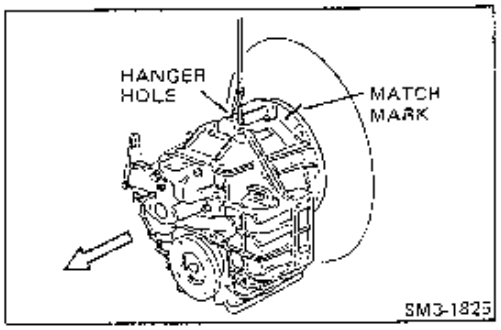


REMOVE THE MARINE TRANSMISSION.

1. Put the match mark on the marine transmission and intermediate flange with a pen.
2. Suspend the marine transmission.

NOTE: **The marine transmission without fluid and fluid cooler weights approx. 431 N (44 kgf, 97 lbf).**

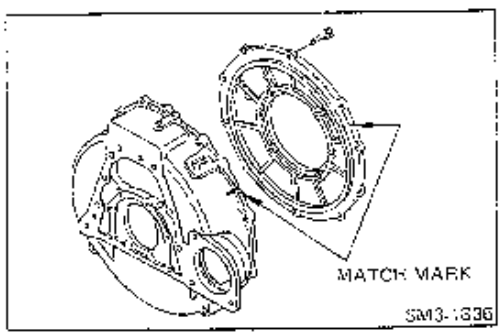
3. Remove the marine transmission fitting bolts.
4. Pull the marine transmission away from the engine.



REMOVE THE INTERMEDIATE FLANGE FROM THE FLYWHEEL HOUSING.

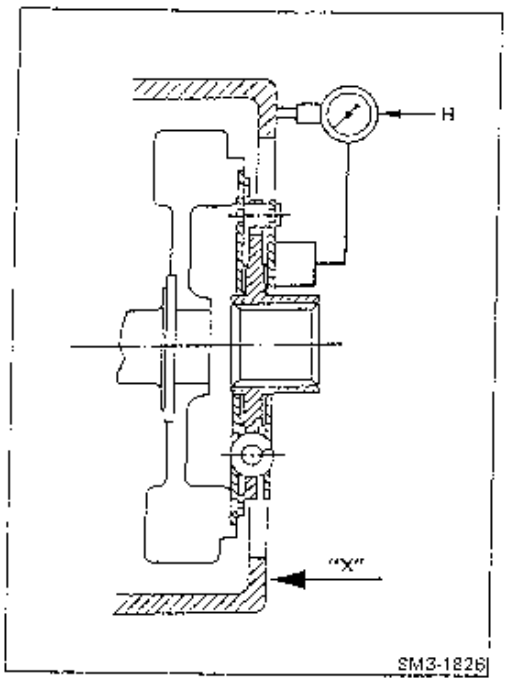
Put the match mark on the intermediate flange and flywheel housing before removing.

REMOVE THE TORSION-ELASTIC COUPLING FROM THE FLYWHEEL.



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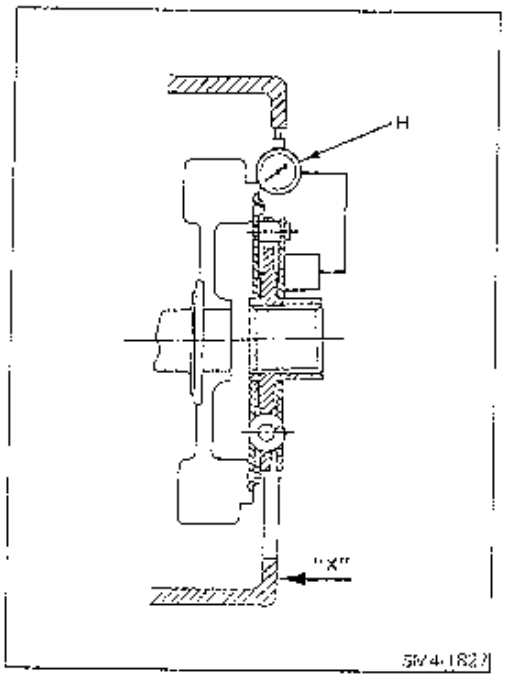


IMPORTANT POINTS – MOUNTING

INSTALL THE TORSION-ELASTIC COUPLING.

1. Install the torsion-elastic coupling to the flywheel.
2. Check the axial tolerances of the connection between marine transmission and engine.
   a. Attach caliper linkage (Item H) to damper plate.
   b. Apply base of caliper at right angles to plane surface of flywheel housing.
   c. Pretension the gauge and set to "0".
   d. Turn the flywheel slowly. The gauge reading must not exceed 0.1 mm (0.004 in.).

"X" : Mounting surface of engine flywheel housing.

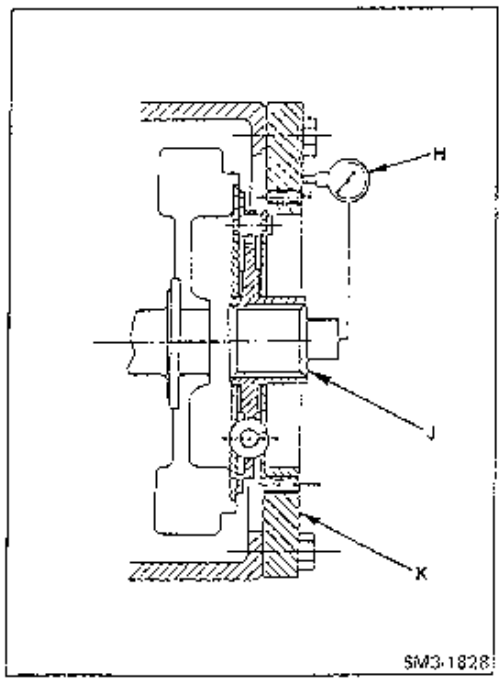


3. Check the radial tolerances of the connection between marine transmission and engine.
   a. Attach caliper linkage (Item H) to damper plate.
   b. Apply base of caliper at right angles to entering surface of flywheel housing.
   c. Pretension the gauge and set to "0".
   d. Turn the flywheel slowly. The gauge reading must not exceed 0.1 mm (0.004 in).

"X" : Mounting surface of engine flywheel housing.

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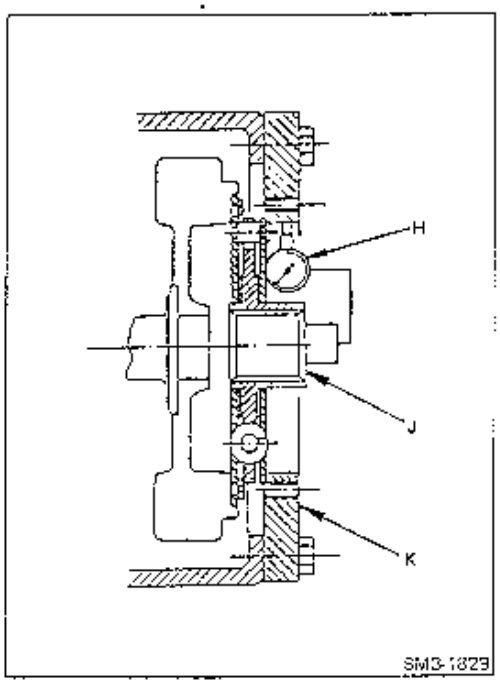
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INSTALL THE INTERMEDIATE FLANGE.

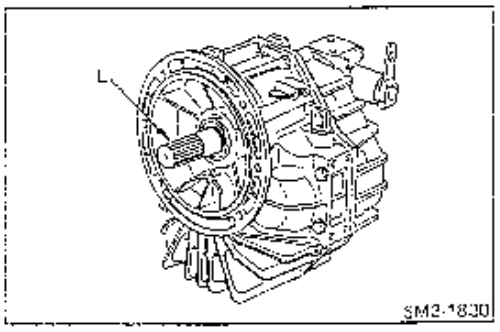
1. Locate the intermediate flange on the flywheel housing to align the match mark.
2. Check the axial tolerances of the intermediate flange (Concentricity).

a. Attach caliper linkage (Item H) to the damper plate (Item D).
b. Apply base of caliper at right angles to centering surface of intermediate flange (Item K).
c. Pretension the gauge and set to "0".
d. Turn the flywheel slowly. The gauge reading must not exceed 0.15 mm (0.0059 in).



2. Check the radial tolerances of the intermediate flange (parallel running).

a. Attach caliper linkage (Item H) to the damper plate (Item J).
b. Apply base of caliper at right angles to plane surface of the intermediate flange (Item K).
c. Pretension the gauge and set to "0".
d. Turn the flywheel slowly. The surface deviation must not exceed 0.05 mm (0.0019 in) 100 mm (3.937 in) measured diameter.

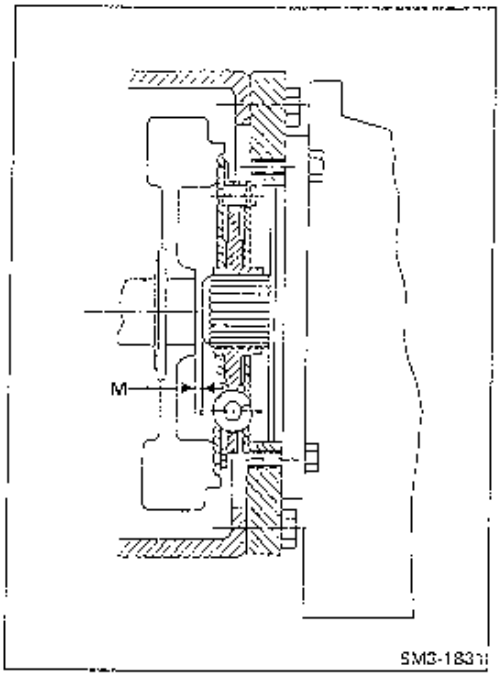


INSTALL THE MARINE TRANSMISSION.

1 Apply grease containing molybdenum disulfide to the input shaft spline (Item L).

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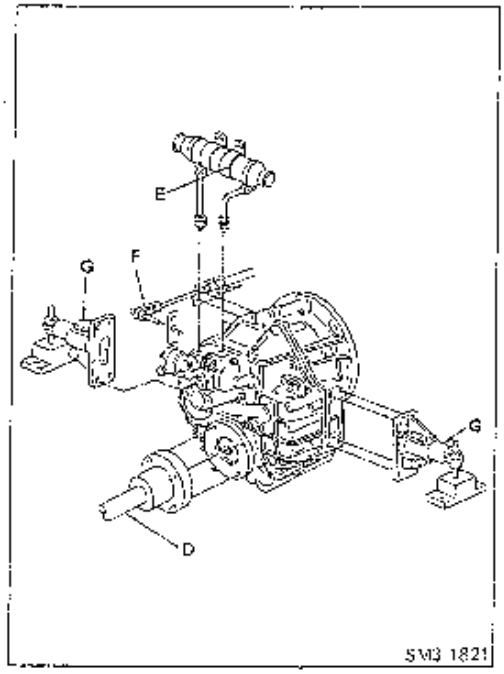
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2. Install the marine transmission to the intermediate flange.

Tightening Torque: 37.27–49.03 N·m (380–500 kgf-cm, 28–36 lbf-ft)
Axial Play (M): Minimum 1 mm (0.04 in)

NOTE: Assure clearance of axial play of the crankshaft.



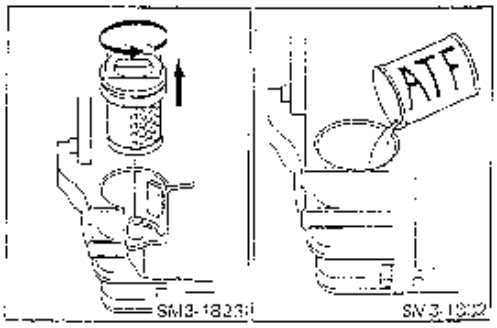
INSTALL THE SUPPORT BRACKET (Item G).

CONNECT THE PROPELLER SHAFT (Item D) TO THE MARINE TRANSMISSION OUTPUT FLANGE.

CONNECT THE ELECTRICAL LINE AND FLUID LINES.

CONNECT THE REMOVE CONTROL (Item F) TO THE SHIFTING LEVER.

INSTALL THE FLUID COOLER WITH PIPES (Item E).



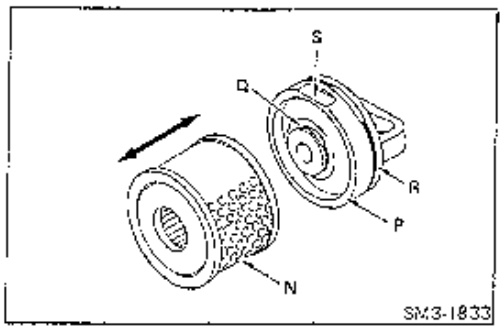
FILL WITH AUTOMATIC TRANSMISSION FLUID (ATF).

NOTE: The filter element must be renewed whenever the fluid is changed.

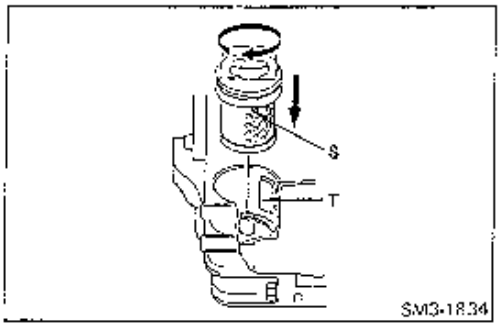
1. Turn filter cover counter-clockwise and pull.
2. Fill with 4.0 L (244.1 cu.in) of Automatic Transmission Fluid. (ATF).

Type of Fluid: ATF (Automatic Transmission Fluid)
e.g. DEXRON II-D, FORD M 2 C-33G, ALLISON C-3
No other fluids unless authorized by HURTH

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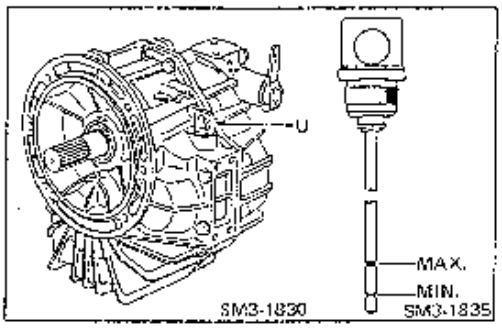


3. Remove filter element (Item N) from cover (Item P).
4. Check O-ring (Item Q) and place new filter element onto cover.
5. Check O-ring (Item R) and insert filter cover with fluid fine filter to its stop into the marine transmission housing.



6. Lock filter cover in place by turning clockwise and pushing.

NOTE: When inserting the filter cover, make sure that flat side of cover (Item S) matches with lug (Item T) in the filter.



7. Loosen fluid dipstick (Item U) turning the handle counter-clockwise.
8. Wipe dipstick with a clean and dustfree cloth and insert dipstick to its stop.
9. Remove dipstick and check fluid level.
10. Insert the dipstick to its stop and lock it by turning the handle clockwise.

11. Let engine run at idle speed with shifting lever in neutral position until fluid cooler and all pipelines are filled in fluid.
12. Shut down engine and check fluid level again. If necessary, top up to the marking on the dipstick.

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EE-S195E-02

CHAPTER EE

ELECTRICAL EQUIPMENT

DATA AND SPECIFICATIONS ..... EE- 2
LOCATION OF ELECTRICAL EQUIPMENT ..... EE- 2
TROUBLESHOOTING ..... EE- 3
GENERAL INSTRUCTION ..... EE- 5
BATTERY ..... EE- 6
ENGINE STARTING CIRCUIT ..... EE- 7
PRE-HEAT CIRCUIT ..... EE- 8
ENGINE STOP AND WARNING LAMP CIRCUIT ..... EE- 8
METER AND GAUGE CIRCUIT EE-10
ELECTRICAL WIRING DIAGRAM

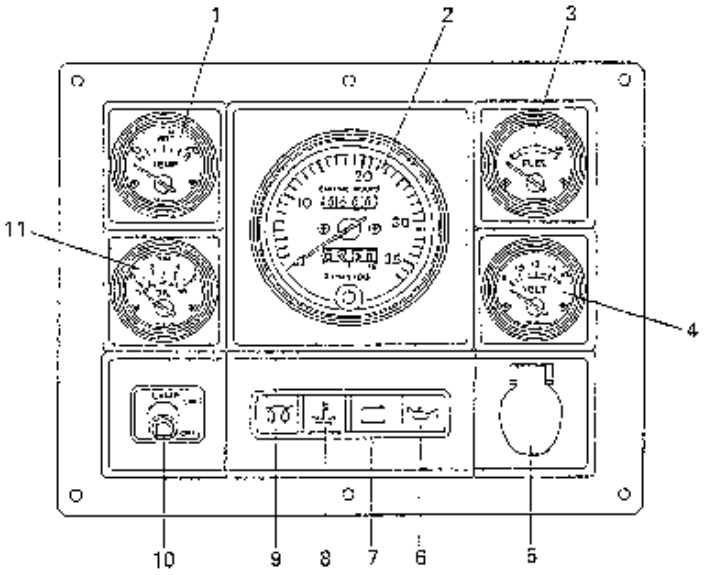
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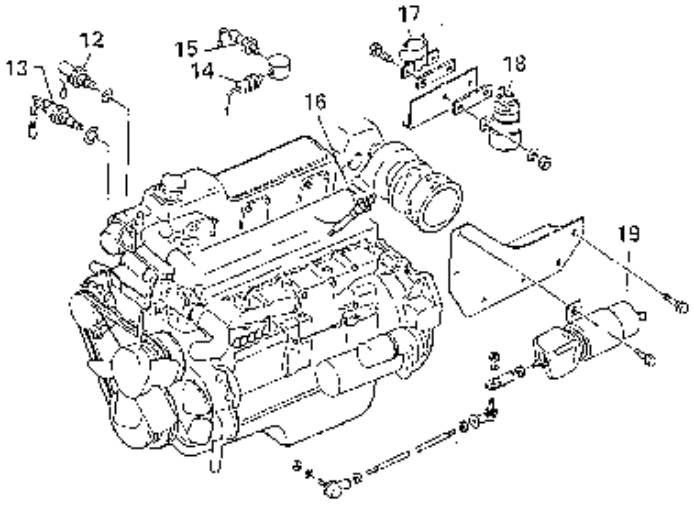
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DATA AND SPECIFICATIONS

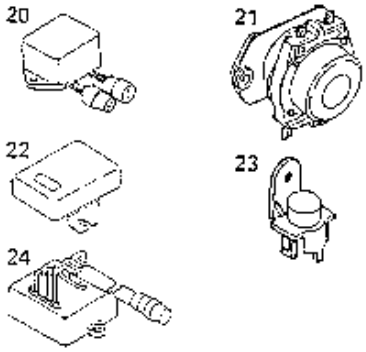
Electrical system	
Voltage	Direct current 12 volts or 24 volts
Ground	Negative (–) ground
Warning and indicator lamp	1.4W ..... 4 pieces
Gauge illumination lamp	1.7W ..... 4 pieces
Tachometer illumination lamp	3.4W ..... 2 pieces

LOCATION OF ELECTRICAL EQUIPMENT





1. Water temperature receiver gauge
2. Engine tachometer
3. Fuel receiver gauge
4. Volt-meter
5. Starter switch
6. Oil pressure warning lamp
7. Battery charge warning lamp
8. Water temperature warning lamp
9. Intake air heater indicator lamp
10. Illumination lamp switch
11. Oil pressure receiver gauge
12. Water temperature switch
13. Water temperature sender gauge
14. Oil pressure sender gauge
15. Oil pressure switch
16. Glow plug
17. Starter block relay
18. Intake air heater relay
19. Solenoid
20. Emergency stop relay
21. Battery main relay
22. Intake air heater timer
23. Relay
24. Sensor amplifier
25. Fuel sender gauge



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TROUBLESHOOTING

Symptom	Possible cause	Remedy/Prevention
A lot of exhaust is emitted but the engine does not start or is difficult to start. (Auxiliary starting device: Standard specifications)	**Auxiliary starting device**	
	• Loose wiring of heater signal or defective heater signal.	Repair or replace.
	• Defective heater plug	Replace.
	• Defective wiring between heater and plug	Repair.
(Auxiliary starting device: Option specifications)	• Defective power relay	Repair or replace.
	• Defective heater plug	Replace.
	• Defective wiring between heater and plug	Repair.
	• Defective sensing resistor	Replace.
	• Defective heater control timer	Replace.
Solenoid does not operate when engine is running, even if abnormal signal is input. (Engine does not stop.)	**Emergency stop relay**	
	• Alternator malfunctions	Repair or replace.
	• Insufficient battery voltage	Charge or replace.
	• Faulty connection at N terminal of emergency relay	Repair.
	• Defective solenoid	Replace.
Solenoid operates when starter switch is turned ON	**Emergency stop relay**	
	• Faulty connection at R1 terminal	Repair.
	• Faulty connection at B and C terminals	Repair.
When the starter switch is turned OFF, the battery relay switch goes OFF and the solenoid fails to operate.	**Battery**	
	• Insufficient voltage	Charge or replace.
	Alternator	
	• Malfunctions	Repair or replace.
Starter chattering or improper plunging	**Battery**	
	• Insufficient voltage	Charge or replace.
	Starter block relay	
	• Faulty connection at terminals	Repair.
	• Internal circuit abnormal	Replace.
	• Relay switch abnormality (faulty contacts), improper slidity between rod and moving core, or open-circuit or burnt out coil	Replace.
	Starter switch	
	• Faulty connection at terminals	

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Symptom	Possible cause	Remedy/Prevention
Improper disengagement of starter or defective hold function when engine is rotating	**Alternator**	
	• Defective (correct voltage not generated)	Repair or replace.
	Starter block relay	
	• Improper terminal connection	Repair.
	• Reverse connections to terminals B and C	Repair.
Re-plunging during inertial rotation	**Starter block relay**	
	• Reverse connections to terminals B and C	Repair.

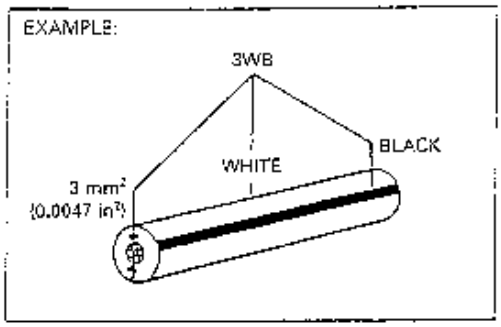
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GENERAL INSTRUCTION

WARNING

Be sure to disconnect the ground cable before servicing the electrical circuits.

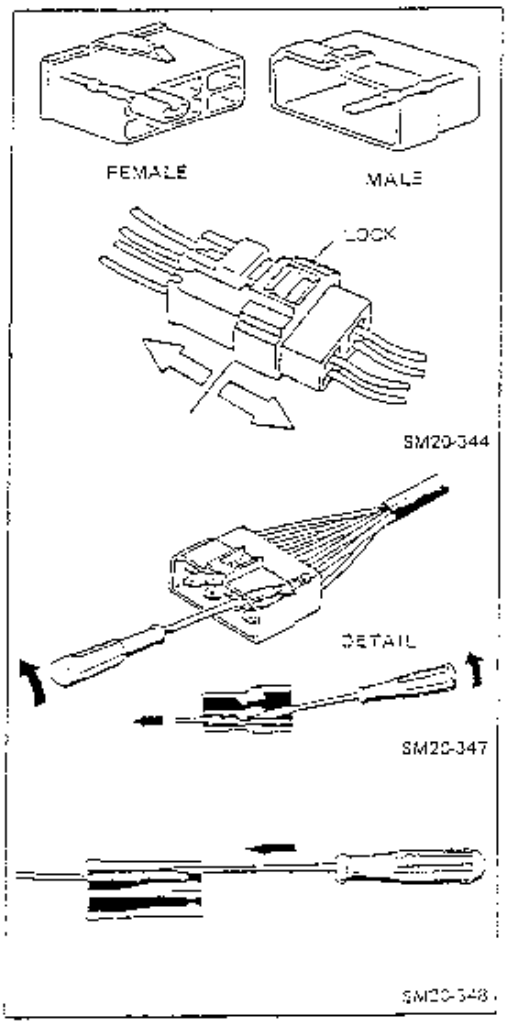


WIRING CODE

1. Wiring colors are indicated by a code.

B	: Black	Lg	: Light green
Br	: Brown	R	: Red
G	: Green	W	: White
L	: Blue	Y	: Yellow

2. The first letter indicates the ground wire color and second letter indicates the stripe color.
3. Arabic numerals indicates the cross sectional area of wire. 3 : 3 mm² (0.0047 in²)



CONNECTOR

- The connectors exist as male and female connectors.
- Male and female connectors are classified according to the shape of the terminals in the connector (refer to the figure on the left).
- Male and female connectors are provided with a lock, so that they can not be separated easily.
- For connector separation, hold the connector, unlock the lock and separate the connector.

NOTE: When the connector is pulled by pulling the wires, the connection between the terminals and the wires will be damaged.

1. Remove the terminal from the connector.
   a. Insert a minature screwdriver or a terminal puller between terminal and connector and unlock the lock between terminal and connector.
   b. When the lock has been released, pull the wire to remove the terminal.
2. Install the terminal in the connector.
   a. Insert the terminal into the connector until the clicking sound of lock engagement can be heard.
   b. Pull the wire to confirm correct lock engagement.

FUSE

- The power supply must be switched off for fuse replacement.
- Use a fuse with a suitable amperage.

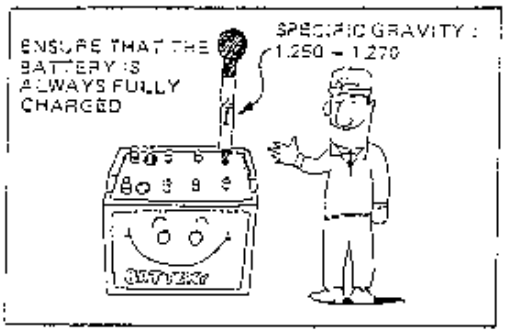
NOTE: Wire burning may be caused when a fuse with an excessively large current capacity is used.

- If the fuse should blow frequently, investigate the cause and remove it.

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BATTERY



CONVERSION FORMULA FOR SPECIFIC GRAVITY.

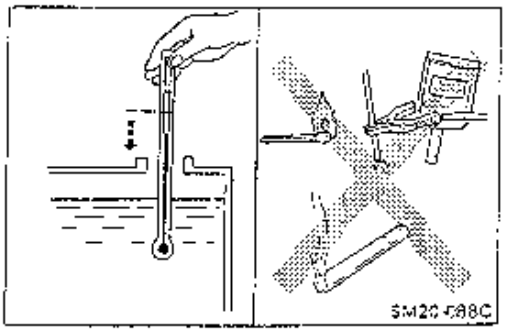
- The specific gravity of electrolyte changes according to the temperature of the electrolyte itself, hence it is based on a temperature of 20°C (68°F).
  Consequently, if the temperature is not 20°C when the specific gravity is measured, it is necessary to convert the measured value to the equivalent value at 20°C.

Temperature conversion formula: S20 = St + 0.0007 (t – 20)

Where,

- S20 is the specific gravity at 20°C (reference temperature)
- St is the specific gravity at the measuring temperature
- t is the temperature during measurement
- 0.0007 is the temperature coefficient of the electrolyte

NOTE: As a rough guide, if the temperature of the electrolyte rises or falls by 15°C (59°F), the specific gravity of the electrolyte will vary by about 0.01.



BATTERY CHARGING

- Be careful of the following points.

1) While the battery is being charged, ensure that the temperature of the electrolyte does not rise above 45°C (113°F).
2) While the battery is being charged, be particularly careful to keep it away from sources of fire.
3) The amount of electrolyte must be within the specified level.

Specific gravity when battery is fully charged: 1.250 – 1.270 at 20°C (68°F)

CLEANING THE BATTERY

- If the terminals at the top of the battery are dirty, clean them with cold water or lukewarm water.
- Apply a light coating of grease to the terminals to prevent them from rusting so as to prevent faulty contact.

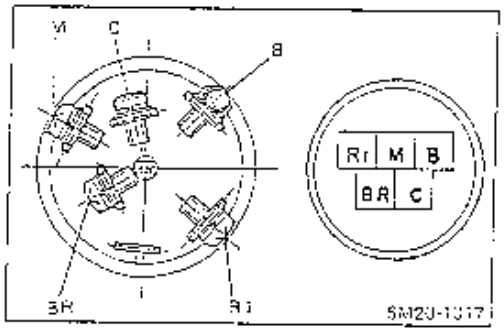
CONNECTING THE BATTERY CABLES

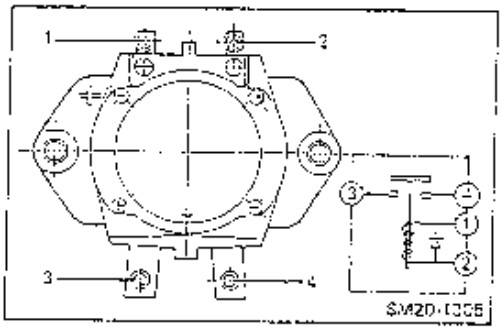
- Clamp the cables securely to prevent improper contact between the cables and the battery terminals.
- Be very careful not to connect the (+) and (–) leads in reverse. (because this may cause equipment run off the battery to be damaged.)

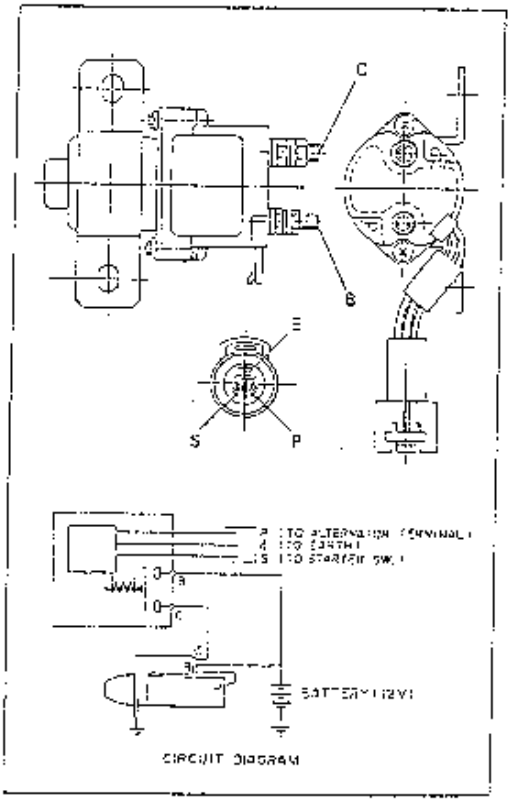
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ENGINE STARTING CIRCUIT







CHECK THE CONTINUITY OF THE STARTER SWITCH.

Check the continuity between terminals.
If continuity is not correct, replace the starter switch.

Terminal / Switch position	B	R_1	R_2	M	BR	C
PRE-HEAT	○	○		○		○
OFF						
ON	○	○		○		
START	○	○	○	○		○

CHECK THE OPERATION OF BATTERY RELAY.

1. Check that there is continuity between terminals 1 and 2.
2. Check that there is no continuity between terminals 3 and 4.
3. Connect the positive (+) lead from the battery to terminal 1. Connect the negative (−) lead to terminal 2. Check that there is continuity between terminals 3 and 4.
4. If operation is not correct, replace the battery relay.

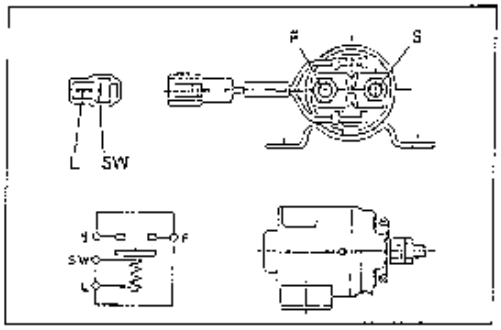
CHECK THE OPERATION OF THE STARTER BLOCK RELAY.

1. Check that there is no continuity between terminals C and B.
2. Connect the positive (+) lead from the battery to terminal S. Connect the negative (−) lead to terminal E. Check that there is continuity between terminals C and B.
3. Connect the positive (+) lead from the battery to terminal P. Connect the negative (−) lead to terminal E. Check that there is no continuity between terminals C and B.
4. If operation is not correct, replace the relay.

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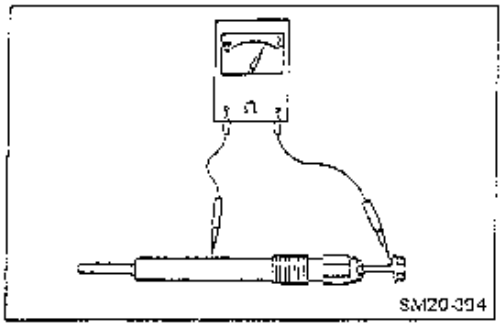
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PRE-HEAT CIRCUIT



CHECK THE OPERATION OF THE INTAKE AIR HEATER RELAY.

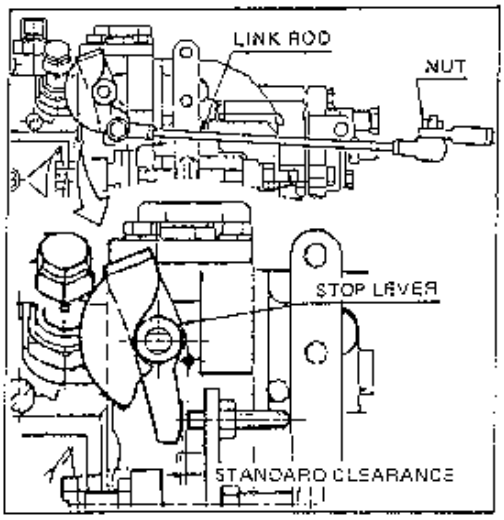
1. Check that there is continuity between terminals SW and L.
2. Check that there is no continuity between terminals S and F.
3. Connect the positive (+) lead from the battery to terminal SW. Connect the negative (−) lead to terminal L. Check that there is continuity between terminals S and F.
4. If operation is not correct, replace the relay.



CHECK THE CONTINUITY OF THE HEATER PLUG.

Check the continuity between terminal and body ground.
If there is no continuity, replace the glow plug.

ENGINE STOP AND WARNING LAMP CIRCUIT



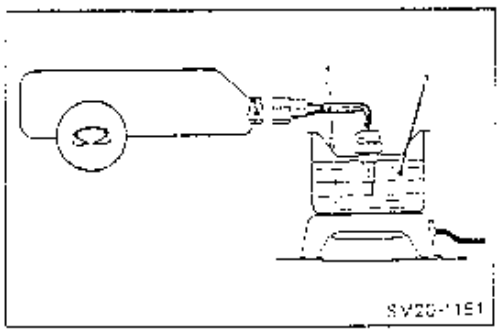
CHECK THE OPERATION OF THE SOLENOID AND ADJUST THE LINK ROD.

1. Connect the battery to the solenoid terminals and confirm that the solenoid is drawn in.
2. Push in the plunger by hand and confirm that there is a clearance between the stopper and the stop lever.

Standard clearance: 2 – 3 mm (0.01188 – 0.1181 in)

If there is no clearance, perform adjustment with the link rod.

NOTE: ○ If the clearance adjustment is unsatisfactory or the action of the solenoid is sluggish, solenoid seizure, insufficient output or engine stoppage may result.
○ Install the link rod with the nut at the top.

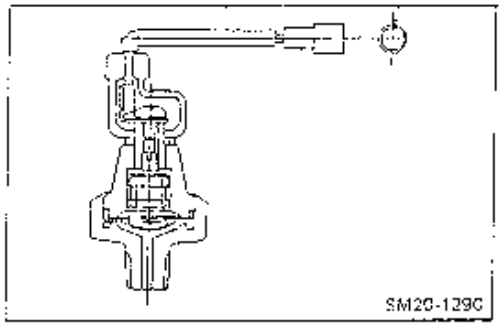


CHECK THE OPERATION OF THE WATER TEMPERATURE SWITCH.

Check the continuity between terminals.
If continuity is not correct, replace the temperature switch.

Terminal / Water temperature: °C (°F)	1	2
More than 96–100 (205–212)	○	○
Less than 91 (196)		

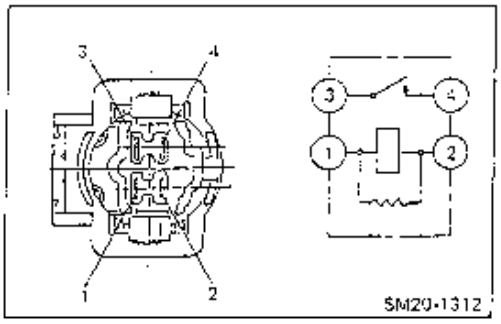
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SM20-1290

CHECK THE OPERATION OF THE PRESSURE SWITCH.

1. Check the continuity between terminal and body ground.
   a. Check that there is continuity when engine is stopped.
   b. Check that there is no continuity when engine is running.
2. If continuity is not correct, replace the oil pressure switch.

NOTE: Engine oil pressure should be more than 49 kPa (0.5 kgf/cm², 7.2 lbf/in²).

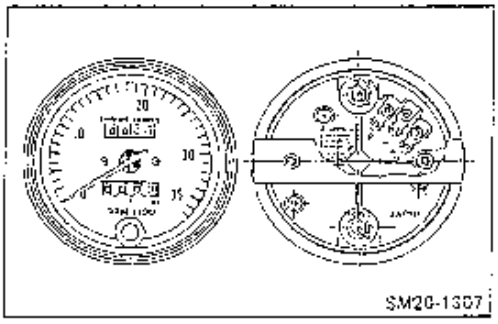


SM20-1312

CHECK THE OPERATION OF THE RELAY. (WATER TEMPERATURE WARNING LAMP RELAY)

1. Check that there is continuity between terminals 1 and 2.
2. Check that there is no continuity between terminals 3 and 4.
3. Connect the positive (+) lead from the battery to terminal 1. Connect the negative (—) lead to terminal 2. Check that there is continuity between terminals 3 and 4.
4. If operation is not correct, replace the relay.

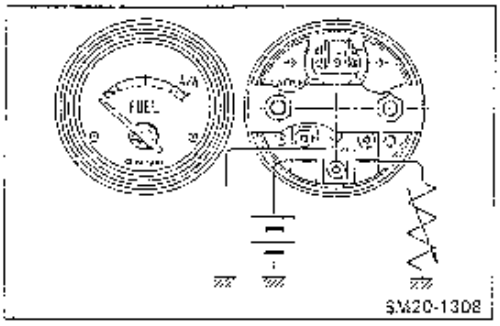
METER AND GAUGE CIRCUIT


SM20-1307

CHECK THE OPERATION OF THE TACHOMETER.

1. Connect a turn-up test tachometer, and start the engine.
2. Check the tester and tachometer indications.
   If the indicated value of tachometer is not correct, replace the tachometer.

Standard revolution (rpm)	600	1,800	3,600
Allowable value (rpm)	± 100	± 100	± 100



SM20-1308

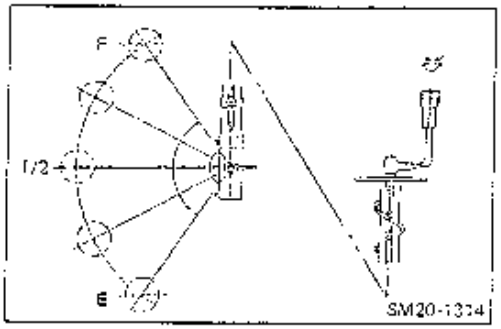
CHECK THE OPERATION OF THE FUEL RECEIVER GAUGE.

1. Wire the receiver gauge, variable resistor and battery, as shown in the figure at left. Check the indicated value on the receiver gauge at the reference resistance value.
2. If the indicated value is not correct, replace the receiver gauge.

Resistance: Ω	33.5	103	240
Gauge reading	F	1/2	E
Allowable value: %	+8 0	± 4	0 −8

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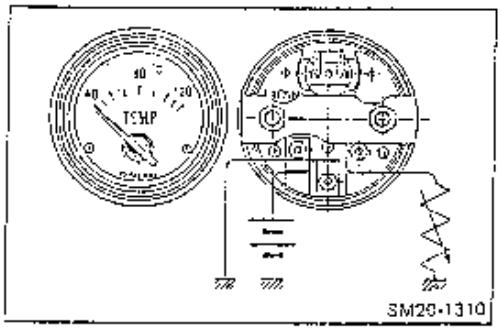
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CHECK THE OPERATION OF THE FUEL SENDER GAUGE.

Measure the resistance between terminals.
If resistance is not correct, replace the sender gauge.

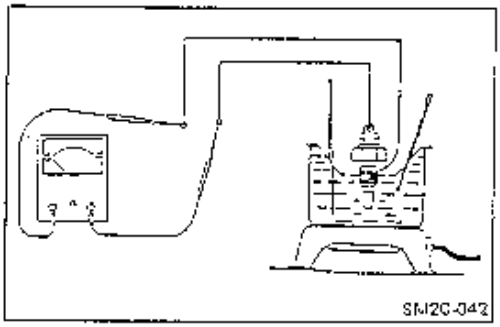
Float position	F	1/2	E
Standard resistance: Ω	30.1	103	250
Allowable value: Ω	± 3.4	± 10.3	± 24



CHECK THE OPERATION OF THE WATER TEMPERATURE RECEIVER GAUGE.

1. Wire the receiver gauge, variable resistor and battery, as shown in the figure at left. Check the indicated value on the receiver gauge at the reference resistance value.
2. If the indicated value is not correct, replace the receiver gauge.

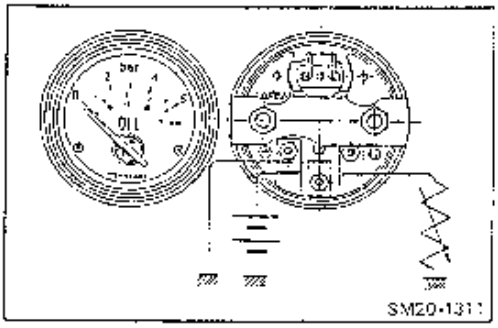
Resistance: Ω	43.2	23.7
Gauge reading: °C (°F)	80 (176)	100 (212)
Allowable value: °C (°F)	± 3.5 (38)	± 5.5 (42)



CHECK THE OPERATION OF THE WATER TEMPERATURE SENDER GAUGE.

1. Wire the sender gauge and ohmmeter as shown in the figure at left. Check the resistance value of the sender gauge at the standard water temperature.
2. If resistance value is not correct, replace the sender gauge.

Water temperature: °C (°F)	50 (122)	80 (176)	100 (212)
Standard resistance: Ω	130	48.5	26.7
Allowable value: Ω	–	± 4.2	± 2.5

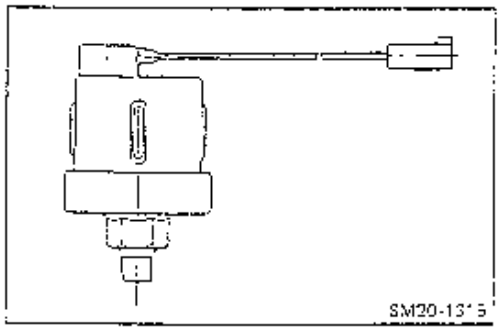


CHECK THE OPERATION OF THE OIL PRESSURE RECEIVER GAUGE.

1. Wire the receiver gauge, variable resistor and battery, as shown in the figure at left. Check the indicated value on the receiver gauge at the reference current value.
2. If the indicated value is not correct, replace the receiver gauge.

Resistance	19Ω	81Ω	112Ω
Gauge reading	0	4 (4, 60)	6 (6, 90)
Allowable value	±0.3 (0.3, 4.3)	+ 0.7 (0.7, 10.0) – 0.6 (0.6, 8.5)	–

Unit: bar (kgf/cm², lbf/in²) NOTE: 1 bar = 100 kPa



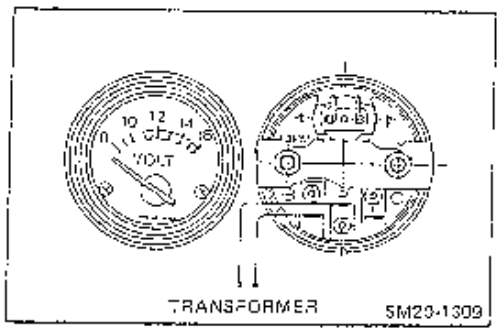
CHECK THE OPERATION OF THE OIL PRESSURE SENDER GAUGE.

1. Wire the sender gauge and ohmmeter as shown in the figure at left. Check the resistance between the sender gauge and the body ground.
2. If the measured value is not correct, replace the sender gauge.

Oil pressure	0	4 (4, 60)	6 (6, 90)
Standard resistance	19Ω	80Ω	110Ω
Allowable value	± 2Ω	± 5Ω	± 9Ω

Unit: bar (kgf/cm², lbf/in²) NOTE: 1 bar = 100 kPa

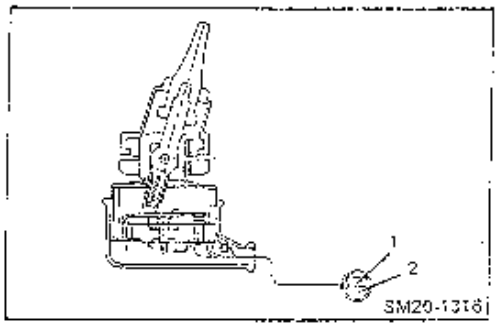
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CHECK THE OPERATION OF THE VOLTMETER.

1. Wire the voltmeter and transformer as shown in the figure at left. Check the indicated value on the voltmeter at the reference voltage value.
2. If the indicated value is not correct, replace the voltmeter.

Gauge reading: V	12	14
Allowable value: V	± 0.5	± 0.5



CHECK THE OPERATION OF THE GENERALLY USE SWITCH (ILLUMINATION LAMP SWITCH).

Check the continuity between terminals.
If operation is not correct, replace the switch.

Terminal / Switch position	1	2
ON	○	○
OFF		

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TU-S20E-02

CHAPTER TU

TURBOCHARGER

DATA AND SPECIFICATIONS TU-2
DESCRIPTION TU-2
TROUBLESHOOTING TU-3
OVERHAUL CRITERIA TU-5
SPECIAL TOOL TU-6
TURBOCHARGER TU-7

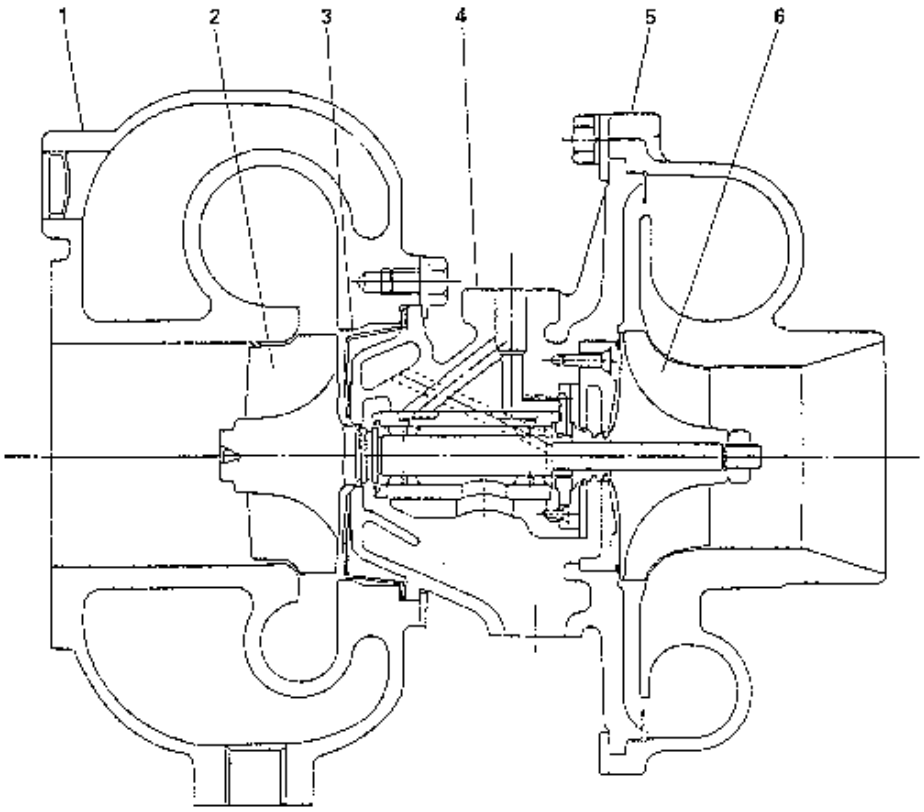
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DATA AND SPECIFICATIONS

Type	RHC7 GW
Turbine type	Radial flow type
Blower type	Centrifugal type
Lubricating method	External lubrication type
Bearing type	Full floating type
Direction of rotation	Counterclockwise as seen from the turbine side

DESCRIPTION



SM51-099A

1. Turbine casing
2. Turbine rotor
3. Heat protector
4. Bearing case
5. Blower case
6. Blower impeller

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TROUBLESHOOTING

Symptom	Possible cause	Remedy/Prevention
Dense black smoke	**Insufficient air intake**	
	• Air cleaner is choked with dust, causing greater intake air resistance.	Disassemble and clean or replace the air cleaner element.
	• Air inlet is choked	Repair.
	• Air is leaking from intake manifold	Repair.
	Turbocharger does not rotate smoothly.	
	• Engine oil impurities deposited on rotor, resulting in heavy rotation or sticking.	Overhaul and clean turbocharger and/or change engine oil.
	Bearing sticking	
	• Insufficient lubrication or blockage of lubricating oil lines.	Check lubricating oil system, and/or repair.
	• Abnormal wear or damage of seal ring caused by wear of journal bearing, due to insufficient lubrication.	Repair.
	• Temperature of lubricating oil too high	Check cooling system.
	• Unbalanced rotating parts	Change rotating parts.
	• Incomplete warming-up, failure to idle before stopping engine, or jack rabbit starts.	Operate vehicle properly.
	Loose or damaged turbine rotor or blower impeller.	
	• Over-rotation	Check and adjust the engine.
	• Temperature of exhaust gas too high	Check and adjust the engine.
	• Foreign matter present	Remove foreign material. Inspect the air cleaner and air intake manifold. Repair if necessary.
	• Worn thrust bearing	Overhaul and repair.
	• Incomplete assembly	Reassemoly.
High volume exhaust like noise.	Exhaust gas leaking before turbocharger, therefore insufficient revolution.	Check and repair connections.
	Deformed or blocked exhaust gas lines therefore insufficient revolution.	Repair.
White smoke	Choking defects, or deformation of oil return lines so that oil leaks around blower or turbine sides.	Repair and replace the lines.
	Seal ring may be broken or worn due to abnormal wear of thrust washer.	Replace the thrust washer.
Sudden shortage of lubricating oil	Abnormal wear or damage of seal ring caused by wear of journal bearing.	Overhaul and repair.

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Symptom	Possible cause	Remedy/Prevention
Loss of power	Gas leakage from exhaust system	Repair.
	Air leakage from air manifold	Repair.
	Clogged air cleaner element	Clean or replace.
	Turbocharger dirty or damaged	Repair or replace.
Poor response of turbocharger	Carbon accumulation on the turbine side seal ring and heavy rotation.	Change engine oil, clean turbocharger.
	Poor combustion	Check fuel system and improve combustion.
High pitched noise and vibration	**Noise**	
	• So called "surging" Surging sometimes occurs when the gas passage at the nozzle of the turbine housing is choked or when compressed air does not flow in proper responses to acceleration.	Overhaul and clean turbocharger.
	• Loosen rotating parts	Replace.
	Vibration	
	• Joints loose between turbocharger and intake, exhaust manifold or oil lines.	Check the mounting and repair.
	• Damaged bearing, loose rotating parts, imbalanced rotating parts, etc.	Repair.

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OVERHAUL CRITERIA

CONDITIONS WHICH DETERMINE WHEN A TURBOCHARGER OVERAHUL MAY BE NEEDED.

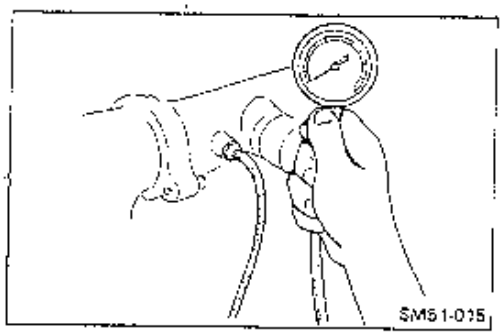
THE ENGINE LACKS POWER OR ENGINE EXHAUST EMITS BLACK SMOKE.

BOOST PRESSURE IS BELOW THE NORMAL VALUE.

Inspect the turbocharger boost pressure according to the following procedures.

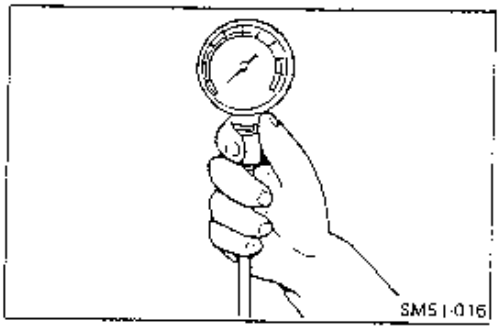
NOTE: Before measurement
- Coolant temperature should approximately 80°C (176°F).
- Air cleaner element should be clean.

> WARNING
>
> When making a pressure test, be sure that personnel are adequately protected against any stream of pressurized air that might be released by a leak or the rupture of a hose.



1. Remove the blind plug on the intake pipe and install the hose and pressure gauge (special tools).

Special Tools: Pressure Gauge (09444-1250)
Hose (17108-1040)



2. Read boost pressure.
If the boost pressure is below the specified value, turbocharger overhaul is needed.

Boost Pressure: Less than 12.75 kPa (0.13 kgf/cm², 1.848 lbf/in²) at no load with maximum revolution.

OTHER FACTORS

1. Noisy of excessive vibration of the turbocharger.
2. Excessive engine oil consumption.
3. Gas leakage at the turbine end or blower end.
4. Oil leakage from the turbocharger.

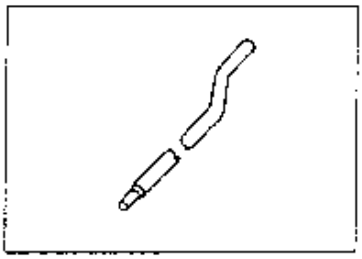
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SPECIAL TOOLS

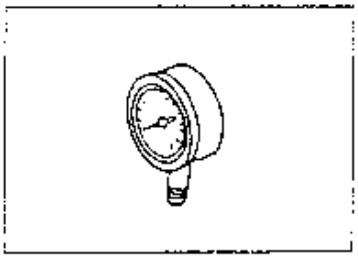
Prior to starting an turbocharger overhaul, it is necessary to have these special tools.

ATTACHMENT FOR MEASURING TURBINE SHAFT RADIAL PLAY



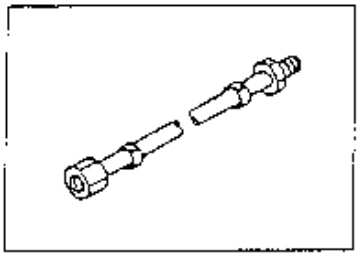
09444-1230

BOOST PRESSURE GAUGE

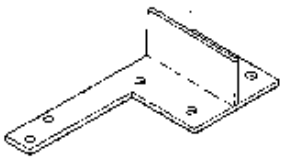
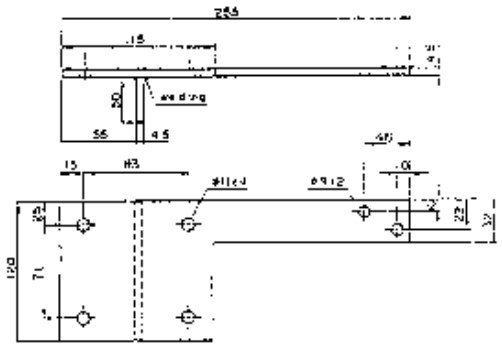
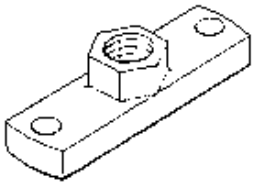
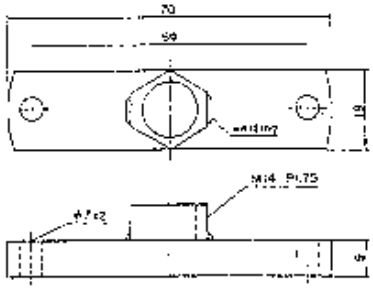


09444-1250

BOOST PRESSURE GAUGE HOSE



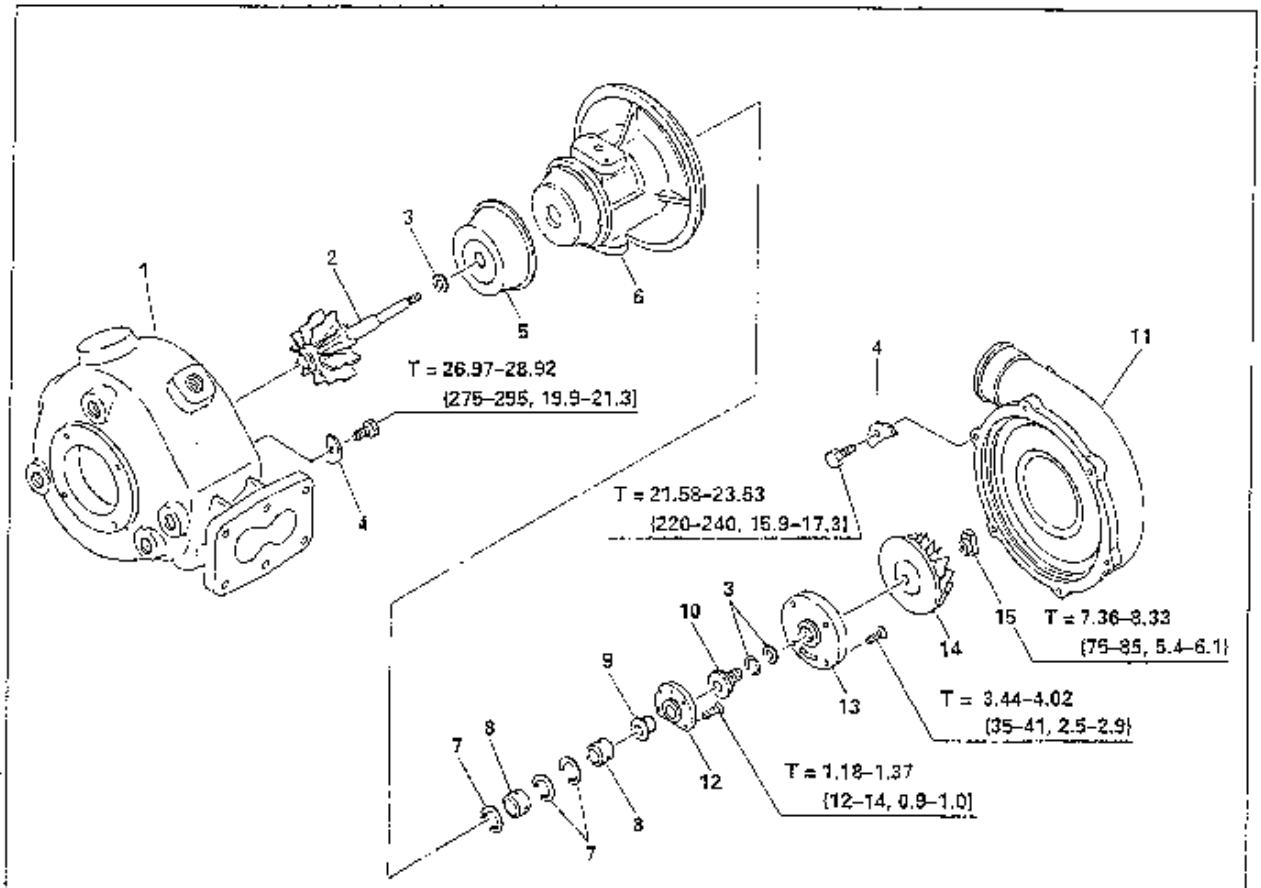
17108-1040

		For assemble, disassemble or measuring of the turbocharger.
		For removing the seal plate.

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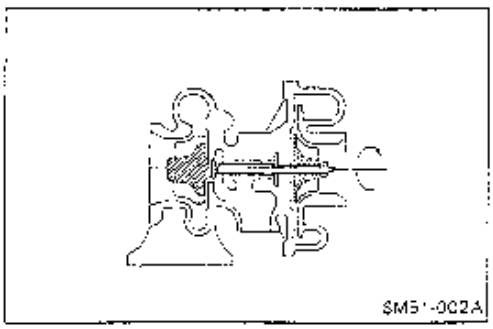
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TURBOCHARGER



T = Tightening torque: N·m {kgf·cm, lbf·ft}

1. Turbine casing
2. Turbine rotor
3. Seal ring
4. Holding plate
5. Heat protector
6. Bearing casing
7. Retainer ring
8. Bearing
9. Thrust spacer
10. Oil thrower
11. Blower casing
12. Thrust bearing
13. Seal plate
14. Blower impeller
15. Lock nut

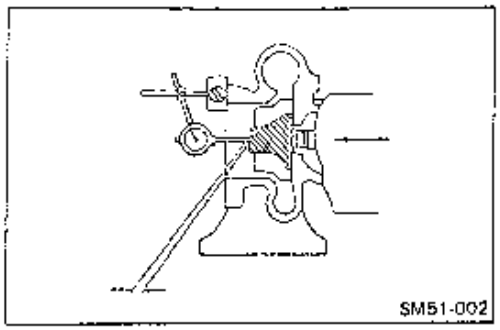


IMPORTANT POINT (S) – BEFORE DISASSEMBLY

1. Rotate the blower impeller by hand to see if it turns smoothly. If it does not turn smoothly, clean and inspect the bearing and turbine rotor.

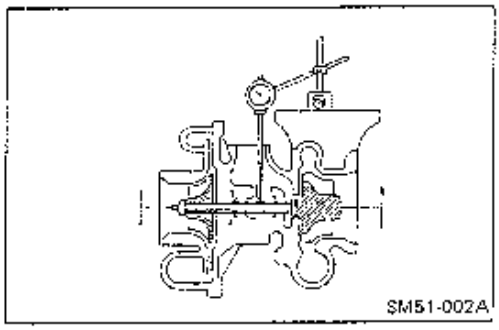
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2. Check the turbine rotor for axial play
If the axial play is greater than the service limit, replace the thrust bearing and/or thrust spacer.

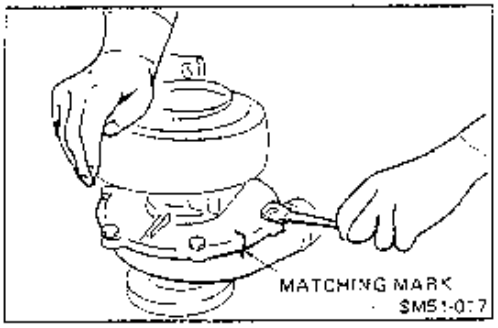
Axial Play: 0.06 – 0.09 mm (0.0023 – 0.0035 in)
Service Limit: 0.11 mm (0.0043 in)



3. Check the turbine rotor for radial play using a special tool.
If the radial play is greater than the service limit, replace the bearings and/or turbine rotor.

Special Tool: 09444-1230

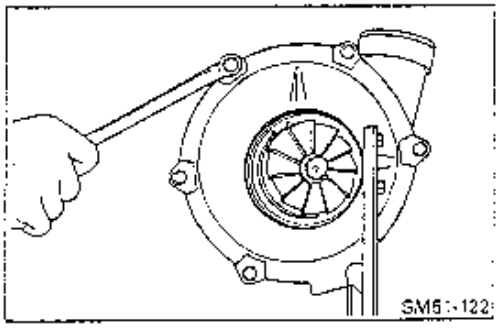
Radial Play: 0.11 – 0.18 mm (0.004 – 0.007 in)
Service Limit: 0.215 mm (0.0085 in)



IMPORTANT POINT (S) – DISASSEMBLY

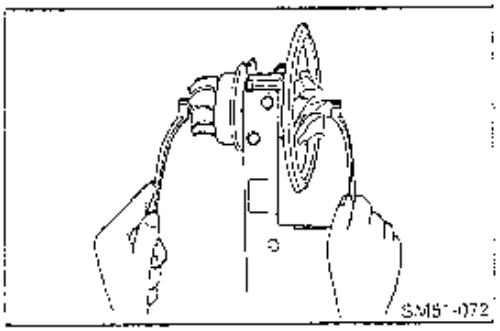
REMOVE THE BLOWER CASING.

NOTE: ○ Make matching marks on the blower case and bearing case to aid alignment during reassembly.
○ If the blower casing cannot easily be removed by hand, tap it carefully all around using a plastic hammer and carefully remove it.
○ Be careful not to damage the blower impeller.



REMOVE THE BLOWER CASING.

NOTE: Be careful not to damage blower impeller.



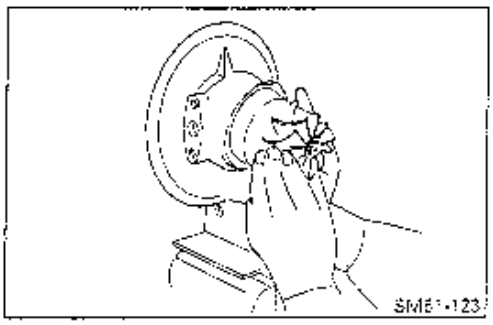
REMOVE THE TURBINE ROTOR.

1. Remove the blower impeller fitting nut.

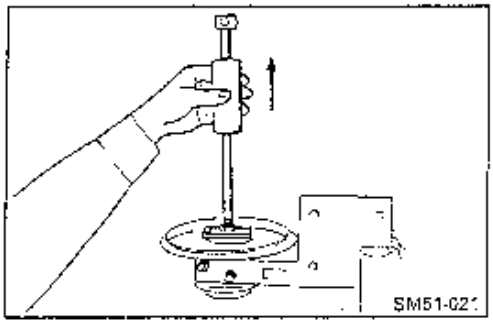
NOTE: Turn the lock nut to clockwise to loosen the nut (left-hand threads).

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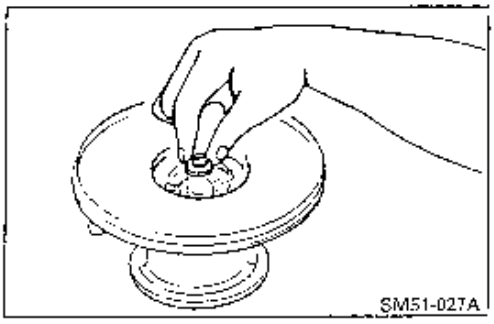


2. Remove the blower impeller and the turbine rotor with heat protector.

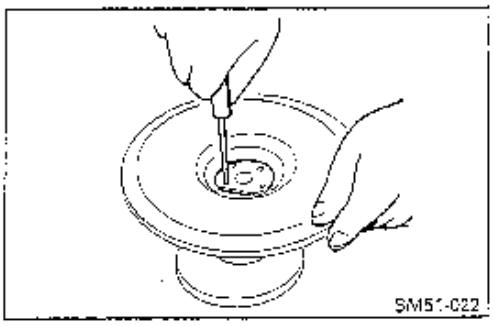


REMOVAL OF BEARINGS.

1. Remove the seal plate.
   Pull out the seal plate used by special tool.

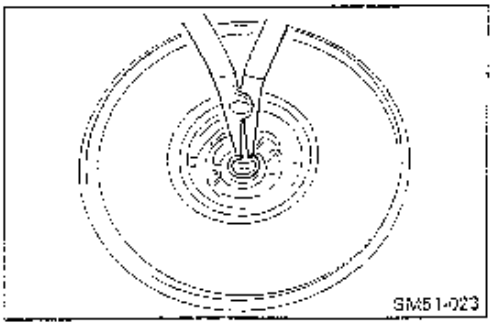


2. Remove the oil thrower.



3. Remove the thrust bearing and thrust spacer.
   Loosen the bolt, then remove the thrust bushing using a 10 dia. copper rod.

NOTE: **When removing the thrust bearing and thrust spacer, be careful not to damage the thrust bearing hole in the bearing case.**



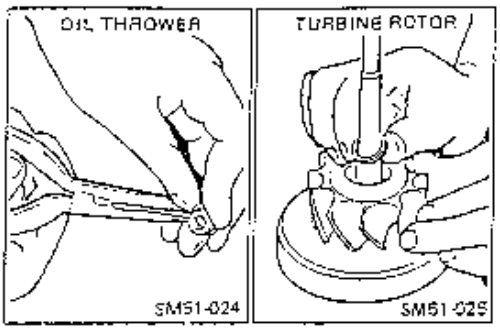
4. Remove the retainer rings of each bearing.

NOTE: **When removing the retainer ring, be careful not to damage the front face of the hole in the bearing case.**

5. Remove the bearings.

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REMOVE THE SEAL RINGS.

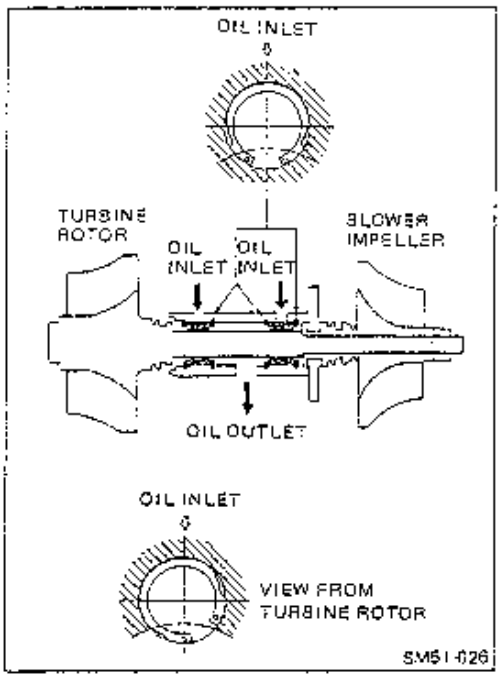
NOTE: When removing the seal ring, be very careful not to damage the groove of the seal ring.

IMPORTANT POINT (S) – ASSEMBLY

CLEAN ALL PARTS.

1. Before cleaning, the disassembled parts should be visually inspected to check for burning, abrasion, carbon deposits, gas and oil leakage.
2. Thoroughly clean all the parts with diesel fuel, using a soft brush, and dry with compressed air.

NOTE: ○ Never use a caustic cleaning solution, as it may attack aluminum.
○ Never use a wire brush.



ASSEMBLE THE JOURNAL BEARINGS.

1. Install the first retainer ring in the bearing casing.

NOTE: ○ Bevelled edge of the retainer ring should be towards the bearing.
○ Make sure that the retainer ring is securely fitted in the groove.
○ Install the retainer ring with the gap facing as shown in the drawing.

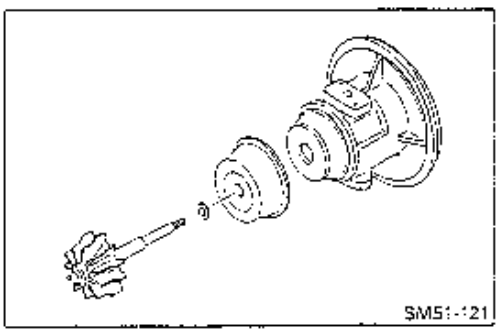
2. Install the bearing in the bearing case.

NOTE: Apply clean engine oil.

3. Install the other retainer ring.

NOTE: The only nearest turbine side of the retainer ring should be installed according to the figure on the left.

4. Repeat step 1) through 4) to install the second bearing.

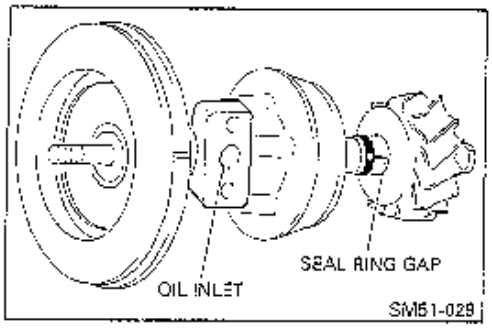


ASSEMBLE THE TURBINE ROTOR.

1. Install a new seal ring in the seal ring groove of the turbine shaft.
2. Position the heat protector on the bearing case.

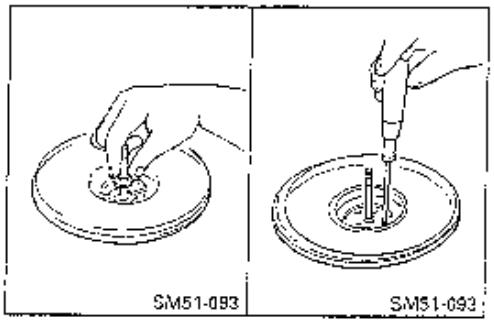
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3. Coat the journals of the turbine rotor with clean engine oil and install the turbine rotor in the bearing case.

NOTE: ○ The gap in the seal ring of the turbine shaft must face towards the oil inlet.
○ Insert the seal ring concentric with the turbine shaft. If it is inserted with unreasonable force, it may be damaged.
○ When inserting the turbine shaft, be very careful not to damage the journal bearing.



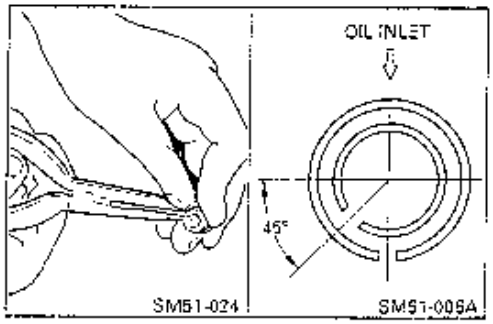
ASSEMBLE THE THRUST BEARING.

1. Install the thrust bush on the turbine shaft.

NOTE: Lubricate thrust bush surface.

2. Coat the thrust bearing with clean engine oil and install the thrust bearing.

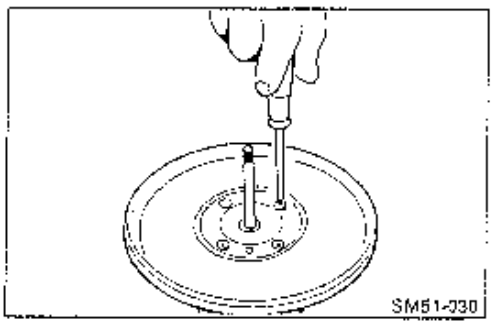
NOTE: Always use new screws and lock washers.



INSTALL THE BACK PLATE.

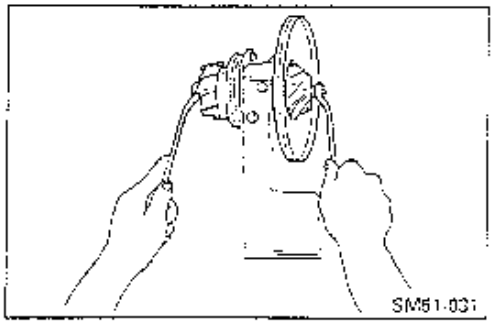
1. Insert two new seal rings on the oil thrower.
2. Install the oil thrower in the back plate.

NOTE: The openings of seal rings should be positioned as shown.



3. Install the back plate in the bearing plate.

NOTE: ○ The oil return hole should face the oil outlet side. Apply silicone R.T.V. sealer to the flanged surface of the back plate.
○ Take care that the silicone sealer does not protrude from the flange.

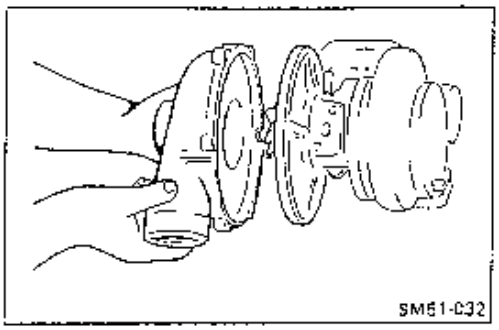


FIT THE BLOWER IMPELLER ON THE TURBINE ROTOR AND TIGHTEN THE LOCK NUT.

NOTE: Remember that this nut has left-hand threads.

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INSTALL THE TURBINE CASE TO THE BEARING CASE, BEING SURE TO ALIGN THE MATCHING MARKS.

NOTE: Always use new lock plates.

ASSEMBLE THE BLOWER CASE.

1. Install the blower case to the bearing case referring to the matching marks.

NOTE: Coat the flange face of the blower case with silicone R.T.V. sealant.

2. Tighten the six fitting bolts.

ASSEMBLY TEST

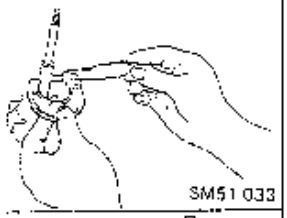
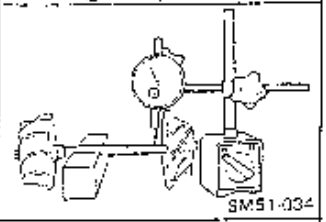
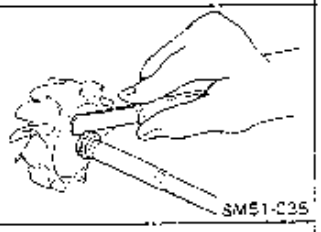
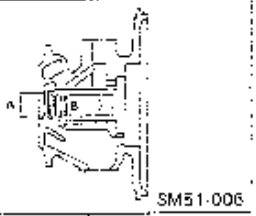
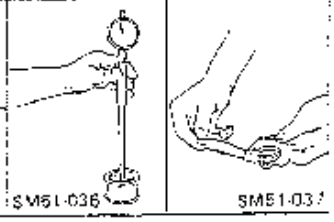
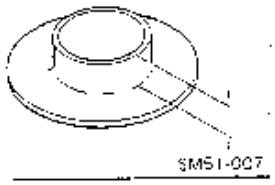
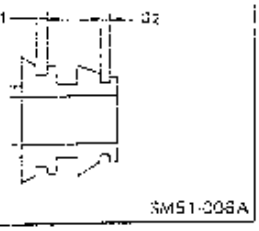
1. Rotate the blower impeller by hand to see if it turns smoothly. Refer to page TU-7.
2. Check the turbine rotor for axial play. Refer to page TU-8.
3. Check the turbine rotor for radial play using a special tool. Refer to page TU-8.

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INSPECTION AND REPAIR

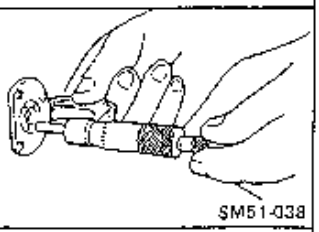
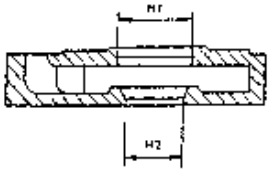
Unit: mm (in)

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Turbine Shaft Outside Diameter	–	12.28 {0.4835}	Replace	 SM51-033
Turbine Shaft Bend	–	0.011 {0.0004}	Replace	 SM51-034
Seal Ring Groove Width of Turbine Shaft	–	1.63 {0.0642}	Replace shaft assembly.	 SM51-035
Bearing Case Inside Diameter	–	A: 18.55 {0.7303} B: 17.11 {0.6736}	Replace	 SM51-006
Journal Bearing Inside Diameter	–	12.36 {0.4866}	Replace	 SM51-036 SM51-037
Journal Bearing Outside Diameter	–	16.98 {0.6685}	Replace	
Thrust Spacer Height	–	4.48 {0.1764}	Replace	 SM51-007
Seal Ring Groove Width of Oil Thrower	–	G1: 1.75 {0.0689} G2: 1.52 {0.0598}	Replace	 SM51-008A

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Unit: mm (in)

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Thrust Bearing Thickness	–	4.48 {0.1764}	Replace	 SM51-038
Sealing Bore of Seal Plate	–	H1: 16.05 {0.6319} H2: 14.05 {0.5531}	Replace	 SM51-0068

(K,F,I)

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IP-S148E-01

CHAPTER IP

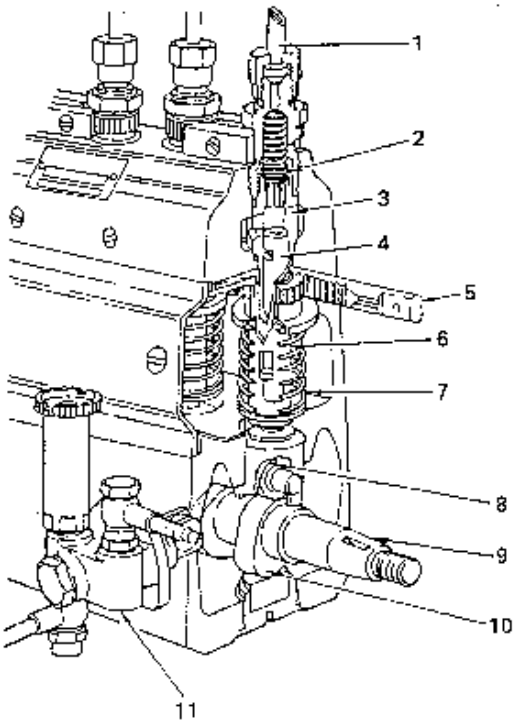
FUEL INJECTION PUMP

DESCRIPTION ..... IP- 2
TROUBLESHOOTING ..... IP- 3
SPECIAL TOOLS ..... IP- 6
INJECTION PUMP ..... IP- 7
FEED PUMP IP-17

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DESCRIPTION



SM1-064

FUEL INJECTION PUMP

1. High pressure pipe
2. Delivery valve
3. Plunger barrel
4. Plunger
5. Control rod
6. Control sleeve
7. Plunger spring
8. Tappet
9. Cam shaft
10. Cam
11. Fuel feed pump

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TROUBLESHOOTING

Symptom	Possible cause	Remedy/Prevention
Engine does not start	**Fuel not reaching injection pump**	
	• Fuel lines clogged or damaged	Clean or replace fuel lines.
	• Fuel filter clogged	Clean or replace the filter element.
	• Air in fuel caused by improper connections of fuel line between fuel tank and feed pump	Repair connections.
	• Filter incorporated in inlet side of feed pump clogged	Remove foreign material.
	• Faulty feed pump check valve	Repair or replace it.
	• Feed pump piston spring broken	Replace it.
	• Feed pump push rod or tappet sticking	Repair or replace it.
	Fuel reaching injection pump	
	• Faulty connection of accelerator wire to pump adjusting lever.	Repair connection.
	• Control rack faulty or sticking	Repair it.
	• Damaged camshaft bearing	Repair it.
	• Plunger worn or sticking	Correct or replace it.
	• Faulty connection of engine stop wire to pump stop lever.	Repair it.
	Nozzle faulty	
	• Fuel leakage caused by loosened nozzle holder.	Inspect and tighten it.
	• Low opening pressure of nozzle	Adjust it.
	• Nozzle pressure spring broken	Replace it.
	• Nozzle needle sticking to nozzle body	Correct or replace it.
	Pump out of timing	
	• Improperly retarded injection timing	Correct injection timing.
	• Incorrect timing caused by improper installation of pump.	Check engine timing and correct it.
	• Woodruff key for pump camshaft cut off.	Replace it.
	• Improper pre-stroke adjustment	Correct it to obtain specified injection timing.

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Symptom	Possible cause	Remedy/Prevention
Excessive smoke	Black smoke	
	• Excessive fuel delivery caused by incorrect adjustment of fuel load stopper screw.	Adjust fuel delivery on test stand.
	• Excessively advanced injection timing.	Correct it.
	• Large spread in fuel delivery	Adjust it.
	• Bad nozzle fuel spray characteristics	Check and correct them.
	White smoke	
	• Improperly retarded injection timing.	Advance injection timing.
	• Water in fuel	Check and clean fuel lines.
Low idle speed irregular	Improper adjustment of idle button	Correct it.
	Bad fuel spray characteristic of nozzles.	Check and repair them.
	Incorrect injection timing	Correct it.
	Incorrect initial tension setting of idling spring or the spring broken.	Adjust or replace it.
	Control rack not smoothly move	Disassemble pump and repair it.
	Large spread in fuel delivery	Adjust it.
	Plunger worn	Replace it.
	Governor linkage not smoothly move.	Correct it.
	Defective feed pump	Disassemble and repair it.
Engine always runs at hig speed	Accelerator cable sticking	Check and correct it.
	Governor linkage sticking	Disassemble and repair the governor.
	Control rack sticking	Check and correct it.
Engine starts and stops	Fuel lines clogged	Clean or replace fuel lines.
	Air in fuel caused by damaged fuel lines or improper connection of fuel lines.	Repair fuel lines or replace fuel lines and gaskets.

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Symptom	Possible cause	Remedy/Prevention
Engine has low power	**Pump out of timing**	
	• Excessive advanced timing, resulting in loud knocking.	Check and correct it.
	• Excessively retarded timing resulting in black smoke.	Check and correct it.
	• Defective injection pump overflow valve.	Repair or replace it.
	• Feed pressure too low	Repair the feed pump.
	• Improper accelerator cable adjustment	Adjust it.
	Nozzle faulty	
	• Fuel leakage from nozzle holder	Check and repair nozzle holder.
	• Bad nozzle spray characteristic	Repair or replace it.
	• Loosened adjusting screw in nozzle holder, resulting in low opening pressure.	Adjust it.
	• Nozzle pressure spring broken	Replace it.
	Pump faulty	
	• Fuel leakage from delivery valve holder.	Retighten the delivery valve holder if it is loosened or replace O-ring if the O-ring is defective.
	• Defective seat of delivery valve assembly.	Repair or replace it.
	• Delivery valve spring broken	Replace the spring.
	• Plunger worn	Replace it.
	• Large spread in fuel delivery	Adjust it.
	• Wear of tappet roller	Replace the roller.
	• Camshaft bearing worn or broken	Replace it.
	• Improper adjustment of governor fuel load stopper screw.	Adjust it.
Loud knocking	Improper injection timing	Correct it.
	Bad fuel nozzle spray pattern after-dribble.	Check and correct it.
	High nozzle opening pressure	Adjust the opening pressure.
	Incorrect fuel deliveries to some nozzles.	Readjust the fuel deliveries.

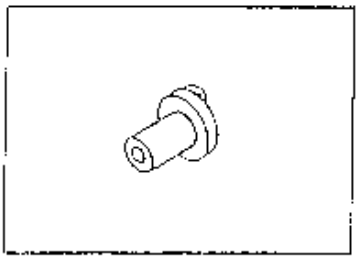
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https://www.tractormanuals.com

SPECIAL TOOLS

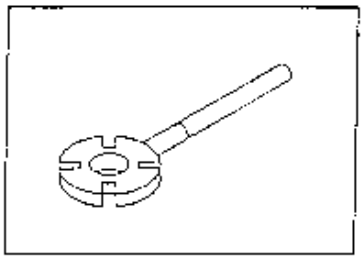
Prior to starting an injection pump overhaul, it is necessary to have these special tools.

COUPLING



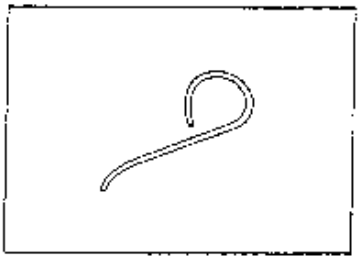
09511-2000

HOLDING WRENCH



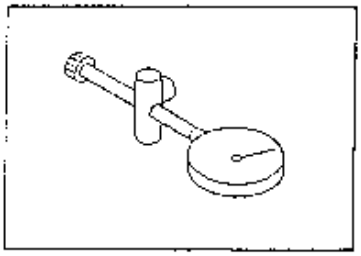
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TAPPET HOLDER



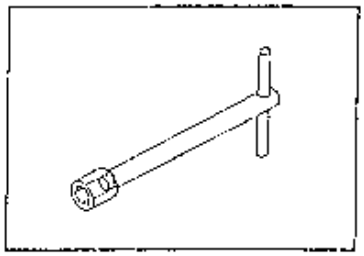
09511-1770

CAMSHAFT END PLAY GAUGE



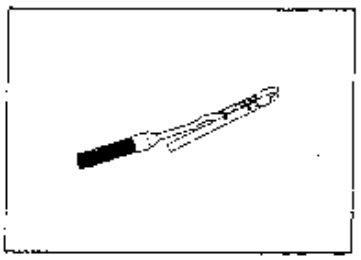
09511-1970

GAUGE ADAPTER



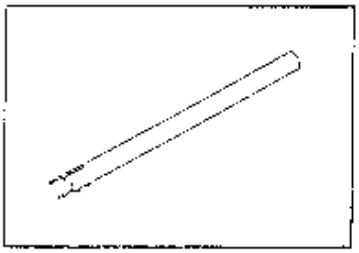
09511-1610 (Use with 09511-1970)

TAPPET ROLLER CLAMP



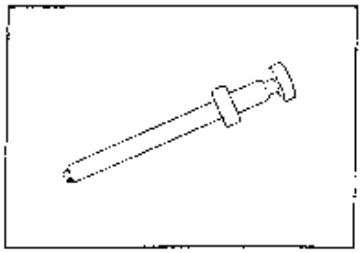
09511-1750

TAPPET CLAMP



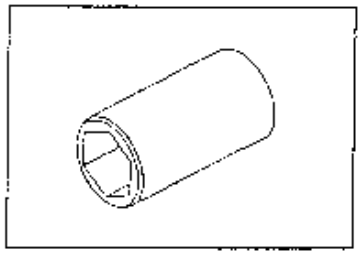
09511-1190

PLUNGER CLAMP



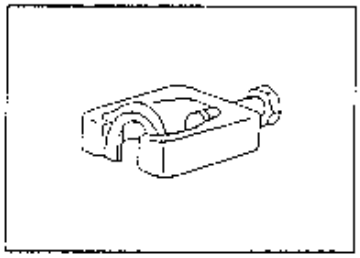
09511-1730

DELIVERY VALVE HOLDER REMOVER



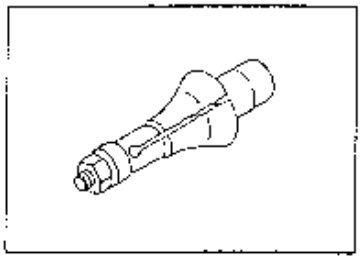
09511-1340

BEARING REMOVER



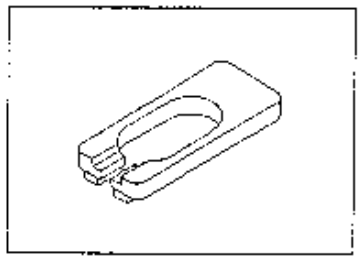
09500-1290

BEARING OUTER RACE PLUNGER



09511-1680

SPRING HOLDER



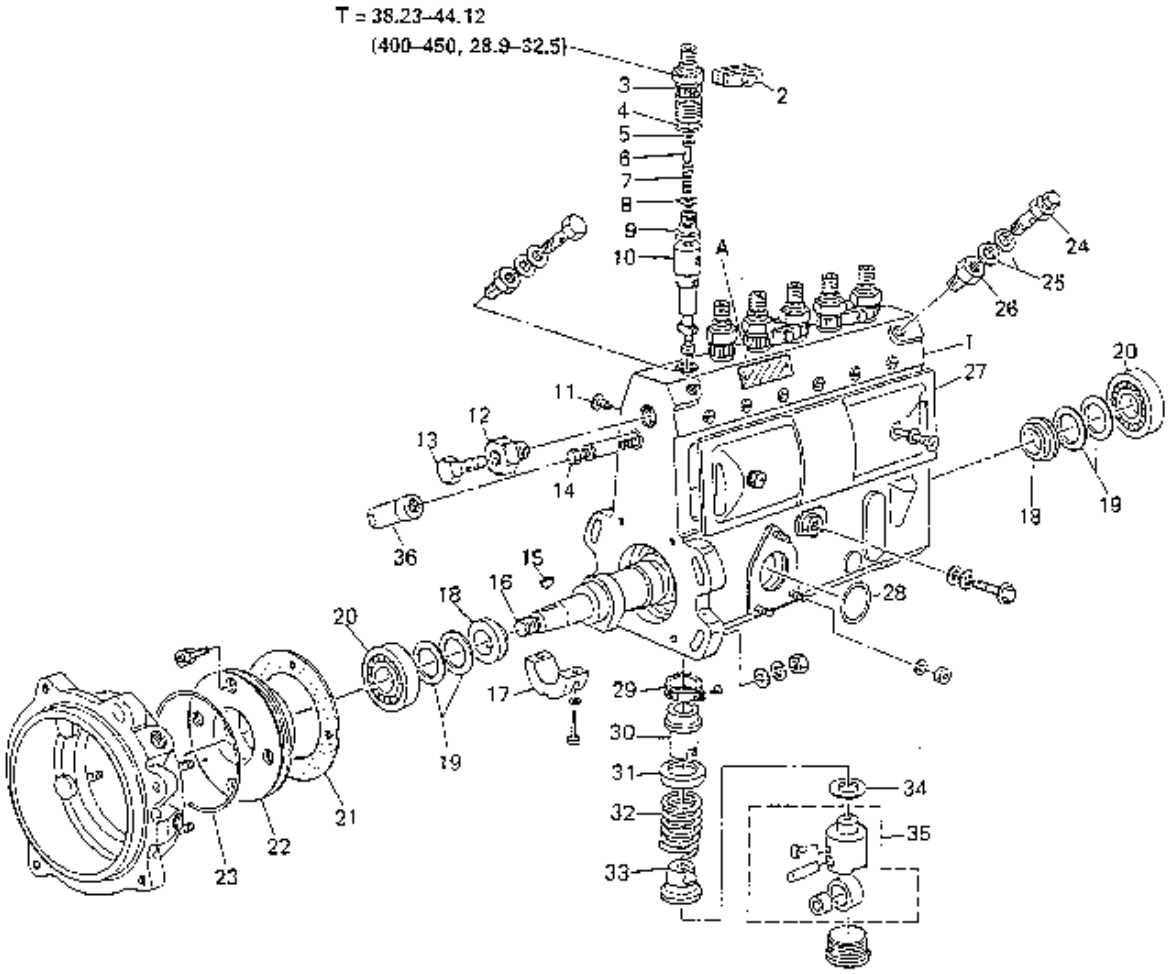
09511-1960

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INJECTION PUMP

A-TYPE PUMP



T = Tightening torque: N·m (kgf·cm, lbf·ft)

1. Injection pump housing
2. Valve holder lock plate
3. Delivery valve holder
4. O-ring
5. Shim
6. Delivery valve stopper
7. Delivery valve spring
8. Gasket
9. Delivery valve
10. Injection pump element
11. Bolt
12. Screw plug
13. Joint bolt
14. Control rack
15. Key
16. Camshaft
17. Center bearing
18. Camshaft shim plate and O-ring
19. Shim
20. Bearing
21. Gasket
22. Bearing cover
23. O-ring
24. Over flow valve
25. Soft washer
26. Adapter
27. Side cover
28. O-ring
29. Plunger control pinion
30. Plunger control sleeve
31. Plunger spring upper seat
32. Plunger spring
33. Plunger spring lower seat
34. Shim
35. Tappet sub-assembly
36. Control rack cover
A. Injection pump No. plate

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IMPORTANT POINT (S) – DISASSEMBLY

WARNING

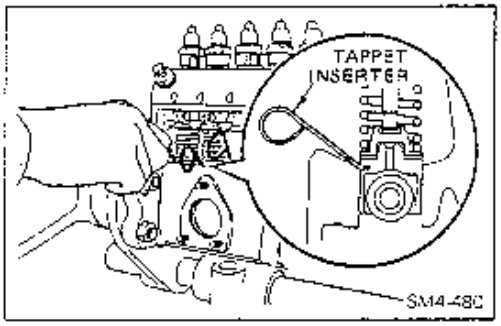
- Breaking of the lead seals or crimp caps by anyone other than HINO or pump manufacture authorized service stations to make these adjustment will void the warranty.
- If fuel pump or governor difficulties are suspected, consult only HINO or pump manufacture authorized service stations, where the problem can be corrected and the injection pump lead seals and crimp caps can be reinstalled as required.
- Measure and record the fuel delivery characteristics of the pump before disassembling it.
- Keep the parts for each cylinder in separate groups and in an orderly arrangement. Parts to be replaced and parts to be used again must be kept separately.

REMOVE THE TIMER ASSEMBLY.

Refer to "SECTION TIMER".

REMOVE THE GOVERNOR.

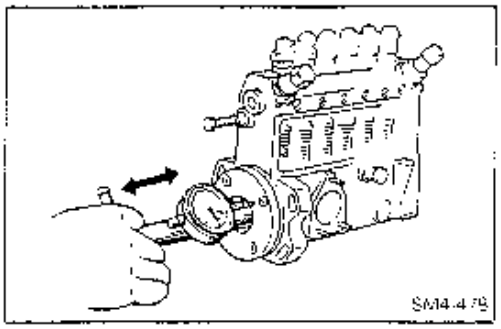
Refer to "CHAPTER GV. GOVERNOR".



INSERT THE TAPPET INSERTER IN THE TAPPET HOLE.

Turn the camshaft and insert the tappet inserters in each tappet hole when their tappet is at the highest position.

Special Tool: Tappet Inserter (09511-1770)



INSPECT THE END PLAY ON CAMSHAFT.

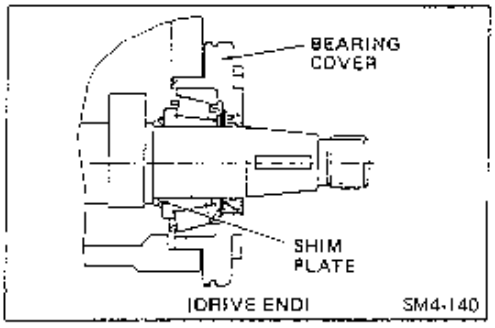
Using a special tool inspect the clearance in the axial direction on a camshaft installation.

Assembly Standard: 0.02–0.06 mm (0.0008–0.002 in)

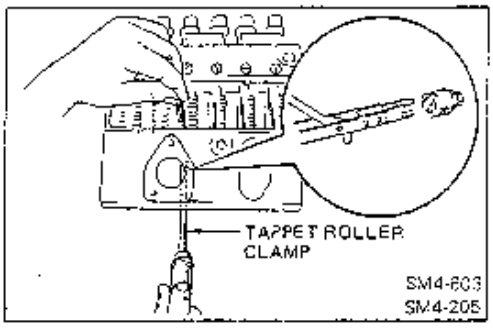
Special Tool: Camshaft End Play Gauge (09511-1970)
Gauge Adapter (09511-1610)

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If the specification is not met, use appropriate shim plates at the drive end of camshaft until the specification is met.

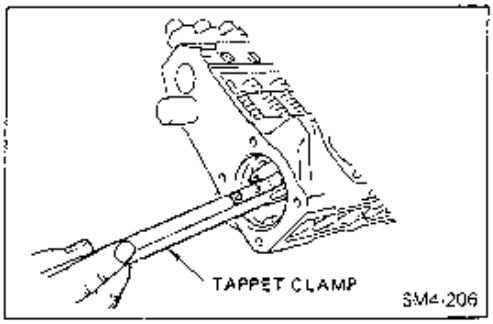


REMOVE THE TAPPET ASSEMBLY.

1. Push the tappet with the tappet roller clamp and remove the tappeter holder.

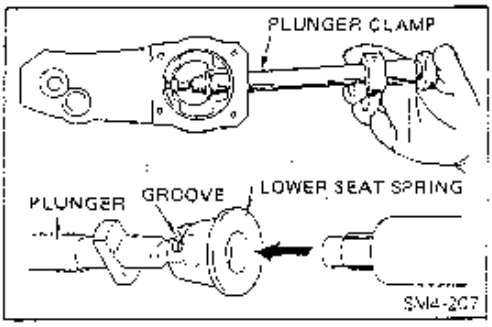
Special Tool: Tappet Roller Clamp (09511-1750)

NOTE: To prevent dropping of the plunger and the plunger spring, adjust the pump installation base so that the upper surface of the pump is slightly below the horizontal.



2. Remove the taopet through the camshaft bearing hole.

Special Tool: Tappet Clamp (09511-1190)

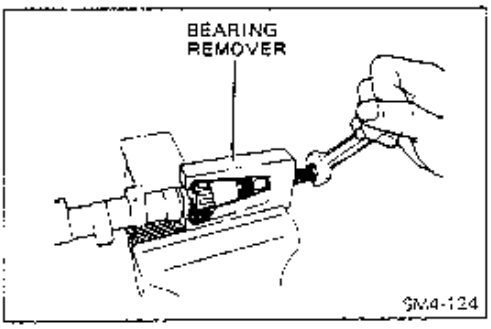


REMOVE THE PLUNGERS, SPRINGS AND CONTROL SLEEVE.

1. Use the plunger clamp hold the lower soring seat and remove it together with the plunger.

Special Tool: Plunger Clamp (09511-1730)

NOTE: ○ The plungers may not be damaged.
○ Arrange the removed plungers in the order of the cylinders in the disassembly box to prevent confusion.
○ Bring the plunger insertion notch of the lower spring seat to the top, and remove so that the plunger will not drop.

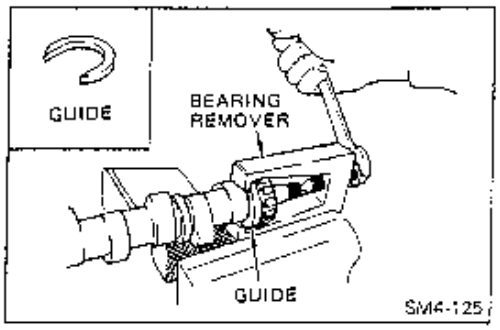


REMOVE THE TAPER BEARING FROM THE CAMSHAFT.

1. Remove the taper bearing from the drive end of the camshaft.

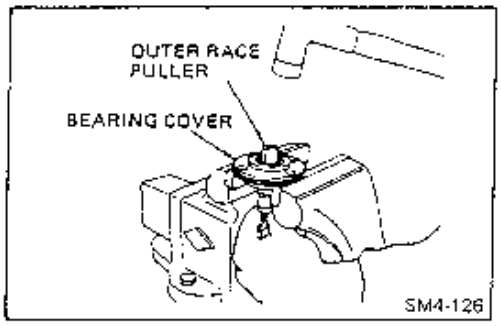
Special Tool: Bearing Remover (09500-1290)

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2. Use the guide to remove the bearing at the governor side.

Special Tool: Bearing Remover (09500-1290)



3. Use the outer race puller, to tap out the outer race in the bearing cover.

Special Tool: Outer Race Puller (09511-1680)

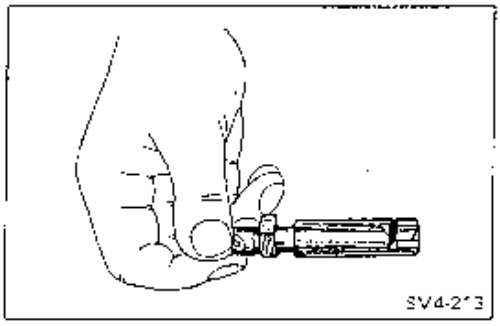
IMPORTANT POINT (S) – ASSEMBLY

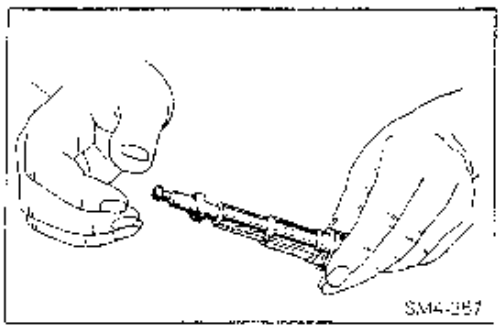
WARNING

- Wash all parts with clean diesel fuel before installing them, and any defective or damaged parts must be replaced.
- Do not allow dust or other foreign matter to enter the pump during assembly.
- Apply grease to O-rings and oil seals before installing them.
- Assemble the parts in correct order and to correct tightening torques, assembled dimensions etc.
- Assembly takes place in the reverse order of disassembly.

INSTALL THE PLUNGER BARRELS.

1. Before install the plunger barrels should be inspect the plunger barrels and plungers for wear, scratches, or discoloration.

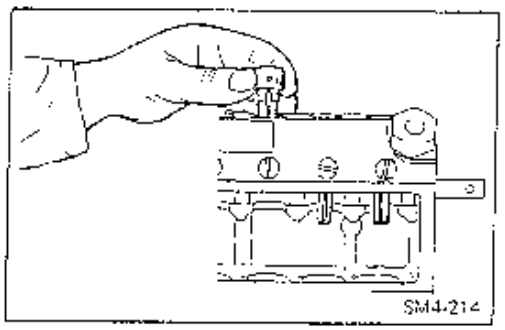




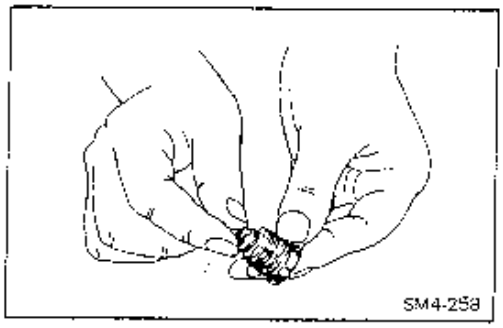
2. Tilt the plunger to about 60°. Pull the plunger out approximately 10 to 15 mm (0.39–0.59 in) and release it to see if it slides down smoothly from its own weight.
If the plunger sticks into the barrel too or does not slides smoothly, replace the plunger assembly.

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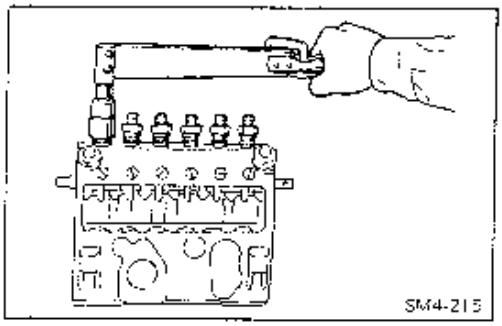


3. Match the plunger notch with the injection pump housing knock pin.



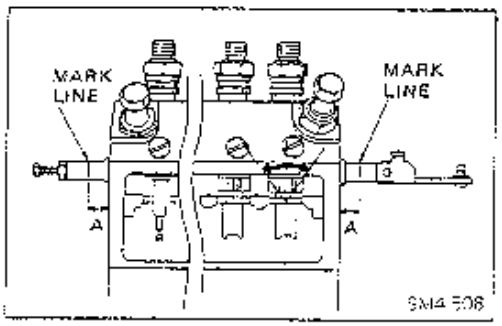
INSTALL THE DELIVERY VALVES, SPRINGS AND HOLDERS.

1. Before install the delivery valves, inspect the delivery valves for scratches on the valve seat or the piston sections.



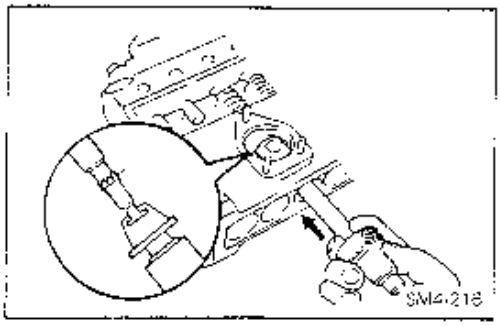
2. Install the gasket, spring, shim and stopper on the delivery valve.
3. Provisionally tighten the delivery valve holder with a new O-ring by hand.

NOTE: Tighten the delivery valve holder after installing the plunger.



INSTALL THE CONTROL SLEEVES ON THE BARRELS.

NOTE: ○ Install with the control sleeve part to the front so that the mark lines on both ends of the control rack are equidistant from the body.
○ Make sure that the control sleeve swings evenly right and left when the control rack is moved to the right and left.

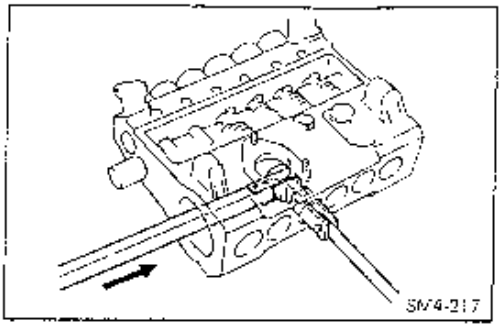


INSTALL THE PLUNGER AND TAPPET.

1. Assembly the plunger and spring lower seat, inserting the driving face marked with a number and the lower seat notch part upward (cover plate side).

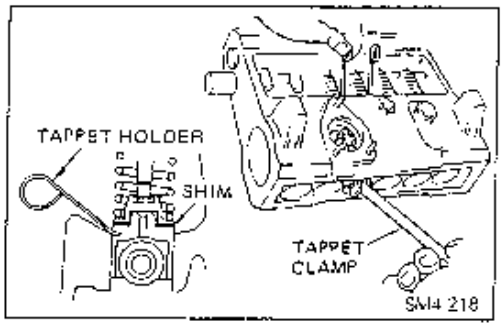
Special Tool: Plunger Clamp (09511-1730)

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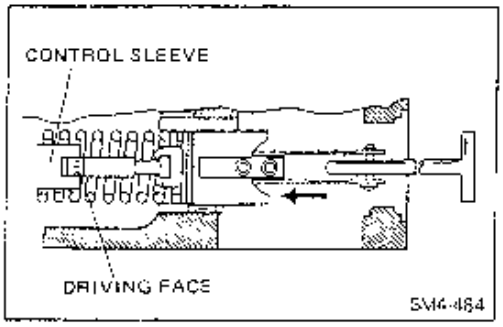
2. Install the tappet to the pump housing with the adjusting shim.

Special Tool: Tappet Roller Clamp (09511-1750)
Tappet Clamp (09511-1190)

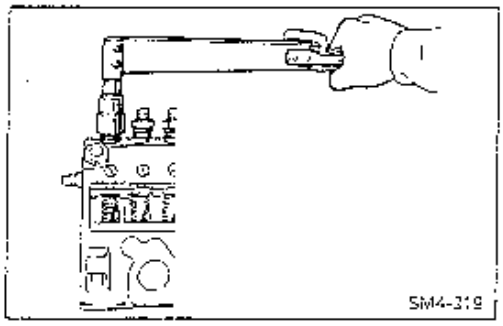


3. Using the tappet roller clamp to press in the tappet and hold it in with the tappet holder.

Special Tool: Tappet Holder (09511-1770)



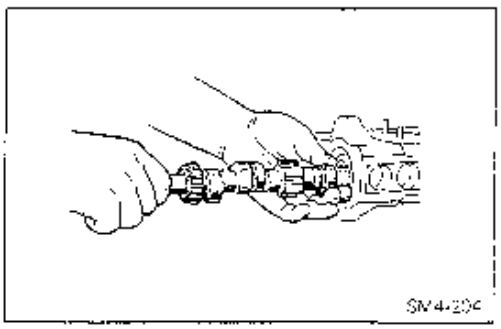
NOTE: ○ Check that the driving face of the plunger fits to the groove of the control sleeve before inserting the tappet.
○ When inserting the tappet, check that the control rack slides smoothly and without catching.



TIGHTEN THE DELIVERY VALVE HOLDER.

When one delivery valve holder is tightened, move the control rack to the right and left and inspect the tightness of the rack.

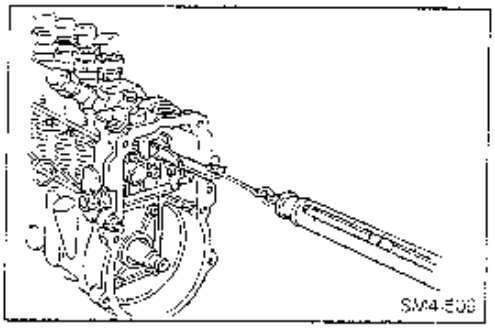
Tightening Torque: 38.23–44.12 N·m (400–450 kgf·cm, 29–32 lbf·ft)



INSTALL THE CAMSHAFT WITH CENTER BEARING.

Place a small amount of oil or grease on the center bearing to hold it to camshaft and the install the camshaft in the pump housing.

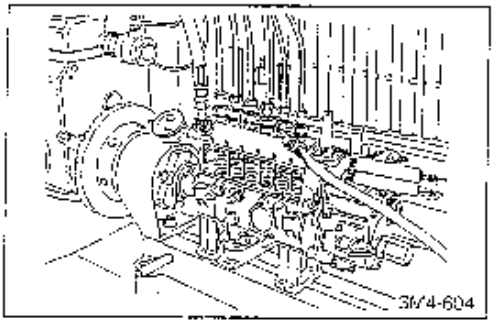
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MEASURE THE SLIDING RESISTANCE OF THE CONTROL RACK.

Assembly Standard: Less than 150 g (5.29 oz)

NOTE: Make sure that the control rack slides smoothly and without catching.

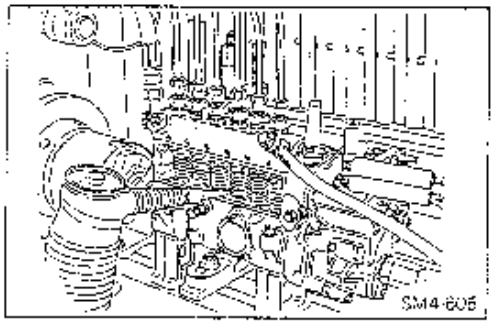


ADJUSTMENT

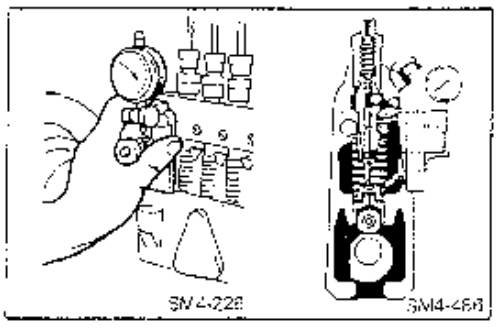
PREPARATION

1. Mount the injection pump correctly on the pump tester.
2. Attach a rack measuring device to the control rack and set to "0".
3. Install calibration nozzles and lines.

Nozzles and Lines: Refer to "CHAPTER C. CALIBRATION".



4. Install the cover on the feed pump mounting surface and fill the pump camshaft chamber with engine oil.

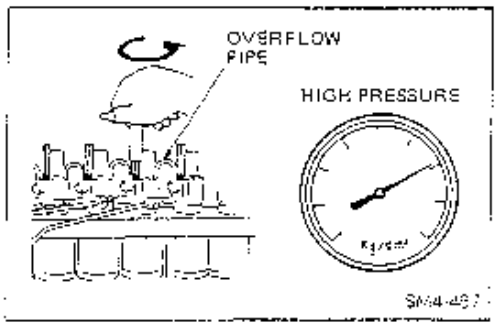


ADJUSTING THE INJECTION TIMING

1. Preparation of the pre-stroke.

a) Remove the plate cover.

b) Install a pre-stroke measuring instrument.
Bring the tappet of the first cylinder to its bottom dead center, and set the pointer tip on the tappet.



2. Measure the pre-stroke (No.1 plunger)

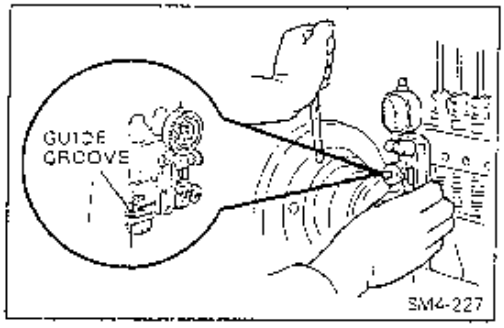
a) Set the control rack at full-load position.

b) Loosen the overflow screw of each nozzle holder.

c) Operate the high-pressure pump of the pump tester and let fuel run out of the overflow line.

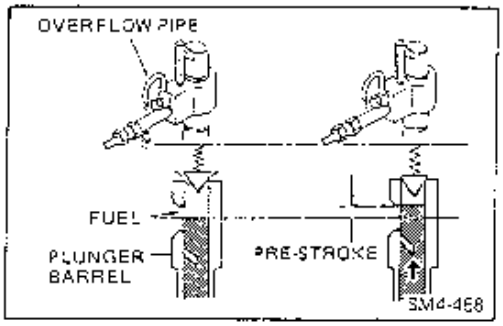
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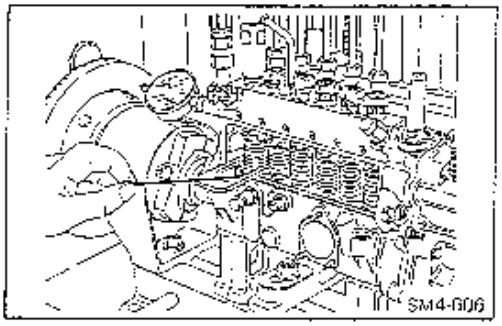
d) Move the angle dial to set the first cylinder of the pump to bottom dead center and adjust the pre-stroke gauge to zero.

NOTE: Bottom dead center is the point at which the pointer of the dial gauge does not move even when the angle dial is rotated while fuel is flowing from the overflow line.



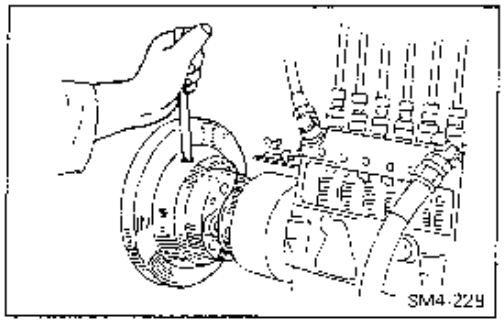
e) Turn the camshaft clockwise with the angle dial and read the dial gauge when the fuel stops running out of the over flow line. This reading is the pre-stroke value of the pump.

Pre-stroke: Refer to "CHAPTER C. CALIBRATION".



f) If the pre-stroke value is not within specification, adjust by changing the tappet adjusting shim.

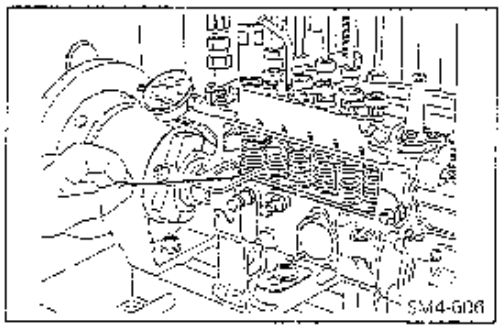
Special Tool: Spring Holder (09511-1960)



ADJUST THE INJECTION INTERVAL.

1. Using the No.1 cylinder injection starting point as a base, inspect and adjust the injection interval in the order of injection.

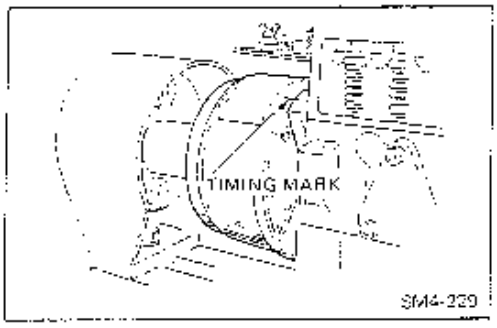
Injection Interval:	59°45' – 60°15'
Injection Order:	1–4–2–6–3–5



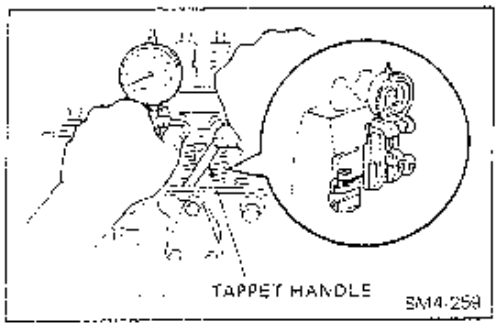
2. If the injection intervals are not within specification, adjust by using the same procedure as for pre-stroke adjustment.

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3. Set the No.1 cylinder at the injection starting point, and check that the marks on the timer and the marks on the pump body are aligned.
   If the timing marks are not aligned, make a new mark on the timer and erase the old mark.

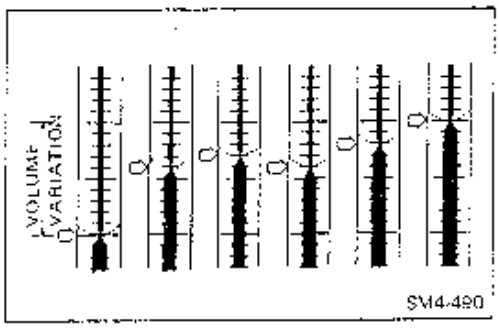


CHECK THE TAPPET TOP CLEARANCE.

1. Set the No.1 cylinder at the injection starting point, then move the tappet with the handle.

Tappet Top Clearance: More than 0.2 mm (0.0079 in)

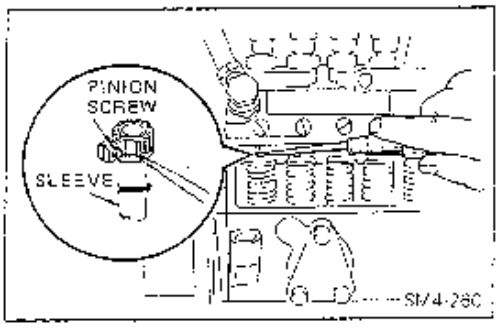
2. Follow the above procedure to check the other cylinders (No.2 through No.6).
3. If the tappet clearance is less than 0.2 mm (0.0079 in), re-check the pre-stroke.



MEASURING AND ADJUSTING THE INJECTION VOLUME.

Measure the injection volume for each control rack position and pump revolution.

Injection Volume: Refer to "CHAPTER C. CALIBRATION".

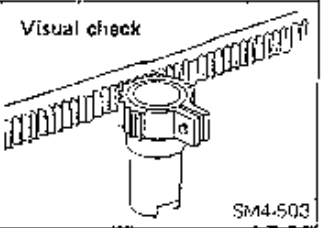
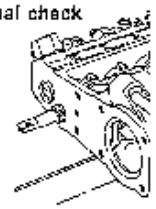
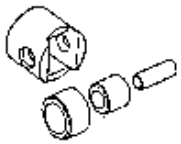
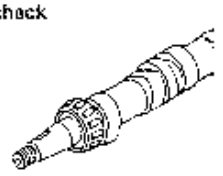
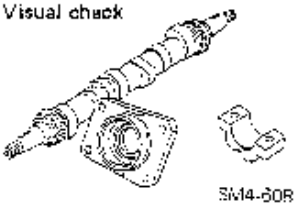


To adjust the injection volume, loosen the pinion screw and insert the adjusting pin into the hole in the control sleeve, then move the sleeve slightly.

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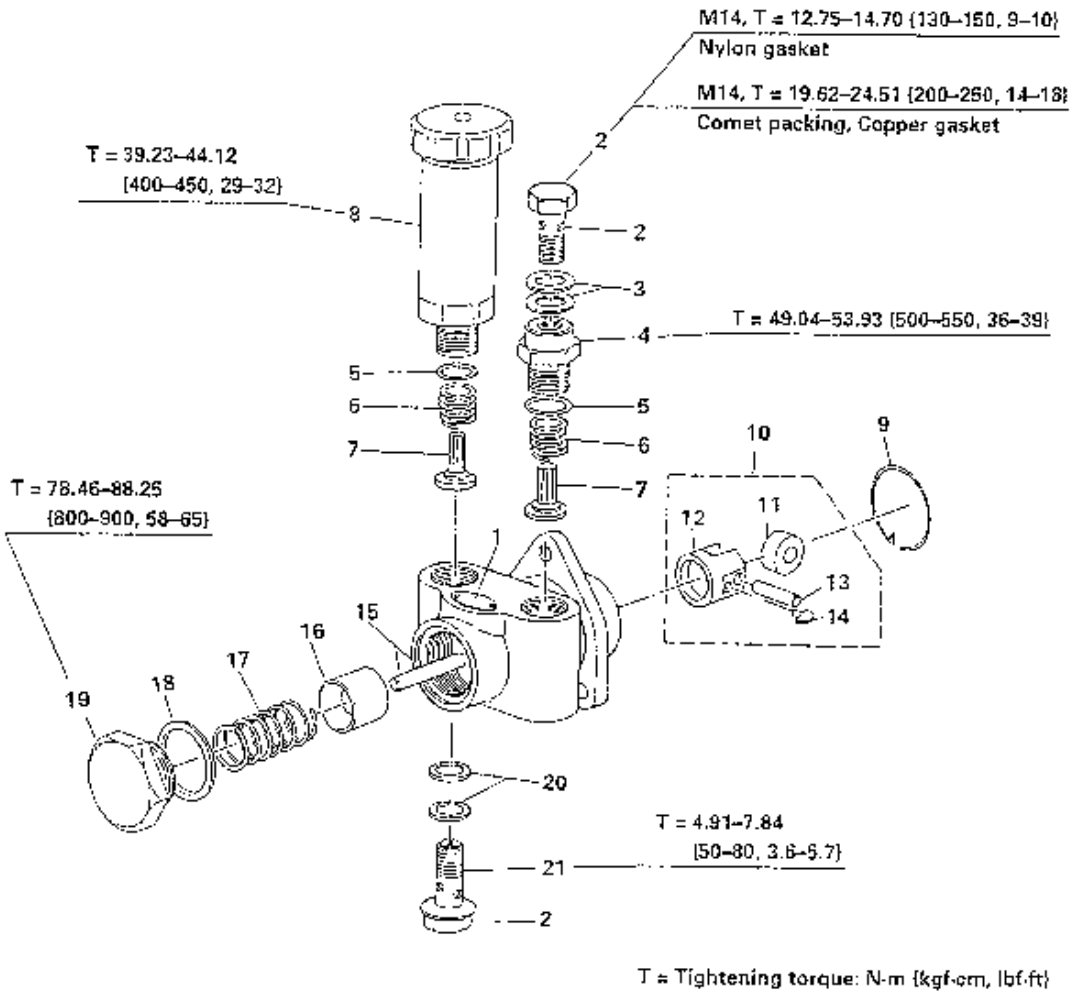
INSPECTION AND REPAIR

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Control Rack. Bent, Wear Gear Teeth. Wear	–	–	Replace, if necessary.	Visual check  SM4-503
Press-fitted bush. Wear	–	–	Replace, if necessary.	Visual check  SM4-607
Control Sleeve. Wear, Damage	–	–	Replace, if necessary.	Visual check  SM4-504
Tappet Roller, Bushing and Pin. Wear, Damage	–	–	Replace, if necessary.	Visual check  SM4-499
Lower Spring Seat. Wear, Damage	–	–	Replace, if necessary.	Visual check  SM4-500
Camshaft. Wear, Damage	–	–	Replace, if necessary.	Visual check  SM4-501
Camshaft Bearing, Bearing Race and Center Bearing. Wear, Damage	–	–	Replace, if necessary.	Visual check  SM4-508

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FEED PUMP

FP/KS-TYPE



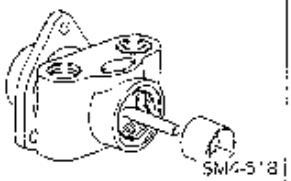
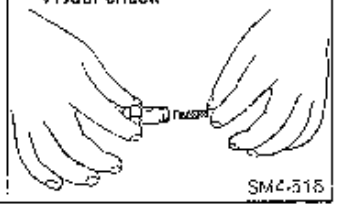
T = Tightening torque: N·m {kgf·cm, lbf·ft}

1. Feed pump serial No.
2. Joint bolt
3. Soft washer
4. Connector
5. O-ring
6. Check valve spring
7. Check valve
8. Priming pump
9. Retainer ring
10. Tappet assembly
11. Roller
12. Tappet
13. Pin
14. Sliding block
15. Feed pump housing, push rod, & oil seal
16. Piston
17. Spring
18. Gasket
19. Plug
20. Soft washer
21. Filter

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https://FUEL INJECTION PUMP/

INSPECTION AND REPAIR

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Valve Seat, Wear, Damage	–	–	Replace, if necessary.	Visual check 
Piston, Cylinder and Oil Seal, Wear, Damage	–	–	Replace, if necessary.	Visual check 
Filter, Clogged	–	–	Clean	Visual check 

(K.P.)

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IP-S149E-01

CHAPTER IP

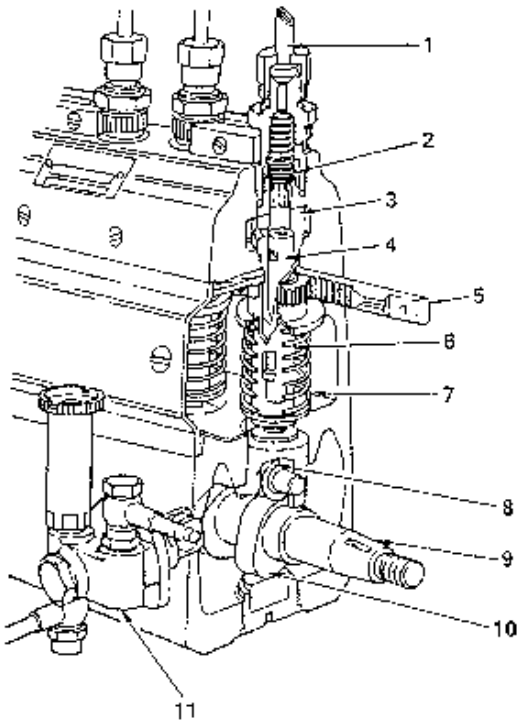
FUEL INJECTION PUMP

DESCRIPTION ..... IP- 2
TROUBLESHOOTING ..... IP- 3
SPECIAL TOOLS ..... IP- 6
INJECTION PUMP ..... IP- 8
FEED PUMP IP-18
TIMER IP-20

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DESCRIPTION



SM4-064

FUEL INJECTION PUMP

1. High pressure pipe
2. Delivery valve
3. Plunger barrel
4. Plunger
5. Control rod
6. Control sleeve
7. Plunger spring
8. Tappet
9. Cam shaft
10. Cam
11. Fuel feed pump

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TROUBLESHOOTING

Symptom	Possible cause	Remedy/Prevention
Engine does not start	**Fuel not reaching injection pump**	
	• Fuel lines clogged or damaged	Clean or replace fuel lines.
	• Fuel filter clogged	Clean or replace the filter element.
	• Air in fuel caused by improper connections of fuel line between fuel tank and feed pump	Repair connections.
	• Filter incorporated in inlet side of feed pump clogged	Remove foreign material.
	• Faulty feed pump check valve	Repair or replace it.
	• Feed pump piston spring broken	Replace it.
	• Feed pump push rod or tappet sticking	Repair or replace it.
	Fuel reaching injection pump	
	• Faulty connection of accelerator wire to pump adjusting lever.	Repair connection.
	• Control rack faulty or sticking	Repair it.
	• Damaged camshaft bearing	Repair it.
	• Plunger worn or sticking	Correct or replace it.
	• Faulty connection of engine stop wire to pump stop lever.	Repair it.
	Nozzle faulty	
	• Fuel leakage caused by loosened nozzle holder.	Inspect and tighten it.
	• Low opening pressure of nozzle	Adjust it.
	• Nozzle pressure spring broken	Replace it.
	• Nozzle needle sticking to nozzle body	Correct or replace it.
	Pump out of timing	
	• Improperly retarded injection timing	Correct injection timing.
	• Incorrect timing caused by improper installation of pump.	Check engine timing and correct it.
	• Woodruff key for pump camshaft cut off.	Replace it.
	• Improper pre-stroke adjustment	Correct it to obtain specified injection timing.

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Symptom	Possible cause	Remedy/Prevention
Excessive smoke	Black smoke	
	• Excessive fuel delivery caused by incorrect adjustment of fuel load stopper screw.	Adjust fuel delivery on test stand.
	• Excessively advanced injection timing.	Correct it.
	• Large spread in fuel delivery	Adjust it.
	• Bad nozzle fuel spray characteristics	Check and correct them.
	White smoke	
	• Improperly retarded injection timing.	Advance injection timing.
	• Water in fuel	Check and clean fuel lines.
Low idle speed irregular	Improper adjustment of idle button	Correct it.
	Bad fuel spray characteristic of nozzles.	Check and repair them.
	Incorrect injection timing	Correct it.
	Incorrect initial tension setting of idling spring or the spring broken.	Adjust or replace it.
	Control rack not smoothly move	Disassemble pump and repair it.
	Large spread in fuel delivery	Adjust it.
	Plunger worn	Replace it.
	Governor linkage not smoothly move.	Correct it.
	Defective feed pump	Disassemble and repair it.
Engine always runs at high speed	Accelerator cable sticking	Check and correct it.
	Governor linkage sticking	Disassemble and repair the governor.
	Control rack sticking	Check and correct it.
Engine starts and stops	Fuel lines clogged	Clean or replace fuel lines.
	Air in fuel caused by damaged fuel lines or improper connection of fuel lines.	Repair fuel lines or replace fuel lines and gaskets.

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Symptom	Possible cause	Remedy/Prevention
Engine has low power	**Pump out of timing**	
	• Excessive advanced timing, resulting in loud knocking.	Check and correct it.
	• Excessively retarded timing resulting in black smoke.	Check and correct it.
	• Defective injection pump overflow valve.	Repair or replace it.
	• Feed pressure too low	Repair the feed pump.
	• Improper accelerator cable adjustment	Adjust it.
	Nozzle faulty	
	• Fuel leakage from nozzle holder	Check and repair nozzle holder.
	• Bad nozzle spray characteristic	Repair or replace it.
	• Loosened adjusting screw in nozzle holder, resulting in low opening pressure.	Adjust it.
	• Nozzle pressure spring broken	Replace it.
	Pump faulty	
	• Fuel leakage from delivery valve holder.	Retighten the delivery valve holder if it is loosened or replace O-ring if the O-ring is defective.
	• Defective seat of delivery valve assembly.	Repair or replace it.
	• Delivery valve spring broken	Replace the spring.
	• Plunger worn	Replace it.
	• Large spread in fuel delivery	Adjust it.
	• Wear of tappet roller	Replace the roller.
	• Camshaft bearing worn or broken	Replace it.
	• Improper adjustment of governor fuel load stopper screw.	Adjust it.
Loud knocking	Improper injection timing	Correct it.
	Bad fuel nozzle spray pattern after-dribble.	Check and correct it.
	High nozzle opening pressure	Adjust the opening pressure.
	Incorrect fuel deliveries to some nozzles.	Readjust the fuel deliveries.

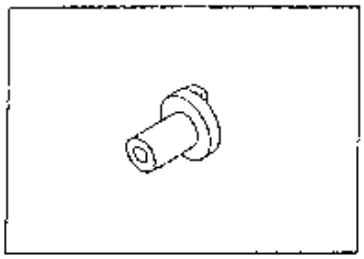
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SPECIAL TOOLS

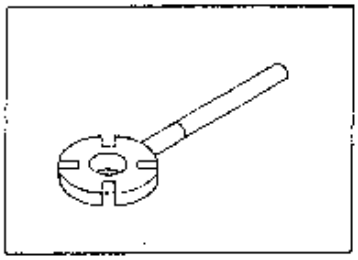
Prior to starting an injection pump overhaul, it is necessary to have these special tools.

COUPLING



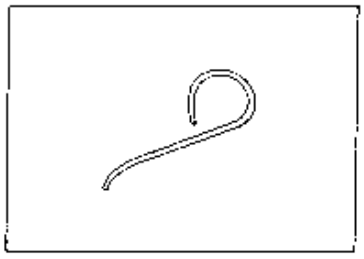
09511-2000

HOLDING WRENCH



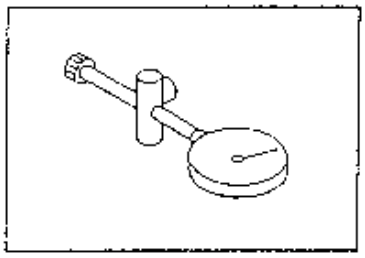
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TAPPET HOLDER



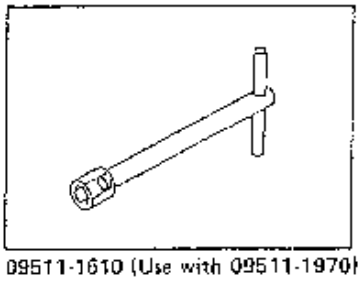
09511-1770

CAMSHAFT END PLAY GAUGE



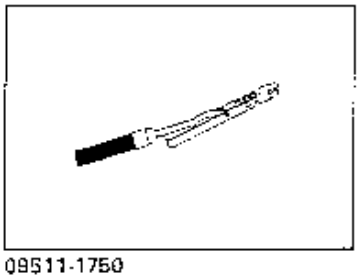
09511-1970

GAUGE ADAPTER



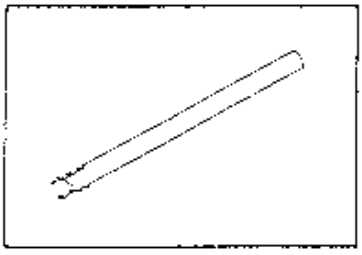
09511-1610 (Use with 09511-1970)

TAPPET ROLLER CLAMP



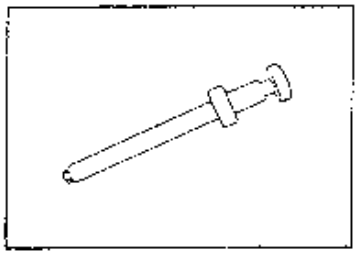
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TAPPET CLAMP



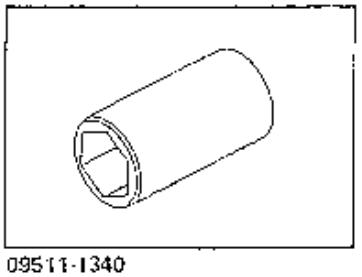
09511-1190

PLUNGER CLAMP



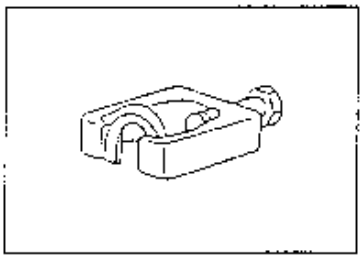
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DELIVERY VALVE HOLDER REMOVER



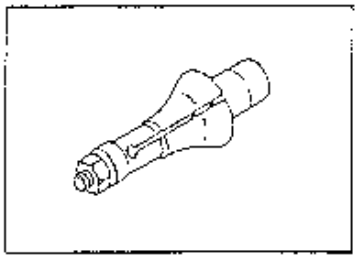
09511-1340

BEARING REMOVER



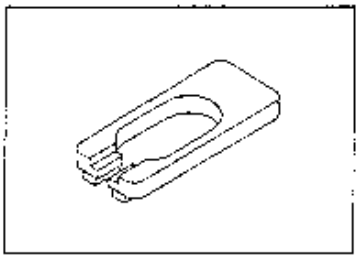
09500-1290

BEARING OUTER RACE PLUNGER



09511-1680

SPRING HOLDER

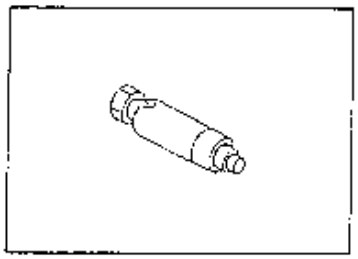


09511-1960

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TIMER EXTRACTOR



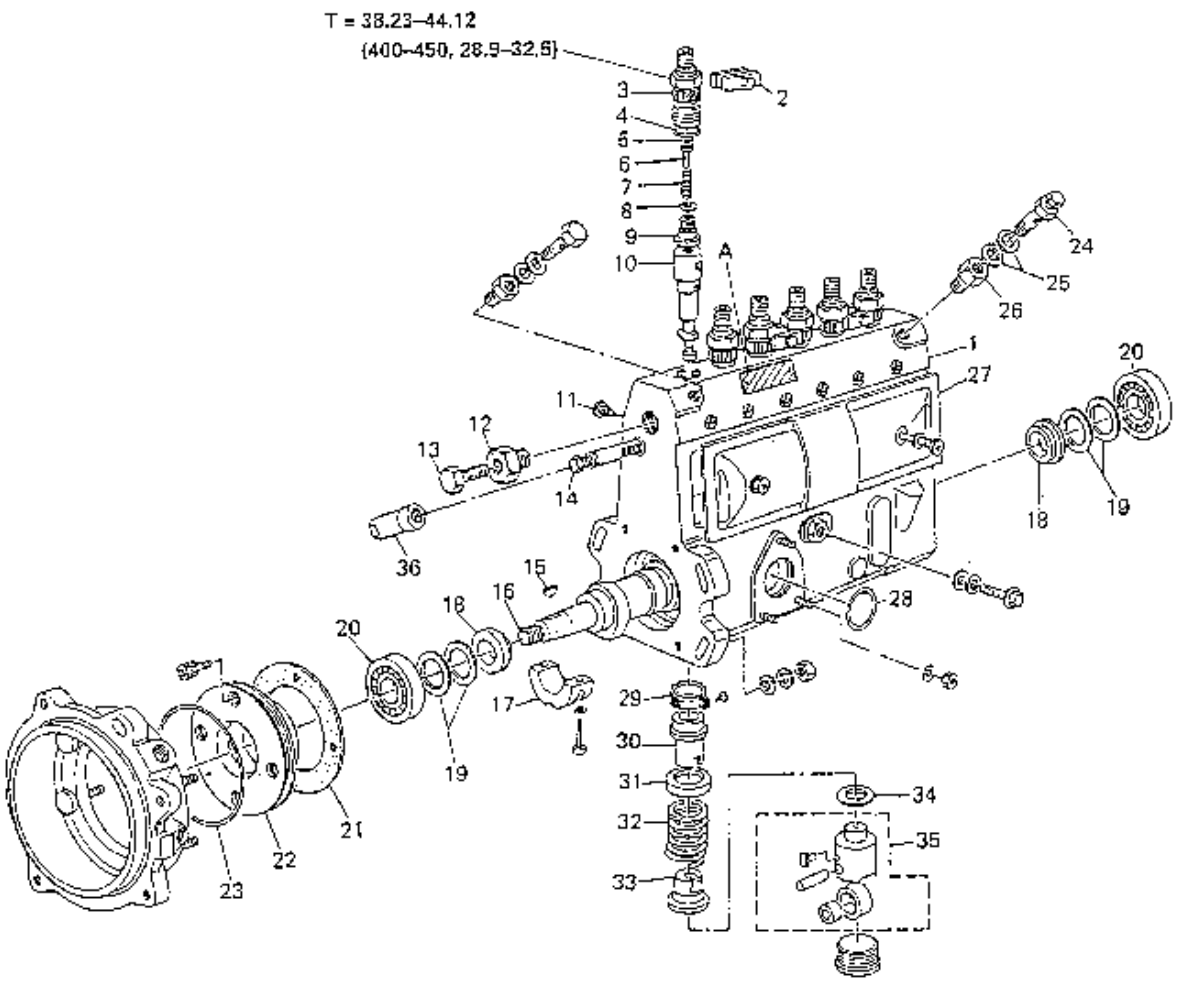
09511-1990

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INJECTION PUMP

A, AD-TYPE PUMP



1. Injection pump housing
2. Valve holder lock plate
3. Delivery valve holder
4. O-ring
5. Shim
6. Delivery valve stopper
7. Delivery valve spring
8. Gasket
9. Delivery valve
10. Injection pump element
11. Bolt
12. Screw plug
13. Joint bolt
14. Control rack
15. Key
16. Camshaft
17. Center bearing
18. Camshaft shim plate and O-ring
19. Shim
20. Bearing
21. Gasket
22. Bearing cover
23. O-ring
24. Over flow valve
25. Soft washer
26. Adapter
27. Side cover
28. O-ring
29. Plunger control pinion
30. Plunger control sleeve
31. Plunger spring upper seat
32. Plunger spring
33. Plunger spring lower seat
34. Shim
35. Tappet sub-assembly
36. Control rack cover
A. Injection pump No. plate

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IMPORTANT POINT (S) – DISASSEMBLY

WARNING

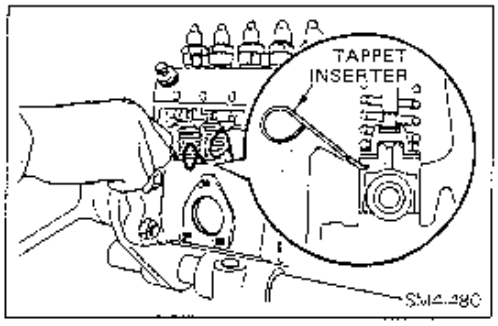
- Breaking of the lead seals or crimp caps by anyone other than HINO or pump manufacture authorized service stations to make these adjustment will void the warranty.
- If fuel pump or governor difficulties are suspected, consult only HINO or pump manufacture authorized service stations, where the problem can be corrected and the injection pump lead seals and crimp caps can be reinstalled as required.
- Measure and record the fuel delivery characteristics of the pump before disassembling it.
- Keep the parts for each cylinder in separate groups and in an orderly arrangement. Parts to be replaced and parts to be used again must be kept separately.

REMOVE THE TIMER ASSEMBLY.

Refer to "SECTION TIMER".

REMOVE THE GOVERNOR.

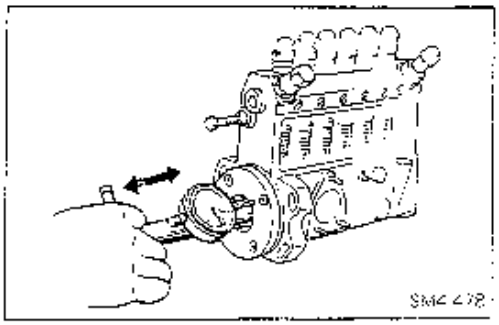
Refer to "CHAPTER GV. GOVERNOR".



INSERT THE TAPPET INSERTER IN THE TAPPET HOLE.

Turn the camshaft and insert the tappet inserters in each tappet hole when their tappet is at the highest position.

Special Tool: Tappet Inserter (09511-1770)



INSPECT THE END PLAY ON CAMSHAFT.

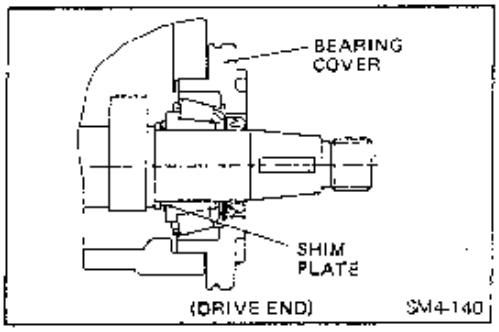
Using a special tool inspect the clearance in the axial direction on a camshaft installation.

Assembly Standard: 0.02–0.06 mm (0.0008–0.002 in)

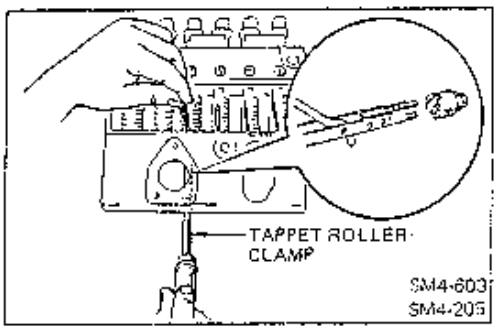
Special Tool: Camshaft End Play Gauge (09511-1970)
Gauge Adapter (09511-1610)

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If the specification is not met, use appropriate shim plates at the drive end of camshaft until the specification is met.

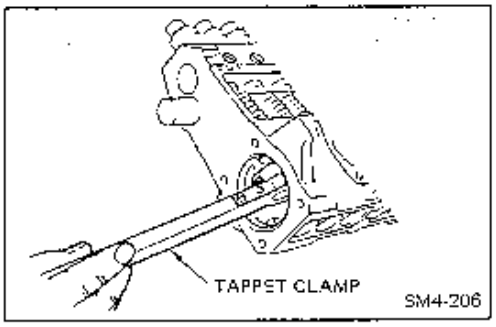


REMOVE THE TAPPET ASSEMBLY.

1. Push the tappet with the tapoet roller clamp and remove the tappeter holder.

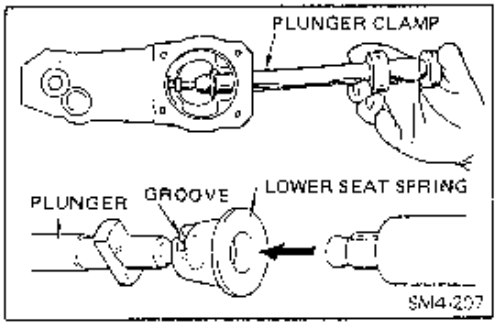
Special Tool: Tappet Roller Clamp (09511-1750)

NOTE: To prevent dropping of the plunger and the plunger spring, adjust the pump installation base so that the upper surface of the pump is slightly below the horizontal.



2. Remove the tappet through the camshaft bearing hole.

Special Tool: Tappet Clamp (09511-1190)

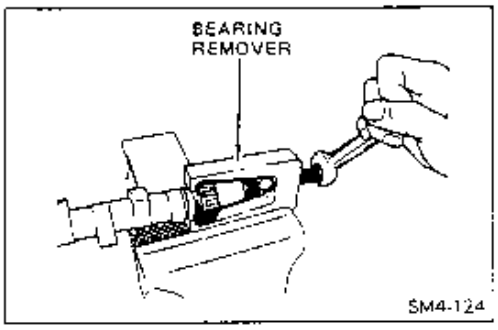


REMOVE THE PLUNGERS, SPRINGS AND CONTROL SLEEVE.

1. Use the plunger clamp hold the lower spring seat and remove it together with the plunger.

Special Tool: Plunger Clamp (09511-1730)

NOTE:
- The plungers may not be damaged.
- Arrange the removed plungers in the order of the cylinders in the disassembly box to prevent confusion.
- Bring the plunger insertion notch of the lower spring seat to the top, and remove so that the plunger will not drop.



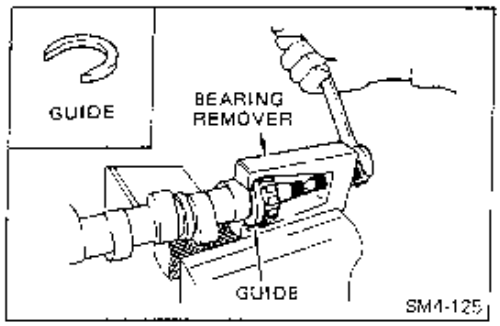
REMOVE THE TAPER BEARING FROM THE CAMSHAFT.

1. Remove the taper bearing from the drive end of the camshaft.

Special Tool: Bearing Remover (09500-1290)

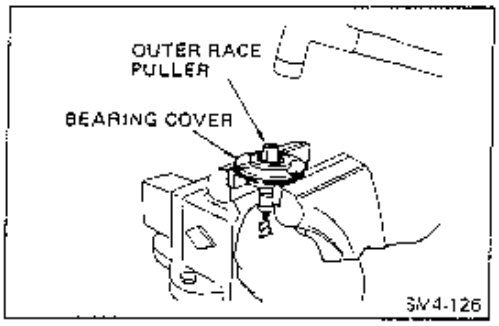
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2. Use the guide to remove the bearing at the governor side.

Special Tool: Bearing Remover (09500-1290)



3. Use the outer race puller, to tap out the outer race in the bearing cover.

Special Tool: Outer Race Puller (09511-1680)

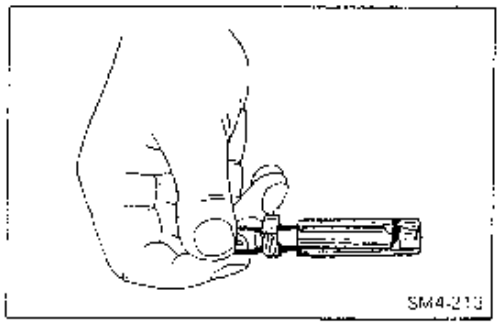
IMPORTANT POINT (S) – ASSEMBLY

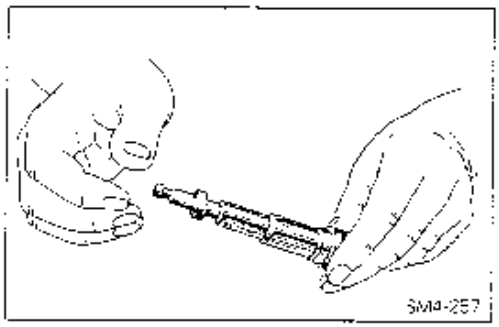
WARNING

- Wash all parts with clean diesel fuel before installing them, and any defective or damaged parts must be replaced.
- Do not allow dust or other foreign matter to enter the pump during assembly.
- Apply grease to O-rings and oil seals before installing them.
- Assemble the parts in correct order and to correct tightening torques, assembled dimensions etc.
- Assembly takes place in the reverse order of disassembly.

INSTALL THE PLUNGER BARRELS.

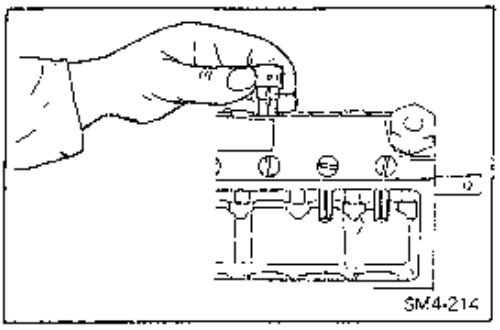
1. Before install the plunger barrels should be inspect the plunger barrels and plungers for wear, scratches, or discoloration.



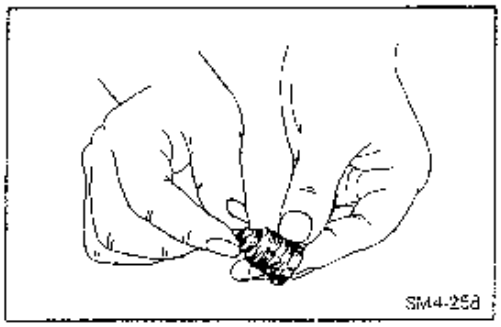


2. Tilt the plunger to about 60°. Pull the plunger out approximately 10 to 15 mm (0.39–0.59 in) and release it to see if it slides down smoothly from its own weight.
   If the plunger slides into the barrel too or does not slides smoothly, replace the plunger assembly.

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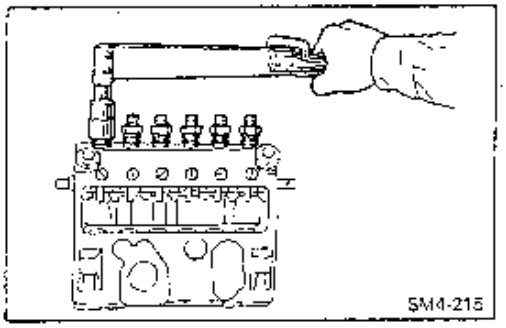


3. Match the plunger notch with the injection pump housing knock pin.



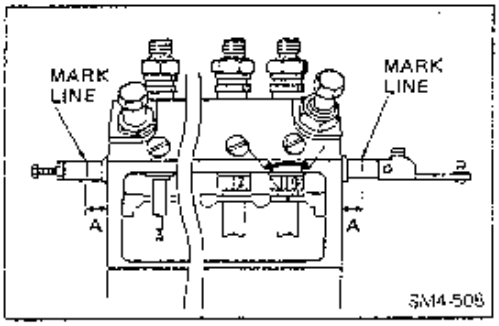
INSTALL THE DELIVERY VALVES, SPRINGS AND HOLDERS.

1. Before install the delivery valves, inspect the delivery valves for scratches on the valve seat or the piston sections.



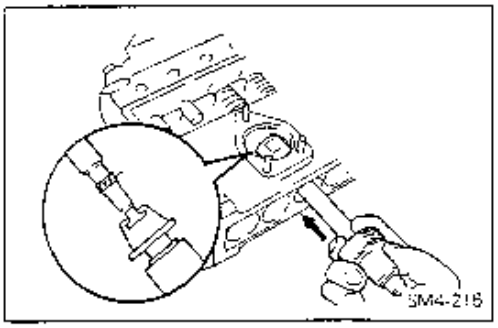
2. Install the gasket, spring, shim and stopper on the delivery valve.
3. Provisionally tighten the delivery valve holder with a new O-ring by hand.

NOTE: Tighten the delivery valve holder after installing the plunger.



INSTALL THE CONTROL SLEEVES ON THE BARRELS.

NOTE: ○ Install with the control sleeve part to the front so that the mark lines on both ends of the control rack are equidistant from the body.
○ Make sure that the control sleeve swings evenly right and left when the control rack is moved to the right and left.

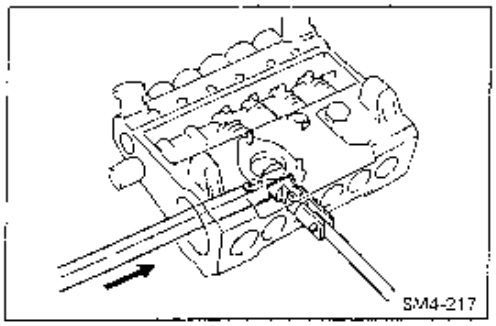


INSTALL THE PLUNGER AND TAPPET.

1. Assembly the plunger and spring lower seat, inserting the driving face marked with a number and the lower seat notch part upward (cover plate side).

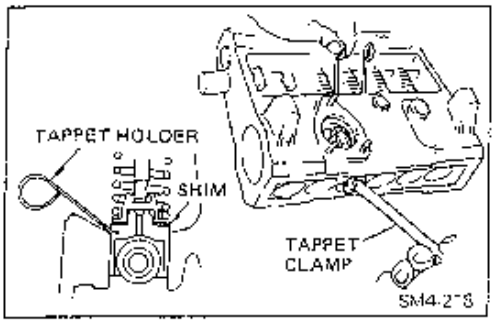
Special Tool: Plunger Clamp (09511-1730)

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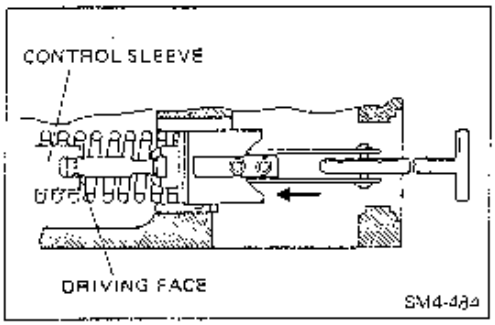
2. Install the tappet to the pump housing with the adjusting shim.

Special Tool: Tappet Roller Clamp (09511-1750)
Tappet Clamp (09511-1190)

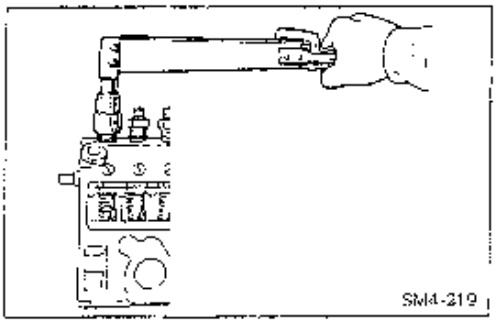


3. Using the tappet roller clamp to press in the tappet and hold it in with the tappet holder.

Special Tool: Tappet Holder (09511-1770)



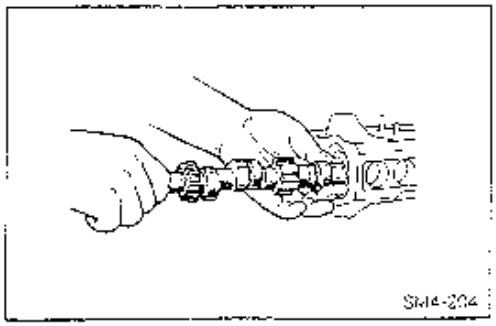
NOTE: ○ Check that the driving face of the plunger fits to the groove of the control sleeve before inserting the tappet.
○ When inserting the tappet, check that the control rack slides smoothly and without catching.



TIGHTEN THE DELIVERY VALVE HOLDER.

When one delivery valve holder is tightened, move the control rack to the right and left and inspect the tightness of the rack.

Tightening Torque: 38.23–44.12 N·m (400–450 kgf-cm, 29–32 lbf-ft)

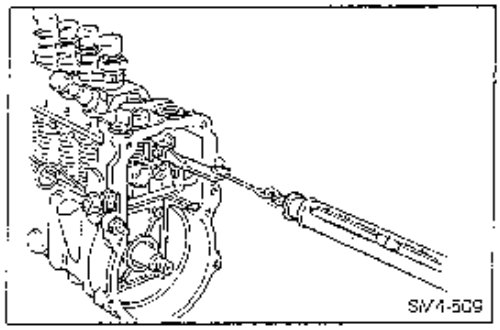


INSTALL THE CAMSHAFT WITH CENTER BEARING.

Place a small amount of oil or grease on the center bearing to hold it to camshaft and the install the camshart in the pump housing.

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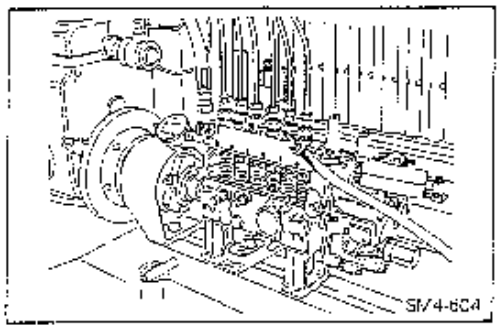
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MEASURE THE SLIDING RESISTANCE OF THE CONTROL RACK.

Assembly Standard: Less than 150 g (5.29 oz)

NOTE: Make sure that the control rack slides smoothly and without catching.

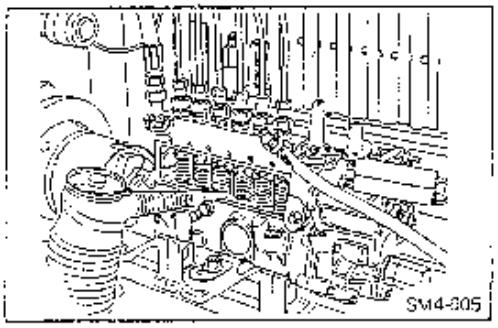


ADJUSTMENT

PREPARATION

1. Mount the injection pump correctly on the pump tester.
2. Attach a rack measuring device to the control rack and set to "0".
3. Install calibration nozzles and lines.

Nozzles and Lines: Refer to "CHAPTER C. CALIBRATION".



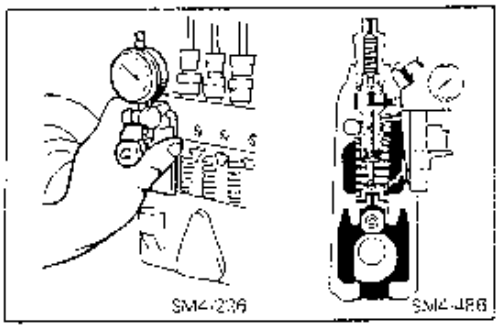
4. Install the cover on the feed pump mounting surface and fill the pump camshaft chamber with engine oil.

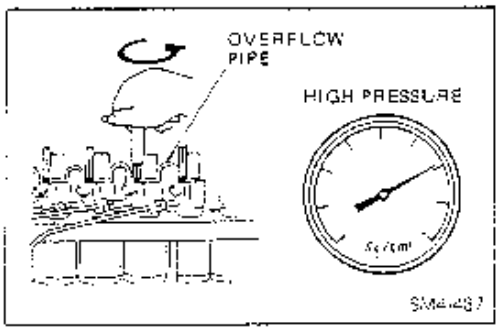
ADJUSTING THE INJECTION TIMING

1. Preparation of the pre-stroke.

a) Remove the plate cover.

b) Install a pre-stroke measuring instrument.
Bring the tappet of the first cylinder to its bottom dead center, and set the pointer tip on the tappet.





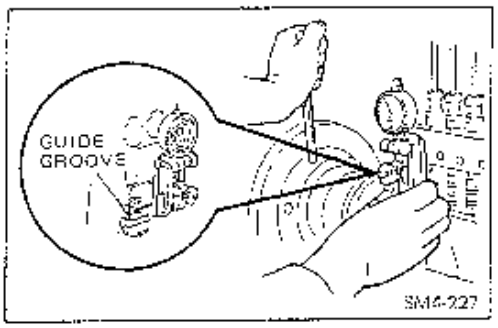
2. Measure the pre-stroke (No.1 plunger)

a) Set the control rack at full-load position.

b) Loosen the overflow screw of each nozzle holder.

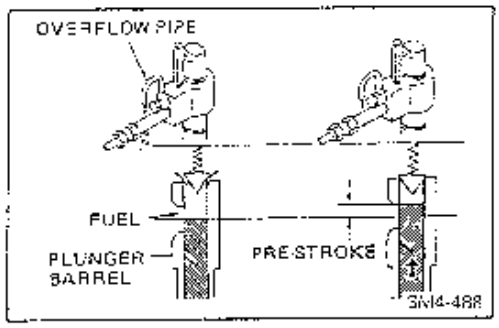
c) Operate the high-pressure pump of the pump tester and let fuel run out of the overflow line.

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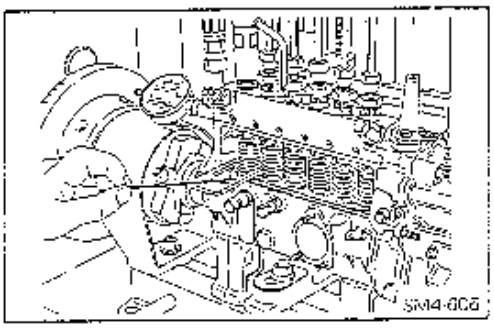
d) Move the angle dial to set the first cylinder of the pump to bottom dead center and adjust the pre-stroke gauge to zero.

NOTE: Bottom dead center is the point at which the pointer of the dial gauge does not move even when the angle dial is rotated while fuel is flowing from the overflow line.



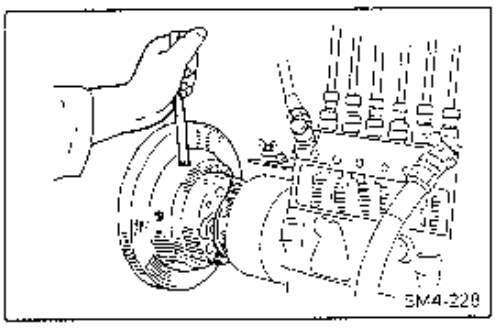
e) Turn the camshaft clockwise with the angle dial and read the dial gauge when the fuel stops running out of the overflow line. This reading is the pre-stroke value of the pump.

Pre-stroke: Refer to "CHAPTER C. CALIBRATION".



f) If the pre-stroke value is not within specification, adjust by changing the tappet adjusting shim.

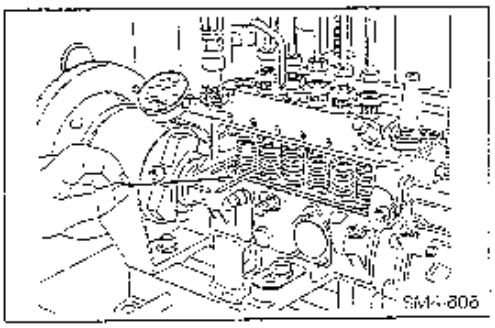
Special Tool: Spring Holder (09511-1960)



ADJUST THE INJECTION INTERVAL.

1. Using the No.1 cylinder injection starting point as a base, inspect and adjust the injection interval in the order of injection.

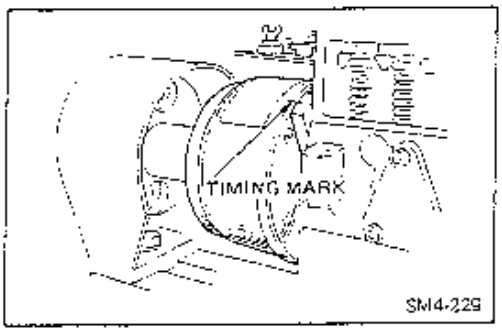
Injection Interval:	59°45' – 60°15'
Injection Order:	1–4–2–6–3–5



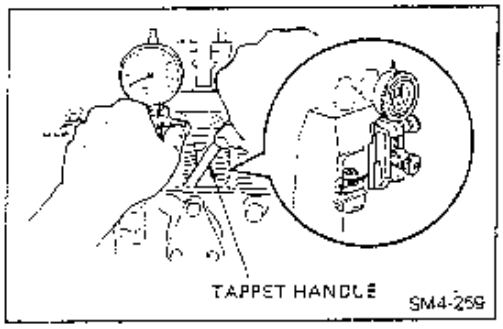
2. If the injection intervals are not within specification, adjust by using the same procedure as for pre-stroke adjustment.

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3. Set the No.1 cylinder at the injection starting point, and check that the marks on the timer and the marks on the pump body are aligned.
If the timing marks are not aligned, make a new mark on the timer and erase the old mark.

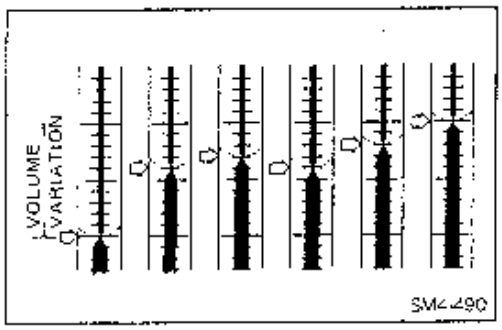


CHECK THE TAPPET TOP CLEARANCE.

1. Set the No.1 cylinder at the injection starting point, then move the tappet with the handle.

Tappet Top Clearance: More than 0.2 mm (0.0079 in)

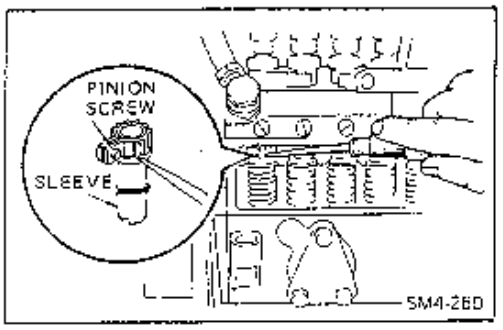
2. Follow the above procedure to check the other cylinders (No.2 through No.6).
3. If the tappet clearance is less than 0.2 mm (0.0079 in), re-check the pre-stroke.



MEASURING AND ADJUSTING THE INJECTION VOLUME.

Measure the injection volume for each control rack position and pump revolution.

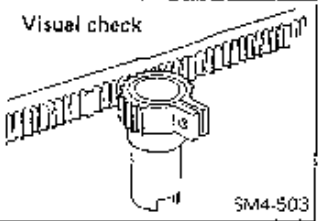
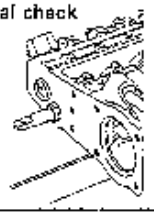
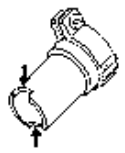
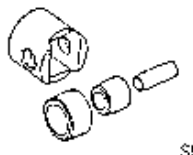
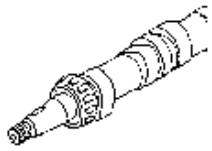
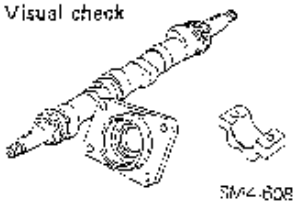
Injection Volume: Refer to "CHAPTER C. CALIBRATION".



To adjust the injection volume, loosen the pinion screw and insert the adjusting pin into the hole in the control sleeve, then move the sleeve slightly.

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INSPECTION AND REPAIR

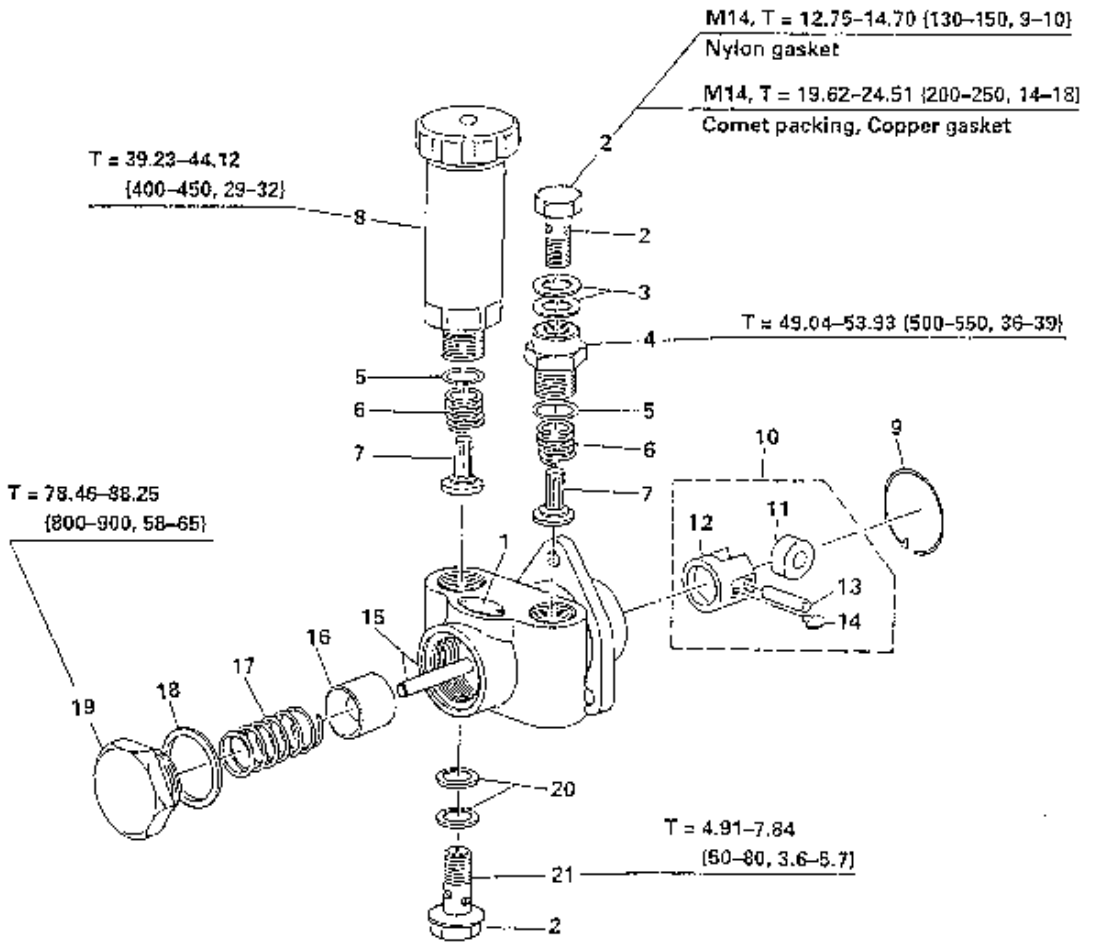
Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Control Rack, Bent, Wear Gear Teeth, Wear	–	–	Replace, if necessary.	Visual check  SM4-503
Press-fitted bush, Wear	–	–	Replace, if necessary.	Visual check  SM4-507
Control Sleeve, Wear, Damage	–	–	Replace, if necessary.	Visual check  SM4-504
Tappet Roller, Bushing and Pin, Wear, Damage	–	–	Replace, if necessary.	Visual check  SM4-499
Lower Spring Seat, Wear, Damage	–	–	Replace, if necessary.	Visual check  SM4-500
Camshaft, Wear, Damage	–	–	Replace, if necessary.	Visual check  SM4-501
Camshaft Bearing, Bearing Race and Center Bearing, Wear, Damage	–	–	Replace, if necessary.	Visual check  SM4-502

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FEED PUMP

FP/KS-TYPE



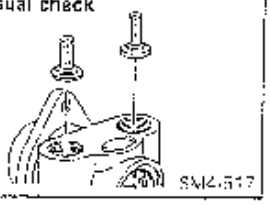
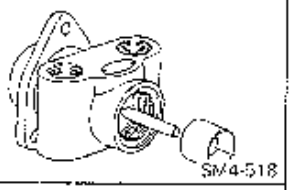
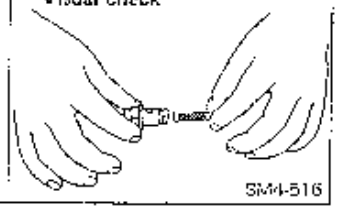
T = Tightening torque: N·m {kgf·cm, lbf·ft}

1. Feed pump serial No.
2. Joint bolt
3. Soft washer
4. Connector
5. O-ring
6. Check valve spring
7. Check valve
8. Priming pump
9. Retainer ring
10. Tappet assembly
11. Roller
12. Tappet
13. Pin
14. Sliding block
15. Feed pump housing, push rod, & oil seal
16. Piston
17. Spring
18. Gasket
19. Plug
20. Soft washer
21. Filter

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INSPECTION AND REPAIR

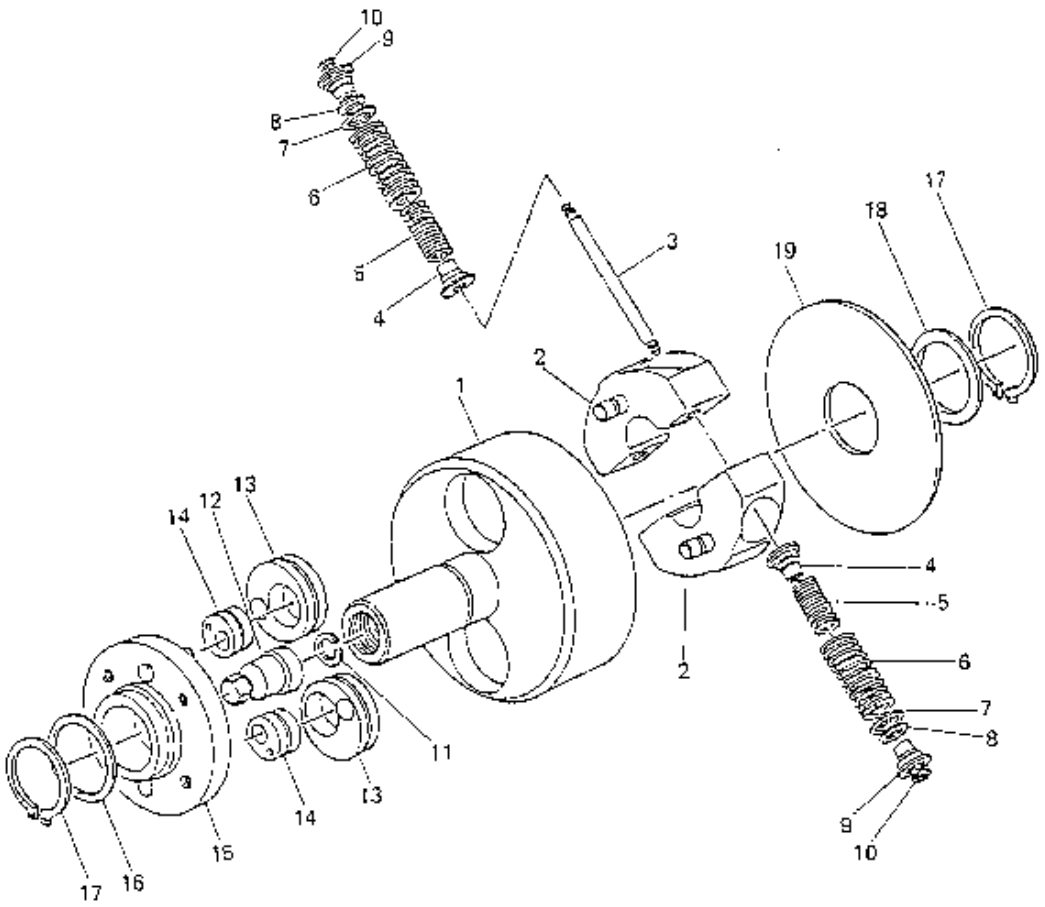
Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Valve Seat, Wear, Damage	–	–	Replace, if necessary.	Visual check  SM4-517
Piston, Cylinder and Oil Seal, Wear, Damage	–	–	Replace, if necessary.	Visual check  SM4-518
Filter, Clogged	–	–	Clean	Visual check  SM4-516

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TIMER

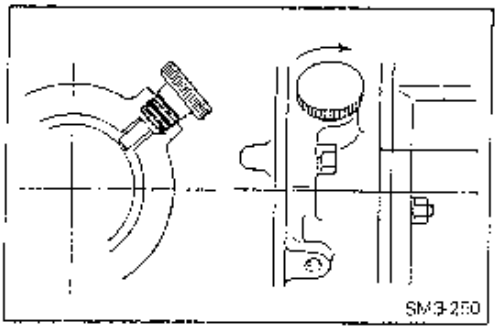
SCDM-TYPE TIMER



1. Timer hub
2. Timer weight
3. Timer weight rod
4. Timer spring seat
5. Timer spring
6. Timer spring
7. Shim
8. Shim
9. Timer spring seat
10. Retainer ring
11. Special washer
12. Bolt
13. Timer cam
14. Timer cam
15. Timer drive flange
16. Shim
17. Retainer ring
18. Shim
19. Timer cover

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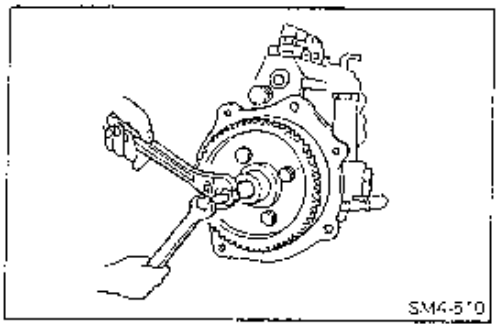
DISASSEMBLY

REMOVE THE TIMER FROM THE INJECTION PUMP.

1. Install the setting tool.

Special Tool: Timer Setting Tool (09512-2100)

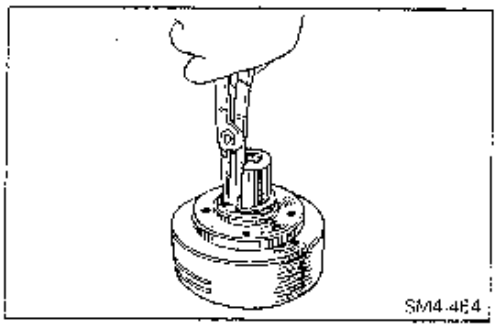
2. Remove the timer round nut.



3. Remove the timer from the injection pump, using the timer extractor.

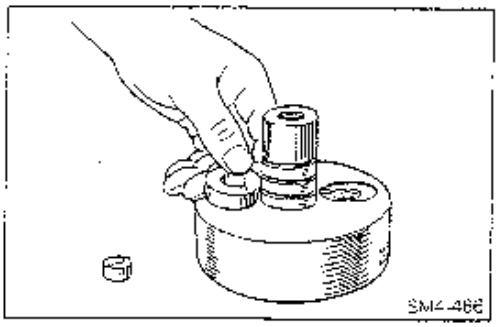
Special Tool: Timer Extractor (09511-1990)

4. Remove the injection pump drive gear.



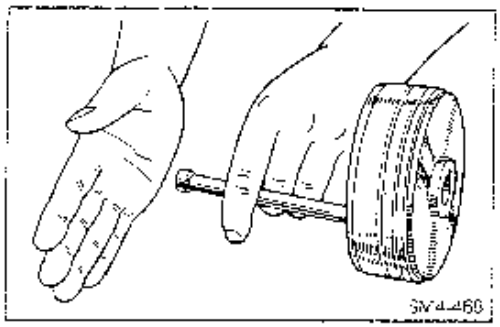
REMOVE THE DRIVE FLANGE.

1. Remove the retainer ring.
2. Remove the shims.
3. Remove the drive flange.



REMOVE THE TIMER CAMS.

NOTE: Before removing the timer cams, the positions of the large and small cams (cam hole positions) should be recorded in order to facilitate installation of the drive flange when reassembling.

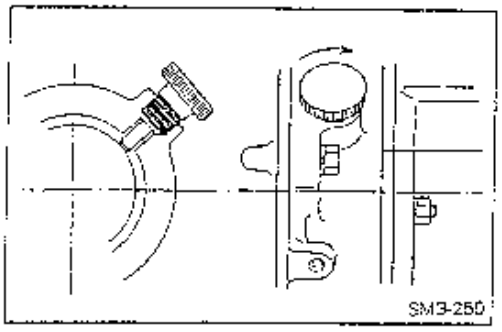


REMOVE THE TIMER COVER.

1. Remove the retainer ring.
2. Remove the shim.
3. Apply a brass rod to the timer cover and tap lightly by hard to remove.

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SM3-250

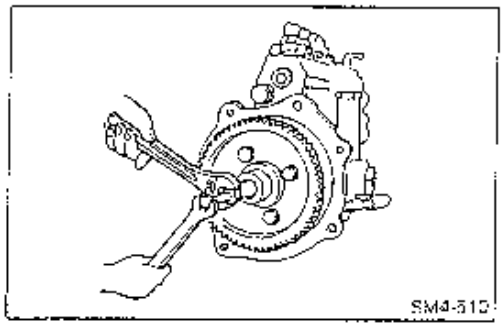
DISASSEMBLY

REMOVE THE TIMER FROM THE INJECTION PUMP.

1. Install the setting tool.

Special Tool: Timer Setting Tool (09512-21000)

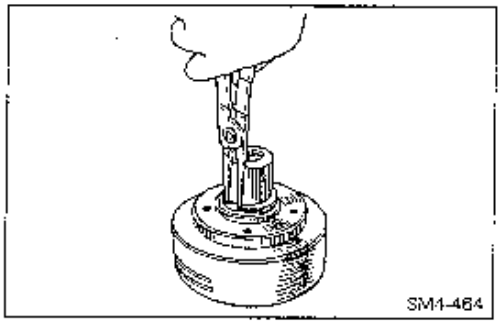
2. Remove the timer round nut.


SM4-513

3. Remove the timer from the injection pump, using the timer extractor.

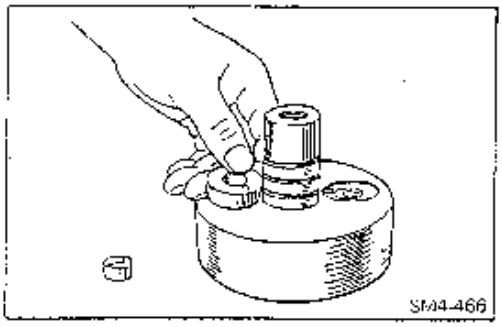
Special Tool: Timer Extractor (09511-1990)

4. Remove the injection pump drive gear.


SM1-464

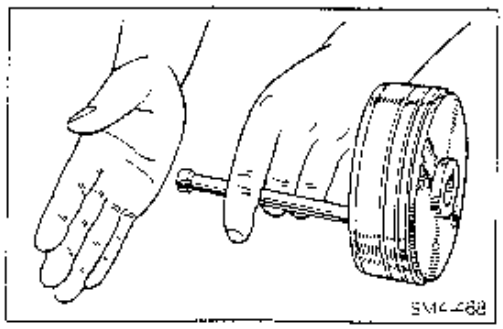
REMOVE THE DRIVE FLANGE.

1. Remove the retainer ring.
2. Remove the shims.
3. Remove the drive flange.


SM4-466

REMOVE THE TIMER CAMS.

NOTE: Before removing the timer cams, the positions of the large and small cams (cam hole positions) should be recorded in order to facilitate installation of the drive flange when reassembling.

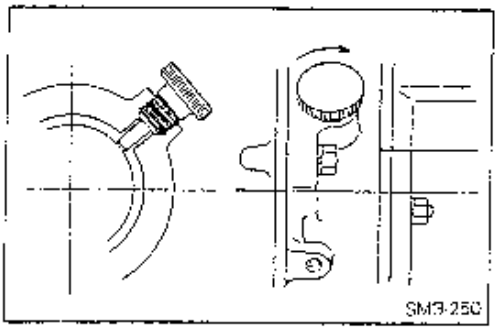

SM4-468

REMOVE THE TIMER COVER.

1. Remove the retainer ring.
2. Remove the shim.
3. Apply a brass rod to the timer cover and tap lightly by hand to remove.

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SM3-250

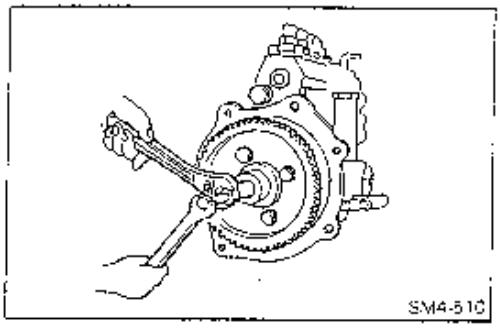
DISASSEMBLY

REMOVE THE TIMER FROM THE INJECTION PUMP.

1. Install the setting tool.

Special Tool: Timer Setting Tool (09512-2100)

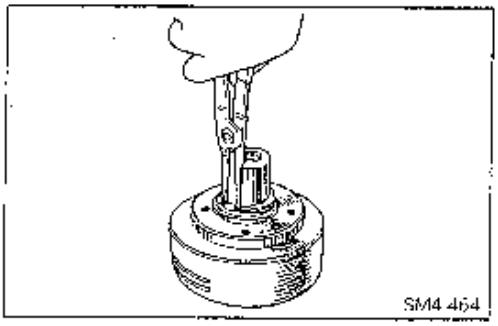
2. Remove the timer round nut.


SM4-510

3. Remove the timer from the injection pump, using the timer extractor.

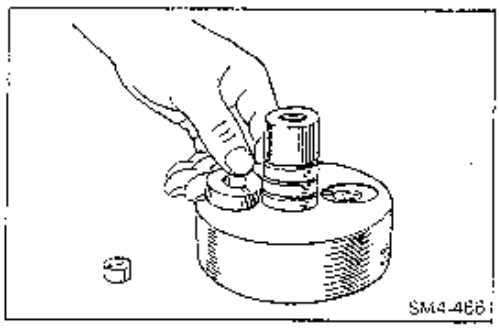
Special Tool: Timer Extractor (09511-1990)

4. Remove the injection pump drive gear.


SM4-464

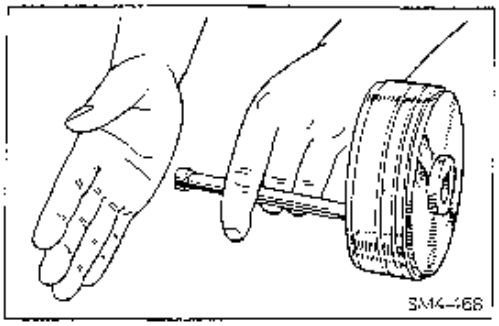
REMOVE THE DRIVE FLANGE.

1. Remove the retainer ring.
2. Remove the shims.
3. Remove the drive flange.


SM4-466

REMOVE THE TIMER CAMS.

NOTE: Before removing the timer cams, the positions of the large and small cams (cam hole positions) should be recorded in order to facilitate installation of the drive flange when reassembling.

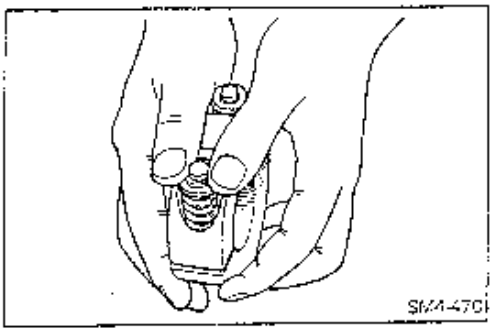

SM4-468

REMOVE THE TIMER COVER.

1. Remove the retainer ring.
2. Remove the shim.
3. Apply a brass rod to the timer cover and tap lightly by hand to remove.

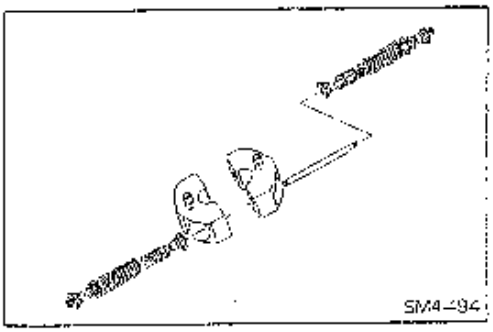
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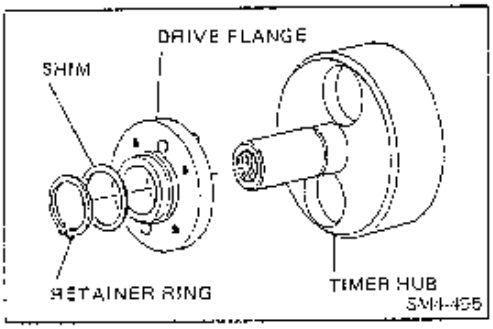
DISASSEMBLY THE FLYWEIGHT ASSEMBLY.

Push the timer spring to comoress it, then remove the retainer ring.



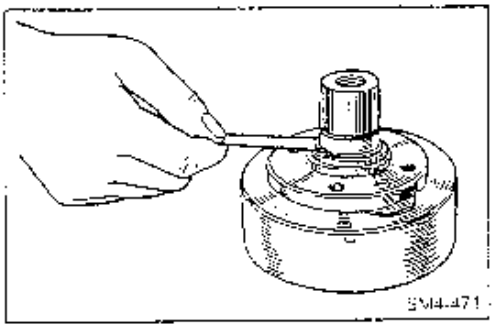
IMPORTANT POINT (S) – ASSEMBLY

ASSEMBLY THE FLYWEIGHT ASSEMBLY.



INSTALL THE DRIVE FLANGE.

1. Install the drive flange on the timer hub.
2. Install the shim.
3. Install the retainer ring.



4. Inspect the end play of the drive flange.
   Push the drive flange all the way toward's the timer hub side, then measure the gap between the drive flange and the shim.

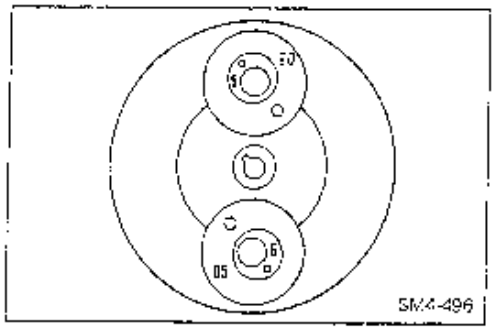
Assembly Standard: 0.02–0.1 mm (0.0008–0.0039 in)

If the end play is not within the standard value, use the following shims for adjustment.

Shim Thicknesses:

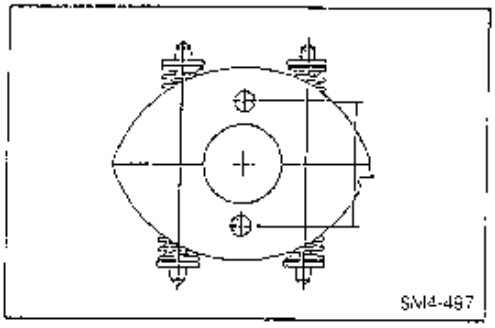
0.10 mm (0.0039 in)	0.90 mm (0.0350 in)
0.12 mm (0.0047 in)	1.10 mm (0.0433 in)
0.14 mm (0.0055 in)	1.30 mm (0.0512 in)
0.16 mm (0.0062 in)	1.50 mm (0.0590 in)
0.18 mm (0.0070 in)	1.70 mm (0.0669 in)

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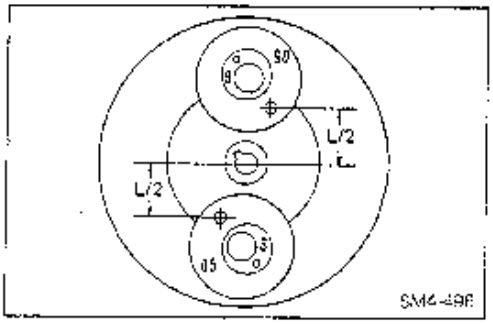
INSTALL THE CAMS.

Install the large and small cams on the timer hub as shown in the figure (as seen from the side of the timer cover).

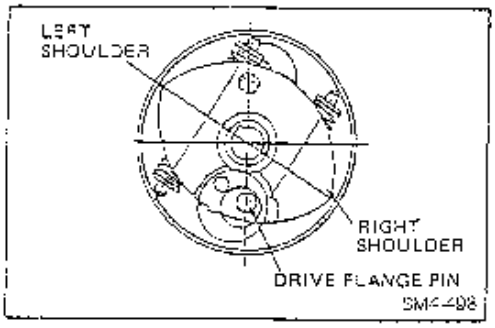


INSTALL THE FLYWEIGHT ASSEMBLY.

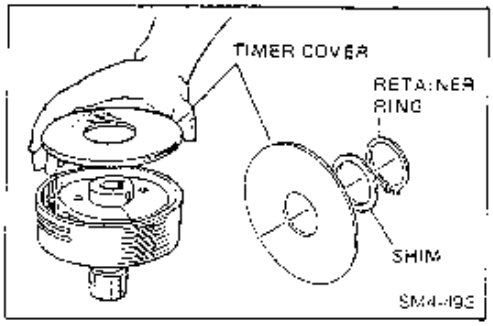
1. Measure the distance (L) between the flyweight pin centers after the flyweight spring has been installed.



2. Turn the large cam so that the same dimension is obtained on the left and the right for the distance (L/2) between the large cam hole center and the timer hub rotation centers.



3. Install the flyweight assembly.
4. To confirm correct installation of the flyweight, check that the right shoulder part of the flyweight is lowered when the two pins of the driving hub are in the vertical axis position, as shown in the figure (as seen from the side of the timer cover).

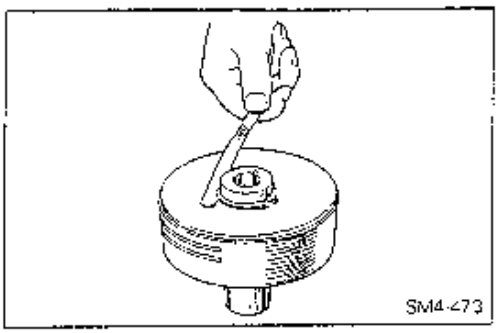


INSTALL THE TIMER COVER.

1. Install the timer cover, shim, and retainer ring.

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SM4-473

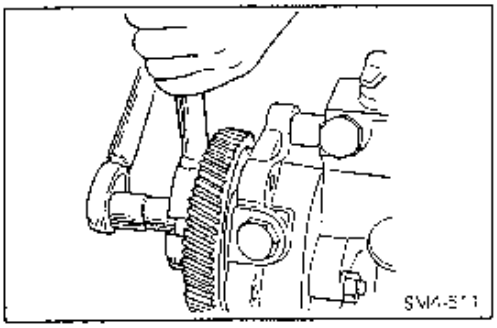
2. Inspect the end play of the timer cover.
   Push the timer cover by hand all the way to the timer hub side, then measure the distance between the timer cover and the shim.

Assembly Standard: 0.05–0.2 mm {0.002–0.007 in}

If the end play is not within the standard value, use the following shims for adjustment.

Shim Thicknesses:

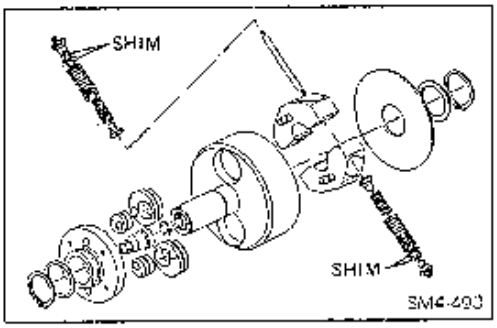
0.10 mm {0.0039 in}	0.90 mm {0.0350 in}
0.12 mm {0.0047 in}	1.10 mm {0.0433 in}
0.14 mm {0.0055 in}	1.30 mm {0.0512 in}
0.16 mm {0.0062 in}	1.50 mm {0.0590 in}
0.18 mm {0.0070 in}	1.70 mm {0.0669 in}


SM4-571

INSTALL THE TIMER ASSEMBLY ON THE INJECTION PUMP.

1. Install the injection pump drive gear.
2. Mount the timer assembly on the injection pump.

Tightening Torque: 83.35–98.06 N·m {850–1,000 kgf·cm, 62–72 lbf·ft}



SM4-490

ADJUSTMENT OF THE TIMER

INSPECT THE TIMER ADVANCE.

1. Set a stroboscope on a pump tester.
2. Check the timer advance.

Advance Angle: Refer to "CHAPTER C. CALIBRATION".

If the angle in not within specification, adjust with proper shim.

Outer Shim Thicknesses:

0.10 mm {0.0039 in}	0.5 mm {0.0196 in}
0.30 mm {0.0118 in}	1.0 mm {0.0393 in}

Inner Shim Thicknesses:

0.5 mm {0.0196 in}	1.0 mm {0.0393 in}

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GV-S23E-02

CHAPTER GV

INJECTION PUMP GOVERNOR

(MODEL: RSV with BOOST COMPENSATOR)

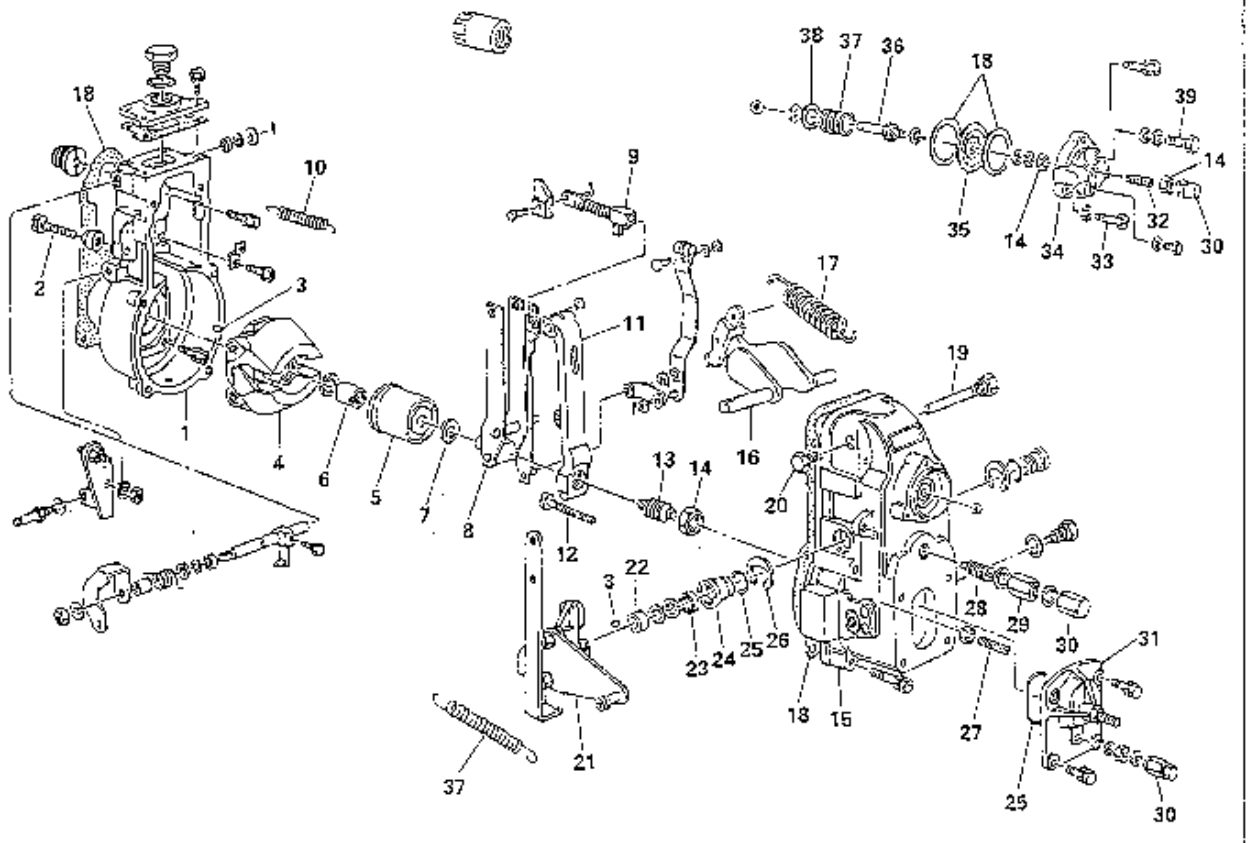
GOVERNOR GV-2
SPECIAL TOOL GV-4
BOOST COMPENSATOR GV-9

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GOVERNOR

(For W06D-TI)



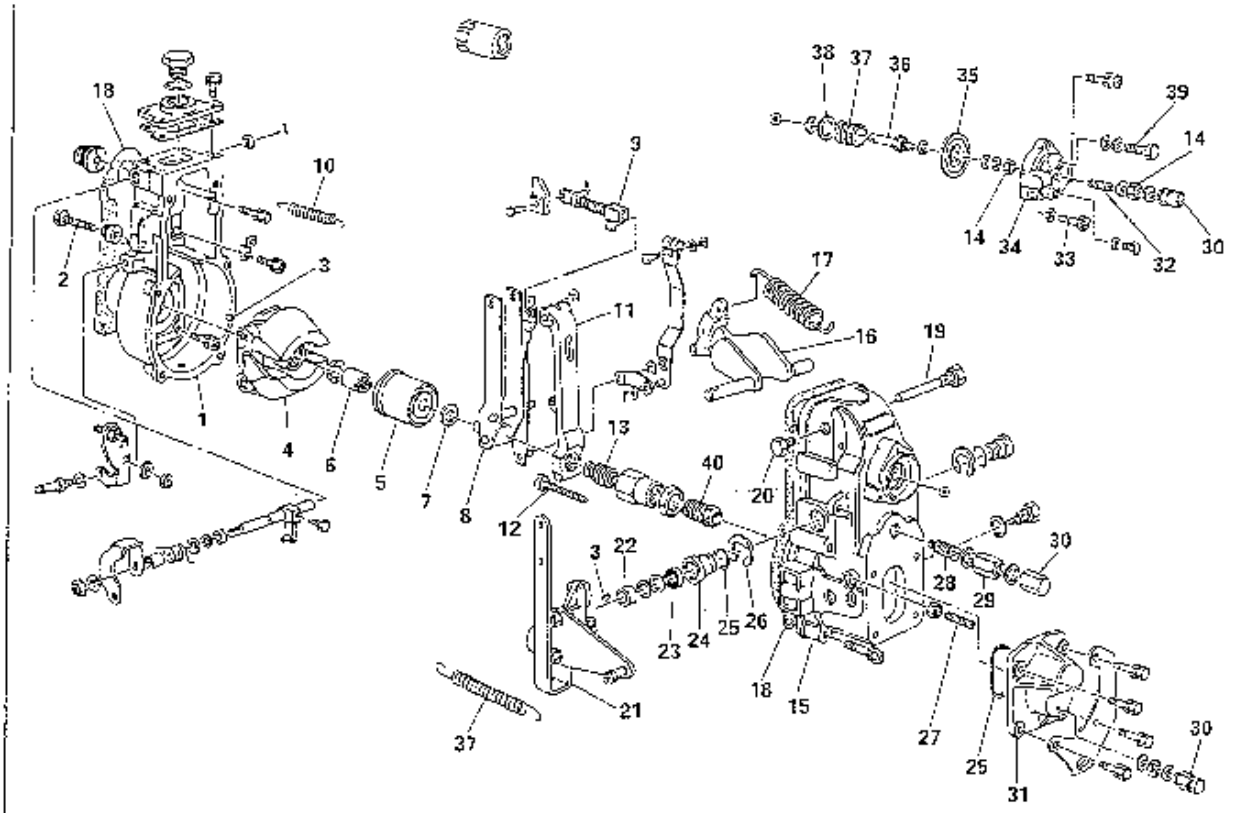
1. Governor housing
2. Stopper bolt
3. Woodruff key
4. Flyweight
5. Sleeve
6. Bearing
7. Shim
8. Guide lever assembly
9. Link
10. Start spring
11. Tension lever
12. Full load stopper
13. Idle spring
14. Lock nut
15. Governor cover
16. Swivel lever
17. Governor spring
18. Gasket
19. Pin
20. Plug
21. Control lever
22. Collar
23. Oil seal
24. Bush
25. O-ring
26. Snap ring
27. Idle stopper bolt
28. Idle sub spring
29. Nut
30. Cap nut
31. Closing cover
32. Adjust screw
33. Cover fixing bolt
34. Cover
35. Diaphragm
36. Push rod
37. Spring
38. Adjusting shim
39. Union bolt

Explanation of governor stated this shop manual is basic models.
See to "Chapter C", CALIBRATION about adjusting points.

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(For W06D-TI-II)



SM4-908

1. Governor housing
2. Stopper bolt
3. Woodruff key
4. Flyweight
5. Sleeve
6. Bearing
7. Shim
8. Guide lever assembly
9. Link
10. Start spring
11. Tension lever
12. Full load stopper
13. Idle spring
14. Lock nut
15. Governor cover
16. Swivel lever
17. Governor spring
18. Gasket
19. Pin
20. Plug
21. Control lever
22. Collar
23. Oil seal
24. Bush
25. O-ring
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28. Idle sub spring
29. Nut
30. Cap nut
31. Closing cover
32. Adjust screw
33. Cover fixing bolt
34. Cover
35. Diaphragm
36. Push rod
37. Spring
38. Adjusting shim
39. Union bolt
40. Torque control spring

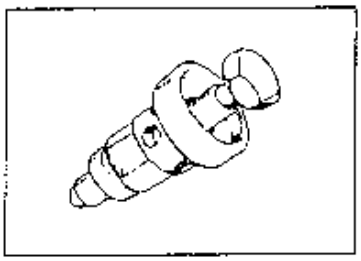
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SPECIAL TOOL

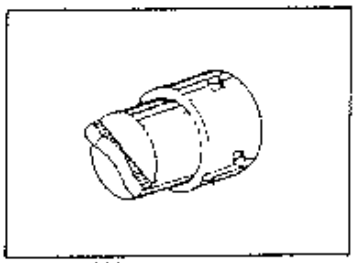
Prior to starting an injection pump governor overhaul, it is necessary to have these special tools.

FLYWEIGHT EXTRACTOR



09511-1900

ROUND NUT WRENCH

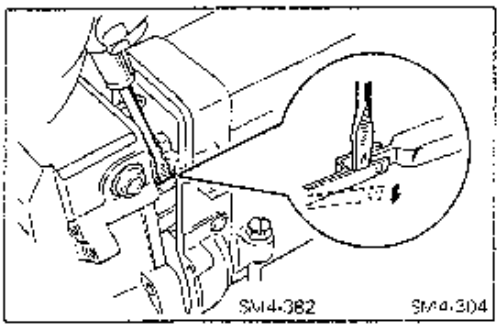


09511-1500

IMPORTANT POINT (S) – DISASSEMBLY

WARNING

- Breaking of the lead seals or crimp caps by anyother other than HINO or pump manufacture authorized service stations to make these adjustment will void the warranty.
- If fuel pump or governor difficulties are suspected, consult only HINO or pump manufacture authorized service stations, where the problem can be corrected and the injection pump lead seals and crimp caps can be rainstalled as required.

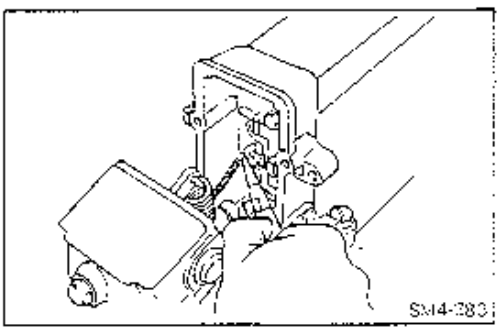


SM4-382 SM4-304

DISASSEMBLY THE GOVERNOR COVER FROM PUMP BODY.

1. Disconnect the shackle from the control rack.

NOTE: When remove the governor cover fitting bolt, hold the governor cover.

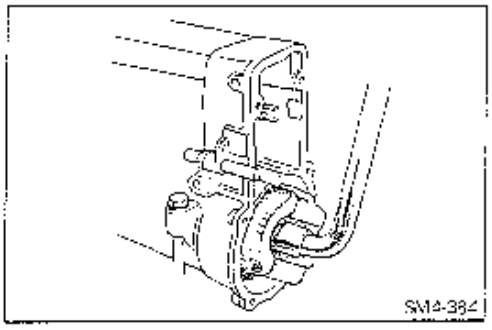


SM4-383

2. Disconnect the start spring.

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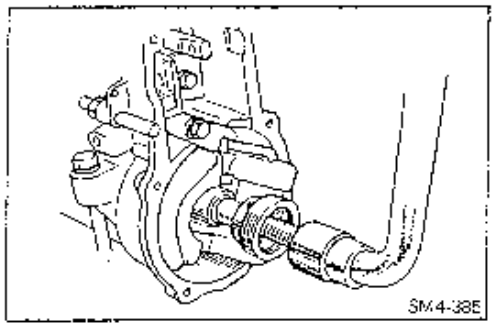
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REMOVE THE FLYWEIGHT ROUND NUT.

NOTE: Use the holding spanner to keep the camshaft from rotating.

Special Tools: Round Nut Wrench (09511-1500)



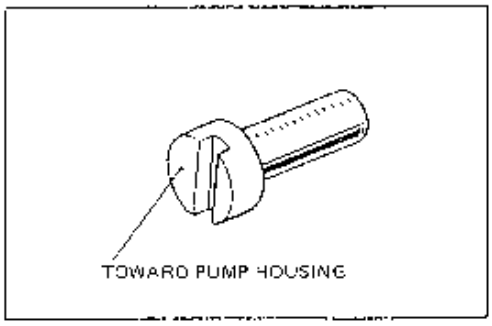
REMOVE THE FLYWEIGHT, USING THE FLYWEIGHT EXTRACTOR.

Special Tool: Flyweight Extractor (09511-1900)

IMPORTANT POINT (S) — Assembly

WARNING

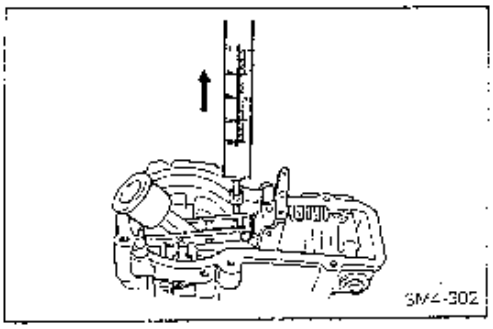
- Wash all parts with clean diesel fuel before installing them, and any defective or damaged parts must be replaced.
- Do not allow dust or other foreign matter to enter the pump during assembly.
- Apply grease to O-rings and oil seals before installing them.
- Assemble the parts in correct order and to correct tightening torque, assembled dimensions etc.
- Assembly takes place in the reverse order of disassembly.



INSTALL THE ADJUSTING LEVER

1. Install the shaft of the adjusting lever so that wide side of the shaft head surface is toward the pump body.

NOTE: Installing in reverse may cause the floating lever to contact the speed control spring, resulting in operational malfunction.



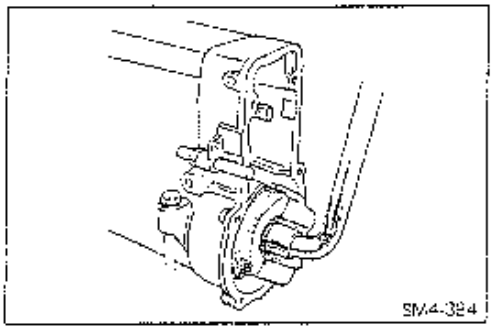
CHECK THE GOVERNOR LINKAGE FOR SMOOTH OPERATION.

Hook under the guide lever, and pull upwards, using a spring balance.

Starting force: 140–180 g (4.9–6.3 oz)

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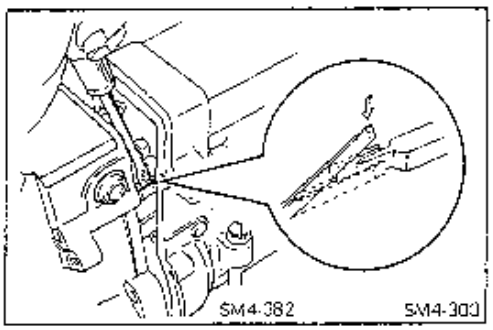
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SM4-384

INSTALL THE FLYWEIGHT TO PUMP CAMSHAFT.

Using a special tools, tighten the round nut.

Special Tools: Round Nut Wrench (09511-1500)


SM4-382 SM4-383

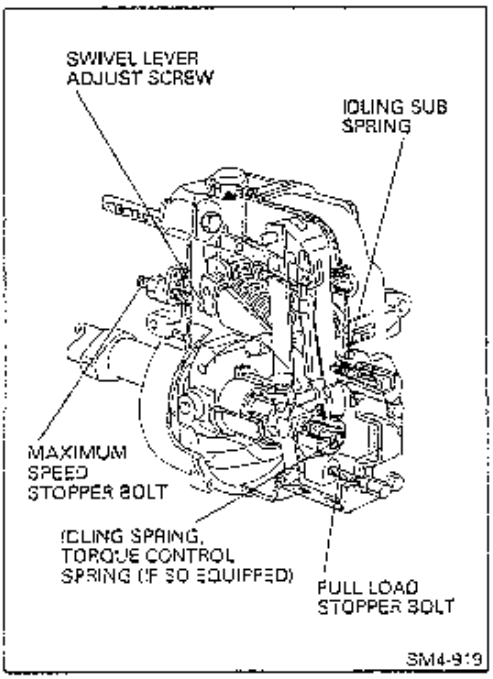
INSTALL THE GOVERNOR HOUSING TO PUMP BODY.

1. Connect the start spring.
2. Connect the shackle to control rack.

ADJUSTMENT OF THE GOVERNOR [MODEL; RSV]

1. PREPARATION

1. Connect the rack measuring device to the control rack and set to "0".
2. Connect the fuel line.
3. Refill the camshaft chamber with engine oil.
4. Install the angle gauge on the adjusting lever.



SM4-919

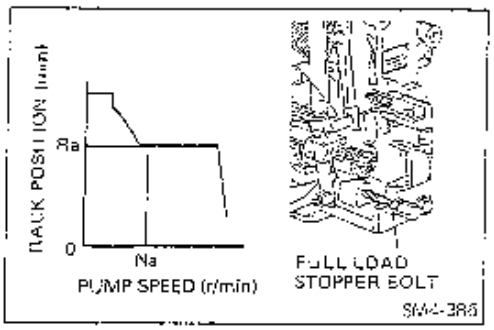
2. STEPS IN GOVERNOR ADJUSTMENT.

Perform governor testing and adjustment in the following sequence (For values of N and R, refer to "CHAPTER C. CALIBRATION"):

1. Adjustment of maximum speed control.
2. Adjustment of speed droop.
3. Adjustment of idling speed control.
4. Adjustment of torque control (If so equipped).

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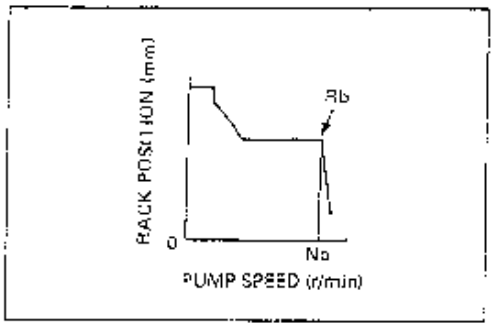
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f. Adjustment of maximum speed control

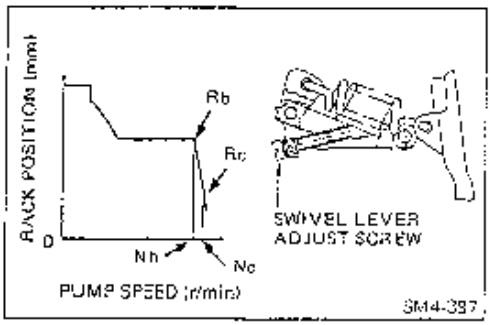
NOTE: The control lever should be full load position.

a) Adjust the full load stopper bolt.
At a pump speed of Na r/min, adjust the rack position to Ra mm with the full load stopper bolt.

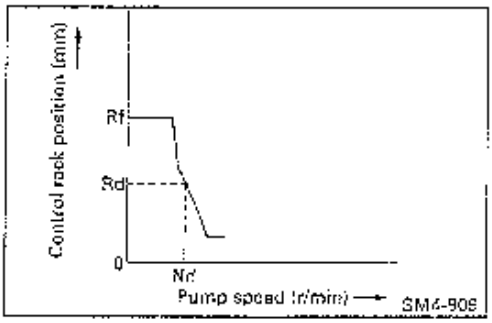


b) Adjust the maximum speed stopper bolt.
At a pump speed of Nb r/min, adjust the rack position to Rb mm with maximum speed stopper bolt.

NOTE: The control rack should start to be pulled.



2. Adjust of speed droop.
At a pump speed of Nc r/min, adjust rack position to Rc mm with swivel lever adjusting screw.



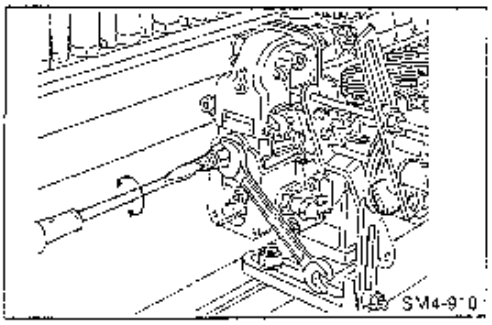
3. Adjusting of idling speed control

a) With the pump not operating, position the control lever so that the control rack position is Rf mm.

b) Operate the pump at Nd r/min, and adjust the idling sub-spring with a screwdriver so that the control rack position is Rd mm.
Lock it with the nut.

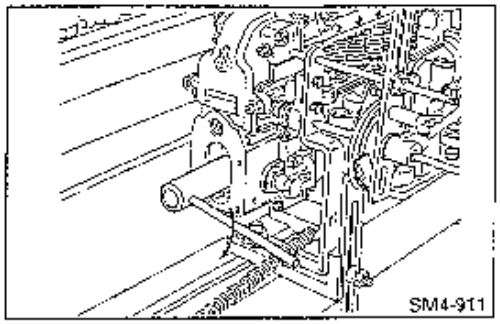
NOTE: ○ If the idling sub-spring is overtightened, engine speed will exceed specifications at no-load maximum speed, resulting in engine damage.

○ The control lever angle, refer to CHAPTER C. CALIBRATION.

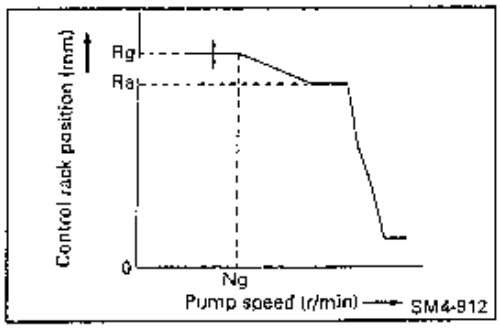


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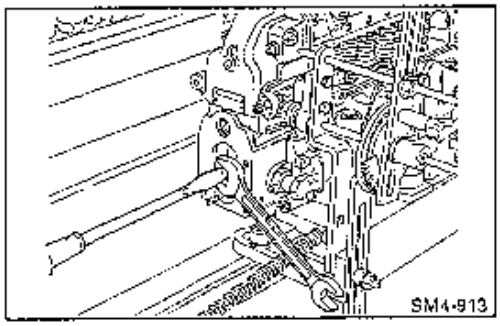
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SM4-911

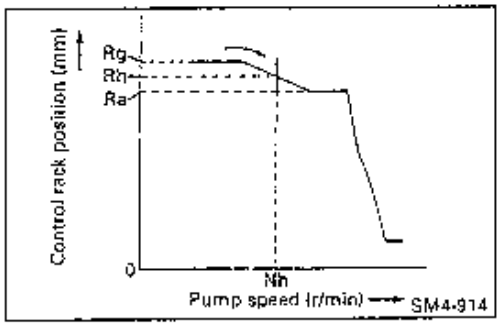
4. Adjustment of torque control (if so equipped)
   a) Operate the injection pump at a speed slightly less than Ng r/min.
   b) Set the control lever so that it contacts the maximum-speed stopper bolt.
   c) Install the torque control spring capsule in the tension lever and adjust using the wrench so that the control rack moves from Ra mm to Rg mm.
   d) Set the torque control spring capsule in this position using the locknut.



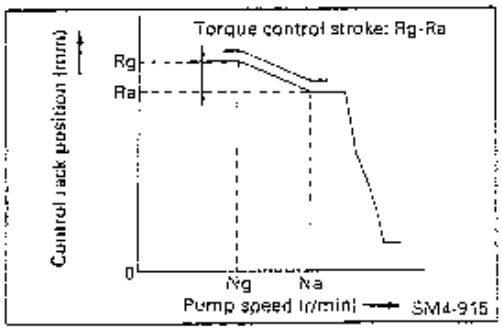
SM4-912


SM4-913

   e) Increase pump speed to Nh (Ni) r/min and set the torque control spring so that the control rack position is Rh (Ri) mm.
   In case of shim(s) adjusting type, adjust by replacing the shim(s).



SM4-914



SM4-915

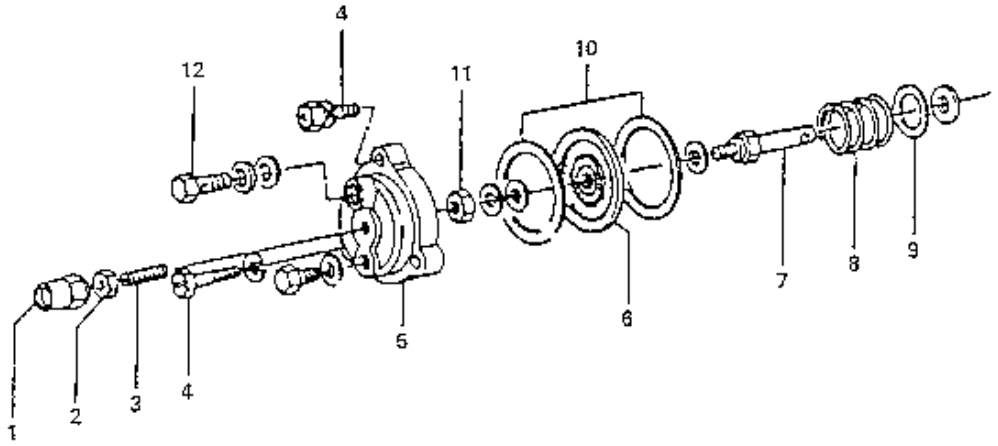
   f) Gradually increase pump speed and confirm that pump speed is Na r/min when the control rack position reaches Ra mm.
   g) Gradually decrease pump speed and confirm that pump speed is Ng r/min when the control rack position reaches Rg mm.

NOTE: ○ If the torque control stroke is not to specifications, readjust the torque control spring capsule.
○ If Ng and Na are not to specifications, replace the torque control spring capsule.

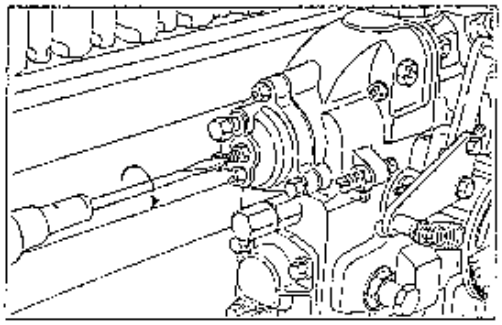
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BOOST COMPENSATOR



1. Cap nut
2. Lock nut
3. Adjust screw
4. Cover fixing bolt
5. Cover
6. Diaphragm
7. Push rod
8. Spring
9. Adjusting shim
10. Gasket
11. Lock nut
12. Union bolt



ADJUSTMENT OF BOOST COMPENSATOR

TEMPORARY FIXING OF ADJUST SCREW FOR BOOST COMPENSATOR STROKE.

1. Remove the cap nut (1) and loose the lock nut (2).
2. Fully tighten the adjusting screw (3) and lock the lock nut (2) temporarily.

ADJUSTMENT OF MAXIMUM SPEED CONTROL.

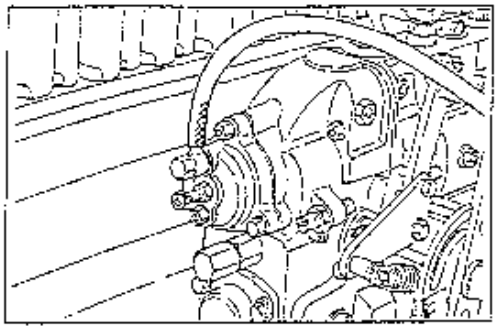
1. Adjustment of full load position.
2. Adjustment of maximum speed control point.

ADJUSTMENT OF SPEED CHANGE RATE.

ADJUSTMENT OF ANGLEICH.

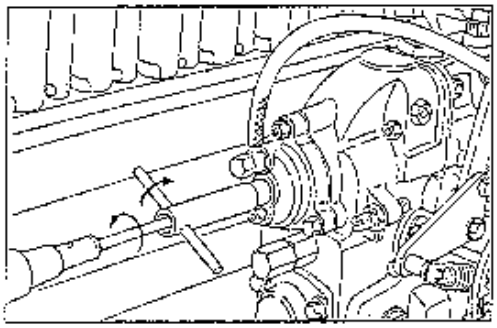
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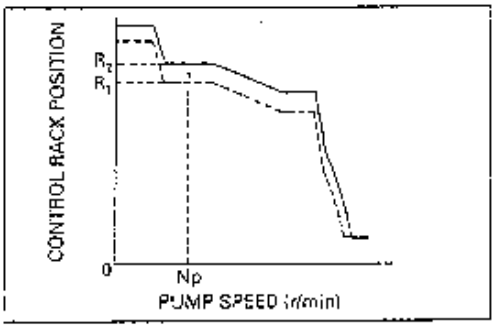
ADJUSTMENT OF BOOST COMPENSATOR STROKE.

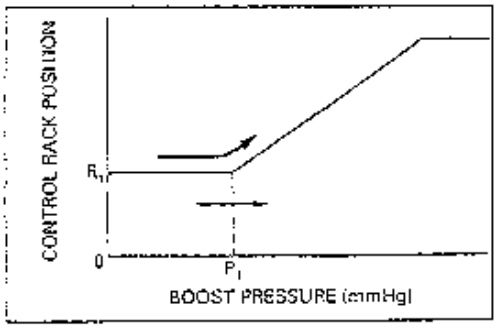
1. Connect the air hose to union bolt (12).
2. Lock the control levar at the full load position.



3. Keep the pump revolution with in "Np" r/min, then adjust the control rack position "R_2" to "R_1" with adjust screw (3) and lock it with lock nut (2).

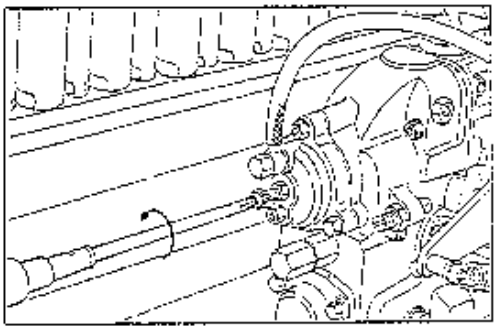
NOTE: No need to pressurization with this adjustment.





ADJUSTMENT OF BOOST COMPENSATOR SPRING (8).

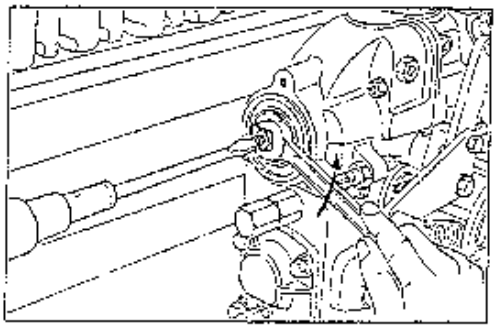
1. Keep the pump revolution with in "Np" r/min then set the control lever to full load position.
2. Raise the boost pressure gradually and when reaches the "P_1" confirm of the control rack is start to move from "R_1" position to direction of "fuel delivery increase".



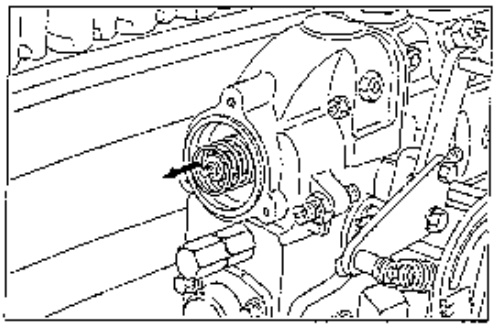
3. In case of nonstandardized, replace with adjusting shim (9) as follow.
   1) Remove the cover (5) with loosening three bolts of installing the cover (4).

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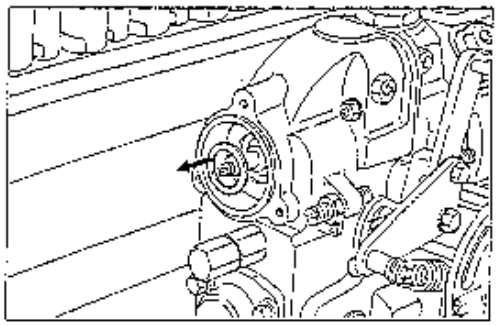
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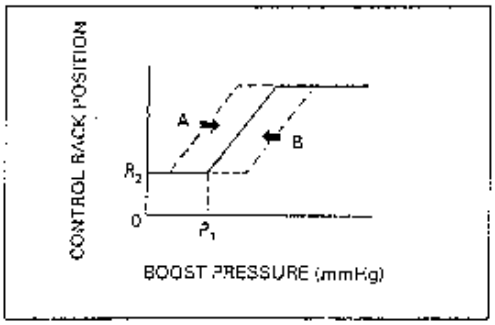
2) Using a screw driver for hold the push rod (7) to not turn it when removing the nut (11).



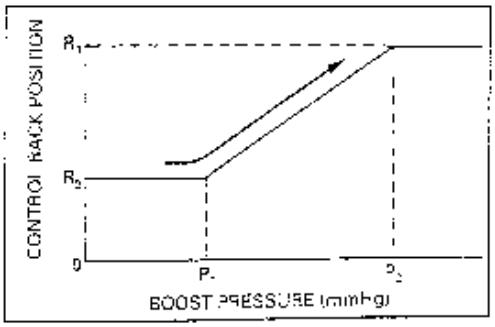
3) Remove the gasket (10), diaphragm (6), and spring (8).



4) Replace the adjusting shim (9).



A : Replace the adjusting shim (9) with thick one.
B : Replace the adjusting shim (9) with thin one.

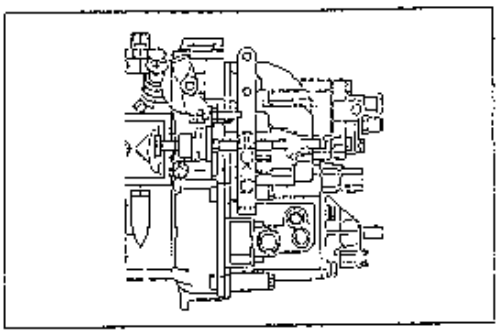


4. Raise the boost pressure to "P_2", confirm the control rack position is "R_1". In case of nonstandardized, replace the spring (8) with new one.

NOTE: In case of change the boost compensator stroke, when remove the cover for this adjustment, reconfirm the boost compensator stroke.

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GOVERNOR EXTERNAL LEAD SEALS AND CRIMP CAPS.

NOTE: All adjusting devices on the fuel injection pump governor, are wired and lead sealed as a protection for the customer. This is to prevent unauthorized readjustment which may cause engine malfunction and/or engine failure. Periodically check to insure that these seals are not broken as this will void the warranty.

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GE-S90E-02

CHAPTER GE

GENERATOR

(12V, 80A)

DATA AND SPECIFICATIONS GE-2
DESCRIPTION GE-2
TROUBLESHOOTING GE-3
OVERHAUL GE-4

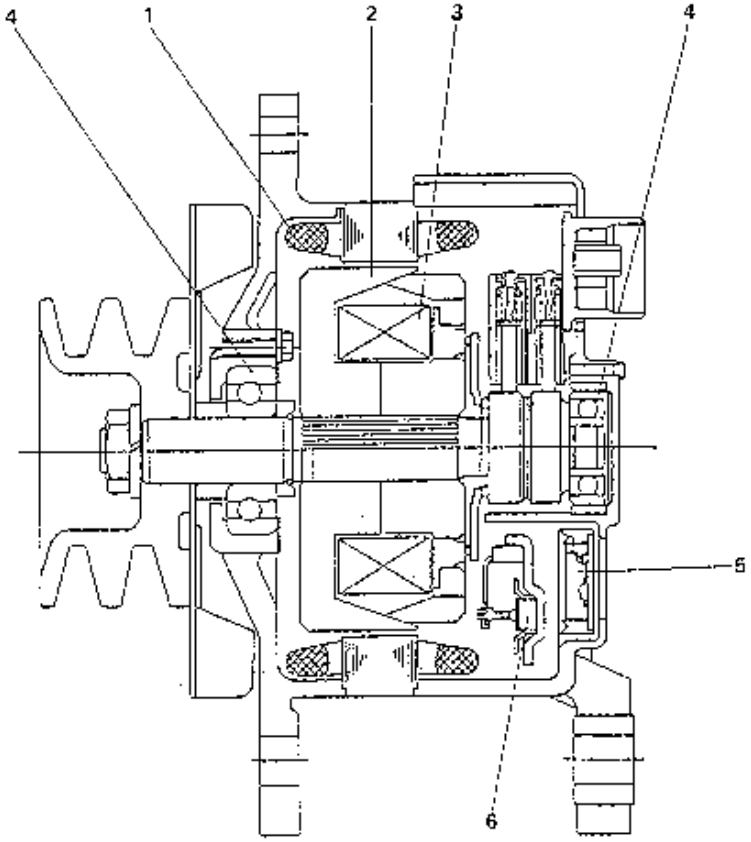
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DATE AND SPECIFICATIONS

MODEL	27040–1261
GENERATOR	
Type	Alternator
Rated voltage	12V
Rated output	80A
Operating output and speed	80A at 13.5V, 4,000 r/min
Rotating direction	Clockwise (Seen from pulley side)

DESCRIPTION

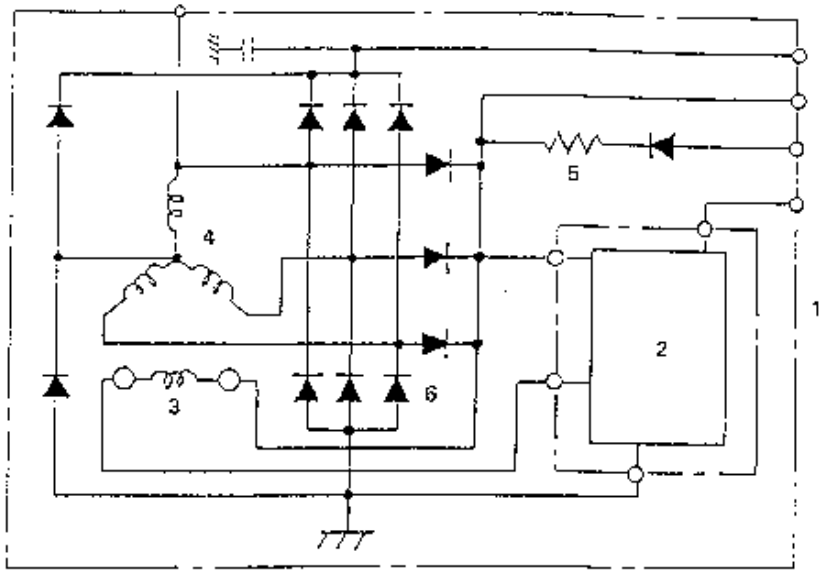


SM21-224

GENERATOR
1. Stator coil
2. Rotor
3. Field coil
4. Ball bearing
5. Regulator
6. Diode

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CHARGING SYSTEM CIRCUIT

1. Generator
2. I.C. regulator
3. Field coil
4. Stator coil
5. Resistor
6. Rectifier

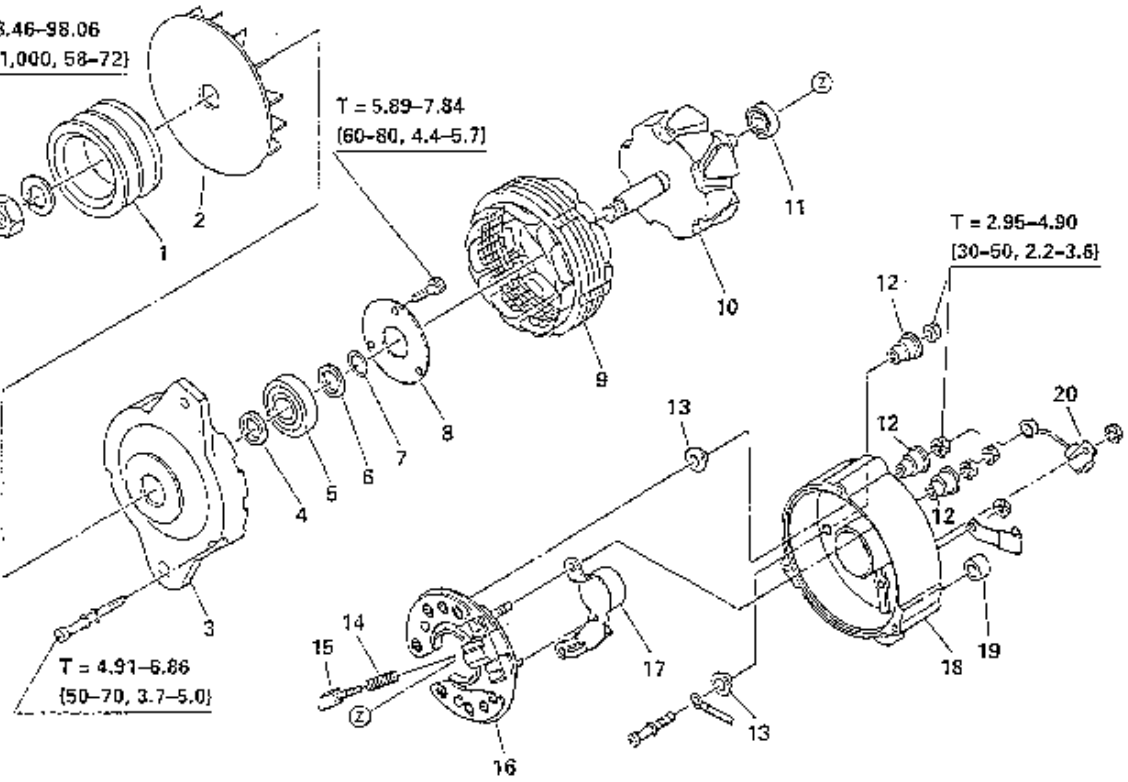
TROUBLESHOOTING

Symptom	Possible cause	Remedy/Prevention
Ammeter does not move to negative side (remained at the neutral position) with starter switch on and engine off	Fuse blown	Determine cause and replace fuse
	Wiring connection loose	Tighten loose connections
	IC regulator faulty	Replace IC regulator
Ammeter indicate the negative side with starter switch on and engine running	Drive belt loose or worn	Adjust or replace drive belt
	Battery cable loose, corroded or worn	Repair or replace cables
	Fuse blown	Determine cause and replace fuse
	Fusible link blown	Replace fusible link
	IC regulator or generator faulty	Check charging system
	Wiring faulty	Repair wiring

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OVERHAUL

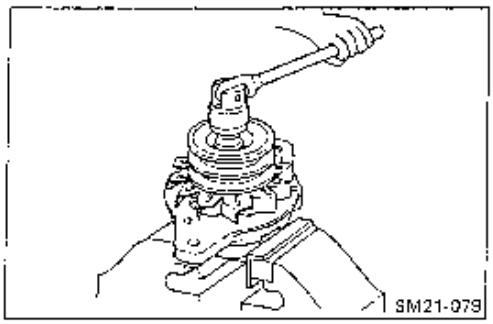


T = Tightening torque: N·m {kgf·cm, lbf·ft}

1. Pulley
2. Fan
3. Drive end frame
4. Spacer
5. Bearing
6. Spacer
7. Ring
8. Retainer plate
9. Stator coil
10. Rotor
11. Bearing
12. Insulator
13. Insulator
14. Brush spring
15. Brush
16. Rectifier assembly
17. Regulator
18. Rear end frame
19. Collar
20. Condenser

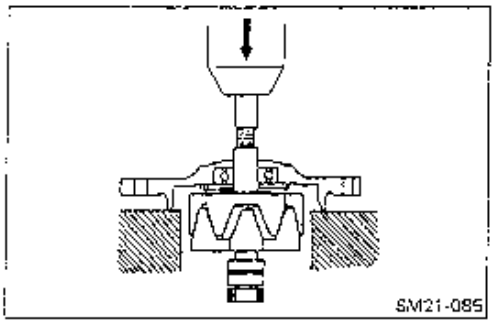
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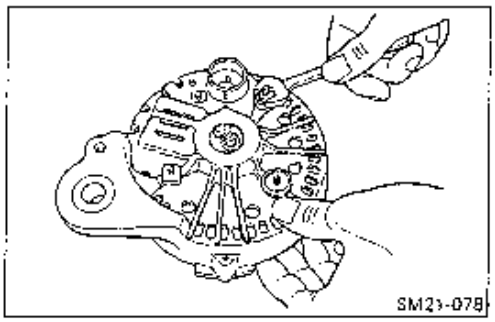


IMPORTANT POINT(S) – DISASSEMBLY

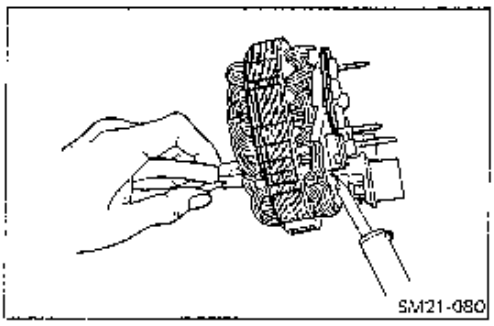
1. REMOVE THE PULLEY AND FAN.
   1. Clamp the rotor in a soft jawed vise.
   2. Remove the pulley nut, spring washer, pulley and fan.



2. REMOVE THE ROTOR SHAFT FROM THE DRIVE END FRAME.
   1. Using a press and a socket wrench, remove the rotor shaft and spacer collars.
   2. Remove the bearing plate from the drive end frame.



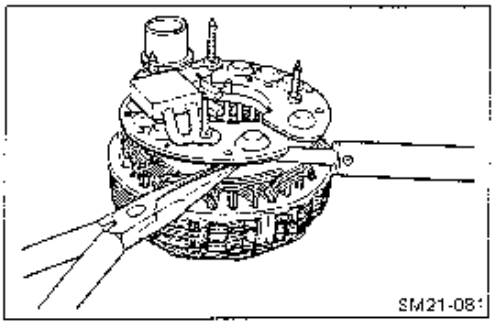
3. REMOVE THE STATOR AND RECTIFIER FROM THE REAR END FRAME.
   1. Remove the nuts and tow insulators.
   2. Remove the stator and rectifier from the rear end frame.



4. UNSOLDER IC REGULATOR FROM THE RECTIFIER HOLDER.

   While holding the IC regulator with long nose pliers, unsolder the leads from the rectifier holder.

   NOTE: The long nose pliers are used as a heat sink to help protect the IC regulator and rectifier from heat.



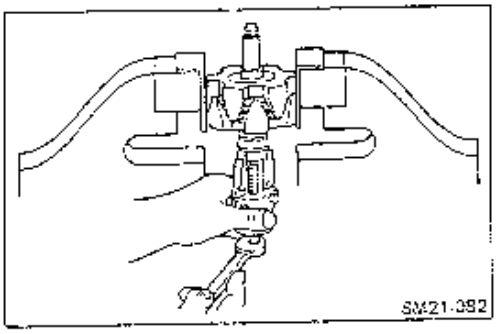
5. UNSOLDER THE STATOR LEADS FROM THE RECTIFIER HOLDER.

   While holding the rectifier terminal with long nose pliers, unsolder the leads from the rectifier holder.

   NOTE: Protect the rectifier from heat.

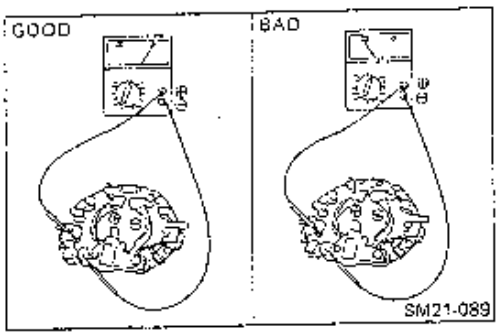
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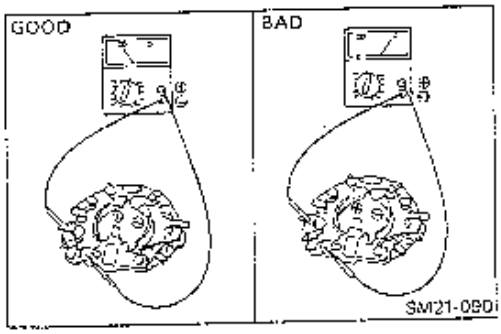
6. REMOVE THE BEARING FROM THE ROTOR SHAFT.

1. Clamp the rotor in a soft-jawed vise.
2. Remove the bearing from the rotor shaft with a bearing remover.

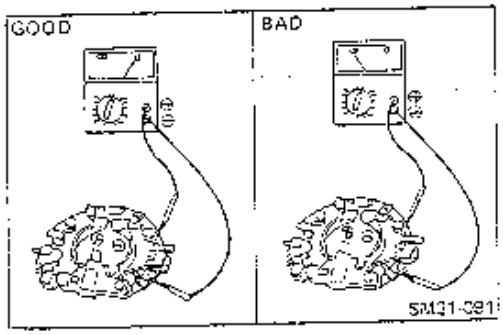


IMPORTANT POINT(S) – TESTING RECTIFIER

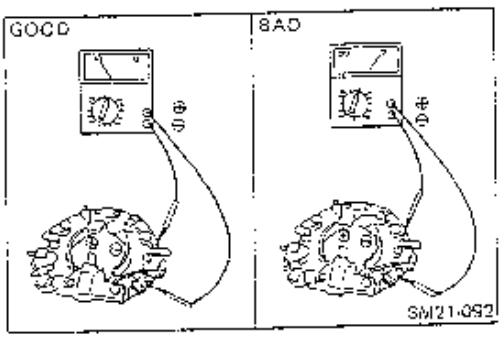
1. Rectifier holder positive side
Connect an ohmmeter (+) lead to rectifier holder, and (–) lead of meter to rectifier terminal. If there is no continuity, rectifier assembly must be replaced.



Reverse polarity of test leads and check again. If there is continuity, rectifier assembly must be replaced.



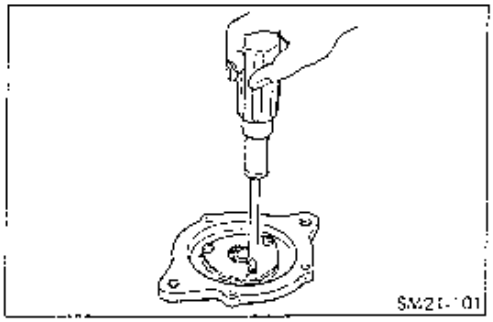
2. Rectifier holder negative side
Connect an ohmmeter (+) lead to rectifier terminal, and (–) lead of meter to rectifier holder. If there is no continuity, rectifier assembly must be replaced.



Reverse polarity of test and check again. If there is continuity, rectifier assembly must be replaced.

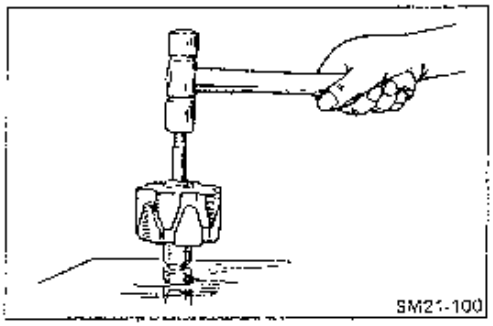
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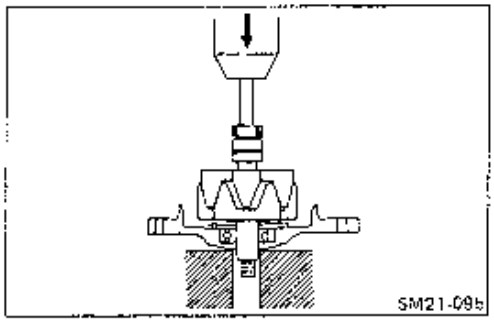
IMPORTANT POINT(S) -- ASSEMBLY

1. INSTALL THE BEARING IN THE DRIVE END FRAME.
   1. Install the bearing in the drive end frame, then install bearing plate.
   2. Tighten the place.

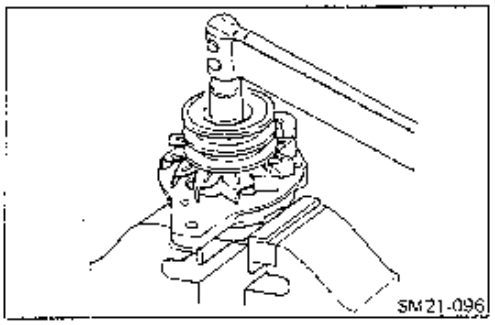


2. INSTALL THE BEARING ON THE ROTOR SHAFT.

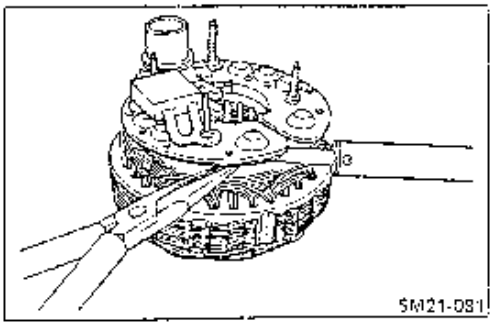
   Tap the rotor shaft on with a plastic hammer.



3. INSTALL THE DRIVE END FRAME.
   1. Slide the spacer collar on the rotor shaft.
   2. Using a press, install the rotor shaft in the drive end frame.



4. INSTALL THE FAN AND PULLEY.
   1. Hold the rotor shaft in a soft-jawed vise.
   2. Slide the spacer collar, fan, pulley, and spring washer on the rotor shaft.
   3. Install and tighten the pulley nut.

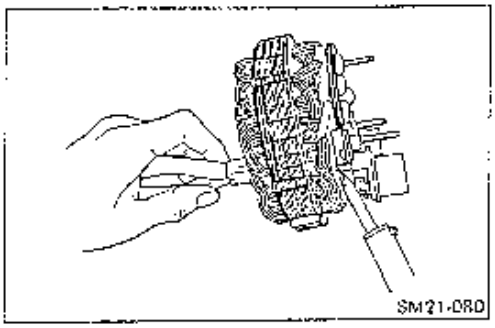


5. ASSEMBLE THE RECTIFIER AND STATOR.
   1. Solder each stator lead to the rectifier holder.
   2. Hold the rectifier terminal with long nose pliers while soldering the leads.

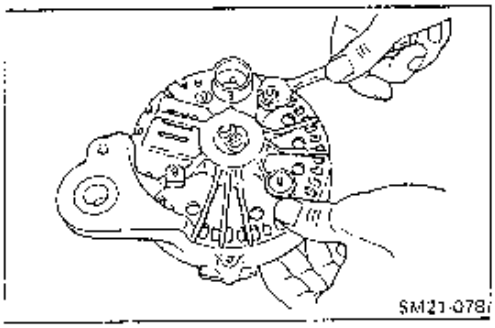
   NOTE: Protect the rectifiers from heat.

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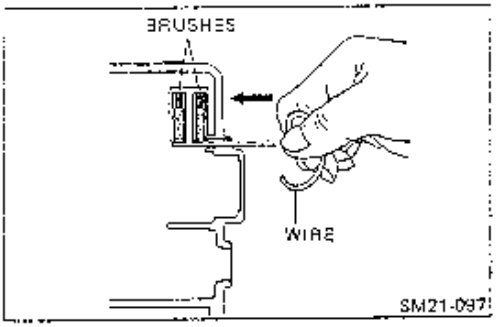
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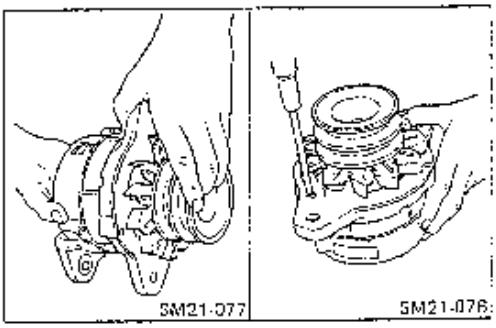
6. ASSEMBLE THE RECTIFIER AND IC REGULATOR.
   1. Solder each the IC regulator leads to the rectifier holder.
   2. Hold the IC regulator leads with long nose pliers while soldering the leads.



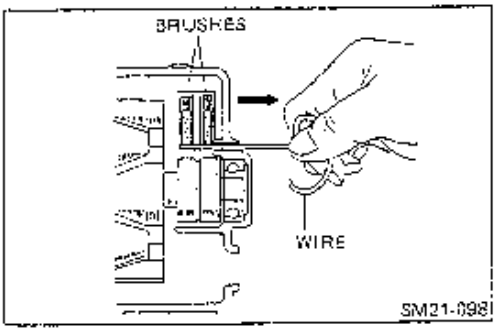
7. INSTALL THE STATOR WITH RECTIFIER ON THE REAR END FRAME.
   1. Install the stator with rectifier on the rear end frame.
   2. Install the condenser, tow insulators, and tighten the nuts.



   3. Push in the brushes and temporarily lock them in place with a wire inserted through the access hole in the rear end frame.



8. CONNECT THE DRIVE END FRAME AND THE REAR END FRAME.
   1. Fit the drive end frame to the rear end frame.
   2. Install the three through bolts and tighten to the specified torque.



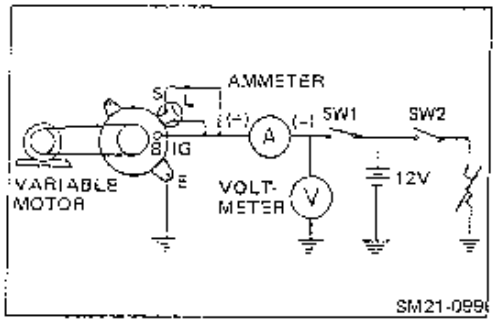
   3. Remove the wire from the access hole.
   4. Make sure that the rotor rotates smoothly.

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PERFORMANCE TEST

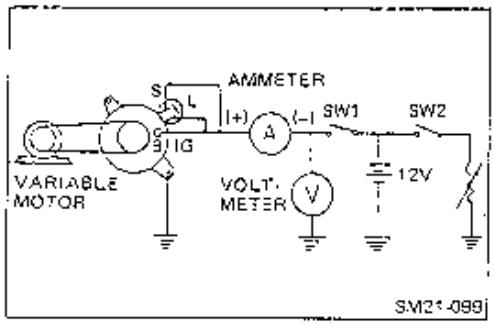
NOTE: ○ Note the battery polarity carefully so as not to make reverse connections.
If the connections are reversed, the diodes will short the circuit and allow large current to flow through and damage the diodes and IC regulator as well as burn up the wiring harness.
○ Use care not to make wrong connections of terminals.
○ When charging the battery with a quick charge.
Disconnect the battery terminals.
○ Do not perform tests high voltage insulation resistance tester.
○ When in operation, never disconnect the battery.



1. GENERATOR PERFORMANCE TEST.

1. Connect the leads, voltmeter, and ammeter as shown in left.
2. Close SW1 on and increase the generator speed until voltmeter reading reaches approx. 13.5V.
3. Close SW2. Regulating the load resistance, increase the generator speed, keeping the voltage at 13.5V, until the ammeter reading reaches 80A.

Generator Speed: Less than 4,000 r/min at 13.5V, 80A



2. VOLTAGE REGULATION TEST.

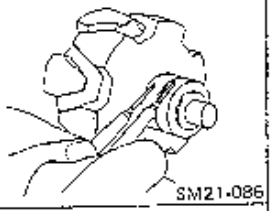
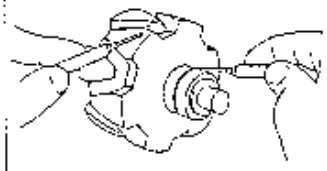
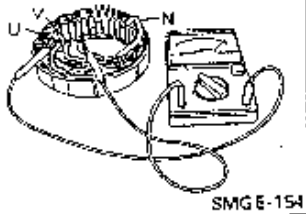
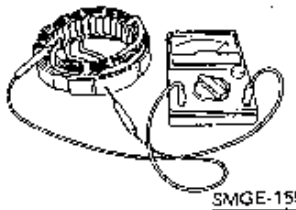
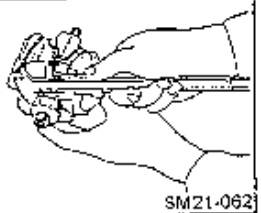
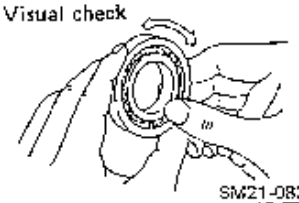
1. Connect the leads, voltmeter and ammeter as shown in left.
2. Close SW1 on and increase the generator speed until voltmeter reading reaches approx. 13.5V.
3. Close SW2. Regulating the load resistance, increase the generator speed to 4,000 r/min, keeping the ammeter reading at 10A.
4. Check the voltmeter reading.

Generated Voltage: 13.8V–14.4V

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INSPECTION AND REPAIR

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Resistance of field coil (at 20°C)	About 4 Ω	–	Replace	 SM21-086
Insulation resistance of field coil	More than 1 MΩ	Less than 0.5 MΩ	Replace	 SM21-087
Resistance of field coil (at 20°C)	U-V, U-W, V-W: About 0 Ω N-U, N-V, N-W: About 0 Ω	–	Replace	 SMGE-154
Insulation resistance of stator coil	More than 1 MΩ	Less than 0.5 MΩ	Replace	 SMGE-155
Slip ring outer diameter	32.5 mm (1.280 in)	32.1 mm (1.264 in)	Replace	 SM21-062
Brush length	19.0 mm (0.748 in)	5.5 mm (0.217 in)	Replace	 SM21-084
Wear or damage ball bearing			Replace, if necessary.	Visual check  SM21-083

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ST-S76E-03

CHAPTER ST

STARTER
(12V, 2.5 KW)

DATA AND SPECIFICATIONS ST-2
DESCRIPTION ST-2
TROUBLESHOOTING ST-3
OVERHAUL ST-5

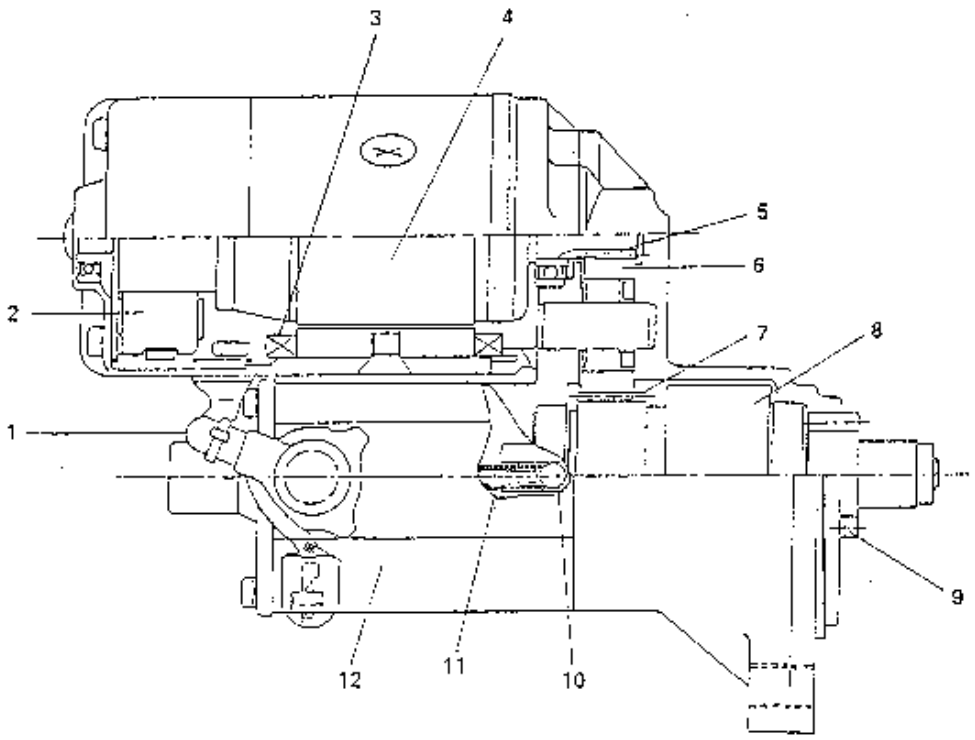
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DATA AND SPECIFICATIONS

Model No.	28100-1561 28100-1960
Starter	
Type	Reduction gear type
Output	12V, 2.5 KW
Number of teeth of pinion	11
Module	3
Rotation	Clockwise, viewed from pinion side

DESCRIPTION



1. Lead wire
2. Brush
3. Field coil
4. Armature
5. Armature shaft gear
6. Idle gear
7. Clutch gear
8. Overrunning clutch
9. Pinion
10. Steel ball
11. Spring
12. Magnetic switch

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TROUBLESHOOTING

Symptom	Possible cause	Remedy/Prevention
Engine does not crank, or cranks slowly.	**Key switch**	
	• Poor contact	Polish or replace contacts
	Battery	
	• Discharged battery	Charge
	• Short circuited between electrodes	Replace battery
	• Poor contact at battery terminal	Plish or retighten
	Engine oil	
	• Improper viscosity oil	Change oil
	Magnetic switch	
	• Poor contact caused by burnt contact plate	Polish or replace contact plate
	• Contact plate worn out	Repair
	• Hold-in coil disconnected (Overrunning clutch moves back and forth)	Replace field coil
	• Pull-in coil disconnected or short circuited	Replace
	Starter relay	
	• Defective or poor contact	Repair or replace
	Starter	
	• Brush worn out	Replace
	• Commutator burnt out	Correct on lathe
	• Commutator worn out	Correct by undercutting
	• Field winding shorted or grounded	Rewind or replace
	• Armature winding shorted or grounded	Replace armature
	• Insufficient brush spring tension	Replace brush spring
	• Poor contact between magnetic switch and field windings	Repair
	• Armature contacts pole core because of worn bearing bush or bent armature shaft	Replace bearing brush or armature
	• Overrunning clutch mulfunction	Replace
Engine does not crank while starter is running in good condition.	**Overrunning clutch**	
	• Overrunning clutch mulfunction	Replace
	• Pinion teeth worn out	Replace
	• Poor sliding of spline teeth	Remove foreign materials, dirt, or replace

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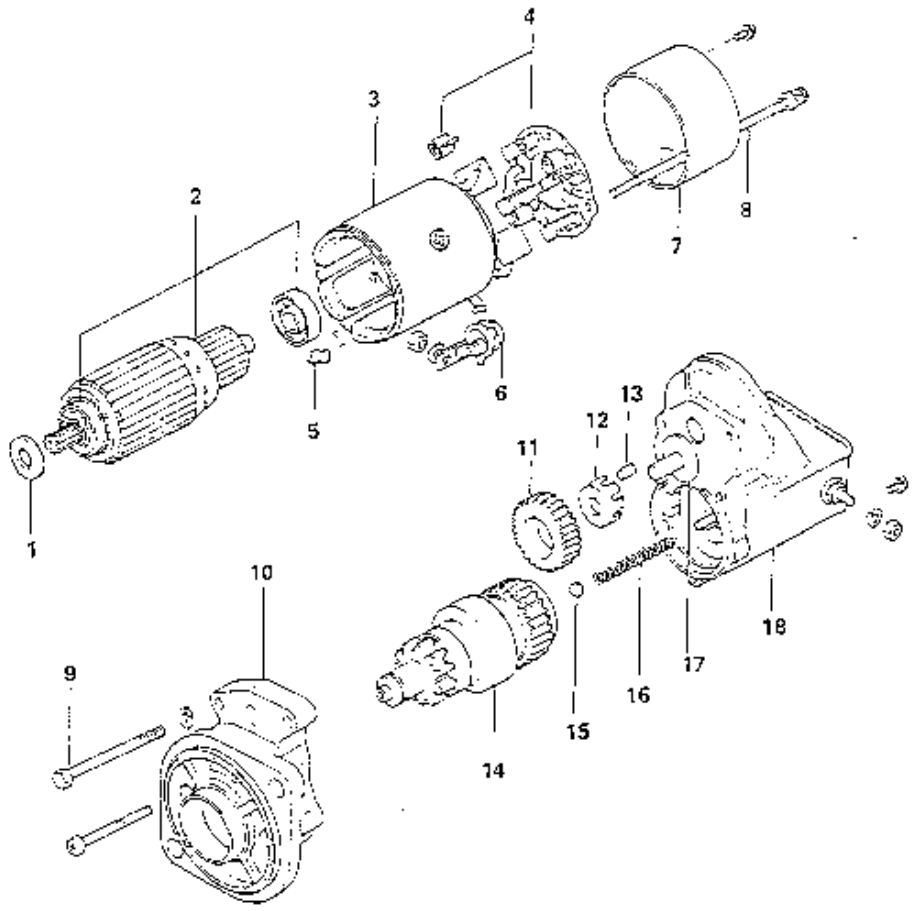
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Symptom	Possible cause	Remedy/Prevention
Starter does not stop running.	Key switch	
	• Contacts keep closing	Replace
	• Key switch sticks	Replace
	• Overrunning clutch sticks to armature	Repair or replace overrunning clutch or armature
	Starter relay	
	• Contacts keep closing	Repair or replace

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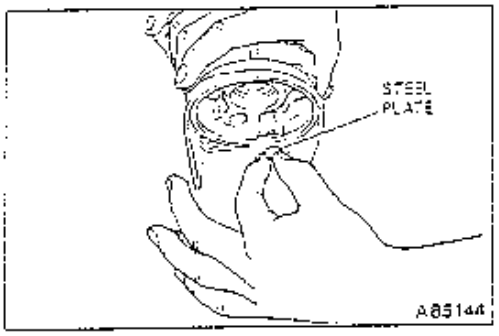
OVERHAUL



1. Felt washer
2. Armature assembly
3. Yoke assembly
4. Brush holder
5. Steel plate
6. Lead wire
7. Rear end flame
8. Through bolt
9. Through bolt
10. Drive end frame
11. Idle gear
12. Retainer
13. Roller
14. Overrunning clutch
15. Steel ball
16. Return spring
17. Steel washer
18. Magnetic switch assembly

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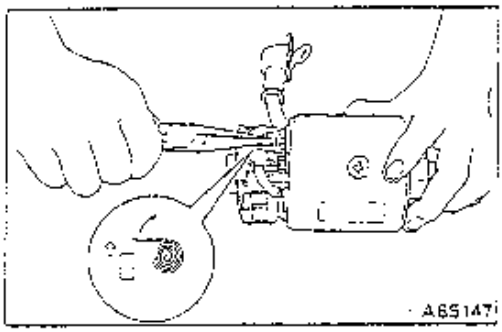
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IMPORTANT POINT (S) – DISASSEMBLY

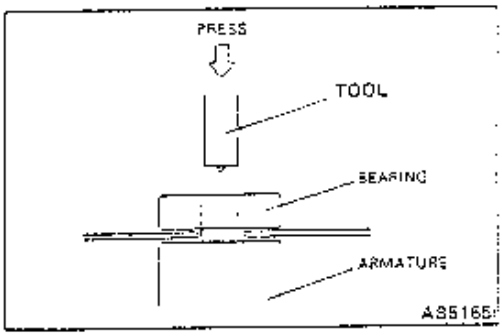
REMOVE THE YOKE FROM THE MAGNETIC SWITCH.

1. Disconnect the lead wire from the magnetic switch.
2. Remove the through bolts from the magnetic switch.
3. Remove the steel plate from the magnetic switch.



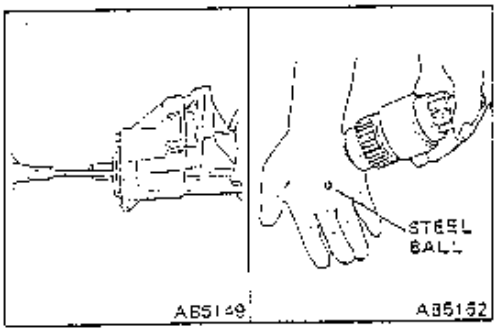
REMOVE THE ARMATURE FROM THE YOKE.

1. Remove the rear end frame from the yoke.
2. Using a long-nose pliers, take off the brushes and remove the brush holder.
3. Loosen the two through bolts and detach the brush holder from the armature shaft.



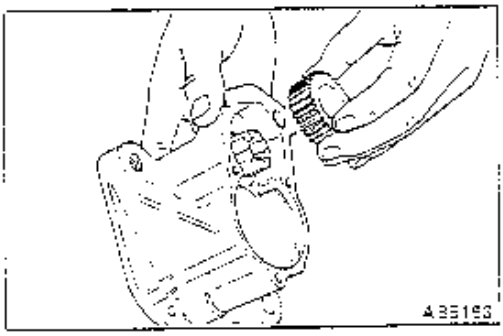
REMOVE THE BALL BEARING FROM THE ARMATURE.

1. Using a press and a suitable tool, remove the ball bearing.



REMOVE THE OVERRUNNING CLUTCH.

1. Remove the screws from the drive end frame.
2. Remove the drive end frame from the magnetic switch.
3. Remove the overruning clutch.
4. Remove the steel ball from the overruning clutch.

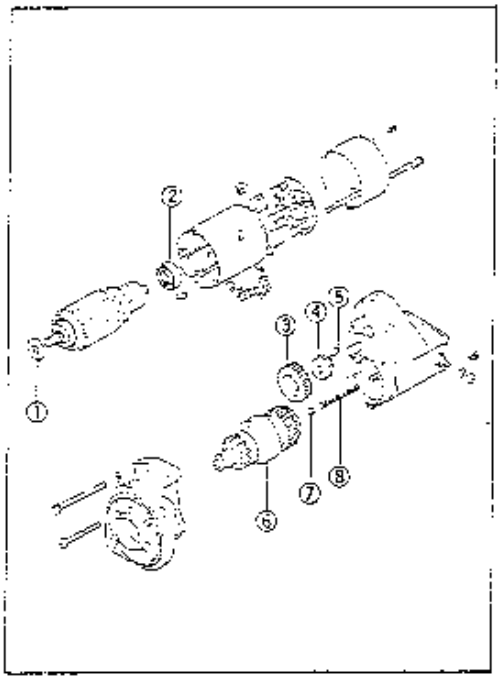


REMOVE THE IDLE GEAR.

1. Remove the idle gear, retainer with rollers, and steel washer from the drive end frame.

NOTE: Do not drop the retainer and the rollers.

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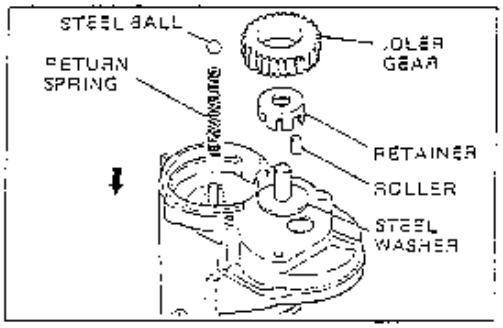


IMPORTANT POINT (S) – ASSEMBLY

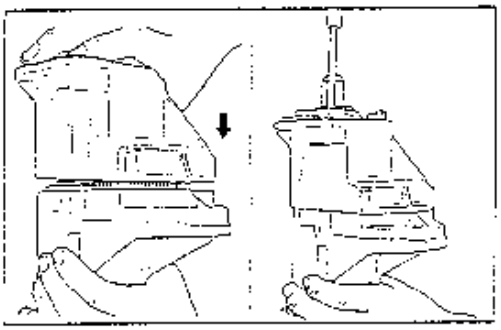
BEFORE REASSEMBLING, APPLY THE RECOMMENDED GREASE TO THE FOLLOWING:

Nippondenso No. 50 grease or equivalent.

① Felt washer
② Bearing
③ Idle gear
④ Retainer
⑤ Roller
⑥ Overrooning clutch
⑦ Steel ball
⑧ Return spring



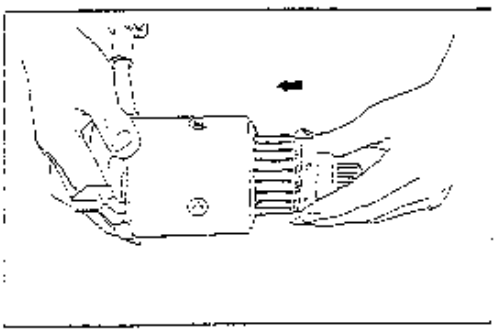
INSTALL THE STEEL WASHER, RETAINER WITH ROLLER, IDLE GEAR, RETURN SPRING, AND STEEL BALL IN THE MAGNETIC SWITCH.



INSTALL THE OVERRUNING CLUTCH IN THE DRIVE END FRAME.

NOTE: Install the steel ball and the return spring.

1. Connect the drive end frame to the magnetic switch and tighten the screws.

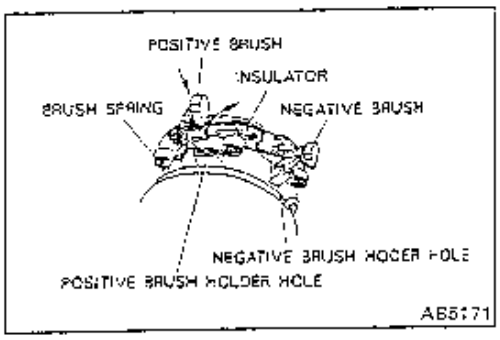


INSTLL THE ARMATURE IN THE YOKE.

NOTE: Do not forget to place a felt washer on the armature shaft bearing.

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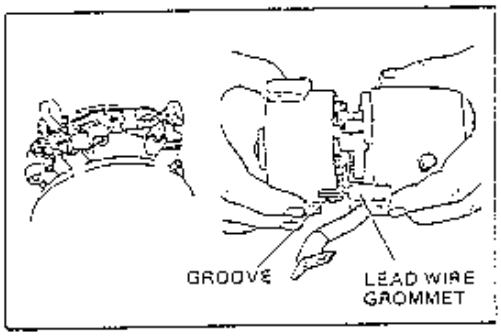
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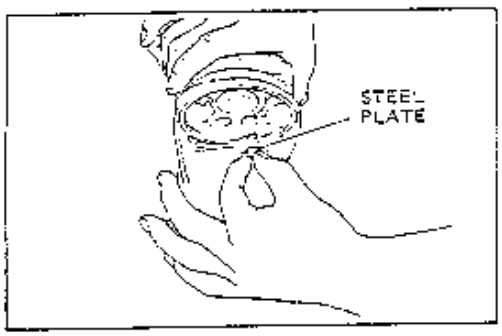
INSTALL THE BRUSH HOLDER ON THE YOKE.

1. Install the negative brush (brush holder side) to the brush holder negative hole (not insulated), and the positive brush (yoke side) to the brush holder positive hole (separated from plate with insulator). Make sure that the positive brush lead wires are not grounded.

2. When assembling the brush holder to the yoke, take care not to damage and get oil on it.



NOTE: Match the lead wire grommet with the rear end frame groove.



INSTALL THE STEEL PLATE ON THE MAGNETIC SWITCH.

1. Install the steel plate on the magnetic switch.
2. Securely put the rubber boot over the terminal.

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TEST

MAGNETIC SWITCH TEST

The following test should be performed with the starter assembled and the field coil lead wire disconnected.

NOTE: ○ Each test should be performed for a short time only (3 to 5 sec.) to prevent the magnetic switch winding from burning.
○ Each test should be performed with the specified voltage applied.

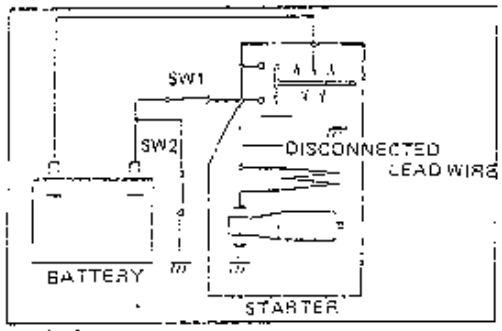


Fig. 22-34

1. Pull-in test
Connect the test leads as shown. When switch 1 (SW1) and switch 2 (SW2) are closed, the pinion should jump out.

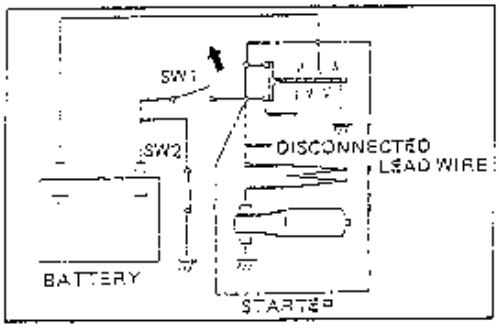
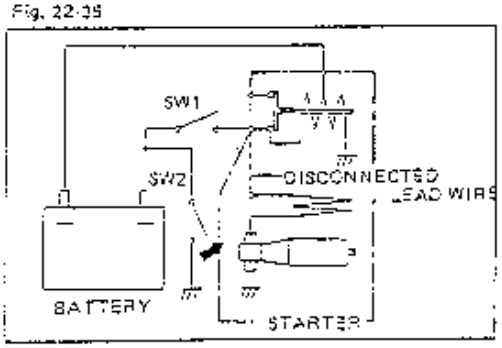
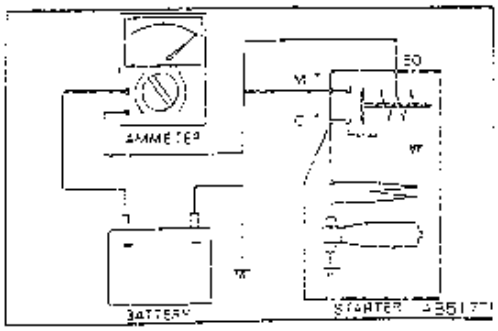


Fig. 22-35

2. Hold-in test
In the same conditions as the pull-in test, open switch 1 (SW 1).
The pinion should remain in the jumped out position.



3. Return test
In the same conditions as the hold-in test, open switch 2 (SW 2).
The pinion should return immediately.



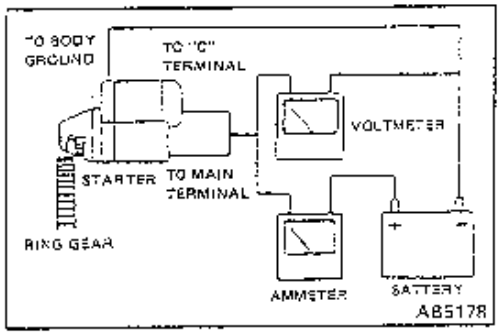
PERFORMANCE TEST

The following test should be carried out after reassembling the starter. If suitable equipment is not available, at least the No-load test should be carried out.

1. No-load test
With the starter securely clamped in a vice, and using a battery and suitable ammeter, connect the positive lead of the battery, and the ammeter to the "50" terminal. Connect the negative lead to the starter body. The starter should show smooth and steady rotation immediately after jumping out of the pinion and should draw less than the specified current.

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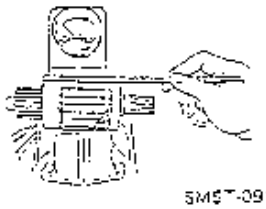
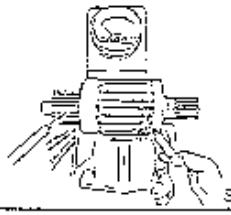
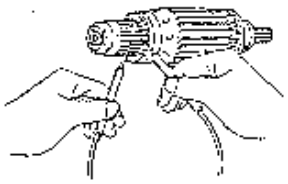
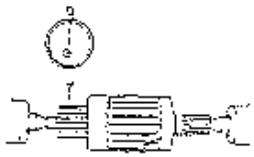
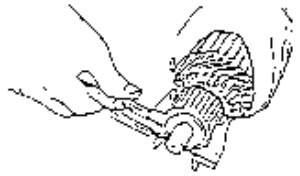
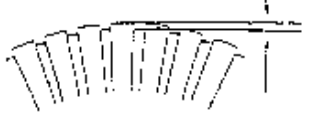
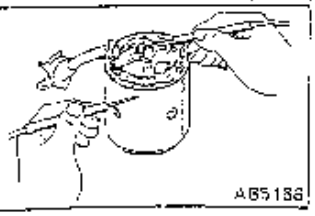
2. Load test
Read the ammeter and voltmeter when the specified torque is applied. The ammeter should indicate less than the specified current, and the tachometer should indicate more than the specified speed.

3. Lock torque test
Read the torque meter and ammeter when the tachometer reading becomes 0 rpm after appling the load. The torque meter should indicate more than the specified torque and the ammeter should indicate less than the specified current.

	Standard value of each test		
	Current	Voltage	Revolution & torque
No load test	Less than 180 A	at 11V	More than 3,500 r/min
Load test	Less than 600 A	at 8V	More than 1,100 r/min
Lock torque test	Less than 1,200A	at 3V	More than 34.3 N·m (3.5 kgf·m, 25.3 lbf·ft) at 0 r/min

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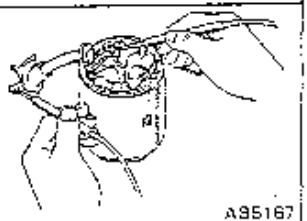
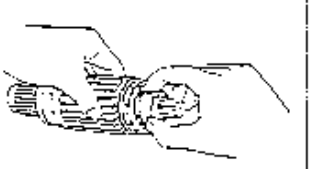
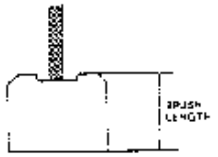
INSPECTION AND REPAIR

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Armature Short Circuit Test	—		If the iron plate is not vibrated, the armature is good	 SMST-091
Armature Insulation	More than 1 MΩ	Less than 0.1 MΩ	Replace	 SMST-092
Commutator continuity	Should be continuity at any point	—	Replace, if there is no continuity at any point	
Commutator run-out	Less than 0.02 mm (0.0008 in)	0.05 mm (0.002 in)	Replace	 SMST-093
Commutator Outside Diameter	36 mm (1.417 in)	35 mm (1.378 in)	Replace	 SM22-055
Mica Depth	0.7 mm (0.0276 in)	0.2 mm (0.0078 in)	Replace	COMMUTATOR UNDERCUT  SM22-056
Conductance between the Field Coil and the Yoke	Should be conducted		Replace	 AB5186

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INSPECTION AND REPAIR

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Field Coil Insulation	More than 1 MΩ	Less than 0.1 MΩ	Replace	 AB5167
Wear or Damage of the Bearing	—	—	Replace, if necessary	 AB5164
Field coil and yoke damage			Replace	Visual check  AB5140
Brush length	20.5 mm (0.807 in)	13 mm (0.512 in)	Replace	 AB5168
Insulation between the Brush Holder and the Bracket	More than 1 MΩ	Less than 0.1 MΩ	Replace	 AB5169
Overrunning clutch test			Replace	 AB5170
Tension of the Brush Springs	38.3 N·m (3.9 kgf, 8.6 lbf)	18.6 N·m (1.9 kgf, 4.2 lbf)	Replace	

(TSD)

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CHAPTER C

INJECTION PUMP CALIBRATION

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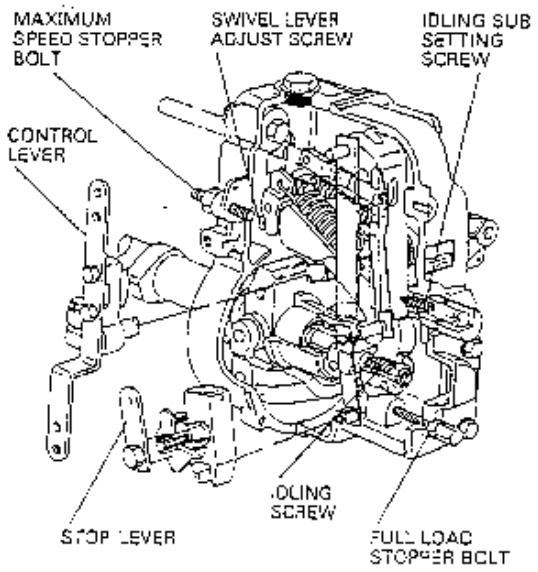
INJECTION PUMP NUMBER: 22020-3521A

INJECTION PUMP SPECIFICATION	Engine		W06D-TI
	Injection pump parts number		22020-3521A
	Injection pump type		NP-PES6A95C320RS2
	Governor type		NP-EP/RSV200-1600
	Timer type		Not equipped
	Feed pump type		NP-FP/KS-AS
TEST CONDITION	Test nozzle type		105780-8140
	Test nozzle opening pressure		17.16 MPa {175 kgf/cm², 2,489 lbf/in²}
	Injection pipe	Outer diameter	6.0 mm {0.236 in}
		Inner diameter	2.0 mm {0.079 in}
		Length	600 mm {23.622 in}
	Calibration oil	Type	SAE J967C
		Oil temperature	40 – 45°C {104–113°F}
	Fuel feed pressure		156.9 kPa {1.6 kgf/cm², 22.75 lbf/in²}
	Overflow valve opening pressure		147.1–176.5 kPa {1.5–1.8 kgf/cm², 21.33–25.0 lbf/in²}
INJECTION TIMING	Rotation		Clockwise viewed from drive side
	Injection order		1–4–2–6–3–5
	Injection interval		60° ± 15'
	Pre-stroke		3.15–3.22 mm {0.125–0.127 in}

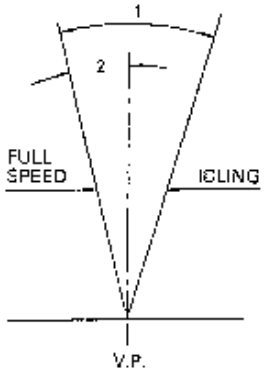
INJECTION VOLUME	Rack position mm {in}	Pump speed {r/min}	Measuring stroke	Injection volume cm³ {cu.in}	Variation limit %
A	10.2 {0.402}	1,600	500	42.30–51.30 {2.582–3.130}	± 3
B	About 7 {0.276}	250	500	3.25–4.75 {0.199–0.289}	± 15

GOVERNOR ADJUSTMENT

ADJUSTING POSITION



CONTROL LEVER ANGLE



NOTE:
- ANGLE: 1 . . . 31° ± 5°
  2 . . . 14° ± 5°
- Lever angle "V.P." means, Vertical Position.

SM4-331

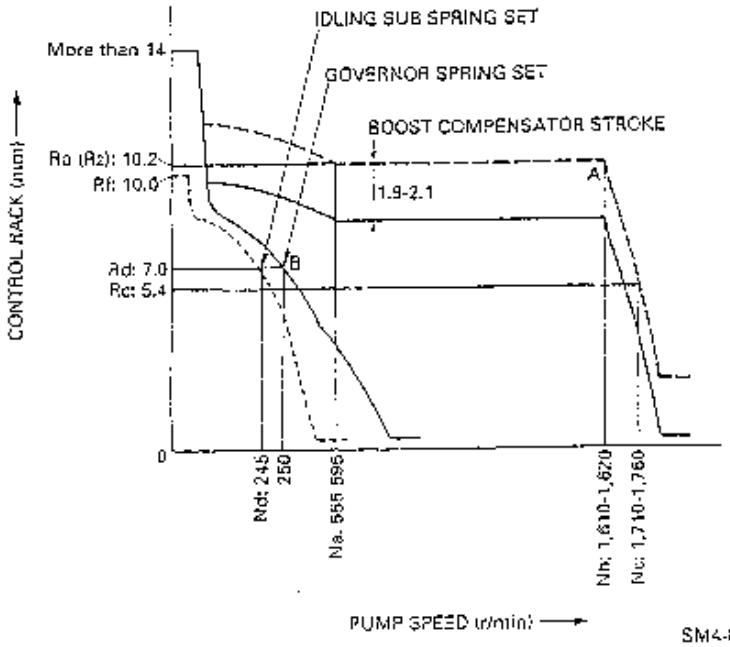
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	Adjusting item	Load control lever position	Pump speed (r/min)	Control rack position mm (in)	Adjusting position
GOVERNOR ADJUSTMENT	Maximum speed	Full load	Na: 555–595	Ra: 10.2 (0.402)	Full load stopper bolt
			Nb: 1,610–1,620	Rb: Should be start to pulled control rack	Maximum speed stopper bolt
			Nc: 1,710–1,760	Rc: 5.4 (0.213)	Swivel lever adjusting screw
	Idling speed	Idle	N : 0 Nd: 245	Rf : 10.0 (0.394) Rd: 7.0 (0.276)	Control lever Idling sub-spring set
	Boost compensator	Full load	Np: 600 Np: 600	R2 : 10.2 (0.402) R1 : 8.1–8.3 (0.319–0.326) When boost pressure is P1 mmHg (60–100 mmHg {2.37–3.93 inHg}), control rack begins to move from R1: 8.1–8.3 mm {0.319–0.326 in} in the direction of "Fuel delivery increase".	Adjusting screw
			Np: 600	When control rack returns to position R2: 10.2 mm (0.402 in), the available pressure corresponds to P2 mmHg {300–400mmHg {11.82–15.74 inHg}}.	Confirm

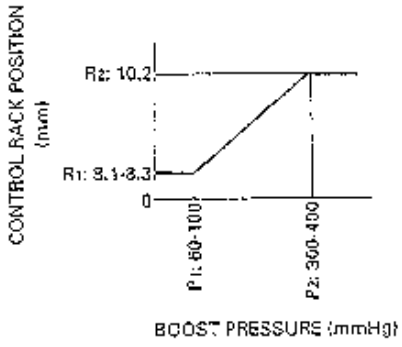
GOVERNOR CHARACTERISTIC DIAPHRAGM

GOVERNING RANGE: 250–1,600 r/min



SM4-831

BOOST COMPENSATOR CHARACTERISTIC DIAPHRAGM



SM4-812

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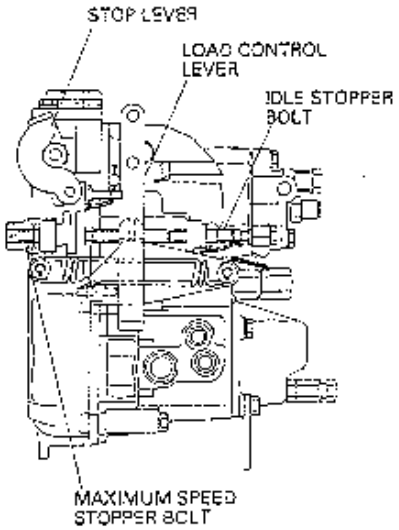
INJECTION PUMP NUMBER: 22020-3851A

INJECTION PUMP SPECIFICATION	Engine		W06D-TI
	Injection pump parts number		22020-3851A
	Injection pump type		NP-PES6A95C320RS2
	Governor type		NP-EP/RSV200-1600
	Timer type		Not equipped
	Feed pump type		NP-FP/KS-AS
TEST CONDITION	Test nozzle type		23600-2500A
	Test nozzle opening pressure		21.57 MPa {220 kgf/cm², 3,128 lbf/in²}
	Injection pipe	Outer diameter	6.0 mm {0.236 in}
		Inner diameter	2.0 mm {0.079 in}
		Length	500 mm {19.685 in}
	Calibration oil	Type	SAE J967C
		Oil temperature	40 – 45°C {104–113°F}
	Fuel feed pressure		156.9 kPa {1.6 kgf/cm², 22.75 lbf/in²}
	Overflow valve opening pressure		147.1–176.5 kPa {1.5–1.8 kgf/cm², 21.33–25.6 lbf/in²}
INJECTION TIMING	Rotation		Clockwise viewed from drive side
	Injection order		1–4–2–6–3–5
	Injection interval		60° ± 30'
	Pre-stroke		3.15–3.25 mm {0.125–0.128 in}

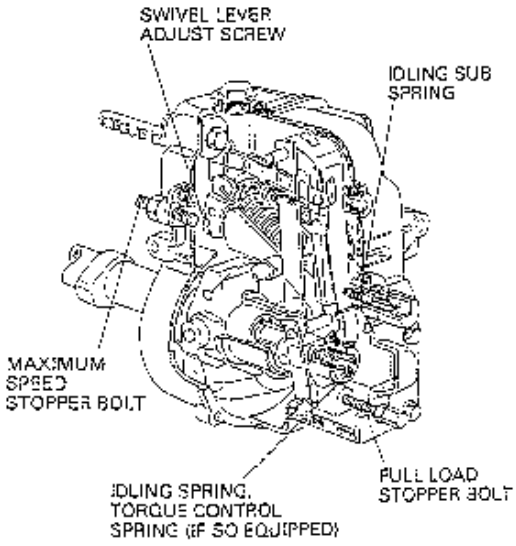
INJECTION VOLUME	Rack position mm {in}	Pump speed {r/min}	Measuring stroke	Injection volume cm³ {cu.in}	Variation limit %
A	10.5 {0.414}	1,500	500	53.7–55.7 {3.277–3.398}	± 3
B	About 7.4 {0.291}	300	500	3.75–5.25 {0.229–0.320}	± 15

GOVERNOR ADJUSTMENT

ADJUSTING POSITION



SM4-918



SM4-919

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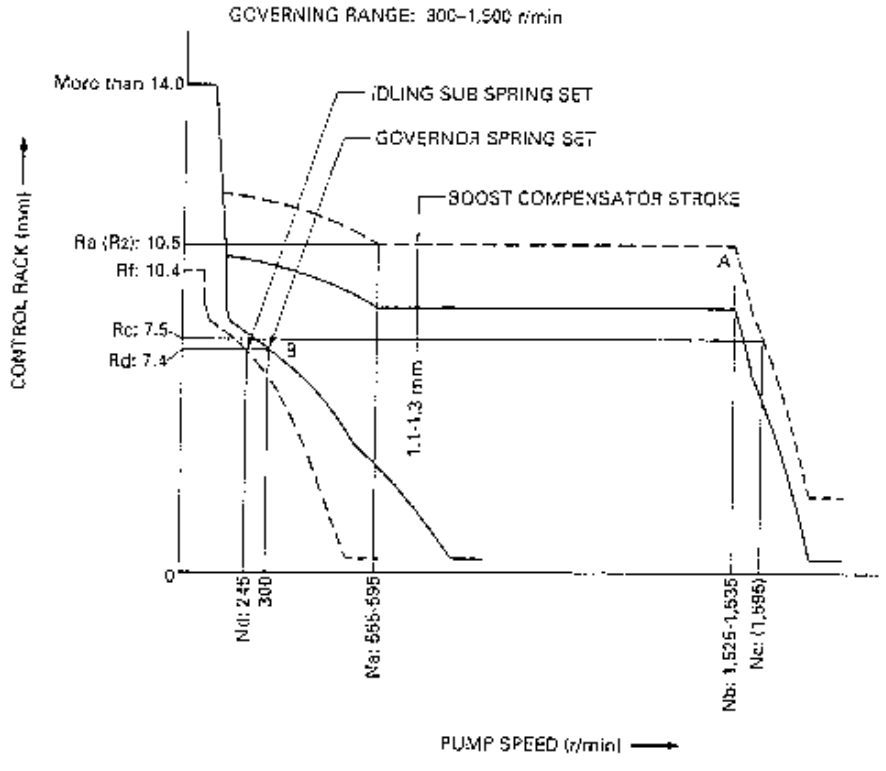
	Adjusting item	Load control lever position	Pump speed (r/min)	Control rack position mm (in)	Adjusting position
GOVERNOR ADJUSTMENT	Maximum speed	Full load	Na: 555–595	Ra: 10.5 (0.413)	Full load stopper bolt
			Nb: 1,525–1,535	Rb: Should be start to pulled control rack	Maximum speed stopper bolt
			Nc: 1,595	Rc: 7.5 (0.295)	Swivel lever adjusting screw
	Idling speed	Idle	N : 0 Nd: 245	Rf : 10.4 (0.409) Rd: 7.4 (0.291)	Control lever Idling sub-spring set
	Boost compensator	Full load	Np: 600 Np: 600	Rz : 10.5 (0.413) R1 : 8.9–9.1 (0.351–0.358) When boost pressure is P1 mmHg (60–100 mmHg (2.37–3.93 inHg)), control rack begins to move from R1: 8.9–9.1 mm (0.351–0.358 in) in the direction of "Fuel delivery increase".	Adjusting screw
			Np: 600	When control rack returns to position Rz: 10.5 mm (0.413 in), the available pressure corresponds to P2 mmHg (200–300mmHg (7.88–11.81 inHg)).	Confirm

C-S164E-01

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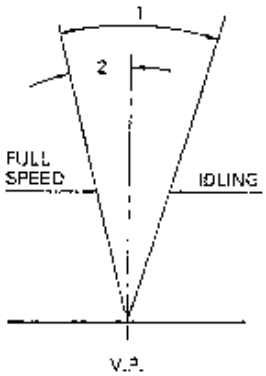
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GOVERNOR CHARACTERISTIC DIAPHRAGM



SM4-916

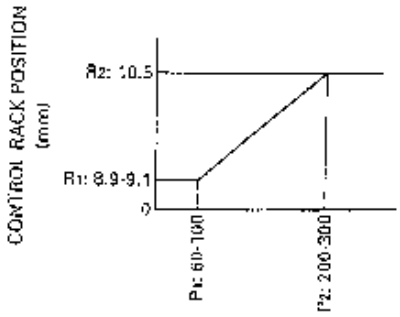
CONTROL LEVER ANGLE



NOTE:
- ANGLE: 1 . . . 26° ± 5°
  2 . . . 13° ± 5°
- Lever angle "V.P." means, Vertical Position.

SM4-837

BOOST COMPENSATOR CHARACTERISTIC DIAPHRAGM



SM4-915

C-3 6-12-0

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C-S165E-01

INJECTION PUMP NUMBER: 22020-3882A

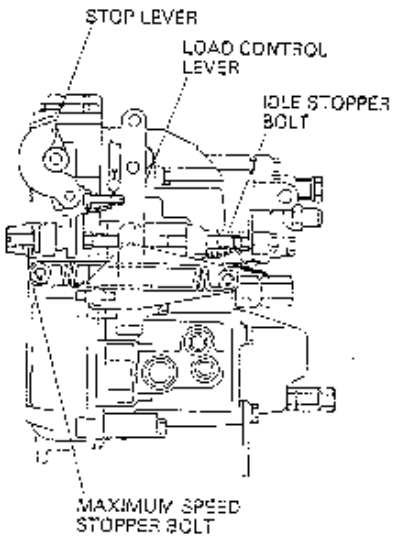
INJECTION PUMP SPECIFICATION	Engine		W06D-TI-II
	Injection pump parts number		22020-3882A
	Injection pump type		NP-PES6AD1008321RS2
	Governor type		NP-EP/RSV200-1600
	Timer type		NP-EP/SCDM1300-1500B 1.5ER
	Feed pump type		NP-FP/KS-ADS
TEST CONDITION	Test nozzle type		23600-2580A
	Test nozzle opening pressure		21.57 MPa {220 kgf/cm², 3,128 lbf/in²}
	Injection pipe	Outer diameter	6.0 mm {0.236 in}
		Inner diameter	2.0 mm {0.079 in}
		Length	500 mm {19.685 in}
	Calibration oil	Type	SAE J967C
		Oil temperature	40 – 45°C {104–113°F}
	Fuel feed pressure		156.9 kPa {1.6 kgf/cm², 22.75 lbf/in²}
	Overflow valve opening pressure		240.3–269.6 kPa {2.45–2.75 kgf/cm², 34.84–39.10 lbf/in²}
INJECTION TIMING	Rotation		Clockwise viewed from drive side
	Injection order		1–4–2–6–3–5
	Injection interval		60° ± 30'
	Pre-stroke		4.35–4.45 mm (0.172–0.175 in)

INJECTION VOLUME		Rack position mm {in}	Pump speed {r/min}	Measuring stroke	Injection volume cm³ {cu.in}	Variation limit %
	A	12.3 {0.484}	1,500	500	62.8–64.8 {3.833–3.954}	± 3
	B	About 7.1 {0.280}	250	500	5.25–6.75 {0.321–0.411}	± 15

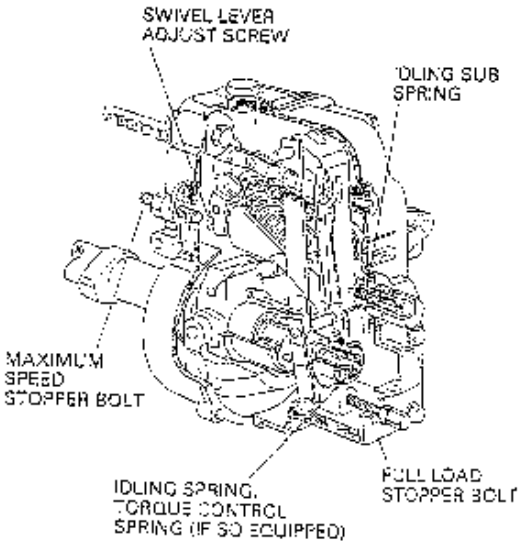
TIMER ADVANCE	Adjusting lever position	Pump speed {r/min}	Advance angle
	Full-load	1,300	0.3°
		1,500	1.5°

GOVERNOR ADJUSTMENT

ADJUSTING POSITION



SM4-915



SM4-919

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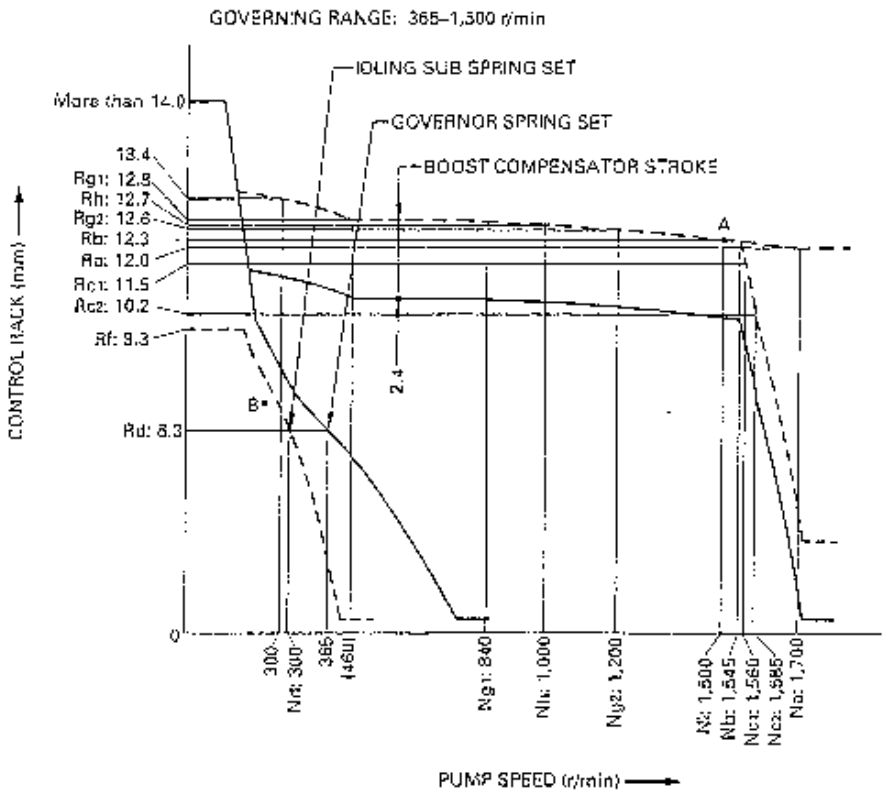
	Adjusting item	Load control lever position	Pump speed (r/min)	Control rack position mm {in}	Adjusting position
GOVERNOR ADJUSTMENT	Maximum speed	Full load	Na : 1,700	Ra : 12.0 {0.472}	Full load stopper bolt
			Nb : 1,545	Rb : Should be start to pulled control rack	Maximum speed stopper bolt
			N_{c1} : 1,560 N_{c2} : 1,585	R_{c1} : 11.5 {0.453} R_{c2} : 10.2 {0.402}	Swivel lever adjusting screw
	Idling speed	Idle	N : 0 Nd : 300	Rf : 9.3 {0.366} Rd : 6.3 {0.248}	Control lever Idling sub-spring set
	Torque control	Full load	N_{g1} : 840 N_{g2} : 1,200	R_{g1} : 12.8 {0.504} R_{g2} : 12.6 {0.496}	Torque control spring capsule
			Nh : 1,000	Rh : 12.7 {0.50}	Torque control spring
	Boost compensator	Full load	Np : 600 Np : 600	R_2 : 12.8 {0.504} R_1 : 10.4 {0.409} When boost pressure is P_1 mmHg {130–170 mmHg {5.12–6.69 inHg}}, control rack begins to move from R_1: 10.4 mm {0.409 in} in the direction of "Fuel delivery increase".	Adjusting screw
			Np : 600	When control rack returns to position R_2: 12.8 mm {0.504 in}, the available pressure corresponds to P_2 mmHg {380–480mmHg {14.97–18.89 inHg}}.	Confirm

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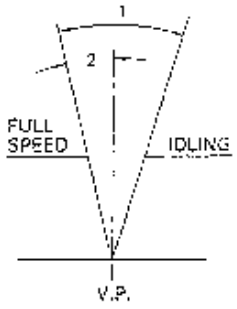
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GOVERNOR CHARACTERISTIC DIAPHRAGM



SM4-917

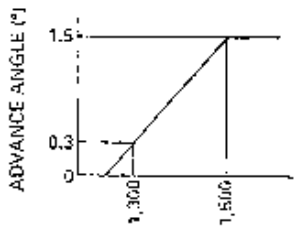
CONTROL LEVER ANGLE



NOTE:
- ANGLE: 1 . . . 26° ± 5°
  2 . . . 13° ± 5°
- Lever angle "V.P." means Vertical Position.

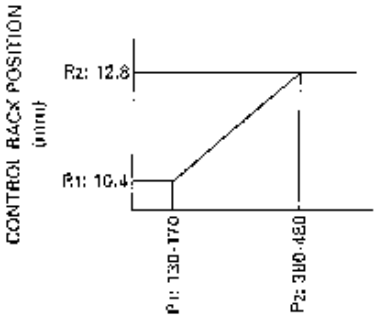
SM4-831

TIMER ADVANCE CHARACTERISTIC DIAPHRAGM



SM4-917

BOOST COMPENSATOR CHARACTERISTIC DIAPHRAGM



SM4-917

C-S185E-C

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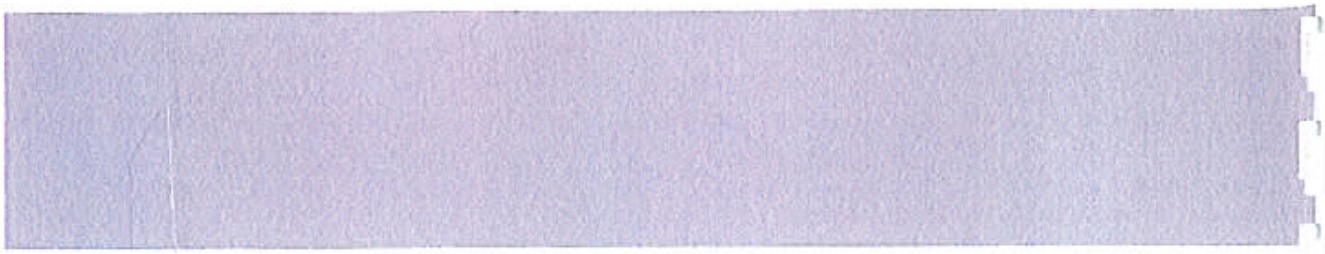
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