ENGINE BASE

SERVICE MANUAL

MITSUBISHI
4G63-32HL, 4G64-33HL

HYUNDAI

REFERENCE ONLY
- FORK LIFT(LPG)

SERVICE MANUAL

4G63-32HL, 4G64-33HL

2004.Jun.

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GENERAL INFORMATION

EXPLANATION OF MANUAL CONTENTS

Scope of Explanation

This book describes the service procedures for the engine removed from the vehicle.
For procedures concerning removal of the engine from the vehicle and on-vehicle inspection and servicing, refer to the appropriate service manuals separately prepared for the individual models.

Maintenance and Servicing Procedures

(1) A diagram of the component parts is provided near the front each section in order to give the reader a better understanding of the installed condition of component parts.
(2) The numbers provided within the diagram indicate the sequence for maintenance and servicing procedures; the symbol [N] indicates a non-reusable part; the tightening torque is provided where applicable.

- Removal steps:
  The part designation number corresponds to the number in the illustration to indicate removal steps.
- Installation steps:
  Specified in case installation impossible in reverse order of removal steps. Omitted if installation is possible in reverse order of removal steps.
- Disassembly steps:
  The part designation number corresponds to the number in the illustration to indicates disassembly steps.
- Reassembly steps:
  Specified in case reassembly is installation impossible in reverse order of disassembly steps. Omitted if reassembly is possible in reverse order of disassembly steps.

Classification of Major Maintenance/Service points

When there are major points relative to maintenance and servicing procedures (such as essential maintenance and service points, maintenance and service standard values, information regarding the use of special tools, etc.), these are arranged together as major maintenance and service points and explained in detail.
←A→ : Indicates that there are essential points for removal or disassembly.
→B← : Indicates that there are essential points for installation or reassembly.

Symbols for Lubrication, Sealants and Adhesives

Information concerning the locations for lubrication and for application of sealants and adhesives is provided, by using symbols, in the diagram of component parts, or on the page following the component parts page, and explained.

 .... Sealant or adhesive

 .... Engine oil or gear oil

Inspection

Only the inspections to be performed by using special tools or measuring instruments are covered. General service procedures not covered in this manual, such as visual inspections and cleaning of parts, however, should always be performed during actual service operations.

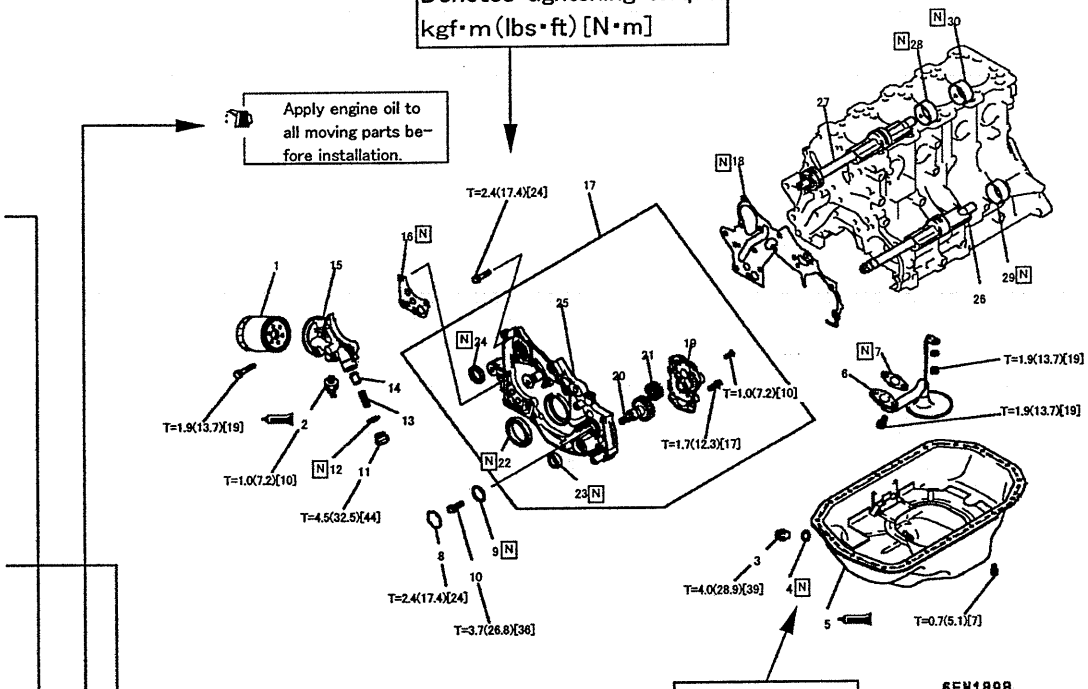
FRONT CASE AND OIL PAN

4G64 engine

Indicates the section title.

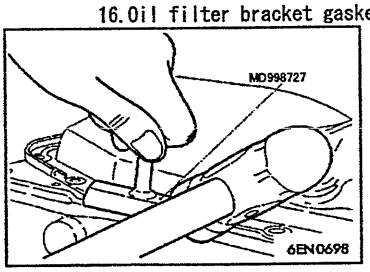
Denotes tightening torque. kgf·m (lbs·ft) [N·m]

Apply engine oil to all moving parts before installation.



Denotes non-reusable part.

Removal steps
- →N←1. Oil filter
- →M←2. Oil pressure switch
- 3. Drain plug
- →L←4. Drain plug gasket
- ←A→→K←5. Oil pan
- 6. Oil screen
- 7. Oil screen gasket
- ←B→→J←8. Plug
- 9. O-ring
- ←C→→I←10. Flang bolt
- 11. Relief plug
- 12. Gasket
- 13. Relief spring
- 14. Relief plunger
- 15. Oil filter bracket
- 16. Oil filter bracket gasket
- →H←17. Oil pump case assembly
- 18. Front case gasket
- →G←19. Oil pump cover
- →G←20. Oil pump drive gear
- →G←21. Oil pump driven gear
- →F←22. Crankshaft front oil seal
- →E←23. Oil pump oil seal
- →D←24. Counterbalance shaft oil seal
- 25. Front case
- 26. Counterbalance shaft, left
- 27. Counterbalance shaft, right
- ←D→ →C←28. Counterbalance shaft, front bearing
- ←E→ →B←29. Counterbalance shaft, rear bearing, left
- ←E→ →A←30. Counterbalance shaft, rear bearing, right



REMOVAL SERVICE POINTS

←A→ Oil pan removal

(1) Remove the all oil pan bolts.

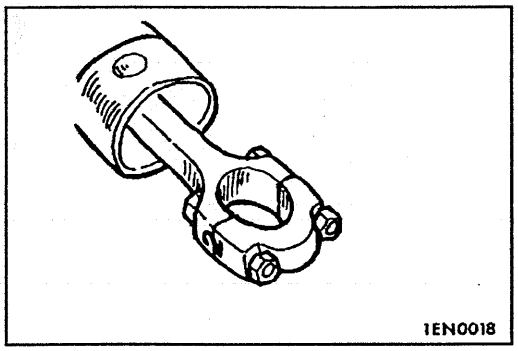
(2) Drive in the special tool between the cylinder block and oil pan.

(3) Side the tool by striking the edge of the special tool to separate

Indicates the page number. → 50

This alphabetical letter corresponds to the one assigned to a part in the removal, installation, disassembly or reassembly steps that are indicated in the drawing on the first page of each section.

Operating procedures, cautions, etc. on removal, installation, disassembly and reassembly are described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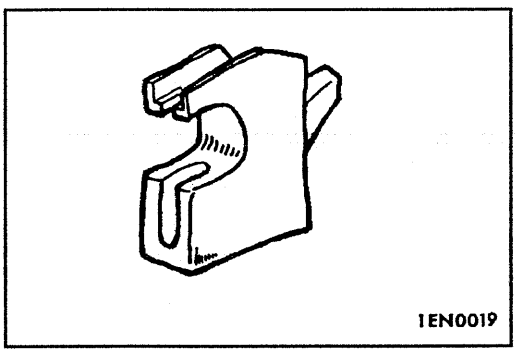
PRECAUTIONS BEFORE SERVICE

Removal and Disassembly

For prevention of wrong installation or reassembly and for ease of operation, put mating marks to the parts where no function is adversely affected.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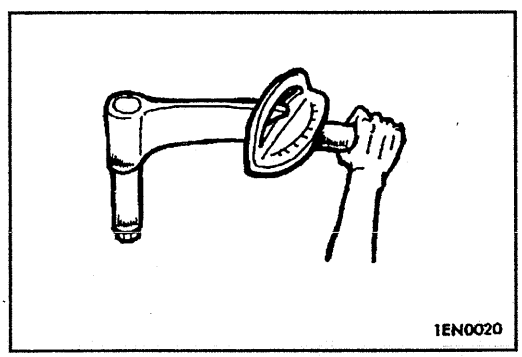
Special Tool

Be sure to use Special Tools when their use is specified for the operation.
Use of substitute tools will result in malfunction of the part or damage it.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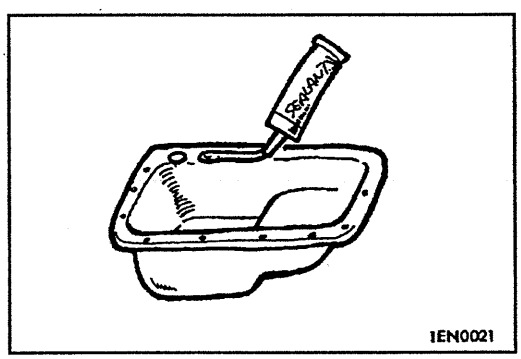
Tightening Torque

Tighten the part properly to specified torque.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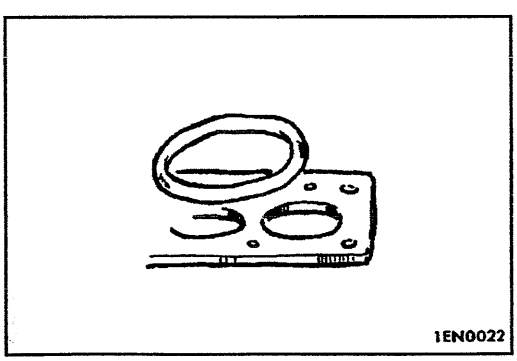
Sealant

Use specified brand of sealant.
Use of sealant other than specified sealant may cause water or oil leaks.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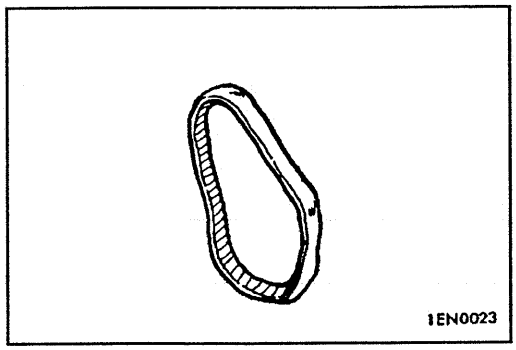
Replacement Part

When oil seal, O-ring, packing and gasket have been removed, be sure to replace them with new parts.
However, rocker cover gasket may be reused if it is not damaged.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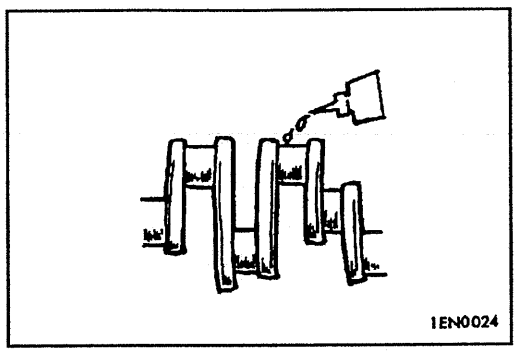
Rubber Parts

Do not stain timing belt and V-belt with oil or water.
Therefore, do not clean the pulley and sprocket with detergent.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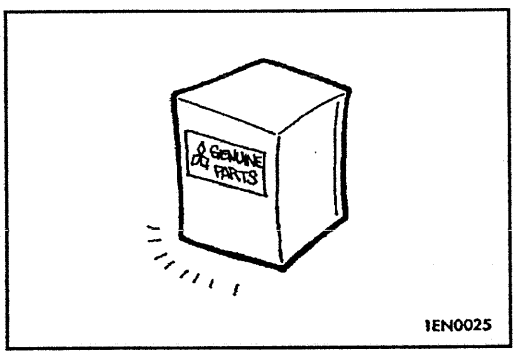
Oil and Grease

Before reassembly, apply specified oil to the rotating and sliding parts.



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Genuine Part

When the part is to be replaced, be sure to use genuine part. For selection of appropriate parts, refer to the Parts Catalog.

GENERAL

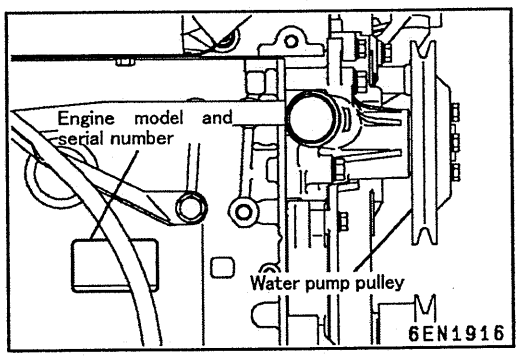
Engine models and numbers

Engine model	Fuel type
4G63-32HL	L.P.G.
4G64-33HL	L.P.G.

Indication of engine model and number

The engine model and serial number are stamped on the right side of cylinder block surface.

Engine model	Engine number
4G63,4G64	AA0001 to YY9999



GENERAL SPECIFICATIONS

Item \ Engine model			4G63	4G64
Type			Water-cooled, 4-cycle	
No. of cylinders and arrangement			4, in-line	
Combustion chamber type			Semi-spherical	
Valve mechanism			OHC	
Total displacement, cm^3 (cc) [cub in.]			1997 (1997) [122]	2350 (2350) [143]
Bore x stroke, mm (in.)			85×88 (3.35×3.46)	86.5×100 (3.41×3.94)
Dry weight, kg (lbs)			145 (320)	148 (326)
Compression ratio			8.5	8.6
Compression pressure, kPa (kgf/cm^2) [psi]			1128 (11.5) [163.5]	
Valve timing	Intake valve	Open	12° BTDC	
		Close	40° ABDC	
	Exhaust valve	Open	54° BBDC	
		Close	6° ATDC	
Firing order			1 - 3 - 4 - 2	
Lubrication system			Pressure feed, full-flow filtration type	
Oil pump			Gear, driven by timing belt	
Oil filter			Filter paper, cartridge type	
Cooling system			Water-cooled, forced circulation	
Water pump			Centrifugal, driven by V-belt	
Thermostat			Wax type	
Electrical system			12V DC, negative ground	
Alternator , (12V-50A)			Alternator current, built-in fan and regulator	
Starter motor, (12V-1.2kW)			Reduction drive	
Distributor			Igniterless and centrifugal mechanismless type	
Spark plug			BPR5ES or W16EP	
Quantity of lubricating oil, cm^3 (liter) [U.S.gal]			4000(4.0)[1.06](including 300 cm^3(0.3 liter)[0.08 U.S. gal]in oil filter	
Quantity of coolant, cm^3 (liter) [U.S.gal]			3100 (3.1) [0.82] (in engine proper)	

SERVICE SPECIFICATIONS

Unit : mm(in.)

Item					Standard value	Limit	Remarks
Cylinder head	Flatness of gasket surface				0.03 (0.0012)		
	Grinding limit					0.2 (0.008)	Total resurfacing depth of both cylinder head and cylinder block
	Overall height				89.9 to 90.1 (3.539 to 3.547)		
	Oversize rework dimensions of valve guide hole			0.05 (0.0020)	13.05 to 13.07 (0.5138 to 0.5146)		
				0.25 (0.0098)	13.25 to 13.27 (0.5217 to 0.5224)		
				0.50 (0.0197)	13.50 to 13.57 (0.5315 to 0.5343)		
	Oversize rework dimensions of valve seat ring hole	4G63	Intake	0.30 (0.0118)	44.30 to 44.33 (1.7441 to 1.7453)		
				0.60 (0.0236)	44.60 to 44.63 (1.7559 to 1.7571)		
			Exhaust	0.30 (0.0118)	38.30 to 38.33 (1.5079 to 1.5091)		
				0.60 (0.0236)	38.60 to 38.63 (1.5197 to 1.5209)		
		4G64	Intake	0.30 (0.0118)	47.30 to 47.33 (1.8622 to 1.8634)		
				0.60 (0.0236)	47.60 to 47.63 (1.8740 to 1.8752)		
			Exhaust	0.30 (0.0118)	40.30 to 40.33 (1.5866 to 1.5878)		
				0.60 (0.0236)	40.60 to 40.63 (1.5984 to 1.5996)		
Camshaft	Cam height			Intake	41.62 (1.6386)	41.12(1.6189)	
				Exhaust	41.62 (1.6386)	41.12(1.6189)	
	Journal diameter				33.935 to 33.950(1.33602 to 1.33661)		
	Oil clearance				0.05 to 0.09 (0.0020 to 0.0035)		
Valve	Overall length	4G63		Intake	109.8 (4.328)	109.3(4.303)	
				Exhaust	106.6 (4.197)	106.1 (4.126)	
		4G64		Intake	106.6 (4.197)	106.1 (4.126)	
				Exhaust	105.2 (4.142)	104.7 (4.122)	
	Valve stem projection				42.05 (1.6555)	42.55(1.6752)	
	Stem diameter			Intake	7.960 to 7.975 (0.31339 to 0.31398)		
				Exhaust	7.930 to 7.950 (0.31220 to 0.31299)		
	Face angle				45° to 45.5°		
	Thickness of valve head (margin)			Intake	1.2 (0.047)		
				Exhaust	2.0 (0.079)		
	Stem-to-guide clearance			Intake	0.025 to 0.058 (0.00098 to 0.00228)		
				Exhaust	0.050 to 0.088 (0.00197 to 0.00346)		
Valve spring	Free height				48.0 (1.89)	47.0 (1.85)	
	Load/installed height				176.5N (18kgf) [39.7lbf] /40.4 (1.591)		
	Out-of-squareness				2° or less	4°	

Unit : mm(in.)

Item				Standard value	Limit	Remarks
Valve guide	Overall length		Intake	47 (1.85)		
			Exhaust	52 (2.05)		
	Inner diameter			8.000 to 8.018 (0.31496 to 0.31567)		
Valve seat	Valve contact width			0.9 to 1.3 (0.035 to 0.051)		
	Sinkage				0.2 (0.008)	
Piston	Outside diameter		4G63	84.97 to 85.00 (3.3453 to 3.3465)		
			4G64	86.47 to 86.50 (3.4043 to 3.4055)		
	Piston clearance			0.02 to 0.04 (0.0008 to 0.0016)		
Piston ring	End gap		No. 1 ring	0.25 to 0.40 (0.0098 to 0.0157)	0.8 (0.031)	
			No. 2 ring	0.45 to 0.60 (0.0177 to 0.0236)	0.8 (0.031)	
			Oil ring	0.20 to 0.60 (0.0079 to 0.0236)	1.0 (0.039)	
	Ring-to-ring groove clearance	No.1	4G63	0.02 to 0.06 (0.0008 to 0.0024)		
			4G64	0.03 to 0.07 (0.0012 to 0.0028)		
		No.2	4G63	0.02 to 0.06 (0.0008 to 0.0024)		
			4G64	0.03 to 0.07 (0.0012 to 0.0028)		
Piston pin	Outside diameter			22.002 to 22.005(0.86622 to 0.86634)		
	Press-in load (at room temperature), N (kgf) [lbf]			7350 to 17160 (750 to 1750) [1650 to 3860]		
Connecting rod	Big end center-to-small end center length			149.9 to 150.0 (5.902 to 5.906)		
	Bend			0.05 (0.0020)		
	Twist			0.10 (0.0039)		
	Big end thrust clearance			0.10 to 0.25 (0.0039 to 0.0098)		
Crankshaft	End play			0.05 to 0.18 (0.0020 to 0.0071)		
	Journal outside diameter			56.982 to 57.000(2.24338 to 2.24409)		
	Pin Outside diameter			44.985 to 45.000(1.77106 to 1.77165)		
	Out-of-roundness and taper of journal and pin			0.005 (0.00020)		
	Concentricity journal and pin			0.03 (0.0012)		
	Oil clearance of journal			0.02 to 0.04 (0.0008 to 0.0016)		
	Oil clearance of pin			0.02 to 0.05 (0.0008 to 0.0020)		

Unit : mm(in.)

Item			Standard value	Limit	Remarks
Cylinder block	Cylinder inner diameter	4G63	85.00 to 85.03 (3.3465 to 3.3476)		
		4G64	86.50 to 86.53 (3.4055 to 3.4067)		
	Flatness of gasket surface		0.05 (0.0020)		
	Grinding limit			0.2(0.008)	Total resurfacing depth of both cylinder head and cylinder block
	Overall height	4G63	283.9 to 284.1 (11.177 to 11.185)		
		4G64	289.9 to 290.1 (11.413 to 11.421)		
Oil pump	Side clearance	Drive gear	0.08 to 0.14 (0.031 to 0.0055)		
		Driven gear	0.06 to 0.12 (0.0024 to 0.0047)		

Unit : mm(in.)

Item			Standard value	Limit	Remarks
Starter motor	Nominal output, kW		1.2		
	No-load characteristics	Voltage, V	11.0		
		Current, A	90 or less		
		Speed, rpm	3000		
	Commutator	Outer diameter	29.4(1.16)	28.8(1.13)	
		Runout	0.05(0.0020)	0.1(0.0039)	
		Undercut	0.5(0.020)	0.2(0.008)	
	Pinion gap		0.5 to 2.0(0.020 to 0.079)		
	Brush length			Wear limit line	
Spark plug	Plug gap		0.7 to 0.8(0.028 to 0.031)		
Thermostat	Valve opening temperature, °C(°F)		82(180)		
	Fully opening temperature, °C(°F)		95(203)		
	Valve lift		8(0.31) or more		

MAJOR BOLTS AND NUTS

Item		Torque			Remarks
		kgf·m	lbf·ft	N·m	
Ignition system	Tensioner plate bolt	2.4	17.4	24	
	Tensioner pulley assembly nut	5.0	35.4	49	
	Fan pulley bolt	2.4	17.4	24	
	Fan suppuort saaembly bolt	5.0	35.4	49	
	Alternator brace bolt	2.4	17.4	24	
	Oil pump support RH nut	2.3	16.6	23	
	Oil pump support RH bolt	5.0	35.4	49	
	Alternator nut	2.3	16.6	23	
	Alternator bracket bolt	5.0	35.4	49	
	Water pump pulley bolt	0.9	6.5	9	
	Crankshaft pulley bolt	2.5	18.1	25	
	Spark plug	2.5	18.1	25	
	Ignition coil bolt	2.2	15.9	22	
	Distributor nut	1.2	8.7	12	
Timing belt	Timing belt cover bolt	1.1	8.0	11	
		0.9	6.5	9	
	Tensioner spring spacer	4.9	35.4	48	
	Tensioner bolt	4.9	35.4	48	
	Oil pump sprocket nut	5.5	39.8	54	
	Crankshaft bolt	16.2	117	162	
	Tensioner B bolt	1.9	13.7	19	
	Counterbalance shaft	4.6	33.3	45	
	Engine support bracket bolt	3.6	26.0	35	
	Camshaft sprocket bolt	9.0	65.1	88	
	Timing belt rear bolt	1.4	10.1	14	
Intake manifold	Water outlet bolt	1.4	10.1	14	
	Intake manifold bolt/nut	1.8	13.0	18	
Exhaust manifold	Oil level gauge guide bolt	1.4	10.1	14	
	Heat protector bolt	0.9	6.5	9	
	Exhaust manifold nut	3.5	25.3	34	
	Water inlet pipe bolt	1.4	10.1	14	
	Water pump bolt	1.4	10.1	14	

Item			Torque			Remarks
			kgf·m	lbf·ft	N·m	
Rocker arm and camshaft	Rocker cover bolt		0.6	4.3	6	
	Bearing cap bolt	M8×25	2.4	17.4	24	
		M6×65	2.0	14.5	20	
	P.C.V. valve		1.0	7.2	10	
Cylinder head, valve	Cylinder head bolt		2.0 kgf·m(14.5 lbf·ft) [20 N·m] + 1/4 turn(90°) + 1/4 turn(90°)			Tighten to 8.0 kgf·m (57.9 lbf·ft) [78 N·m] and then completely loosen before finally tightening with above procedure.
Front case, oil pan	Oil filter inner plug		4.5	32.5	44	
	Drain plug		4.0	28.9	39	
	Oil pan bolt		0.7	5.1	7	
	Oil screen bolt/nut		1.9	13.7	19	
	Plug		2.4	17.4	24	
	Flange bolt		3.7	26.8	36	
	Relief plug		4.5	32.5	44	
	Oil filter bracket bolt		1.9	13.7	19	
	Oil pump cover bolt		1.7	12.3	17	
	Oil pump cover screw		1.0	7.2	10	
	Front case bolt		2.4	17.4	24	
Piston, connecting rod	Connecting rod bearing nut		2.0 kgf·m(14.5 lbf·ft)[20 N·m] +1/4 turn(90°)			
Crankshaft, cylinder block	Flywheel bolt		13.5	97.6	132	
	Rear plate bolt / Flywheel housing		0.9	6.5	9	
			6.0	43.4	59	
	Rear plate cover		1.1	8.0	11	
	Oil seal case bolt		1.1	8.0	11	
	Bearing cap bolt		2.0 kgf·m(14.5 lbf·ft)[20 N·m] +1/4 turn(90°)			
Starter motor	Starter motor bolt		2.7	19.5	26	

GENERAL BOLTS AND NUTS TIGHTENING TORQUE

Standard Bolts and Nuts

Norminal diameter	Pitch	Torque, kgf·m (lbf·ft) [N·m]				
		Bolt, stud, nut (with spring washer)			Flange bolt, flange nut	
		Head mark 4	Head mark 7	Head mark 10	Head mark 4	Head mark 7
M5	0.8	–	0.5 (0.5) [3.6]	–	–	0.6 (4.3) [5.9]
M6	1.0	–	0.9 (6.5) [8.8]	1.2 (8.7) [12]	–	1.0 (7.2) [9.8]
M7	1.25	1.2 (8.7) [12]	2.2 (15.9) [22]	3.0 (21.7) [29]	1.3 (9.4) [13]	2.4 (17.4) [24]
M8	1.25	2.5 (18.1) [25]	4.5 (32.5) [44]	6.0 (43.4) [59]	2.6 (18.8) [25]	5.0 (36.2) [49]
M9	1.25	4.2 (30.4) [41]	8.6 (60.0) [81]	10.7 (77.4) [105]	4.7 (34.0) [46]	9.5 (68.7) [93]
M10	1.5	7.3 (52.8) [72]	14.0 (101.3) [137]	14.5 (104.9) [142]	–	–

Tapered Threads

Size	Torque, kgf·m (lbf·ft) [N·m]	
	Material of internal threads: Aluminum alloy	Material of internal threads: Cast iron or steel
NPTF 1/16	0.5 to 0.8 (3.6 to 5.8) [5 to 8]	0.8 to 1.2 (5.8 to 8.7) [8 to 11]
PT 1/8	0.8 to 1.2 (5.8 to 8.7) [8 to 11]	1.5 to 2.2 (10.8 to 15.9) [15 to 21]
PT 1/4	2.0 to 3.0 (14.5 to 21.7) [20 to 29]	3.5 to 4.5 (25.3 to 32.5) [34 to 44]
NPTF 1/4	2.0 to 3.0 (14.5 to 21.7) [20 to 29]	3.5 To 4.5 (25.3 to 32.5) [34 to 44]
PT 3/8	4.0 to 5.5 (28.9 to 39.8) [39 to 59]	5.5 to 7.5 (39.8 to 54.2) [54 to 73]
PT 1/2	7.0 to 10.0 (50.6 to 72.3) [69 to 98]	12.0 to 16.0 (86.8 to 115.7) [118 to 156]

NEW TIGHTENING METHOD – BY USE OF BOLTS TO BE TIGHTENED IN PLASTIC AREA

A new type of bolts, to be tightened in plastic area, is currently used in some parts of the engine. The tightening method for the bolts is different from the conventional one. Be sure to observe the method described in the text when tightening the bolts.

Service limits are provided for the bolts. Make sure that the service limits described in the text are strictly observed.

- Area where the bolts are in use:

  (1) Cylinder head bolts

  (2) Main bearing cap bolts

  (3) Connecting rod cap bolts

- Tightening method

After tightening the bolts to the specified torque, tighten them another 90° or 180° (twice 90°). The tightening

SEALANT

Part to be applied	Brand
Semi circular packing	3M™ AAD Part No.8672 or equivalent
Rocker cover	3M™ AAD Part No.8672 or equivalent
Oil pressure switch	3M™ AAD Part No.8672 or equivalent
Oil pan	MITSUBISHI Genuine Part No. MD970389 or equivalent
Rear oil seal case	MITSUBISHI Genuine Part No. MD970389 or equivalent
Rear plate bolt	3M™ AAD Part No.8672 or equivalent
Oil seal case bolt	3M™ AAD Part No.8672 or equivalent

FROM-IN-PLACE GASKET(FIPG)

The engine has several areas where the from-in-place gasket(FIPG) is in use. To ensure that gasket fully serves its purpose, it is necessary to observe some precautions when applying the gasket. Bead size, continuity and location are of paramount importance. Too thin a bead could cause leaks. Too thick a bead, on the other hand, could be squeezed out of location, causing blocking or narrowing of the fluid feed line. To eliminate the possibility of leaks from a joint, therefore, it is absolutely necessary to apply the gasket evenly without a break, while observing the correct bead size.

Since the FIPG used in the engine hardens as it reacts with the moisture in the atmospheric air, it is normally used in the metallic flange areas.

Disassembly

The parts assembled with the FIPG can be easily disassembled without use of a special method. In some cases, however, the sealant between the joined surfaces may have broken by lightly striking with a mallet or similar tool. A flat and thin gasket scraper may be lightly hammered in between the joined surfaces. In this case, however, care must be taken to prevent damage to the joined surfaces. For removal of the oil pan, the special tool "Oil Pan Remover" (MD998727) is available. Be sure to use the special tool to remove the oil pan.

Surface preparation

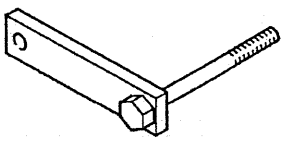
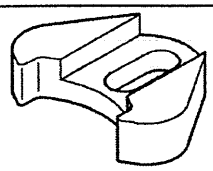
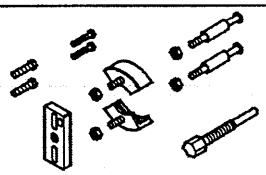
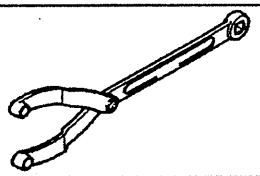
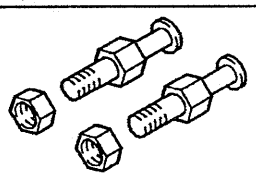
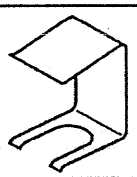
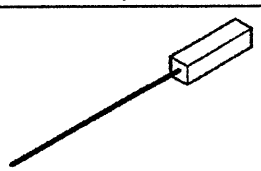
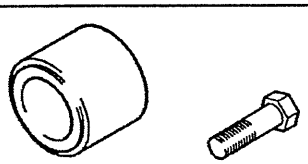
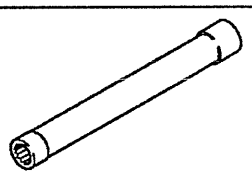
Thoroughly remove all substances deposited on the gasket application surfaces, using a gasket scraper or wire brush. Check to ensure that the surfaces to which the FIPG is to be applied is flat. Make sure that there are no oils, greases and foreign substances deposited on the application surfaces. Do not forget to remove the old FIPG remaining in the bolt holes.

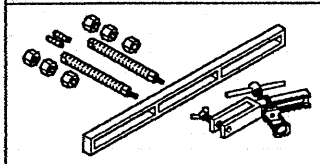
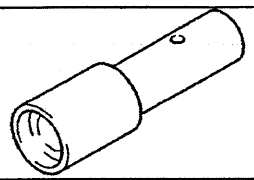
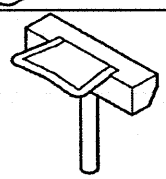
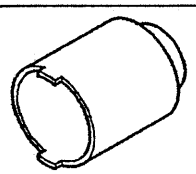
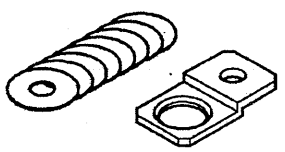
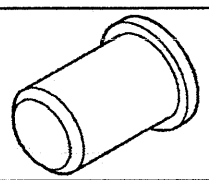
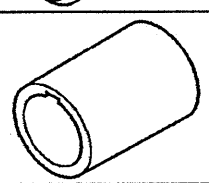
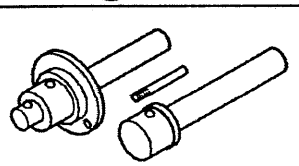
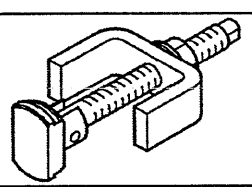
From-in-place gasket Application

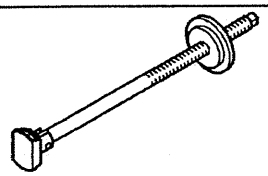
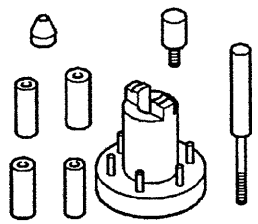
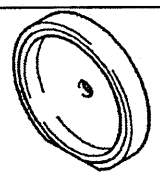
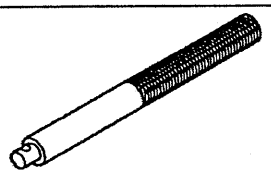
Applied FIPG bead should be of the specified size and without breaks. Also be sure to encircle the bolt hole circumference with a completely continuous bead. The FIPG can be wiped away unless it is hardened. While the FIPG is still moist (in less than 15 minutes), mount the parts in position. When the parts are mounted, make sure that the gasket is applied to the required area only.

The FIPG application procedure may vary on different areas. Observe the procedure described in the text when applying the FIPG.

SPECIAL TOOLS

Style	Tool No.	Tool name	Use
	MD998781	Flywheel stopper	Holding flywheel
	MD998785	Sprocket stopper	Holding counterbalance shaft sprocket
	MD998778	Crankshaft spocket puller	Removal of crankshaft sprocket
	MB990767	End yoke holder	Holding camshaft sprocket (Use with MD998719)
	MD998719	Pulley holding pins	Holding camshaft sprocket when loosening or torquing bolt (Use with MB990767)
	MD998443	Lash adjuster holder	Retainer for holding lash adjuster in rocker arm at timer of removal and installation of rocker arm and rocker shaft assembly
	MD998442	Air bleed wire	Air bleeding of lash adjuster
	MD998713	Camshaft oil seal installer	Installation of oil seal
	MB991654	Cylinder head bolt wrench(12)	Removal and installation of cylinder head bolt

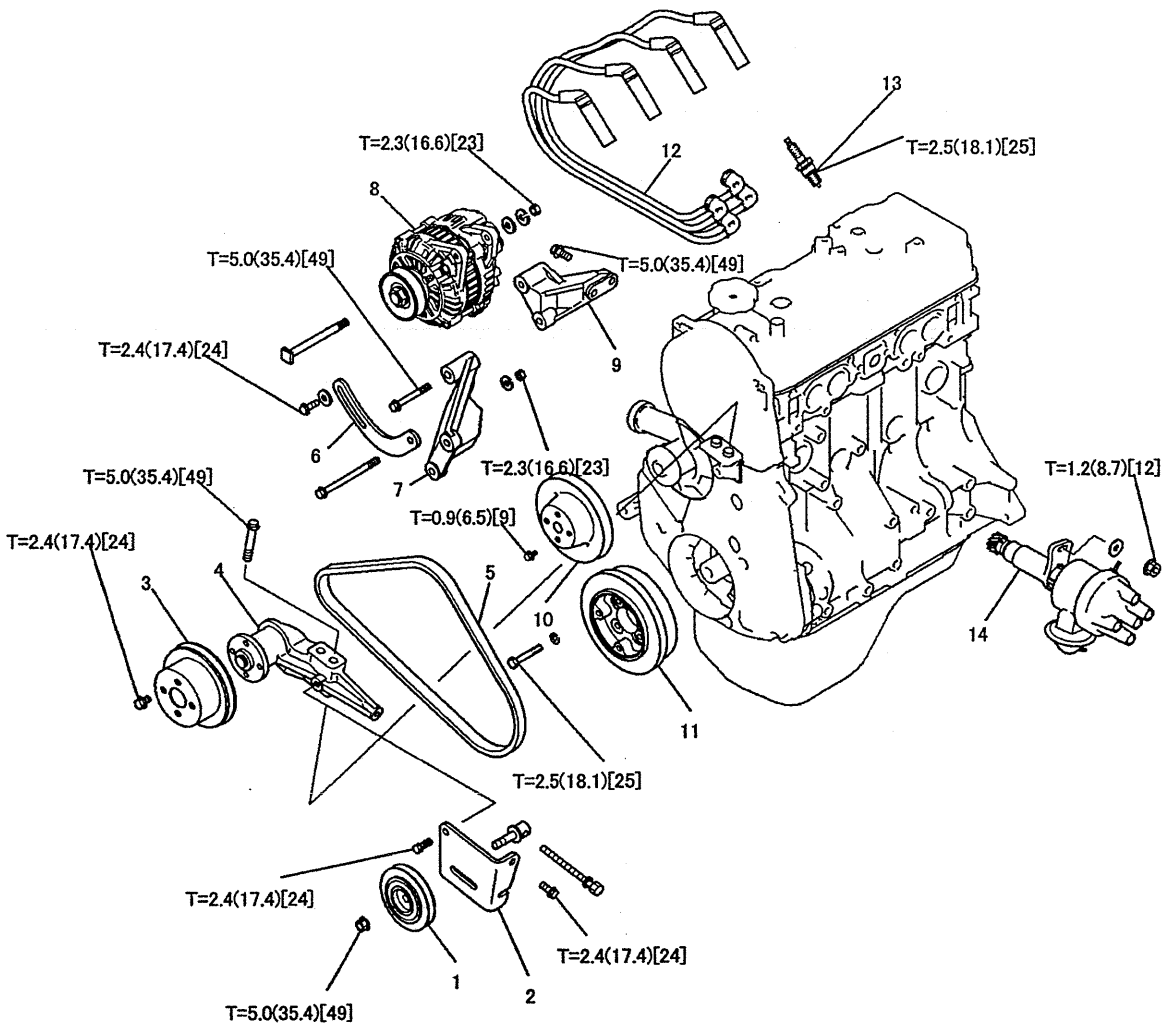
Style	Tool No.	Tool name	Use
	MD998772	Valve spring compressor	Compression of valve spring
	MD998729	Valve stem seal installer	Installation of valve stem seal
	MD998727	Oil pan remover	Removal of the oil pan
	MD998162	Plug wrench	Removal and installation of front case cap plug
	MD998783	Plug wrench retainer	Removal and installation of front case cap plug (Use with MD998162)
	MD998375	Crankshaft front oil seal installer	installation of crankshaft front oil seal
	MD998285	Crankshaft front oil seal guide	Guide for installation of crankshaft front oil seal
	MD998705	Silent sahaft bearing installer	Installation of counterblance shaft front and rear bearing
	MD998371	Silent sahaft bearing puller	Removal of counterblance shaft front bearing

Style	Tool No.	Tool name	Use
	MD998372	Silent sahaft bearing puller	Removal of counterblance shaft rear bearing
	MD998780	Piston pin setting tool	Removal and installation of piston pin
	MD998776	Crankshaft rear oil seal installer	Installation of crankshaft rear oil seal
	MB990938	Handle	Installation of crankshaft rear oil sear (Use with MD998776)

ADJUSTMENT

1. Valve Clearance Adjustment
   Being adjusted automatically with a lash adjuster, the valve clearance needs no adjustment.

IGNITION SYSTEM
REMOVAL AND INSTALLATION



6EN2344

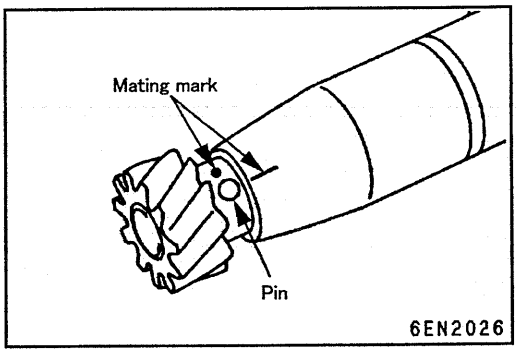
Removal steps

→C← 1. Tension pulley assembly
2. Tensioner plate
3. Fan pulley
4. Fan support assembly
5. Drive belt
6. Alternator brace
→B← 7. Oil pump support RH
→B← 8. Alternator assembly
9. Alternator bracket
10. Water pump pulley
11. Crankshaft pulley
12. Spark plug cable
13. Spark plug
14. High tension cable
→A← 15. Distoributor

INSPECTION

Spark Plug Cable/High Tension Cable

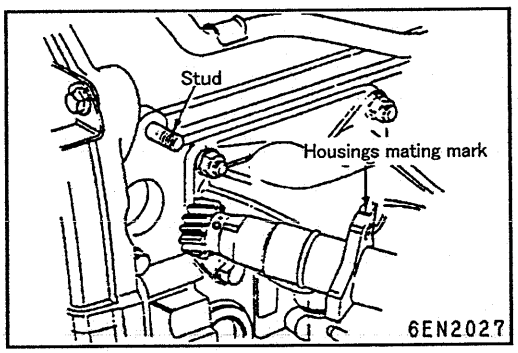
(1) Check the caps and covering for cracks.
(2) Measure the resistance values:
Standard value: 16 kΩ/m



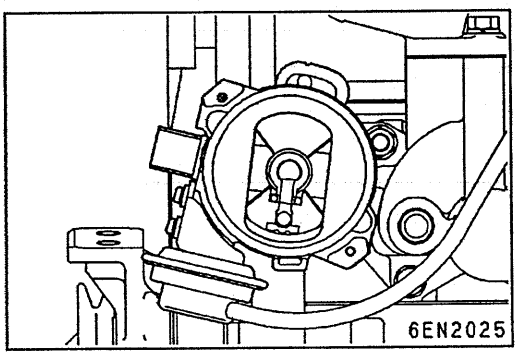
INSTALLATION SERVICE POINTS

→A← Distributor installation

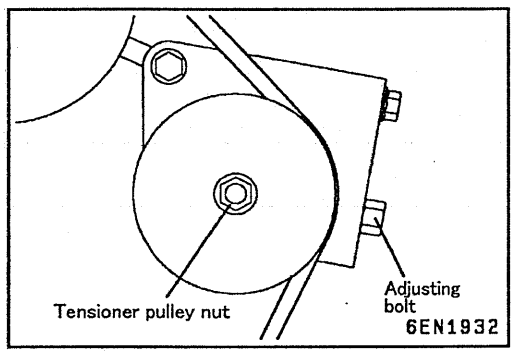
(1) Turn the crankshaft so that the No.1 cylinder is at top dead center.
(2) Align the distributor housing and gear mating marks.
(3) Shift 1 tooth of gear to meet the pin with the mating mark of distributor housing as shown in the illustration.



(4) Install the distributor to the engine while aligning mating of distributor housings(groove) of the distributor's installation flange with the center of the distributor installation stud.



(5) Removes distributor cap and confirms that the rotor becomes as shown in the illustration.
(6) When the rotor is not in this position, redo from the operation in step (2)



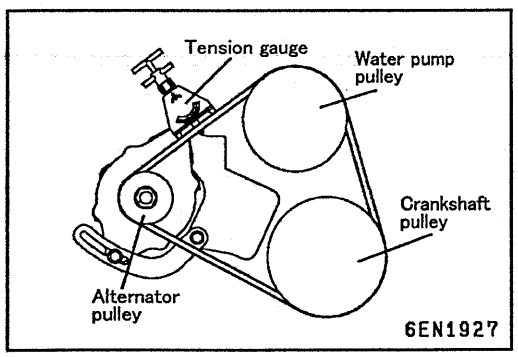
→C← Tensioner pulley assembly installation

(1) Tighten fasteners temporarily adjusting bolt.

(2) Tighten fasteners temporarily tensioner pulley nut.

NOTE:

Adjustment of drive belt tension refer to DRIVE BELT TENSION CHECK AND ADJUSTMENT.



DRIVE BELT TENSION CHECK AND ADJUSTMENT

Alternator Drive Belt Tension Check

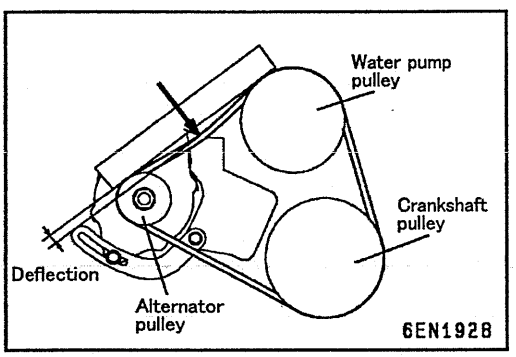
Check the drive belt tension in the following procedure.

Standard value:

Tension N(kgf)	123 to 221(12.5 to 22.5)
Deflection mm(in.)	13.0 to 15.5(0.51 to 0.61)

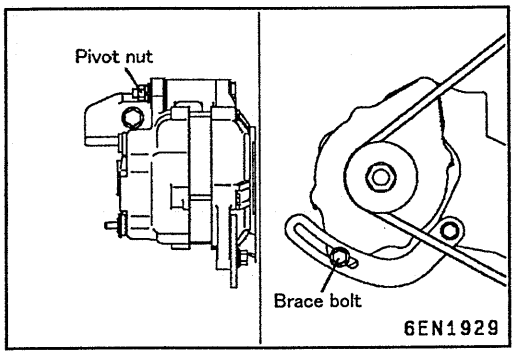
<When using a tension gauge>

Use a belt tension gauge to check that the belt tension is with the standard value.



<Belt deflection check>

Apply 98N Of force to the middle of the drive belt between the pulleys(at the pace indicated by the arrow) and check that the amount of deflection is within the standard value.



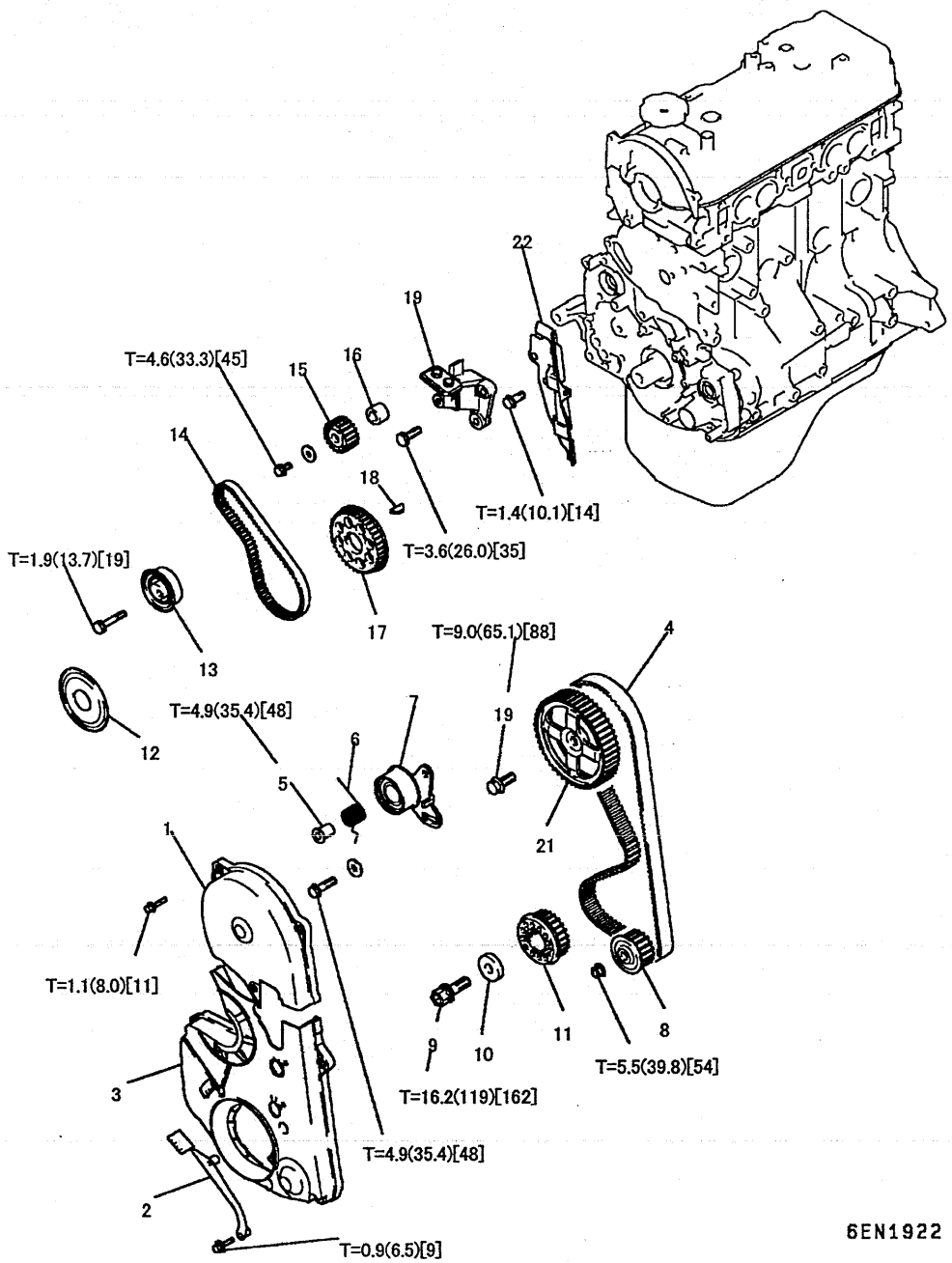
Alternator Drive Belt Adjustment

(1) Loosen the nut of the alternator pivot bolt.
(2) Loosen the brace bolt
(3) Move alternator, tension belt moderately and adjust belt tension.
(4) Adjustment the belt tension.
(5) Tighten alternator brace bolt.
(6) Tighten alternator pivot bolt.

Standard value:

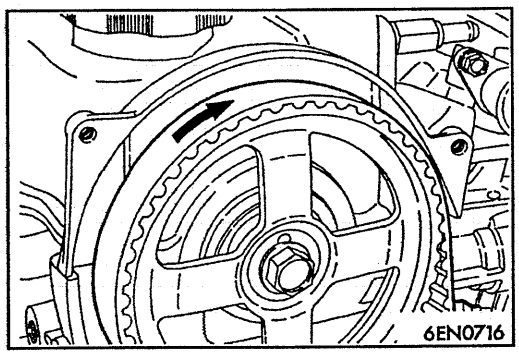
When a new belt installed	Tension N(kgf)	196 to 294(20 to 30)
	Deflection mm(in.)	11.5 to 13.5 (0.45 to 0.53)
When a used belt installed	Tension N(kgf)	147 to 197(15 to 20)
	Deflection mm(in.)	13.5 to 15.0 (0.53 to 0.59)

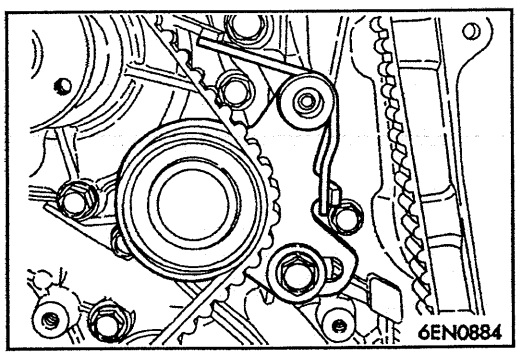
TIMING BELT
REMOVAL AND INSTALLATION



Removal steps

1.Timing belt front cover upper
2.Timing indicator
3.Timing belt front cover lower
←A→→H←4.Timing belt
→G←5.Tensioner spacer
→G←6.Tensioner spring
→G←7.Tensioner pulley
←B→→F←8.Oil pump sprocket
←C→→E←9.Crankshaft bolt
10.Crankshaft washer
←D→ 11.Crankshaft sprocket.
12. Flange
13.Tensioner B
←E→→D←14.Timing belt B
←F→→C←15.Counterbalance shaft sprocket
16.Spacer
←G→→a←17.Crankshaft sprocket B
18.Crankshaft key
→B←19.Engine support bracket
20.Camshaft sprocket bolt
←H→→A←21.Camshaft sprocket
22.Timing belt rear cover

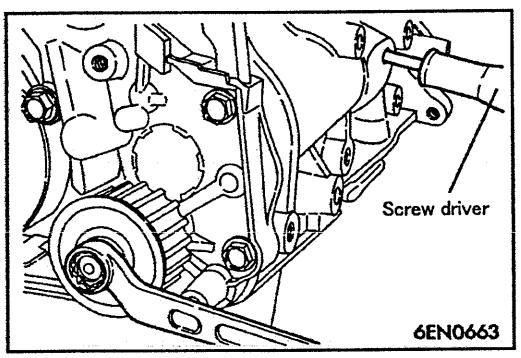




REMOVAL SERVICE POINTS

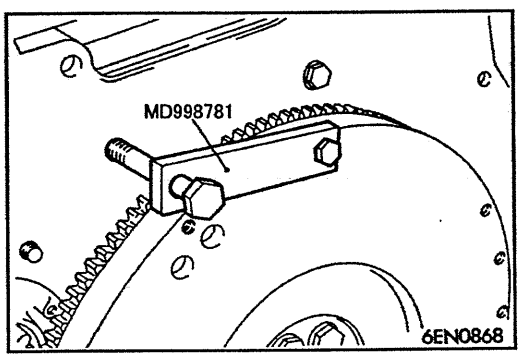
←A→ Timing belt removal

(1) When the timing belt is to be re-used, make an arrow mark on the back surface on the belt to indicate the rotating direction with a chalk or the like so that the belt can be installed in the same direction.
(2) Move the timing belt tensioner upward and temporarily tighten the tensioner lock bolt.
(3) Remove the timing belt.



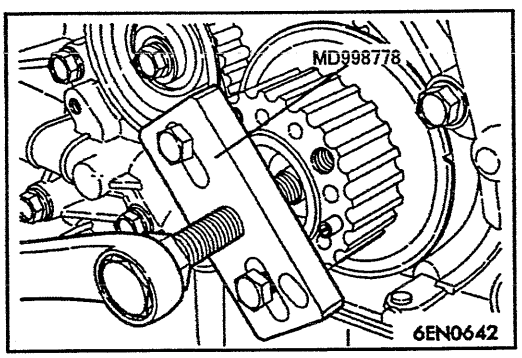
←B→ Oil pump sprocket removal

(1) Remove the plug on the left side of cylinder block.
(2) Insert a screwdriver(shank diameter 8 mm[0.31 in.]) to block the counterbalance shaft.
(3) Remove the nut.
(4) Remove the oil pump sprocket.



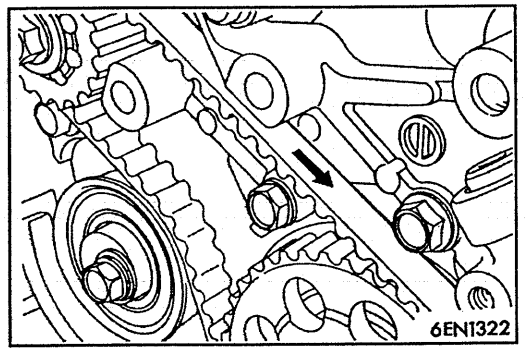
←C→ Crankshaft bolt removal

(1) Hold the flywheel with the special tool as shown.
(2) Remove the crankshaft bolt.



←D→ Crankshaft sprocket removal

(1) If it is difficult to remove the sprocket, use the special tool.



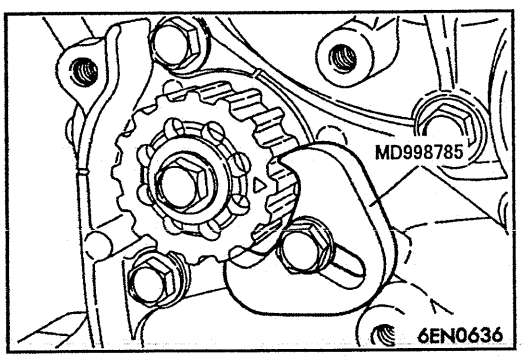
←E→ Timing belt "B" removal

(1) Make a mark on the back of the timing belt indicating the direction of rotation so it may be reassembled in the same direction if it is to be reused.

NOTE:

(1) Water or oil on the belt shortens its life drastically, so the removed timing belt, sprocket, and tensioner must be free from oil and water. These parts should not be washed. Replace part if seriously contaminated.

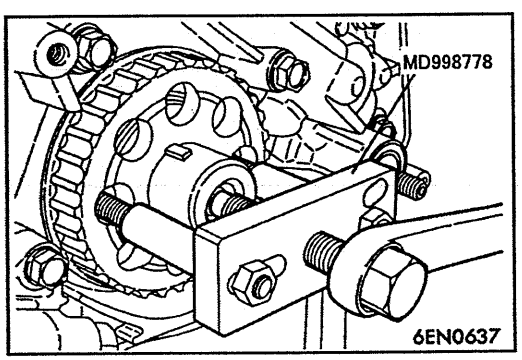
(2) If there is oil or water on each part check front case oil seals, camshaft oil seal and water pump for leaks.



←F→ Counterbalance shaft sprocket removal

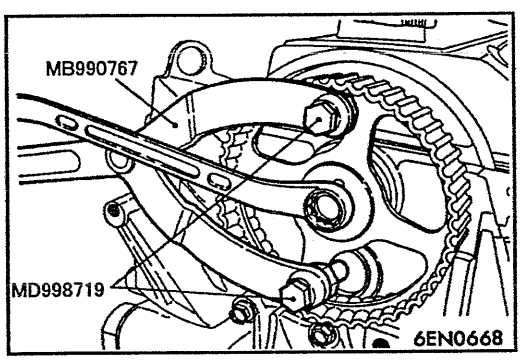
(1) Set the special tool as shown to prevent the counterbalance shaft sprocket from turning together.

(2) Loosen the bolt and remove the sprocket.



←G→ Crankshaft sprocket "B" removal

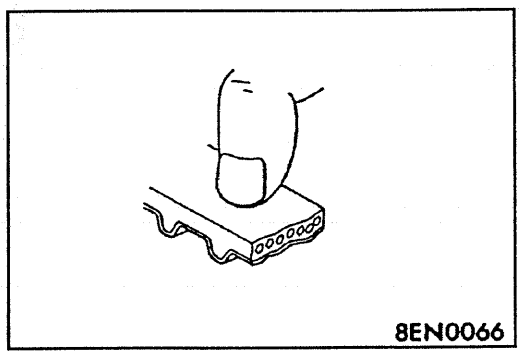
(1) If it is difficult to remove the sprocket, use the special tool.



←H→ Crankshaft sprocket removal

(1) Using the special tools show in the illustration, lock the camshaft sprocket in position.

(2) Loosen the camshaft sprocket bolt.

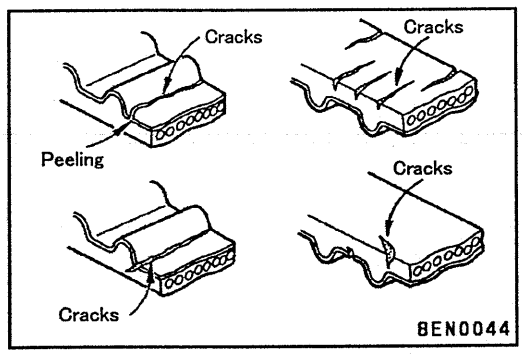


INSPECTION

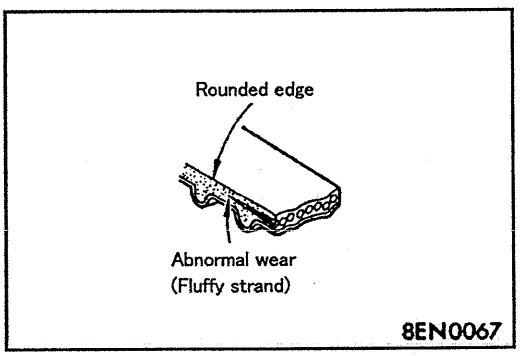
1. Timing Belt

Replace belt if any of the following conditions exist.

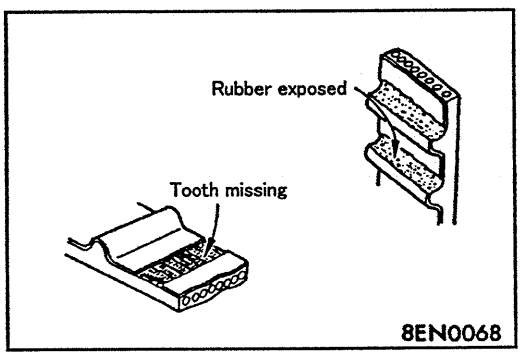
(1) Hardening of back rubber.
Back side is glossy without resilience and leaves no indent when pressed with fingernail.



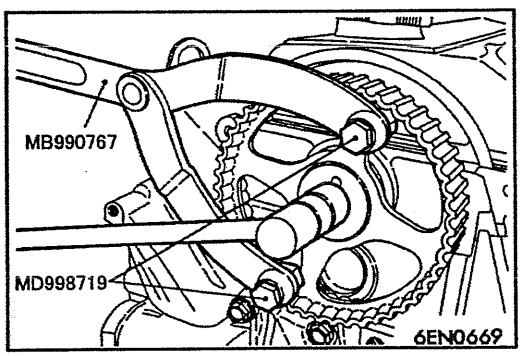
(2) Cracks on rubber back.
(3) Cracks or peeling of canvas.
(4) Cracks on tooth bottom.
(5) Cracks on belt sides.



(6) Abnormal wear of belt sides.
NOTE:
The sides are normal if they are sharp as if cut by a knife.



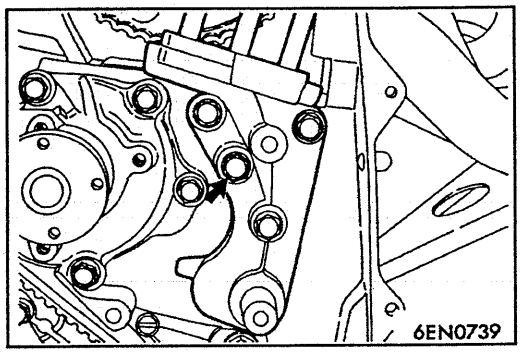
(7) Abnormal wear on teeth.
Earlier stage:
Canvas worn (canvas fibers napped, rubber lost, discolored whitish, and unclear canvas texture)
Latter stage:
Canvas lost, rubber exposed (tooth width thinner)
(8) Missing tooth



INSTALLATION SERVICE POINTS

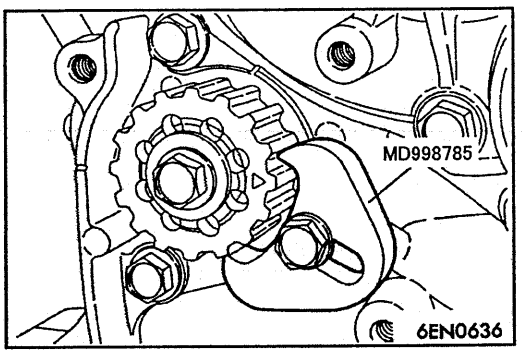
→A← Camshaft sprocket installation

(1) Using the special tools show in the illustration, lock the camshaft sprocket in position.
(2) Tighten the camshaft sprocket bolt to the specified torque.



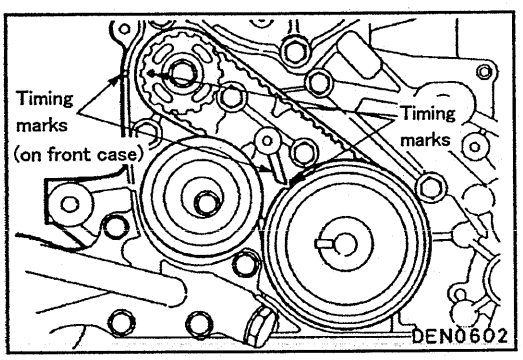
→B← Engine support bracket installation

(1) Coat the bolts illustrated with sealant before tightening.
Specified sealant: 3M™ AAD Part No. 8762 or equivalent



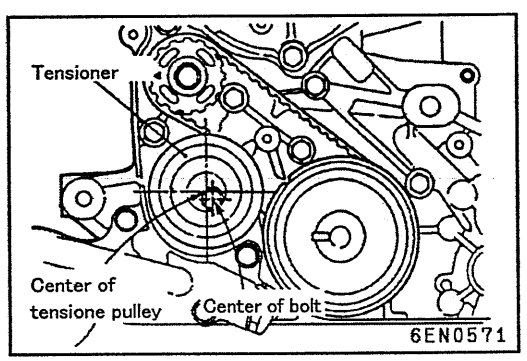
→C← Counterbalance shaft sprocket installation

(1) Install the counterbalance shaft sprocket and screw the bolt.
(2) Install special tool as shown in the illustration to lock the counter balance shaft.
(3) Tighten the bolt, and then remove the special tool.

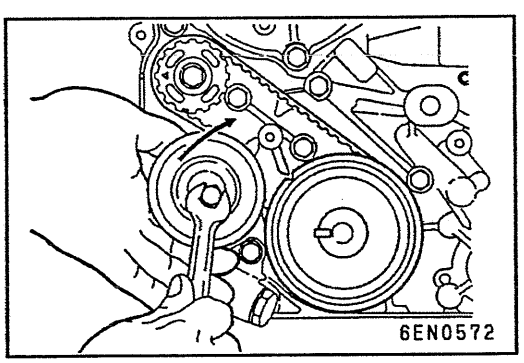


→D← Timing belt "B" installation

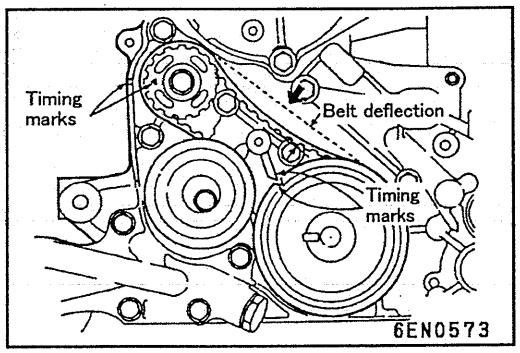
(1) Align timing mark on the crankshaft sprocket "B" and counterbalance shaft sprocket with the marks on the front case respectively.
(2) Install the timing belt "B" on the crankshaft sprocket "B" and counterbalance shaft sprocket. There should be no slack on the tension side.



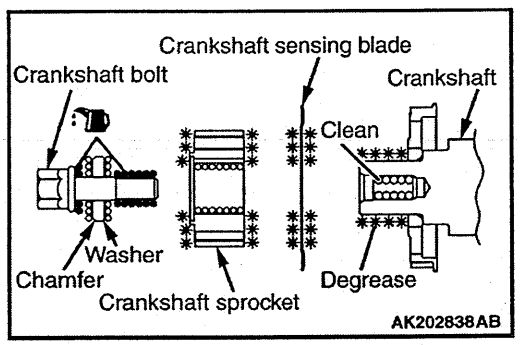
(3) Make sure that the relationship between the tensioner pulley center and the bolt center is as shown in the illustration.



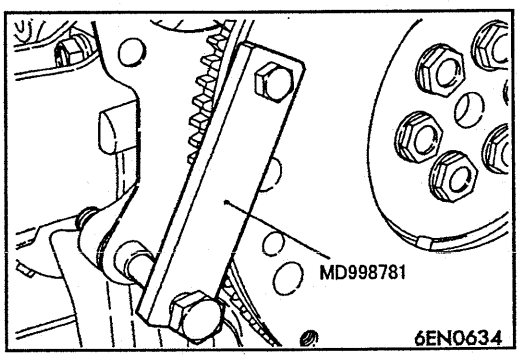
(4) Move the tensioner "B" in the direction of arrow while lifting with a finger to give a sufficient tension to the tension side of timing belt. In this condition, tighten bolt to secure tensioner "B". When the bolt is tightened, use care to prevent shaft from turning together. If shaft is turned together, belt will be over tensioned.

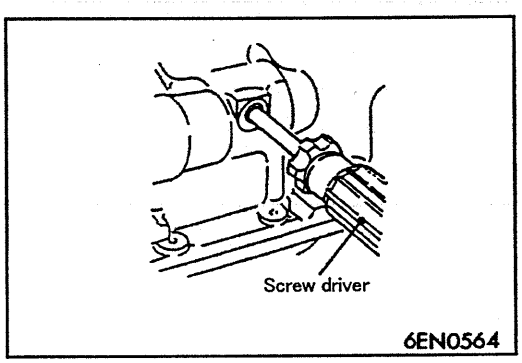


(5) Check to ensure that timing marks on sprockets and front case are in alignment.
(6) Press with index finger the center of span on the tension side of timing belt "B". The bolt must deflect 5 to 7 mm.[0.196 to 0.276 in.]

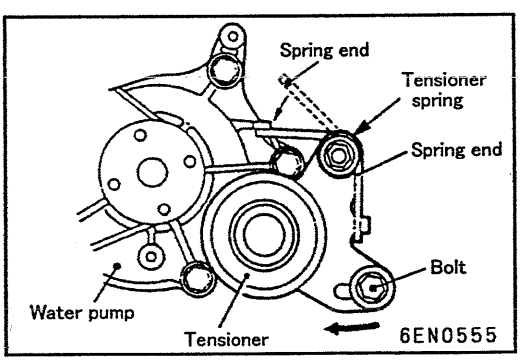


→E← Crankshaft bolt installation
(1) Clean and then degrease the crankshaft sprocket, sprocket fitting surface of the crankshaft, and crankshaft sensing blade. Install the crankshaft sprocket and crankshaft sensing blade on the crankshaft.
(2) Clean the bolt hole in the crankshaft, and then washer.
(3) Apply a necessary minimum amount of oil to the threads and seating surface of the crankshaft bolt.Using the special tool, hold the flywheel.
(4) Install the crankshaft pulley in position.
(5) Using the special tool, hold the flywheel.
(6) Install the crankshaft pulley in position.

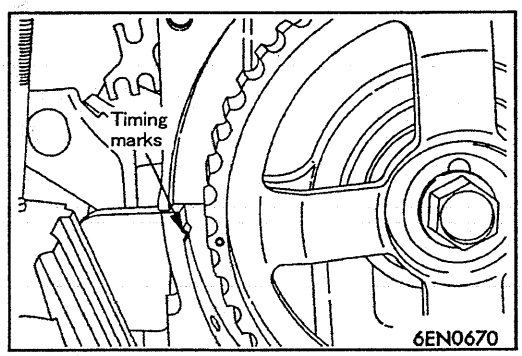




→F← Oil pump sprocket installation
(1) Insert a phillips screwdriver (shank diameter 8 mm [0.31 in.]shaft) through the plug hole on the left side of the cylinder block to the left counterbalance shaft.
(2) Install the oil pump sprocket.
(3) Apply a proper amount of engine oil to the bearing surfaces of the nuts.
(4) Tighten the nuts to the specified torque.

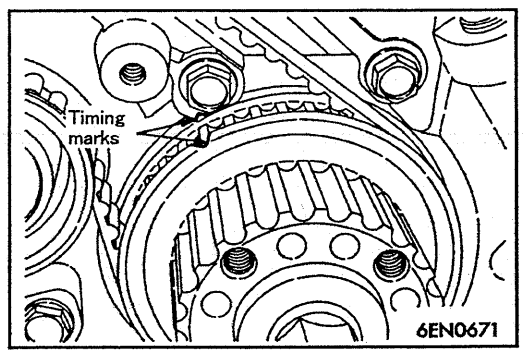


→G← Crankshaft bolt installation
(1) Hook the tensioner spring end to the water pump body projection and tensioner bracket.
(2) Move the tensioner fully toward the water pump and tighten the bolt and tensioner spacer.

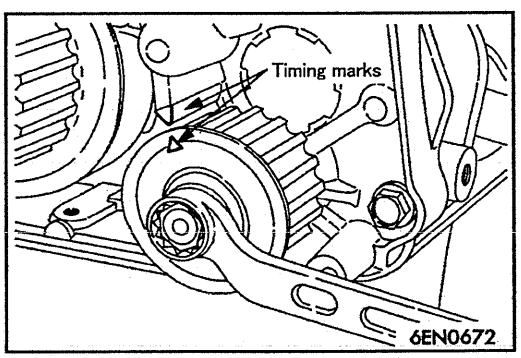


→H← Timing belt installation

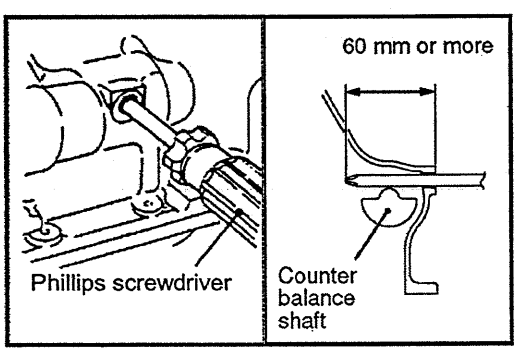
(1) Align the timing mark on the camshaft sprocket with that on the cylinder head.



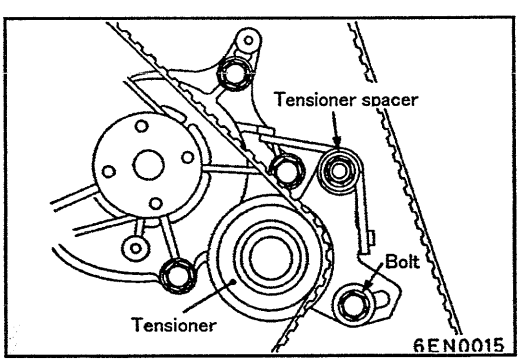
(2) Align the timing mark on the crankshaft sprocket with that on the front case.



(3) Align the timing mark on the oil pump sprocket with its mating mark.



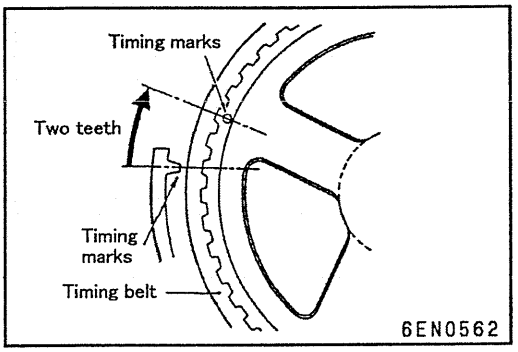
(4) Remove the plug on cylinder block and insert a Phillips screwdriver [shank diameter 8 mm (0.31 in.)] through the hole (Engine with balance shaft)
If it can be inserted as deep as 60 mm (2.4 in.) or more, the timing marks are correctly aligned. If the inserted depth is only 20–25 mm (0.8–1.0 in.), turn the oil pump sprocket one turn and realign the timing marks. Then check to ensure that the screwdriver can be inserted 60 mm (2.4 in.) or more. Keep the screwdriver inserted until installation of the timing belt is finished.



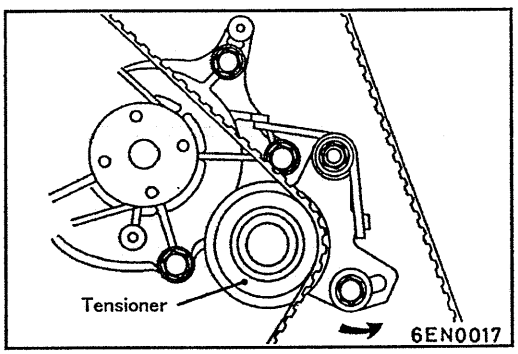
(5) Install the timing belt on the crankshaft sprocket, oil pump sprocket and camshaft sprocket in that order. There should be no slack on the tension side.

(6) Apply a reverse direction (counterclockwise) force to the camshaft sprocket to make the tension side of the belt "tight". In that state, recheck that all the timing marks are in alignment.

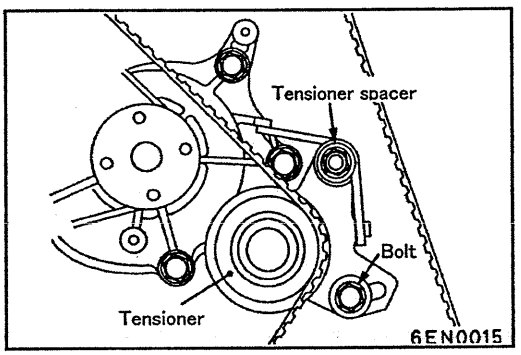
(7) Loosen a turn or two the tensioner bolt and nut that were temporarily tightened to hold the tensioner on the water pump side. This gives tension to the belt by the action of the tensioner spring.



(8) Rotate the crankshaft by the amount equivalent to two camshaft sprocket teeth in the forward (clockwise) direction. Since this step is intended for giving the timing belt proper tension, do not attempt rotate the crankshaft in the reverse (counterclockwise) direction or press the belt to check the tension.



(9) Apply force to the tensioner in the direction shown by arrow to make the belt engage completely with each sprocket.

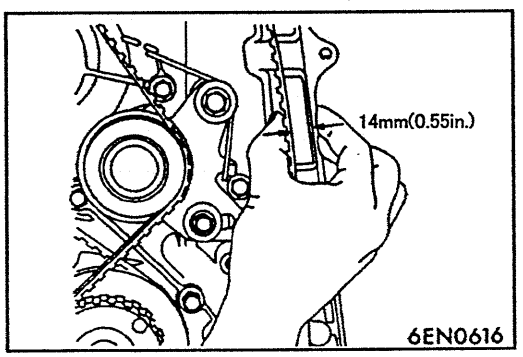


(10) Tighten the tensioner attaching bolt to the specified torque.

(11) Tighten the tensioner spacer to the specified torque.

NOTE:

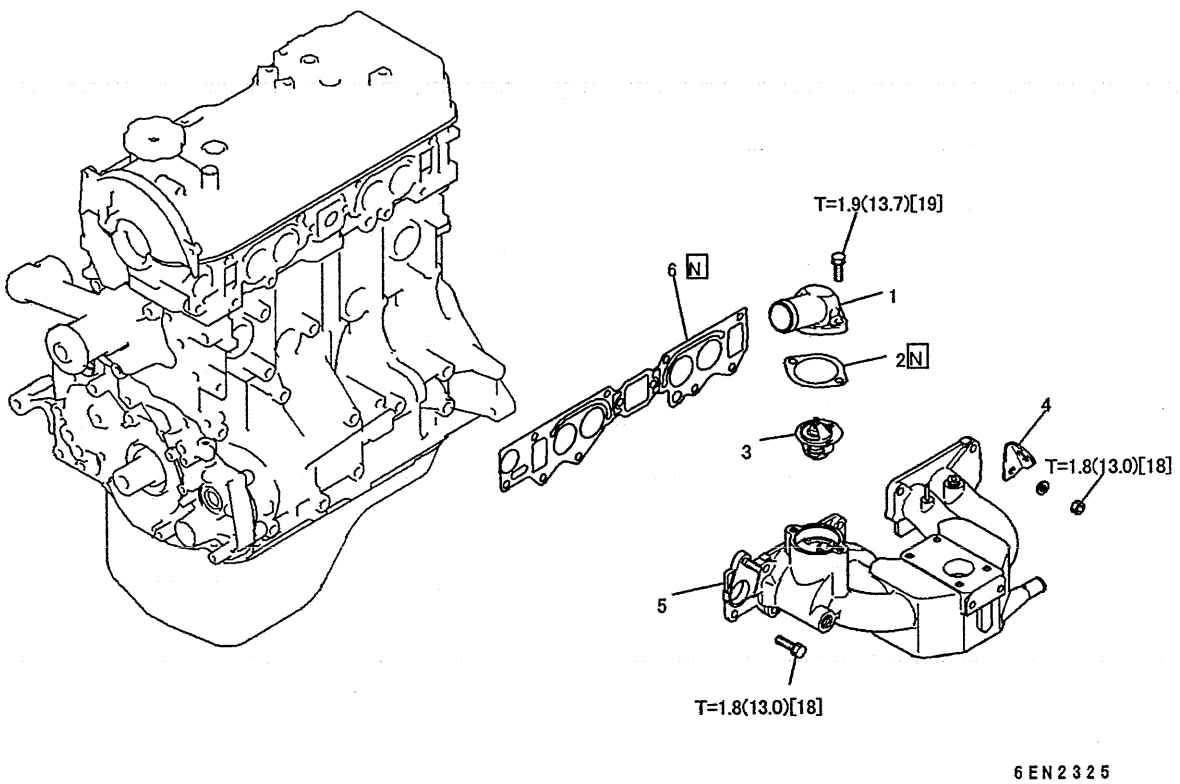
If the nut is tightened first, the tensioner may also turn together with the nut and loose tension of the belt may result. Always tighten the bolt (at the bottom of the tensioner) first and then tighten the nut (at the top of the tensioner).



(12) Hold the center of the tension side span of the timing belt (between the camshaft and oil pump sprockets) between your thumb and index finger as shown. Then, make sure that the clearance between the belt back surface and cover meets the standard value.

Standard value: 14 mm (0.55 in.)

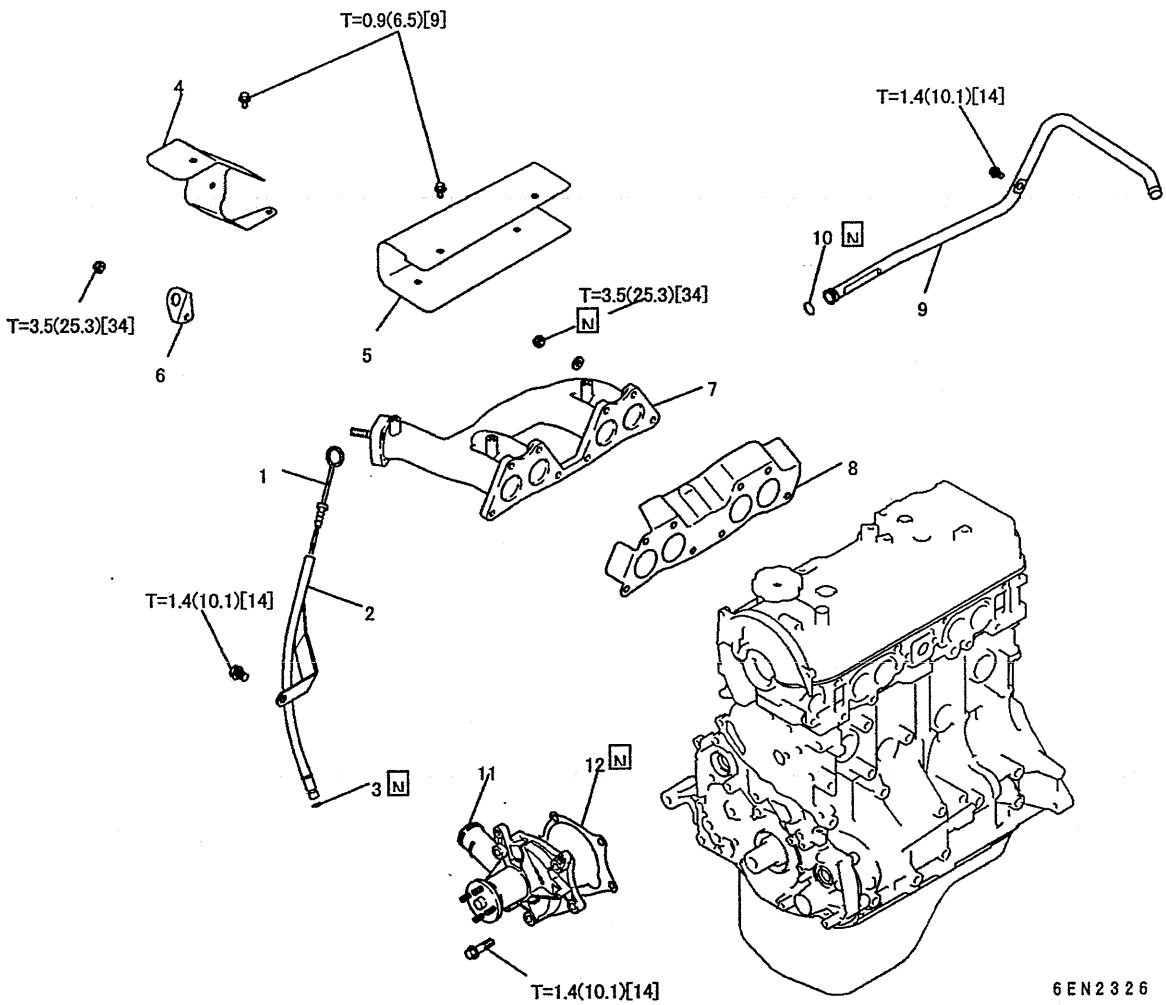
INTAKE MANIFOLD
REMOVAL AND INSTALLATION



Removal steps

1. Water outlet fitting
2. Gasket
3. Thermostat
4. Engine hanger
5. Intake manifold
6. Gasket

EXHAUST MANIFOLD AND WATER PUMP
REMOVAL AND INSTALLATION



Removal steps

1. Oil level gauge
2. Oil level gauge guide
3. O-ring
4. Heat protector A
5. Heat protector B
6. Engine hanger
7. Exhaust manifold
8. Gasket

→A← 9. Water inlet pipe

→A← 10. O-ring.

11. Water pump
12. Gasket

→A← O-ring and water pipe installation

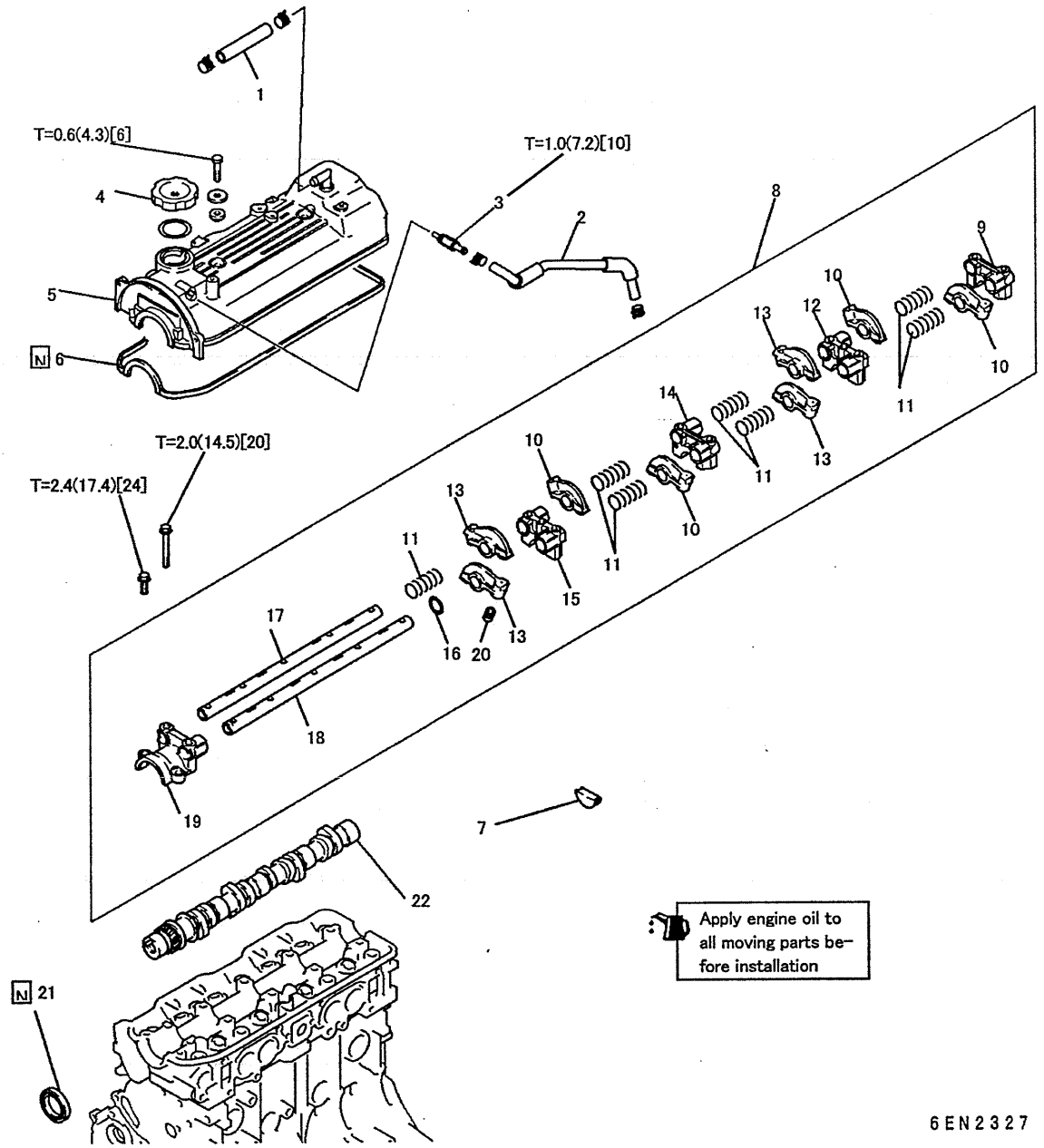
Replace the water inlet pipe O-ring with a new one. Apply water to the outer circumference of the O-ring for easier insertion into the water pump and thermostat housing.

Caution:

1) Never apply engine oil any other oil or grease to the O-ring .
2) Fasten the water pipe after the thermostat housing has been installed.

ROCKER ARMS AND CAMSHAFT

REMOVAL AND INSTALLATION



Removal steps

1. Breather hose
2. P.C.V. hose
3. P.C.V. valve
4. Oil filler cap
5. Rocker cover
6. Gasket

→G← 7. Semi-circular packing

←A→ 8. Rocker arms and rocker shafts

9. Rear bearing cap
10. Rear arm D
11. Spring

→D← 12. Bearing cap No. 4

13. Rocker arm C

→D← 14. Bearing cap No. 3

→D← 15. Bearing cap No. 2

→C← 16. Wave washer

→B← 17. Right rocker shaft

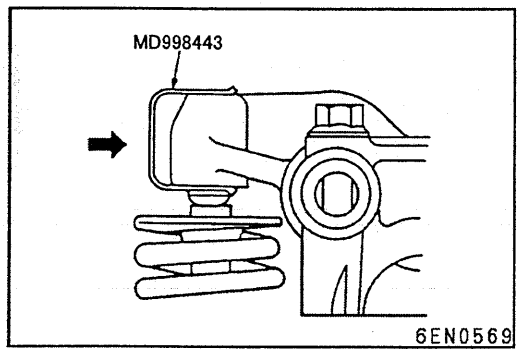
→B← 18. Left rocker shaft

19. Front bearing cap

→E← 20. Lash adjuster

→F← 21. Oil seal

→A← 22. Camshaft



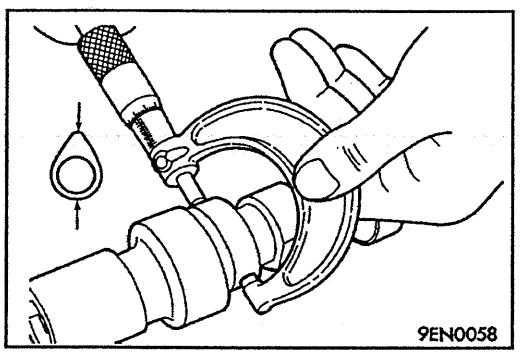
REMOVAL SERVICE POINTS

←A→ Rocker arm and rocker shaft removal

Caution:

If the lash adjuster is re-used, clean the lash adjuster.

(1) Fit the lash adjuster onto the rocker arm without allowing diesel fuel to spill out. Fit. Special tool MD998443 to prevent the lash adjuster coming free and falling to the floor.



INSPECTION

1. Camshaft

Measure the cam height and if the limit is exceeded, replace the camshaft.

Standard value: 41.62 mm (1.6386 in.)

Limit: 41.12 mm (1.6189 in.)

2. Lash Adjuster

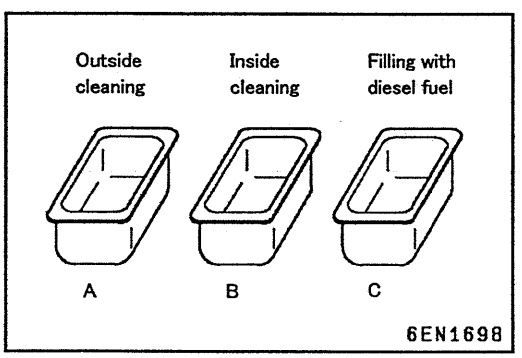
Caution:

1)The lash adjusters are precision-engineered mechanisms.

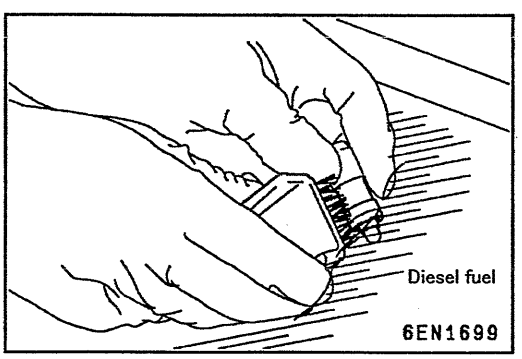
Do not allow them to become contaminated by dirt or other foreign substances.

2)Do not attempt to disassemble the lash adjusters.

3)Use only fresh diesel fuel to clean the lash adjusters



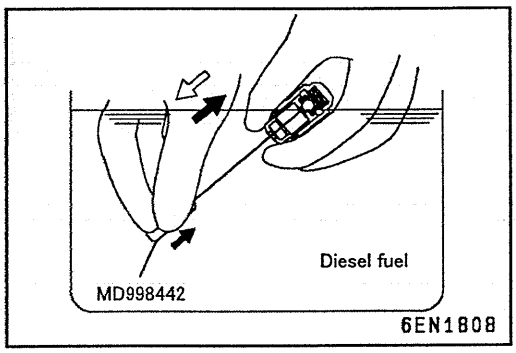
(1) Prepare three containers and approximately 5 liters (5.3 qt) of diesel fuel. Into each container, pour enough diesel fuel to completely cover a lash adjuster when it is standing upright. Then, perform the following steps with each lash adjuster.



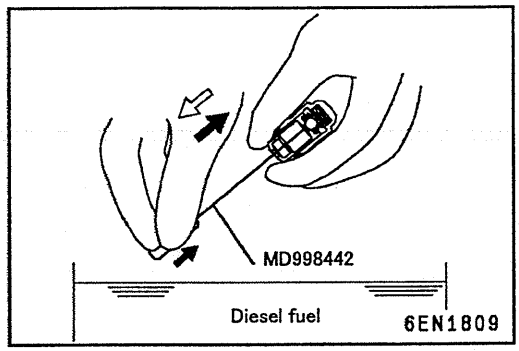
(2) Place the lash adjuster in container A and clean its outside surface.

NOTE:

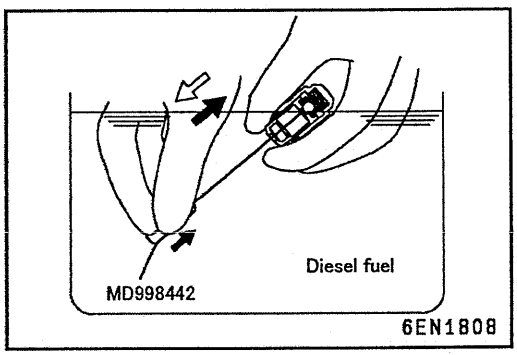
Use a nylon brush if deposits are hard to remove.



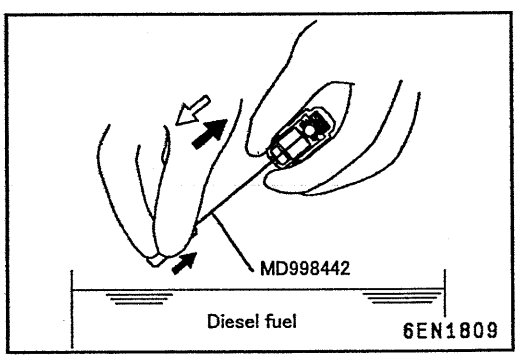
(3) While gently pushing down the internal steel ball using special tool MD998442, move the plunger through five to ten strokes until it slides smoothly. In addition to eliminating stiffness in the plunger, this operation will remove dirty oil.
Caution:
The steel ball spring is extremely weak, so the lash adjuster's functionality may be lost if the air bleed wire is pushed in hard.
NOTE:
If the plunger remains stiff or the mechanism appears otherwise abnormal, replace the lash adjuster.



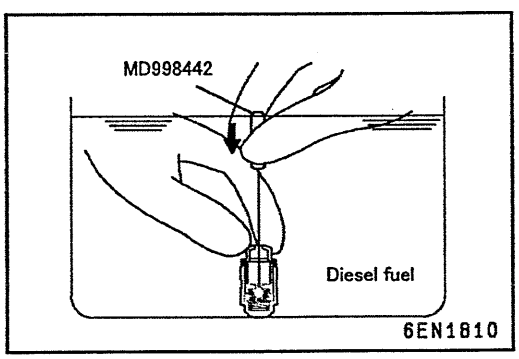
(4) Remove the lash adjuster from the container. Then, push down the steel ball gently and push the plunger to eliminate diesel fuel from the pressure chamber.



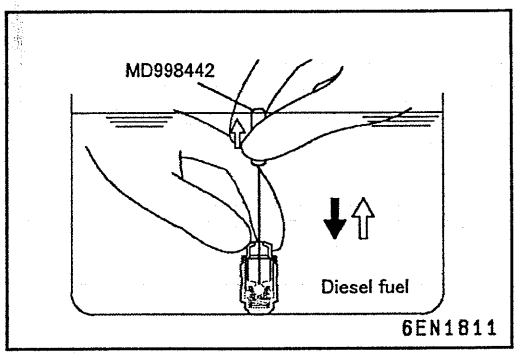
(5) Place the lash adjuster in container B. Then, gently push down the internal steel ball using special tool MD998442 and move the plunger through five to ten strokes until it slides smoothly. This operation will clean the lash adjuster's pressure chamber.
Caution:
The steel ball spring is extremely weak, so the lash adjuster's functionality may be lost if the air bleed wire is pushed in hard.



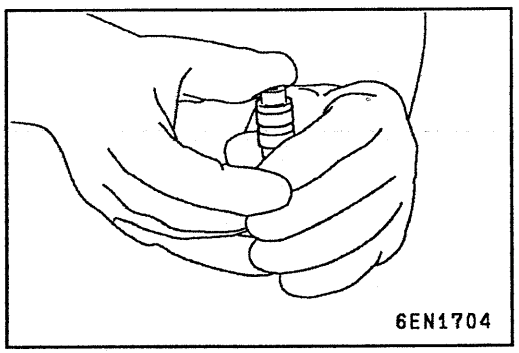
(6) Remove the lash adjuster from the container. Then, push down the steel ball gently and push the plunger to eliminate diesel fuel from the pressure chamber.



(7) Place the lash adjuster in container C. Then, gently push down the internal steel ball using special tool MD998442.
Caution:
Do not use container C for cleaning. If cleaning is performed in container C, foreign matter could enter the pressure chamber when the chamber is filled with diesel fuel.



(8) Stand the lash adjuster with its plunger at the top, then push the plunger downward firmly until it moves through its greatest possible stroke. Return the plunger slowly, then release the steel ball and allow the pressure chamber to fill with diesel fuel.



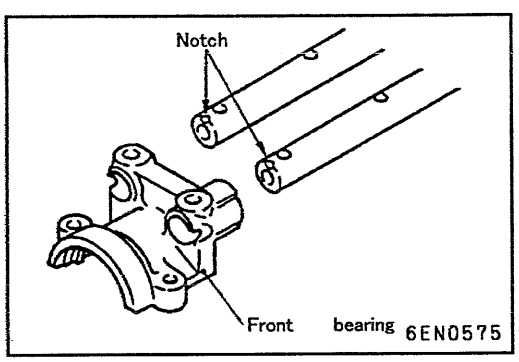
(9) Remove the lash adjuster from the container, then stand the lash adjuster with its plunger at the top. Push the plunger firmly and check that it does not move.
NOTE:
If lash adjuster contracts, perform the operations (7) through (9) again to fill it with diesel fuel completely. Replace the lash adjuster if it still contracts after performing these steps.

(10) Stand the lash adjuster upright to prevent diesel fuel spilling out. Do not allow the lash adjuster to become contaminated by dirt or other foreign matter. Fit the lash adjuster onto the engine as soon as possible.

INSTALLATION SERVICE POINTS

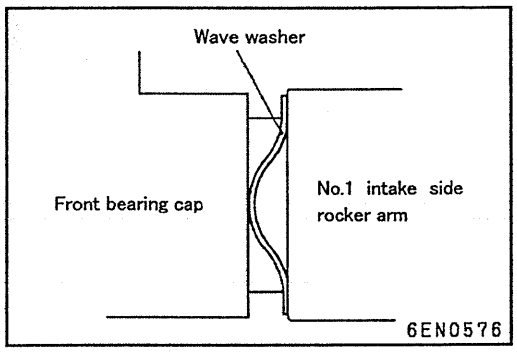
→A← Camshaft installation

Apply engine oil to the journals and cams of the camshafts. Install the camshaft on the cylinder head.

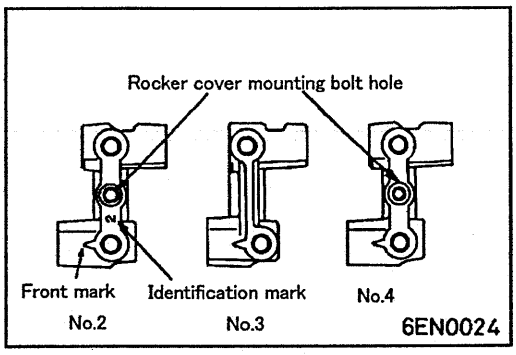


→B← Rocker shaft installation

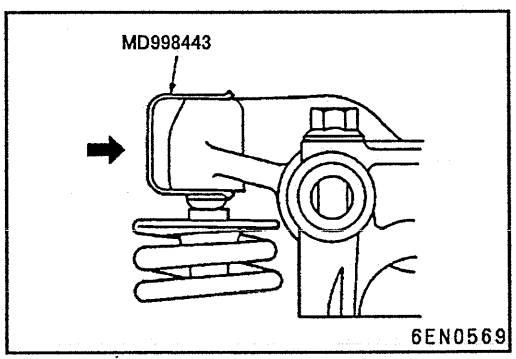
Insert the rocker shafts into the front bearing cap so that the notches on the shafts face up, and insert the installation bolts without tightening them.



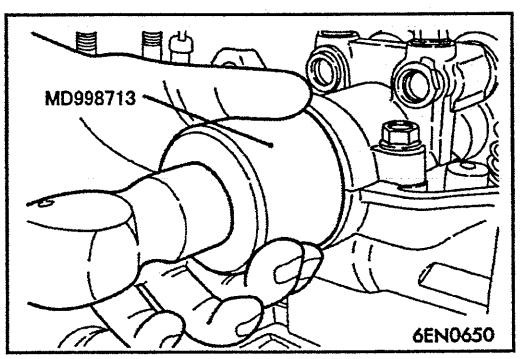
→C← Wave washer installation
Install the wave washer in correct direction as shown.



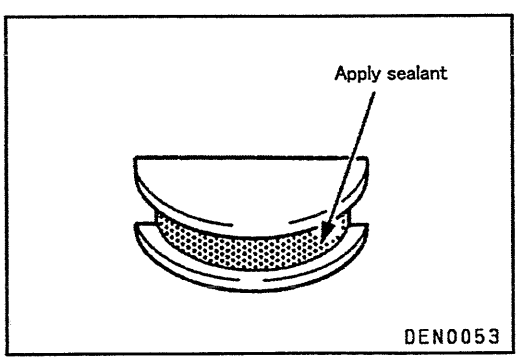
→D← Bearing cap installation
(1) No.3 bearing cap looks very similar to No.2 and No.4 bearing caps.
NOTE:
No.2 bearing cap is the same as No.4 bearing cap.
(2) Install the bearing caps with their front marks pointing to the camshaft sprocket side.



→E← Lash adjuster installation
Caution:
If the lash adjuster is re-used, clean the lash adjuster.
(1) Set special tool MD998443 to prevent the lash adjuster coming free and falling to the floor.

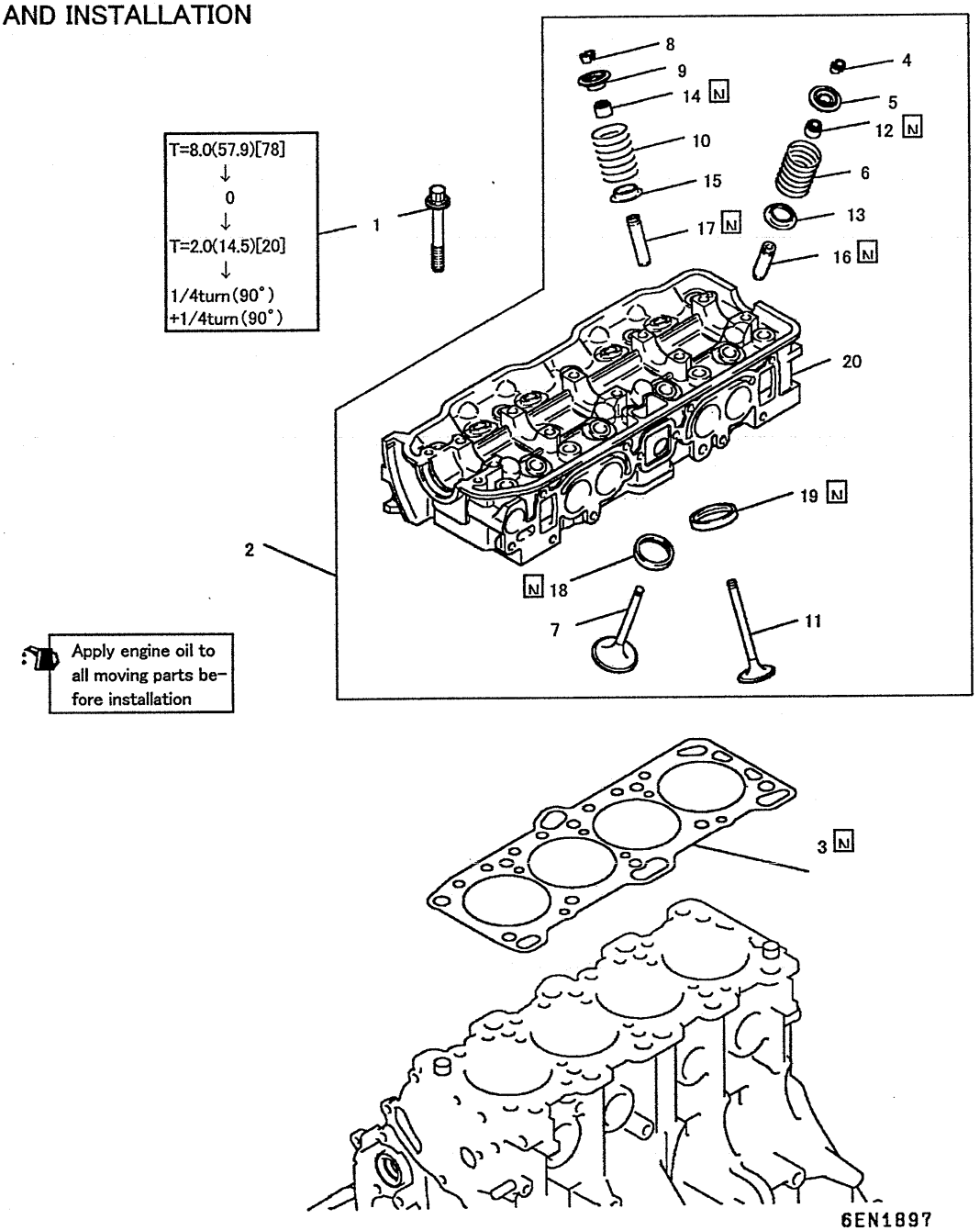


→F← Camshaft oil seal installation
(1) Apply engine oil to the lip area of the oil seal and the camshaft front end outer diameter.
(2) Using special tool, install the camshaft oil seal.



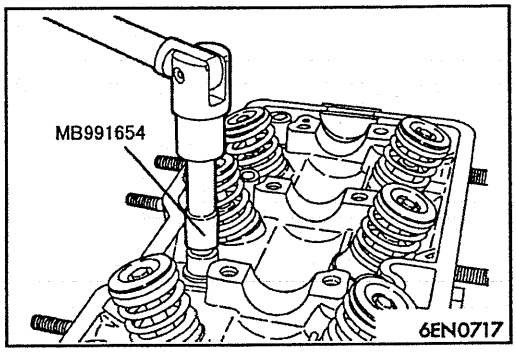
→G← Semi-circular packing installation
(1) Apply sealant to the location shown in the illustration.
Specified sealant: 3M™ AAD Part No 8672 or equivalent.

CYLINDER HEAD AND VALVES
REMOVAL AND INSTALLATION



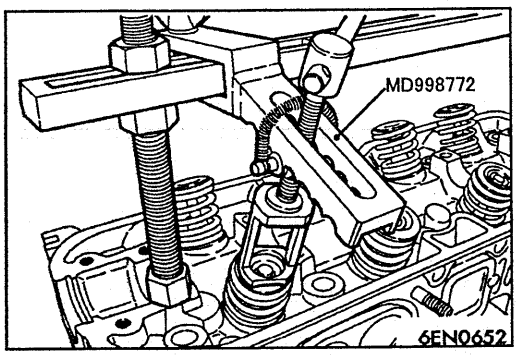
Removal steps

←A→ →D← 1. Cylinder head bolt
2. Cylinder head assembly
3. Cylinder head gasket
←B→ →C← 4. Retainer lock
5. Valve spring retainer
→B← 6. Valve spring
7. Intake valve
←B→ →C← 8. Retainer lock
9. Valve spring retainer
→B← 10. Valve spring
11. Exhaust valve
←C→ →A← 12. Valve stem seal
13. Valve spring seat
←C→ →A← 14. Valve stem seal
15. Valve spring seat
16. Intake valve guide
17. Exhaust valve guide
18. Intake valve seat
19. Exhaust valve seat
20. Cylinder head

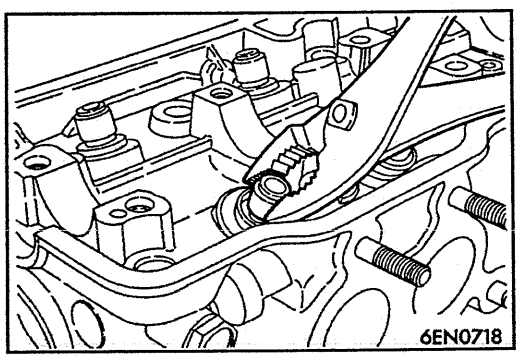


REMOVAL SERVICE POINTS

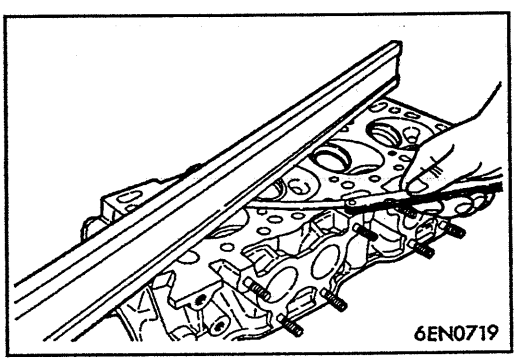
←A→ Cylinder head bolt removal
Using special tool, loosen the cylinder head bolts. Loosen each bolt evenly, little by little, by two or three steps.



←B→ Retainer lock removal
Store removed valves, springs and other parts, tagged to indicate their cylinder No. and location for reassembly.

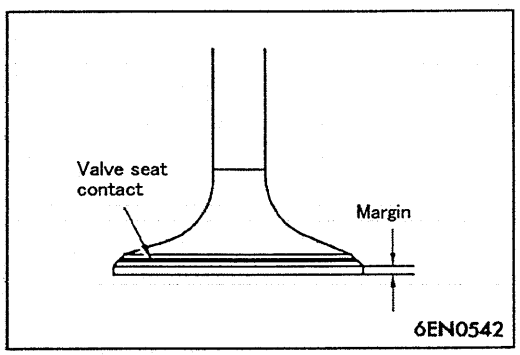


←C→ Valve stem seal removal
Caution:
Do not reuse removed valve stem seal.

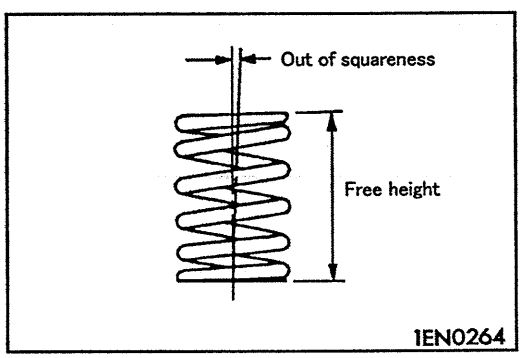


INSPECTION

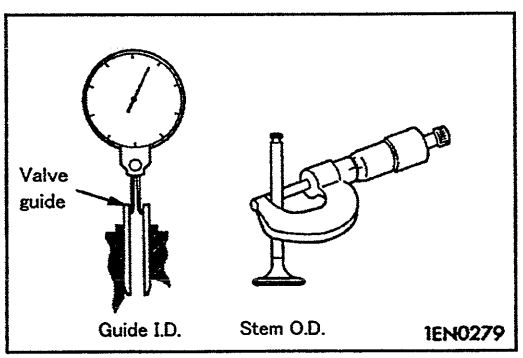
1. Cylinder Head
   (1) Check the cylinder head for water leaks, gas leaks, damage or cracks before cleaning.
   (2) Thoroughly remove oil, water scale, sealant, carbon deposit, etc. After the oil passages have been cleaned, blow air to make sure that they are clean.
   (3) Check the cylinder head gasket surface for flatness by using a straightedge and thickness gauge.
   If the service limit is exceeded, correct to meet the specification.
   Standard valve: 0.03 mm (0.0012 in.) or less.
   Limit: 0.2 mm (0.008 in.)
   Grinding limit: 0.2 mm (0.008 in.)
   Cylinder head height (when new): 89.9 to 90.1 mm (3.539 to 3.547 in.)
   NOTE:
   Grinding the cylinder head is permitted as long as the total thickness of the metal removed from the cylinder head and the cylinder block does not exceed 0.2 mm (0.008 in.).



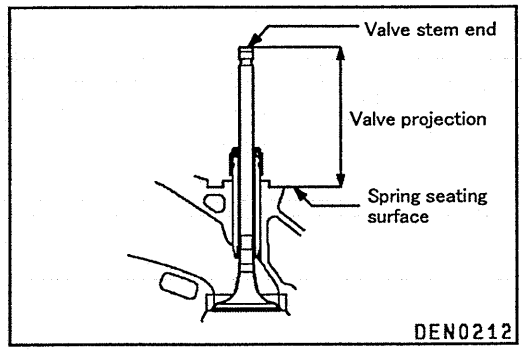
2. Valve
   (1) Check the valve face for correct contact. If incorrect, reface. Valve seat contact should be maintained uniform at the center of valve face.
   (2) If the margin exceeds the service limit, replace the valve.
   Standard value:
   Intake 1.2 mm (0.047 in.)
   Exhaust 2.0 mm (0.079 in.)
   Limit:
   Intake 0.7 mm (0.028 in.)
   Exhaust 1.5 mm (0.059 in.)
   (3) Measure the valve's total length. If the measurement is less than specified, replace the valve.
   Standard value:
   4G63 Intake 109.8 mm (4.328 in.)
   Exhaust 108.7 mm (4.280 in.)
   4G64 Intake 106.6 mm (4.197 in.)
   Exhaust 105.2 mm (4.142 in.)
   Limit:
   4G63 Intake 109.3 mm (4.3031 in.)
   Exhaust 108.2 mm (4.260 in.)
   4G64 Intake 106.1 mm (4.177 in.)
   Exhaust 104.7 mm (4.122 in.)



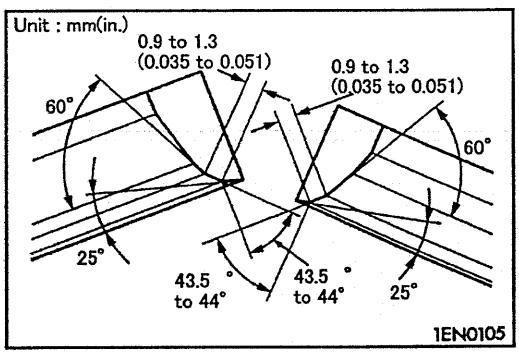
3. Valve Spring
   (1) Measure the free height of spring and, if it is smaller than the limit, replace.
   Standard value: 48.0 mm (1.89 in.)
   Limit: 47.0 mm (1.85 in.)
   (2) Measure the squareness of the spring and, if the limit is exceeded, replace.
   Standard value: 2° or less
   Limit: 4°



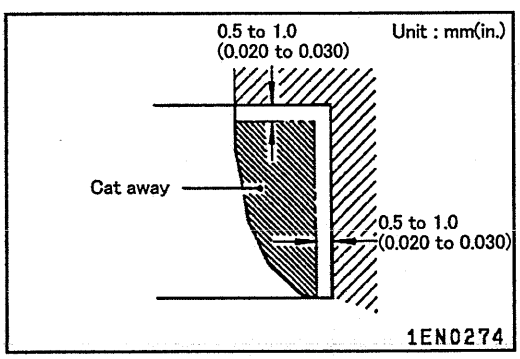
4. Valve Guide
   Measure the clearance between the valve guide and valve stem. If the limit is exceeded, replace the valve guide or valve, or both.



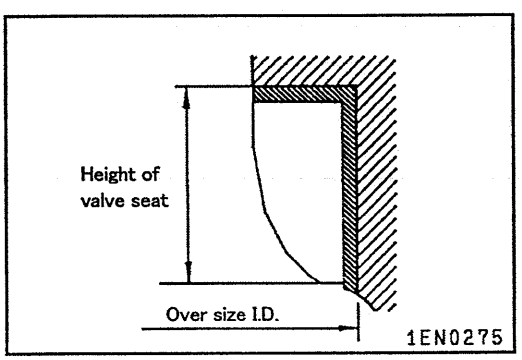
5. Valve Seats
Assemble the valve, than measure the valve stem projection between the end of the valve stem and the spring seating surface. If the measurement exceeds the specified limit, replace the valve seat.
Standard value: 42.05 mm (1.6555 in.)
Limit: 42.55 mm (1.6752 in.)



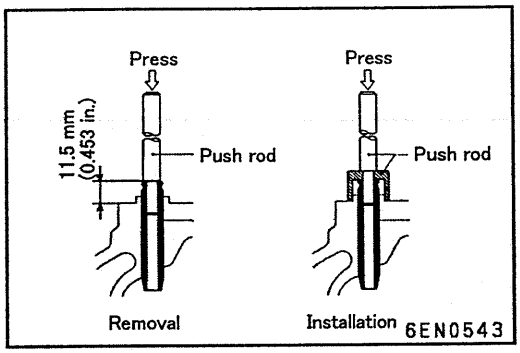
Valve Seat Reconditioning Procedure
(1) Before correcting the valve seat, check for clearance between the valve guide and valve and, if necessary, replace the valve guide.
(2) Correct to obtain the specified seat width and angle.
(3) After correction, valve and valve seat should be lapped with a lapping compound.



Valve Seat Replacement Procedure
(1) Cut the valve seat to be replaced from the inside to thin the wall thickness. Then, remove the valve seat.



(2) Rebore the valve seat hole in the cylinder head to a selected oversize valve seat diameter.
(3) Before fitting the valve seat, cool the valve seat in liquid nitrogen, to prevent the cylinder head bore from galling.
(4) Using a valve seat cutter, correct the valve seat to the specified width and angle.
See "Valve Seat Reconditioning Procedure".

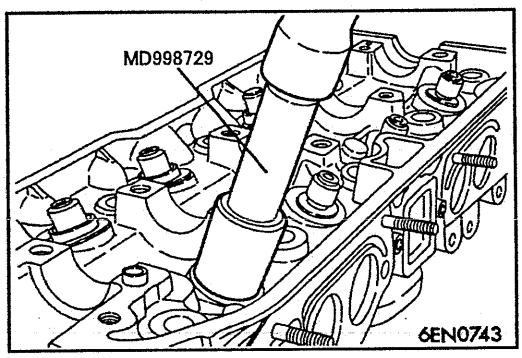


Valve Guide Replacement Procedure

(1) Using a press, remove the valve guide toward the cylinder block side.

(2) Rebore the valve guide hole to the new oversize valve guide outside diameter.
NOTE:
Do not install a valve guide of the same size again.
Valve guide hole diameter:
0.05 O.S. 13.05 to 13.07 mm (0.5138 to 0.5146 in.)
0.25 O.S. 13.25 to 13.27 mm (0.5217 to 0.5224 in.)
0.50 O.S. 13.50 to 13.52 mm (0.5315 to 0.5323 in.)

(3) Press in the valve guide to the position shown in the illustration.
Standard value: 11.5 mm (0.453 in.)
NOTE:
1) Press-fit the valve guide, working from the cylinder head top surface.
2) Note that the intake and exhaust side valve guides are different in length.
3) After installing valve guides, insert new valves in them to check for sliding condition.

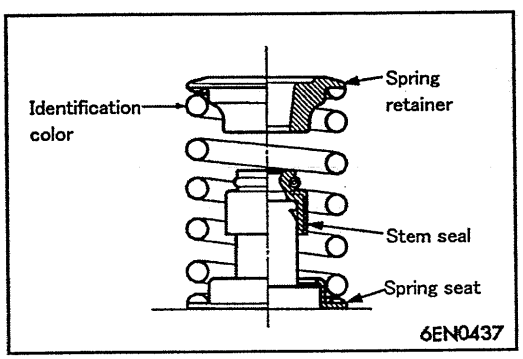


INSTALLATION SERVICE POINTS

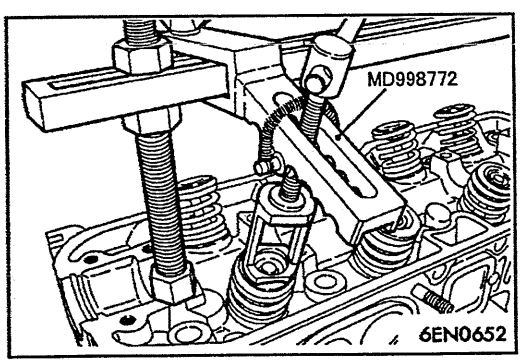
→A← Valve stem seal installation

(1) Install the valve spring seat.

(2) Using special tool, install the new valve stem seat to the valve guide.
Caution:
1) Do not reuse removed valve stem seal.
2) The special tool must be used to install the valve stem seal. Improper installation could result in oil leaking past the valve guide.



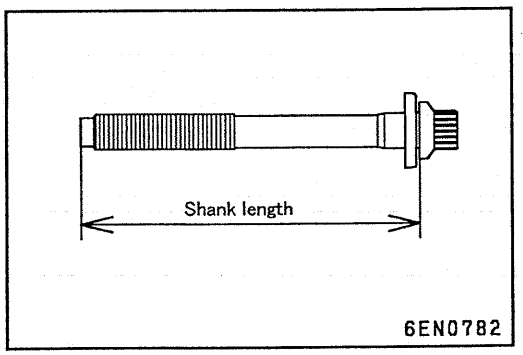
→B← Valve spring installation
Direct the valve spring end with identification color toward the rocker arm.

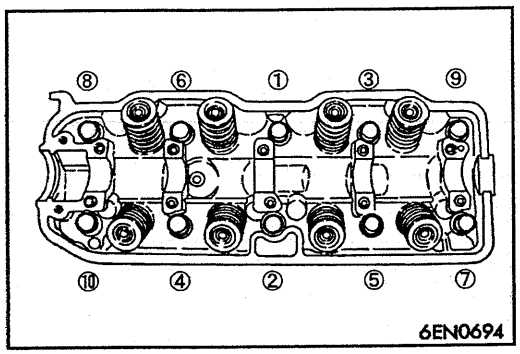


→C← Retainer lock installation

(1) Using special tool install retainer lock.

(2) The valve spring, if excessively compressed, causes the bottom end of the retainer to be in contact.





→D← Cylinder head bolt installation

(1) When installing the cylinder head bolts, check that the shank length of each bolt meets the limit. If the limit is exceeded, replace the bolt.
Limit: Max 120.4 mm (4.740 in.)

(2) Apply engine oil to the bolt threads and washers.

(3) According to the tightening sequence, tighten the bolts to 8.0 kgf·m (57.9 lbf·ft) [80 N·m].

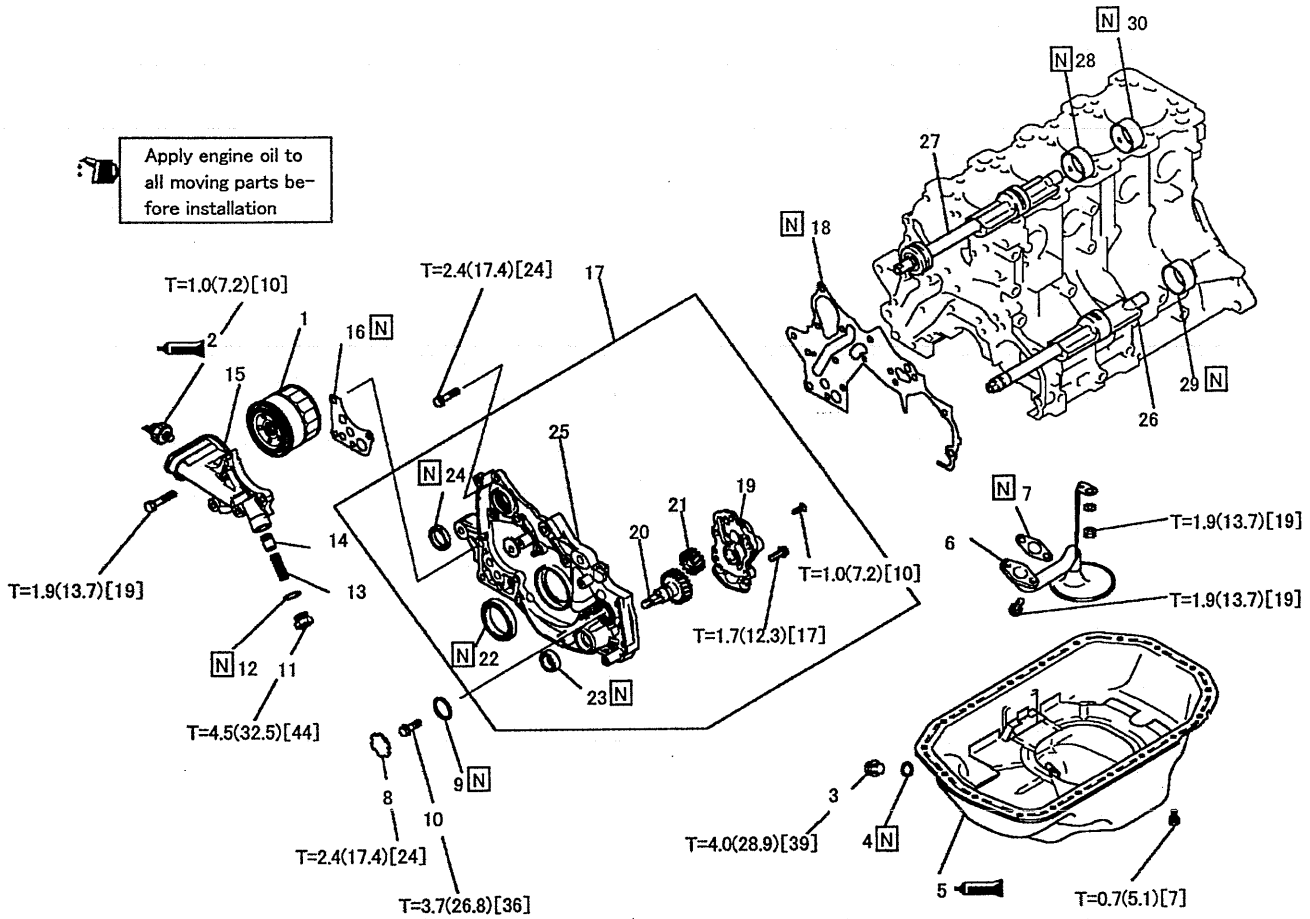
(4) Loosen the bolts completely.

(5) Torque the bolts to 2.0 kgf·m (14.5 lbf·ft) [20 N·m].

(6) Tighten the bolts 1/4 turns (90°) more.

(7) Tighten the bolts 1/4 turns (90°) additionally.
Caution:
1) If the bolt is turned less than 90° , proper fastening performance may not be expected. When tightening the bolt, therefore, be careful to give a sufficient turn to it.
2) If the bolt is over tightened, loosen the bolt completely and then retighten it by repeating the tightening procedure from step (1).

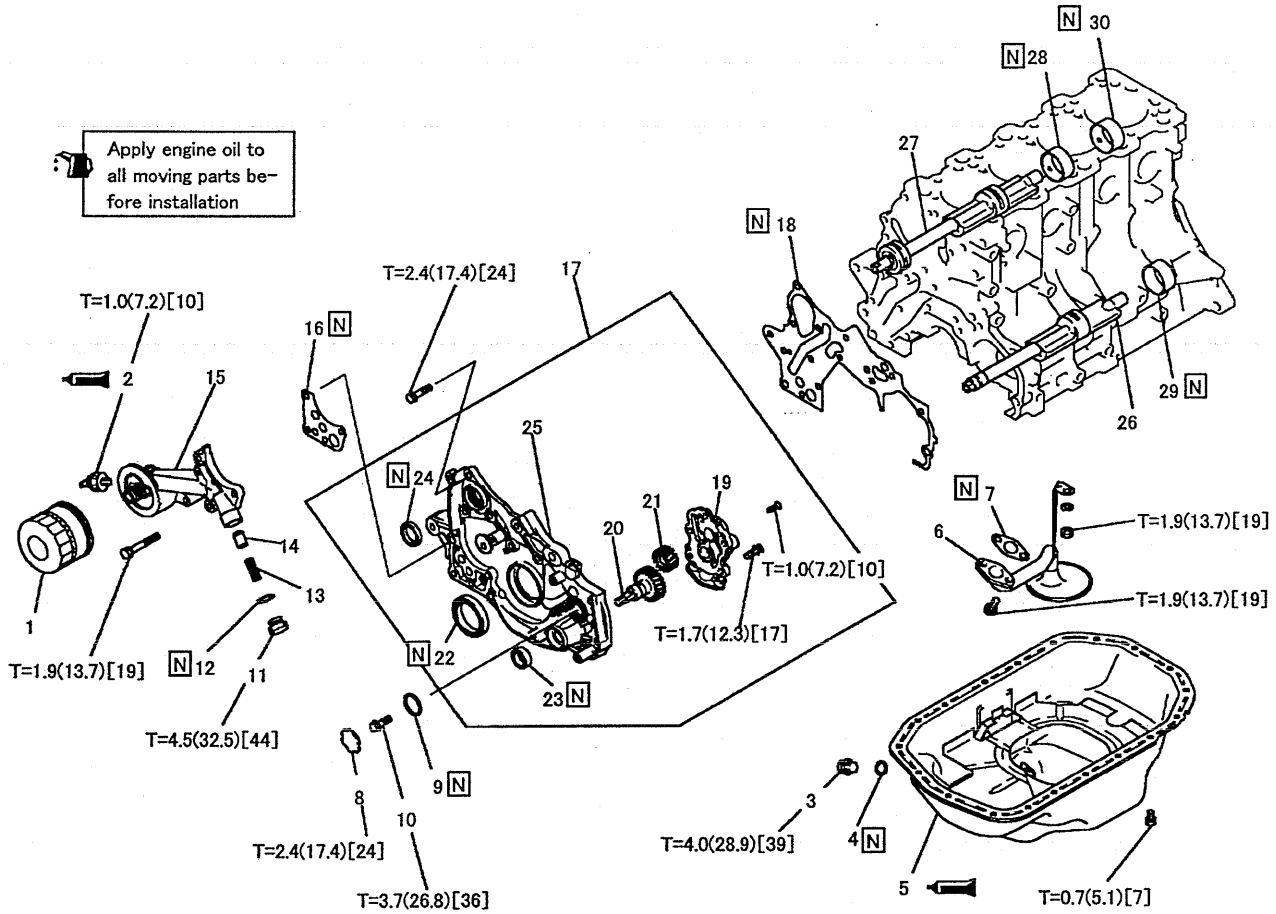
FRONT CASE AND OIL PAN
REMOVAL AND INSTALLATION
4G63 Engine



Removal steps

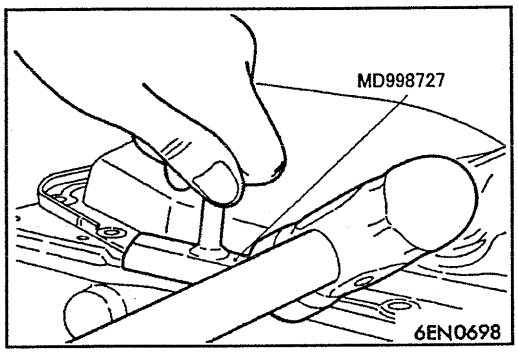
- →N←1. Oil filter
- →M←2. Oil pressure switch
- 3. Drain plug
- →L←4. Drain plug gasket
- ←A→→K←5. Oil pan
- 6. Oil screen
- 7. Oil screen gasket
- ←B→→J←8. Plug
- 9. O-ring
- ←C→→I←10. Flange bolt
- 11. Relief plug
- 12. Gasket
- 13. Relief spring
- 14. Relief plunger
- 15. Oil filter bracket
- 16. Oil filter bracket gasket
- →H←17. Oil pump case assembly
- 18. Front case gasket
- →G←19. Oil pump cover
- →G←20. Oil pump drive gear
- →G←21. Oil pump driven gear
- →F←22. Crankshaft front oil seal
- →E←23. Oil pump oil seal
- →D←24. Counterbalance shaft oil seal
- 25. Front case
- 26. Counterbalance shaft, left
- 27. Counterbalance shaft, right
- ←D→→C←28. Counterbalance shaft, front bearing
- ←E→→B←29. Counterbalance shaft, rear bearing, left
- ←E→→A←30. Counterbalance shaft, rear bearing, right

REMOVAL AND INSTALLATION
4G64 Engine



Removal steps

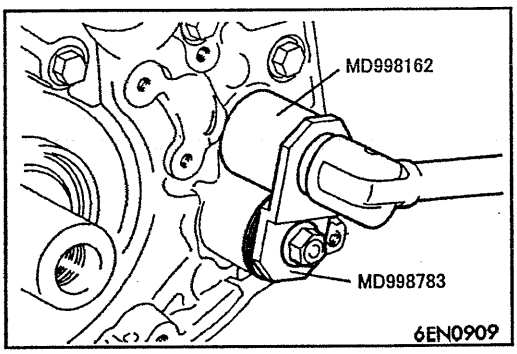
- →N←1. Oil filter
- →M←2. Oil pressure switch
- 3. Drain plug
- →L←4. Drain plug gasket
- ←A→→K←5. Oil pan
- 6. Oil screen
- 7. Oil screen gasket
- ←B→→J←8. Plug
- 9. O-ring
- ←C→→I←10. Flange bolt
- 11. Relief plug
- 12. Gasket
- 13. Relief spring
- 14. Relief plunger
- 15. Oil filter bracket
- 16. Oil filter bracket gasket
- →H←17. Oil pump case assembly
- 18. Front case gasket
- →G←19. Oil pump cover
- →G←20. Oil pump drive gear
- →G←21. Oil pump driven gear
- →F←22. Crankshaft front oil seal
- →E←23. Oil pump oil seal
- →D←24. Counterbalance shaft oil seal
- 25. Front case
- 26. Counterbalance shaft, left
- 27. Counterbalance shaft, right
- ←D→→C←28. Counterbalance shaft, front bearing
- ←E→→B←29. Counterbalance shaft, rear bearing, left
- ←E→→A←30. Counterbalance shaft, rear bearing, right



REMOVAL SERVICE POINTS

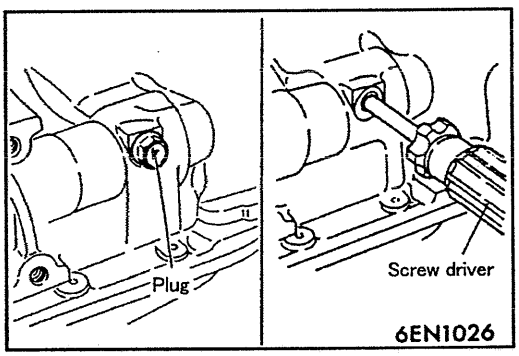
←A→ Oil pan removal

(1) Remove the all oil pan bolts.
(2) Drive in the special tool between the cylinder block and oil pan.
(3) Side the tool by striking the edge of the special tool to separate the oil pan from the cylinder block.



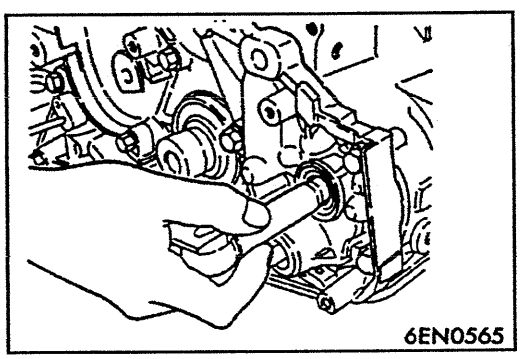
←B→ Plug removal

(1) Fit special tool MD998162 on the plug, then hold it in position with special tool MD998783.
(2) Loose the plug.

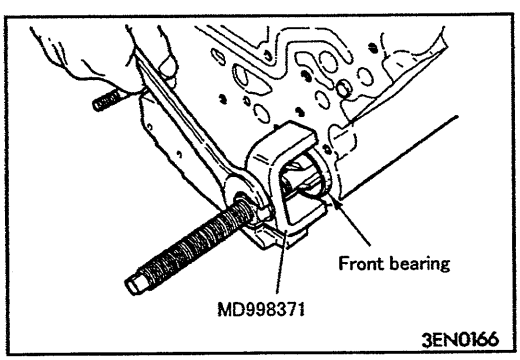


←C→ Oil pump oil seal removal

(1) Remove the plug on the side of cylinder block.
(2) Insert a phillips screwdriver(shank diameter 8mm[0.31 in.]) into the plug hole to lock the counterbalance shaft.

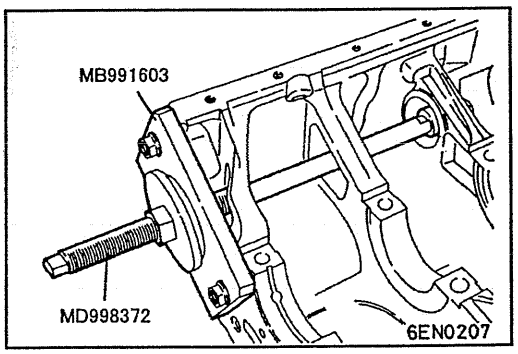


(3) Loosen the flange bolt.



←D→ Counterbalance shaft front bearing removal

(1) Using the special tool, remove the counterbalance shaft front bearing from the cylinder block.
NOTE:
Be sure to remove the front bearing first. If it has not been removed, the rear bearing puller cannot be used.



←E→ Counterbalance shaft rear bearing removal

(1) Using the special tools, remove the counterbalance shaft rear bearing from the cylinder block.
NOTE:
When removing the left counterbalance shaft bearing, install the special tool (MB991603) in front of the cylinder block.

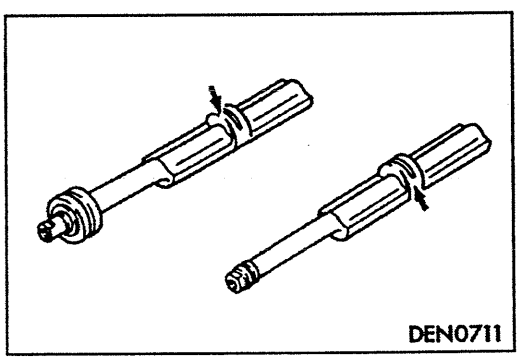
INSPECTION

1.Front Case

(1) Check oil holes for clogging and clean if necessary.
(2) Check the left counterbalance shaft front bearing section for wear, damage and seizure. If there is anything wrong with the section, replace the front case.
(3) Check the front case for cracks for and other damage. Replace cracked or damaged front case.

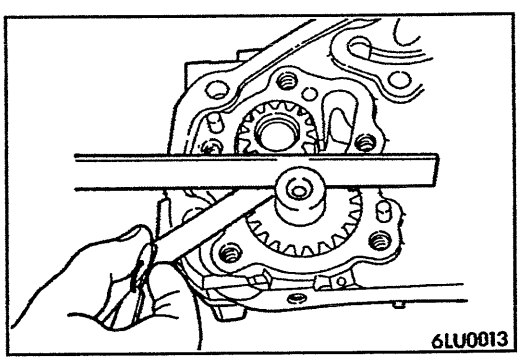
2.Oil Seal

(1) Check the oil seal lip for wear and Replace oil seal if necessary.
(2) Check the oil seal lip for deterioration. Replace oil seal if necessary.



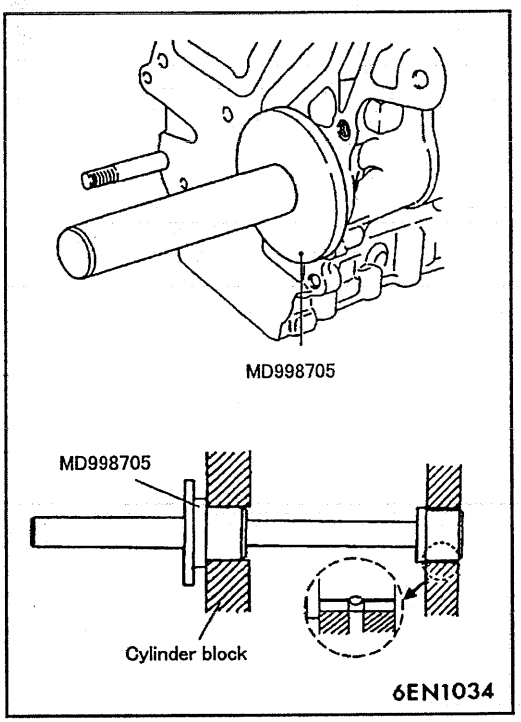
3.Counterbalance Shaft

(1) Check oil hole for clogging.
(2) Check journals for seizure, damage and contact with bearing. If there is anything wrong with the journal assembly.



4. Oil Pump

(1) Assemble the oil pump to the front case and rotate it to ensure smooth rotation with no looseness.
(2) Check the side clearance using a thickness gauge.
(3) Check the side clearance
Standard value:
Drive gear 0.08 to 0.14 mm (0.0031 to 0.0055 in.)
Driven gear 0.06 to 0.12 mm (0.0024 to 0.0047 in.)

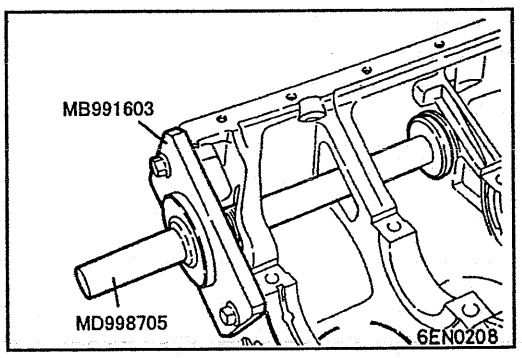


INSTALLATION SERVICE POINTS

→A← Right counterbalance shaft rear bearing installation

(1) Apply engine oil to the outer surface of bearing.

(2) Using special tools, install right rear bearing. Make sure that oil hole of bearing is aligned with oil hole of cylinder block.

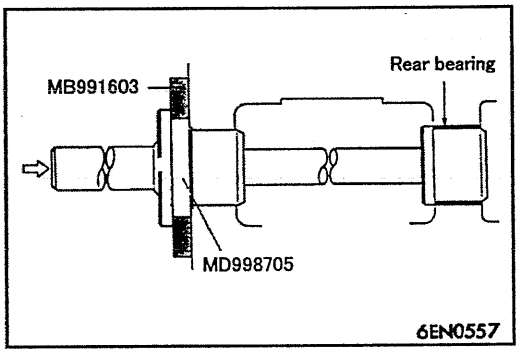


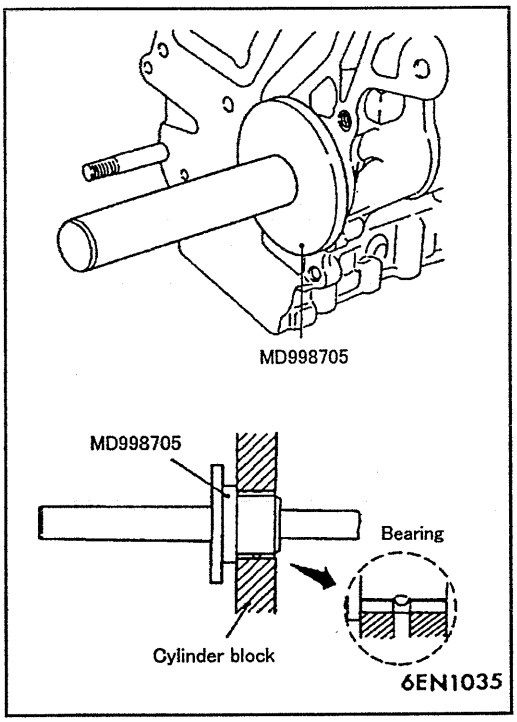
→B← Left counterbalance shaft rear bearing installation

(1) Install the special tool (Guide Plate) to cylinder block.

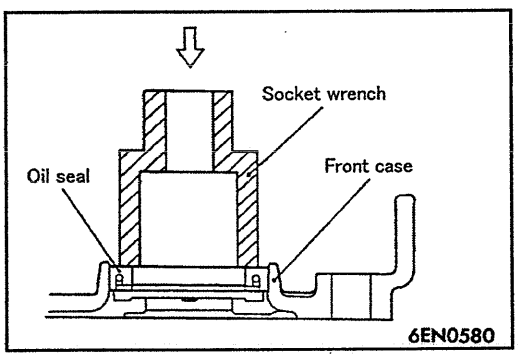
(2) Apply engine oil to the rear bearing outer circumference and bearing hole in the cylinder block.

(3) Using the special tools, install the rear bearing.
NOTE:
The left rear bearing has no oil holes.

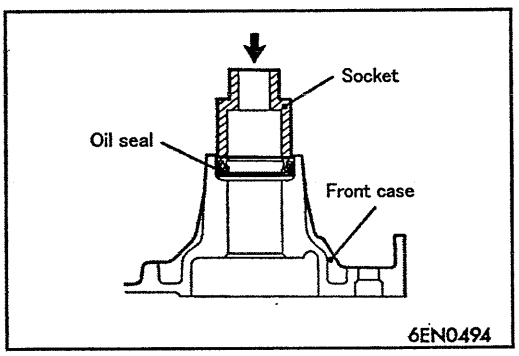




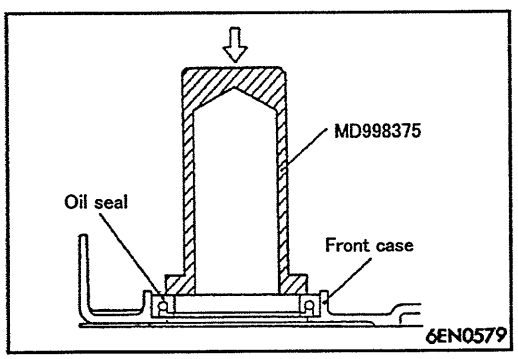
→C← Counterbalance shaft front bearing installation
(1) Using the special tool, install the rear bearing.



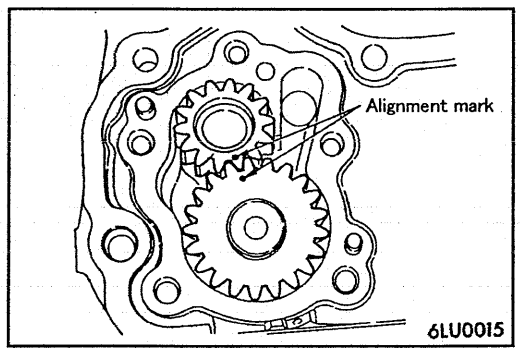
→D← Counterbalance shaft oil seal installation
(1) Using a suitable socket wrench, install the counterbalance shaft oil seal into the front case.



→E← Oil pump oil seal installation
(1) Using a suitable socket wrench, install the oil pump oil seal into the front case.

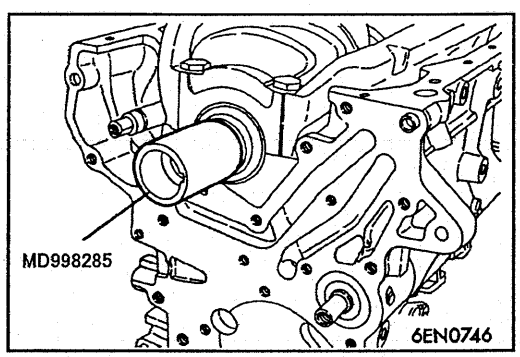


→F← Crank shaft front oil seal installation
(1) Using the special tool, install the crankshaft front oil seal into the front case.



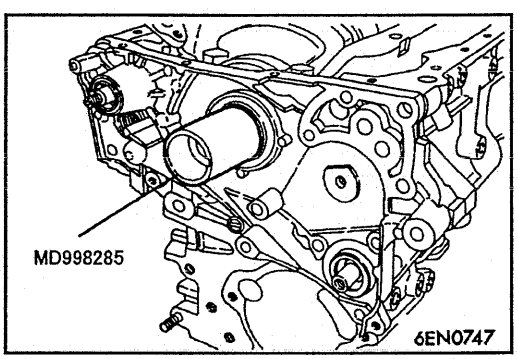
→ G ← Oil pump driven gear/oil pump drive gear installation

(1) Apply engine oil amply to the gears and line up the alignment marks.

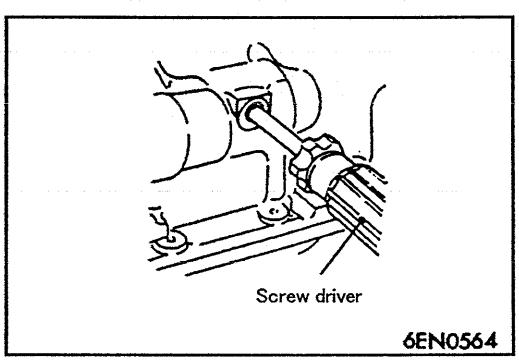


→H← Front case installation

(1) Set the special tool on the front end of the crankshaft and apply a thin coat of engine oil to the outer circumference of the special tool to install the front case.

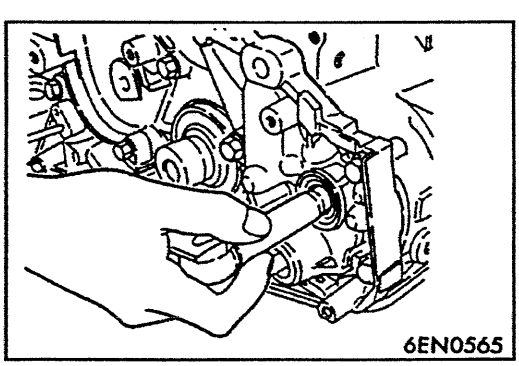


(2) Install the front case assembly through a new front case gasket and temporarily tighten the flange bolts(other than those for tightening the filter bracket).

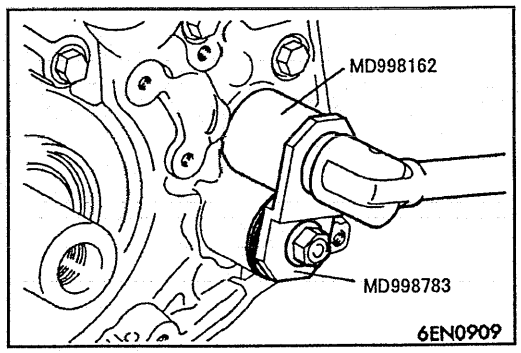


→I← Flange bolt installation

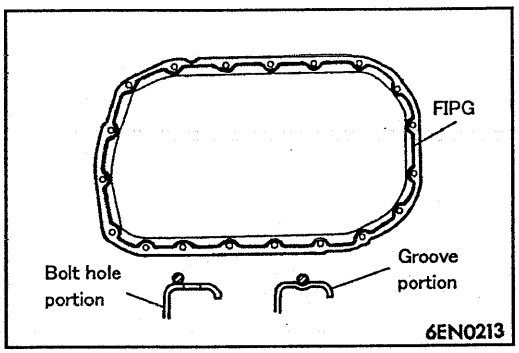
(1) Insert a Phillips screwdriver into a hole in the left side of the cylinder block to lock the counterbalance shaft .



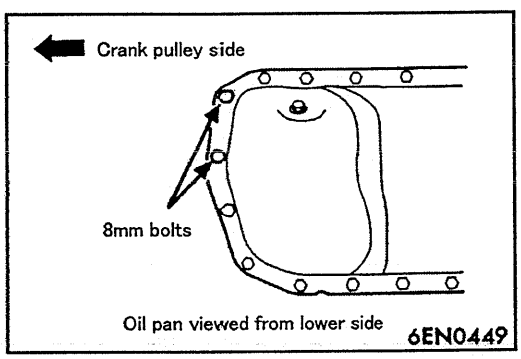
(2) Secure the oil pump driven gear onto the left counterbalance shaft by tightening the flange bolt to specified torque.



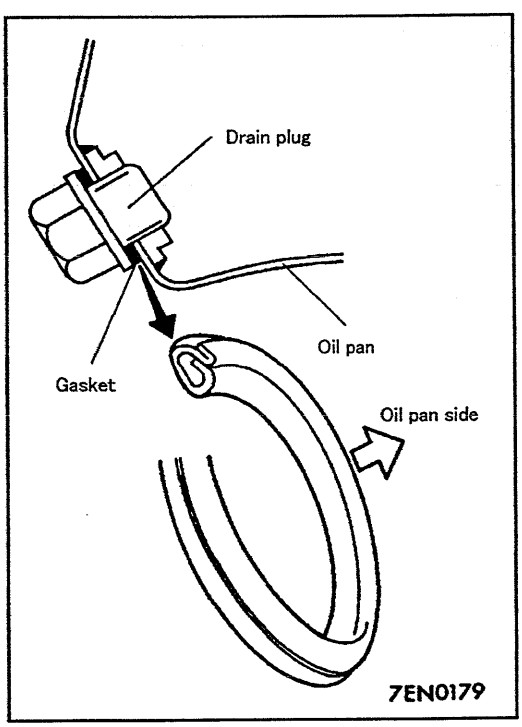
→J← Plug installation
(1) Install a new o-ring to the groove of the front case.
(2) Install a plug to the front case.
(3) Fit the special tool MD998162 on the plug, and then hold in position with special tool MD998783.
(4) Tighten the plug to the specified torque.



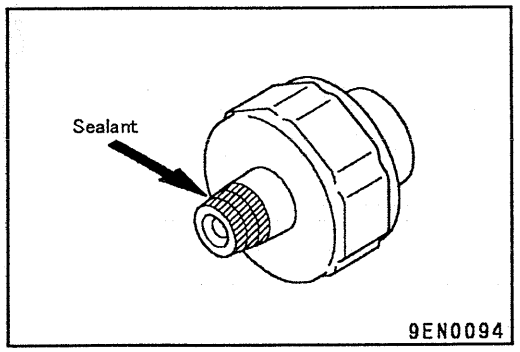
→K← Oil pan installation
(1) Clean both mating surface of the oil pan and cylinder block.
(2) Apply a 4 mm (0.16 in.) wide bead of FIPG to the entire circumference of the oil pan flange. The oil pan should be installed in 15 minutes after the application of FIPG.
Specified FIPG: 3M™AAD Part No.8672 or equivalent



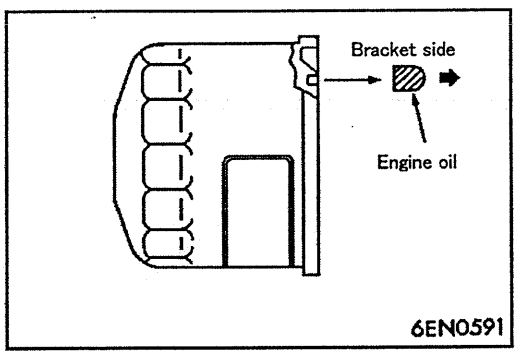
(3) Note the difference in bolt lengths at the location shown.



→L← Drain plug gasket installation
(1) Install the drain plug gasket in the direction shown.
Caution:
Fitting the gasket in a wrong way will result in oil leakage.



→M← Oil pressure switch installation
Specified sealant: 3M™ AAD Part No. 8672 or equivalent
Caution:
1) Keep the end of threaded portion clear of sealant.
2) Avoid an over tightening.

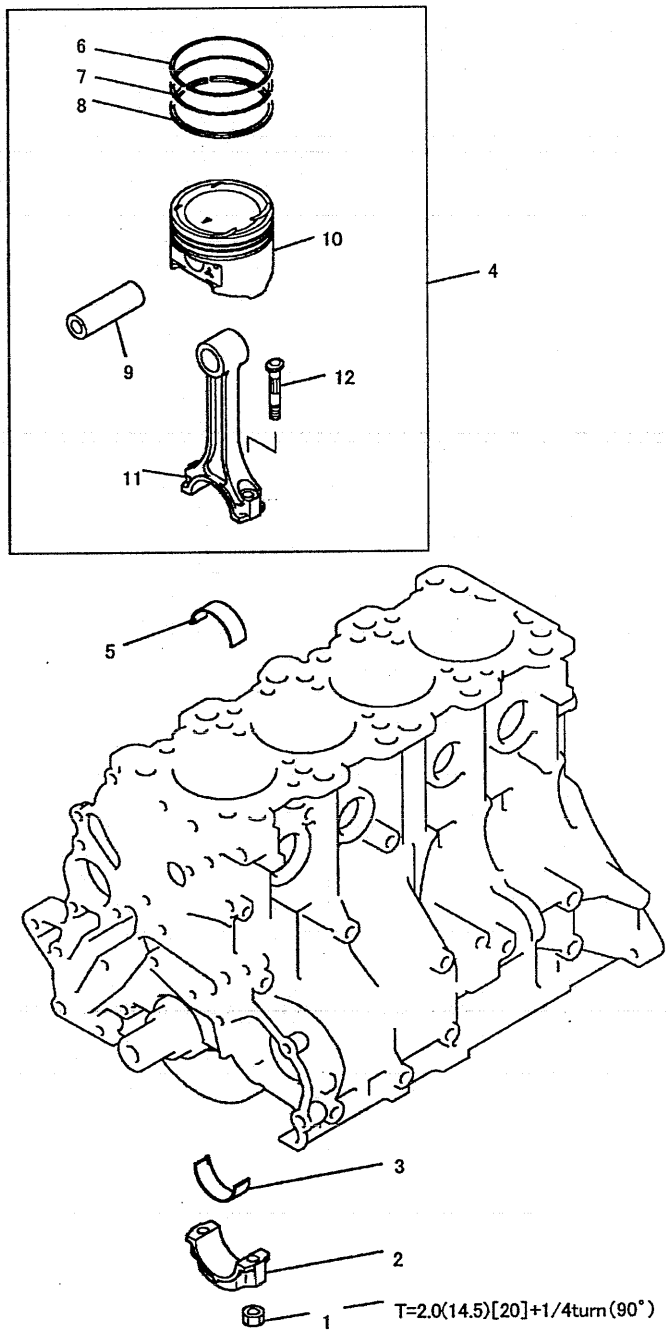


→N← Oil filter installation
(1) Clean the installation surfaces of the filter bracket.
(2) Apply engine oil to the o-ring of oil filter.
(3) Screw the oil filter in until the o-ring contacts the bracket.

PISTON AND CONNECTING ROD

REMOVAL AND INSTALLATION

Apply engine oil to all moving parts before installation



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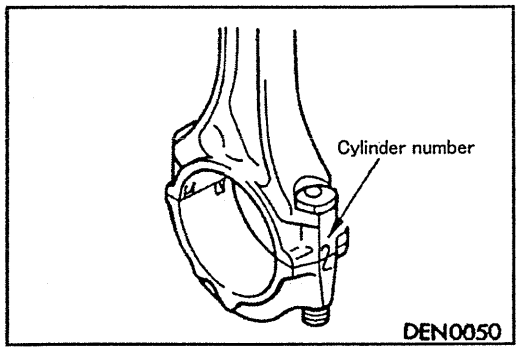
Removal steps

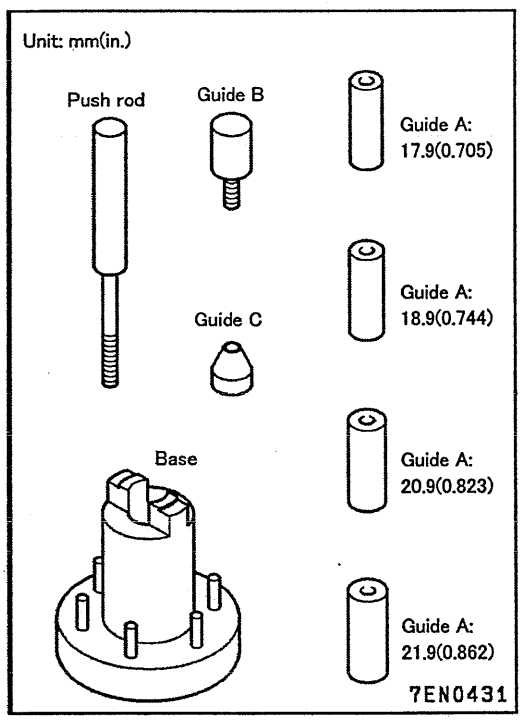
→G←	1.	Nut
←A→ →F←	2.	Connecting rod cap
→E←	3.	Connecting rod bearing
→D←	4.	Piston and connecting rod assembly
→E←	5.	Connecting rod bearing
→C←	6.	Piston ring No. 1
→C←	7.	Piston ring No. 2
→B←	8.	Oil ring
←B→ →A←	9.	Piston pin
	10.	Piston
	11.	Connecting rod
	12.	Bolt



REMOVAL SERVICE POINTS

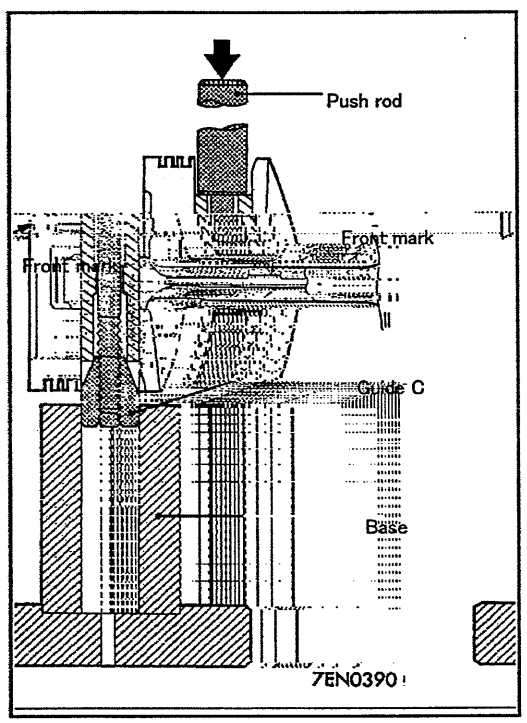
←A→ Connecting rod cap removal

Mark the cylinder number on the side of the connecting rod big end for correct reassembly.



←B→ Piston pin removal

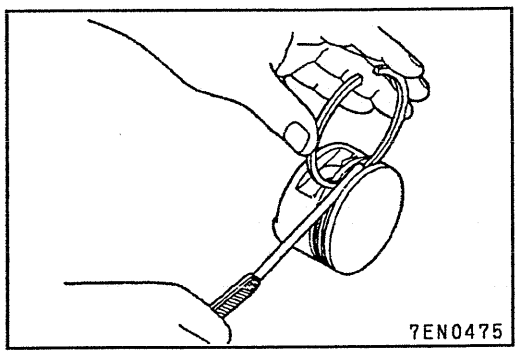
The special tool, Piston Pin Setting Tool (MD998780), consists of the parts shown in the illustration at the left.

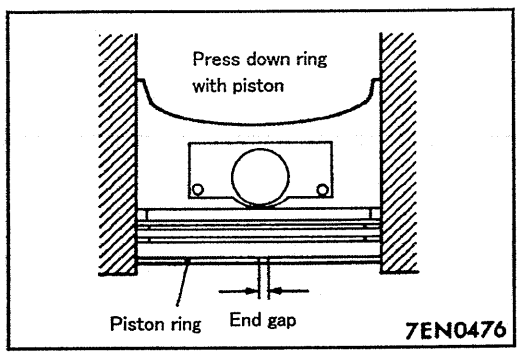


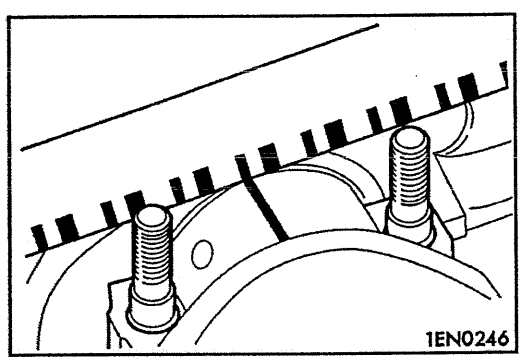
(1) Insert the special tool, Push Rod, into the piston from the side on which the front mark is stamped in the piston head, and attach the guide C to the push rod end.
(2) Place the piston and connecting rod assembly on the special tool, Piston Pin Setting Base, with the front mark facing upward.
(3) Using a press, remove the piston pin.

NOTE:

Keep the disassembled piston, piston pins and connecting rods in order according to the cylinder number.







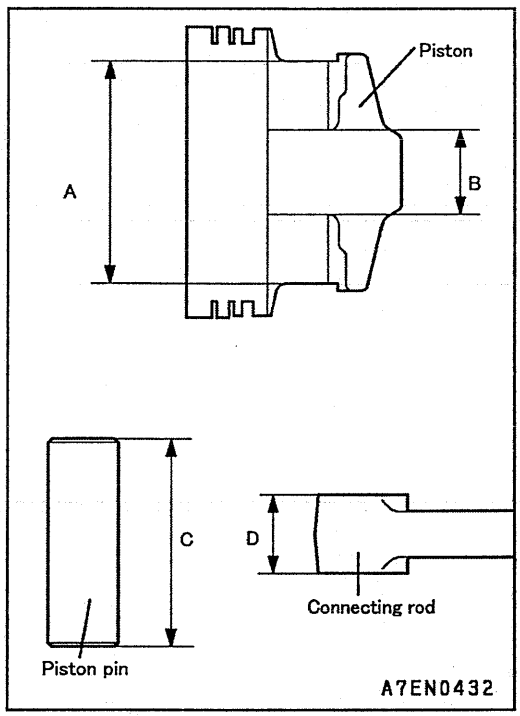
INSPECTION

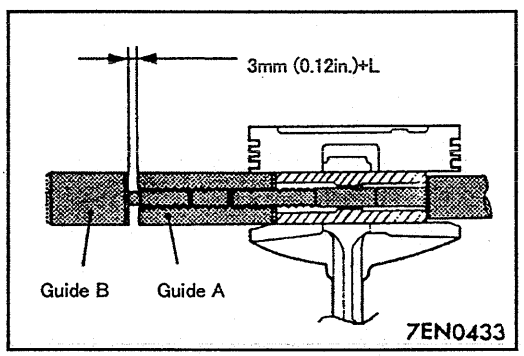
1. Piston Ring
   (1) Check for the clearance between the piston ring and ring groove. If the limit is exceeded, replace the ring or both piston and ring.
   (2) Install the piston ring into the cylinder bore. Force it down with a piston, its crown being in contact with the ring, to correctly position it at right angles to the cylinder wall. Then, measure the end gap with a feeler gauge.

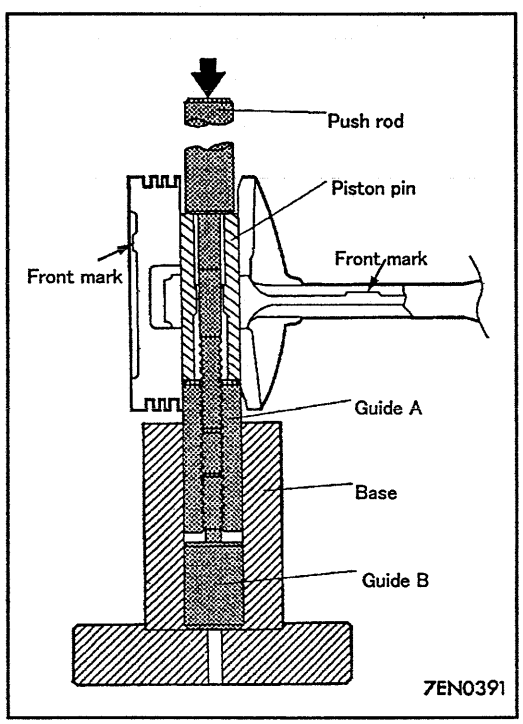
   If the ring gap is excessive, replace the piston ring.
   Standard value:
   No. 1 0.25 to 0.40 mm (0.0098 to 0.0157 in.)
   No. 2 0.45 to 0.60 mm (0.0177 to 0.0236 in.)
   Oil 0.20 to 0.60 mm (0.0079 to 0.0236 in.)
   Limit:
   No. 1, No. 2 0.8 mm (0.031 in.)
   Oil 1.0 mm (0.039 in.)

2. Crankshaft Pin Oil Clearance (Plastic Gauge Method)
   (1) Remove oil from the crankshaft pin and the connecting rod bearing.
   (2) Cut the plastic gauge to the same length as the width of the bearing and place it on the crankshaft pin in parallel with its axis.
   (3) Install the connecting rod cap carefully and tighten the bolts to the specified torque.
   (4) Remove the bolt and carefully remove the connecting rod cap.
   (5) Measure the width of the plastic gauge at its widest part by using the scale printed on the plastic gauge package.

   Standard value: 0.02 to 0.05 mm
   (0.0008 to 0.0020 in.)
   Limit: 0.1 mm (0.004 in.)







INSTALLATION SERVICE POINTS

→A← Piston pin installation

(1) Measure the following dimensions of the piston, piston pin and connecting rod.

A: Piston pin insertion hole length
B: Distance between piston bosses
C: Piston pin length
D: Connecting rod

(2) Obtain dimension L (to be used later) from the above measurements by using by following formula.

$$L = \frac{(A - C) - (B - D)}{2}$$

(3) Insert the special tool, Push Rod, into the piston pin and attach the guide A to the push rod end.

(4) Assemble the connecting rod in the piston with their front marks facing the same direction.

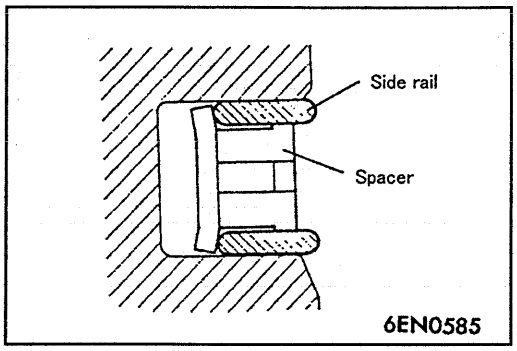
(5) Apply engine oil to the entire periphery of the piston pin.

(6) Insert the piston pin, push rod and guide A assembly having assembled in stop (3) from the guide A side into the piston pin hole on the front marked side.

(7) Screw the guide B into the guide A until the gap between both guides amounts to the value L obtained in step (2) plus 3 mm (0.12 in.).

(8) Place the piston onto the piston setting base with the front marks directed upward.

(9) Press-fit the piston pin using a press.
If the press-fitting force required is less than the standard value, replace the piston and piston pin set or/and the connecting rod.
Standard value: 750 to 1750 kgf
(1654 to 3859 lbf)
[7350 to 17160N]



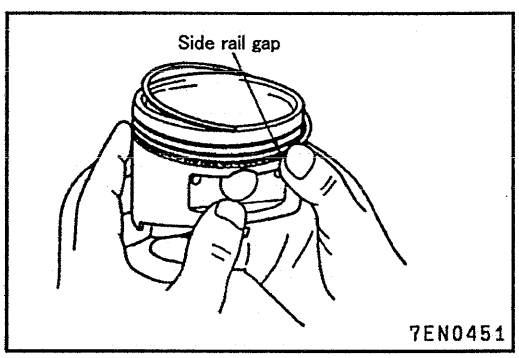
→B← Oil ring installation

(1) Fit the oil ring spacer into the piston ring groove. First, install the upper side rail, and then install the lower side rail.

NOTE:

1) The side rails and spacer may be installed in either direction.
2) The new spacers and side rails are painted in the following colors to identify their sizes.

Size	Identification color
STD	No color
0.50 mm (0.020 in.) O.S.	Blue
1.00 mm (0.040 in.) O.S.	Yellow

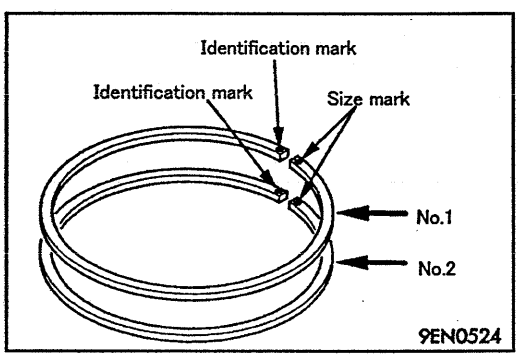


(2) To install the side rail, first fit one end of the rail into the piston groove, then press the remaining portion into position by finger. See illustration.

Caution:

The side rail could be broken if it is expanded with a piston ring expander in the same way as with a compression ring.

(3) Make sure that the side rails move smoothly in either direction.



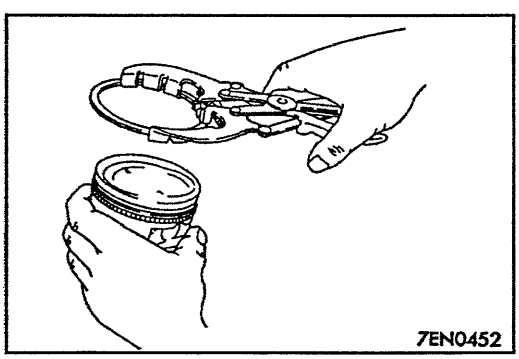
→C← Piston ring No. 2/piston ring No. 1 installation

(1) To prevent wrong installation, check the identification mark of each piston ring. The installation mark is stamped near the ring gap.

NOTE:

Size marks on piston ring are as follows.

Size	Size mark
STD	Paint red
0.50 mm (0.020 in.) O.S.	50
1.00 mm (0.040 in.) O.S.	100

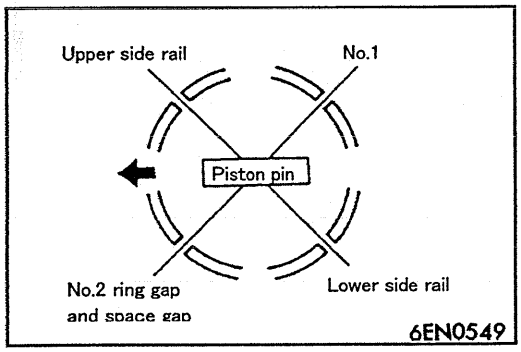


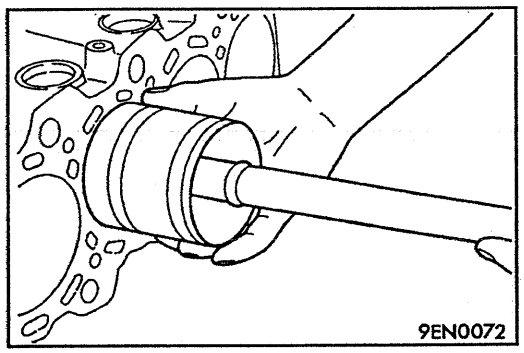
(2) Using piston ring expander, fit No. 2 and then No. 1 piston ring into position.

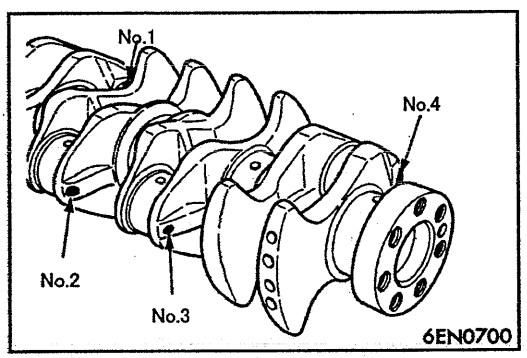
NOTE:

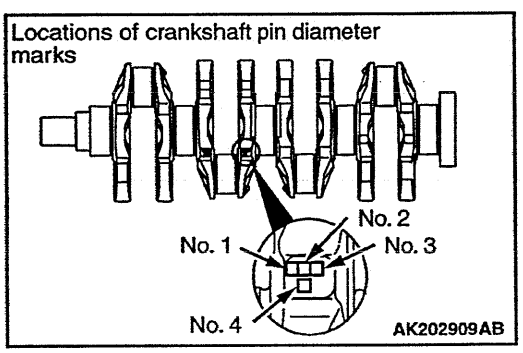
Install piston ring with identification mark facing up, to the piston crown

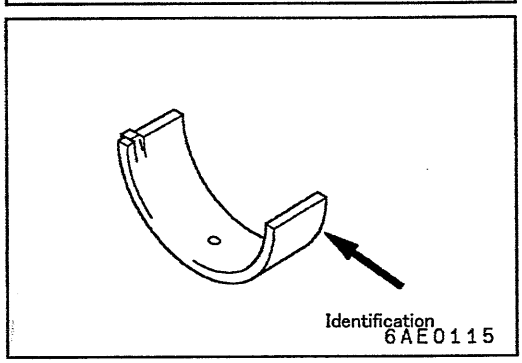
(3) Install the No. 1 piston ring in the same manner as step 2.











→D← Piston and connecting rod installation

(1) Liberally coat engine oil on the circumference of the piston, piston ring, and oil ring.

(2) Arrange the piston ring and oil ring gaps (side rail and spacer) as shown in the illustration.

(3) Insert the piston and connecting rod assembly from above the cylinder in such a way that the front mark (arrow) on the top of the piston will be directed toward the camshaft sprocket.

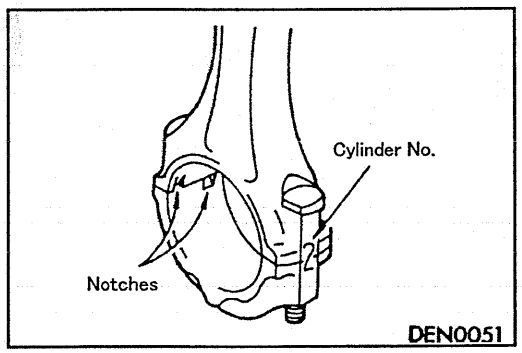
(4) Insert the piston and connecting rod assembly with the piston rings held firmly with a ring band. Forcing it by pounding should be avoided because damage to the piston rings or crank pin could result.

→E← Connecting rod bearing installation

When the bearings are replaced, select and install them according to the identification colors on the crankshaft and identification marks stamped on the connecting rod bearing.

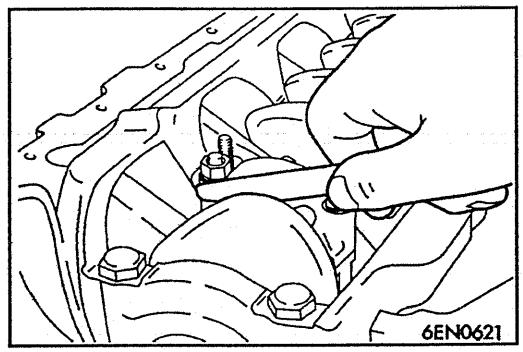
Crankshaft		Connecting rod bearing	
Pin identification color or mark	Pin O. D. mm (in.)	Identification mark or color	Thickness mm (in.)
Yellow or I	44.995 to 45.000 (1.77145 to 1.77165)	1 or Yellow	1.487 to 1.491 (0.05854 to 0.05870)
None or II	44.985 to 44.995 (1.77106 to 1.77145)	2 or None	1.491 to 1.495 (0.05870 to 0.05886)
White or III	44.980 to 44.985 (1.77086 to 1.77106)	3 or Blue	1.495 to 1.499 (0.05886 to 0.05902)

Connecting rod inside diameter:
48.000 to 48.015 mm (1.88976 to 1.89035 in.)



→F← Connecting rod cap installation

(1) Verifying the mark made during disassembly, install the bearing cap to the connecting rod. If the connecting rod is new with no index mark, make sure that the bearing locking notches come on the same side as shown.



(2) Make sure that connecting rod big end side clearance meets the specification.

Standard value: 0.10 to 0.25 mm
(0.0039 to 0.0098 in.)
Limit: 0.4 mm (0.016 in.)

→G← Connecting rod cap nut installation

(1) Since the connecting rod bolts and nuts are torque using a plastic area tightening method, they should be examined BEFORE reuse. If the bolt threads are "necked down", the bolts should be replaced.
Necking can be checked by running a nut with fingers to the full length of the bolt's thread. If the nut does not run down smoothly, the bolt should replaced.

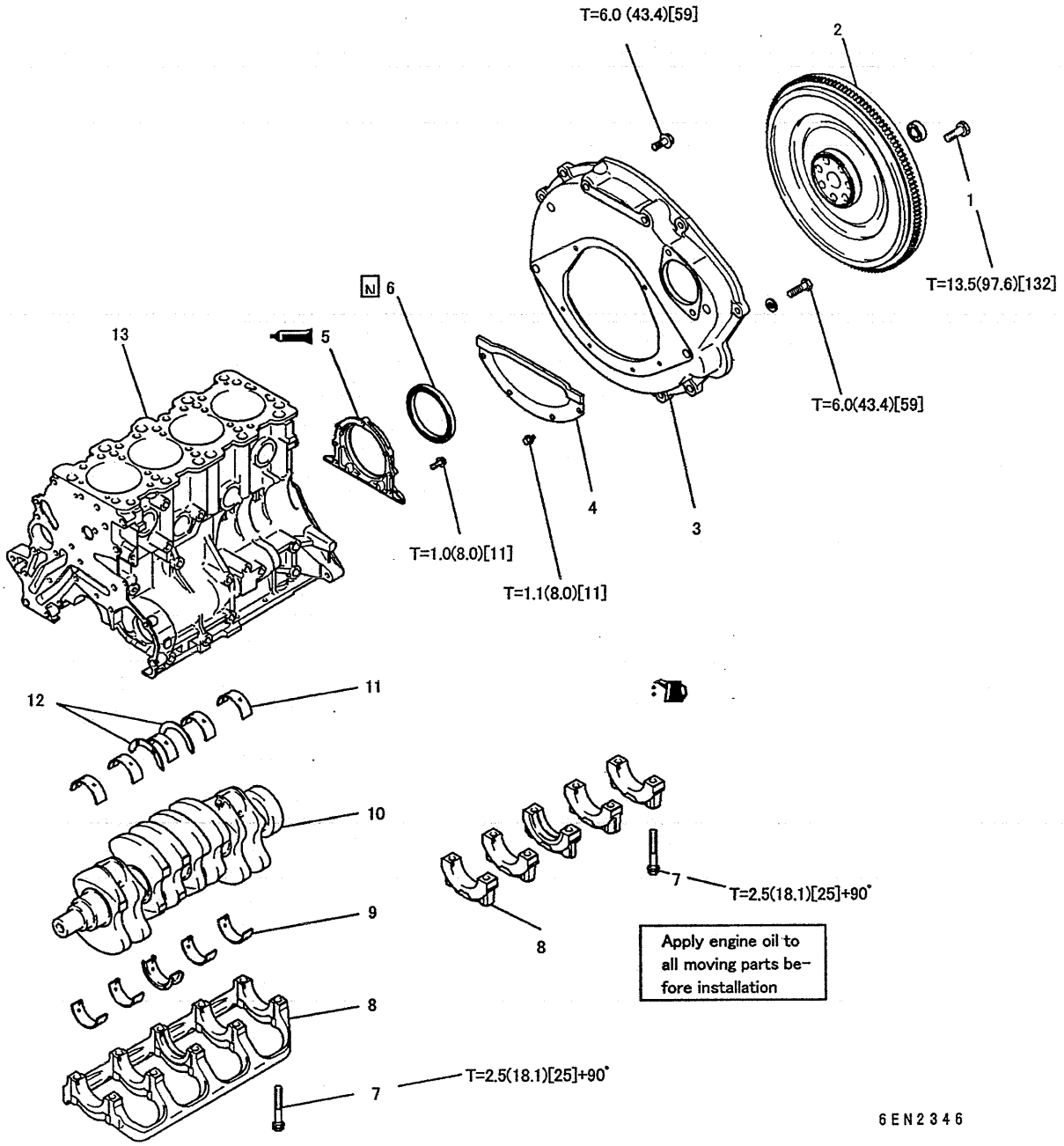
(2) Before installing the nuts, the threads should be oiled with engine oil.

(3) Install both nuts on the bolts finger tight, then alternately torque each nut to assemble the cap properly.

(4) Tighten the nuts to 2.0 kgf·m (14.5 lbf·ft) [20 N·m] and plus 1/4 (90°) turn.
Caution:
1) If the nut is turned less than 90° , proper fastening performance may not be expected. When tightening the nut, therefore, be careful to give a sufficient turn to it.
2) If the nut is over tightened (exceeding 100°), loosen the nut completely and then retighten it by repeating the tightening procedure from step (1).

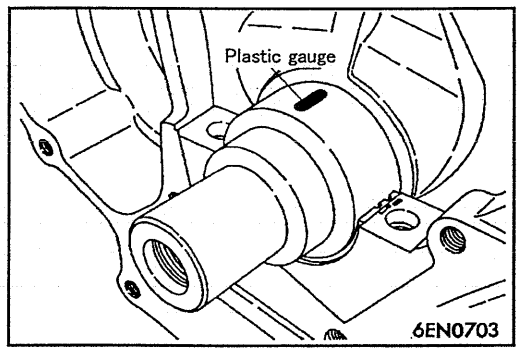
CRANKSHAFT AND CYLINDER BLOCK

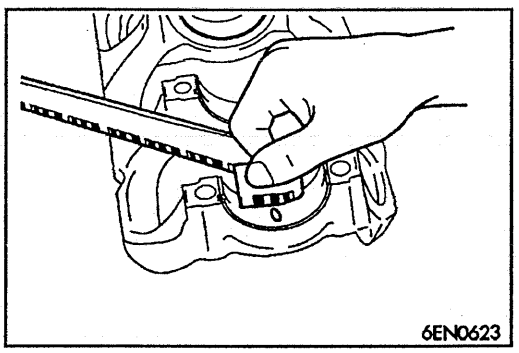
REMOVAL AND INSTALLATION

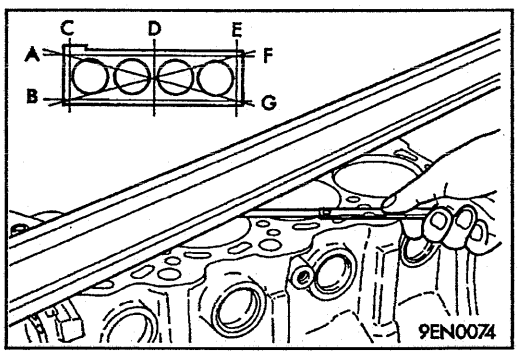


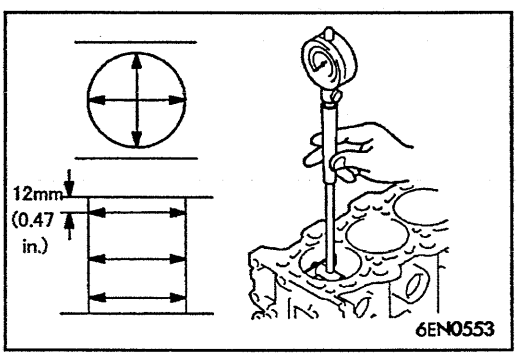
Removal steps

1. Flywheel bolt
2. Flywheel
→F← 3. Flywheel housing
4. Rear plate cover
→E← 5. Oil seal case
→D← 6. Oil seal
→C← 7. Crankshaft bearing cap bolt
→C← 8. Crankshaft bearing cap
→B← 9. Crankshaft bearing lower
10. Crankshaft
→B← 11. Crankshaft bearing upper
→A← 12. Thrust bearing
13. Cylinder block









INSPECTION

1. Crankshaft Oil Clearance (Plastic Gauge Method)

Use of the plastic gauge can facilitate the oil clearance measurement work.

To use the plastic gauge, proceed as follows:

(1) Remove oil from the crankshaft journal and crankshaft bearing.
(2) Install the crankshaft.
(3) Cut the plastic gauge to the same length as the width of the bearing and place it on the journal in parallel with its axis.
(4) Install the crankshaft bearing cap carefully and tighten the bolts to specified torque.
(5) Remove the bolt, and carefully remove the crankshaft bearing cap.
(6) Measure the width of the plastic gauge at its widest part by using a scale printed on the plastic gauge package.

Standard value: 0.02 to 0.04 mm
(0.0008 to 0.0016 in.)
Limit: 0.1 mm (0.004 in.)

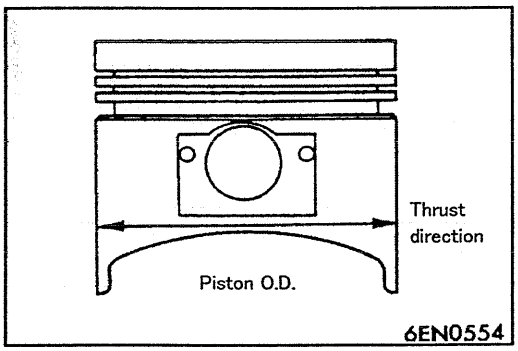
2. Cylinder Block

(1) Visually check for scratches, rust, and corrosion. Use also a flaw detecting agent for the check. If defects are evident, correct, or replace.
(2) Using a straightedge and feeler gauge, check the block top surface for warpage. Make sure that the surface is free from gasket chips and other foreign matter.

Standard value: 0.05 mm (0.0020 in.)
Limit: 0.1 mm (0.004 in.)

(3) Check the cylinder walls for scratches and seizure. If defects are evident, correct (bored to oversize) or replace.
(4) Using a cylinder gauge, measure the cylinder bore and cylindricity. If worn badly, rebore all cylinders to an oversize and replace piston rings. Measure at the points shown in the illustration.

Standard value:
Cylinder I.D.
4G63
85.00 to 85.03 mm (3.3465 to 3.3476 in.)
4G64
86.50 to 86.53 mm (3.4055 to 3.4067 in.)
Cylindricity 0.1 mm (0.004 in.)



3. Cylinder Boring
   (1) Oversize pistons to be used should be determined on the basis of largest bore cylinder.
   (2) Oversize pistons are available in four size 0.50 mm (0.0197 in.), and 1.00 mm (0.0394 in.). Rebore the cylinder to a diameter that matches the selected piston outside diameter with the specified clearance. The reference piston outside diameter measuring point is shown in the illustration.
   (3) Based on the measured piston O.D. calculate the boring finish dimension.

Boring finish dimension = Piston O.D. + 0.02 to 0.04 mm (0.0008 to 0.0016 in.) (clearance between piston O.D. and cylinder) − 0.02 mm (0.0008 in.) (honing margin)

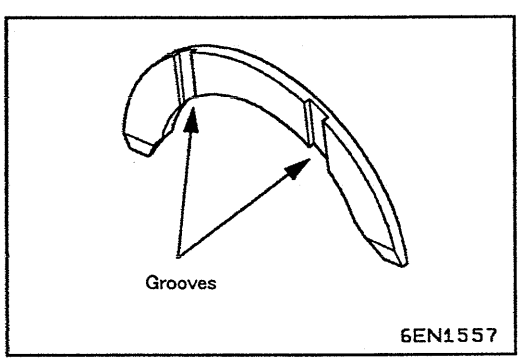
   (4) Bore all cylinders to the calculated boring finish dimension.

Caution:
To prevent distortion that may result from temperature rise during boring, bore cylinders, working from No. 2 to No. 4 to No. 1 to No. 3.

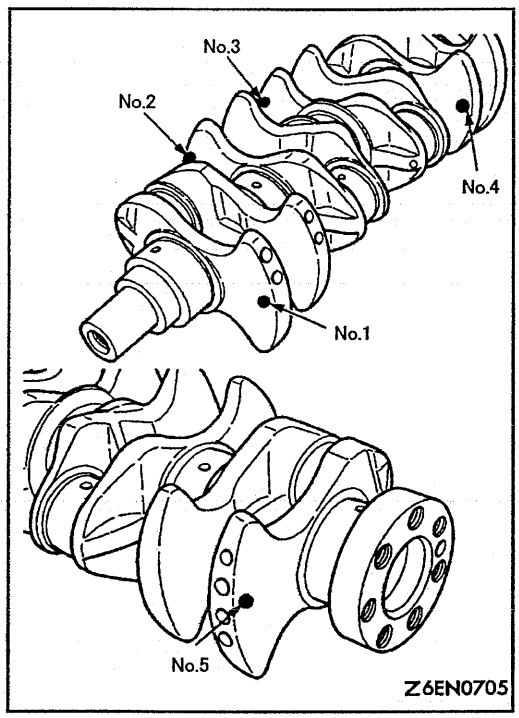
   (5) Hone to the final finish dimension (piston O.D. + clearance between piston O.D. and cylinder).
   (6) Check the clearance between the piston and cylinder.

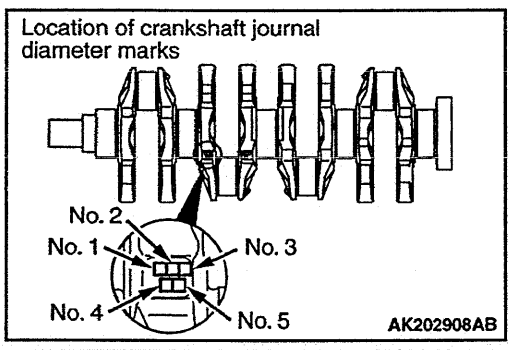
Standard value:
Clearance between piston and cylinder
0.02 to 0.04 mm (0.0008 to 0.0016 in.)

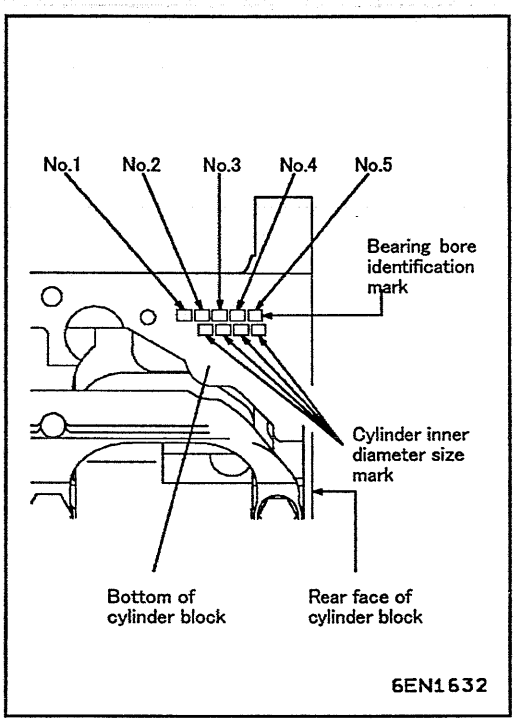
INSTALLATION SERVICE POINTS



→A← Crankshaft thrust bearing installation
   (1) Install the two thrust bearings in the No. 3 bearing bore in the cylinder block. For easier installation, apply engine oil to the bearings, this will help fold them in position.
   (2) The thrust bearings must be installed with their groove side toward the crankshaft web.





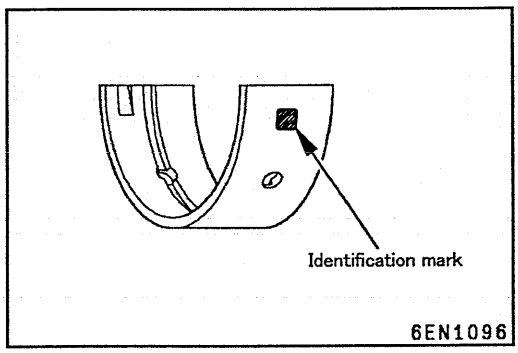


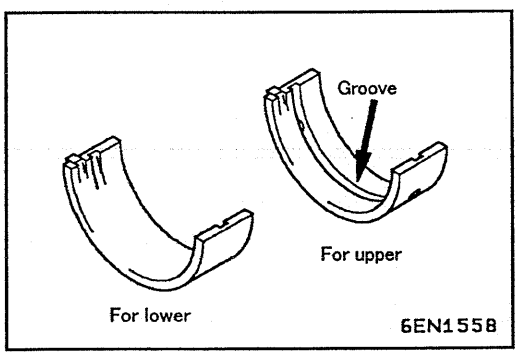
→B← Crankshaft bearing installation

(1) From the following table, select a bearing whose size is appropriate for the crankshaft journal outside diameter.

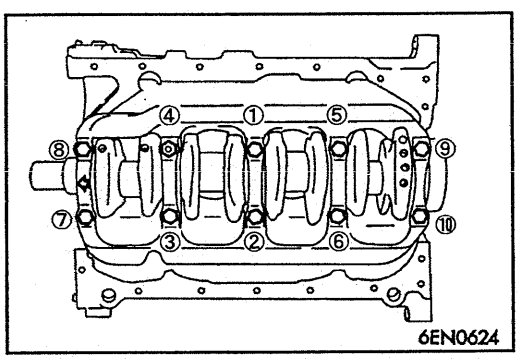
Crankshaft journal outside diameter		Cylinder block bearing bore	Crankshaft bearing for No. 1, 2, 4, 5	Crankshaft bearing for No. 3
Identification mark or color	Size mm (in.)	Identification mark	Identification mark or color	Identification mark or color
Yellow or 0	56.994 to 57.000 (2.2439 to 2.2241)	0	1 or Green	0 or Black
		1	2 or Yellow	1 or Green
		2	3 or None	2 or Yellow
None or 1	56.988 to 56.994 (2.2436 to 2.2439)	0	2 or Yellow	1 or Green
		1	3 or None	2 or Yellow
		2	4 or Blue	3 or None
White or 2	56.982 to 56.984 (2.2438 to 2.2436)	0	3 or None	2 or Yellow
		1	4 or Blue	3 or None
		2	5 or Red	4 or Blue

If the crankshaft journal outside diameter ID color is "yellow"and the cylinder block bearing bore ID mark is "1", for example, select a bearing whose ID mark is "2" or ID color is "yellow" for No. 1, 2, 4 and 5, and a bearing whose ID mark is "1" or ID color is "green" for No. 3.
If there is no ID color paint on the crankshaft, measure the journal outside diameter and select a bearing appropriate for the measured value.

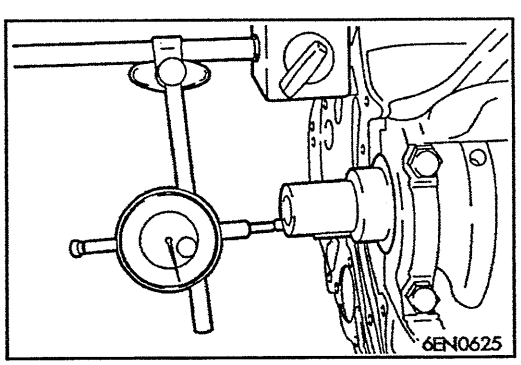




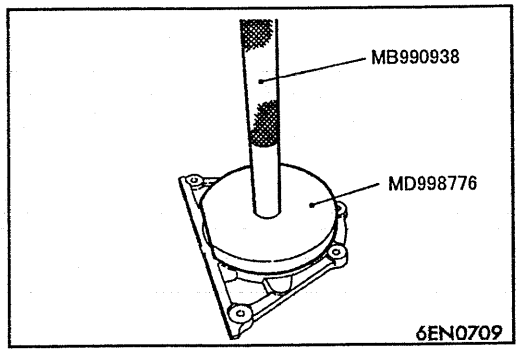
(2) Install the bearings having an oil groove to the cylinder block.
(3) Install the bearings having no oil groove to the bearing caps.



→C← Bearing cap/bearing cap bolt installation
(1) Install the bearing caps so that their arrows are positioned on the timing belt side.
(2) When installing the bearing cap bolts, check that the shank length of each bolt meets the limit. If the limit is exceeded, replace the bolt.
Limit: Max. 71.1 mm (2.799 in.)
(3) Torque the bearing cap bolts to 2.5 kgf·m (18.1 lbf·ft) [25 N·m] and, from that position, retighten them 1/4 (90°) turns more.
Caution:
1) If the bolt is turned less than 90° , proper fastening performance may not be expected. When tightening the bolt, therefore, be careful to give a sufficient turn to it.
2) If the bolt is over tightened (exceeding 100°), loosen the bolt completely and then retighten it by repeating the tightening procedure from step (1).

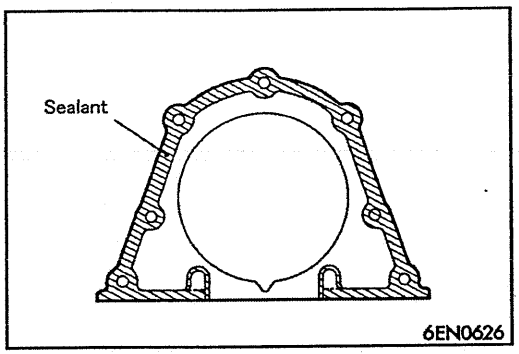


(4) After installing the bearing caps, make sure that the end play is correct. If the end play exceeds the limit, replace the crankshaft bearings.
Standard value: 0.05 to 0.25 mm
(0.0020 to 0.0098 in.)
Limit: 0.4 mm (0.016 in.)



→D← Oil seal installation

(1) Using the special tools, knock, the oil seal into the oil seal case.

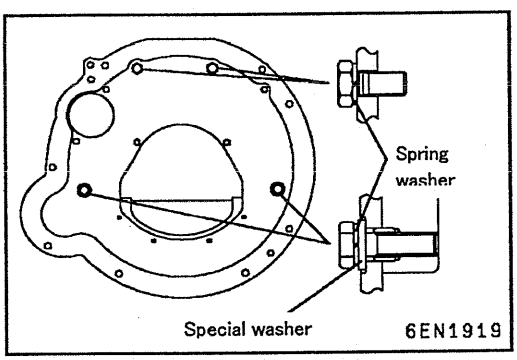


→E← Sealant application to oil seal case installation

Specified sealant: Mitsubishi Genuine Part No. MD970389 or equivalent

NOTE:

1) Be sure to install the case quickly while the sealant is wet(within 15 minutes).
2) After installation, keep the sealant area away front the oil and coolant for approx. one hour.

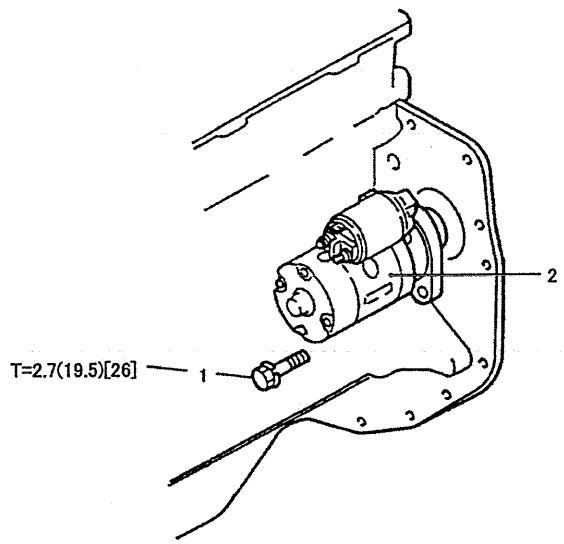


→F← Rear plate(4G63)/Flywheel housing(4G64) installation

(1) Be sure to install the spring washers and special washers in correct position.

STARTER MOTOR

REMOVAL AND INSTALLATION



Removal steps
1. Bolt
2. Starter motor

INSPECTION

Pinion Gap Adjustment

(1) Disconnect the field coil wire from terminal M of the magnetic switch.

(2) Connect a 12 V battery between terminal S and starter motor body (positive terminal to terminal S).

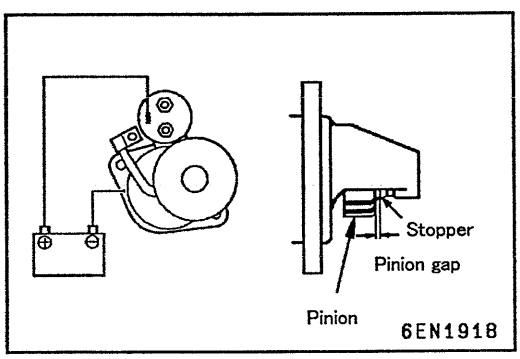
Caution:

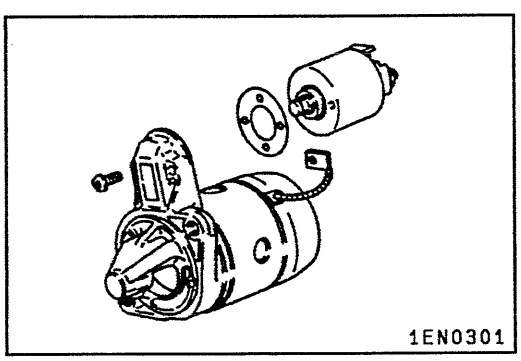
This test must be performed quickly (in less than 10 seconds) to prevent the coil from burning out.

(3) Set switch to "ON", and pinion will move out.

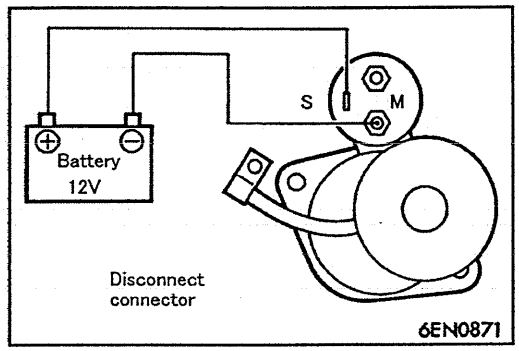
(4) Check pinion to stopper clearance (pinion gap) with a thickness gauge.

Pinion gap: 0.5 to 2.0 mm(0.0197 to 0.0787 in.)





(5) If the pinion gap is out of specification, adjust by adding or removing gaskets between magnetic switch and front bracket.

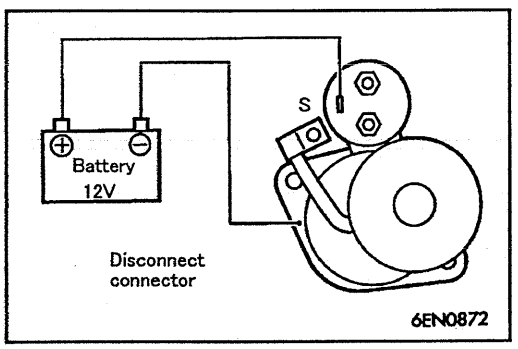


Pull-in Test of Magnetic Switch

(1) Disconnect field coil wire from terminal M of magnetic switch.
(2) Connect a 12V battery between terminal S and terminal M.

Caution:
This test must be performed quickly (in less than 10 seconds) to prevent coil from burning.

(3) If pinion moves out , then pull-in coil is good. If it doesn't. replace magnetic switch.

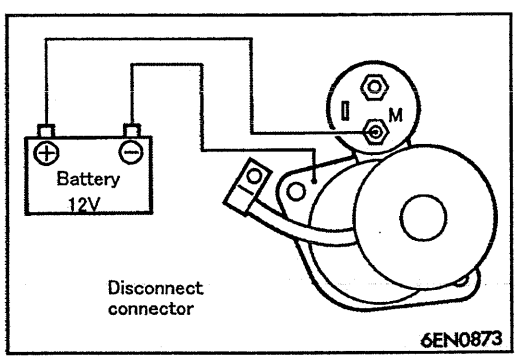


Hold-in Test of Magnetic Switch

(1) Disconnect field coil wire from terminal M of magnetic switch.
(2) Connect a 12V battery between terminal S and body.

Caution:
This test must be performed quickly (in less than 10 seconds) to prevent coil from burning.

(3) Manually pull out the pinion as far as the pinion stopper position.
(4) If pinion remains out, everything is in order. If pinion moves in, hold-in circuit is open. Replace magnetic switch.



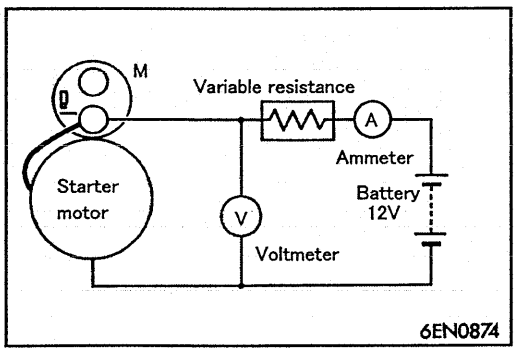
Return Test of Magnetic Switch

(1) Disconnect field coil wire from terminal M of magnetic switch.
(2) Connect a 12V battery between terminal S and body.

Caution:
This test must be performed quickly (in less than 10 seconds) to prevent coil from burning.

(3) Pull pinion out and release. If pinion quickly returns to its original position, everything is in order. If it doesn't, replace magnetic switch.

Caution:
Be careful not to get your fingers caught when pulling out the pinion.



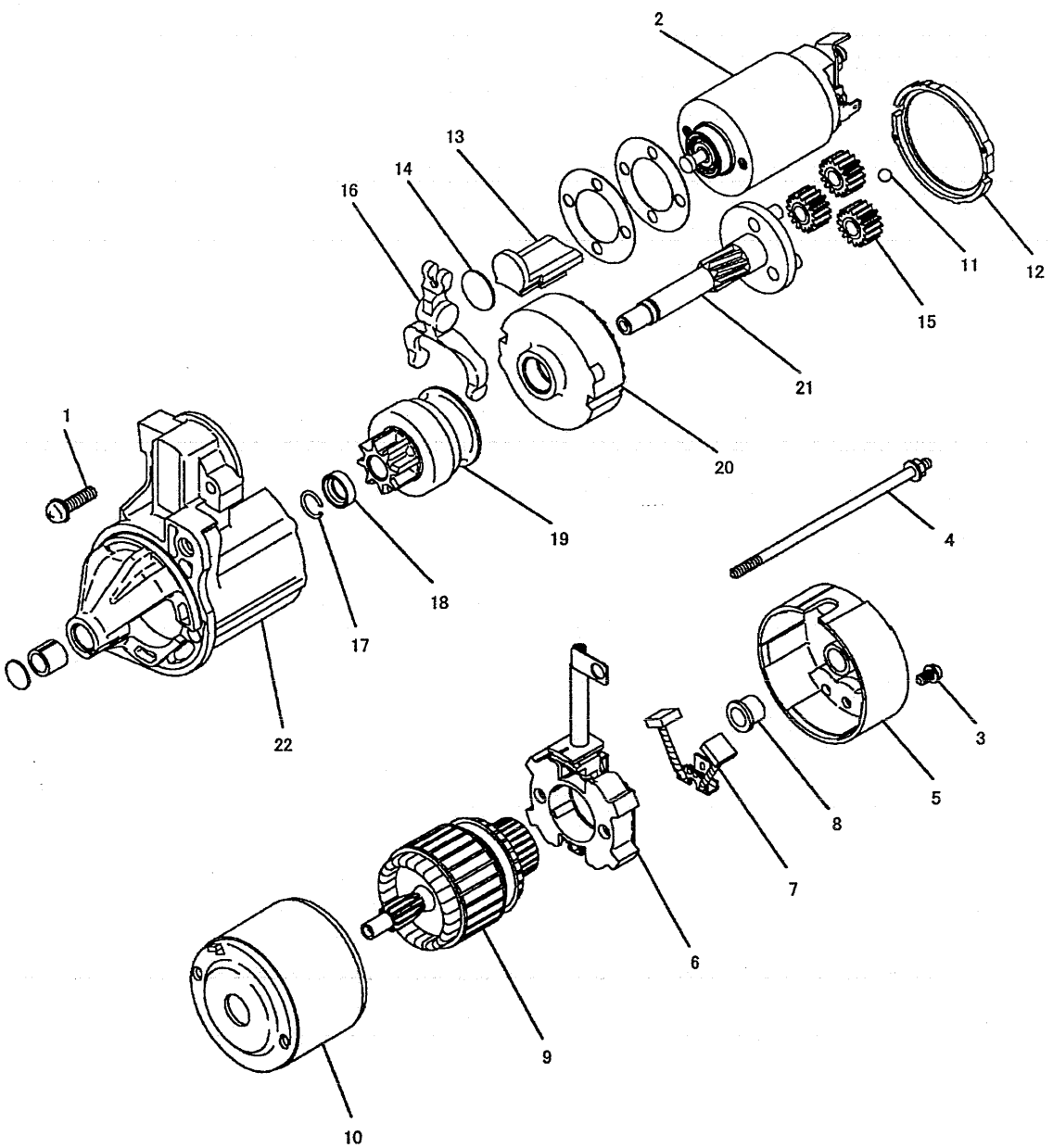
Free Running Test

(1) Place starter motor in a vise equipped with soft jaws and connect a fully-charged 12-volt battery to starter motor as follows:
(2) Connect a ammeter (100-ampere scale) and carbon pile rheostat in series with battery positive post and starter motor terminal.
(3) Connect a voltmeter (15-volt scale) across starter motor.
(4) Rotate carbon pile to full-resistance position.
(5) Connect battery cable from battery negative post to starter motor body
(6) Adjust the rheostat until the battery voltage shown by the voltmeter is 11V.
(7) Confirm that the maximum amperage is within the specifications and that the starter motor turns smoothly and freely.

Current: max. 60 amps

Symptom	Possible cause
Current is too large, and starter motor rotates at too low speeds. (Motor output torque is insufficient.)	• Contaminated or oil stained metal • Friction between armature core and pole piece • Armature coil and/or field coil not properly grounded • Armature coil short-circuited
Current is too large, and motor does not rotate at all.	• Electromagnetic switch not properly grounded • Armature coil and/or field coil not properly grounded • Seizure of metal
No current is available, and motor does not rotate.	• Armature coil and/or field coil open-circuited • Brush and/or pigtail open-circuited Poor contact of brush and commutator due to contaminated commutator, high mica, etc.
Current is too small, and motor rotates at low speed. (Motor output torque is insufficient.)	Loose field coil connections (If the shunt coil alone is open-circuited or loosely connected, the motor will rotate at a high speed.)
Current is too large, and motor rotates at too high speeds. (Motor output torque is insufficient.)	Field coil short-circuited

DISASSEMBLY AND REASSEMBLY



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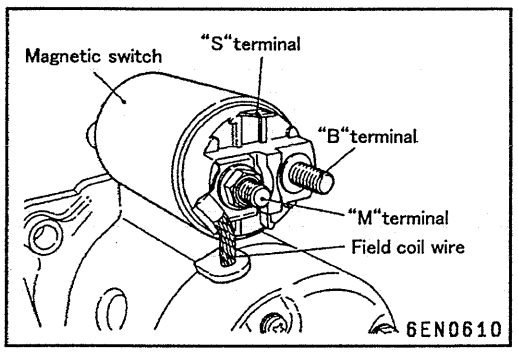
Disassembly steps

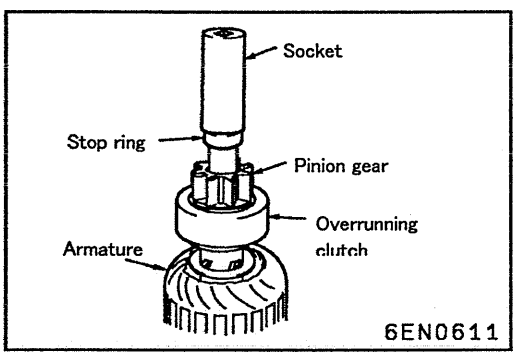
	1. Screw		12. Packing A
←A→	2. Magnetic switch		13. Packing B
	3. Screw		14. Plate
	4. Screw		15. Planetary gear
	5. Rear bracket		16. Lever
	6. Brush holder	←C→ →A←	17. Snap ring
	7. Brush	←C→ →A←	18. Stop ring
	8. Rear bearing		19. Overrunning clutch
←B→	9. Armature		20. Internal gear
	10. Yoke assembly		21. Planetary gear holder
←B→	11. Ball		22. Front bracket



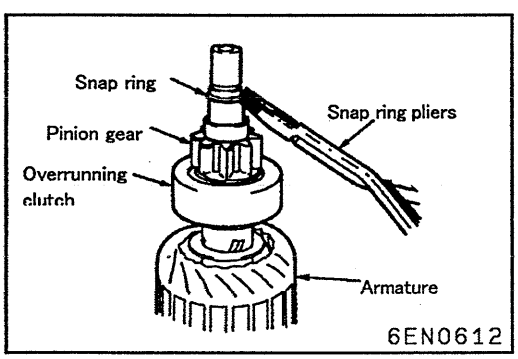
DISASSEMBLY SERVICE POINTS

←A→ Magnetic switch removal
Disconnect the field coil wire from terminal M of the magnetic switch.

←B→ Armature/ball removal
Caution:
When removing the armature, take care not to lose the ball(which is used as a bearing)in the armature end.



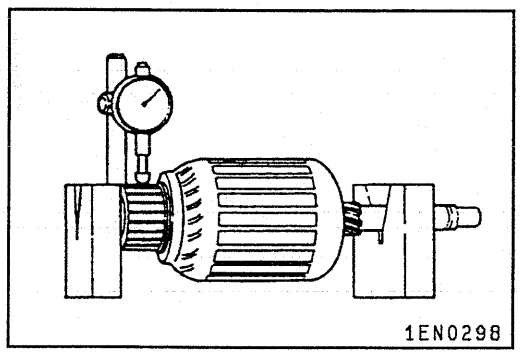
←C→ Snap ring/stop ring removal
(1) Press stop ring off snap ring with a suitable socket.



(2) Remove snap ring with snap ring pliers and then remove stop ring and overrunning clutch.

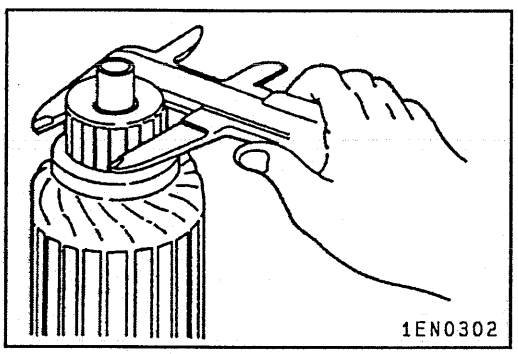
CLEANING OF STARTER MOTOR PARTS

Do not immerse the parts in cleaning solvent. Immersion of the yoke, field coil assembly and/or armature will damage to insulation.
Do not immerse the drive unit cleaning solvent.
Overrunning clutch is pre-lubricated at the factory and solvent will wash lubricant form clutch.
The drive may be cleaned with a brush moistened with cleaning solvent and wiped dry with a cloth.

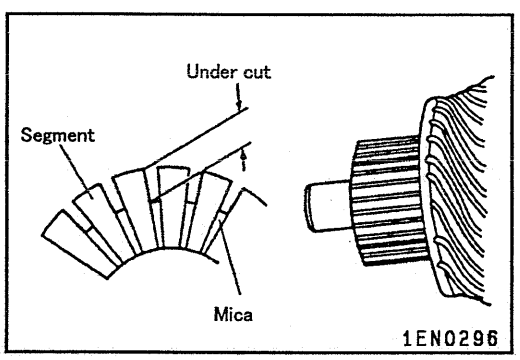


INSPECTION

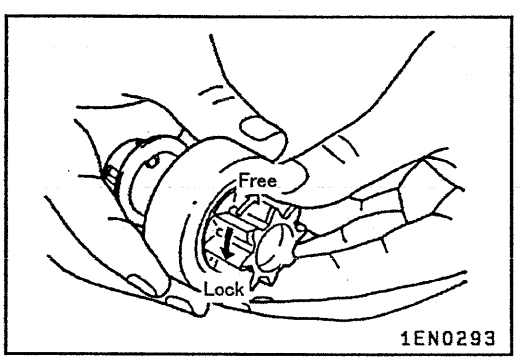
1. Commutator
   (1) Place the armature on a pair of V-blocks and check the runout using a dial gauge.
   Standard value: 0.5 mm (0.020 in.)
   Limit: 0.1 mm (0.004 in.)



   (2) Check the outer diameter of the commutator.
   Standard value: 29.4 mm (1.16 in.)
   Limited: 28.8 mm (1.13 in.)

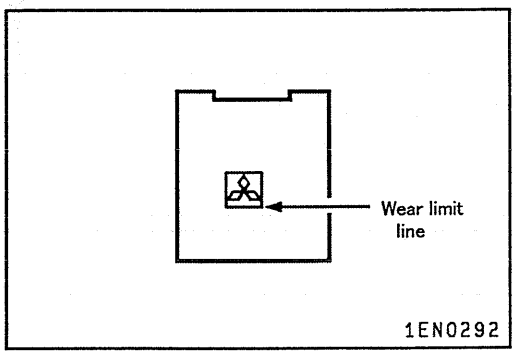


   (3) Check depth of the undercuts between the segments.
   Standard value: 0.5 mm (0.020 in.)
   Limit: 0.2 mm (0.008 in.)

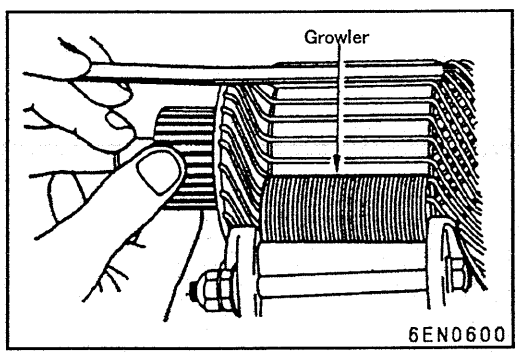


2. Overrunning Clutch Check
   (1) While holing clutch housing, rotate the pinion. Drive pinion should rotate smoothly in one direction, but should not rotate in opposite direction. If clutch does not function properly, replace overrunning clutch assembly.
   (2) Inspect pinion for wear or burrs. If pinion is worn or burred, replace overrunning clutch assembly. If pinion is damaged, also inspect ring gear for wear or burrs.

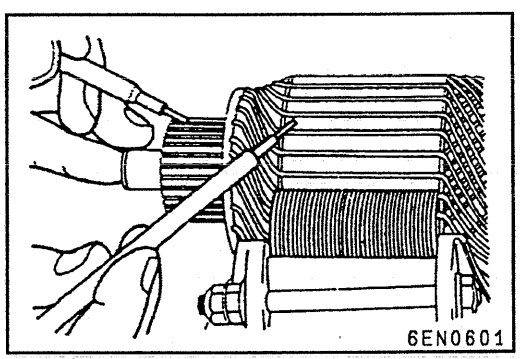
3. Front And Rear Bracket Bushing Check
   Inspect bushing for wear or burrs. If bushing is worn or burred, replace front bracket assembly or rear bracket assembly



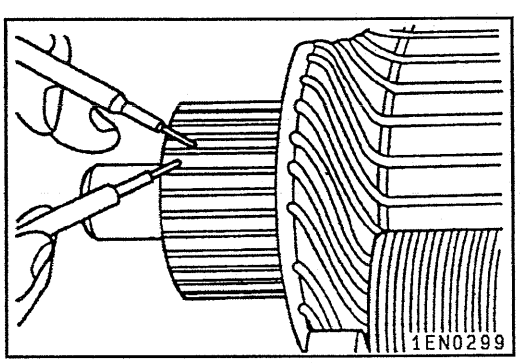
4. Brush
   (1) Brushes that are worn beyond wear limit line, or oil soaked, should be replaced.
   (2) When replacing ground brush, side the brush from brush holder by prying retainer spring back.



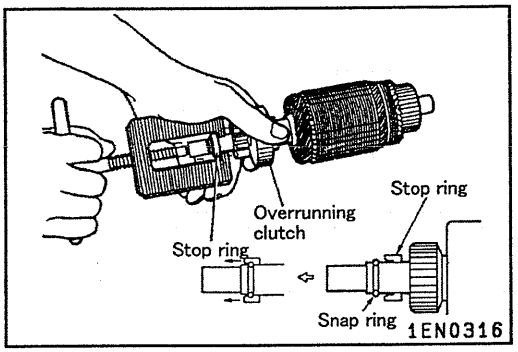
5. Armature Coil Short Circuit Test
   (1) Place armature on a growler.
   (2) Hold a thin steel blade parallel and just above while rotating armature slowly in growler. A shorted armature will cause blade to vibrate and be attracted to the core. Replace shorted armature.



6. Armature Coil Ground Test
   Check the insulation between ground commutator segment and the armature coil core. If there should be no continuity.



7. Armature Coil Open Circuit Check
   Check the continuity between segments. If there should be continuity.



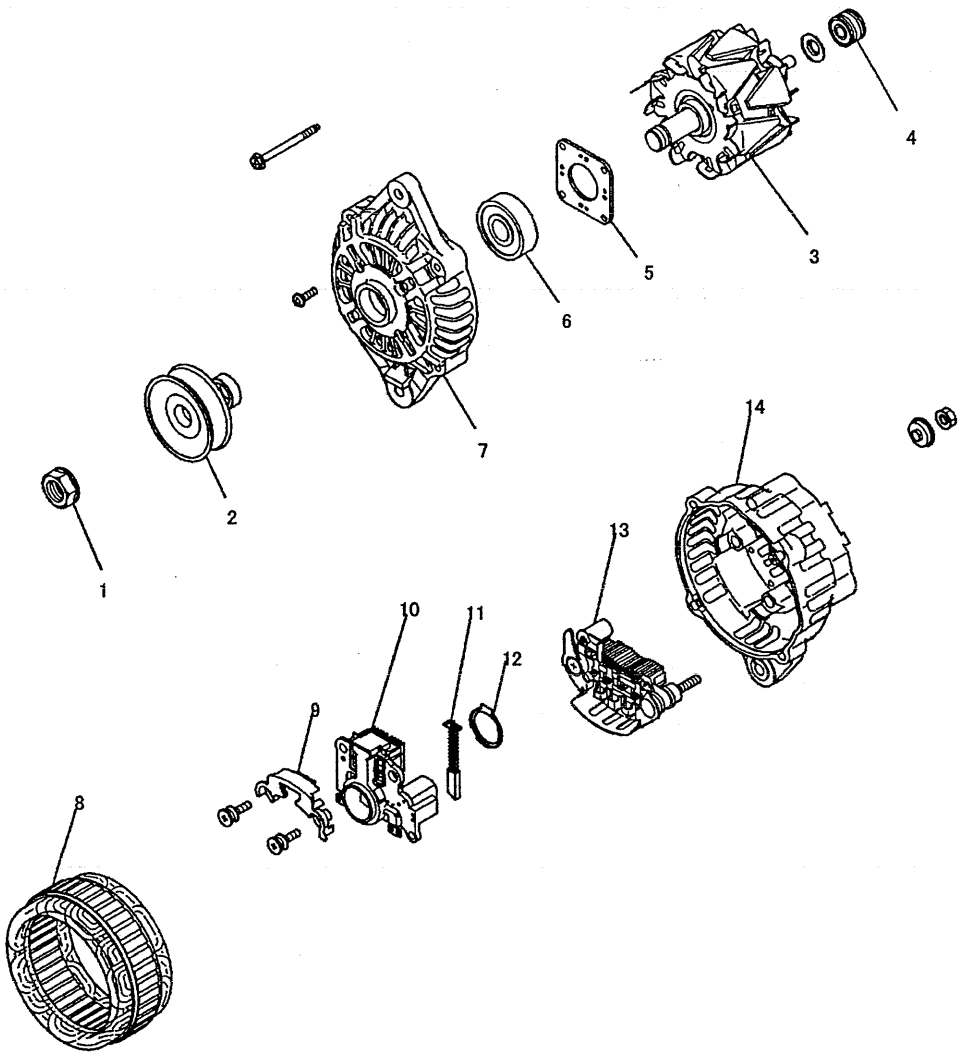
REASSEMBLY SERVICE POINT

→A← **Stop ring/snap ring Installation**

Using a suitable pulling tool, pull overrunning clutch stop ring over snap ring.

ALTERNATOR

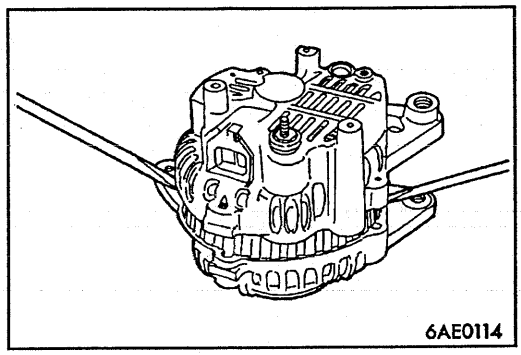
DISASSEMBLY AND REASSEMBLY



1EN0411

Disassembly steps

←A→	1.	Pulley nut	←B→	8. Stator
	2.	Alternator pulley		9. Plate
→A←	3.	Rotor assembly	←B→	10. Regulator assembly
	4.	Rear bearing		11. Brush
	5.	Bearing retainer		12. Slinger
	6.	Front bearing		13. Rectifier
	7.	Front bracket		14. Rear bracket



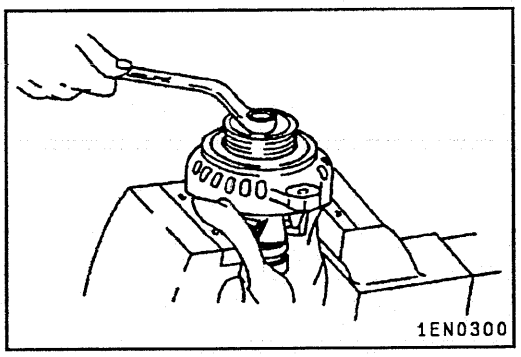
DISASSEMBLY SERVICE POINTS

Separation of the stator and front bracket

With a screwdriver blade inserted between the front bracket and stator core, pry to separate the stator from the front bracket.

Caution:

Do not insert the screwdriver too deep as the stator core could be damaged.

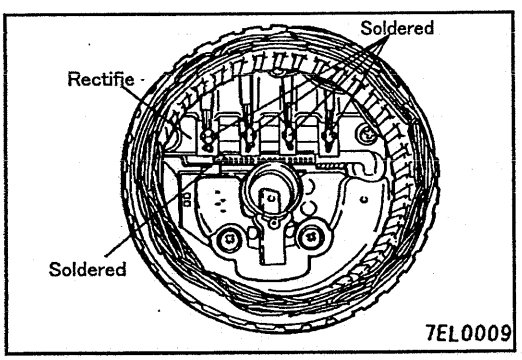


←A→ Removal of alternator pulley

With the pulley side facing up, hold the rotor in a vice and remove the pulley.

Caution:

Use care not to damage the rotor.



←B→ Stator/regulator assembly removal

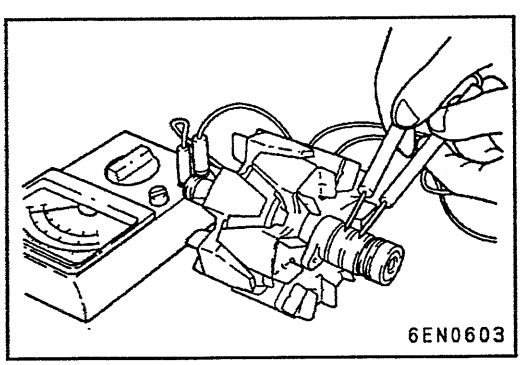
(1) Use a soldering iron (180 to 250 W) to unsolder the stator. This work should complete within approximately four seconds to prevent heat from transferring to the diode.

(2) When removing the rectifier from the regulator assembly, remove the soldered sections of the rectifier.

Caution:

1) Use care to make sure that the heat of the soldering iron is not transmitted to the diodes for a long period.

2) Use care that no undue force is exerted to leads of diodes.



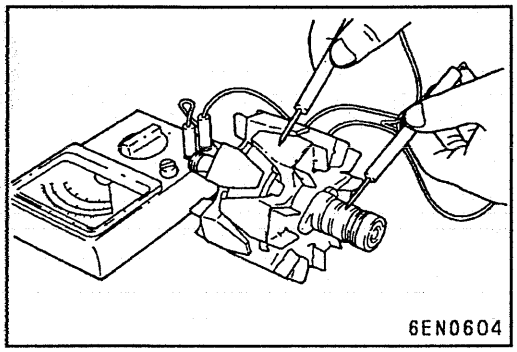
INSPECTION

1. Rotor

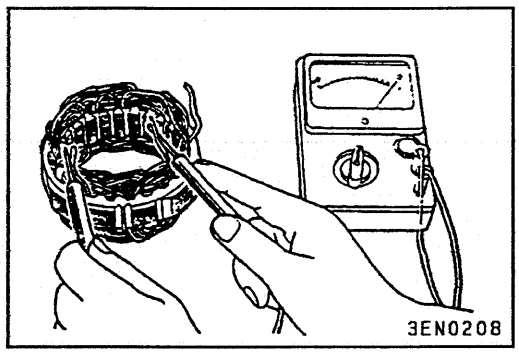
(1) Check the rotor coil continuity. Make sure that there is continuity between the slip rings.

Measure the rotor resistance. If it is excessively small, it indicates a shorted rotor. If there is no continuity or if it is shorted, replace the rotor assembly.

Standard value: 3 to 5 Ω

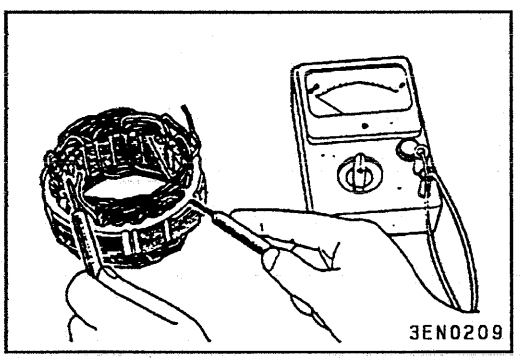


(2) Check for rotor coil grounding. Make sure that there is no continuity between the slip ring and the core. Replace the rotor assembly if there is continuity.

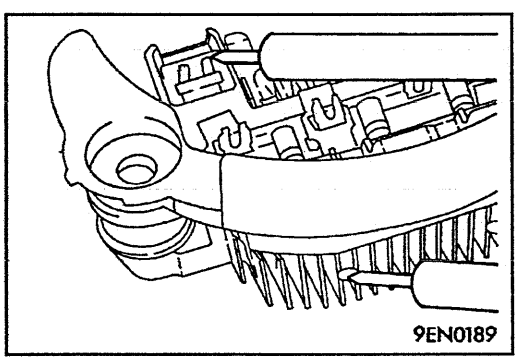


2. Stator

(1) Check the stator continuity. Make sure that there is continuity between the coil leads. Replace the stator assembly if there is no continuity.

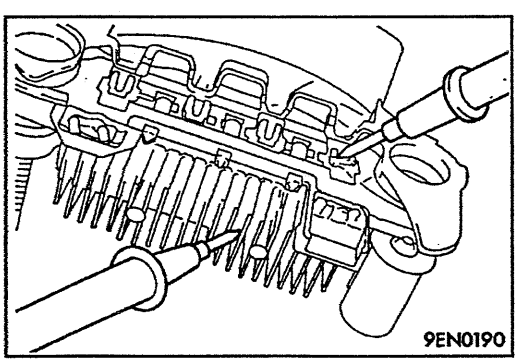


(2) Check for coil grounding. Make sure that there is no continuity between the coil and the core. Replace the stator assembly if there is continuity.

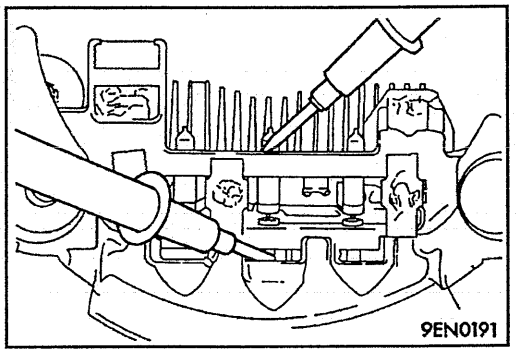


3. Rectifier

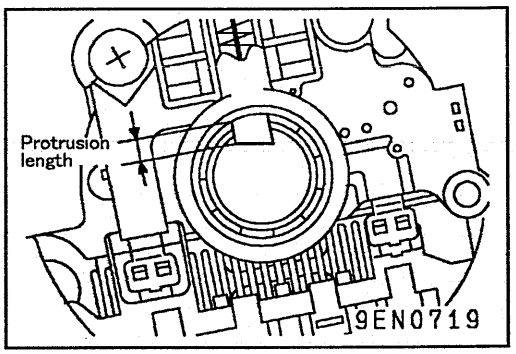
(1) Inspection of (+) heat sink assembly
Using a circuit tester, check continuity between the (+) heat sink and the stator coil lead connection terminals. If there is continuity in both directions, the diode is shorted and the rectifier assembly must be replaced.



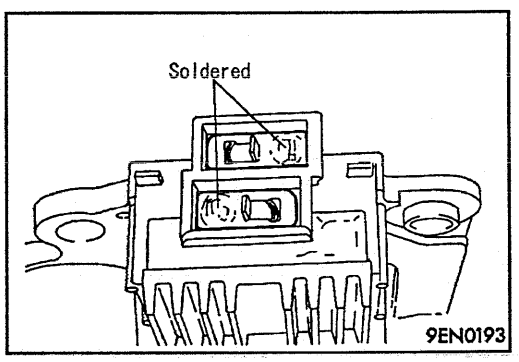
(2) Inspection of (−) heat sink assembly
Check continuity between the (−) heat sink and the stator coil lead connection terminals. If there is continuity in both directions, the diode is shorted and the rectifier assembly must be replaced.



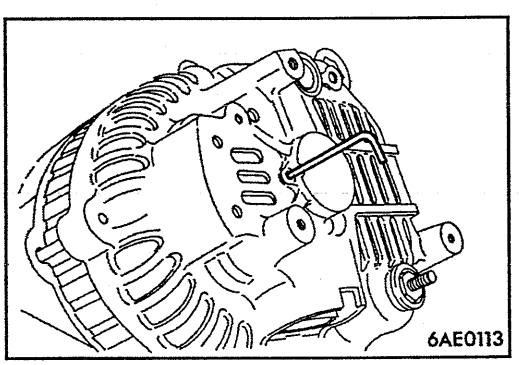
(3) Inspection o diode trio
With a circuit tester connected to both ends of each diode, check continuity of the three diodes. If there is continuity or no continuity in both directions, the diode is damaged and the rectifier assembly must be replaced.



4. Brush
(1) Measure the length of the brush protrusion shown in the illustration, and replace the brush if the measured value is below the limit value.
Limit: 2.0 mm (0.08 in.) or below

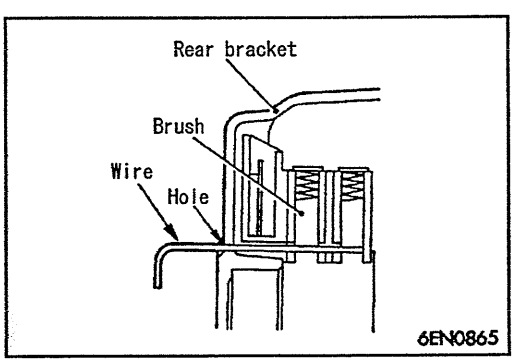


(2) The brush can be removed if the solder of the brush lead wire is removed.
(3) When installing a new brush, push the brush in the brush holder as shown in the illustration, and solder the lead wire.



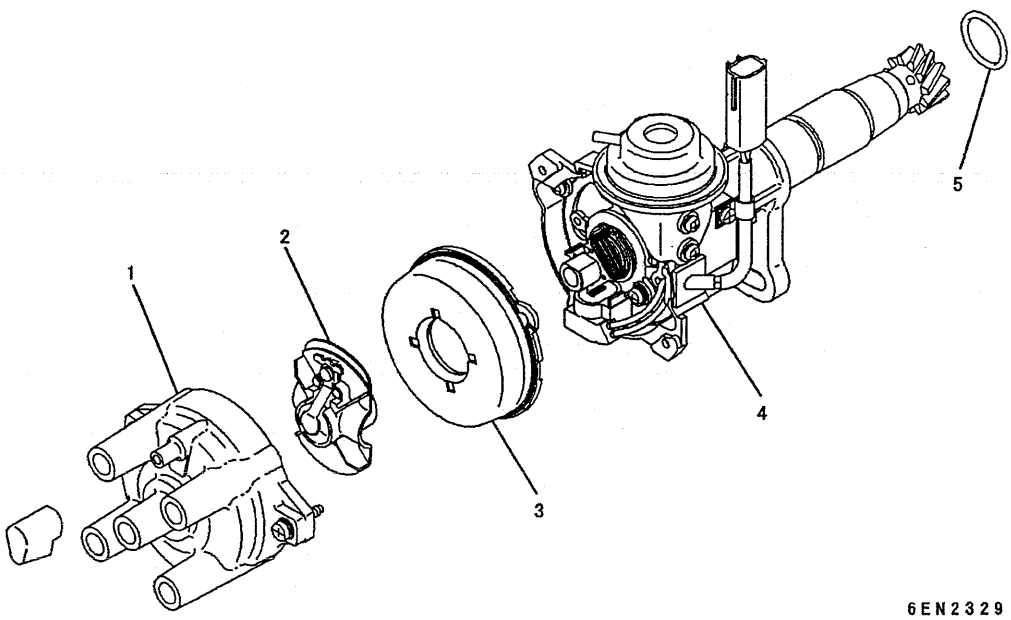
REASSEMBLY SERVICE POINTS

→A← Installation of rotor
Before installing the rotor on the rear bracket, thread a steel wire through the small hole provided in the rear bracket to hold back the brush. After rotor installation, remove the steel wire.



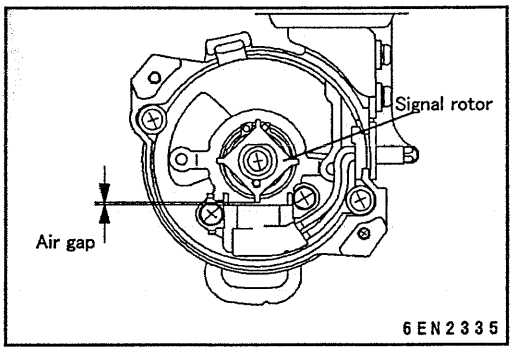
DISTRIBUTOR

DISASSEMBLY AND REASSEMBLY



Disassembly steps

1. Distributor cap
2. Rotor
3. Cover
4. Distributor housing assembly with pickup coil
5. O-ring



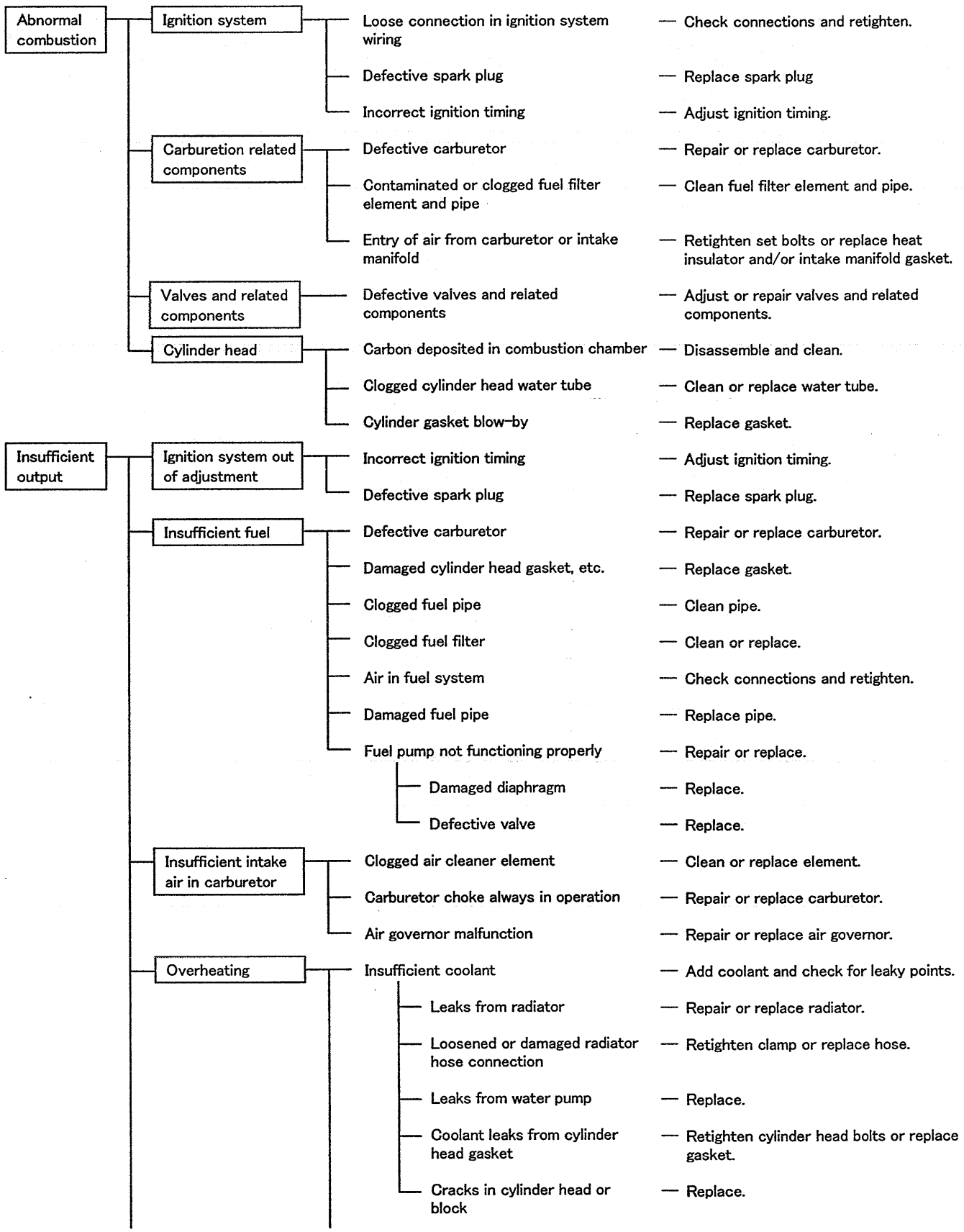
INSPECTION

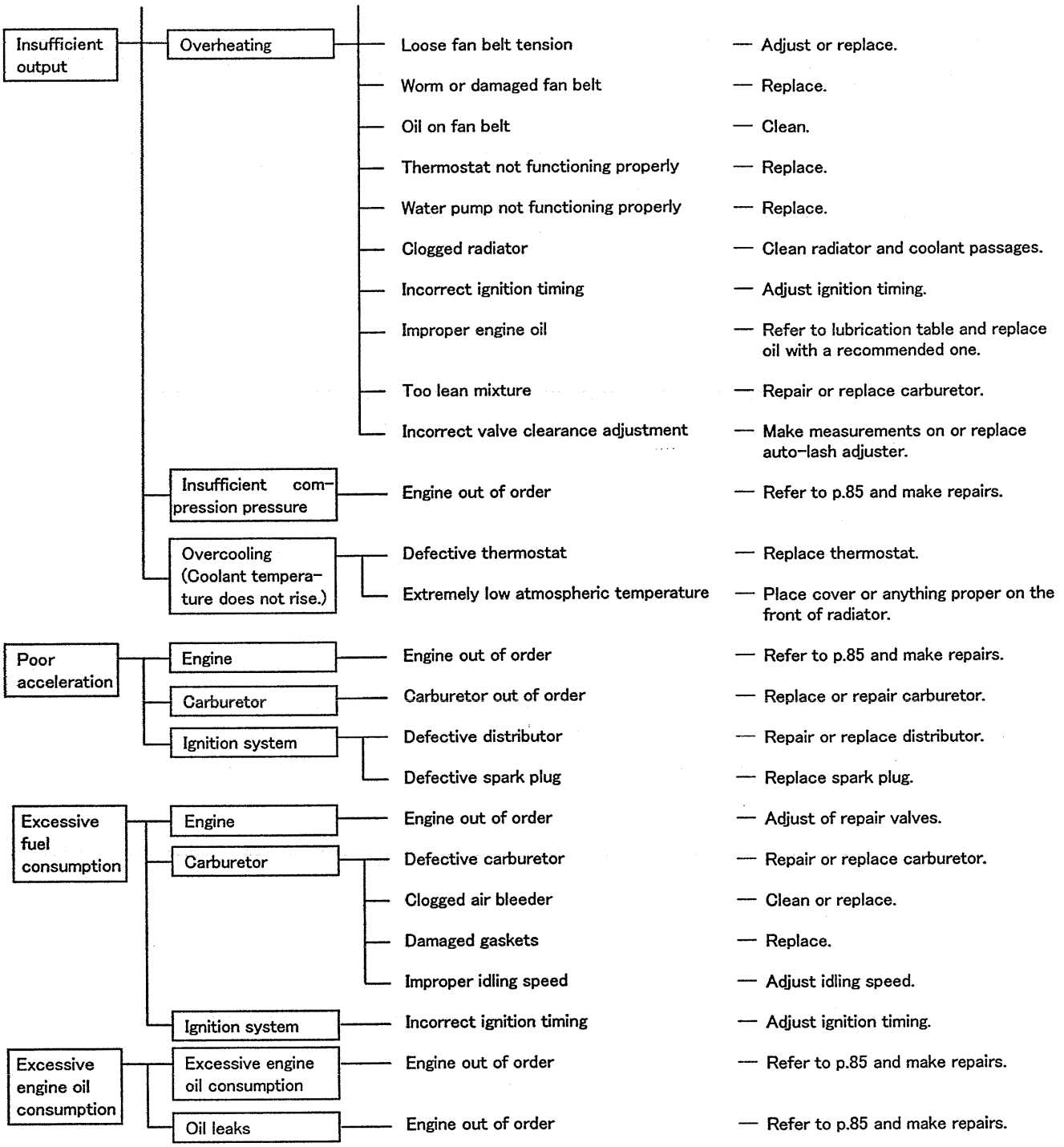
Pickup Coil

Check the air gap between the signal rotor and pickup assembly.

Standard value: 0.35 to 0.45 mm
(0.0138 to 0.0177 in.)

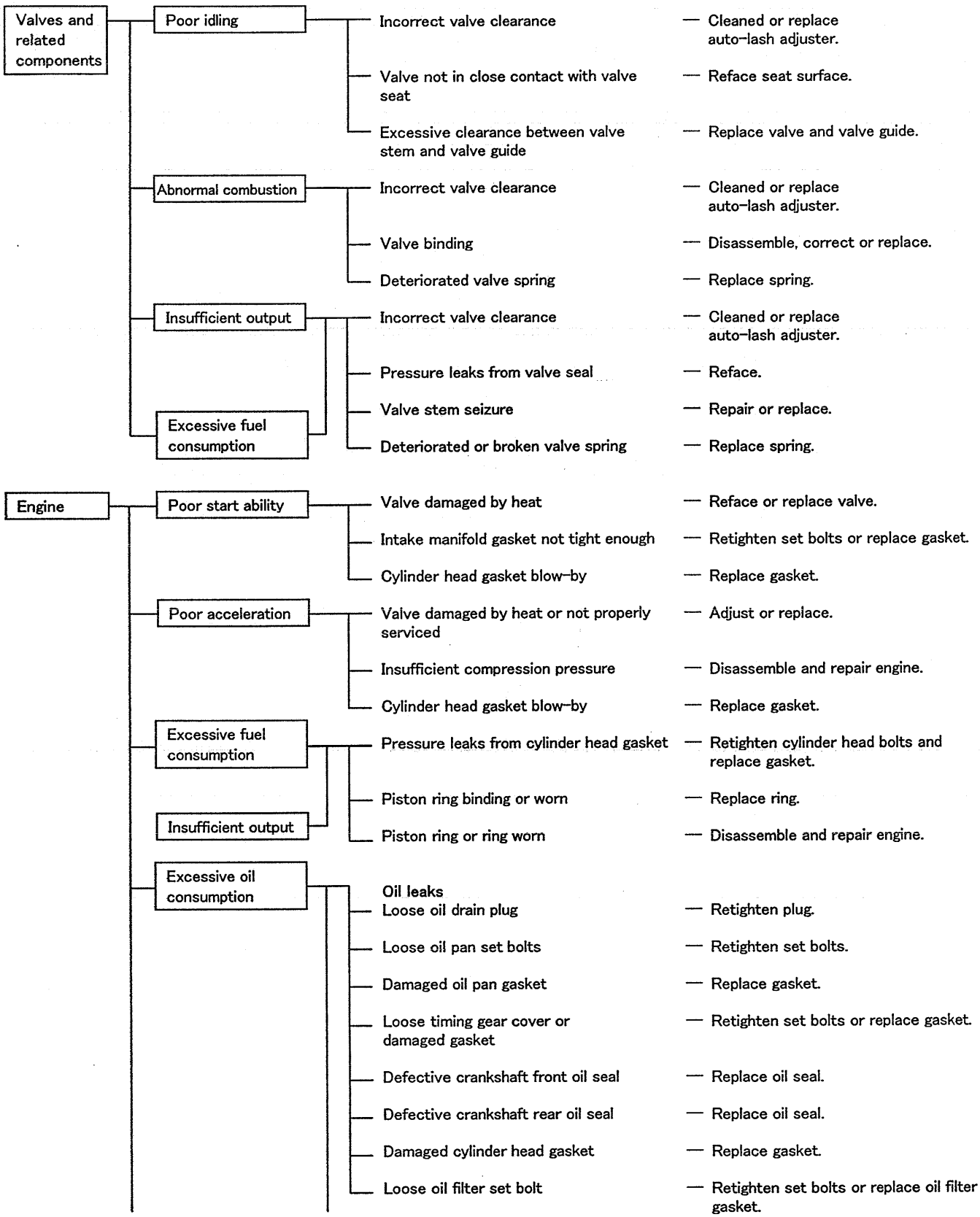
TROUBLESHOOTING

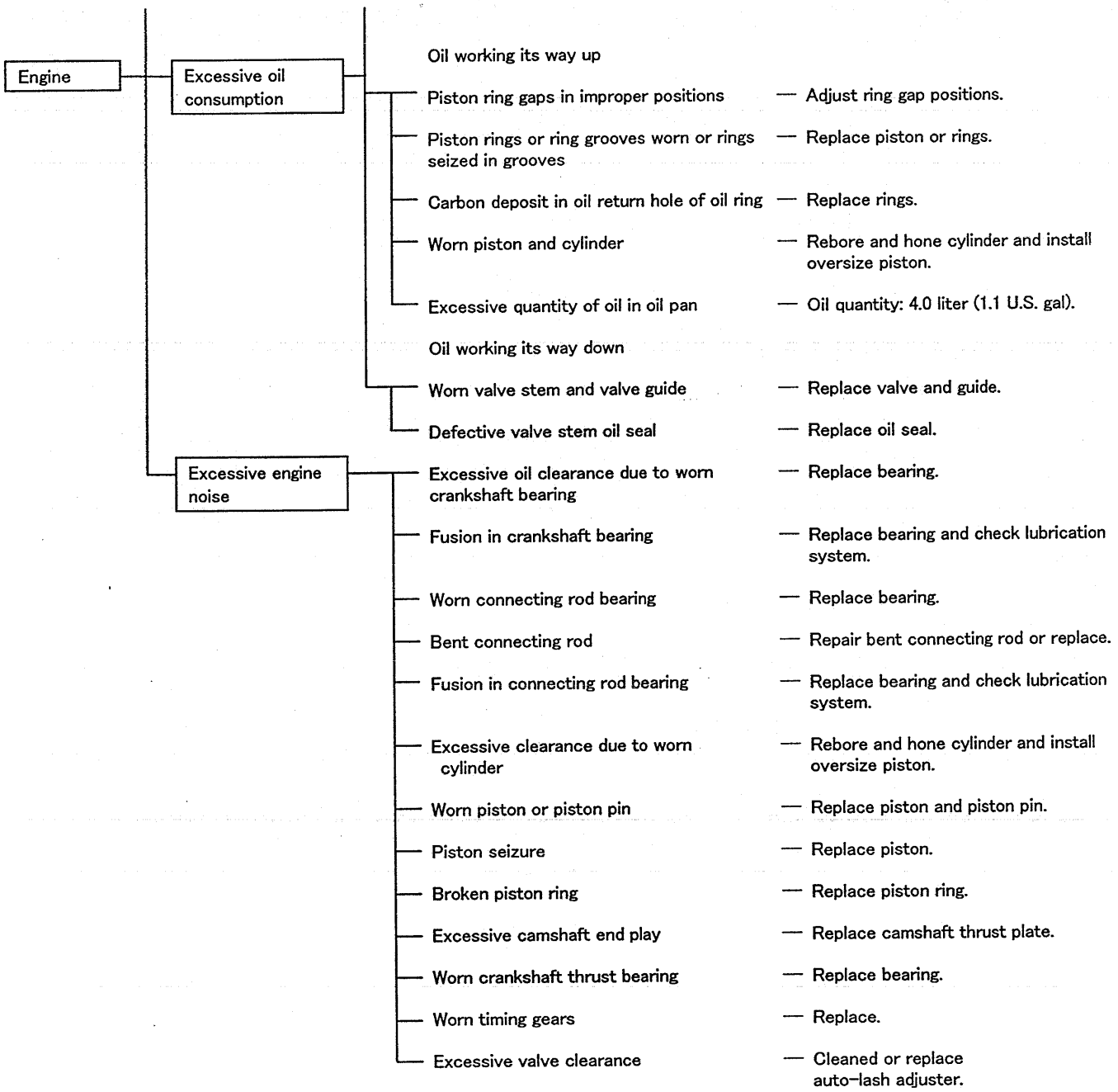


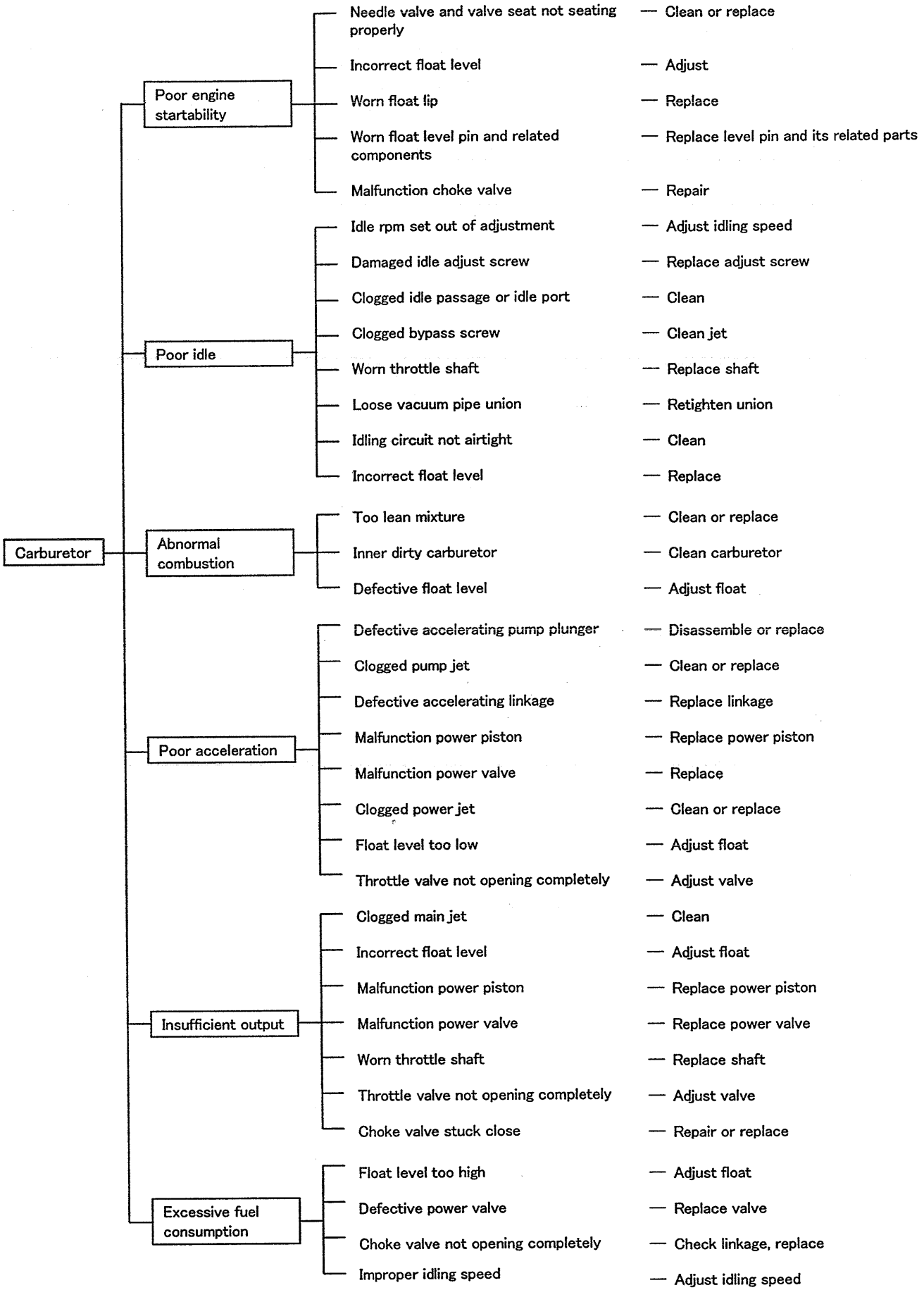

Insufficient output
Overheating
Loose fan belt tension — Adjust or replace.
Worm or damaged fan belt — Replace.
Oil on fan belt — Clean.
Thermostat not functioning properly — Replace.
Water pump not functioning properly — Replace.
Clogged radiator — Clean radiator and coolant passages.
Incorrect ignition timing — Adjust ignition timing.
Improper engine oil — Refer to lubrication table and replace oil with a recommended one.
Too lean mixture — Repair or replace carburetor.
Incorrect valve clearance adjustment — Make measurements on or replace auto-lash adjuster.
Insufficient compression pressure
Engine out of order — Refer to p.85 and make repairs.
Overcooling (Coolant temperature does not rise.)
Defective thermostat — Replace thermostat.
Extremely low atmospheric temperature — Place cover or anything proper on the front of radiator.
Poor acceleration
Engine
Engine out of order — Refer to p.85 and make repairs.
Carburetor
Carburetor out of order — Replace or repair carburetor.
Ignition system
Defective distributor — Repair or replace distributor.
Defective spark plug — Replace spark plug.
Excessive fuel consumption
Engine
Engine out of order — Adjust of repair valves.
Carburetor
Defective carburetor — Repair or replace carburetor.
Clogged air bleeder — Clean or replace.
Damaged gaskets — Replace.
Improper idling speed — Adjust idling speed.
Ignition system
Incorrect ignition timing — Adjust ignition timing.
Excessive engine oil consumption
Excessive engine oil consumption
Engine out of order — Refer to p.85 and make repairs.
Oil leaks
Engine out of order — Refer to p.85 and make repairs.

Engine, Carburetor and Electrical Components Troubleshooting

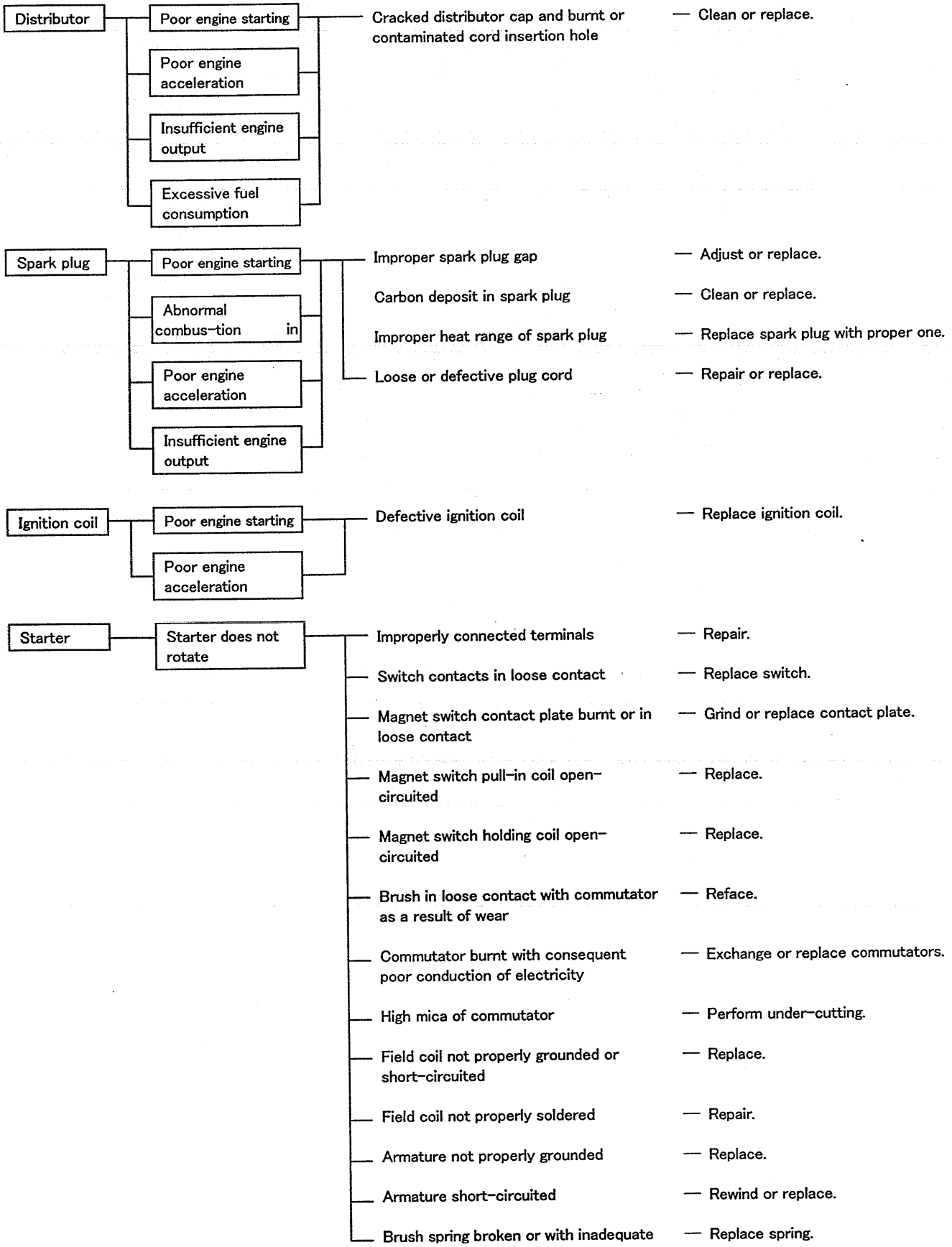
Engine



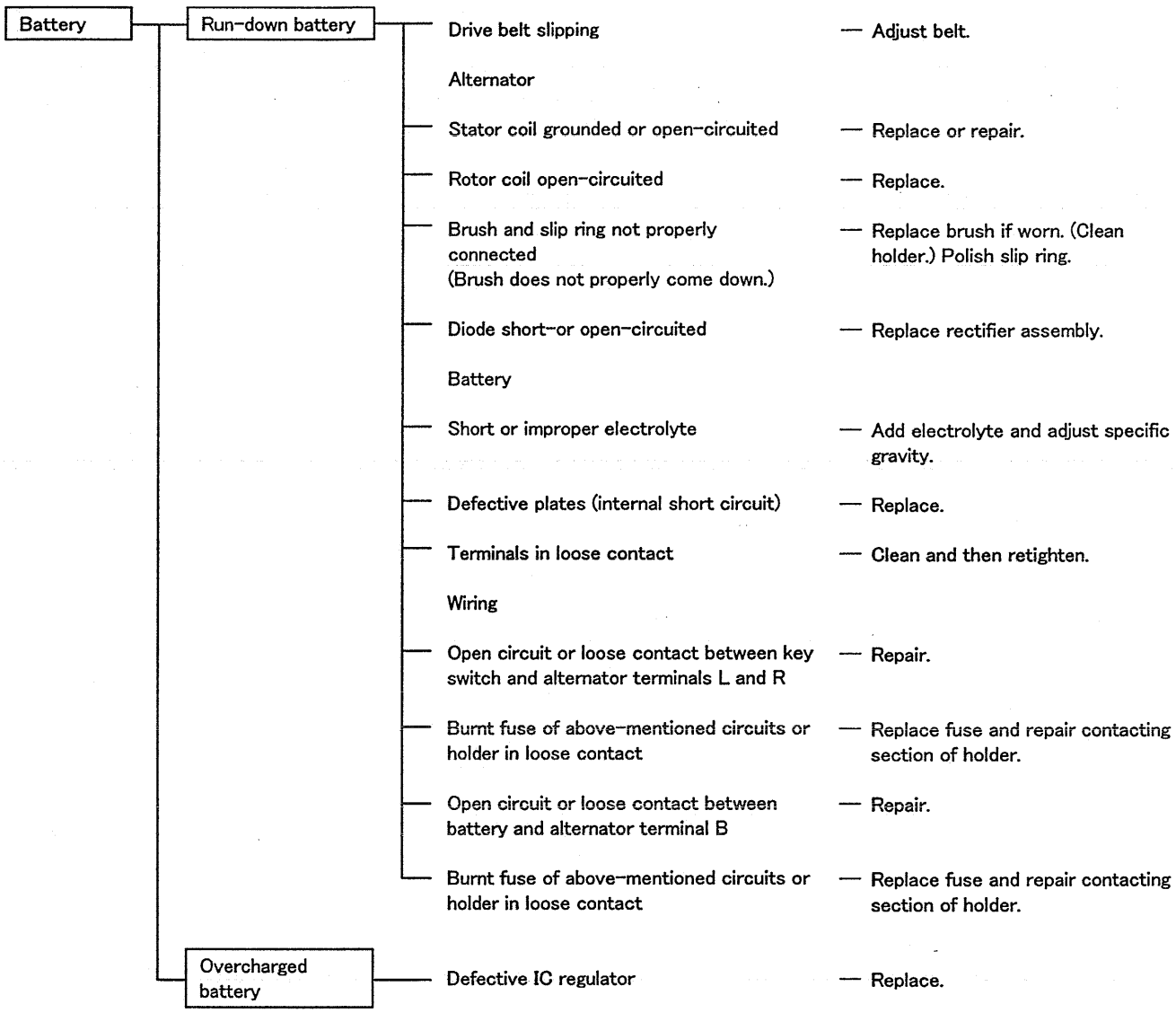

Engine
Excessive oil consumption
Oil working its way up
Piston ring gaps in improper positions — Adjust ring gap positions.
Piston rings or ring grooves worn or rings seized in grooves — Replace piston or rings.
Carbon deposit in oil return hole of oil ring — Replace rings.
Worn piston and cylinder — Rebore and hone cylinder and install oversize piston.
Excessive quantity of oil in oil pan — Oil quantity: 4.0 liter (1.1 U.S. gal).
Oil working its way down
Worn valve stem and valve guide — Replace valve and guide.
Defective valve stem oil seal — Replace oil seal.
Excessive engine noise
Excessive oil clearance due to worn crankshaft bearing — Replace bearing.
Fusion in crankshaft bearing — Replace bearing and check lubrication system.
Worn connecting rod bearing — Replace bearing.
Bent connecting rod — Repair bent connecting rod or replace.
Fusion in connecting rod bearing — Replace bearing and check lubrication system.
Excessive clearance due to worn cylinder — Rebore and hone cylinder and install oversize piston.
Worn piston or piston pin — Replace piston and piston pin.
Piston seizure — Replace piston.
Broken piston ring — Replace piston ring.
Excessive camshaft end play — Replace camshaft thrust plate.
Worn crankshaft thrust bearing — Replace bearing.
Worn timing gears — Replace.
Excessive valve clearance — Cleaned or replace auto-lash adjuster.


Carburetor
Poor engine startability
Needle valve and valve seat not seating properly — Clean or replace
Incorrect float level — Adjust
Worn float lip — Replace
Worn float level pin and related components — Replace level pin and its related parts
Malfunction choke valve — Repair
Poor idle
Idle rpm set out of adjustment — Adjust idling speed
Damaged idle adjust screw — Replace adjust screw
Clogged idle passage or idle port — Clean
Clogged bypass screw — Clean jet
Worn throttle shaft — Replace shaft
Loose vacuum pipe union — Retighten union
Idling circuit not airtight — Clean
Incorrect float level — Replace
Abnormal combustion
Too lean mixture — Clean or replace
Inner dirty carburetor — Clean carburetor
Defective float level — Adjust float
Poor acceleration
Defective accelerating pump plunger — Disassemble or replace
Clogged pump jet — Clean or replace
Defective accelerating linkage — Replace linkage
Malfunction power piston — Replace power piston
Malfunction power valve — Replace
Clogged power jet — Clean or replace
Float level too low — Adjust float
Throttle valve not opening completely — Adjust valve
Insufficient output
Clogged main jet — Clean
Incorrect float level — Adjust float
Malfunction power piston — Replace power piston
Malfunction power valve — Replace power valve
Worn throttle shaft — Replace shaft
Throttle valve not opening completely — Adjust valve
Choke valve stuck close — Repair or replace
Excessive fuel consumption
Float level too high — Adjust float
Defective power valve — Replace valve
Choke valve not opening completely — Check linkage, replace
Improper idling speed — Adjust idling speed

Electrical components




Starter
Starter does not rotate.
Brush holder not properly insulated — Clean brush or replace holder.
Worn bearing bushing — Replace bushing.
Starter rotates but slowly and irregularly.
Wires of armature coil about to be short-circuited or grounded — Rewind or replace.
Field coil not properly connected or about to be short-circuited — Repair connections.
Commutator heat-damaged with consequent poor conduction — Replace armature.
Brush movement due to damaged or worn commutator — Repair or replace.
Commutator vibrating, causing brush to move — Repair or replace.
Lifted mica between commutator segments causing brush to move — Perform under-cutting.
One or two commutator segments lifted causing brush to move — Repair or replace.
Commutator in loose contact due to worn brush — Repair or replace.
Chipped brush — Repair or replace.
Pinion does not engage with ring gear.
Worn starter clutch pinion end — Replace.
Clutch rotates always freely — Replace.
Deteriorated clutch drive spring — Replace.
Does not rotate in overrunning direction — Replace.
Poor sliding of splined section — Rub surfaces smooth, clean and repair.
Worn bushing — Replace.
Improper projecting position of magnet switch pinion — Adjust with stud bolt.
Worn bearing bushing — Replace.
Motor continues to rotate and does not stop.
Magnet switch coil layer shorted-circuited — Replace.
Magnet switch contact plate seizure — Replace.
Starter switch does not return properly — Replace switch.


Battery
Run-down battery
Drive belt slipping
— Adjust belt.
Alternator
Stator coil grounded or open-circuited
— Replace or repair.
Rotor coil open-circuited
— Replace.
Brush and slip ring not properly connected
(Brush does not properly come down.)
— Replace brush if worn. (Clean holder.) Polish slip ring.
Diode short-or open-circuited
— Replace rectifier assembly.
Battery
Short or improper electrolyte
— Add electrolyte and adjust specific gravity.
Defective plates (internal short circuit)
— Replace.
Terminals in loose contact
— Clean and then retighten.
Wiring
Open circuit or loose contact between key switch and alternator terminals L and R
— Repair.
Burnt fuse of above-mentioned circuits or holder in loose contact
— Replace fuse and repair contacting section of holder.
Open circuit or loose contact between battery and alternator terminal B
— Repair.
Burnt fuse of above-mentioned circuits or holder in loose contact
— Replace fuse and repair contacting section of holder.
Overcharged battery
Defective IC regulator
— Replace.