Ingersoll-Rand
4IRL5N
Diesel Engine

WORKSHOP MANUAL

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FOREWORD

This Workshop Manual is designed to help you perform necessary maintenance, service, and repair procedures on applicable Ingersoll-Rand industrial engines.

Information contained in this Workshop Manual is the latest available at the time of publication.

Ingersoll-Rand reserves the right to make changes at any time without prior notice.

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SECTION 1

GENERAL INFORMATION

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GENERAL REPAIR INSTRUCTIONS

1. Before performing any service operation with the engine mounted, disconnect the grounding cable from the battery.
This will reduce the chance of cable damage and burning due to short circuiting.

2. Always use the proper tool or tools for the job at hand.
Where specified, use the specially designed tool or tools.

3. Use genuine INGERSOLL-RAND parts.

4. Never reuse cotter pins, gaskets, O-rings, lock washers, and self locking nuts. Discard them as you remove them. Replace them with new ones.

5. Always keep disassembled parts neatly in groups. This will ensure a smooth reassembly operation.
It is especially important to keep fastening parts separate. These parts vary in hardness and design, depending on their installation position.

6. All parts should be carefully cleaned before inspection or reassembly.
Oil ports and other openings should be cleaned with compressed air to make sure that they are completely free of obstructions.

7. Rotating and sliding part surfaces should be lubricated with oil or grease before reassembly.

8. If necessary, use a sealer on gaskets to prevent leakage.

9. Nut and bolt torque specifications should be carefully followed.

10. Always release the air pressure from any machine-mounted air tank(s) before dismounting the engine or disconnecting pipes and hoses. To not do so is extremely dangerous.

11. Always check and recheck your work. No service operation is complete until you have done this.

NOTES ON THE FORMAT OF THIS MANUAL

This Workshop Manual is applicable to 4IRL5N family of industrial diesel engines. Unless otherwise specified, these engines have common parts and components as well as data specifications.
Illustrations used in this Workshop Manual are based on the 4IRL5N engines.

1. Find the applicable section by referring to the Table of Contents at the beginning of the Manual.

2. Common technical data such as general maintenance items, service specifications, and tightening torques are included in the “General Information” section.

3. Each section is divided into sub-sections dealing with disassembly, inspection and repair, and reassembly.

4. When the same servicing operation is applicable to several different units, the manual will direct you to the appropriate page.

5. For the sake of brevity, self-explanatory removal and installation procedures are omitted.
More complex procedures are covered in detail.

GENERAL INFORMATION

6. Each service operation section in this Workshop Manual begins with an exploded view of the applicable area.

(Example)

Major components
Figures in parentheses "( )" show the order of disassembling or reassembling.

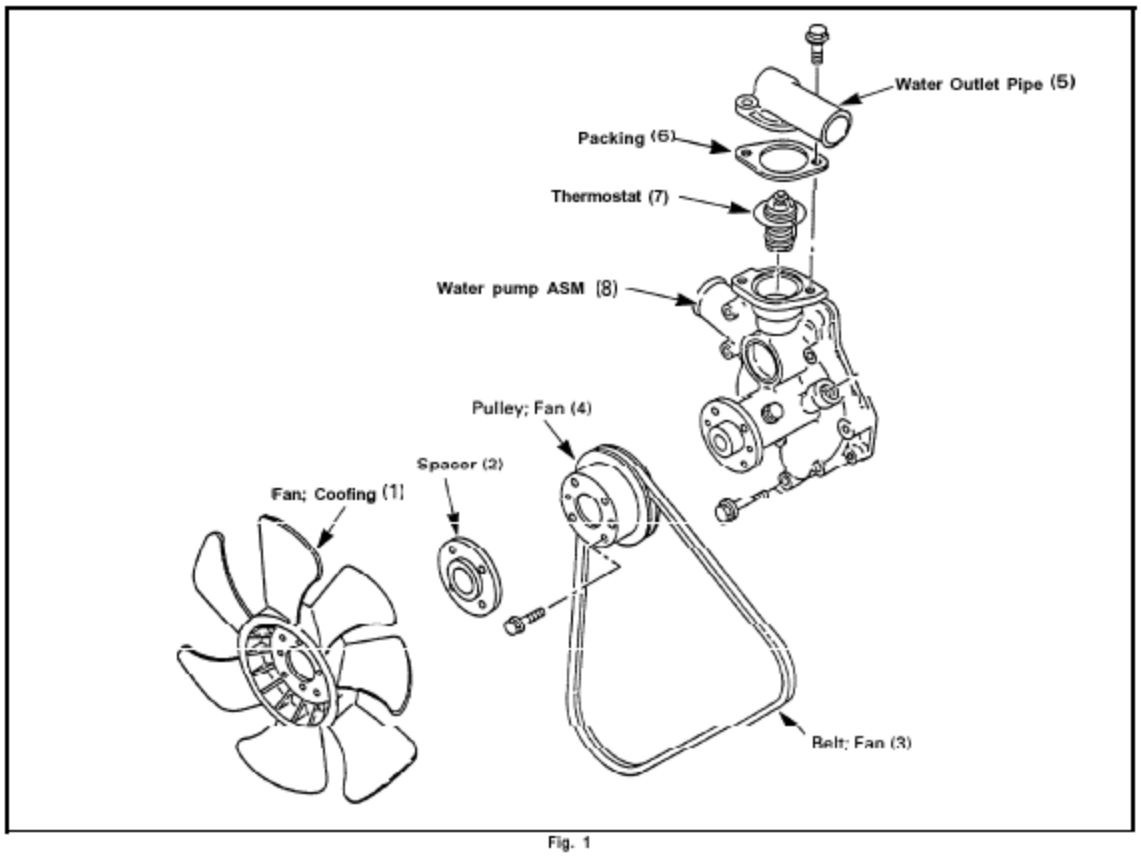


Fig. 1

7. Measurement criteria are defined by the terms "standard" and "limit".

A measurement falling within the "standard" range indicates that the applicable part or parts are serviceable.

"Limit" should be thought of as an absolute value.
A measurement which is outside the "limit" indicates that the applicable part or parts must be either repaired or replaced.

8. Components and parts are listed in the singular form throughout the Manual.

GENERAL INFORMATION

9. The following symbols appear throughout this Worshop Manual. They tell you the type of service operation or step to perform.

 ... Remove

 ... Installation

 ... Disassembly

 ... Reassembly

 ... Alignment (Marks)

 ... Directional Indication

 ... Inspection

 ... Measurement

 ... Sealant

 ... Adjustment

 ... Cleaning

 ... Important Operation Requiring Extra Care

 ... Specified Torque (Tighten)

 ... Special Tool Use Required for Recommended

 ... Commercially Available Tool Use Required or Recommended

 ... Lubrication (Oil)

 ... Lubrication (Grease)

10. Direction used in this Manual are as follows:

Front

The cooling fan side of the engine viewed from the flywheel.

Right

The injection pump side of the engine.

Left

The exhaust manifold side of the engine.

Rear

The flywheel side of the engine.

Cylinder numbers are counted from the front of the engine.
The front most cylinder is No. 1 and rear most cylinder is No.4.

The engine's direction of rotation is counterclockwise viewed from the flywheel.

APPEARANCE

1. MODEL 4LE2

(1) Left side view

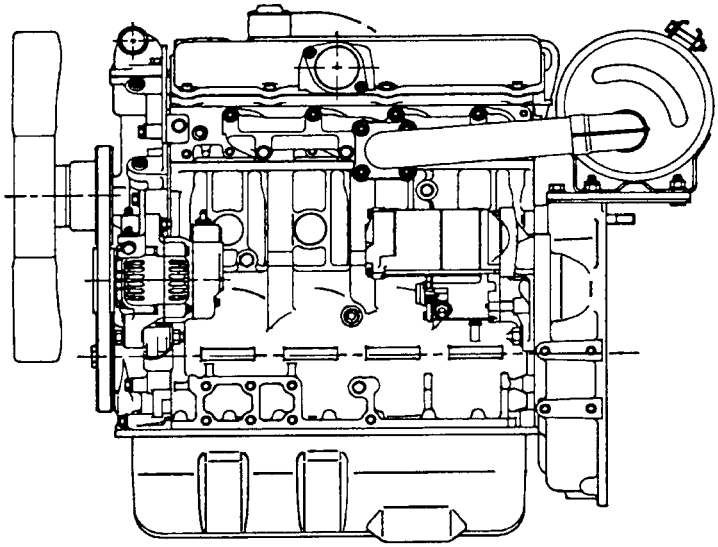


Fig. 2

(2) Right side view

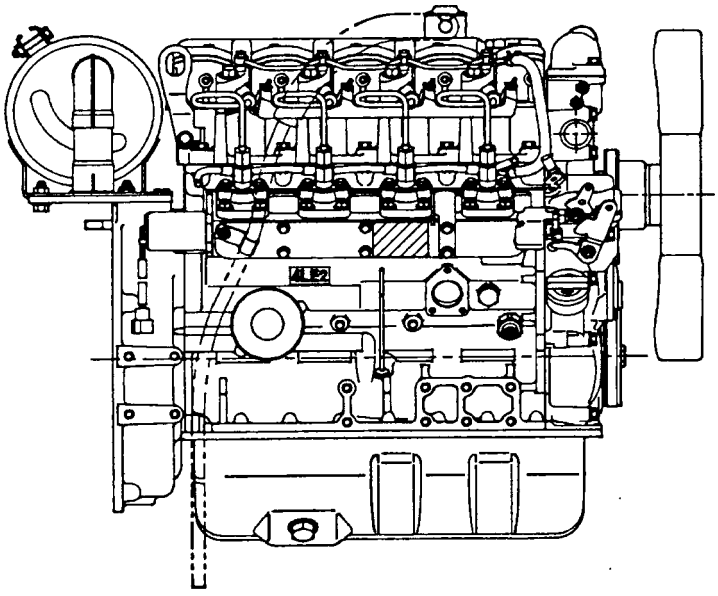


Fig. 3

MAIN DATA AND SPECIFICATIONS

1. MODEL 4LE2

Item \ Engine model(s)				4LE2
Type				4-cycle, verlical in-line, water cooled, OHV
Timing drive system				Gear drive
No. of cylinders - bore × stroke			mm	4 – 85 × 92
Displacement			L (cid)	2.179 (133)
Compression ratio				18.8 : 1
Type of combustion				Direct injection
Overall length × width × height			mm	* 691 × 449 × 616
Dry weight			kg (lb)	* 155 (342)
Fuel injection timing (BTDC)			(when at stop)	* 14°
Firing order				1 – 3 – 4 – 2
Fuel				Highspeed diesel fuel (SAE No.2)
Idling speed			min^{-1}	* 850
Compression pressure			MPa(kg/cm²/psi)	3 (31/440) or more/250 min^{-1}
Valve clearance (cold) mm (in)		Intake		0.4 (0.0157)
		Exhaust		0.4 (0.0157)
Valve operating timing	Intake valve	Open (BTDC)		15°
		Close (ABDC)		29°
	Exhaust valve	Open (BBDC)		40°
		Close (ATDC)		16°
Injection pump				Bosch type
Governor				Mechanical type
Nozzle				Multi-hole type
Injection pressure			MPa(kg/cm²/psi)	* 17.7 (180/2560)
Oil pump				Trochoid type
Oil filter				Cartridge type
Lubricant capacity: In total			L (qts)	* About 8.7 (9.2)
Generator output			(V – A)	* 12 – 35
Starter output			(V – KW)	* 12 – 2.0

(Note) These specifications may be subject to change without notice.
Figures in the column with an asterisk (*) are different for each machine. Refer to the specifications provided by machine manufacturers.

TIGHTENING TORQUE SPECIFICATIONS

The tightening torque values given in the table below are applicable to the bolts unless otherwise specified.

STANDARD BOLT

N·m (kgf·m)

Bolt Identification / Bolt Diameter × pitch (mm)	4	8	8	9
M6 × 1.0	3.9 ··· 7.8 (0.4 ~ 0.8)	4.9 ~ 9.8 (0.5 ~ 1.0)		
M8 × 1.25	7.8 ~ 17.7 (0.8 ~ 1.8)	11.8 ··· 22.6 (1.2 ··· 2.3)		16.7 ~ 30.4 (1.7 ··· 3.1)
M10 × 1.25	20.6 ··· 34.3 (2.1 ··· 3.5)	27.5 ~ 46.1 (2.8 ~ 4.7)		37.3 ··· 62.8 (3.8 ~ 6.4)
* M10 × 1.5	19.6 ~ 33.4 (2.0 ~ 3.4)	27.5 ··· 45.1 (2.8 ··· 4.6)		36.3 ~ 59.8 (3.7 ··· 6.1)
M12 × 1.25	49.1 ··· 73.6 (5.0 ··· 7.5)	60.8 ~ 91.2 (6.2 ~ 9.3)		75.5 ··· 114.0 (7.7 ~ 11.6)
* M12 × 1.75	45.1 ~ 68.7 (4.6 ~ 7.0)	56.9 ~ 84.4 (5.8 ··· 8.6)		71.6 ~ 107.0 (7.3 ~ 10.9)
M14 × 1.5	76.5 ~ 115.0 (7.8 ··· 11.7)	93.2 ··· 139.0 (9.5 ~ 14.2)		114.0 ··· 171.0 (11.6 ~ 17.4)
* M14 × 2.0	71.6 ~ 107.0 (7.3 ~ 10.9)	88.3 ~ 131.0 (9.0 ··· 13.4)		107.0 ~ 160.0 (10.9 ~ 16.3)
M16 × 1.5	104.0 ··· 157.0 (10.6 ··· 16.0)	135.0 ··· 204.0 (13.8 ~ 20.8)		160.0 ··· 240.0 (16.3 ··· 24.5)
* M16 × 2.0	100.0 ··· 149.0 (10.2 ~ 15.2)	129.0 ~ 194.0 (13.2 ~ 19.8)		153.0 ~ 230.0 (15.6 ~ 23.4)
M18 × 1.5	161.0 ~ 226.0 (15.4 ··· 23.0)	195.0 ··· 293.0 (19.9 ~ 29.9)		230.0 ··· 345.0 (23.4 ··· 35.2)
* M18 × 2.5	151.0 ··· 226.0 (15.4 ~ 23.0)	196.0 ~ 294.0 (20.0 ~ 30.0)		231.0 ~ 346.0 (23.6 ~ 35.3)
M20 × 1.5	206.0 ~ 310.0 (21.0 ··· 31.6)	270.0 ··· 405.0 (27.5 ~ 41.3)		317.0 ··· 476.0 (32.3 ··· 48.5)
* M20 × 2.5	190.0 ~ 286.0 (19.4 ~ 29.2)	249.0 ~ 376.0 (25.4 ··· 38.2)		293.0 ~ 440.0 (29.9 ~ 44.9)
M22 × 1.5	251.0 ~ 414.0 (25.6 ··· 42.2)	363.0 ··· 544.0 (37.0 ~ 55.5)		425.0 ··· 637.0 (43.3 ··· 64.9)
* M22 × 2.5	216.0 ~ 328.0 (22.2 ~ 33.4)	338.0 ~ 507.0 (34.5 ··· 51.7)		394.0 ~ 592.0 (40.2 ~ 60.4)
M24 × 2.0	359.0 ··· 540.0 (36.6 ··· 55.0)	431.0 ··· 711.0 (43.9 ~ 72.5)		554.0 ··· 831.0 (56.5 ~ 84.7)
* M24 × 3.0	338.0 ~ 507.0 (34.5 ~ 51.7)	406.0 ~ 608.0 (41.4 ··· 62.0)		521.0 ~ 782.0 (53.1 ~ 79.7)

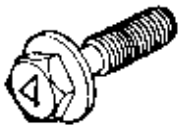
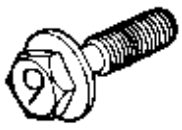
An asterisk (*) indicates that the bolts are used for female threaded parts that are made of soft materials such as casting.

TIGHTENING TORQUE SPECIFICATIONS

The tightening torque values given in the table below are applicable to the bolts unless otherwise specified.

FLANGED HEAD BOLT

N·m (kgf·m)

Bolt Identification / Bolt Diameter × pitch (mm)			
M 6 × 1.0	4.6 ~ 8.5 { 0.5 ~ 0.9}	6.6 ~ 12.2 { 0.6 ~ 1.2}	———
M 8 × 1.25	10.5 ~ 19.6 { 1.1 ~ 2.0}	15.3 ~ 28.4 { 1.6 ~ 2.9}	18.1 ~ 33.6 { 2.1 ~ 3.4}
M10 × 1.25	23.1 ~ 38.5 { 2.4 ~ 3.9}	35.4 ~ 58.9 { 3.6 ~ 6.1}	42.3 ~ 70.5 { 4.3 ~ 7.2}
* M10 × 1.5	22.3 ~ 37.2 { 2.3 ~ 3.8}	34.5 ~ 57.5 { 3.5 ~ 5.8}	40.1 ~ 66.9 { 4.1 ~ 6.8}
M12 × 1.25	54.9 ~ 82.3 { 5.6 ~ 8.4}	77.7 ~ 117.0 { 7.9 ~ 11.9}	85.0 ~ 128.0 { 8.7 ~ 13.0}
* M12 × 1.75	51.0 ~ 76.5 { 5.2 ~ 7.8}	71.4 ~ 107.0 { 7.3 ~ 10.9}	79.5 ~ 119.0 { 8.1 ~ 12.2}
M14 × 1.5	83.0 ~ 125.0 { 8.5 ~ 12.7}	115.0 ~ 172.0 {11.7 ~ 17.6}	123.0 ~ 185.0 {12.6 ~ 18.9}
* M14 × 2.0	77.2 ~ 116.0 { 7.9 ~ 11.8}	108.0 ~ 162.0 {11.1 ~ 16.6}	116.0 ~ 173.0 {11.8 ~ 17.7}
M16 × 1.5	116.0 ~ 173.0 {11.8 ~ 17.7}	171.0 ~ 257.0 {17.4 ~ 26.2}	177.0 ~ 265.0 {18.0 ~ 27.1}
* M16 × 2.0	109.0 ~ 164.0 {11.2 ~ 16.7}	163.0 ~ 244.0 {16.6 ~ 24.9}	169.0 ~ 253.0 {17.2 ~ 25.8}

A bolt with an asterisk (*) is used for female screws of soft material such as cast iron.

ANGULAR NUT AND BOLT TIGHTENING METHOD

1. Carefully wash the nuts and bolts to remove all oil and grease.

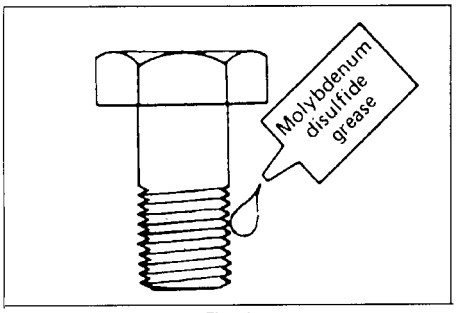


Fig. 4

2. Apply a coat of molybdenum disulfide grease to the threads and setting faces of the nuts and bolts.

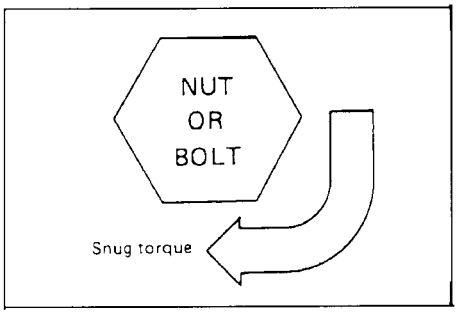


Fig. 5

3.Tighten the nuts and bolts to the specified torque (snug torque) with a torque wrench.

4. Draw a line [A-B] across the center of each bolt.

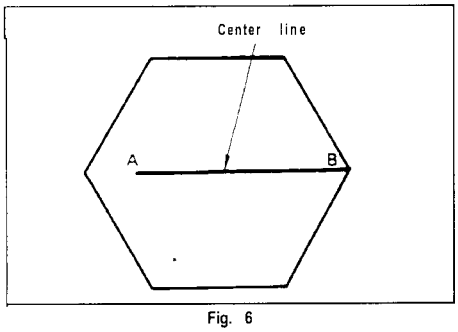


Fig. 6

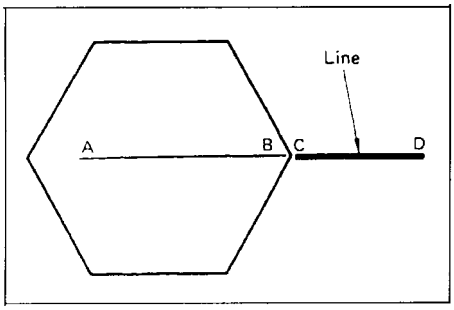


Fig. 7

5. Draw another line [C-D] on the face of each of the parts to be clamped. This line should be an extension of the line [A-B].

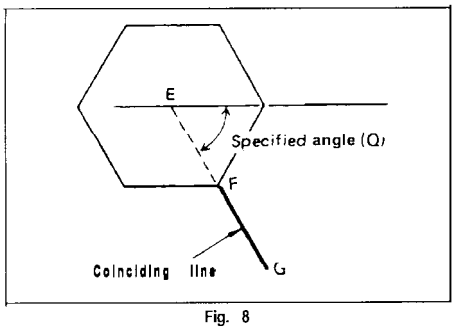


Fig. 8

6. Draw another line [F-G] on the face of each of the parts to be clamped. This line will be in the direction of the specified angle [Q] across the center [E] of the nut or bolt.

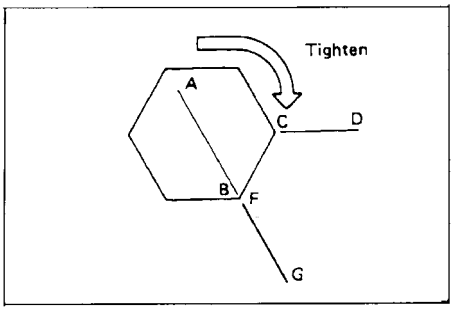


Fig. 9

7. Use a socket wrench to tighten each nut or bolt to the point where the line [A-B] is aligned with the line [F-G].

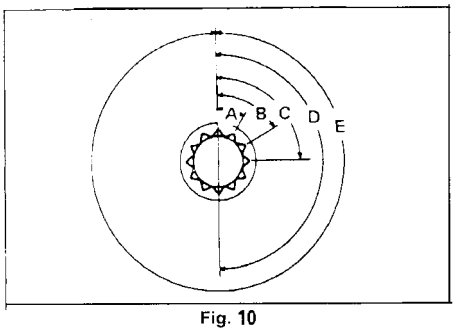


Fig. 10

Example: Specified Angle and Tightening Rotation

A	30°	1/12 of a turn
B	60°	1/6 of a turn
C	90°	1/4 of a turn
D	180°	1/2 of a turn
E	360°	One full turn

TIGHTENING TORQUE ON MAJOR COMPONENTS

1. COOLING FAN AND WATER PUMP

N·m (kgf·m/ft. lb)

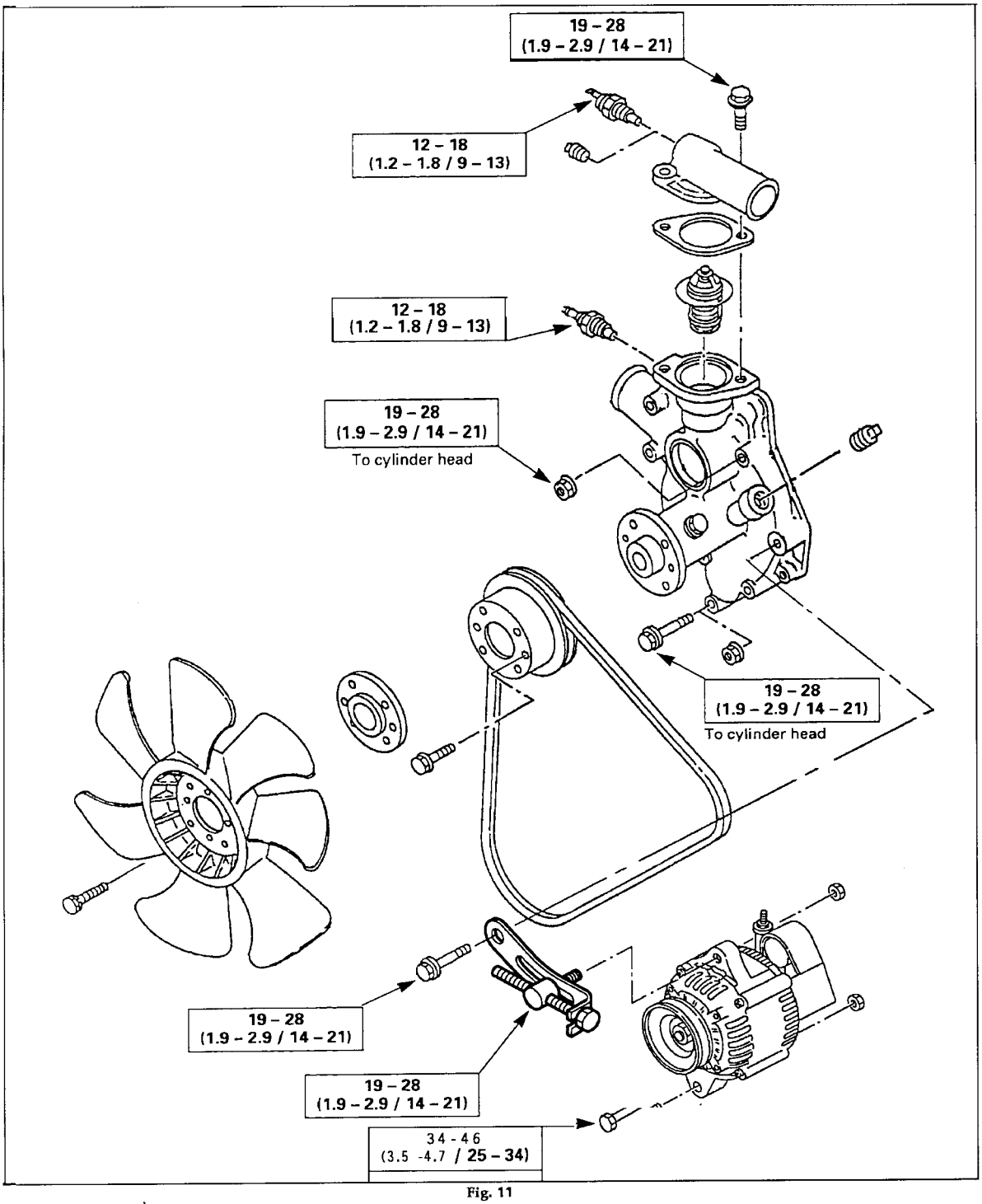


Fig. 11

2. CYLINDER HEAD AND CYLINDER HEAD COVER

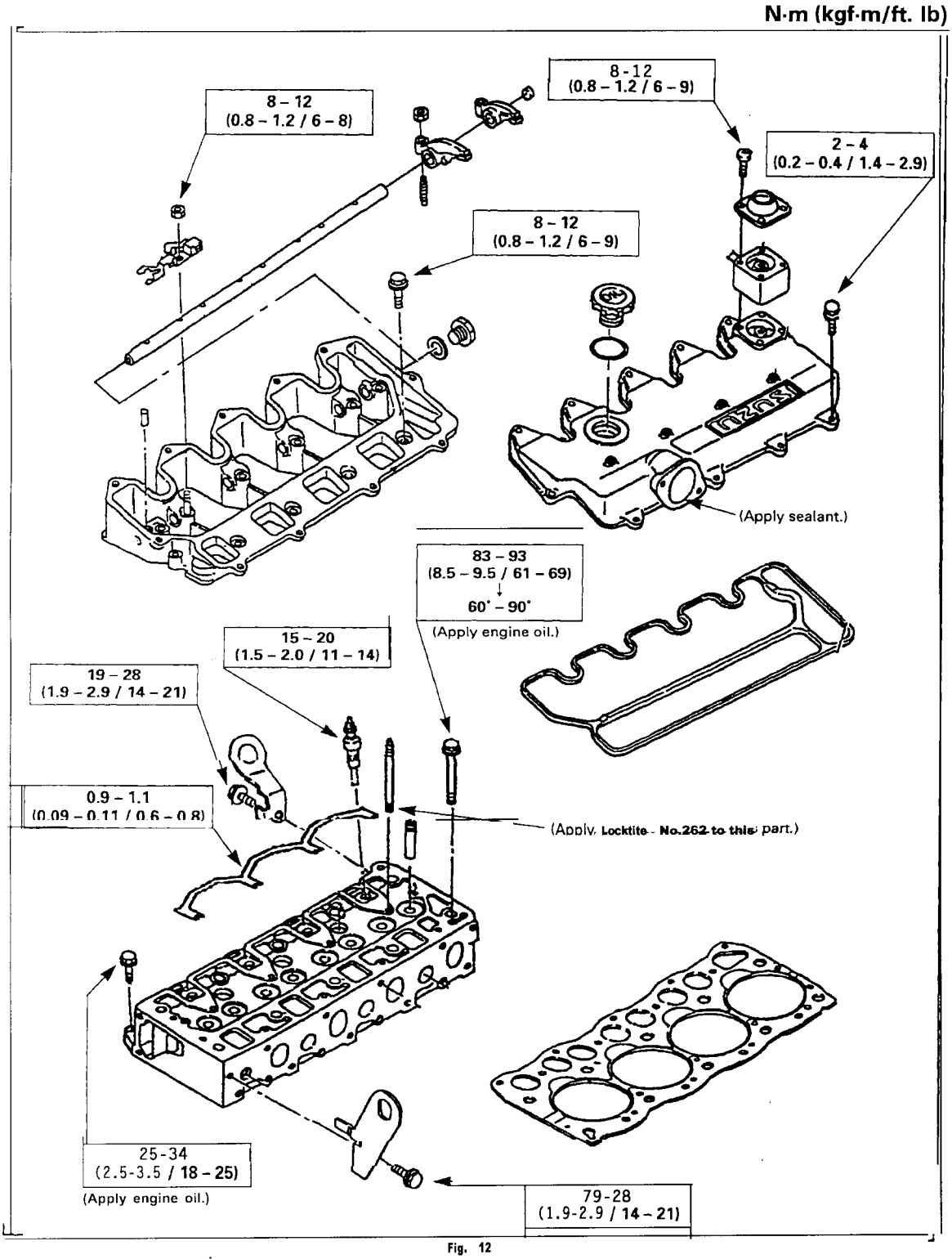


Fig. 12

3. CYLINDER BLOCK AND OTHER COMPONENTS (1)

N-m (kgf-m/ft. lb)

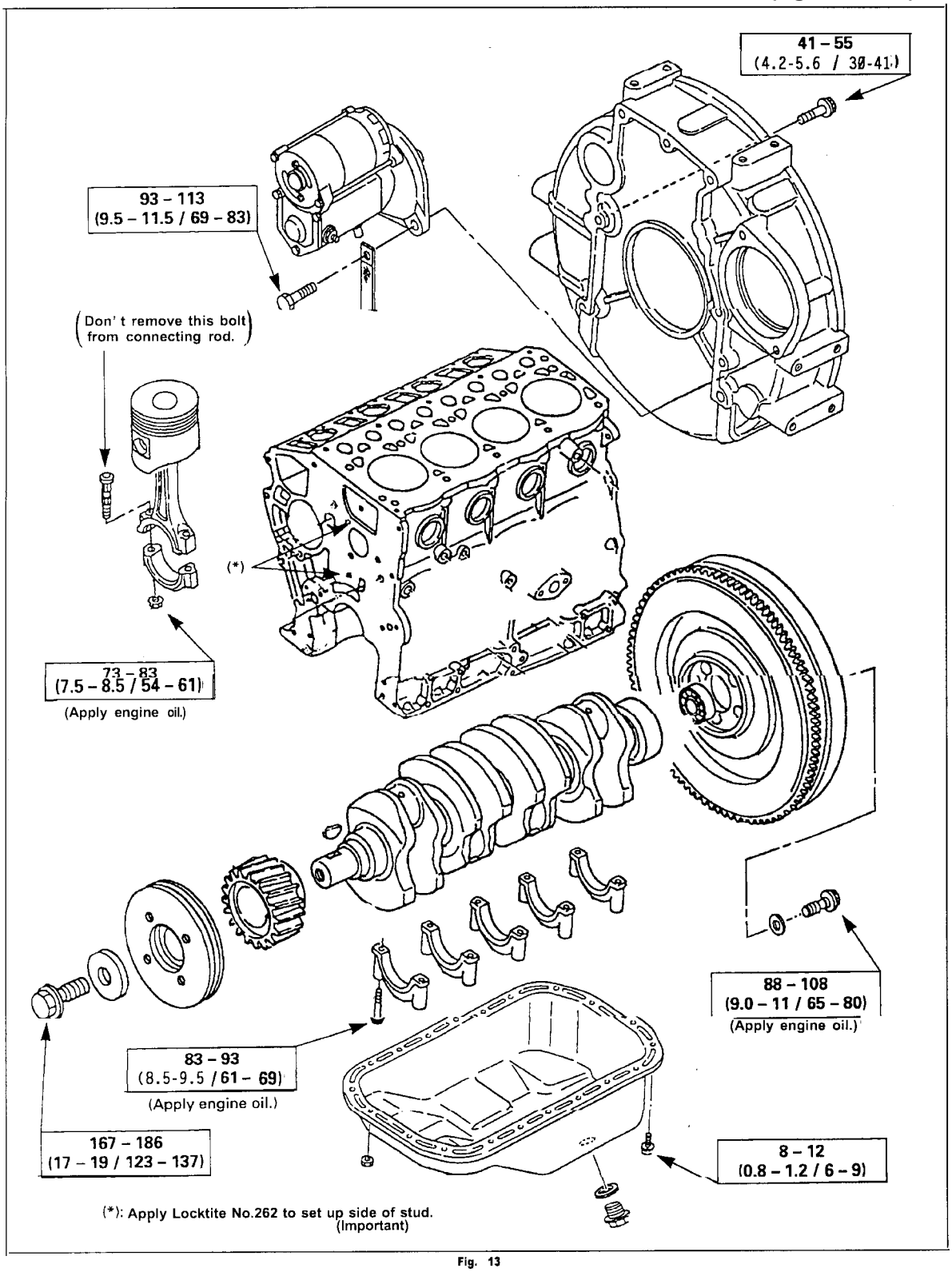


Fig. 13

4. CYLINDER BLOCK AND OTHER COMPONENTS (2)

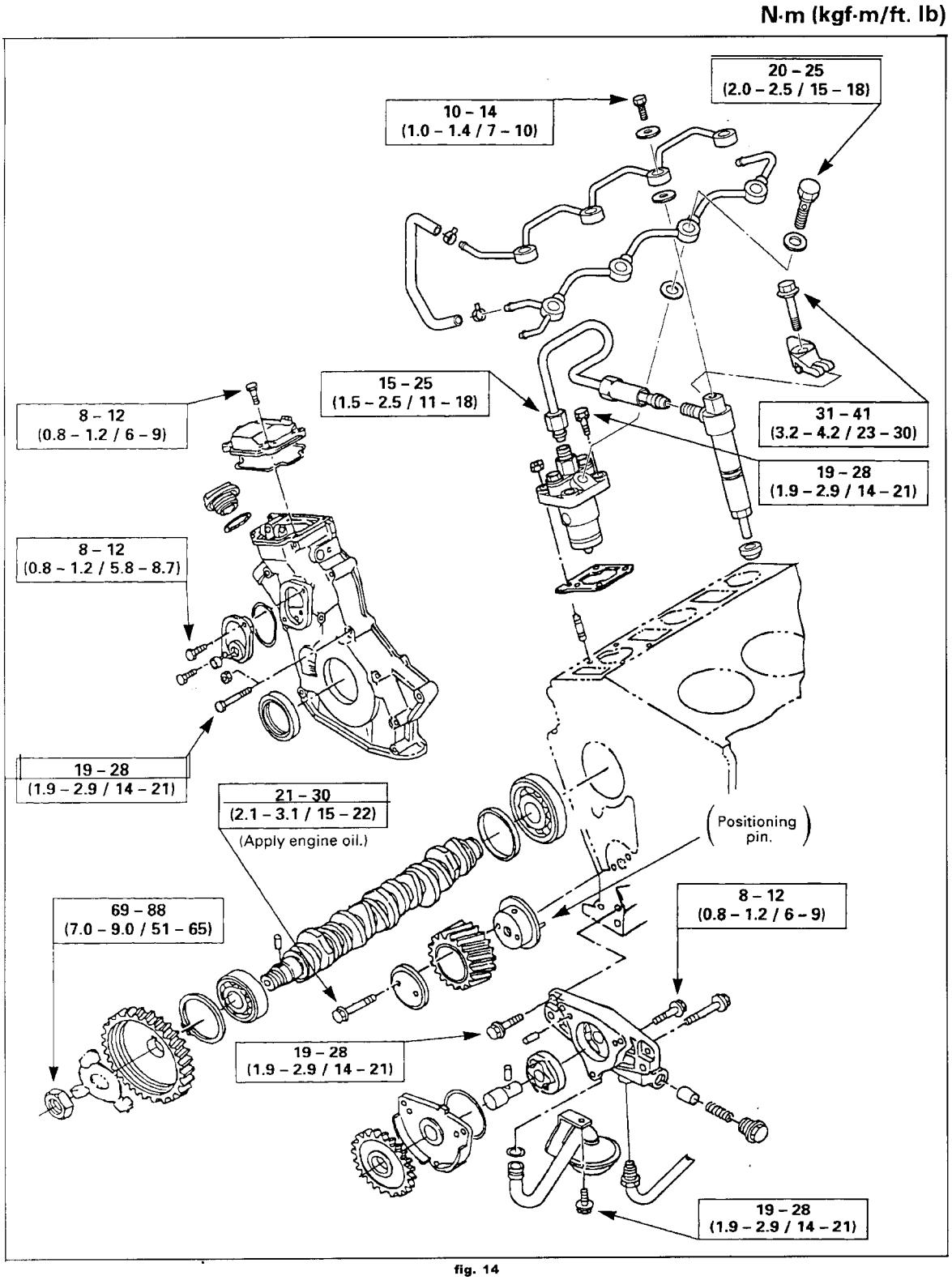


fig. 14

5. CYLINDER BLOCK AND OTHER COMPONENTS (3)

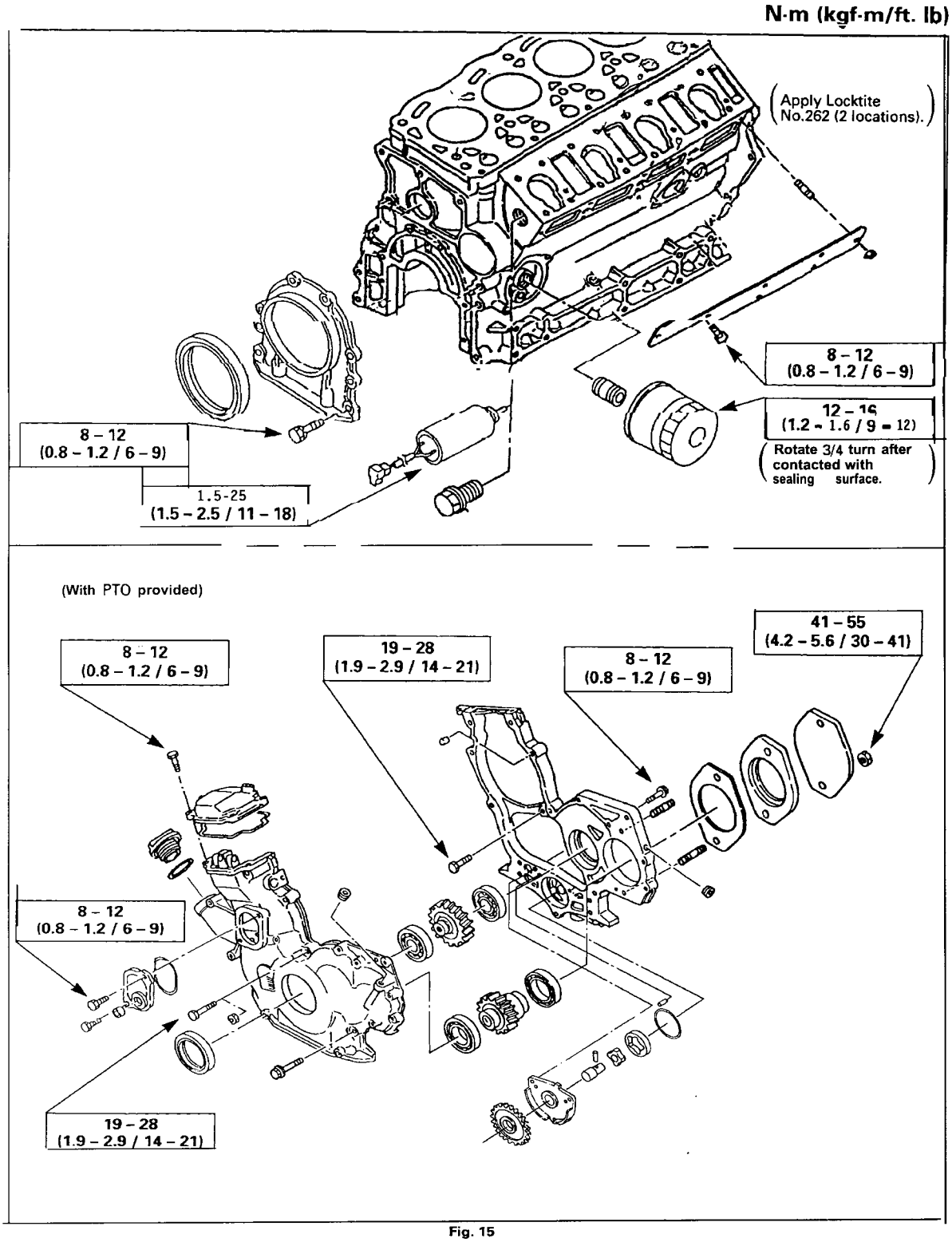


Fig. 15

6. TURBOCHARGER

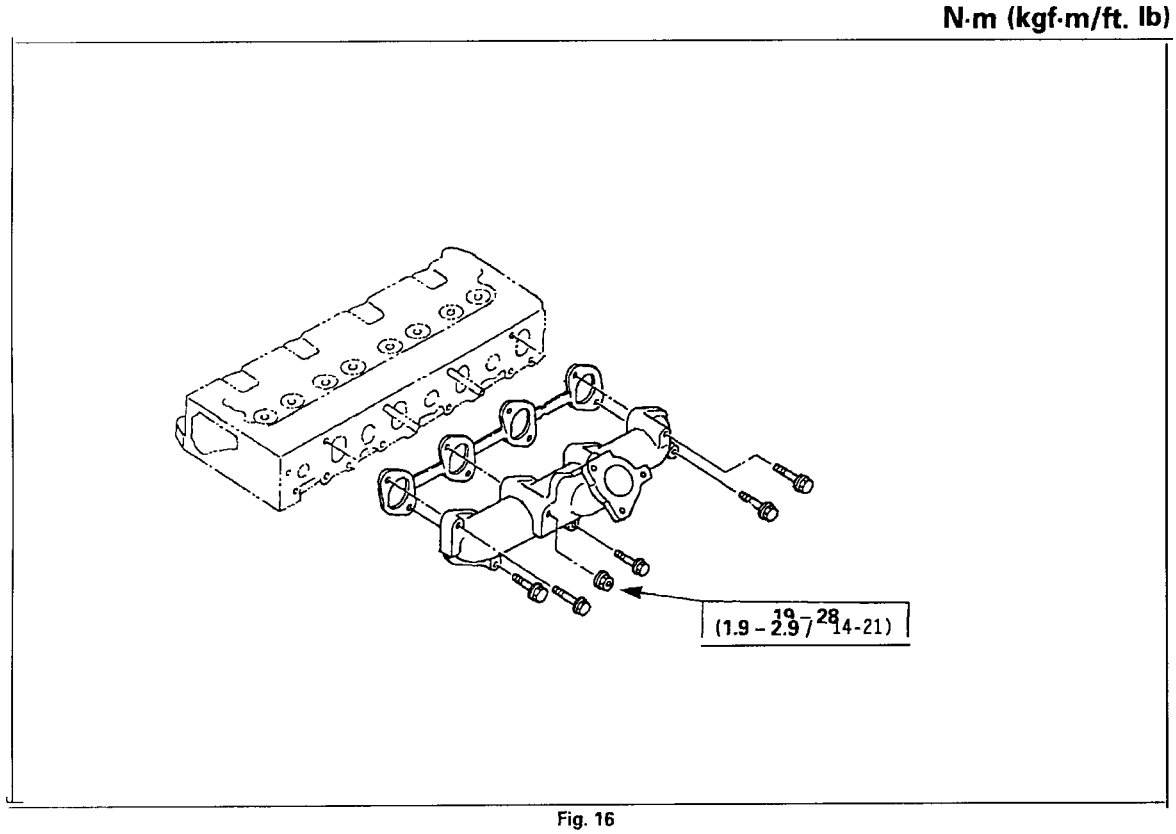


Fig. 16

GASKET LOCATION

1. LOCATIONS WHERE GASKETS ARE USED

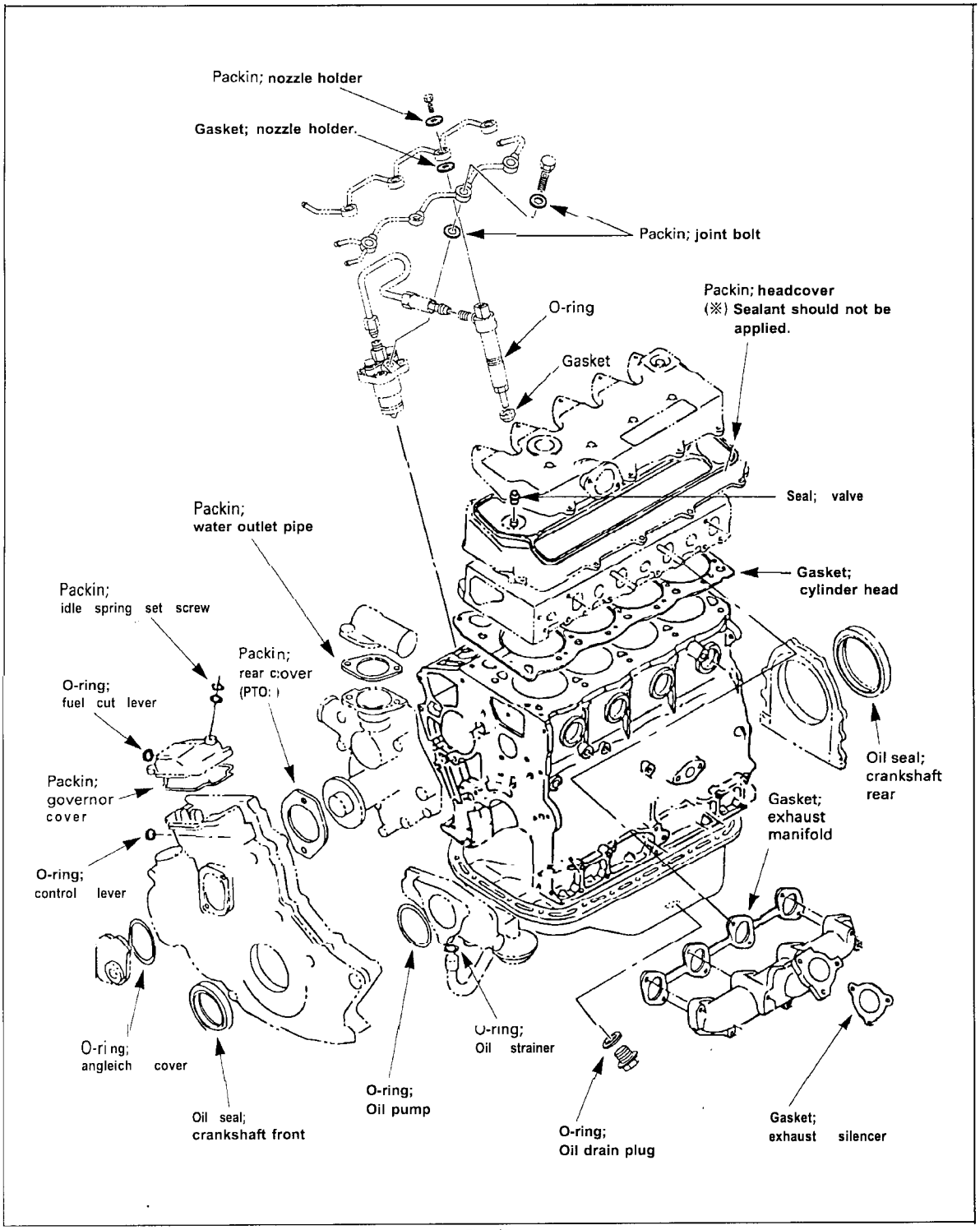


Fig. 17

2. LOCATIONS WHERE SEALANT IS APPLIED

	Location		Condition for use		Name of sealant
	Name of part	Name of mating part	Object to be sealed	Groove to be applied	
1	Oil pan	Cylinder block	Engine oil (10W-30)	Not provided	TB1207C
2	Rocker bracket	Cylinder head	Engine oil (10W-30)	Provided	TB1207B
3	Air inlet pipe	Cylinder head cover	Air	Provided	TB1207C
4	Front plate (with PTO provided)	Cylinder block	Engine oil (10W-30)	Provided	TB1207B
5	Timing case (with PTO provided)	Front plate	Engine oil (10W-30)	Provided	TB1207B
6	Timing case (with no PTO provided)	Cylinder block	Engine oil (10W-30)	Provided	TB1207B
7	Water pump ASM	Cylinder block	Cooling water	Not provided	TB1207C
8	Rear cover; water pump	Body; water pump	Cooling water	Provided	TB1207B
9	Housing cover; injection pump	Cylinder block	Engine oil (10W-30)	Provided	TB1207B
10	Solenoid; fuel cut	Cylinder block	Engine oil (10W-30)	Provided	TB1207C
11	Retainer; oil seal	Cylinder block	Engine oil (10W-30)	Provided	TB1207B
12	Indicator; air cleaner	Air cleaner	Air	Not provided	(Sealing tape)

Fig. 18

Cautions:

1 . Always use the above brandnames or an equivalent as the sealant.

2 . Since Loctite FMD127 and Three-Bond 1386 are anaerobic, do not use them in case a gap exceeding 0.25 mm is occurring between the metallic mating surfaces since satisfactory effects cannot be expected.

3. Always use the optimum quantity of sealant. Observe the handling precautions designated for respective products.

When applying a sealant :

(1) When applying a sealant over a surface where some other liquid gasket was used previously, thoroughly clean the reside sealant using a scraper and wipe the surface by waste cloth to remove oil,moisture, dust, etc. from the surface.

(2) When using the gasket remover “Bundo 391D” made by Three-Bond, to facilitate the “cleaning work”, apply the remover and leave it as is for “about 10 minutes” before starting the removal work.

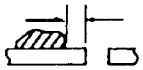
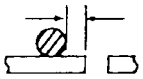
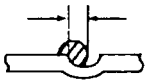
(3) Be careful not to apply too much or too little.

(4) How to use the TB1207C and TBl207B

Apply them with a line diameter of 3 mm or more and for a thickness of 1- 2 mm.

Apply them along the gluing groove without interruptions and assemble the mating structures with 5 minutes.

Also, after finishing the assembly, leave the assembly as is for at least 2 hours and do not run the engine during this period.

Bolt hole	Dent	Determination
		○
		○
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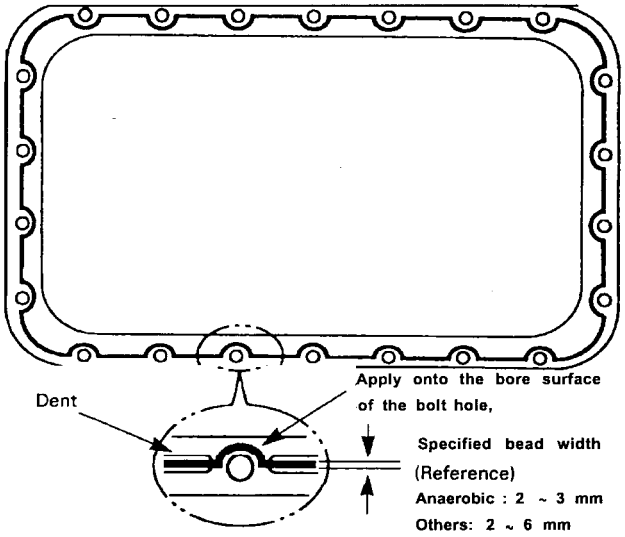
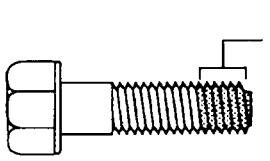


Caution: When the application method is being designated in the repair manual, follow the designation.

3. Locktite

Types	Colors	Work procedures
Loctite 242	Blue	1. Wipe the thoroughly remove oil, grease and moisture from the mating surfaces such as the bolt surface, bolt hole, thread surface of the nut. 2. Apply Locktite.  Apply over the tip end surface, namely 1/3 of the threaded section. 3. Tighten the bolt at the "specified torque". Caution: After tightening the bolt, do not apply excessive torque or vibrations for "about an hour" until the applied Loctite sets.
Loctite 262	Red	
Loctite 27 1	Red	

MAINTENANCE

1. VALVE CLEARANCE AND ADJUSTMENT

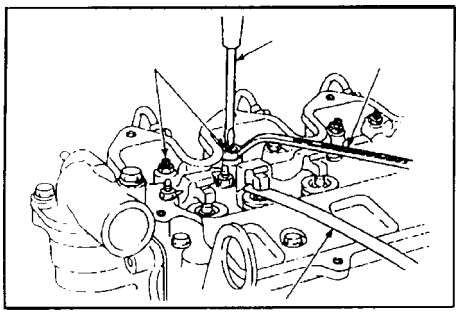


Fig. 19

Note:
The cylinder head bolts were previously tightened with the “Angular Tightening Method”. Therefore, it is not necessary to retighten the cylinder head bolts before adjusting the valve clearance.

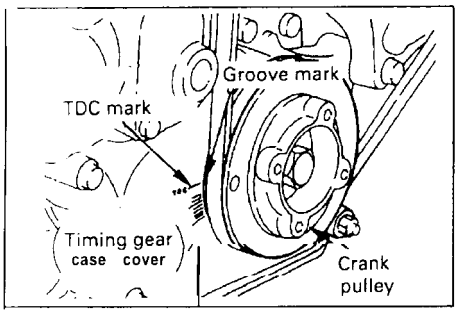


Fig. 20

1. Bring the piston in either the No. 1 cylinder or the No. 4 cylinder to Top Dead Center on the compression stroke by turning the crankshaft until the TDC mark on the front cover aligns with the groove mark on the crankshaft pulley.

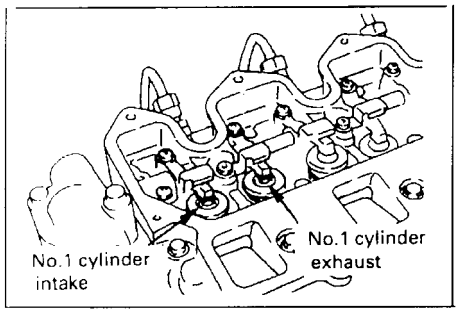


Fig. 21

2. Check to see if there is play in the No. I intake and exhaust valve rocker arms.
If the No. 1 cylinder intake and exhaust valve rocker arms have play, the No. 1 piston is at TDC on the compression stroke.
If the No. 1 cylinder intake and exhaust valve rocker arms are depressed, the No. 4 piston is at TDC on the compression stroke.
Adjust the circle or double circle marked valves as shown in Fig. 22, while the No. 1 or the No.4 cylinder is at TDC on compression stroke.

Cylinder No.	1		2		3		4	
Valve arrangement	I	E	I	E	I	E	I	E
No. 1 cylinder TDC for compression	○	○	○			0		
No. 4 cylinder TDC for compression				◎	◎		◎	◎

I ; Intake E ; Exhaust

Fig. 22

mm (in)

Intake and Exhaust Valve Clearance (cold)	0.40 ± 0.05 (0.015 ± 0.002)

3. Loosen each valve clearance adjusting screw as shown in the illustration.

4. Insert a 0.40 mm (0.015 in) feeler gauge between the rocker arm and the valve stem end.

5. Turn the valve clearance adjusting screw until a slight drag can be belt on the feeler gauge.

6. Tighten the lock nut securely.

7. Rotate the crankshaft 360 degree.
Realign the crankshaft pulley.

8. Adjust the clearances for the remaining valves as shown in the illustration.

2. LUBRICATIN SYSTEM

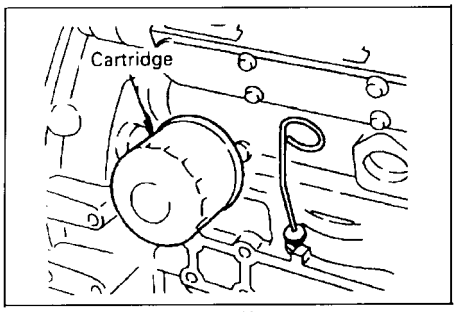


Fig. 23

Cartridge (Spin-On) Type

Removal

Remover and Installer: Filter Wrench

1. Loosen the used oil filter by turning it counterclockwise with the filter wrench.
2. Discard the used oil filter.

Installation

1. Wipe the oil filter mounting face with a clean rag. This will allow the new oil filter to seat properly.
2. Lightly oil the O-ring.
3. Turn in the new oil filter until the sealing face is fitted against the O-ring.
4. Use the filter wrench to turn in the oil filter an additional 3/4 of a turn or one turn.
5. Check the engine oil level and replenish to the specified level if required.
6. Start the engine and check for oil leakage from the oil filter.

3. COOLING SYSTEM

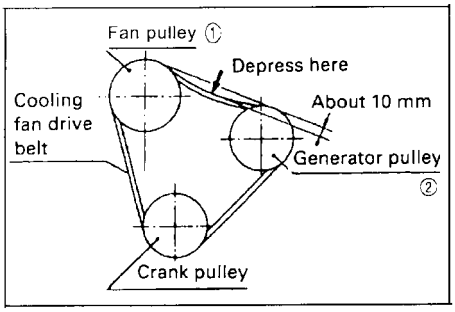


Fig. 24

Cooling Fan Drive Belt

Adjustment

1. Check the cooling fan drive belt for cracking and other damage.
2. Check the drive belt tension by exerting a force of 98 N (10 kg) midway between the Fan pulley 1 and the Generator pulley 2.
3. Adjust the belt tension by loosening the Generator mounting bolt and the Generator adjusting bolt and pivoting the Generator.

Be sure to retighten the bolts after adjusting the belt tension.

mm (in)

Cooling Fan Drive Belt Deflection	7.5 – 8.5 (0.3 – 0.33)

4. INJECTION TIMING

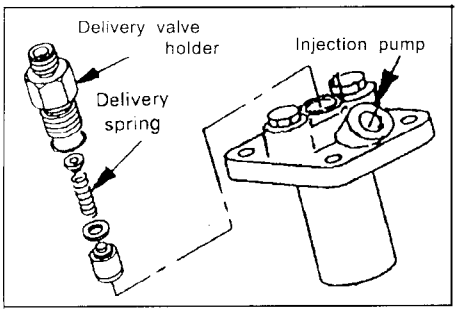


Fig. 25

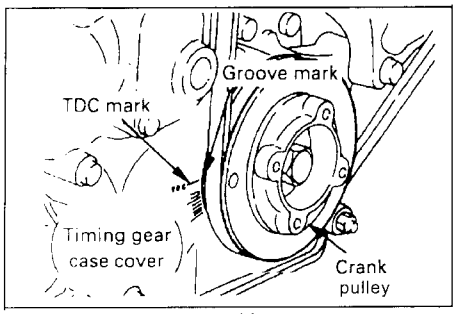


Fig. 26

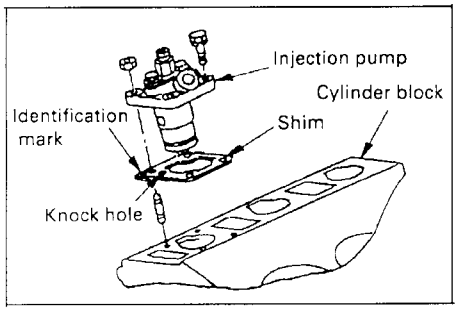


Fig. 27

Note:
Take care to avoid entry of dust or foreign particles into the pump interior when the timing adjustment is made.

1. Remove the injection pipe of the No. 1 cylinder.
2. Remove the delivery valve holder of the injection pump of the No. 1 cylinder, and then pull out the delivery spring.
3. With the spring left removed, install the delivery valve holder.
4. Slowly turn the crankshaft pulley clockwise, at the same time, continue to feed the fuel.
When the fuel stop flowing out from the No. 1 delivery valve holder, stop turning the crankshaft.
This crank angle position is the starting point of injection.
5. In the condition at Step (4) above, confirm what degree the “groove mark” of the crank pulley is at, when seen by the “timing mark”, provided in the timing gear case.
When the value is out of the range of the normal injection timing, adjust it accordingly.

* Injection timing	BTDC 14°

Note:
The injection timing varies according to the specifications of the machine.

6. Adjust the injection timing with a shim between the injection pump and the cylinder block.
Shim is available in the following 9 types, and “identification mark” is stamped (or imprinted) on the top face.

Identification mark of shim and its thickness (mm)

Mark	Thickness	Mark	Thickness	Mark	Thickness
2	0.2	5	0.5	8	0.8
3	0.3	6	0.6	10	1.0
4	0.4	7	0.7	12	1.2

Note:
For each of the injection pumps of three cylinders, the shim adjustment is made at the same time.
When a shim is missing while overhauling the engine and the shim thickness is unknown, assemble the engine with provisional shim inserted. After assembling the engine, check the injection timing and adjust the shim until the normal injection timing is obtained.

Reference:
To add the 0.1 mm shim thickness corresponds to the 1 degree of crankshaft angle advance.

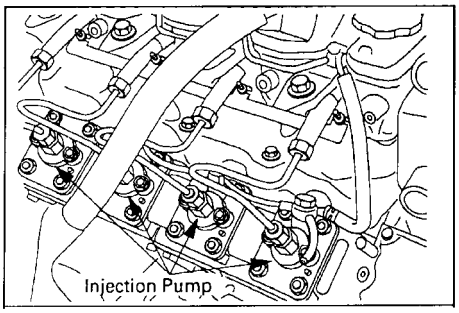


Fig. 28

Air bleeding from fuel (automatic air-bleeding system)

1 . For the automatic air-bleeding system
When the starter switch is set to “OPERATION”, the electromagnetic pump is activated to force-feed fuel to the fuel pipe and the leak-off pipe, and air in the fuel system is automatically bled.

2 . For non-automatic air-bleeding system
While sending fuel by means of the force of the electromagnetic pump, the fall from the fuel tank or the feed pump lever, bleed air out of the fuel pipe eye bolt of the No. 1 cylinder injection pump, the leak-off pipe eye bolt of the injection nozzle and the air-bleeder plug of the fuel filter, starting with the one installed the lower most and upward.

5. COMPRESSION PRESSURE MEASUREMENT

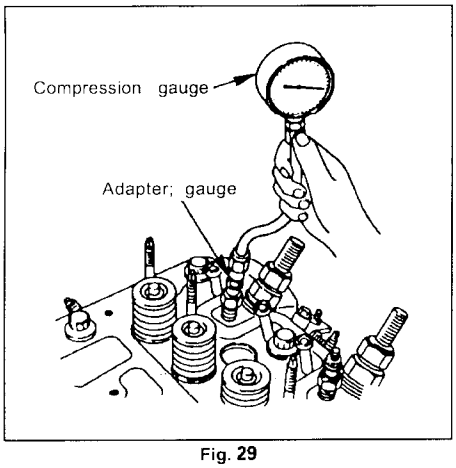


Fig. 29

1. Operate the engine to warm-up until the coolant temperature reachs to 75 degree C (167°F).
2. Remove all of the glow plugs and the injection pipes.
3. Attach a compression gauge to the No. 1 cylinder glow plug installation threads.

Note:
Compression pressure may be measured starting at any cylinder and in no particular cylinder order. However, it is very important that the compression pressure be measured in each cylinder.
Therefore, start at the No. 1 cylinder and work back. In this way, you will be sure to measure the compression pressure in each cylinder.

Compression Gauge 54368691

Compression Gauge Adapter 54368709

4. Crank the engine with the starter motor and take the compression gauge reading.

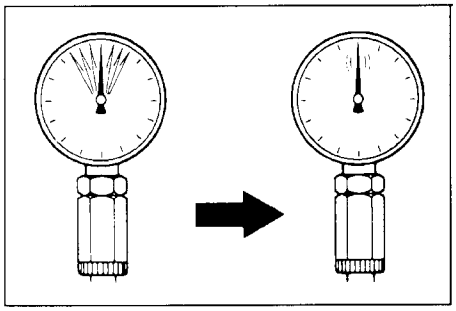


Fig. 30

MPa (kgf/cm^2 /psi) at 250 min^{-1}

Standard	Limit
3 (31/440)	2.5 (26/370)

5. Repeat the procedure (Steps 3 and 4) for the remaining cylinders.

Compression pressure should be approximately the same for each cylinder. A variation exceeding 200 kPa (2.0 kg/cm* /28 psi) is unacceptable.

If the measured value exceeds the specified limit, the related parts must be checked.

6. FUEL SYSTEM

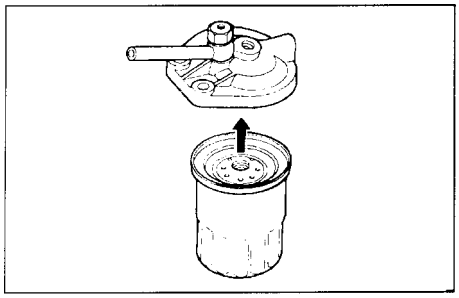


Fig. 31

Fuel Filter Replacement

Cartridge (Spin-On) Type
Removal
I . Loosen the fuel filter by turning it counterclockwise with the filter wrench or your hand. Discard the used filter.

Filter Wrench
2. Wipe the fuel filter fitting face clean with a rag. This will allow the new fuel filter to seat properly.

Installation
1. Apply a light coat of engine oil to the O-ring.
2. Supply fuel to the new filter.
This will facilitate air bleeding.
3. Turn in the new fuel filter until the filter O-ring is fitted against the sealing face.
4. Use the filter wrench to turn in the fuel filter an additional 2/3 of a turn.

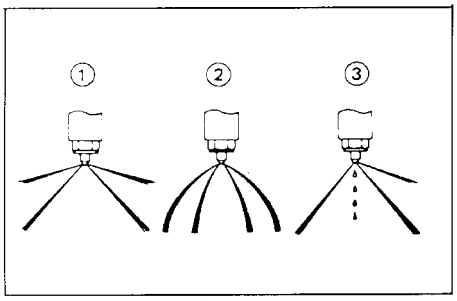


Fig. 32

Injection nozzle
Check to see if the spray condition and the injection pressure are normal. Adjust them to the specified value respectively when they don't meet the standard valve.

Spray Condition
(I) Correct
(2) Incorrect (Restrictions in orifice)
(3) Incorrect (Dipping)

Using a nozzle tester, adjust the injection pressure with a shim.

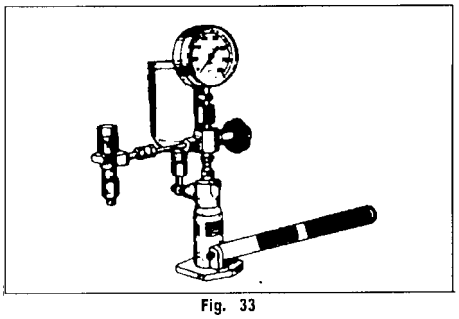


Fig. 33

Special tool: Nozzle Tester-54378187

RECOMMENDED LUBRICATING OIL

TYPE OF LUBRICANTS (API)	DIESEL ENGINE OIL; CC OR CD GRADE

ENGINE OIL VISCOSITY CHART

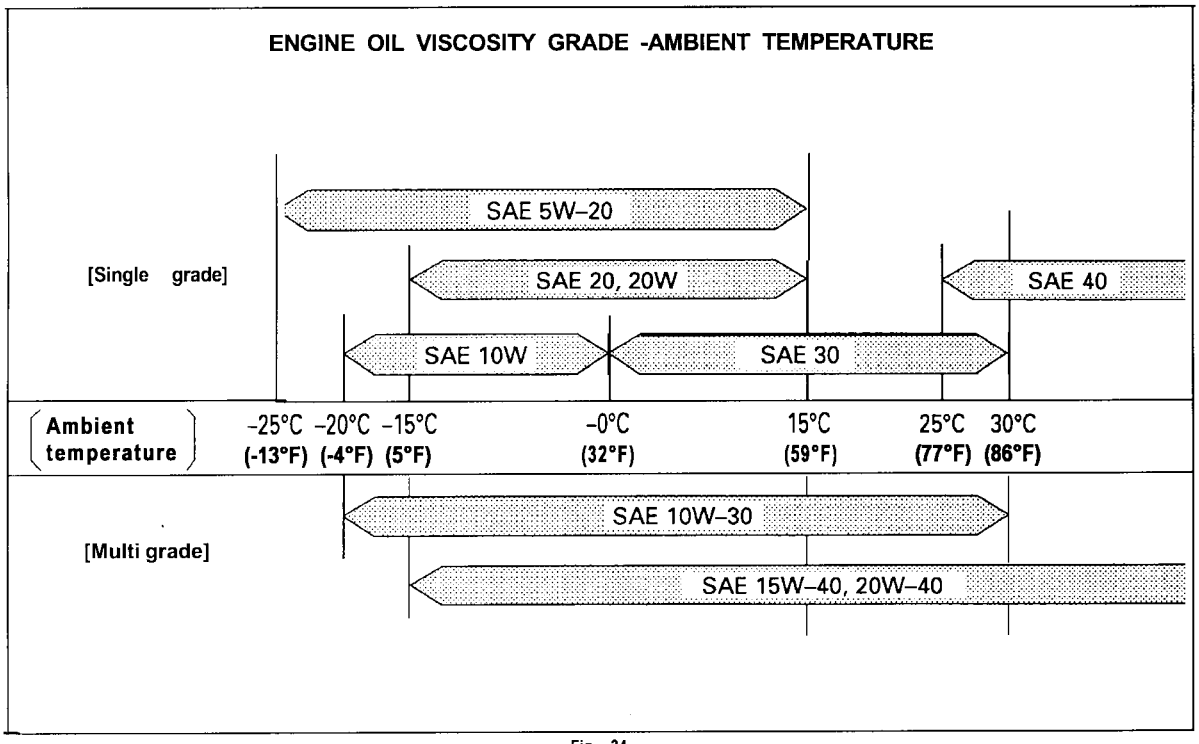


Fig. 34

Protect your investment!!!

Use IR PRO-TECH Engine Fluid and Filters

Package sizes available:
1 Gallon/3.78 Litres-54480918
5 Gallon/18.9 Litres-36875938
55 Gallon/208 Litres-36866903

SECTION 2

ENGINE

TABLE OF CONTENTS

DISASSEMBLY

1. EXTERNAL PARTS (Left-hand side)

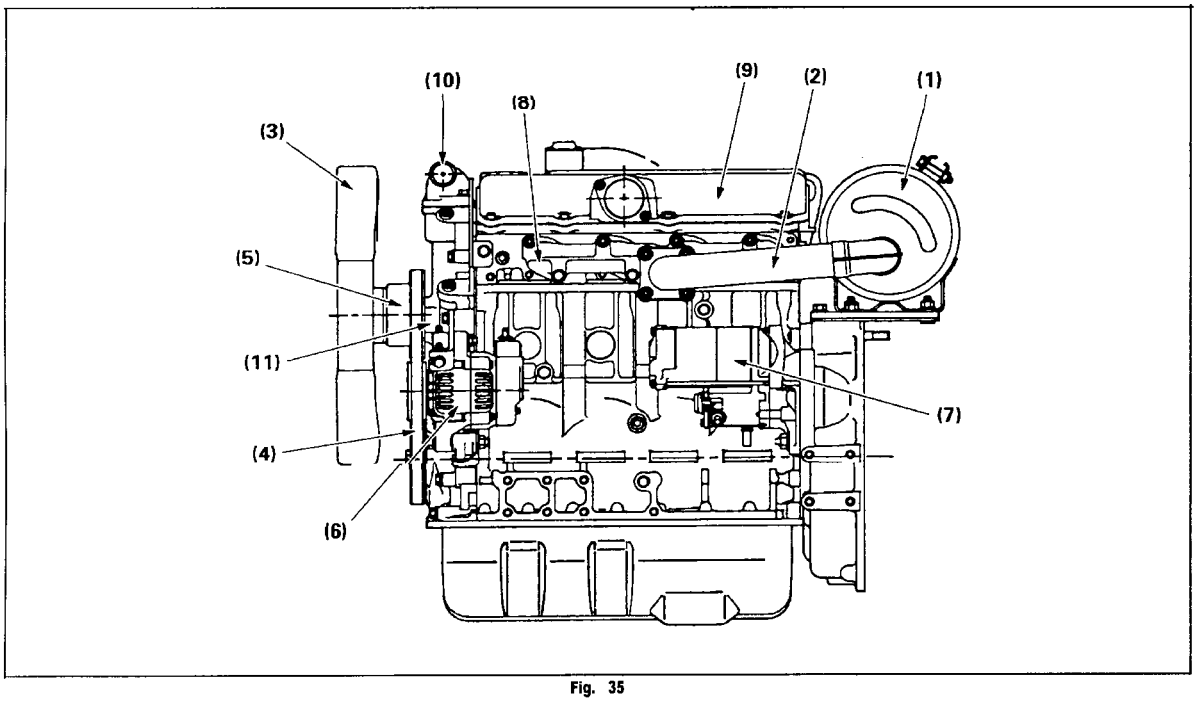


Fig. 35

(1) Exhaust silencer
(2) Exhaust pipe
(3) Cooling fan and spacer
(4) Fan belt
(5) Fan pulley
(6) Generator
(7) Starter
(8) Exhaust manifold and gasket
(9) Cylinder head cover and air intake pipe
(10) Water outlet pipe and thermostat
(11) Water pump assembly

2. EXTERNAL PARTS (Right-hand side)

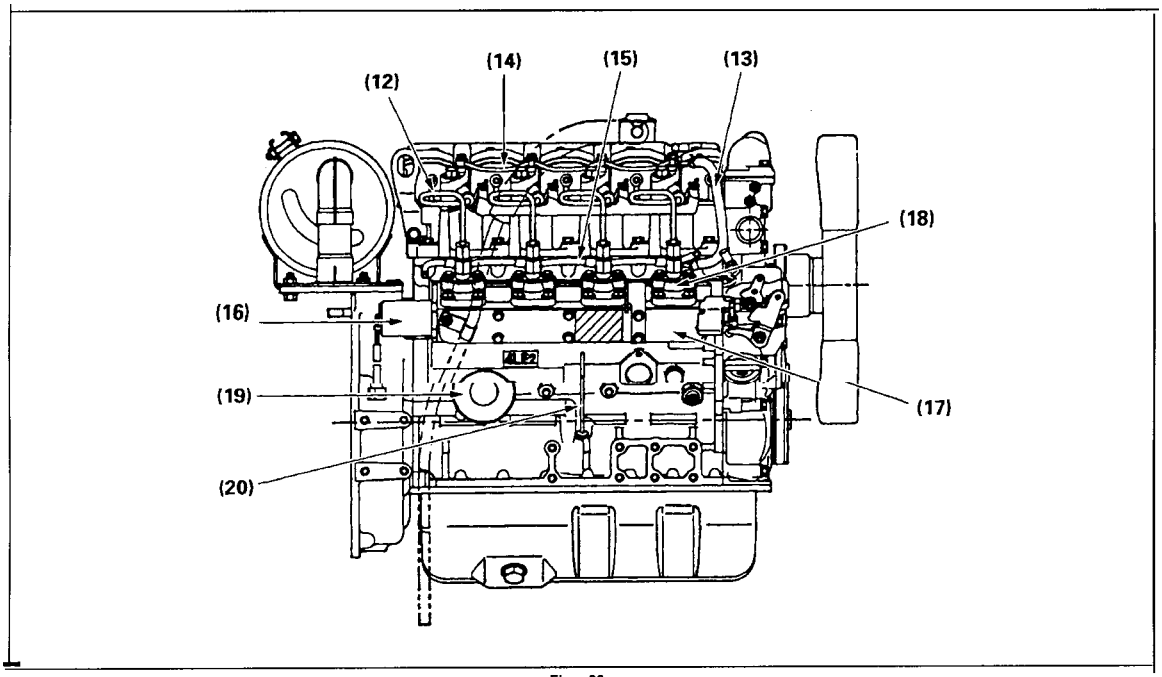


Fig. 36

(12) Injection pipe . . . . . 4 pcs.
(13) fuel hose
(14) F&I leak off pipe
(15) Fuel pipe
(16) Engine stop solenoid
(17) Injection pump housing cover
(18) Injection pump and shim . . . . . 4 set
(19) Oil filter
(20) Oil level gauge

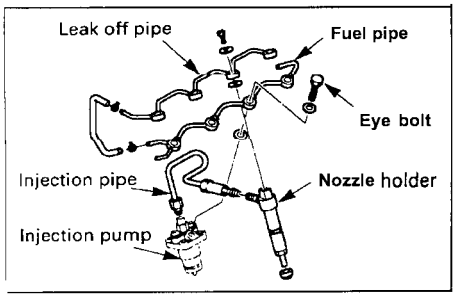


Fig. 37

Injection pipe
Leak off pipe
Fuel pipe

1. Loosen the sleeve nuts on the nozzle holder side and on the injection pump side, and then disconnect the injection pipes.
2 . Disconnect the leak off pipe together with gaskets.
3 . Remove the eye bolt, and then disconnect the fuel pipe.

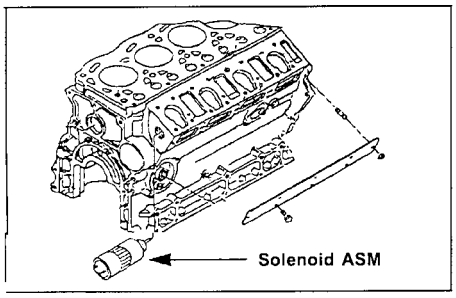


Fig. 38

Solenoid ASM

Remove the solenoid ASM.

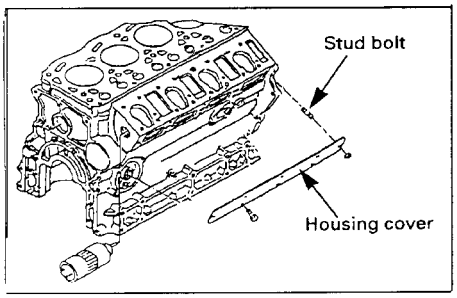


Fig. 39

Injection pump housing cover

1 . Remove the bolts and nut.
2 . Install the bolts (M8 x 1.25) to the replacer hole.
3 . Tighten the bolts, and then remove housing cover.

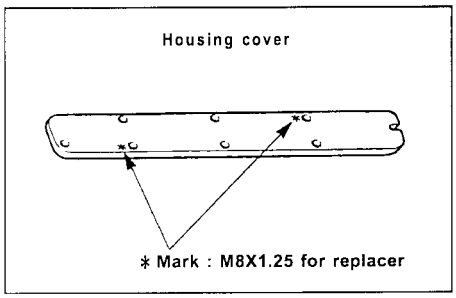


Fig. 40

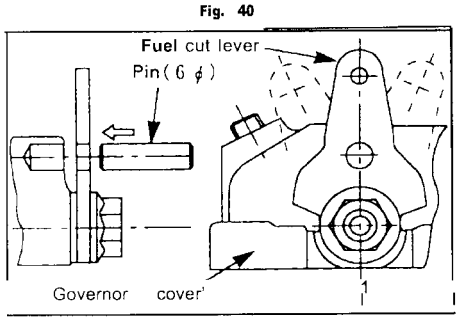


Fig. 41

Injection pump

1 . Align the hole of the fuel cut lever with the hole of the governor cover, and then insert a pin (6o) into this hole to hold the fuel cut lever.
2 . Check to see if the pin groove of the control link is at the center of the injection pump.
3 . Remove the injection pump, and then take out the shim.

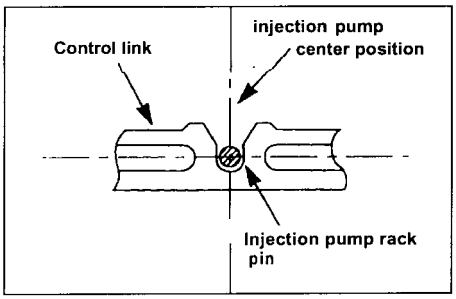


Fig. 42

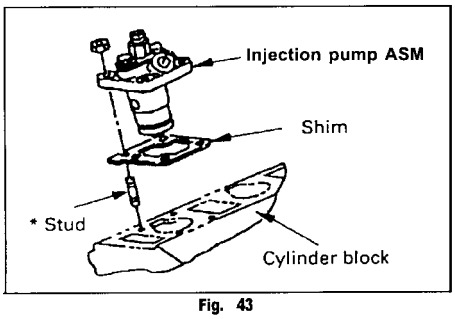


Fig. 43

NOTE:
1 . Mark each injection pump as to which cylinder it was removed from.
2. Do not reuse the shim, replace it with the same thickness that was removed.

Backlash of timing gear

mm (In)

	STANDARD	LIMIT
CRANK GEAR/ IDLER GEAR	0.04 (0.0017)	0.2 (0.0079)
CAM GEAR/ IDLER GEAR	0.03 (0.0012)	0.2 (0.0079)

IDLER GEAR END PLAY

mm (in)

STANDARD	LIMIT
0.058 – 0.115 (0.0023 – 0.0045)	0.2 (0.0079)

CRANKSHAFT END PLAY

mm (in)

STANDARD	LIMIT
0.058 – 0.208 (0.0023 – 0.0082)	0.3 (0.0118)

ENGINE

3. INTERNAL PARTS

Disassembly Steps

(I) Rocker Bracket Assembly
(2) Push Rods
(3) Rear Hanger
(4) Front Hanger
(5) Cylinder Head Assembly
(6) Cylinder Head Gasket
(7) Tappets
(8) Oil Pan
(9) Oil Strainer
(IO) Oil Pipe
(11) Crank Pulley
(12) Flywheel
(13) Flywheel Housing
(14) Timing Gear Case (without PTO)
(15) Oil Pump Assembly
(16) Idler Gear and Shaft
(17) Cam Gear
(18) Camshaft
(19) Rear Seal Retainer
(20) Piston Assemblies
(21) Crankshaft

Internal Parts (1 /3)

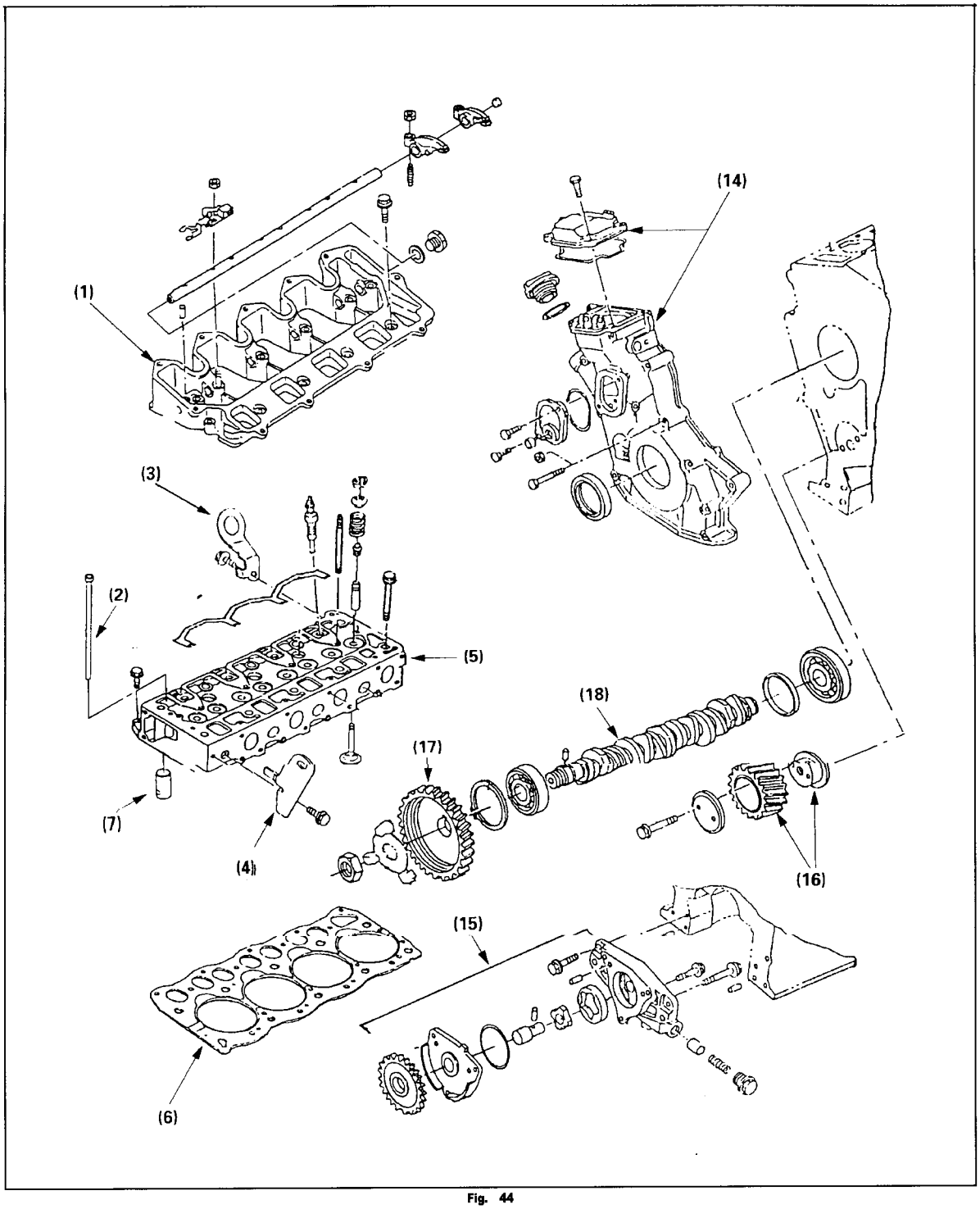


Fig. 44

Internal Parts (2/3)

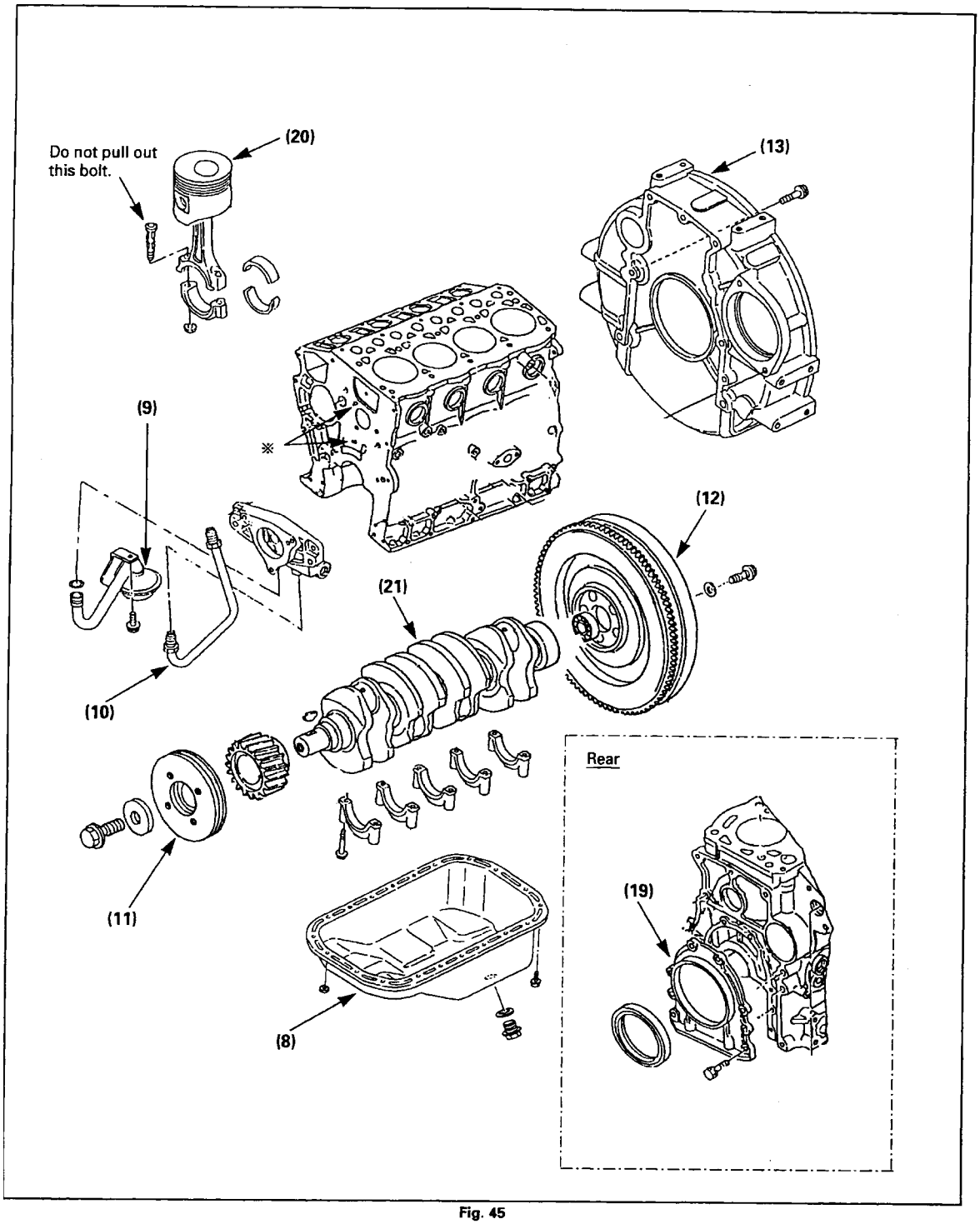


Fig. 45

Internal Parts (3/3)

When provided with PTO

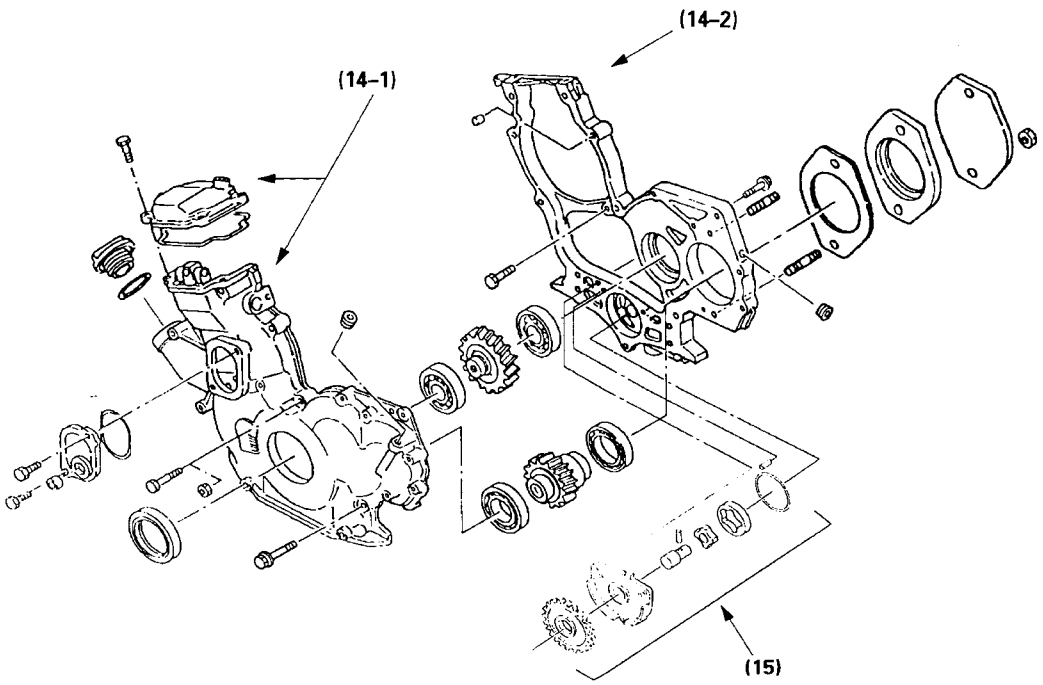


Fig. 46

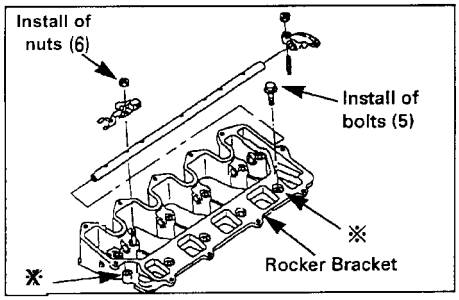


Fig. 47

Rocker bracket
Push rod

1. Remove the rocker bracket assembly.
(M6x 1.. . . . . 5 bolts and 6 nuts)

2 . Pull out the push rods (8 PCS.).
* Marks : Thread hole (M8 x 1.25) for replacer of rocker bracket assembly

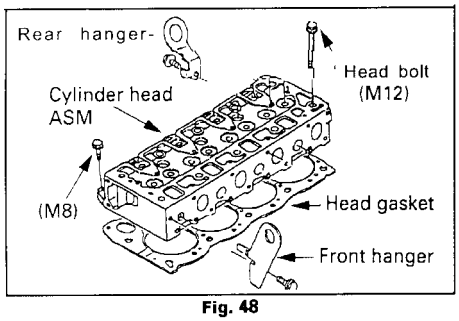


Fig. 48

Cylinder head assembly

I Remove the rear and front hangers.

2. When removing the cylinder head bolts, loosen them slowly, a little at a time, starting with the outside, working in a circular pattern inward.

3 . Remove the cylinder head assembly and the head gasket.

4 . Pull out the tappet from the cylinder body.

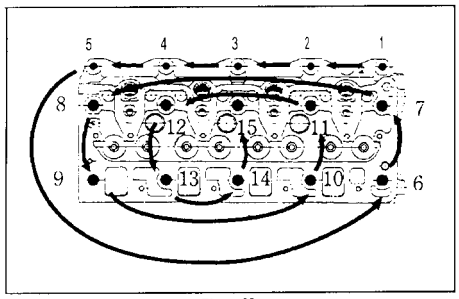


Fig. 49

Cylinder Head Assembly

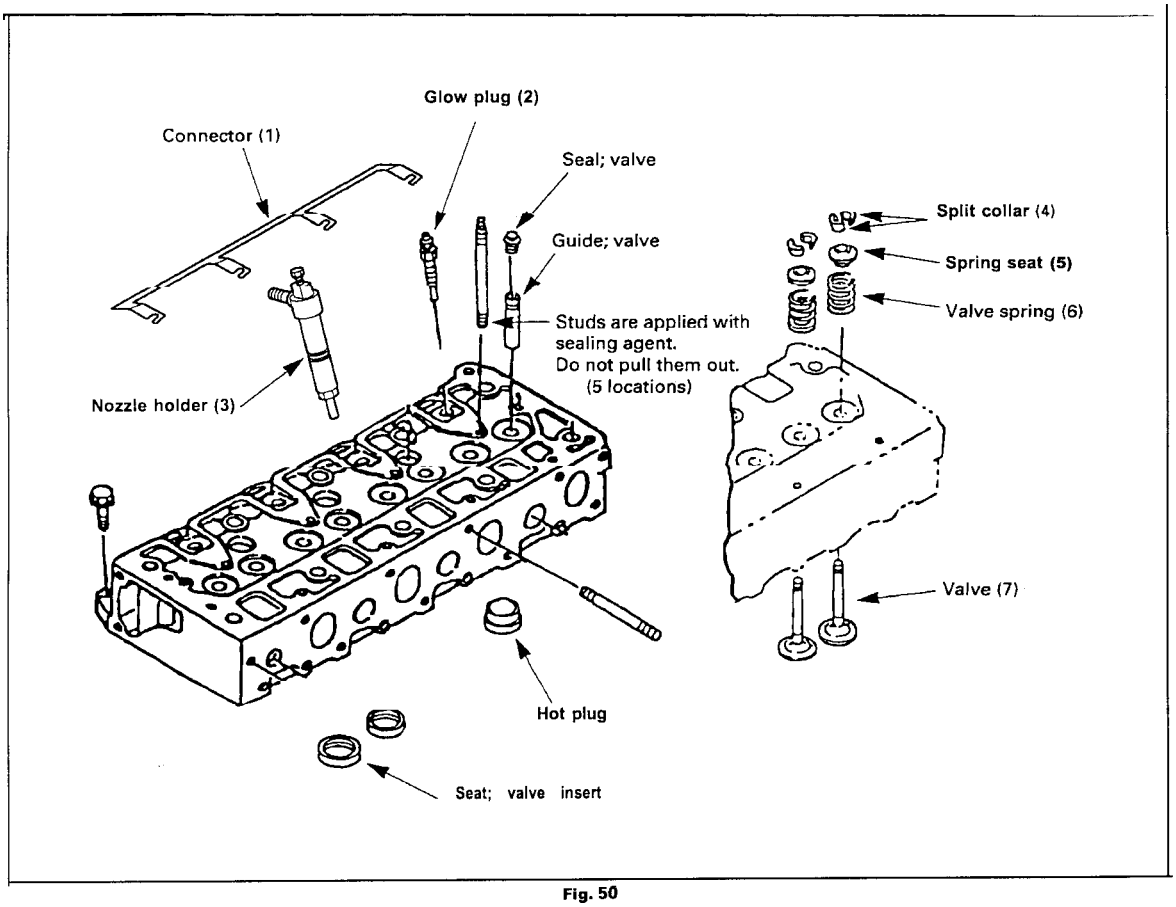


Fig. 50

Valve mechanism

1. Before disassembling the valve mechanism, remove the connector, glow plug and nozzle holder assembly.

2 . Compressing the valve spring, remove the split collar, spring seat, valve spring and valve.

Timing Gear

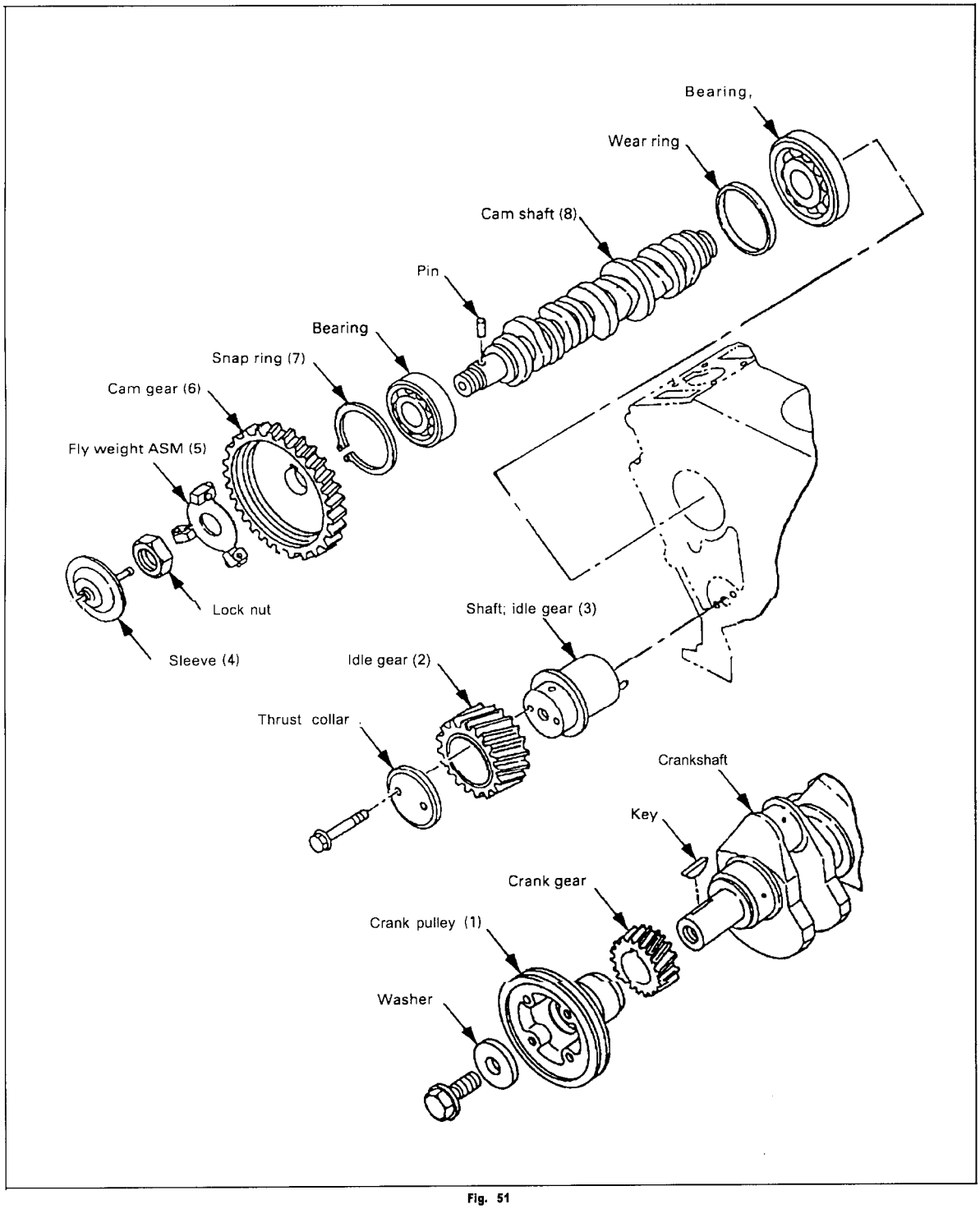


Fig. 51

Timing gear

1.Remove the idle gear and the idle gear shaft.
2. Pull out the sleeve from the tip end of the cam-shaft.
3. Remove the lock nut of the cam shaft gear, and then remove the flyweight assembly and the cam gear.

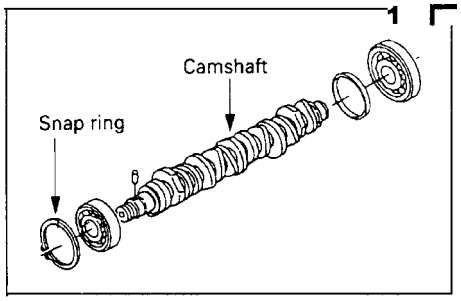


Fig. 52

Camshaft

1.Remove the snap ring which holds down the front bearing of the cam shaft from the ring groove of the cylinder block.
2. Pull out the cam shaft from the cylinder block, together with the bearing.

Piston and Connecting Rod

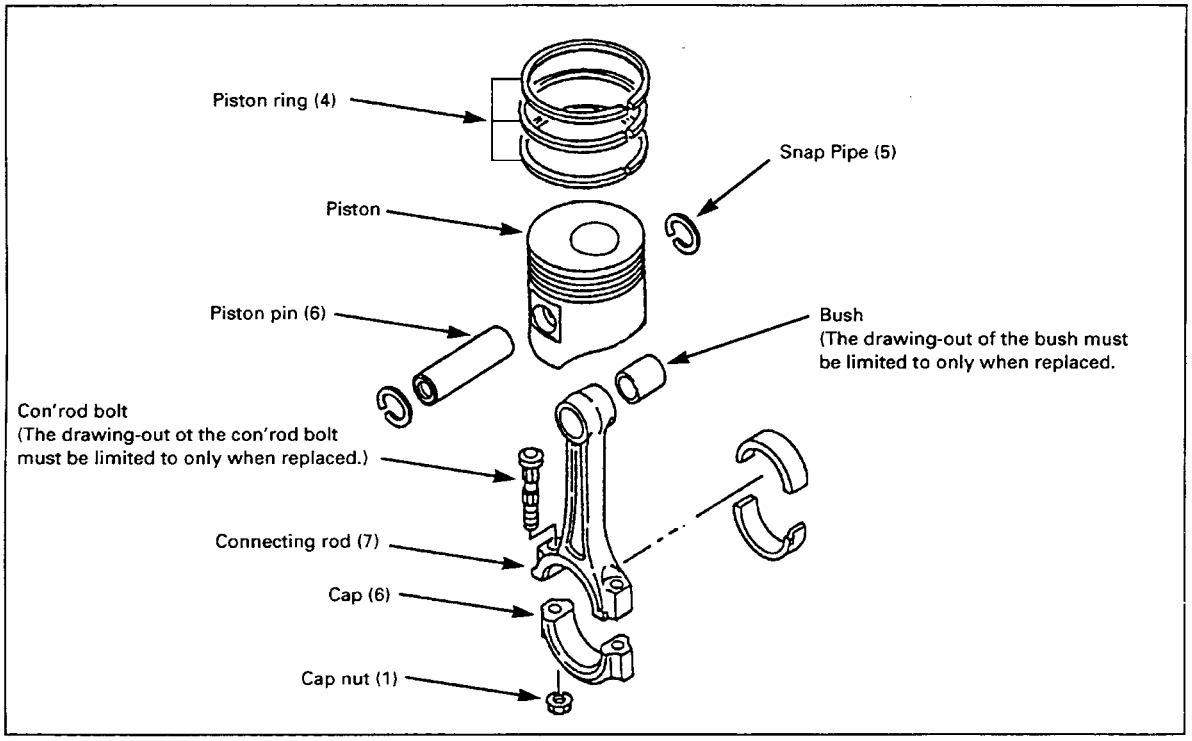


Fig. 53

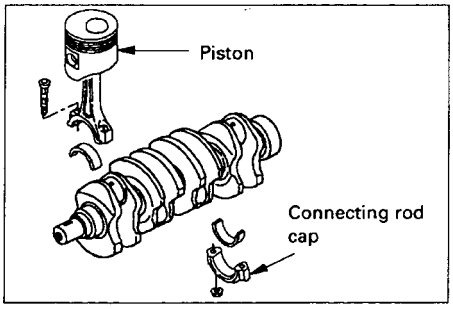


Fig. 54

Piston and connecting rod

1. Turning the crankshaft, position the piston to be removed at the bottom dead center.
2 . Loosen the cap nut of the connecting rod, and then remove it.
3. Give another rotation to the crankshaft to position the piston at the top dead center.
4 . With the handle of a hammer placed at the bottom of the connecting rod, push the piston assembly upward out of the cylinder block.

Notes:

1 . Before removing the piston, scrape the carbon deposit off the cylinder wall.
2. When pushing out the piston assembly, care should be taken not to damage the cylinder wall.
3. Attach a tag with a cylinder number to the removed caps and bearings to keep them in order.

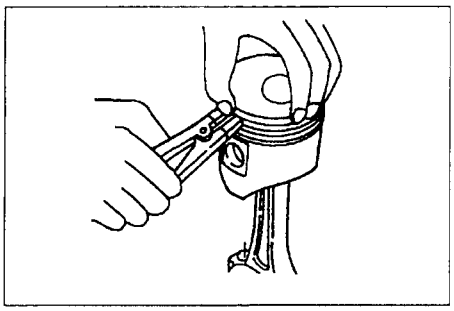


Fig. 55

Piston ring
Remove the piston ring with a ring pliers.

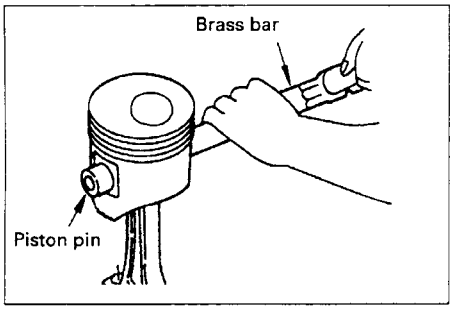


Fig. 56

Piston pin
1 . Remove the snap rings with a commercially available tool.
2 . With a brass bar attached to the piston pin, push it out by hammering it lightly.

Note:
Keep the pistons, piston pins and connecting rods in order for each cylinder.

INSPECTION AND REPAIR

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

1. CYLINDER BLOCK

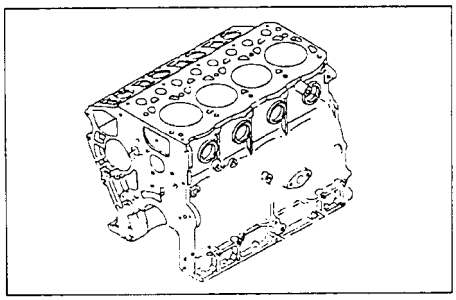


Fig. 57

Cylinder block
Check the cylinder block for wear, damage or any other defects.

Use the hydraulic gauge to check the water jacket water pressure.

Apply water pressure to the water jacket at 5 kg/cm2 (71.1 psi) for three minutes.

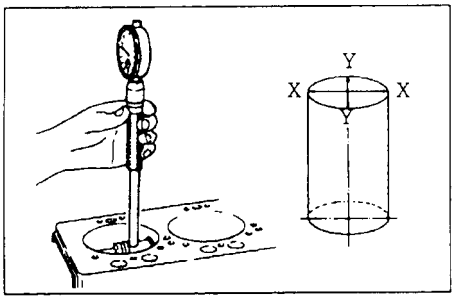


Fig. 58

Cylinder bore
Measurement position: 13mm below the top
(Measure in X-X and Y-Y directions.)
(Near the No. 1 compression ring)

mm (in)

Standard	Limit	Repair method
ø 85	ø 85.2	Perform boring and honing of the inner diameter.

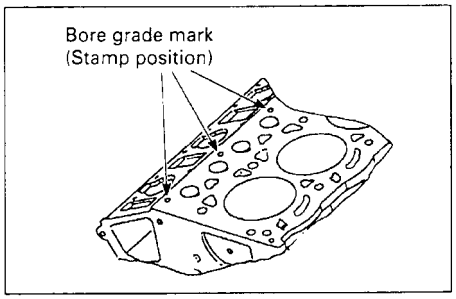


Fig. 59

Cylinder bore diameter and grade mark

The grade mark is stamped on the top surface of the cylinder block (on the mating face with the cylinder head).

mm (in)

Engine	Bore Diameter	Grade
4LE2	85.000 – 85.010 (3.3464 – 3.3468)	A
	85.011 – 85.020 (3.3468 – 3.3472)	B
	85.021 – 85.030 (3.3472 – 3.3476)	C

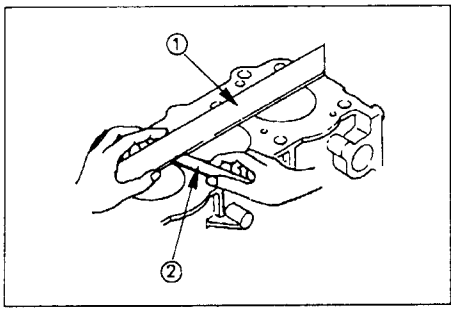


Fig. 60

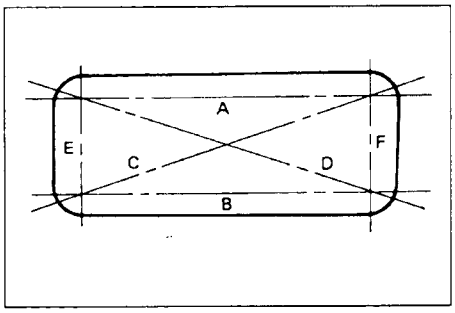


Fig. 61

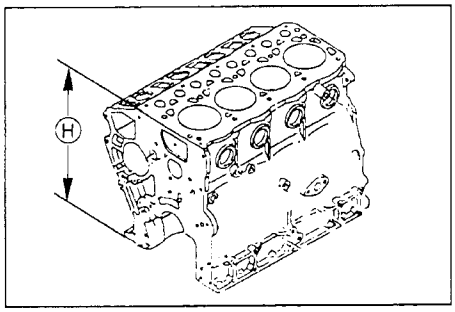


Fig. 62

Cylinder Body Upper Face Warpage

Use a straight edge 1 and a feeler gauge 2 to measure the four sides and the two diagonals of the cylinder body upper face.

Regrind the cylinder body upper face if the measured values are greater than the specified limit but less than the maximum grinding allowance.

If the measured values exceed the maximum grinding allowance, the cylinder body must be replaced.

Cylinder Body Upper Face Warpage mm (in)

Standard	Limit	Maximum Grinding Allowance
0.075 (0.0029)	0.15 (0.0059)	0.3 (0.0118)

If the measured value is less than the limit, the cylinder body may be reground.

Cylinder Body Height Ⓗ (Reference) mm (in)

Engine	Standard
4LE2	307.94 – 308.06 (12.123 – 12.128)

2. CYLINDER HEAD

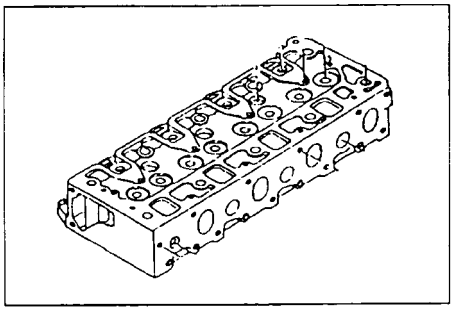


Fig. 63

Cylinder head inspection
Remove carbon deposit on the bottom surface of the head with care not to damage the valve seat.

Leakage:Water pressure test 5kg/cm2 (for 3 minutes)

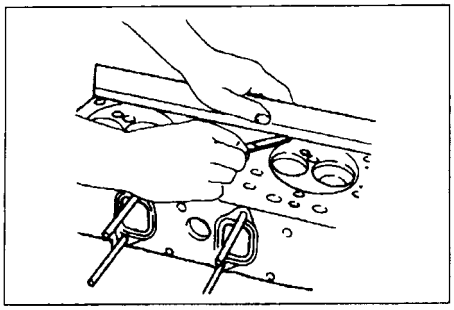


Fig. 64

Cylinder Head Lower Face Warpage
1 .Use a straight edge and a feeler gauge to measure the four sides and the two diagonals of the cylinder head lower face.
2. Regrind the cylinder head lower face if the measured values are greater than the specified limit but less than the maximum grinding allowance.

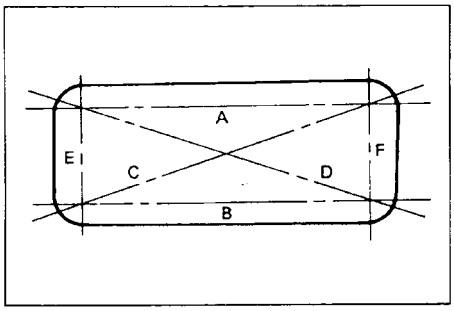


Fig. 65

If the measured values exceed the maximum grinding allowance, the cylinder head must be replaced.

Cylinder Head Lower Face Warpage mm (in)

Standard	Limit	Maximum Grinding Allwance
0.075 (0.0029)	0.15 (0.0059)	0.3 (0.0118)

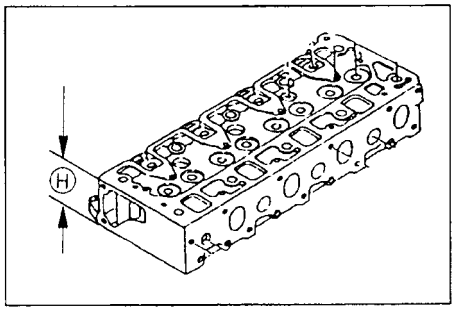


Fig. 66

Cylinder Head Height Ⓗ (Reference) mm (in)

Engine	Standard
4LE2	63.90 – 64.10 (2.515 – 2.523)

Note:
If the cylinder head lower face is reground, valve depression must be checked.

3. VALVE, VALVE SEAT INSERT AND VALVE SEAL

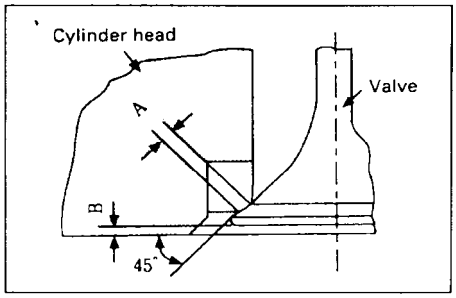


Fig. 67

Inspection of valve seat

1 . A - Contact width
2. B -Valve depression

mm (in)

		Standard	Limit
Contact width		2.0 (0.0787)	2.5 (0.0984)
Valve depression	IN	0.7 (0.0276)	1.2 (0.0427)
	EX	0.9 (0.0354)	1.5 (0.0591)

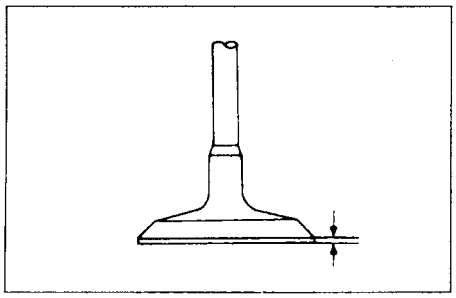


Fig. 68

Valve thickness

	Nominal	Limit	Repair method
IN	1.0 (0.03937)	0.7 (0.0276)	Replace
EX	0.8 (0.0315)	0.5 (0.0197)	

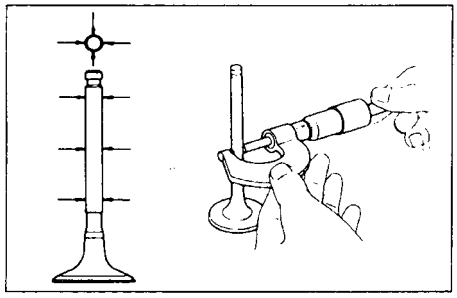


Fig. 69

Valve Stem Outside Diameter

Measure the valve stem diameter at three points.
If the measured value is less than the specified limit, the valve must be replaced.

Valve Stem Outside Diameter mm (in)

	Standard	Limit
Intake Valve	7.0 (0.2756)	6.85 (0.2697)
Exhaust Valve	7.0 (0.2756)	6.80 (0.2677)

Valve Seat Insert Replacement

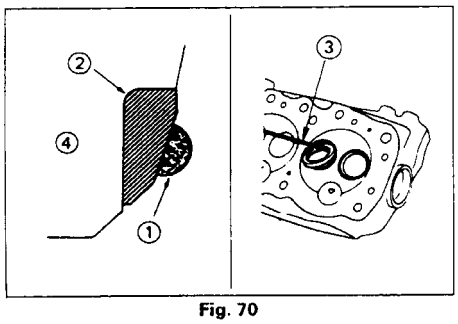


Fig. 70

Valve Seat Insert Removal

1. Arc weld the entire inside circumference 1 of the valve seat insert 2.
2. Allow the valve seat insert to cool for a few minutes.
This will invite contraction and make removal of the valve seat insert easier.
3. Use a screwdriver 3 to pry the valve seat insert free.
Take care not to damage the cylinder head 4.
4. Carefully remove carbon and other foreign material from the cylinder head insert bore.

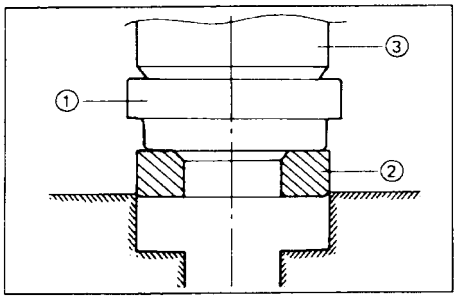


Fig. 71

Valve Seat Insert Installation

1 . Carefully place the attachment 1 (having a smaller outside diameter than the valve seat insert) on the valve seat insert 2.

Note:
The smooth side of the attachment must contact the valve seat insert.

2 . Use a bench press 3 to gradually apply pressure to the attachment and press the valve seat insert into place. 4,000 kg (8,819 lbs.)

Note:
Do not apply an excessive amount of pressure with the bench press. Damage to the valve seat insert will result.

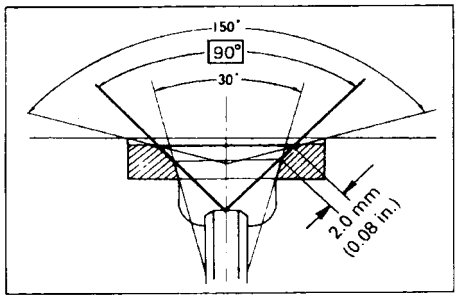


Fig. 72

Valve Seat Insert Correction

I. Remove the carbon from the valve seat insert surface.
2. Use a valve cutter (15, 45, and 75 degree blades) to mini-mize scratches and other rough areas. This will bring the contact width back to the standard value.

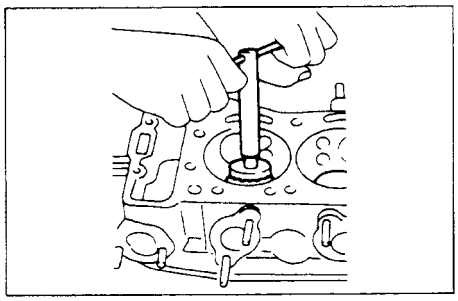


Fig. 73

Remove only the scratches and rough areas. Do not cut away too much. Take care not to cut away unblemished areas of the valve seat surface.

Valve Seat Angle	degree
45	

Note:
Use an adjustable valve cutter pilot.
Do not allow the valve cutter pilot to wobble inside the valve guide.

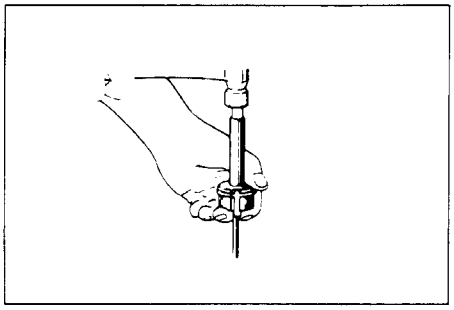


Fig. 74

3. Apply abrasive compound to the valve seat insert surface.
4 . Insert the valve into the valve guide.
5 . Apply light pressure to the valve while turning it to fit the valve seat insert.
6 . Check that the valve contact width is correct.
7 . Check that the valve seat insert surface is in contact with the entire circumference of the valve.
8 . Clean the head and valves to remove the abrasive compound and metal particles.

4. VALVE SPRING

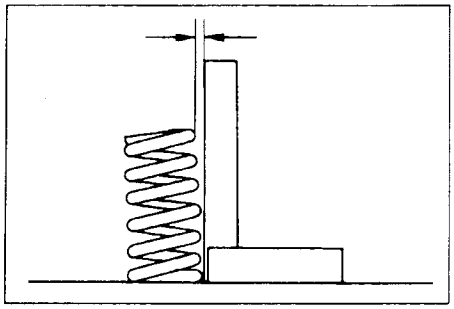


Fig. 75

Valve Spring Inclination
Use a surface plate and a square to measure the valve spring inclination.
If the measured value exceeds the specified limit, the valve spring must be replaced.

mm (in)

	Standard	Limit
Valve Spring Inclination	1.8 (0.0709)	2.5 (0.0984)

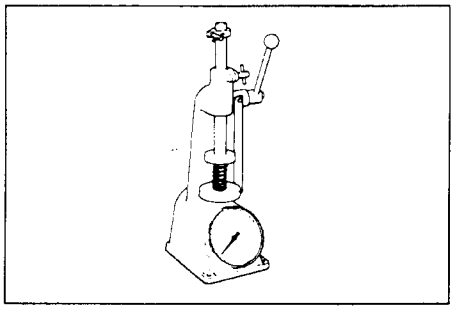


Fig. 76

Valve Spring Tension
Use a spring tester to measure the valve spring tension.
If the measured value is less than the specified limit, the valve spring must be replaced.

mm (in)

	Standard	Limit
Valve Spring Tension at 29.9 mm Set Length	17.0 (37.479)	15.0 (33.069)

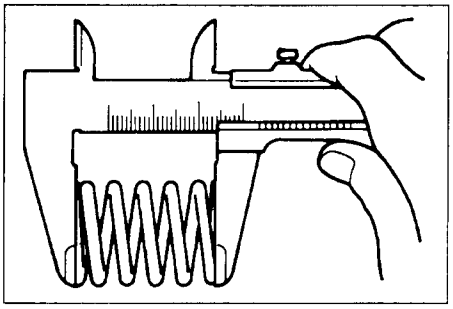


Fig. 77

Valve Spring Free Length
Use a vernier caliper to measure the valve spring free length.
If the measured value is less than the specified limit, the valve spring must be replaced.

mm (in)

	Standard	Limit
Exhaust and Intake Valve Spring Free Length	42.1 (1.6575)	40.0 (1.5748)

5. TAPPET (Cam Follower or Valve Lifter) AND PUSH ROD

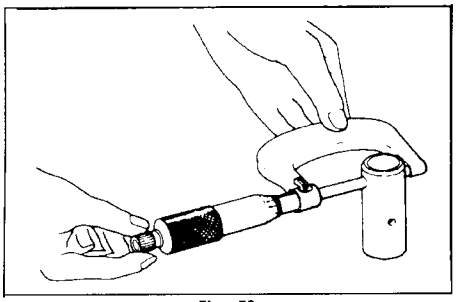


Fig. 78

TAPPET

Inspect the tappets for excessive wear, damage and any abnormalities.

Use a micrometer to measure the tappet diameter.

mm (in)

	Standard
Tappet Diameter	20.967 – 20.980 (Ø.82547 -0.82598)

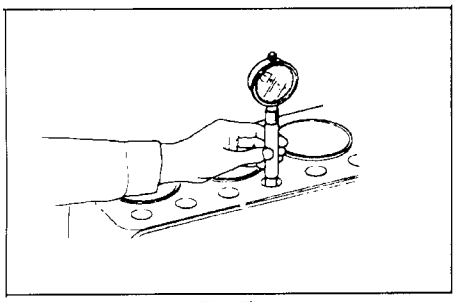


Fig. 79

Use a dial indicator to measure the clearance between the tappet and cylinder body tappet travelling bore.

mm (in)

	Standard	Limit
Tappet and Tappet Travelling Bore Clearance	Ø.Ø2Ø-Ø.Ø54 (0.00079 – Ø.ØØ213)	Ø.Ø8 (0.00315)

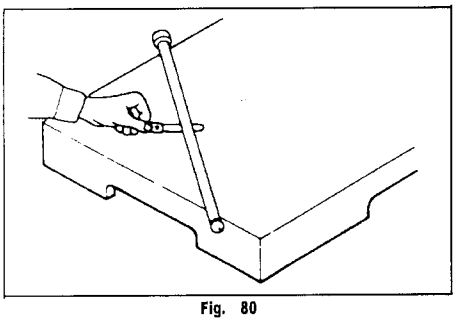


Fig. 80

PUSH ROD

Use a filler gauge to measure the valve push rod runout.

Roll the push rod along a smooth flat surface (illustration).

6. CAM SHAFT

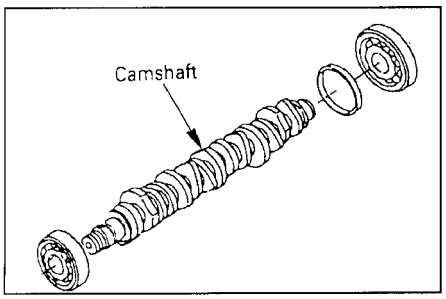


Fig. 81

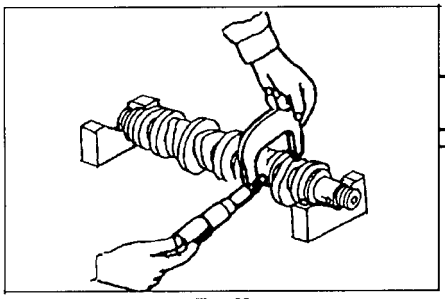


Fig. 82

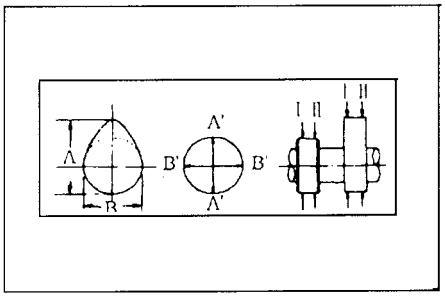


Fig. 83

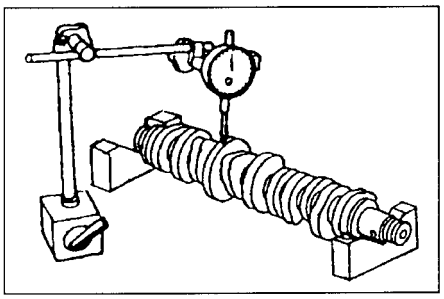


Fig. 84

Inspection of cam shaft

Check the journal and the cam for evidence of wear, damage or any other defect.

Note:

With the front and rear parts of camshaft pressed in with ball bearings, and with the cylinder block pressed in with roller bearings as the center bearing, check to see if the camshaft rotates smoothly with no play at each bearing.

Measurement of journal and cam

1. Cam height (A- B) mm (in)

	Standard	Limit	Repair method
Intake	6.13 (Ø.2413)	5.83 (0.2295)	Replace
Exhaust	6.43 (0.2531)	6.13 (0.2413)	Replace

2. Center journal diameter mm (in)

Nominal	Limit	Repair method
52 ø (2.Ø472)	51.92 ø (2.0441)	Replace

3. Uneven wear of journal mm (in)

Nominal	Limit	Repair method
52 ø (2.Ø472)	Ø.Ø5 (Ø.ØØ2)	Replace

4. Runout of cam shaft mm (in)

Nominal	Limit	Repair method
0.02 (0.008)	0.1 (0.004)	Replace

7. ROCKER ARM SHAFT AND ROCKER ARM

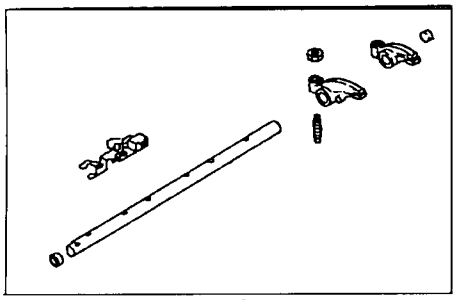


Fig. 85

Inspect ail disassembled parts for wear, damage and any abnormalities.

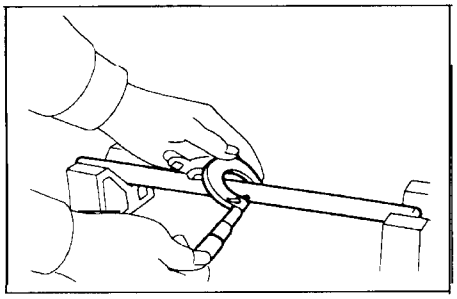


Fig. 86

Rocker Arm Shaft Outside Diameter

Use a micrometer to measure the rocker arm outside diameter.

If the measured value is less than the specified limit, the shaft must be replaced.

mm (in)

	Standard	Limit
Rocker Arm Shaft Diameter	11.935 – 11.955 (0.4699 – 0.4707)	11.85 (0.4665)

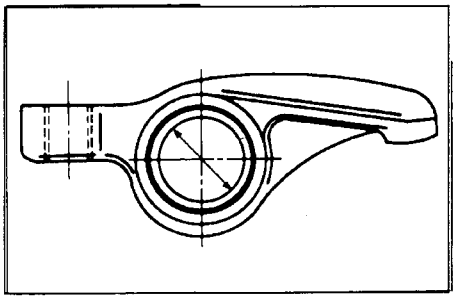


Fig. 87

Rocker Arm Shaft and Rocker Arm Clearance

1 . Use a vernier caliper to measure the rocker arm bushing inside diameter.

mm (in)

	Standard
Rocker Arm Bushing Inside Diameter	11.960 – 11.980 (0.4709 – 0.4717)

2 . Measure the rocker arm shaft outside diameter.

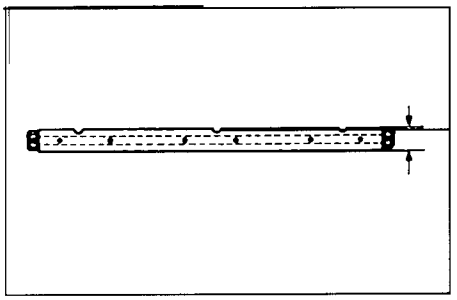


Fig. 88

Replace either the rocker arm or the rocker arm shaft if the clearance exceeds the specified limit.

mm (in)

	Standard	Limit
Rocker Arm Bushing and Rocker Arm Shaft Clearance	0.005 – 0.045 (0.0002 – 0.0018)	0.2 (0.0079)

3 . Check that the rocker arm oil port is free of obstructions.

If necessary, use compressed air to clean the rocker arm oil port.

8. PISTON, PISTON PIN AND PISTON RING

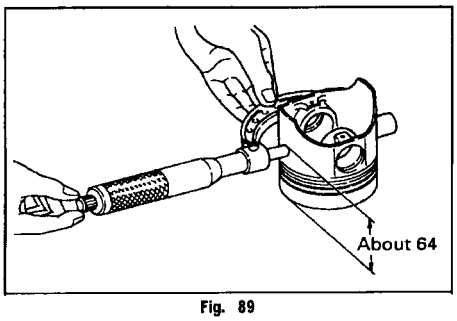


Fig. 89

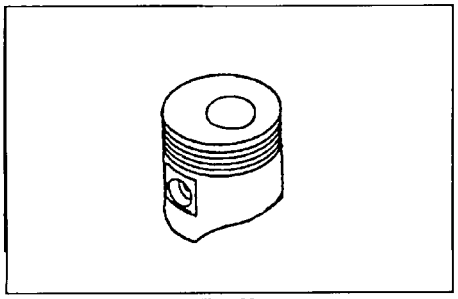


Fig. 90

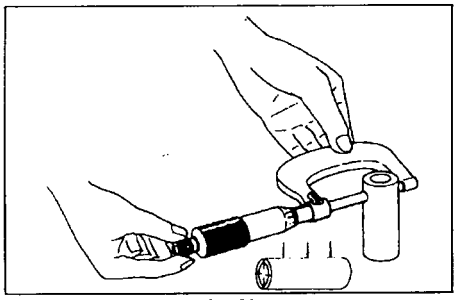


Fig. 91

Clearance between piston and cylinder bore

1 . Measure the outside diameter of the piston at about 64 mm from the top in a right angle to the piston pin (in the unit of l/1,000 mm).

2. Calculate the clearance based on the measurements of the cylinder bore and the outside diameter of the piston.

mm (in)

Clearance	0.040 – 0.085 (0.0015 – 0.0033)

Outside diameter of piston and grade mark

The grade mark is stamped on the top surface of the piston installed at the factory.
The piston for service part doesn't have the grade.

mm (in)

Model	Outside diameter of piston	Grade
4LE2	84.945 – 84.960 (3.3443 – 3.3449)	NON

Wear of piston pin (outside diameter)

mm (in)

Nominal	Limit	Remarks
25.0 (0.9843)	24.97 (0.9831)	Replace if worn beyond limit

Clearance between piston pin and piston pin hole

mm (in)

	Standard
4LE2	0.007 – 0.017 (0.00027 – 0.00067)

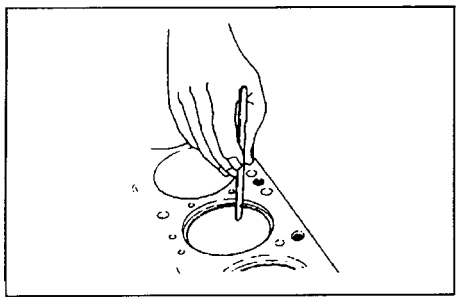


Fig. 92

Piston ring gap

With the ring inserted into the cylinder bore, push it in with the piston head so that it becomes a right angle to the cylinder, and then measure the gap of the piston ring.

If worn beyond the limit, replace the rings.

mm (in)

	Standard	Limit
1st compression ring	0.2 – 0.35 (0.0079 – 0.0138)	1.5 (0.0590)
2nd compression ring	0.35 – 0.5 (0.0138 – 0.0197)	
Oil ring	0.2 – 0.4 (0.0079 – 0.0157)	1.0 (0.03937)

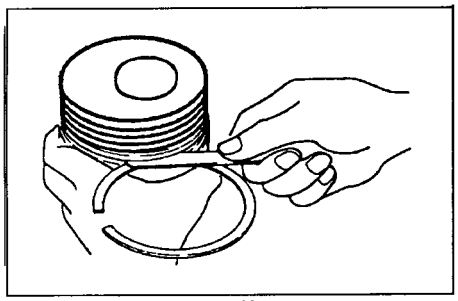


Fig. 93

Clearance between piston ring groove and ring

Measure clearance at several places on the circumference.

If worn beyond the limit, replace the rings or piston.

4LE2 mm (in)

	Standard	Limit
1st compression ring	0.085 – 0.105 (0.0033 – 0.0041)	0.2 (0.0078)
2nd compression ring	0.050 – 0.085 (0.0020 – 0.0033)	0.15 (0.0059)
Oil ring	0.030 – 0.070 (0.001 1 – 0.0027)	

9. CONNECTING ROD AND CONNECTING ROD BEARING

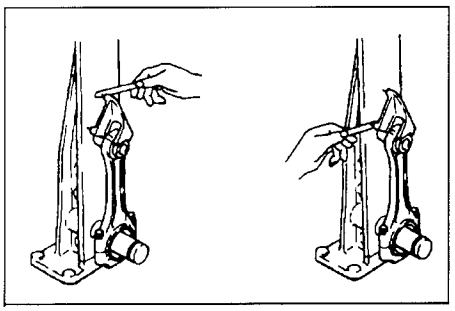


Fig. 94

Torsion and parallelism of connecting rod

If worn beyond the limit-repair or replace.

mm (in)

Per 100 mm (3.94)	Standard	Limit
Torsion	0.05 (0.002)	0.2 (0.0079)
Parallelism	0.05 (0.002)	0.15 (0.0059)

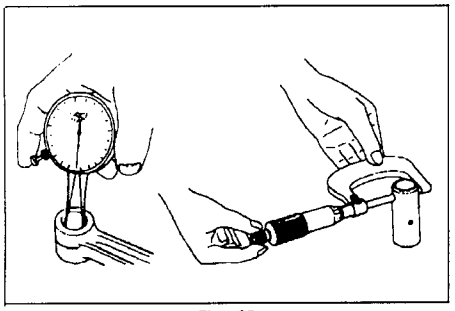


Fig. 95

Clearance between small end pin hole of connecting rod and piston pin, inside diameter of bushing

mm (in)

	Standard	Limit
Clearance	0.008-0.020 (0.0003-0.0008)	0.05 (0.0020)
Inside diameter	25 (0.9843)	—

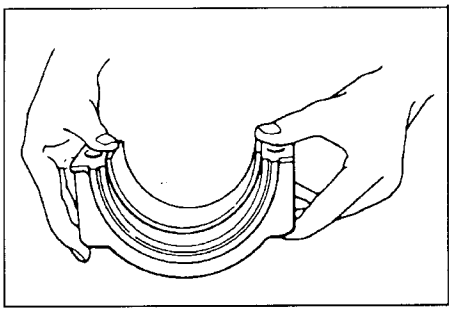


Fig. 96

Connecting Rod Bearing Inspection

1 . Fit the connecting rod bearing lower half into the connecting rod bearing cap.
2 . Check the connecting rod bearing lower half tension.
If the tension is insufficient, the bearing must be replaced.
3. Tighten the connecting rod and the bearing cap to the specified torque.

N-m (kgf·m/ft. lb)

Tightening torque	74 - 83 (7.5 - 8.5 / 54 - 61)

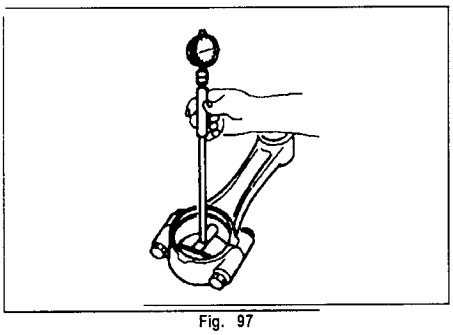


Fig. 97

Clearance between bearing and crank pin, inside diameter with bearing installed and without.

mm (in)

	Standard	Limit
Clearance	0.035 – 0.073 (0.0014-0.0029)	0.10 (0.0039)

IO.CRANKSHAFT AND CRANKSHAFT BEARING

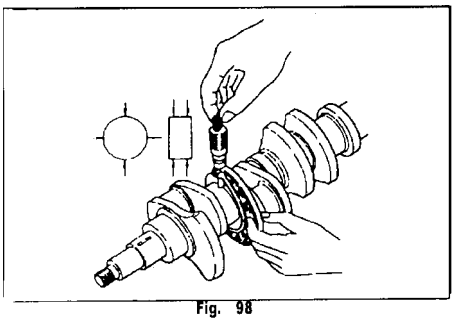


Fig. 98

Outside diameters of journal and pin

If worn beyond the limits,replace.

Crank journal mm (in)

	Standard	Limit
4LE2	60.0 (2.3622)	59.86 (2.3567)

Crank pin mm (in)

	Standard	Limit
4LE2	49.0 (1 .9291)	48.87 (1.9240)

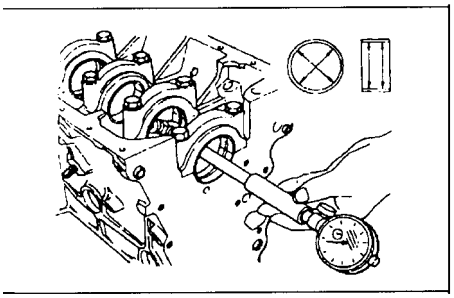


Fig. 99

Note:
When there occurs an uneven wear to the crankshaft, replace it with a new one without grinding it for reuse.

Clearance between journal and bearing inside diameter with bearing installed and without

	Standard	Limit
Clearance	0.029 - 0.072 (0.0011 - 0.0028)	0.11 (0.0043)

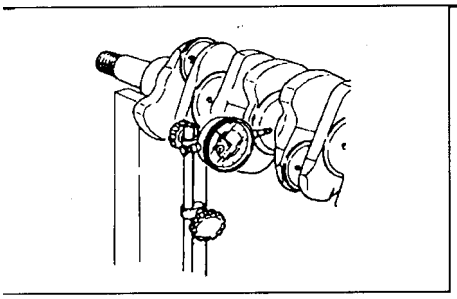


Fig. 100

Runout of crankshaft

Replace if beyond limit

mm (in)

Standard	Limit
0.025 (0.001)	0.05 (0.002)

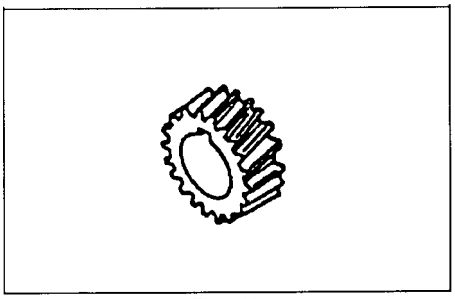


Fig. 101

Crankshaft gear

Check the crankshaft gear visually for damage and any other defects.

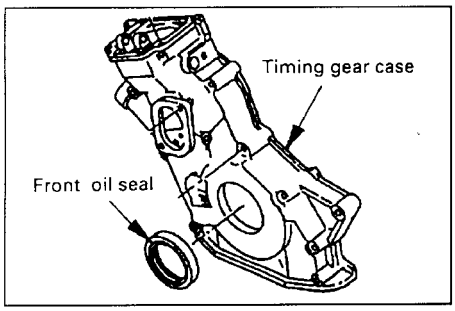


Fig. 102

Oil Seal

When the lip of an oil seal is found defective, replace it with a new one.

Installation

Use the crankshaft front oil seal installer to install the crankshaft front oil seal.

1 1.FLYWHEEL AND RING GEAR

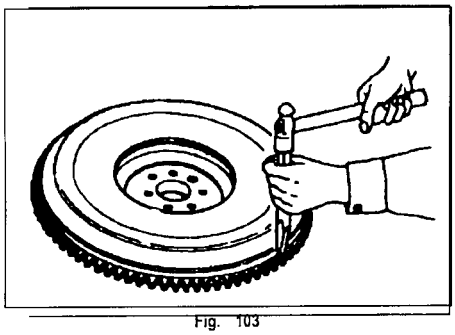


Fig. 103

Ring Gear Replacement

Ring Gear
Inspect the ring gear.
If the ring gear teeth are broken or excessively worn, the ring gear must be replaced.

Ring Gear Removal

Strike around the edges of the ring gear with a hammer and chisel to remove it.

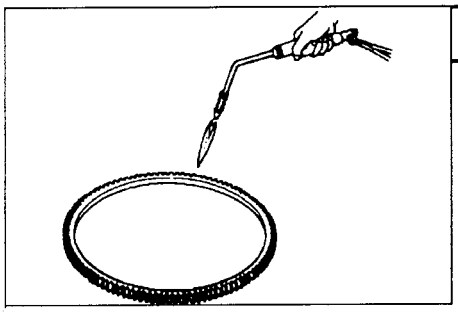


Fig. 104

Ring Gear Installation

1 . Heat the ring gear evenly with a gas burner to invite thermal expansion.
Do not allow the temperature of the gas burner to exceed 200°C (390°F).

2 . Use a hammer to install the ring gear when it is sufficiently heated.

12.TIMING GEAR

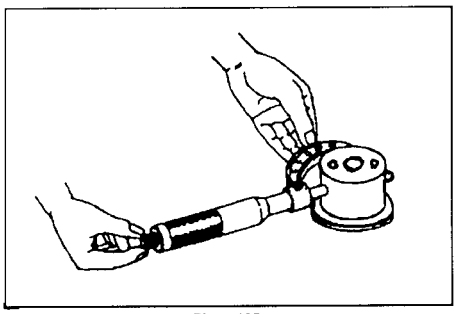


Fig. 105

Uneven wear of idle gear shaft

mm (in)

Nominal	Limit
45.0 (1.7717)	0.1 (0.0039)

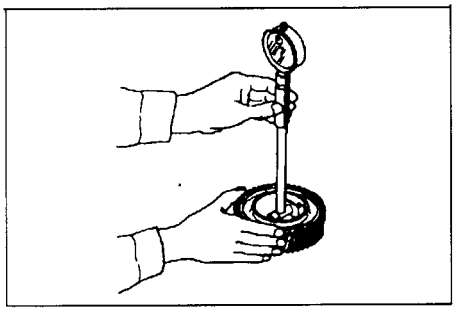


Fig. 106

Clearance between idle gear bushing and shaft

mm (in)

Standard	Limit
0.025 – 0.085 (0.001 – 0.0033)	0.2 (0.0079)

REASSEMBLY

1. CYLINDER HEAD ASSEMBLY

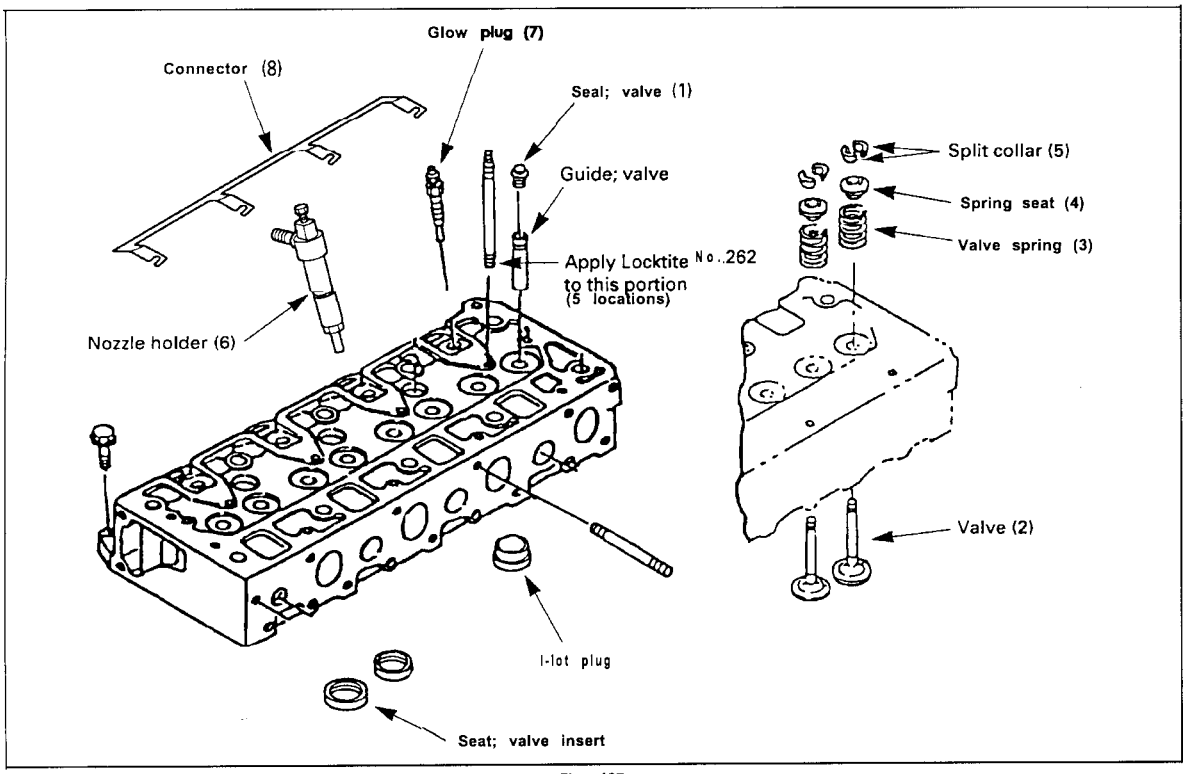


Fig. 107

Important Operations

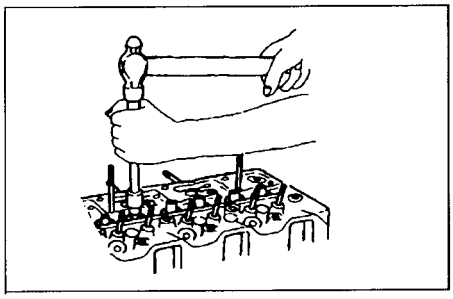


Fig. 108

Valve Stem Oil Seal

1 . Lubricate the oil seals and valve stem sealing area with engine oil.

Use a valve stem oil seal installer to install the oil seal.

Valve Stem Oil Seal Installer: 54419403

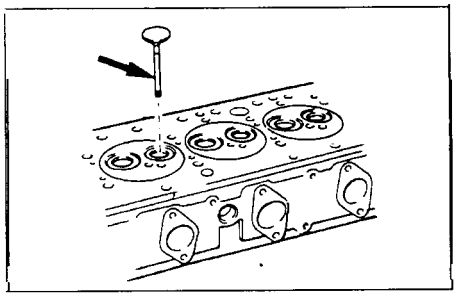


Fig. 109

Intake and Exhaust Valves

I. Place the cylinder head on a flat wooden surface.

2 . Lubricate valve stems with engine oil.

3 . Install the valves to the intake or exhaust guides. Install the valves to their original lapped valve seats.

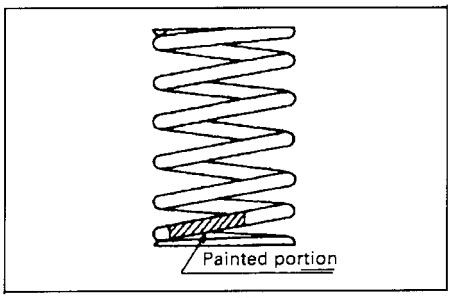


Fig. 110

Intake and Exhaust Valve Springs
Install the valve springs with their painted end (the close pitched end) facing down.

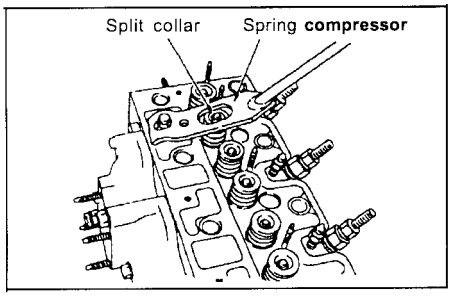


Fig. 111

Spring Seat Split Collar
I. Use a spring compressor to push the valve spring into position.
2 . Install the spring seat split collar.
3. Set the spring seat split collar by tapping lightly around the head of the collar with a rubber hammer.
Spring Compressor:54368717

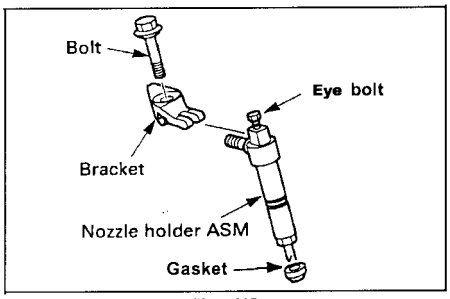


Fig. 112

Nozzle holder assembly
Before assembling the nozzle holder assembly, check to see if the spray condition and the spray pressure of the injection nozzle are appropriate, (Refer to “INSPECTION AND SERVICE.“)

Assemble to the cylinder head the gasket.
Install the nozzle holder assembly, and then tighten it to the specified torque.

N·m (kgf·m/ft. lb)

Tightening torque	31 - 41 (3.2 – 4.2 / 23 - 30)

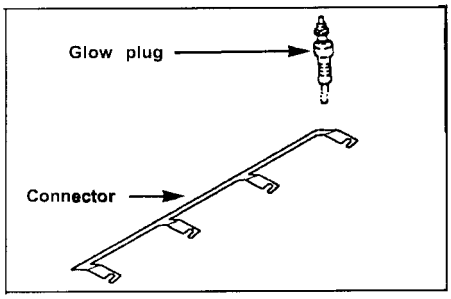


Fig. 113

Glow plug and connector
Assemble the glow plug to the cylinder head, and then tighten it to the specified torque.
Install the connector to the glow plug, and then tighten until snug.

N·m (kgf·m/ft. lb)

Parts	Tightening torque
Glow plug	15 - 20 (1.5 – 2.0 / 11 - 14)

2. PISTON AND CONNECTING ROD

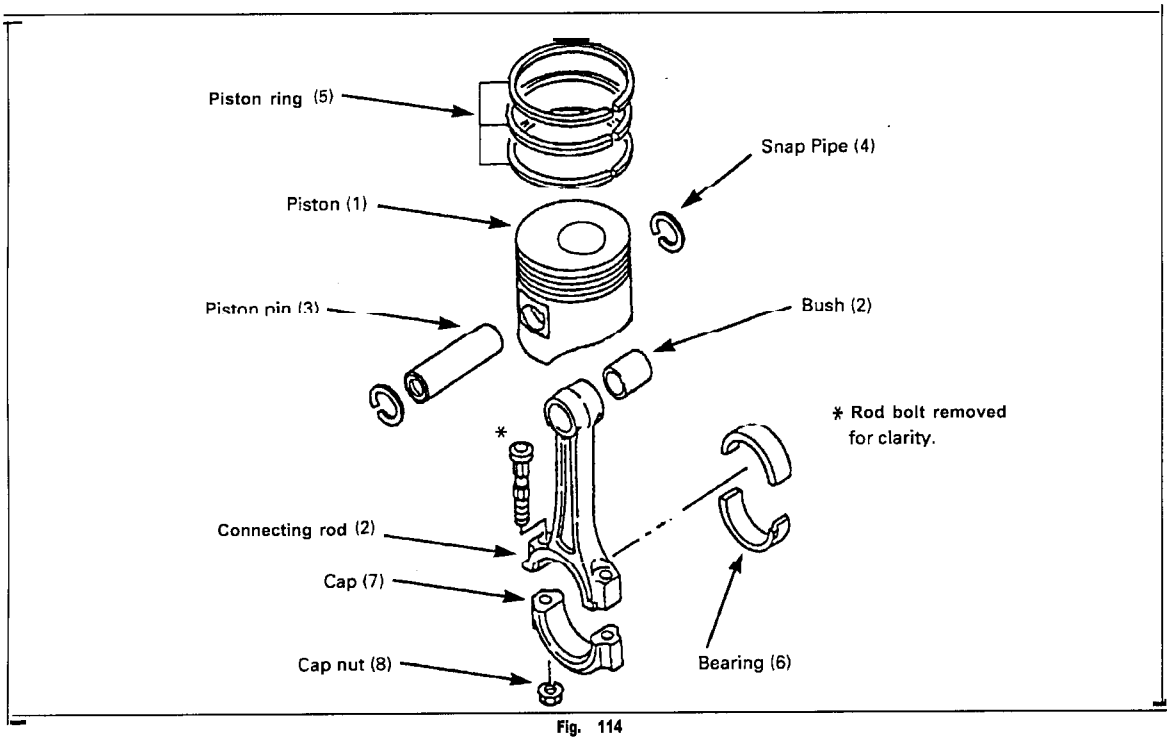


Fig. 114

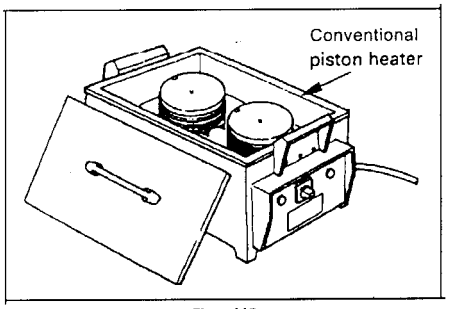


Fig. 115

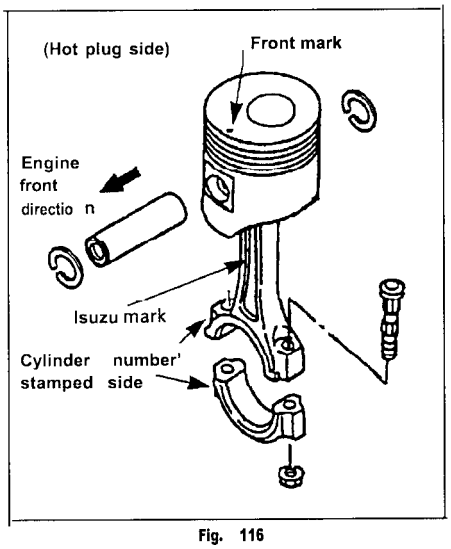


Fig. 116

Important Operations

Piston

Use a piston heater to heat the pistons to approximately 100°C (212°F).

Connecting Rod

1 . Install the connecting rod to the piston with setting the marks as illustrated.
2 . Install the piston pin into the piston and the connecting rod bushing.

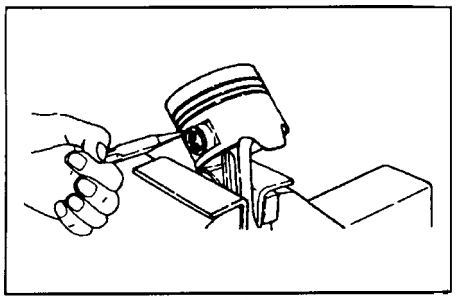


Fig. 117

Piston Pin Snap Ring

1. Use a pair of snap ring pliers to install the piston pin snap ring.
2. Check that the piston moves smoothly on the piston pin.

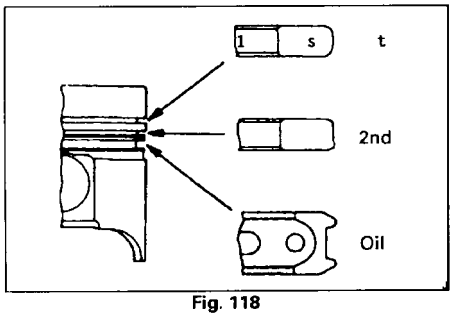


Fig. 118

Piston Ring

1.Use a piston ring installer to install the three piston rings.

Piston Ring Installer

Install the piston rings in the following order.
(1) Oil ring
(2) 2nd compression ring
(3) 1st compression ring

The marked side of the two compression rings must be facing up.

The undercut side of the second compression ring will be facing down.

As the oil ring has no any facing mark, it may face in either direction.

2.Lubricate the piston ring surfaces with engine oil.

3.Check that the piston rings rotate smoothly in the piston ring grooves.

3. INTERNAL PARTS

 Reassembly Steps

(1) Crankshaft
(2) Piston Assembly
(3) Rear Seal Retainer
(4) Camshaft
(5) Cam Gear
(6) Idler gear and Shaft
(7) Oil Pump Assembly
(8) Timing Gear Case (Without PTO)
(9) Flywheel Housing
(10) Flywheel
(11) Crank Pulley
(12) Oil Pipe
(13) Oil Strainer
(14) Oil Pan
(15) Tappets
(16) Cylinder Head Gasket
(17) Cylinder Head Assembly
(18) Push Rods
(19) Rocker Bracket Assembly
(20) Engine Hangers

Internal Parts (I/3)

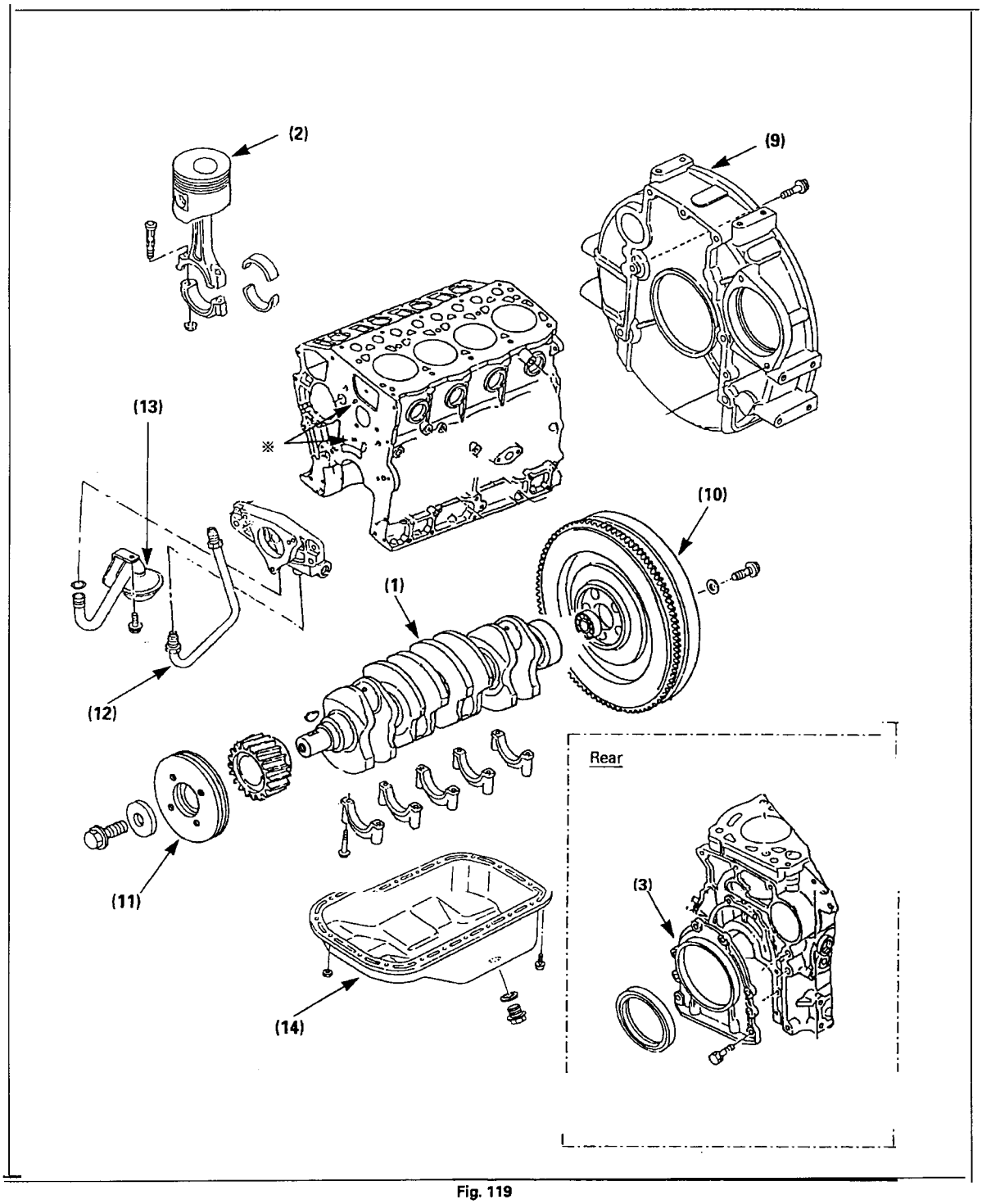


Fig. 119

Internal Parts (2/3)

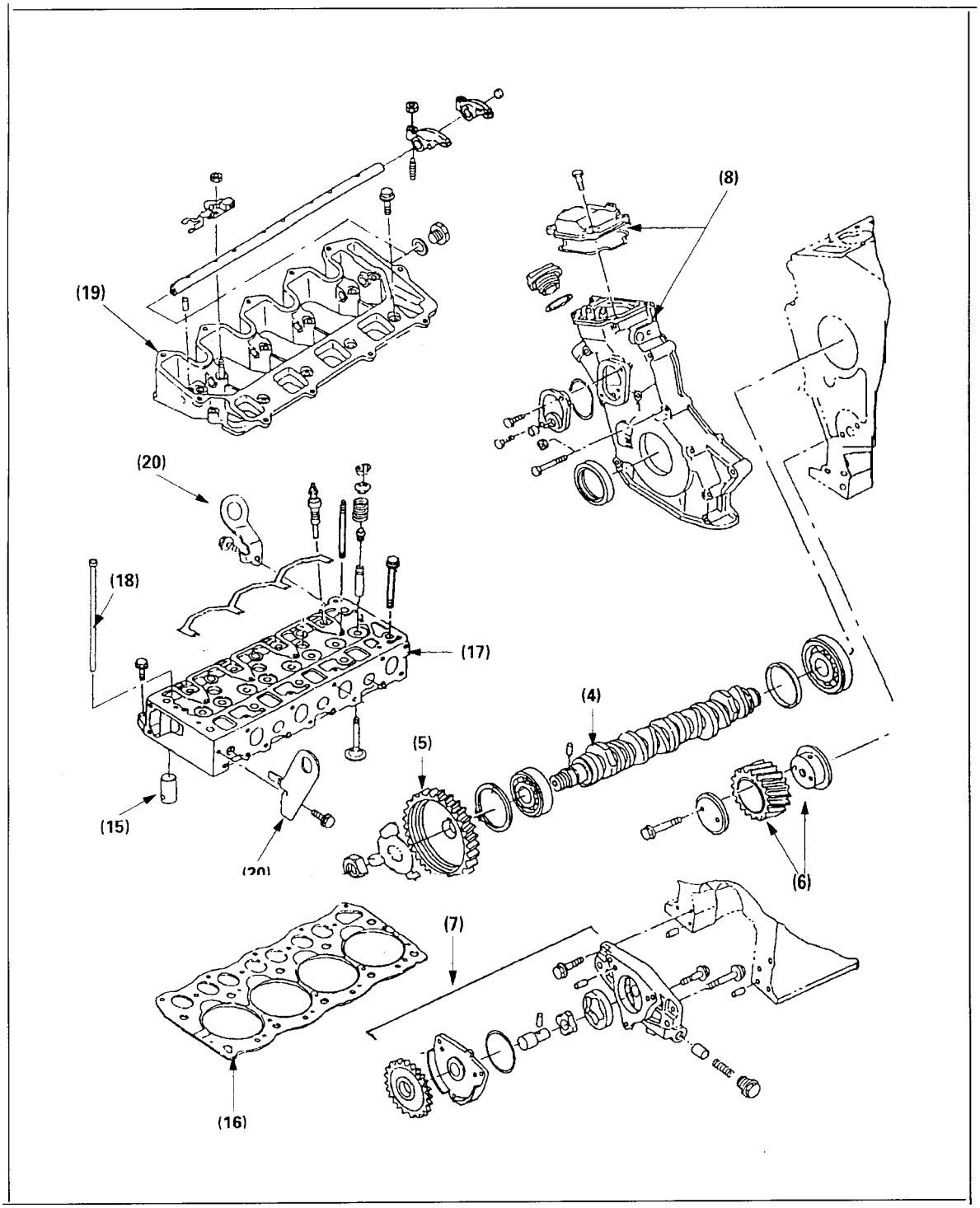


Fig. 120

Internal Parts (3/3)

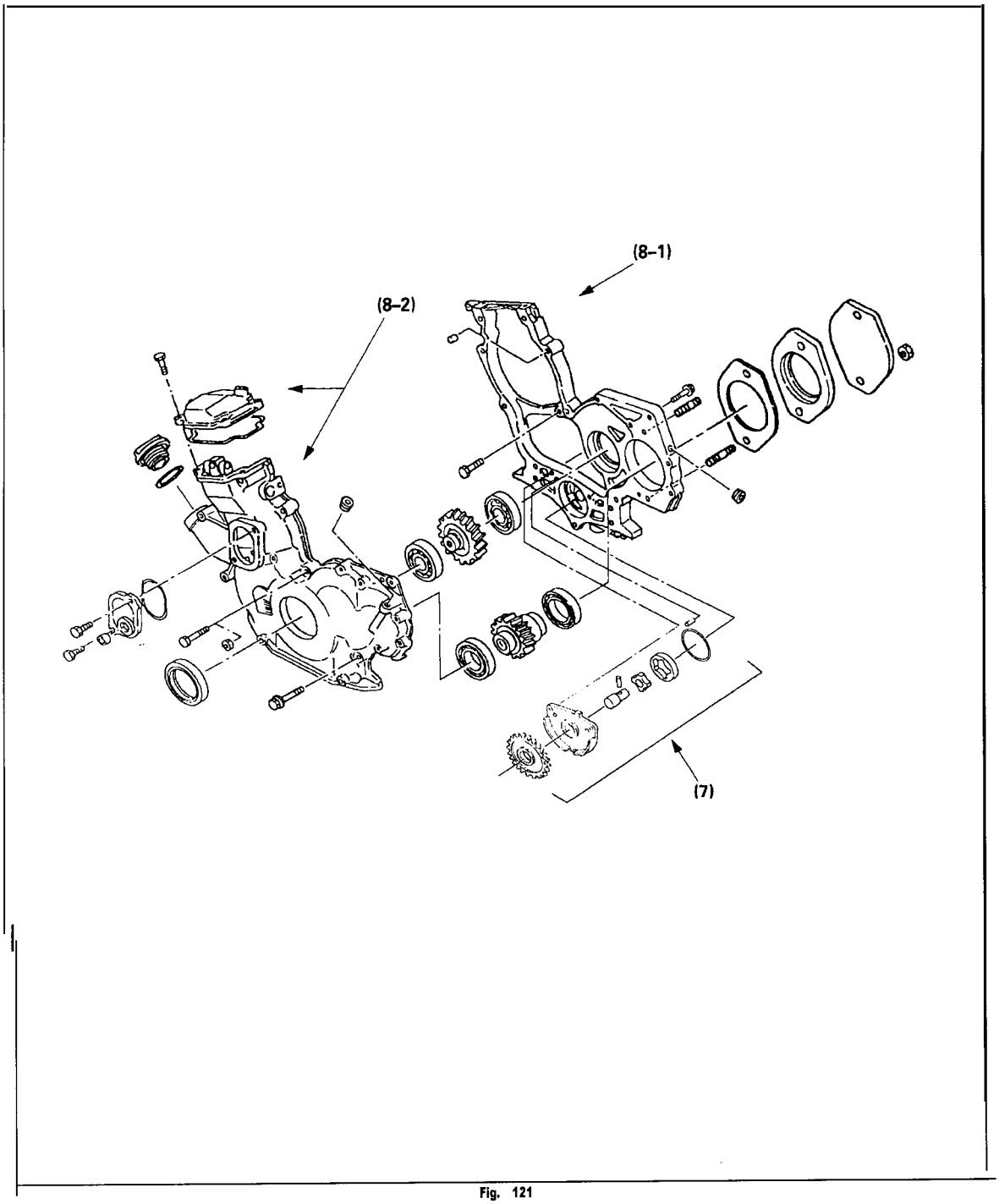


Fig. 121

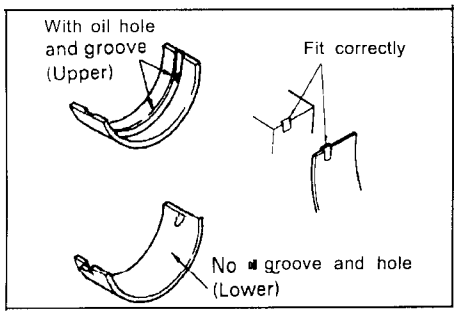


Fig. 122

Crankshaft bearing

Note that there is an oil hole and an oil groove in the upper bearing (on the block side), but not in the lower bearing (on the bearing cap side).

Fit the bearing tang firmly into the slot machined on the cylinder body bearing arches.

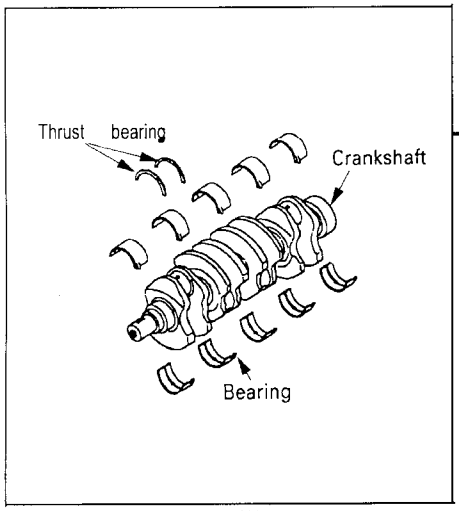


Fig. 123

Crankshaft and bearing

Lubricate the bearings with engine oil, install the crankshaft, install the thrust bearings with the groove facing the crankshaft.

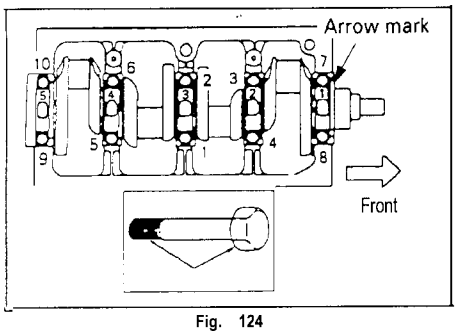


Fig. 124

Crankshaft Bearing Cap

1 . Lubricate the bearing cap bolts with engine oil.
2 . Install the bearing caps to the crankshaft.
The arrow mark must be pointing to the front of the engine.
3 . Tighten the bearing cap bolts to the specified torque a little at a time in the numerical order shown in the illustration.

N·m (kgf·m/ft. lb)

Crankshaft Bearing Cap Bolt Torque	83 - 93 (8.5 - 9.5 / 61 – 69)

4 . Check that the crankshaft turns smoothly by manually rotating it.

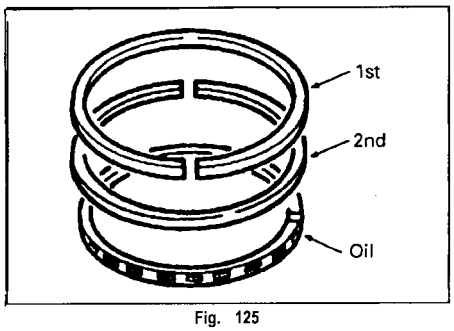


Fig. 125

Position the rings as shown making sure the ring gaps are away from the thrust side.

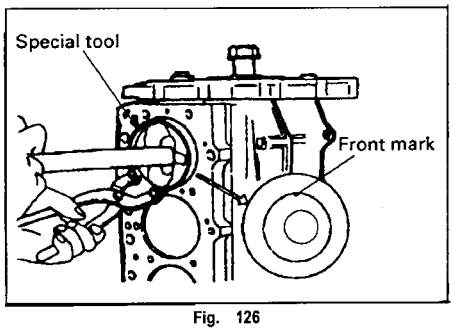


Fig. 126

Piston and Connecting Rod

Lubricate the piston, the piston rings, and the connecting rod bearings with engine oil.
Position the piston front mark towards the front of the engine.
Use the piston ring compressor to compress the piston rings.
Use a hammer grip to push the piston in until it makes contact with the crank pin.
At the same time, rotate the crankshaft until the crankpin reaches its highest point.

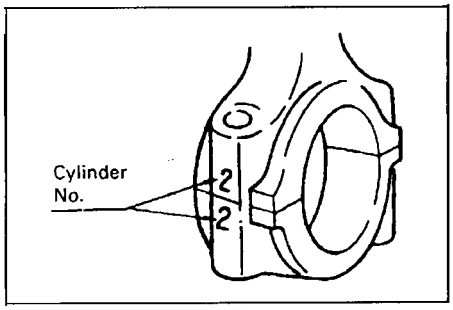


Fig. 127

Set the bearing cap cylinder number marks and the connecting rod cylinder number marks.

The marks must be facing the injection pump side.

N·m (kgf·m/ft. lb)

Tightening torque	74 - 83 (7.5 – 8.5 / 54 - 61)

Note:
After installation, confirm that the crankshaft rotates smoothly.

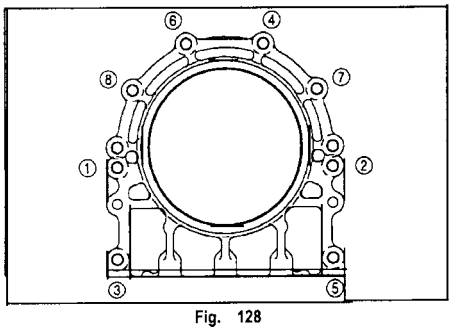


Fig. 128

Installation of retainer

After applying engine oil to the lip of the oil seal, install the retainer. Apply sealant TB1207B to the retainer.
Tighten bolts on the retainer to the specified torque in the-order as shown in the figure left.

N·m (kgf·m/ft. lb)

Tightening torque	8 - 12 (0.8 - 1.2 / 6 - 9)

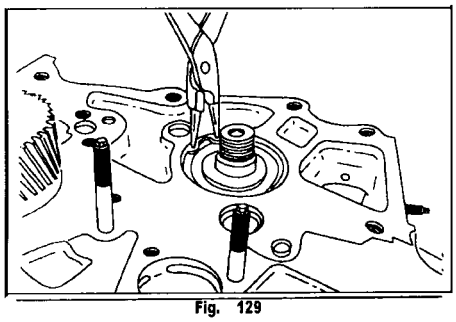


Fig. 129

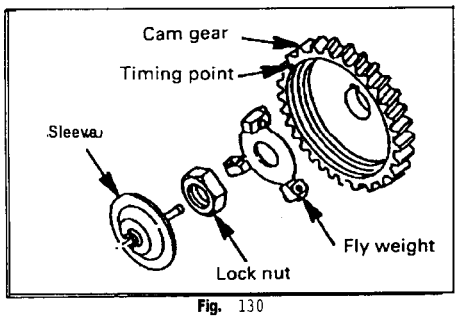


Fig. 130

Camshaft assembly

1. Apply engine oil to the inside of the bearing of the cylinder block, and then install the camshaft assembly.

Note:

When installing the assembly, care should be taken not to damage the bearing.

2 . After installation of the snap ring to the outside of the front bearing, check to see if the camshaft rotates smoothly.

Cam gear and sleeve

1 . Install the cam gear to the camshaft so that the timing point (a dot mark “a”) comes to the front side.

2. With the flyweight installed, tighten the cam gear with a lock nut.

N·m (kgf·m/ft. lb)

Tightening torque	69 - 88 (7.0 - 9.0 / 51 - 65)

3 . Apply engine oil to the shaft of the sleeve and the slide of the flyweight.

4 . With the lip of the sleeve placed in the cavity of the flyweight, insert the shaft of the sleeve into the tip end of the camshaft.

Note:

Check to see if the sleeve moves smoothly.

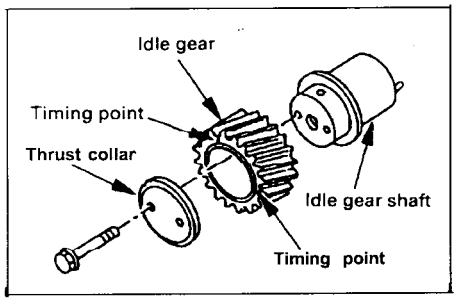


Fig. 131

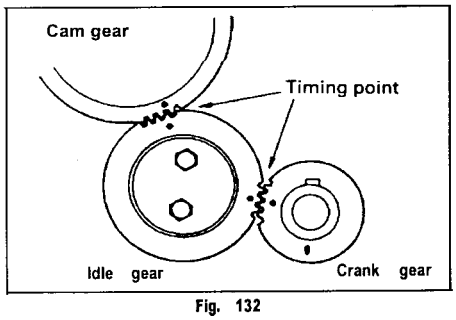


Fig. 132

Idle Gear

Install the idler gear shaft with the oil hole facing upward.

Lubricate the shaft with oil.

Install the idler gear.

Align the timing marks as shown in the illustration.

Install the thrust collar and tighten the bolts to the specified torque.

N·m (kgf·m/ft. lb)

Tightening torque	21 - 30 (2.1 – 3.1 / 15 – 22)

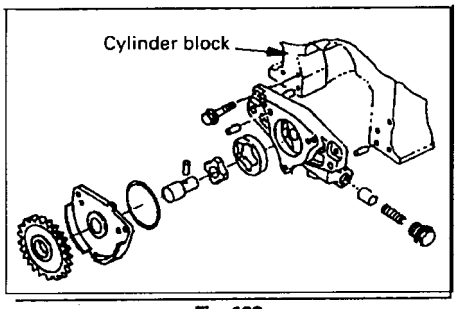


Fig. 133

Oil pump assembly

1. When PTO is not provided, install the oil pump assembly to the cylinder block.

PTO not provided	N·m (kgf·m/ft. lb)
Tightening torque	19 - 28 (1.9 – 2.9 / 14-21)

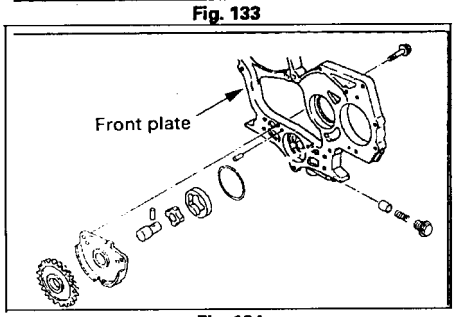


Fig. 134

2. When PTO is provided, install the oil pump to the front plate.

PTO provided	N·m (kgf·m/ft. lb)
Tightening torque	8 - 12 (0.8 – 1.2 / 6 – 9)

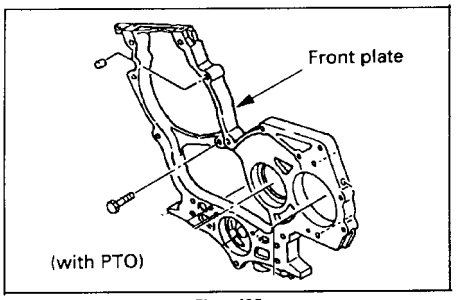


Fig. 135

Front plate (only for those provided with PTO)

Apply sealant to the front plate incorporated with the oil pump before installing it to the cylinder block.

N·m (kgf·m/ft. lb)

Tightening torque	19 - 28 (1.9 – 2.9 / 14-21)

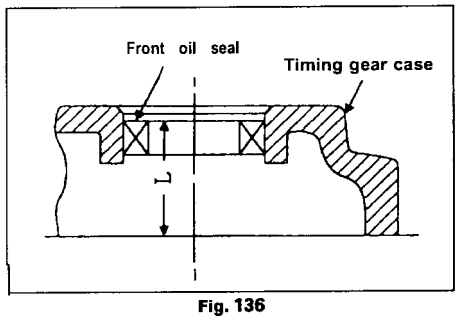


Fig. 136

Front oil seal

Install the front oil seal to the timing gear case. Installation is made according to the “L” dimension shown in the figure.

mm (in)

	L dimension
PTO not provided	60.2 – 60.8 (2.370 – 2.384)
PTO provided	40.2 – 40.8 (1.582 – 1.606)

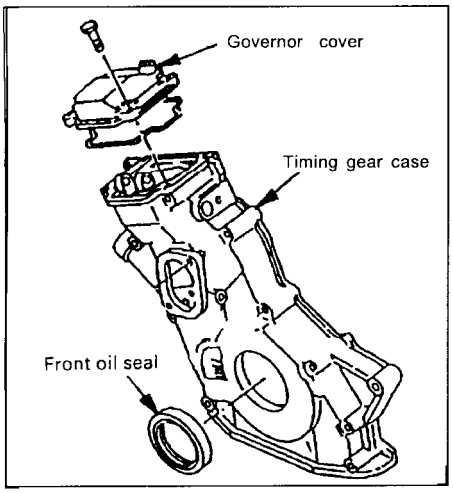


Fig. 137

Timing gear case (with governor)

When not provided with PTO, install the timing gear case to the cylinder block. When provided with PTO, install it to the front plate.

1 . Put the link plate of the governor incorporated in the gear case through the connecting hole of the injection pump in advance.

2. Apply engine oil to the bushes provided on both ends of the main spring lever of the governor.

3 . Apply sealant to the gear case, and then install it to the cylinder block or the front plate.

N-m (kgf·m/ft. lb)

Case tightening torque	19 - 28 (1.9 – 2.9 / 14– 21)

4 . Assemble the gasket and the governor cover to the top of the gear case, and then tighten them to the specified torque.

N-m (kgf·m/ft. lb)

Cover tightening torque	8 - 12 (0.8 – 1.2 / 6 – 9)

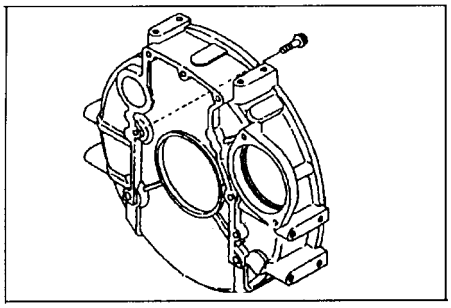


Fig. 138

Flywheel housing

Install the flywheel housing to the cylinder body.

N·m (kgf·m/ft. lb)

Tightening torque	41 - 55 (4.2 – 5.6 / 30 – 40)

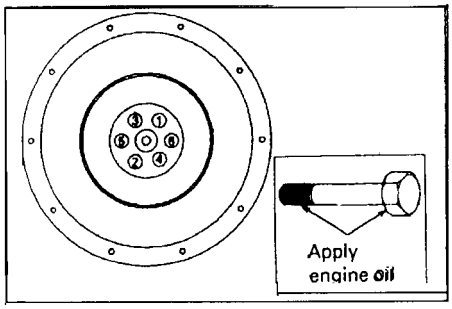


Fig. 139

Flywheel

Lubricate bolts with engine oil.

Tighten a little at a time in the sequence shown in the illustration.

N·m (kgf·m/ft. lb)

Tightening torque	88 - 108 (9 – 11 / 65 – 80)

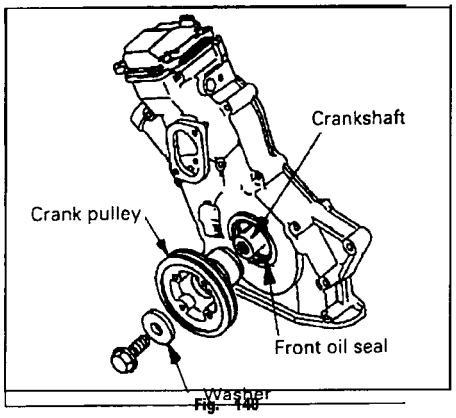


Fig. 140

Crank pulley

Lubricate the lip of the front, seal with oil
Install the crank pulley, lock the crankshaft and tighten the front bolt.

N·m (kgf·m/ft. lb)

Tightening torque	167 - 186 (17 – 19 /123 – 137)

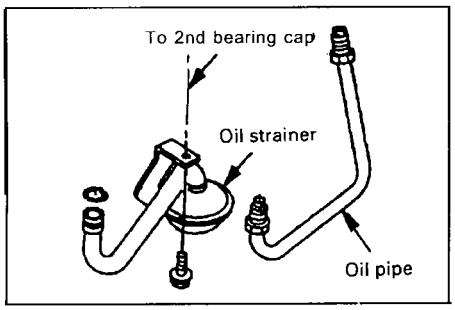


Fig. 141

Oil pipe and oil strainer

1 . Install the oil pipe from the oil pump assembly to the cylinder block and tighten the sleeve nuts.
2. Install the oil strainer to the oil pump, and then tighten the bracket of the strainer to the No. 2 bearing cap.

N·m (kgf·m/ft. lb)

Tightening torque	19 - 28 (1.9 – 2.9 / 14 – 21)

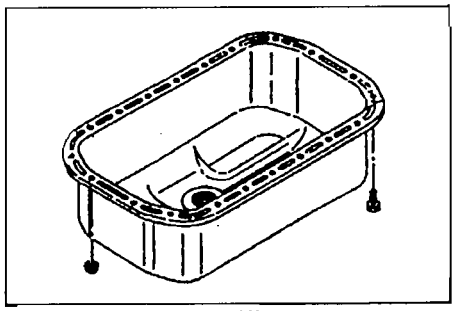


Fig. 142

Oil pan

1 . Apply sealant to the oil pan.
2 . Install the oil pan to the cylinder block and tighten fixing bolts evenly.

N·m (kgf·m/ft. lb)

Tightening torque	8 - 12 (0.8 – 1.2 / 6 – 9)

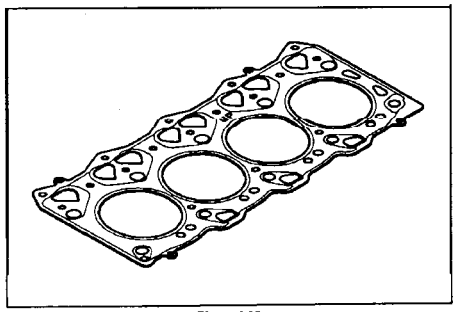


Fig. 143

Tappet and head gasket

1 . Install the tappet to the cylinder block.
2. When installing the head gasket, face up the “UP” mark.
Install the head gasket over the cylinder head locaing dowels.

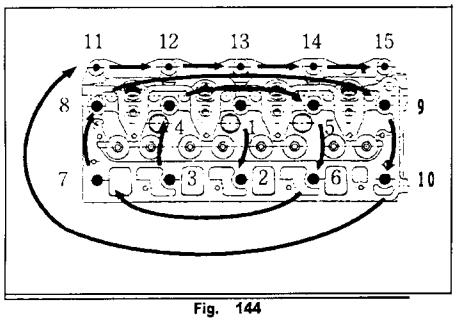


Fig. 144

Cylinder head assembly

Lubricate the bolts with oil.
Tighten the bolts in the sequence shown in the illustration to the specified torque.

N·m (kgf·m/ft. lb)

Bolt size	Tightening torque
MI2 x 1.5 (8 each)	83-93 (8.5 - 9.5 / 61 – 69) → 60°~90°
M8 x 1.25 (4 each)	24-34 (2.5 - 3.5 / 8 – 25)

Push rod

Install the push rods.

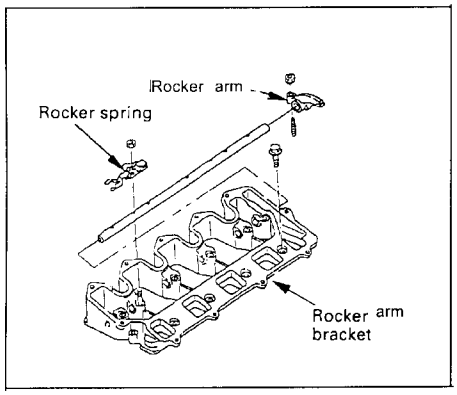


Fig. 145

Rocker arm bracket assembly

Apply liquid gasket to the the bottom of the rocker arm bracket assembly, being careful not to get any in the groove around the oil galley as shown in the illustration.
Install the rocker arm bracket assembly making sure the push rods align with the rocker arms and tighten to the specified torque.

N·m (kgf·m/ft. lb)

Tightening torque	8 - 12 (0.8 – 1.2 / 6 – 9)

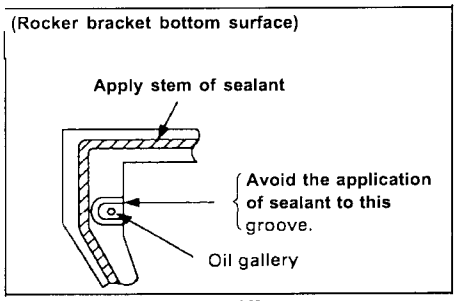


Fig. 146

Refer to Section "General Information - Maintenance" (on page 20).

Adjustment of valve clearance

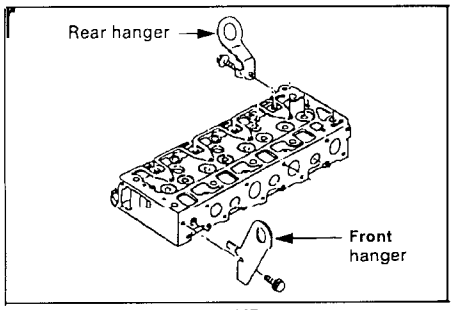


Fig. 147

Front hanger and rear hanger

Tighten them to the specified torque shown below.

N·m (kgf·m/ft. lb)

Tightening torque	19 - 28 (1.9 -2.9 / 14 – 21)

4. EXTERNAL PARTS (Right-hand Side)

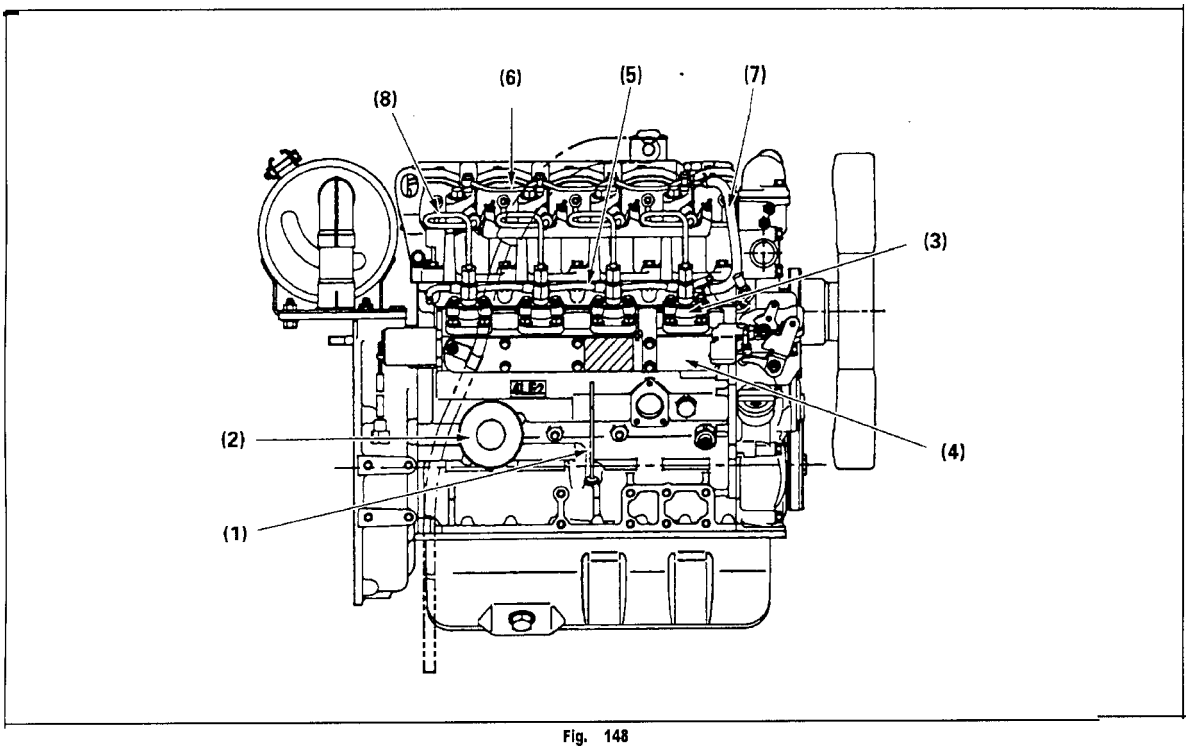


Fig. 148

(1) Dipstick
(2) Oil Filter
(3) Injection Pump
(4) Injection Pump Housing Cover
(5) Fuel Pipe
(6) Leak Off Pipe
(7) Fuel Hose
(8) Injection Pipe

5. EXTERNAL PARTS (Left-hand Side)

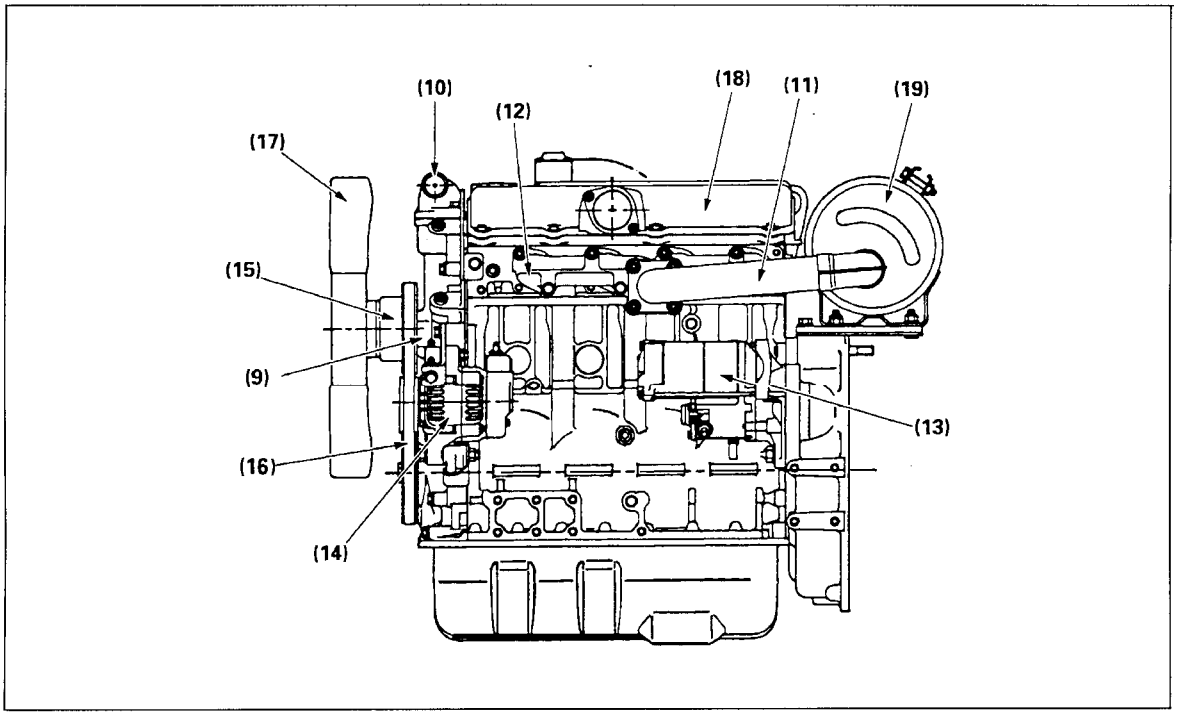


Fig. 149

(9) Water Pump
(10) Thermostat and Water Outlet Pipe
(11) Cylinder Head Cover
(12) Exhaust Manifold
(13) Starter
(14) Generator
(15) Fan Pulley
(16) Fan Belt
(17) Cooling Fan
(18) Exhaust Pipe
(19) Exhaust Silencer

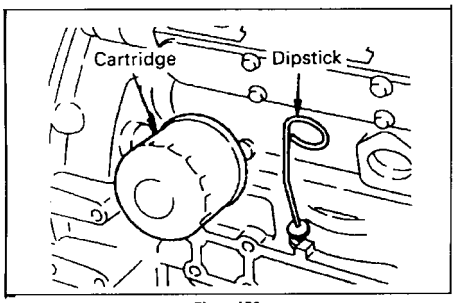


Fig. 150

Dipstick
Oil filter (cartridge)
1 . Insert the dipstick.
2. Install the cartridge with a filter wrench (commercially available).
(I) Apply engine oil thinly to the gasket of the cartridge.
(2) Screw in the cartridge until the gasket comes into contact with the seal, and then tighten it by giving it about 3/4 turns.
(Reference: Tightening torque 12 to 16 Nm (1.2 - 1.6 kgf,m))

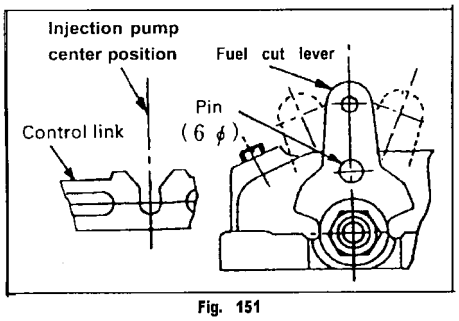
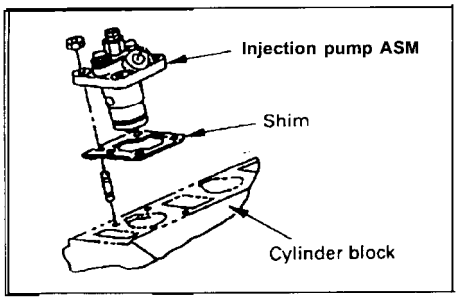


Fig. 151

Injection pump
Align the two (2) holes in the fuel cut lever and the governor and lock into place with a pin.
This will center and hold the control link for the installation of the injection pumps.



Fig, 152

Install a new shim with the same thickness as the one that was removed. (Refer to the maintenance section on shim selection).

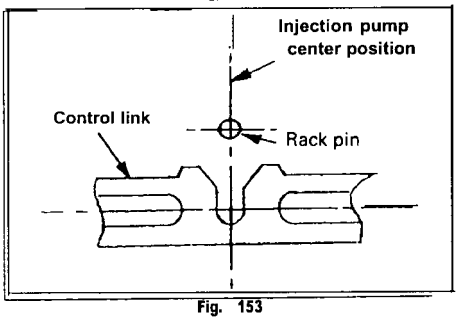


Fig. 153

Install the injection pump making sure the rack pin is in the groove of the control rack before tightening the injection pump to the specified torque.

N·m (kgf·m/ft. lb)

Tightening torque	19 - 28 (1.9 – 2.9 / 14 – 21)

Remove the rack pin (6o) which is inserted into the fuel cut lever, and then confirm that the fuel cut lever moves smoothly.

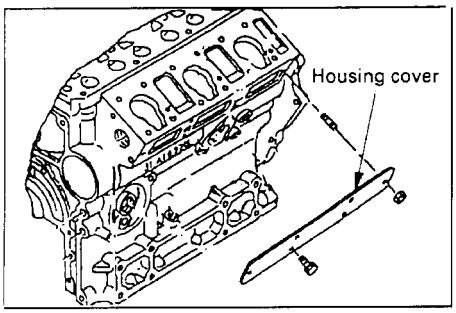


Fig. 154

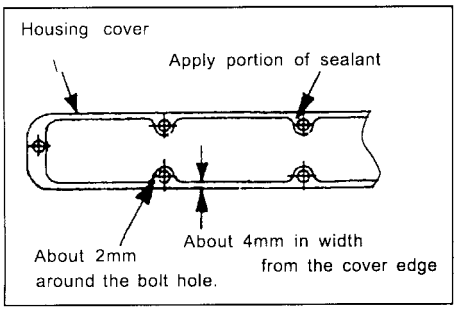


Fig. 155

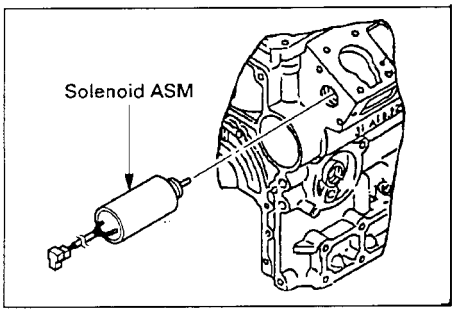


Fig. 156

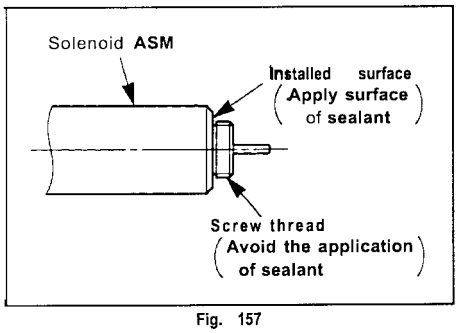


Fig. 157

Injection pump housing cover

After applying sealant (TB1207B) to the housing cover, install it to the cylinder block by the side of the injection pump

N·m (kgf·m/ft. lb)

Tightening torque	**8 - 12 (0.8 – 1.2 / 6 – 9)**

Note:

The areas of the housing cover to which liquid gasket is applied are about 4 mm in width from the cover edge and about 2 mm around the bolts.

Solenoid assembly

1 . Apply sealant (TB1207C) to the surface (bite groove) in which the solenoid is installed.

Note:

Avoid the application of sealant to the screw thread.

2 . Screw in the solenoid from the rear of the cylinder block (the rear of the No. 3 injection pump rack), and then tighten it to the specified torque.

N·m (kgf·m/ft. lb)

Tightening torque	**15 - 25 (1.5 – 2.5 / 11 – 18)**

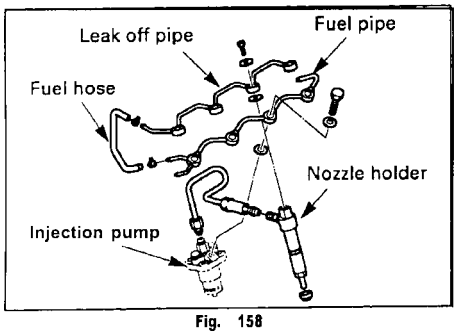


Fig. 158

Fuel pipe
Leak off pipe

1 . Install the fuel pipe to the injection pump and then tighten it to the specified torque.
2 . Install the leak off pipe to the nozzle holder and then tighten it to the specified torque.

N·m (kgf·m/ft. lb)

Tightening torque	
Fuel pipe	20 - 25 (2.0 – 2.5 / 14 – 18)
Leak off pipe	10 - 14 (1.0 – 1.4 / 7 – 10)

Note:
When tightening it, hold the pipe securely by hand so that it will not rotate.

3 . Connect the fuel pipe and the leak off pipe with the fuel hose and fix them with clips.

Injection pipe

Install the injection pipe to the injection pump and the nozzle holder and tighten them up with sleeve nuts.

N-m (kgf·m/ft. lb)

Tightening torque	15 - 25 (1.5 – 2.5 / 11 – 18)

Note:
Set the thread of the sleeve nut securely before tightening it up.

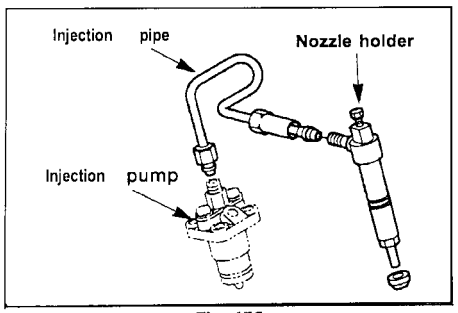


Fig. 159

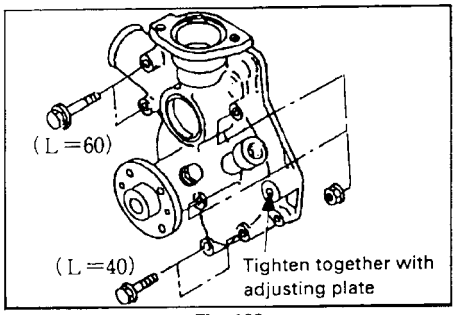


Fig. 160

Water pump assembly

1 . Put sealant on the water pump where it contacts the block and head.
2 . Tighten to the specified torque.

N·m (kgf·m/ft. lb)

Tightening torque	19 - 28 (1.9 – 2.9 / 14 – 21)

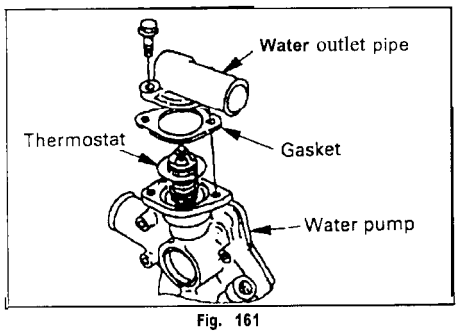


Fig. 161

Thermostat
Water outlet pipe

Assemble the thermostat, install the gasket and the water outlet pipe, and then tighten it to the specified torque.

N·m (kgf·m/ft. lb)

Tightening torque	19 - 28 (1.9 – 2.9 / 14 – 21)

Adjustment of valve clearance
(Refer to Section "GENERAL INFORMATION - MAINTENANCE.")

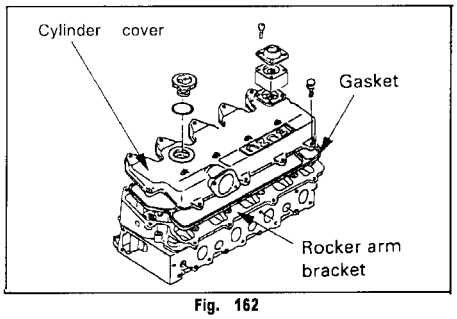


Fig. 162

Cylinder head cover
1 . Install the gasket to the cylinder head cover.
Notes:
I . Much care should be taken for the gasket not to get dislocated or twisted when installing the head cover.
2. Avoid the application of sealant to the rubber gasket.
3. Install the cylinder head cover to the rocker arm bracket, and tighten it to the specified torque.

N·m (kgf·m/ft. lb)

Tightening torque	2 - 4 (0.2 - 0.4 / 1.4 - 2.9)

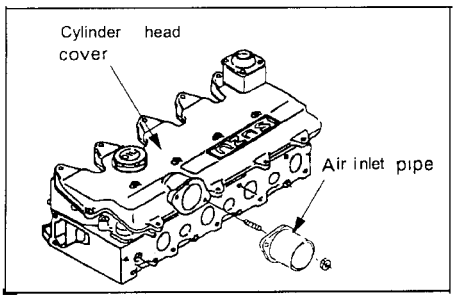


Fig. 163

Air inlet pipe
1 . Apply sealant (TB1207C) to the surface in which the air inlet pipe is installed.
2 . Install the air inlet pipe to the cylinder head cover, and tighten it to the specified torque.

N·m (kgf·m/ft. lb)

Tightening torque	8 - 12 (0.8 – 1.2 / 6 – 9)

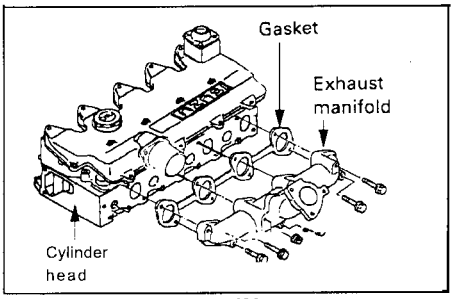


Fig. 164

Exhaust manifold
Assemble the gasket to the cylinder head, install the exhaust manifold along the stud bolts and tighten it to the specified torque.

N·m (kgf·m/ft. lb)

Tightening torque	19 - 28 (1.9 – 2.9 / 14 – 21)

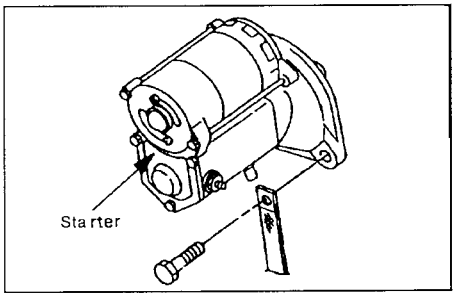


Fig. 165

Starter
Install the starter to the flywheel housing, and tighten it to the specified torque.

N·m (kgf·m/ft. lb)

Tightening torque	93 - 113 (9.5 – 11.5 / 69 – 83)

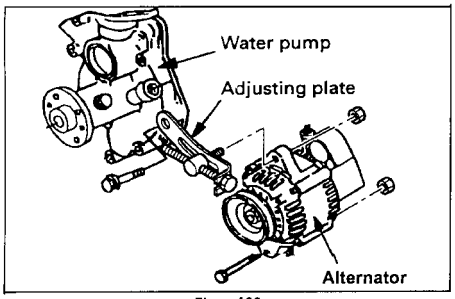


Fig. 166

Generator

1 . Tighten the adjust plate together with the water pump, and then install them temporarily.
2 . Install the bottom of the alternator to the timing gear case, and then tighten it temporarily with bolts and nuts.
3. Install the fixing bolts onto the top of the alternator through the adjusting plate. (Temporary tightening)

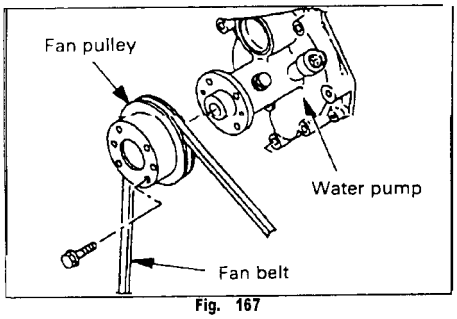


Fig. 167

Fan pulley and fan belt

1. Install the fan pulley to the water pump and then tighten it up. (2 locations)
2 . Set the fan belt to each pulley.

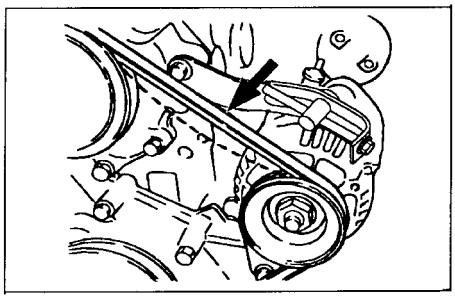


Fig. 168

Fan belt tension

Adjust the alternator as specified and tighten to the specified torque.

mm (in)

Deflection amount (Press the belt at its center between the pulleys with 98 N (10kg / 22 lbs.) force.)	7.5 to 8.5 (0.29 – 0.33)

mm (in)

Generator upper	1.9 – 2.9 (14.0 – 21.0)
Generator lower	3.5 – 4.7 (25.0 – 34.0)
Adjust plate	1.9-2.9 (14.0-21.0)

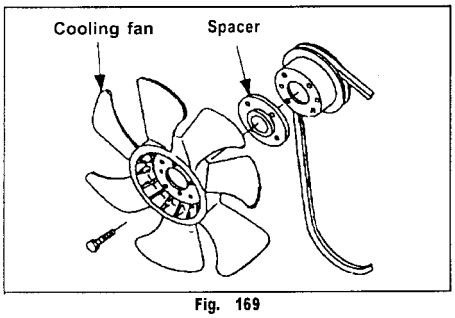


Fig. 169

Cooling fan

1 . Assemble the spacer before tightening the cooling fan .
2 . Tighten it to the specified torque. (4 locations)

SECTION 3

LUBRICATING SYSTEM

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LUBRICATING OIL CIRCULATION DIAGRAM

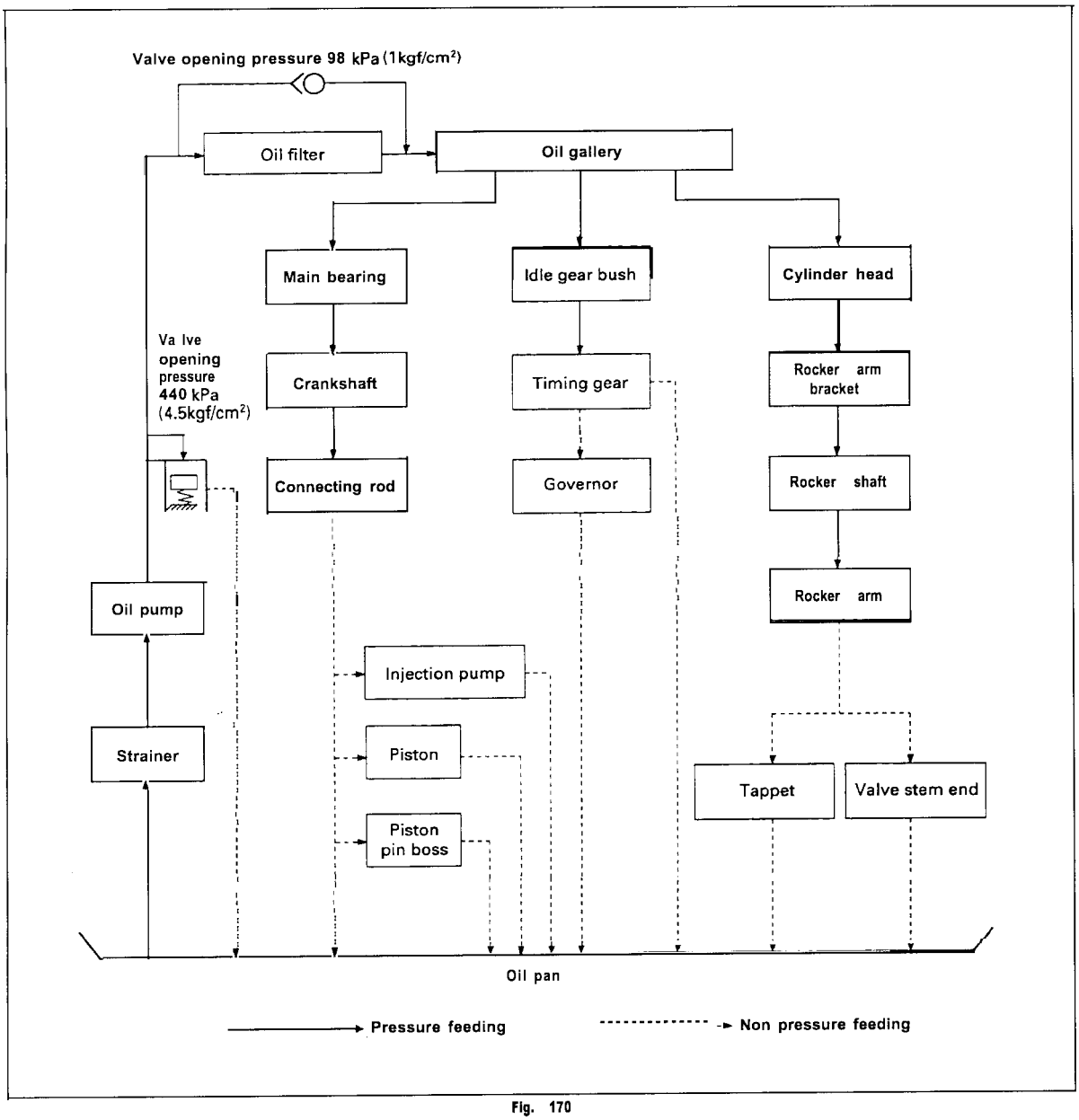

Fig. 170

OIL PUMP

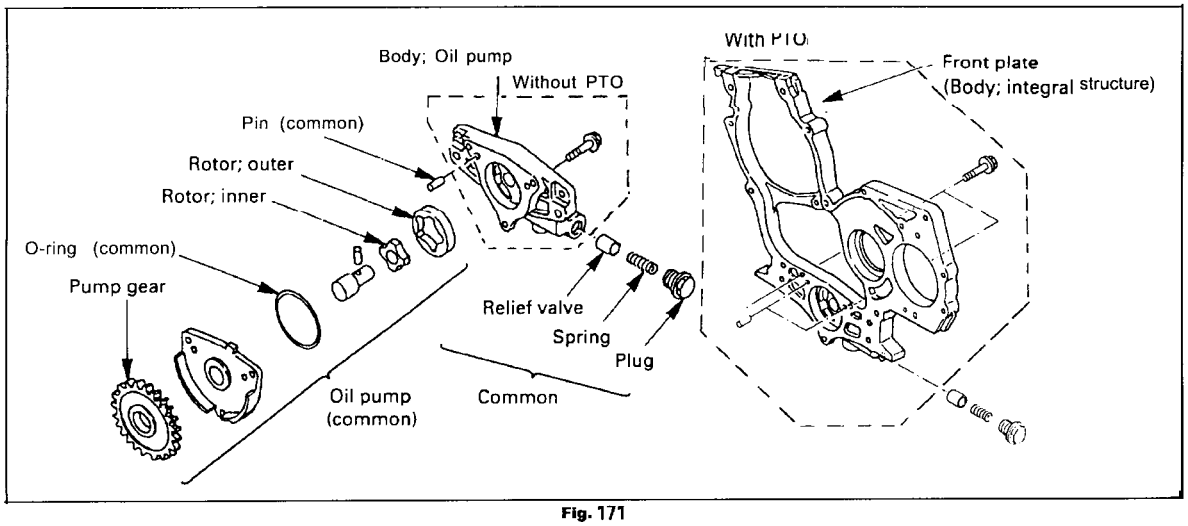

Fig. 171

Inspection and replacement

When there is wear, damages or any other defects found, repair or replace the rotor.

Clearance between the outer rotor or inner rotor and the pump cover

mm (in)

Standard	Limit
0.040 – 0.085 (0.0016 – 0.0033)	0.15 (0.0059)

Clearance between the periphery of the outer rotor and the pump body

mm (in)

Standard	Limit
0.10 – 0.185 (0.0039 – 0.0073)	0.4 (0.0157)

Clearance between the inner rotor and the outer rotor

mm (in)

Standard	Limit
0.17 (0.0067)	0.2 (0.0079)

SECTION 4

COOLING- SYSTEM

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COOLING WATER CIRCULATION SYSTEM DIAGRAM

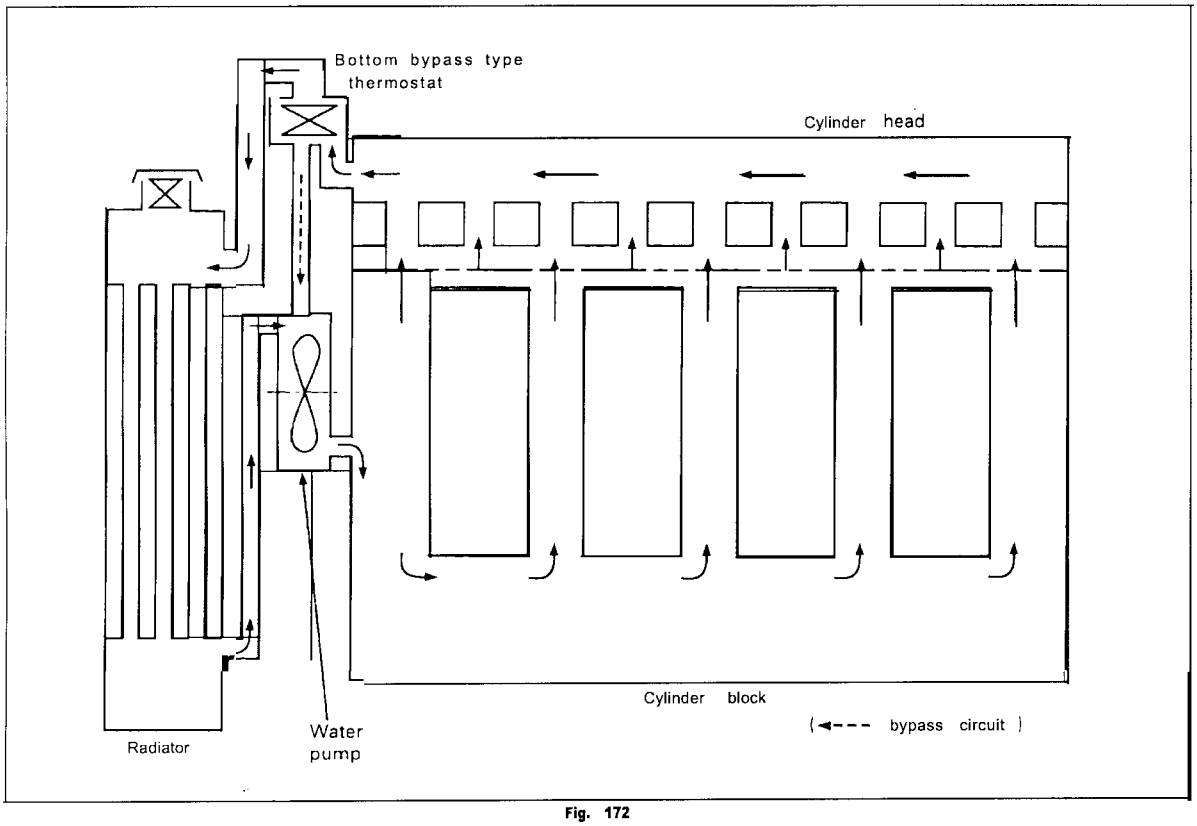
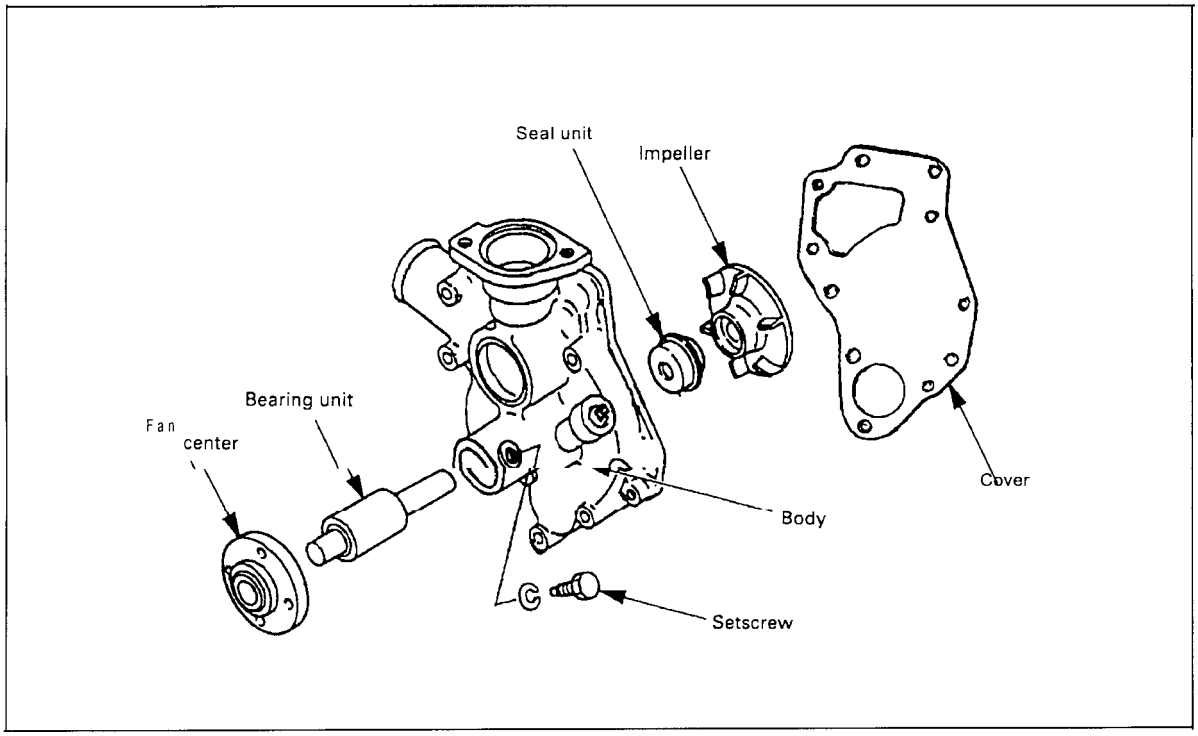


Fig. 172

WATER PUMP

DISASSEMBLY



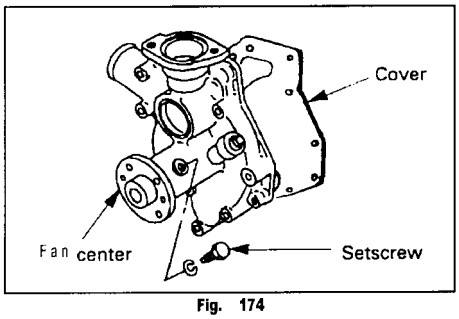


Fig. 174

Fan center
Cover
1 . Loosen the set screw.
2. Remove the cover.
Note:
The cover is applied with sealant (TB1207B). When removing the cover, much care should be taken not to deform it by applying an excessive force to it.

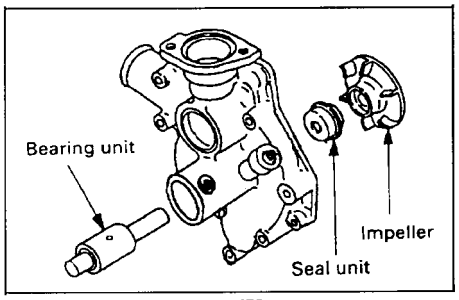


Fig. 175

Impeller
Seal unit
Bearing unit

REASSEMBLY

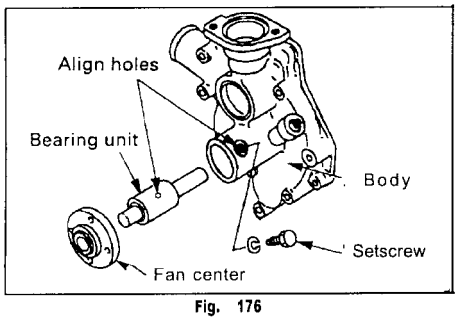


Fig. 176

Bearing unit
With a hole in the bearing unit set in line with one in the body, lock the bearing unit with a setscrew.

N·m (kgf·m/ft. lb)

Set screw tightening torque	8 - 12 (0.8 – 1.2 / 6 – 9)

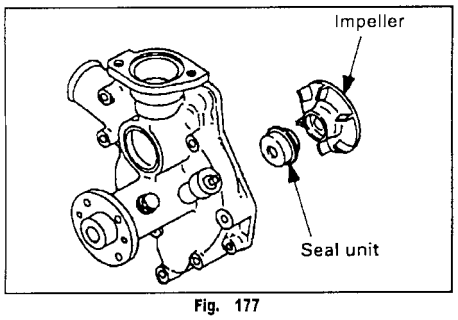


Fig. 177

Seal unit
Impeller
1 . Apply BELCO bond No. 4 to the surface where the seal unit comes into contact with the body, and then assemble the seal unit.
2 . Press in the impeller with a press until the clearance between the pump impeller and the body gets to the specified value.

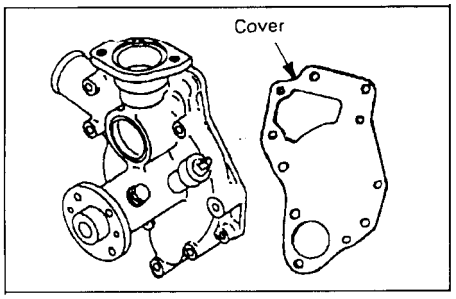


Fig. 178

Cover
1. Apply sealant to the surface to which the cover is installed, and then install the cover.
2. Apply Screw-lock to the cover installation screws, and then tighten them.

Clearance, play and tightening allowance between parts
1. Clearance between the pump impeller and the body

mm (in)

Standard	0.53 – 2.17 (0.0209 – 0.0854)

2. Play in the water pump ball bearing

mm (in)

Standard	Limit
IO.008 – 0.010 (0.0003 – 0.0004)	0.2 (0.0079)

3. Tightening allowance between the fan center and the bearing shaft

mm (in)

Standard	0.026 – 0.061 (0.001 – 0.0024)

THERMOSTAT

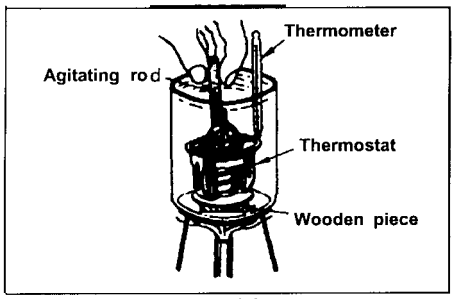


Fig. 179

Inspection and replacement
Replace the thermostat when there is wear, damages or any other defects found.

Opening temp.	80.5 – 83.5°C (177 – 182°F)
Valve lift mm (in.)	8mm or more at 95°C (0.31 inch or more at 203°F)

SECTION 5

FUEL SYSTEM

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FUEL CIRCULATION SYSTEM DIAGRAM

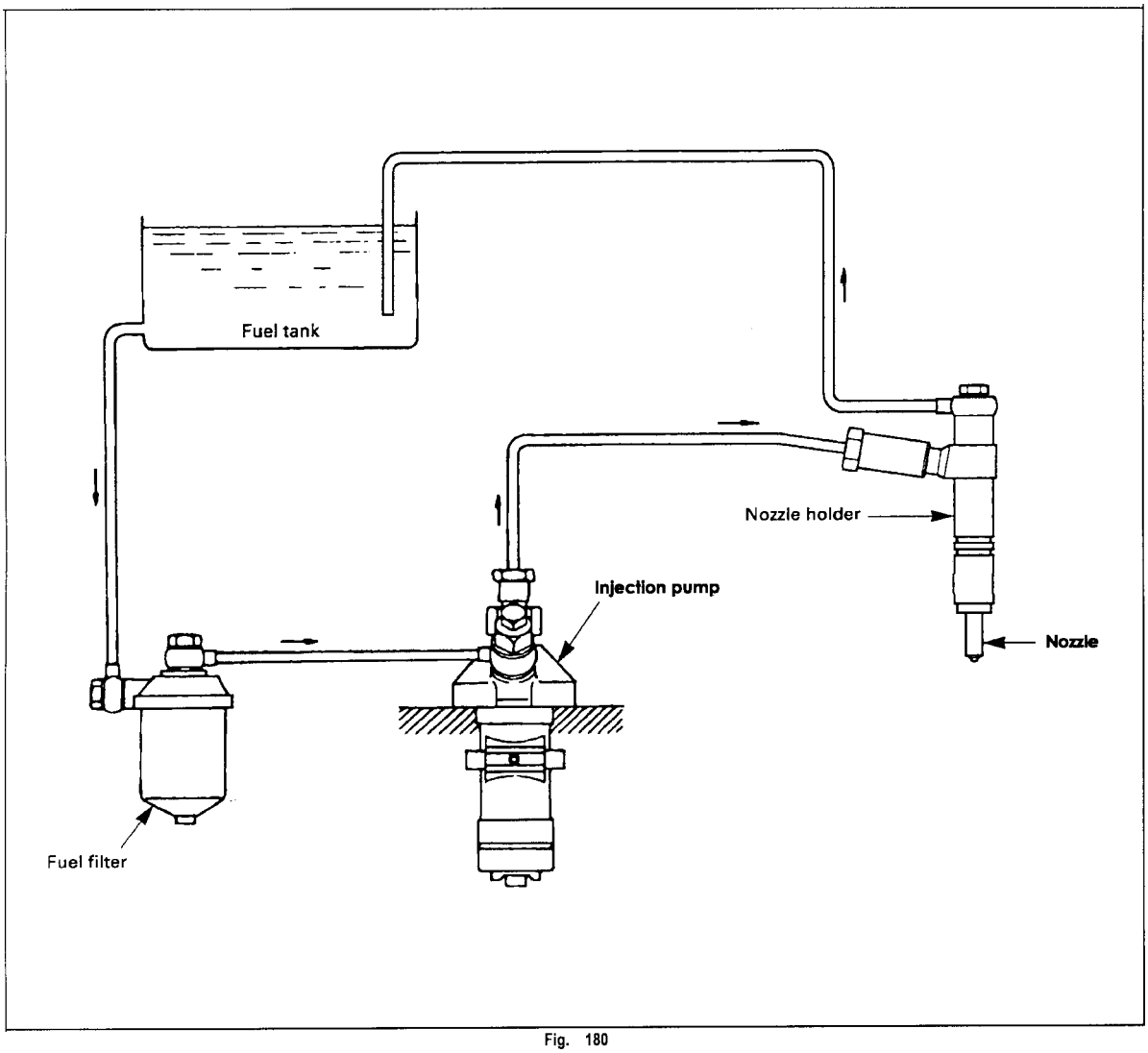


Fig. 180

GOVERNOR

1. The adjustments of the governor-related parts require the engine performance test.

2. Before disassembling the governor, measure the dimensions “A” and “B” given in the structural drawing to ensure the same dimensions in reassembly.

3 . Do not disassemble the governor when the performance test cannot be conducted after reassembly.

1. STRUCTURAL DRAWING OF GOVERNOR (1)

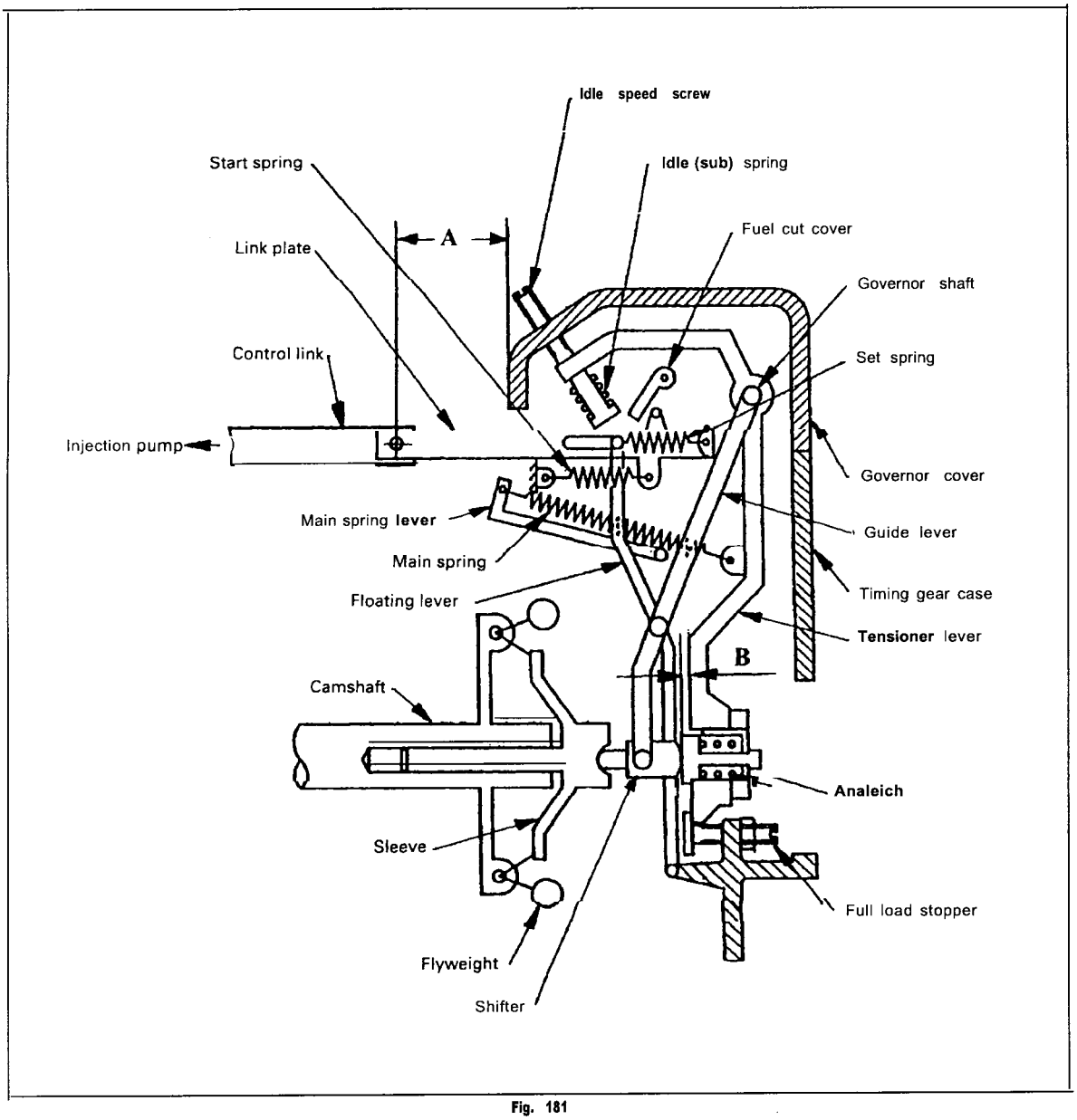


Fig. 181

2. STRUCTURAL DRAWING OF GOVERNOR (2)

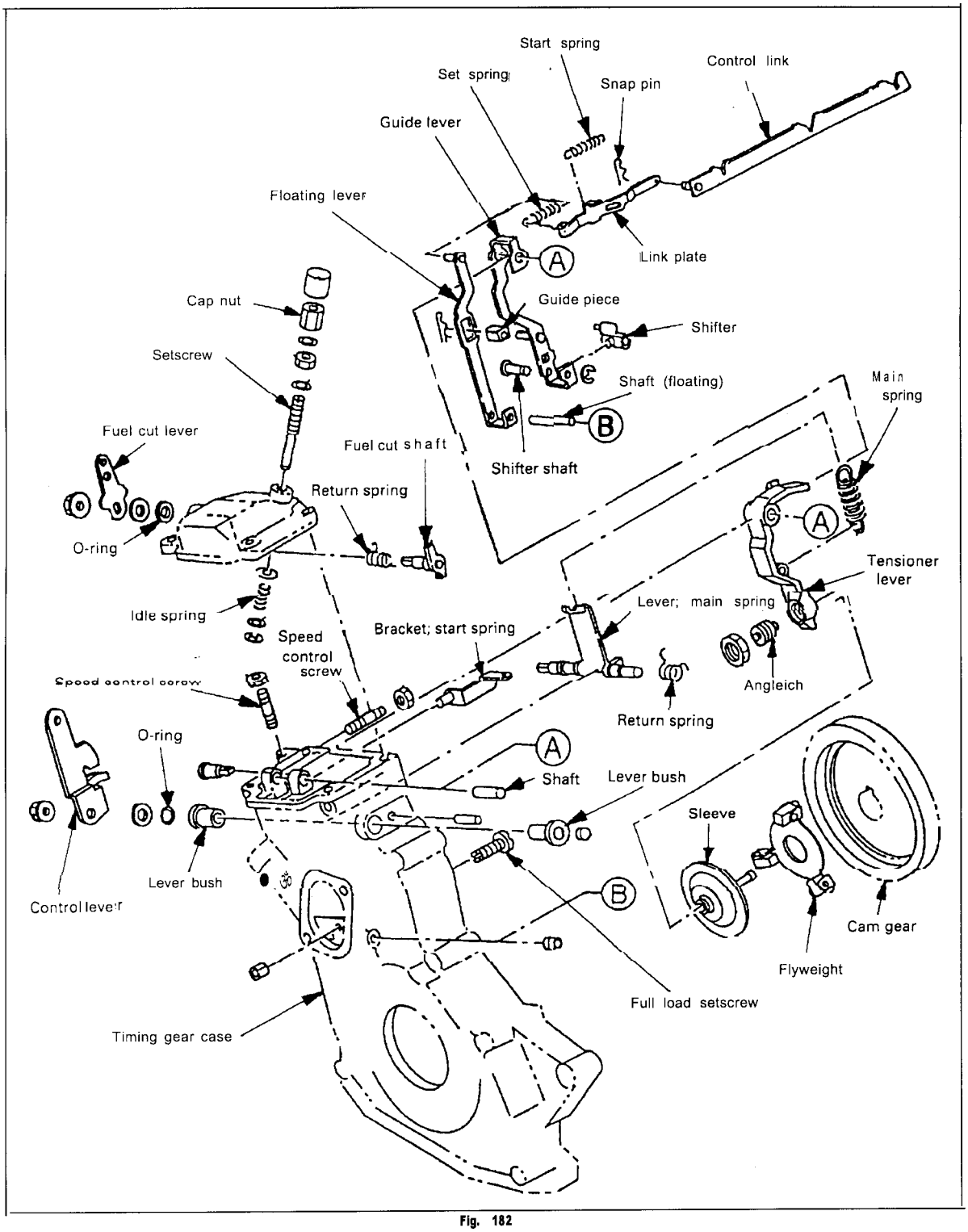


Fig. 182

3. REASSEMBLY OF CONTROL LEVER RELATED PARTS

(I) Put the lever (main spring) through the hole of the timing gear case lever.

Note:
Before hammering in the bushes, put both shafts of the lever through the holes of the timing gear case lever respectively.

(2) Put the return spring of the control lever through the shalt of the lever (main spring).
(3) Assemble the bushes.
Assemble the bush of the lever (main spring) first, and then the control lever bush.

Note:
When assembling the bushes, apply Loctite (#601) to the periphery of the bushes.

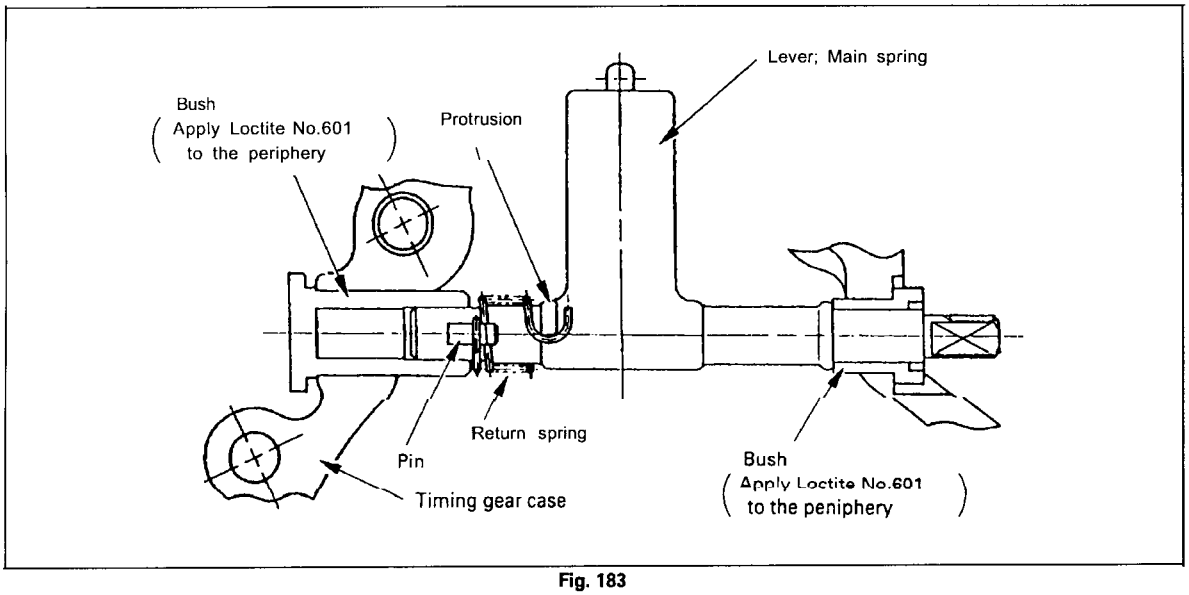


Fig. 183

(4) Hook both ends of the return spring (control lever) securely to the protrusion and the pin of the lever (main spring) respectively.

(5) Assemble the control lever.

Assemble the O-ring to the groove of the bushes (control lever) first, and then assemble the washers and the control lever before tightening up the control lever with a nut.

N·m (kgf·m/ft. lb)

Control lever tightening torque	12 - 18 (1.2 – 1.8 / 9 – 13)

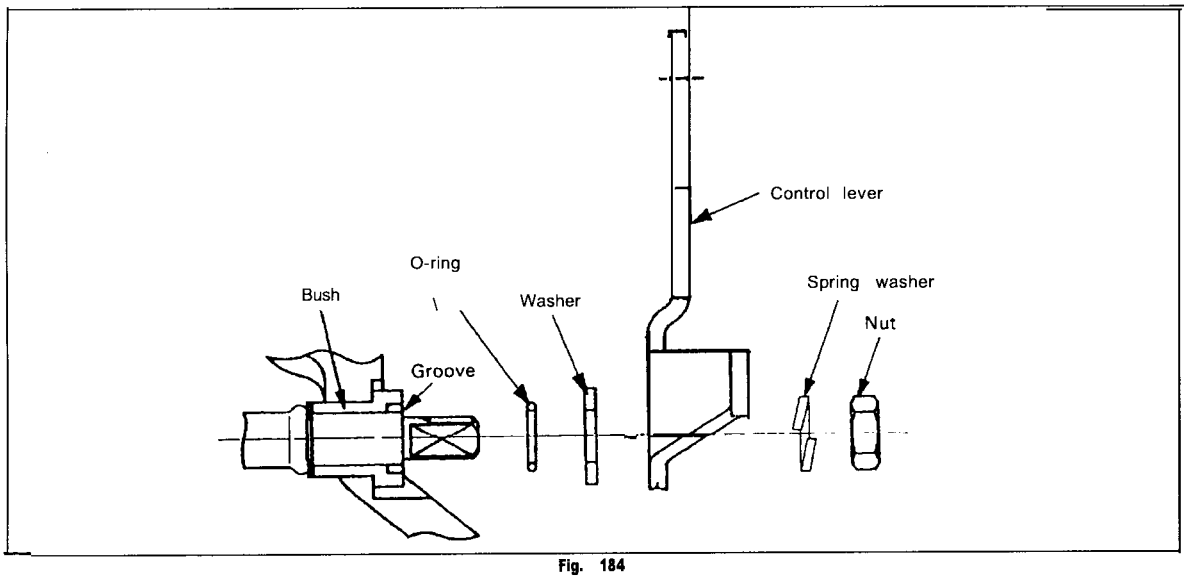


Fig. 184

Notes:

1.Tighten the control lever after locking the control lever firmly.
(Do not tighten the control lever after locking the main spring lever.)

2. After assembly, confirm that the control lever moves smoothly.

4. Reassembly of shifter

(I) Assemble the shifter to the guide lever, put the shaft through it, and then assemble the snap ring.
(2) After assembly, confirm that the shaft moves smoothly.
(3) Also, confirm that the shifter shakes smoothly.

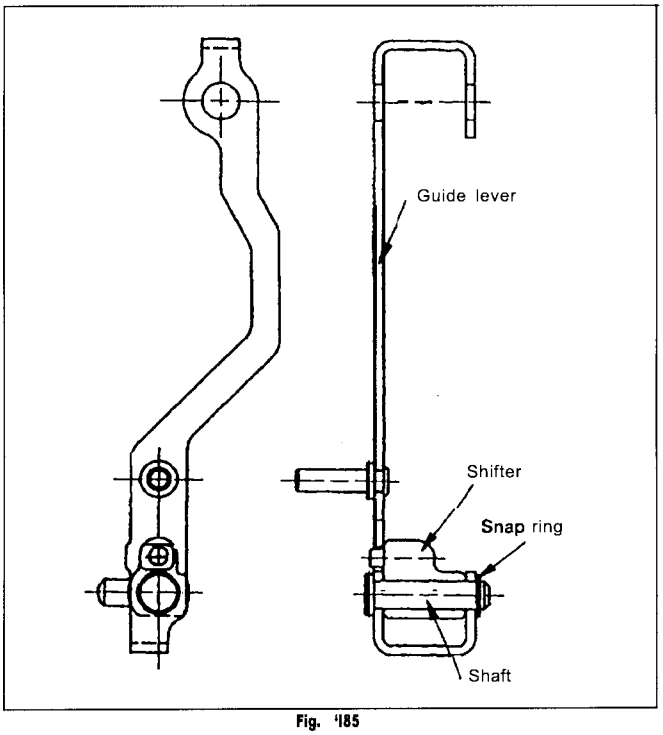


Fig. '185

5. Reassembly of governor cover

Assemble the related parts such as the fuel cut lever and the idle spring to the governor cover.

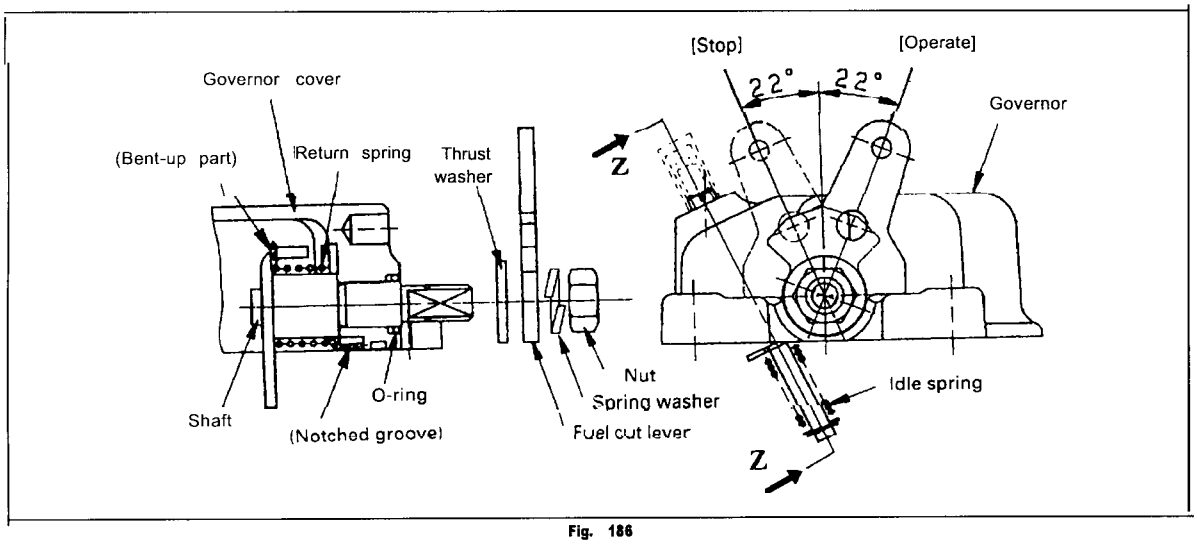


Fig. 186

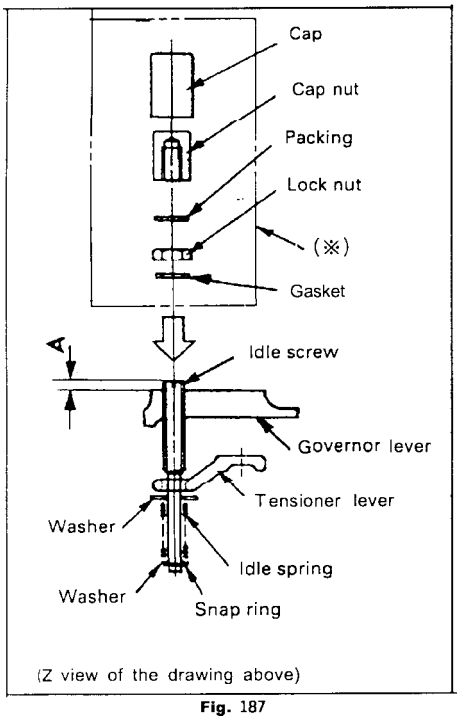


Fig. 187

(I) When assembling the shaft, apply engine oil to the sliding portion with the governor cover.
(2) Set both ends of the return spring securely to the notched groove at the bottom of the cover and the bent-up arm of the lever respectively.
(3) After reassembling the governor cover, confirm that the governor moves smoothly.
(4) When assembling the timing gear case to the governor cover, tighten the “A” dimension shown in the illustration to 2 - 3 mm temporarily.
The parts given in the square indicated by (*) are assembled after performance test.

mm (in)

“A” dimension	(When assembling temporarily) 2 – 3 (0.0787 – 0.0118)

6. Reassembly of full-load stopper

Install the full-load stopper to the timing gear case, and then tighten it with a nut temporarily.

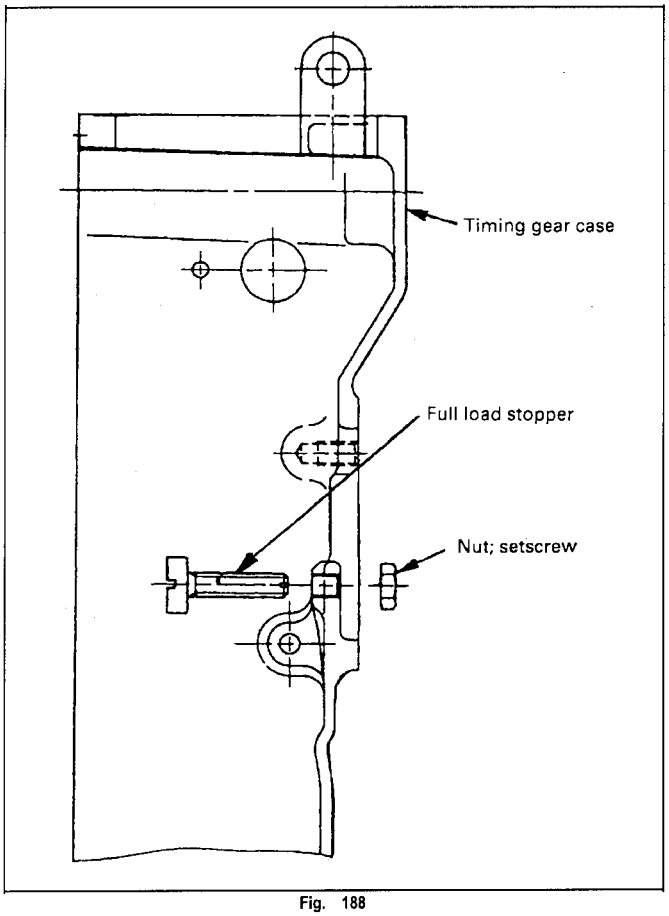


Fig. 188

7. Reassembly of governor lever related components

Assemble each lever and spring to the timing gear case.

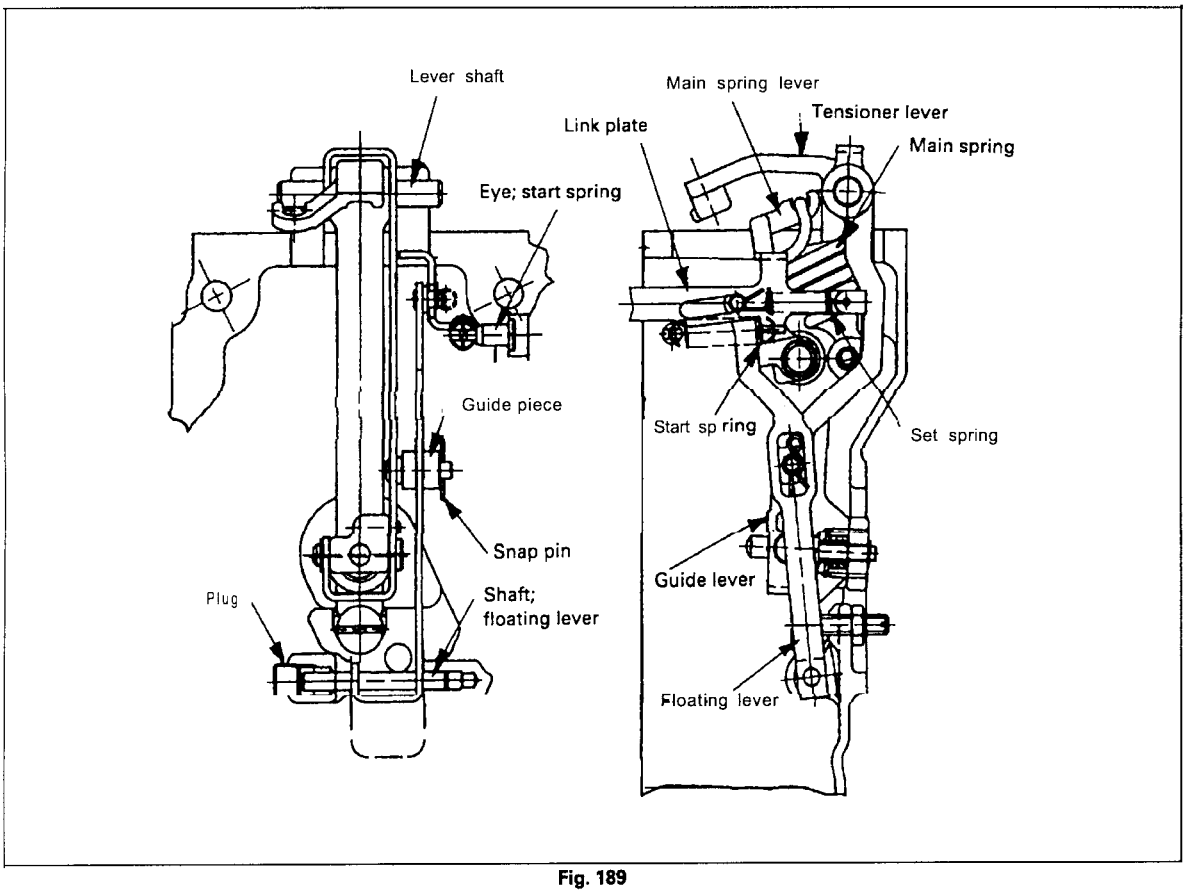


Fig. 189

8. Notes when assembling governor related components

(I) When assembling components, apply engine oil to each slide (such as the end face of the lever, the hole in the shaft, and the periphery of the shaft).
(2) Install the set spring securely to the groove of the pin connecting the floating lever, with much care to its assembling direction.
(3) Confirm that each lever moves by its dead weight before installing the start spring.
(4) After assembly, confirm that each lever moves smoothly.
and also confirm that each spring operates properly.

NOZZLE HOLDER ASSEMBLY

DISASSEMBLY

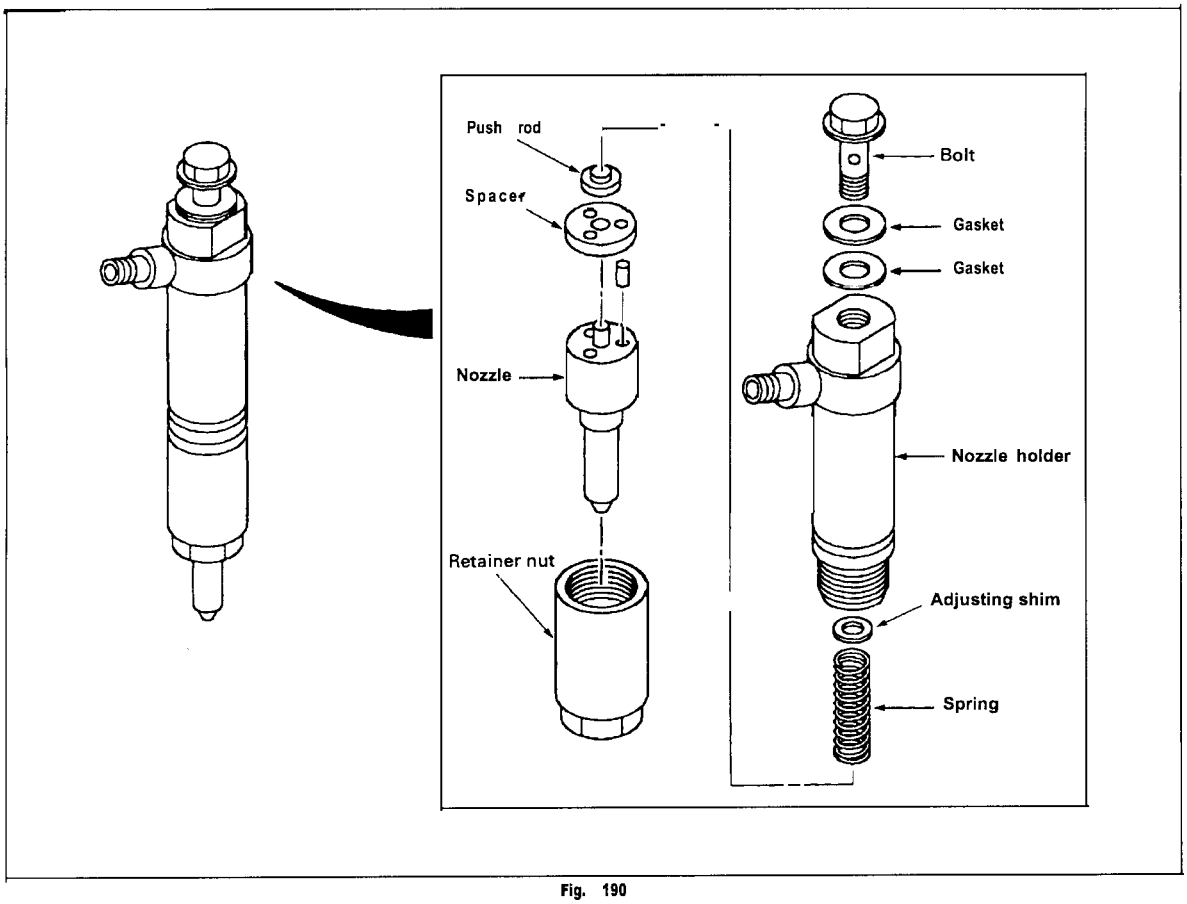


Fig. 190

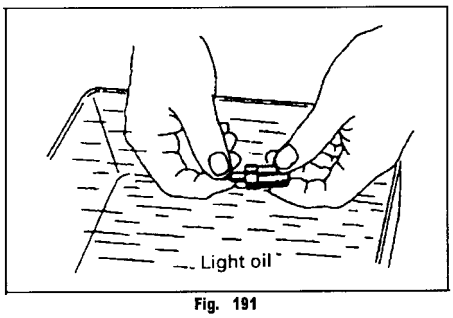


Fig. 191

NOZZLE ASSEMBLY

Inspection and replacement

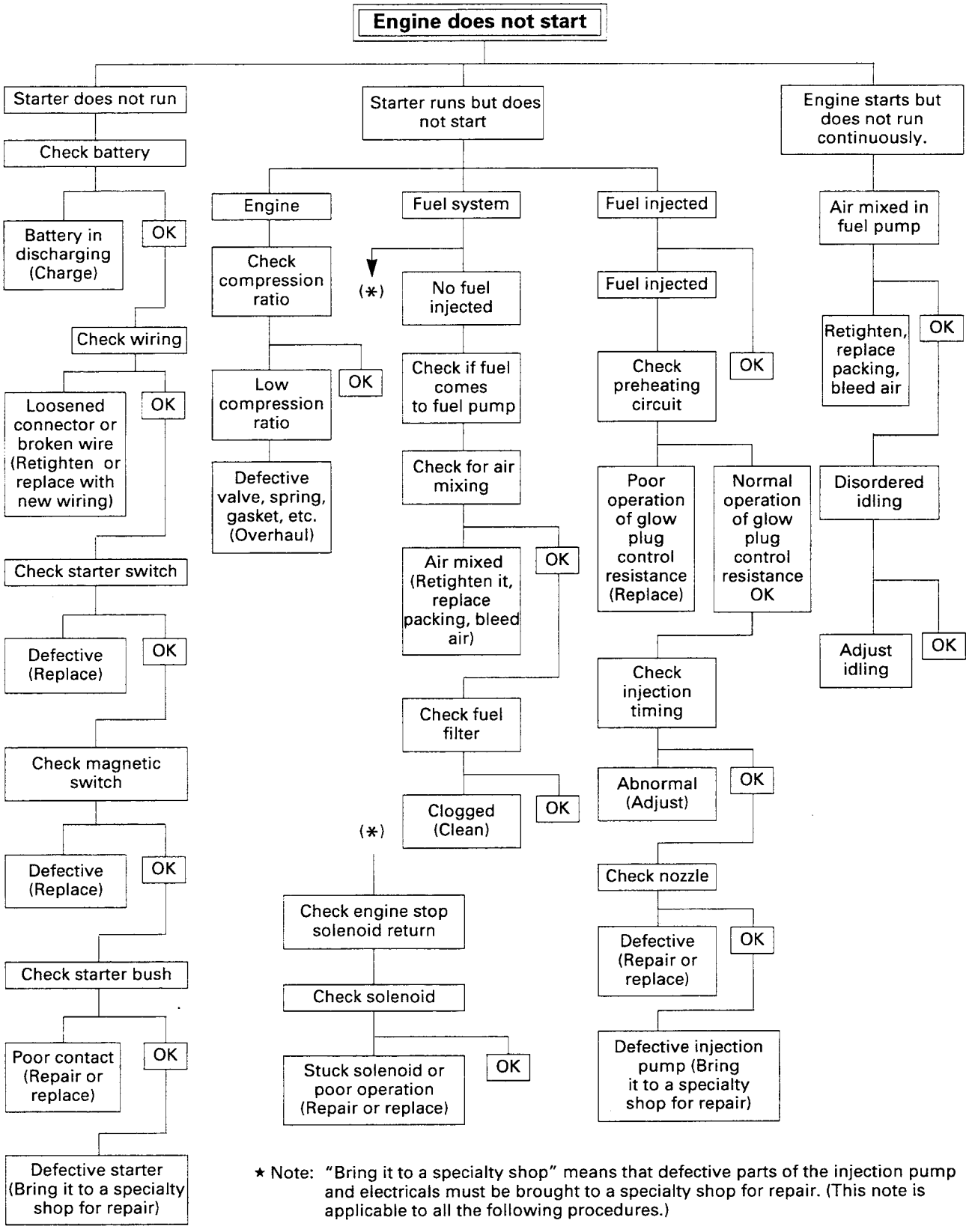
Place the removed nozzle in the clean light oil, disassemble it into the nozzle body and the needle valve and clean them thoroughly. Then check to see if the valve moves smoothly in the body.

When it does not move smoothly, repair or replace the nozzle.

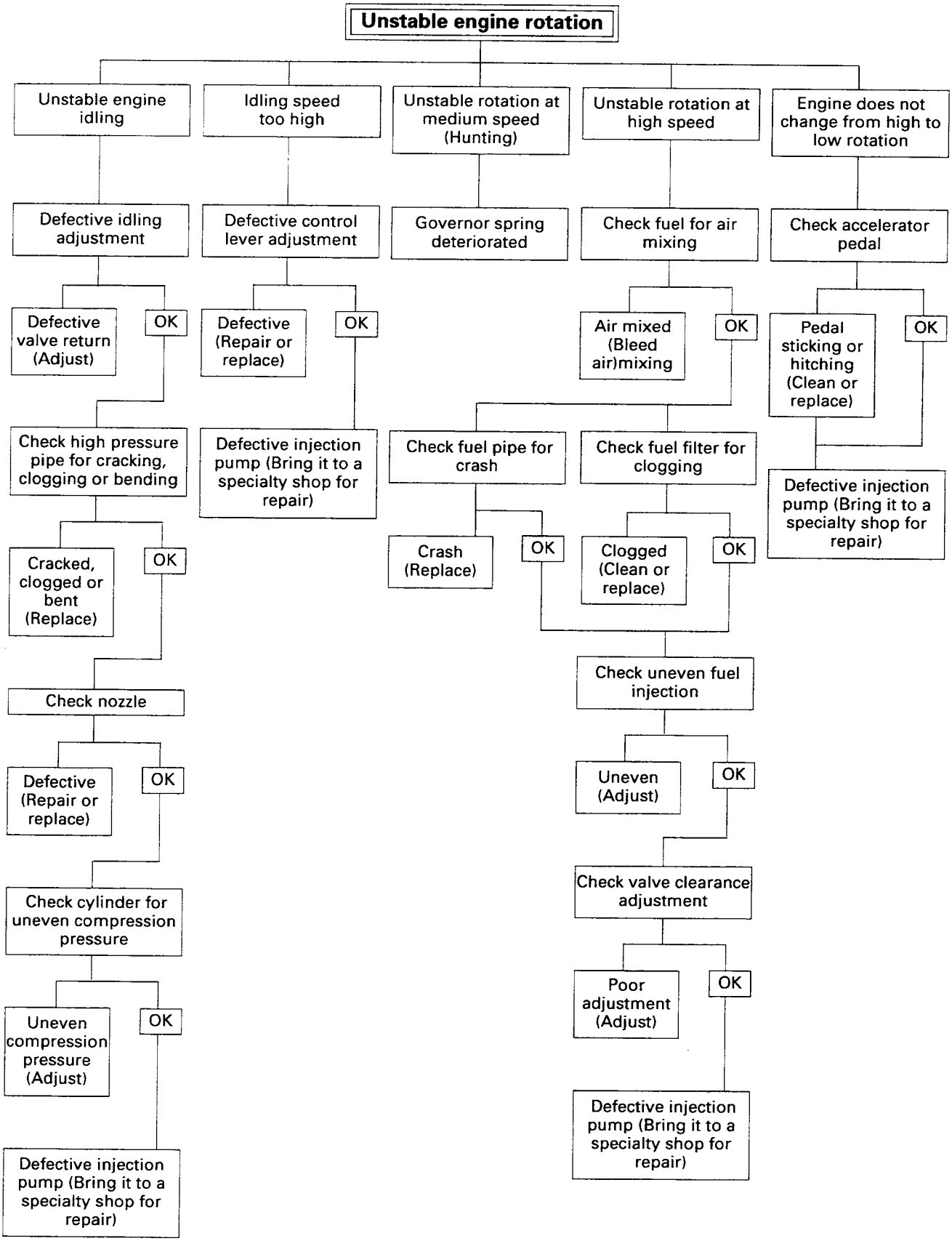
Adjustment

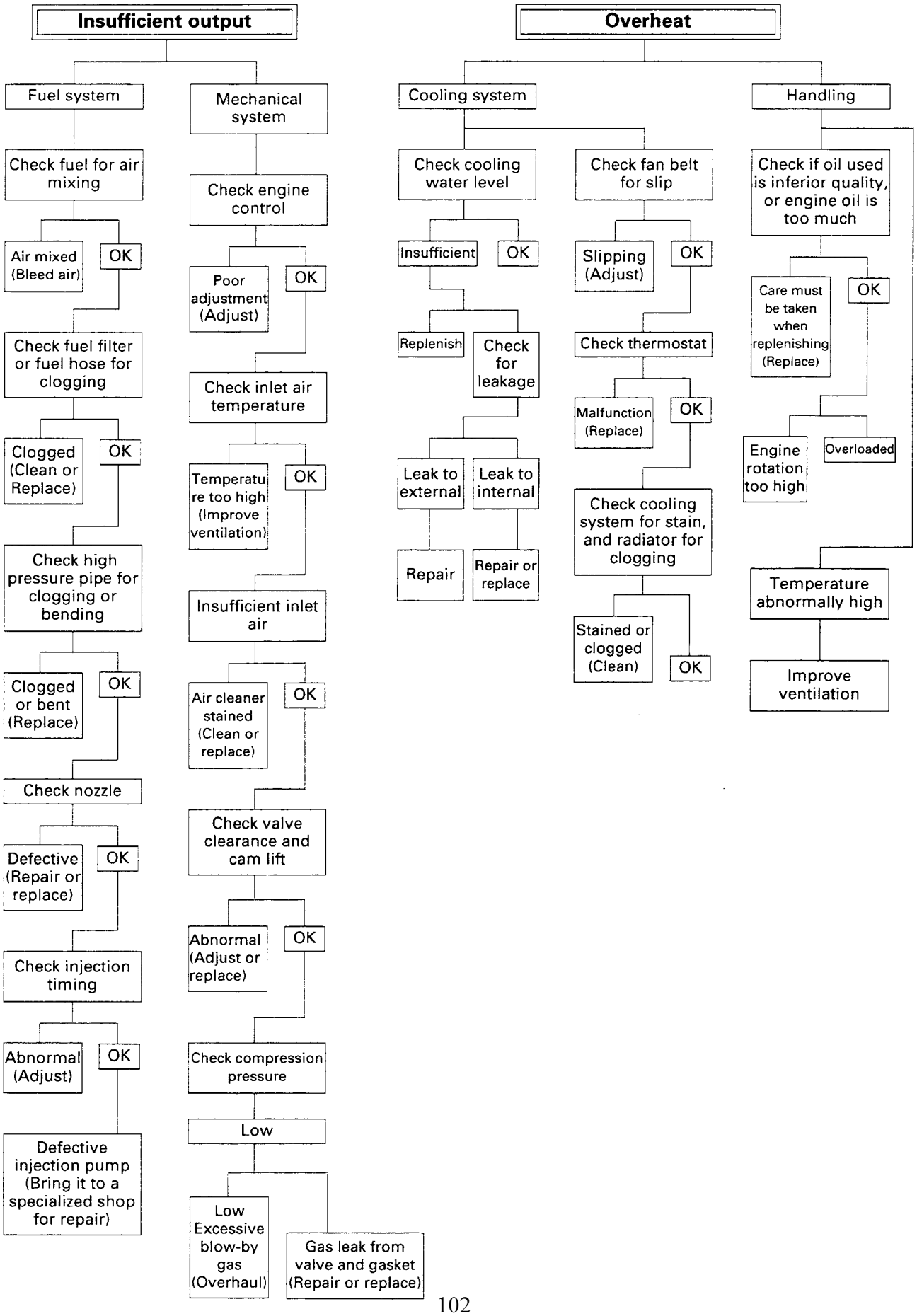
For the adjustment of the injection pressure and the spray condition of fuel, refer to **Section 1 "INSPECTION AND SERVICE."**

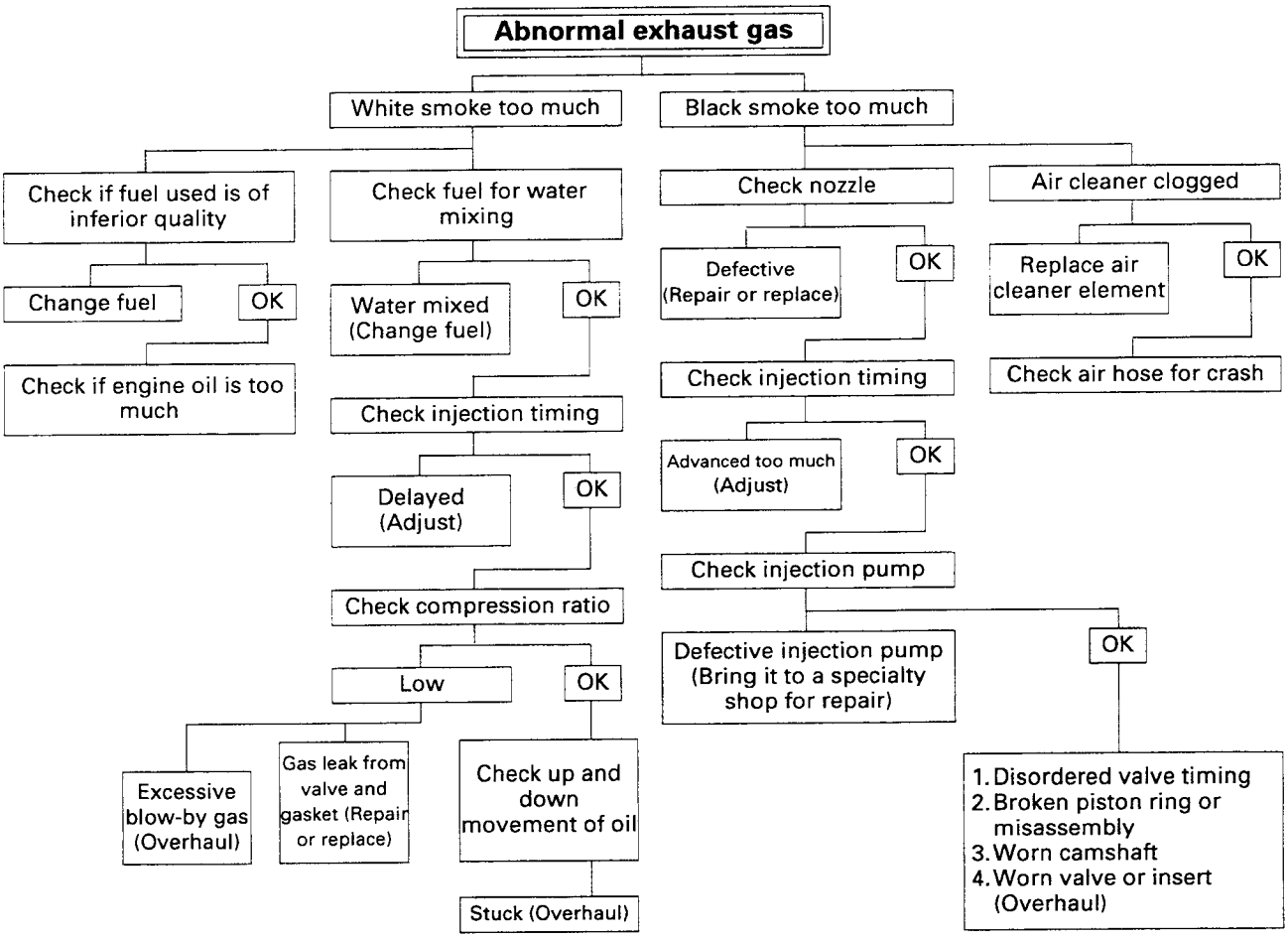
SECTION 6
TROUBLESHOOTING

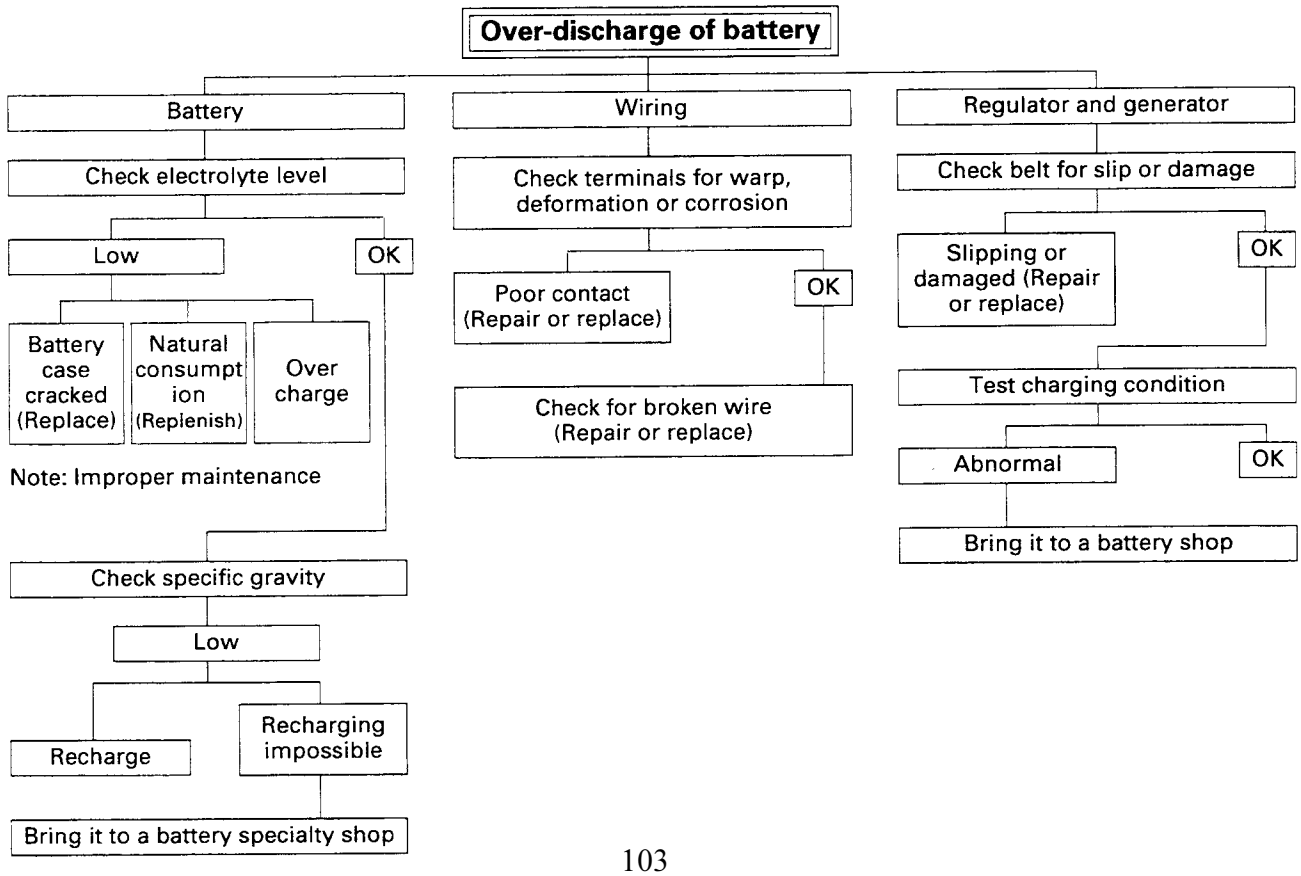


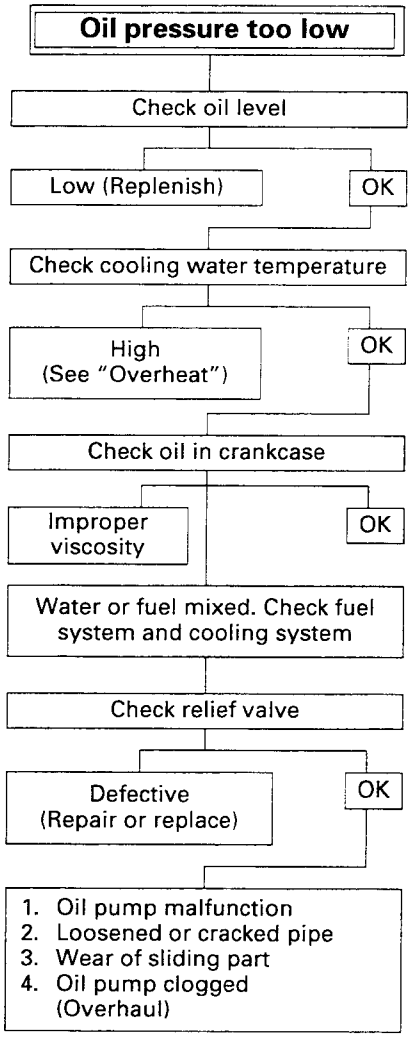
★ Note: "Bring it to a specialty shop" means that defective parts of the injection pump and electricals must be brought to a specialty shop for repair. (This note is applicable to all the following procedures.)

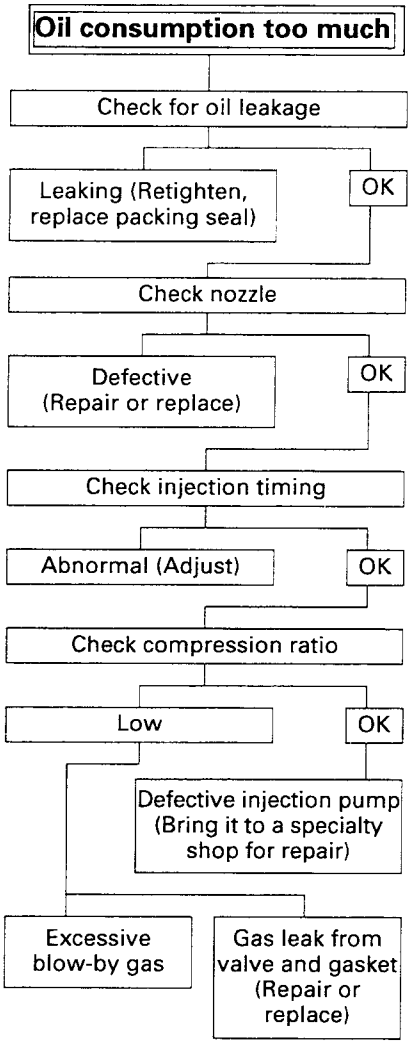

Unstable engine rotation
Unstable engine idling
Idling speed too high
Unstable rotation at medium speed (Hunting)
Unstable rotation at high speed
Engine does not change from high to low rotation
Defective idling adjustment
Defective control lever adjustment
Governor spring deteriorated
Check fuel for air mixing
Check accelerator pedal
Defective valve return (Adjust)
OK
Defective (Repair or replace)
OK
Air mixed (Bleed air)mixing
OK
Pedal sticking or hitching (Clean or replace)
OK
Check high pressure pipe for cracking, clogging or bending
Defective injection pump (Bring it to a specialty shop for repair)
Check fuel pipe for crash
Check fuel filter for clogging
Defective injection pump (Bring it to a specialty shop for repair)
Cracked, clogged or bent (Replace)
OK
Crash (Replace)
OK
Clogged (Clean or replace)
OK
Check nozzle
Check uneven fuel injection
Defective (Repair or replace)
OK
Uneven (Adjust)
OK
Check cylinder for uneven compression pressure
Check valve clearance adjustment
Uneven compression pressure (Adjust)
OK
Poor adjustment (Adjust)
OK
Defective injection pump (Bring it to a specialty shop for repair)
Defective injection pump (Bring it to a specialty shop for repair)

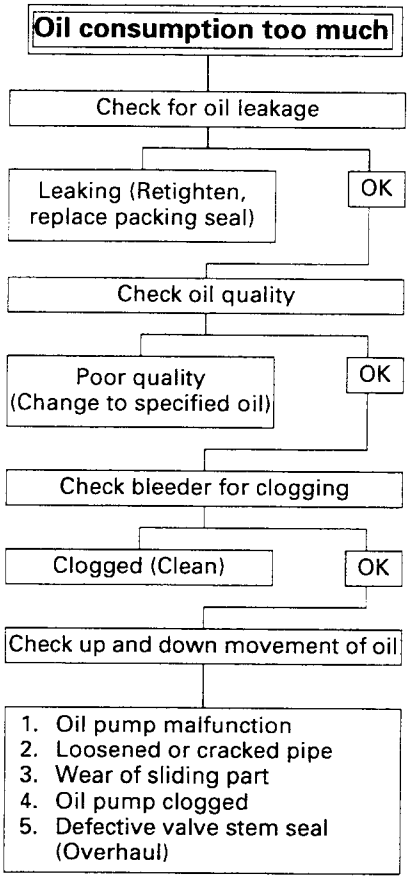

Insufficient output
Fuel system
Check fuel for air mixing
Air mixed (Bleed air)
OK
Check fuel filter or fuel hose for clogging
Clogged (Clean or Replace)
OK
Check high pressure pipe for clogging or bending
Clogged or bent (Replace)
OK
Check nozzle
Defective (Repair or replace)
OK
Check injection timing
Abnormal (Adjust)
OK
Defective injection pump (Bring it to a specialized shop for repair)
Mechanical system
Check engine control
Poor adjustment (Adjust)
OK
Check inlet air temperature
Temperatu re too high (Improve ventilation)
OK
Insufficient inlet air
Air cleaner stained (Clean or replace)
OK
Check valve clearance and cam lift
Abnormal (Adjust or replace)
OK
Check compression pressure
Low
Low Excessive blow-by gas (Overhaul)
Gas leak from valve and gasket (Repair or replace)
Overheat
Cooling system
Check cooling water level
Insufficient
OK
Replenish
Check for leakage
Leak to external
Leak to internal
Repair
Repair or replace
Check fan belt for slip
Slipping (Adjust)
OK
Check thermostat
Malfunction (Replace)
OK
Check cooling system for stain, and radiator for clogging
Stained or clogged (Clean)
OK
Handling
Check if oil used is inferior quality, or engine oil is too much
Care must be taken when replenishing (Replace)
OK
Engine rotation too high
Overloaded
Temperature abnormally high
Improve ventilation


Abnormal exhaust gas
White smoke too much
Black smoke too much
Check if fuel used is of inferior quality
Check fuel for water mixing
Check nozzle
Air cleaner clogged
Change fuel
OK
Water mixed (Change fuel)
OK
Defective (Repair or replace)
OK
Replace air cleaner element
OK
Check if engine oil is too much
Check injection timing
Check injection timing
Check air hose for crash
Delayed (Adjust)
OK
Advanced too much (Adjust)
OK
Check compression ratio
Check injection pump
Low
OK
Defective injection pump (Bring it to a specialty shop for repair)
OK
Excessive blow-by gas (Overhaul)
Gas leak from valve and gasket (Repair or replace)
Check up and down movement of oil
1. Disordered valve timing
2. Broken piston ring or misassembly
3. Worn camshaft
4. Worn valve or insert (Overhaul)
Stuck (Overhaul)

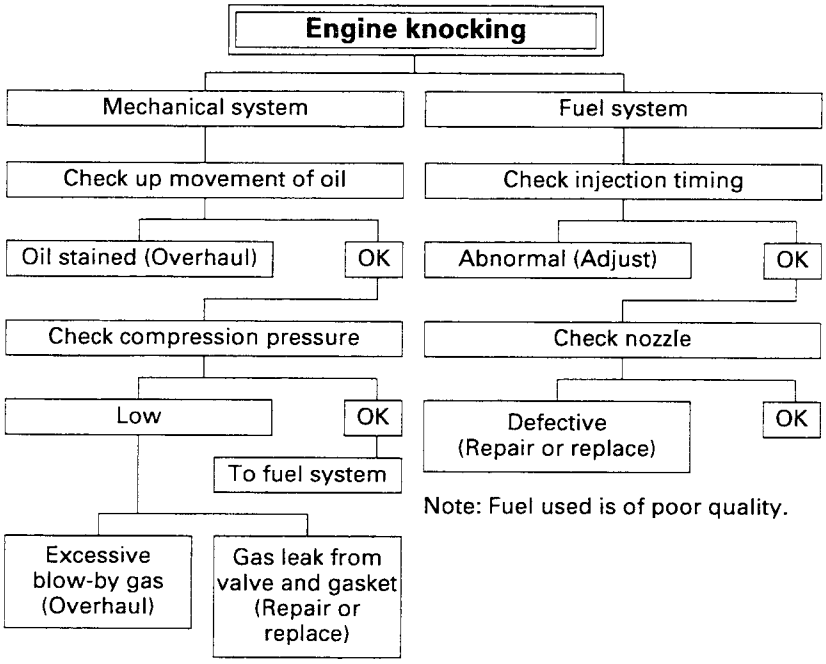

Over-discharge of battery
Battery
Wiring
Regulator and generator
Check electrolyte level
Check terminals for warp, deformation or corrosion
Check belt for slip or damage
Low
OK
Poor contact (Repair or replace)
OK
Slipping or damaged (Repair or replace)
OK
Battery case cracked (Replace)
Natural consumption (Replenish)
Over charge
Check for broken wire (Repair or replace)
Test charging condition
Abnormal
OK
Note: Improper maintenance
Bring it to a battery shop
Check specific gravity
Low
Recharge
Recharging impossible
Bring it to a battery specialty shop







(*) Worn bore,and worn or broken ring (Measure compression pressure, and check entrance of dust)



Note: Fuel used is of poor quality.

SECTION 7
CONVERSION TABLE
TABLE OF CONTENTS

MILLIMETERS TO INCHES

mm	in.	mm	in.	mm	in.	mm	in.
1	0.0394	26	1.0236	51	2.0079	76	2.9921
2	0.0787	27	1.0630	52	2.0472	77	3.0315
3	0.1181	28	1.1024	53	2.0866	78	3.0709
4	0.1575	29	1.1417	54	2.1260	79	3.1102
5	0.1969	30	1.1811	55	2.1654	80	3.1496
6	0.2362	31	1.2205	56	2.2047	81	3.1890
7	0.2756	32	1.2598	57	2.2441	82	3.2283
8	0.3150	33	1.2992	58	2.2835	83	3.2677
9	0.3543	34	1.3386	59	2.3228	84	3.3071
10	0.3937	35	1.3780	60	2.3622	85	3.3465
11	0.4331	36	1.4173	61	2.4016	86	3.3858
12	0.4724	37	1.4567	62	2.4409	87	3.4252
13	0.5118	38	1.4961	63	2.4803	88	3.4646
14	0.5512	39	1.5354	64	2.5197	89	3.5039
15	0.5906	40	1.5748	65	2.5591	90	3.5433
16	0.6299	41	1.6142	66	2.5984	91	3.5827
17	0.6693	42	1.6535	67	2.6378	92	3.6220
18	0.7087	43	1.6929	68	2.6772	93	3.6614
19	0.7480	44	1.7323	69	2.7165	94	3.7008
20	0.7874	45	1.7717	70	2.7559	95	3.7402
21	0.8268	46	1.8110	71	2.7953	96	3.7795
22	0.8661	47	1.8504	72	2.8346	97	3.8189
23	0.9055	48	1.8898	73	2.8740	98	3.8583
24	0.9449	49	1.9291	74	2.9134	99	3.8976
25	0.9843	50	1.9685	75	2.9528	100	3.9370

101	3.9764	111	4.3701	121	4.7638	131	5.1575
102	4.0157	112	4.4094	122	4.8031	132	5.1968
103	4.0551	113	4.4488	123	4.8425	133	5.2362
104	4.0945	114	4.4882	124	4.8819	134	5.2756
105	4.1339	115	4.5276	125	4.9213	135	5.3150
106	4.1732	116	4.5669	126	4.9606	136	5.3543
107	4.2126	117	4.6063	127	5.0000	137	5.3937
108	4.2520	118	4.6457	128	5.0394	138	5.4331
109	4.2913	119	4.6850	129	5.0787	139	5.4724

INCHES TO MILLIMETERS

in.			mm	in.			mm
		1/64	0.3969			33/64	13.0969
	1/32		0.7938		17/32		13.4938
		3/64	1.1906			35/64	13.8906
1/16			1.5875	9/16			14.2875
		5/64	1.9844			37/64	14.6844
	3/32		2.3813		19/32		15.0813
		7/64	2.7781			39/64	15.4781
1/8			3.1750	5/8			15.8750
		9/64	3.5719			41/64	16.2719
	5/32		3.9688		21/32		16.6688
		11/64	4.3656			43/64	17.0656
3/16			4.7625	11/16			17.4625
		13/64	5.1594			45/64	17.8594
	7/32		5.5563		23/32		18.2563
		15/64	5.9531			47/64	18.6531
1/4			6.3500	3/4			19.0500
		17/64	6.7469			49/64	19.4469
	9/32		7.1438		25/32		19.8438
		19/64	7.5406			51/64	20.2406
5/16			7.9375	13/16			20.6375
		21/64	8.3344			53/64	21.0344
	11/32		8.7313		27/32		21.4313
		23/64	9.1281			55/64	21.8281
3/8			9.5250	7/8			22.2250
		25/64	9.9219			57/64	22.6219
	13/32		10.3188		29/32		23.0188
		27/64	10.7156			59/64	23.4156
7/16			11.1125	15/16			23.8125
		29/64	11.5094			61/64	24.2094
	15/32		11.9063		31/32		24.6063
		31/64	12.3031			63/64	25.0031
1/2			12.7000	1			25.4000

CONVERSION TABLE

LENGTH

FEET TO METERS

ft.	0	1	2	3	4	5	6	7	8	9	ft.
	m	m	m	m	m	m	m	m	m	m	
	—	0.305	0.610	0.914	1.219	1.524	1.829	2.134	2.438	2.743	—
10	3.048	3.353	3.658	3.962	4.267	4.572	4.877	5.182	5.486	5.791	10
20	6.096	6.401	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839	20
30	9.144	9.449	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887	30
40	12.192	12.497	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935	40
50	15.240	15.545	15.850	16.154	16.459	16.764	17.069	17.374	17.678	17.983	50
60	18.288	18.593	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031	60
70	21.336	21.641	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079	70
80	24.384	24.689	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127	80
90	27.432	27.737	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175	90
100	30.480	30.785	31.090	31.394	31.699	32.004	32.309	32.614	32.918	33.223	100

METERS TO FEET

m	0	1	2	3	4	5	6	7	8	9	
	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	
—	—	3.2808	6.5617	9.8425	13.1234	16.4042	19.6850	22.9659	26.2467	29.5276	
10	32.8084	36.0892	39.3701	42.6509	45.9318	49.2126	52.4934	55.7743	59.0551	62.3360	10
20	65.6168	68.8976	72.1785	75.4593	78.7402	82.0210	85.3018	88.5827	91.8635	95.1444	20
30	98.4252	101.7060	104.9869	108.2677	111.5486	114.8294	118.1102	121.3911	124.6719	127.9528	30
40	131.2336	134.5144	137.7953	141.0761	144.3570	147.6378	150.9186	154.1995	157.4803	160.7612	40
50	164.0420	167.3228	170.6037	173.8845	177.1654	180.4462	183.7270	187.0079	190.2887	193.5696	50
60	196.8504	200.1312	203.4121	206.6929	209.9738	213.2546	216.5354	219.8163	223.0971	226.3780	60
70	229.6588	232.9396	236.2205	239.5013	242.7822	246.0630	249.3438	252.6247	255.9055	259.1864	70
80	262.4672	265.7480	269.0289	272.3097	275.5906	278.8714	282.1522	285.4331	288.7139	291.9948	80
90	295.2756	298.5564	301.8373	305.1181	308.3990	311.6798	314.9606	318.2415	321.5223	324.8032	90
100	328.0840	331.3648	334.6457	337.9265	341.2074	344.4882	347.7690	351.0499	354.3307	357.6116	100

MILES TO KILOMETERS

miles	0	1	2	3	4	5	6	7	8	9	
	km	km	km	km	km	km	km	km	km	km	
		1.609	3.219	4.828	6.437	8.047	9.656	11.265	12.875	14.484	—
10	16.093	17.703	19.312	20.921	22.531	24.140	25.750	27.359	28.968	30.578	10
20	32.187	33.796	35.406	37.015	38.624	40.234	41.843	43.452	45.062	46.671	20
30	48.280	49.890	51.499	53.108	54.718	56.327	57.936	59.546	61.155	62.764	30
40	64.374	65.983	67.592	69.202	70.811	72.420	74.030	75.639	77.249	78.858	40
50	80.467	82.077	83.686	85.295	86.905	88.514	90.123	91.733	93.342	94.951	50
60	96.561	98.170	99.779	101.389	102.998	104.607	106.217	107.826	109.436	111.045	60
70	112.654	114.263	115.873	117.482	119.091	120.701	122.310	123.919	125.529	127.138	70
80	128.748	130.357	131.966	133.576	135.185	136.794	138.404	140.013	141.622	143.232	80
90	144.841	146.450	148.060	149.669	151.278	152.888	154.497	156.106	157.716	159.325	90
100	160.934	162.544	164.153	165.762	167.372	168.981	170.590	172.200	173.809	175.418	100

KILOMETERS TO MILES

km	0	1	2	3	4	5	6	7	8	9	
	miles	miles	miles	miles	miles	miles	miles	miles	miles	miles	
		0.621	1.243	1.864	2.485	3.107	3.728	4.350	4.971	5.592	
10	6.214	6.835	7.456	8.078	8.699	9.321	9.942	10.563	11.185	11.806	10
20	12.427	13.049	13.670	14.292	14.913	15.534	16.156	16.777	17.398	18.020	20
30	18.641	19.262	19.884	20.505	21.127	21.748	22.369	22.991	23.612	24.233	30
40	24.855	25.476	26.098	26.719	27.340	27.962	28.583	29.204	29.826	30.447	40
50	31.069	31.690	32.311	32.933	33.554	34.175	34.797	35.418	36.039	36.661	50
60	37.282	37.904	38.525	39.146	39.768	40.389	41.010	41.632	42.253	42.875	60
70	43.496	44.117	44.738	45.360	45.981	46.603	47.224	47.845	48.467	49.088	70
80	49.710	50.331	50.952	51.574	52.195	52.816	53.438	54.059	54.681	55.302	80
90	55.923	56.545	57.166	57.787	58.408	59.030	59.652	60.273	60.894	61.516	90
100	62.137	62.758	63.380	64.001	64.622	65.244	65.865	66.487	67.108	67.729	100

AREA

SQUARE INCHES TO SQUARE CENTIMETERS

in²	0	1	2	3	4	5	6	7	8	9	in²
	cm²	cm²	cm²	cm²	cm²	cm²	cm²	cm²	cm²	cm²	
		6.452	12.903	19.355	25.806	32.258	38.710	45.161	51.613	58.064	—
10	64.516	70.968	77.419	83.871	90.322	96.774	103.226	109.677	116.129	122.580	10
20	129.032	135.484	141.935	148.387	154.839	161.290	167.742	174.193	180.645	187.096	20
30	193.548	200.000	206.451	212.903	219.354	225.806	232.258	238.709	245.161	251.612	30
40	258.064	264.516	270.967	277.419	283.870	290.322	296.774	303.225	309.677	316.128	40
50	322.580	329.032	335.483	341.935	348.386	354.838	361.290	367.741	374.193	380.644	50
60	387.096	393.548	399.999	406.451	412.902	419.354	425.806	432.257	438.709	445.160	60
70	451.612	458.064	464.515	470.967	477.418	483.870	490.322	496.773	503.225	509.676	70
80	516.128	522.580	529.031	535.483	541.934	548.386	554.838	561.289	567.741	574.192	80
90	580.644	587.096	593.547	599.999	606.450	612.902	619.354	625.805	632.257	638.708	90
100	645.160	651.612	658.063	664.515	670.966	677.418	683.870	690.321	696.773	703.224	100

SQUARE CENTIMETERS TO SQUARE INCHES

cm²	0	1	2	3	4	5	6	7	8	9	cm²
	in²	in²	in²	in²	in²	in²	in²	in²	in²	in²	
—	—	0.155	0.310	0.465	0.620	0.775	0.930	1.085	1.240	1.395	—
10	1.550	1.705	1.860	2.015	2.170	2.325	2.480	2.635	2.790	2.945	10
20	3.100	3.255	3.410	3.565	3.720	3.875	4.030	4.185	4.340	4.495	20
30	4.650	4.805	4.960	5.115	5.270	5.425	5.580	5.735	5.890	6.040	30
40	6.200	6.355	6.510	6.665	6.820	6.970	7.130	7.285	7.440	7.590	40
50	7.750	7.905	8.060	8.215	8.370	8.525	8.680	8.835	8.990	9.140	50
60	9.300	9.455	9.610	9.765	9.920	10.075	10.230	10.385	10.540	10.695	60
70	10.850	11.005	11.160	11.315	11.470	11.625	11.780	11.935	12.090	12.245	70
80	12.400	12.555	12.710	12.865	13.020	13.175	13.330	13.485	13.640	13.795	80
90	13.950	14.105	14.260	14.415	14.570	14.725	14.880	15.035	15.190	15.345	90
100	15.500	15.655	15.810	15.965	16.120	16.275	16.430	16.585	16.740	16.895	100

VOLUME

CUBIC INCHES TO CUBIC CENTIMETERS

in³	0	1	2	3	4	5	6	7	8	9	in³
	cm³(cc)	cm³(cc)	cm³(cc)	cm³(cc)	cm³(cc)	cm³(cc)	cm³(cc)	cm³(cc)	cm³(cc)	cm³(cc)	
		16.387	32.774	49.161	65.548	81.935	98.322	114.709	131.097	147.484	
10	163.871	180.258	196.645	213.032	229.419	245.806	262.193	278.580	294.967	311.354	10
20	327.741	344.128	360.515	376.902	393.290	409.677	426.064	442.451	458.838	475.225	20
30	491.612	507.999	524.386	540.773	557.160	573.547	589.934	606.321	622.708	639.095	30
40	655.483	671.870	688.257	704.644	721.031	737.418	753.805	770.192	786.579	802.966	40
50	819.353	835.740	852.127	868.514	884.901	901.288	917.676	934.063	950.450	966.837	50
60	983.224	999.611	1015.998	1032.385	1048.772	1065.159	1081.546	1097.933	1114.320	1130.707	60
70	1147.094	1163.482	1179.869	1196.256	1212.643	1229.030	1245.417	1261.804	1278.191	1294.578	70
80	1310.965	1327.352	1343.739	1360.126	1376.513	1392.900	1409.288	1425.675	1442.062	1458.449	80
90	1474.836	1491.223	1507.610	1523.997	1540.384	1556.771	1573.158	1589.545	1605.932	1622.319	90
100	1638.706	1655.093	1671.481	1687.868	1704.255	1720.642	1737.029	1753.416	1769.803	1786.190	100

CUBIC CENTIMETERS TO CUBIC INCHES

cm³(cc)	0	1	2	3	4	5	6	7	8	9	cm³(cc)
	in³	in³	in³	in³	in³	in³	in³	in³	in³	in³	
-		0.0610	0.1220	0.1831	0.2441	0.3051	0.3661	0.4272	0.4882	0.5492	—
10	0.6102	0.6713	0.7323	0.7933	0.8543	0.9153	0.9764	1.0374	1.0984	1.1594	10
20	1.2205	1.2815	1.3425	1.4035	1.4646	1.5256	1.5866	1.6476	1.7086	1.7697	20
30	1.8307	1.8917	1.9527	2.0138	2.0748	2.1358	2.1968	2.2579	2.3189	2.3799	30
40	2.4409	2.5020	2.5630	2.6240	2.6850	2.7460	2.8071	2.8681	2.9291	2.9901	40
50	3.0512	3.1122	3.1732	3.2342	3.2952	3.3563	3.4173	3.4783	3.5393	3.6004	50
60	3.6614	3.7224	3.7834	3.8444	3.9055	3.9665	4.0275	4.0885	4.1496	4.2106	60
70	4.2716	4.3326	4.3937	4.4547	4.5157	4.5767	4.6377	4.6988	4.7598	4.8208	70
80	4.8818	4.9429	5.0039	5.0649	5.1259	5.1870	5.2480	5.3090	5.3700	5.4310	80
90	5.4921	5.5531	5.6141	5.6751	5.7362	5.7972	5.8582	5.9192	5.9803	6.0413	90
100	6.1023	6.1633	6.2243	6.2854	6.3464	6.4074	6.4684	6.5295	6.5905	6.6515	100

CONVERSION TABLE

VOLUME

GALLONS (U.S.) TO LITERS

U.S. gal	0	1	2	3	4	5	6	7	8	9	U.S gal.
	liters	liters	liters	liters	liters	liters	liters	liters	liters	liters	
		3.7854	7.5708	11.3562	15.1417	18.9271	22.7125	26.4980	30.2834	34.0688	
10	37.8543	41.6397	45.4251	49.2105	52.9960	56.7814	60.5668	64.3523	68.1377	71.9231	10
20	75.7085	79.4940	83.2794	87.0648	90.8502	94.6357	98.4211	102.2065	105.9920	109.7774	20
30	113.5628	117.3482	121.1337	124.9191	128.7045	132.4899	136.2754	140.0608	143.8462	147.6316	30
40	151.4171	155.2025	158.9879	162.7734	166.5588	170.3442	174.1296	177.9151	181.7005	185.4859	40
50	189.2713	193.0568	196.8422	200.6276	204.4131	208.1985	211.9839	215.7693	219.5548	223.3402	50
60	227.1256	230.9110	234.6965	238.4819	242.2673	246.0527	249.8382	253.6236	257.4090	261.1945	60
70	264.9799	268.7653	272.5507	276.3362	280.1216	283.9070	287.6924	291.4779	295.2633	299.0487	70
80	302.8342	306.6196	310.4050	314.1904	317.9759	321.7613	325.5467	329.3321	333.1176	336.9030	80
90	340.6884	344.4738	348.2593	352.0447	355.8301	359.6156	363.4010	367.1864	370.9719	374.7573	90
100	378.5427	382.3281	386.1135	389.8990	393.6844	397.4698	401.2553	405.0407	408.8261	412.6116	100

LITERS TO GALLONS (U.S.)

liters	0	1	2	3	4	5	6	7	8	9	liters
	gal	gal.	gal.	gal.	gal.	gal.	gal.	gal.	gal.	gal	
—	—	0.2642	0.5283	0.7925	1.0567	1.3209	1.5850	1.8492	2.1134	2.3775	—
10	2.6417	2.9059	3.1701	3.4342	3.6984	3.9626	4.2268	4.4909	4.7551	5.0193	10
20	5.2834	5.5476	5.8118	6.0760	6.3401	6.6043	6.8685	7.1326	7.3968	7.6610	20
30	7.9252	8.1893	8.4535	8.7177	8.9818	9.2460	9.5102	9.7744	10.0385	10.3027	30
40	10.5669	10.8311	11.0952	11.3594	11.6236	11.8877	12.1519	12.4161	12.6803	12.9444	40
50	13.2086	13.4728	13.7369	14.0011	14.2653	14.5295	14.7936	15.0578	15.3220	15.5861	50
60	15.8503	16.1145	16.3787	16.6428	16.9070	17.1712	17.4354	17.6995	17.9637	18.2279	60
70	18.4920	18.7562	19.0204	19.2846	19.5487	19.8129	20.0771	20.3413	20.6054	20.8696	70
80	21.1338	21.3979	21.6621	21.9263	22.1904	22.4546	22.7188	22.9830	23.2471	23.5113	80
90	23.7755	24.0397	24.3038	24.5680	24.8322	25.0963	25.3605	25.6247	25.8888	26.1530	90
100	26.4172	26.6814	26.9456	27.2097	27.4739	27.7381	28.0022	28.2664	28.5306	28.7947	100

GALLONS (IMP.) TO LITERS

Imp gal.	0	1	2	3	4	5	6	7	8	9	Imp gal.
	liters	liters	liters	liters	liters	liters	liters	liters	liters	liters	
—	—	4.5459	9.0918	13.6377	18.1836	22.7295	27.2754	31.8213	36.3672	40.9131	—
10	45.4590	50.0049	54.5508	59.0967	63.6426	68.1885	72.7344	77.2803	81.8262	86.3721	10
20	90.9180	95.4639	100.0098	104.5557	109.1016	113.6475	118.1934	122.7393	127.2852	131.8311	20
30	136.3770	140.9229	145.4688	150.0147	154.5606	159.1065	163.6524	168.1983	172.7442	177.2901	30
40	181.8360	186.3819	190.9278	195.4737	200.0196	204.5655	209.1114	213.6573	218.2032	222.7491	40
50	227.2950	231.8409	236.3868	240.9327	245.4786	250.0245	254.5704	259.1163	263.6622	268.2081	50
60	272.7540	277.2999	281.8458	286.3917	290.9376	295.4835	300.0294	304.5753	309.1212	313.6671	60
70	318.2130	322.7589	327.3048	331.8507	336.3966	340.9425	345.4884	350.0343	354.5802	359.1261	70
80	363.6720	368.2179	372.7638	377.3097	381.8556	386.4015	390.9474	395.4933	400.0392	404.5851	80
90	409.1310	413.6769	418.2228	422.7687	427.3146	431.8605	436.4064	440.9523	445.4982	450.0441	90
100	454.5900	459.1359	463.6818	468.2277	472.7736	477.3195	481.8654	486.4113	490.9572	495.5031	100

LITERS TO GALLONS (IMP.)

liters	0	1	2	3	4	5	6	7	8	9	liters
	gal.	gal.	gal.	gal.	gal	gal	gal.	gal.	gal.	gal.	
		0.2200	0.4400	0.6599	0.8799	1.0999	1.3199	1.5399	1.7598	1.9798	—
10	2.1998	2.4198	2.6398	2.8597	3.0797	3.2997	3.5197	3.7397	3.9596	4.1796	10
20	4.3996	4.6196	4.8396	5.0595	5.2795	5.4995	5.7195	5.9395	6.1594	6.3794	20
30	6.5994	6.8194	7.0394	7.2593	7.4793	7.6993	7.9193	8.1393	8.3592	8.5792	30
40	8.7992	9.0192	9.2392	9.4591	9.6791	9.8991	10.1191	10.3391	10.5590	10.7790	40
50	10.9990	11.2190	11.4390	11.6589	11.8789	12.0989	12.3189	12.5388	12.7588	12.9788	50
60	13.1988	13.4188	13.6388	13.8587	14.0787	14.2987	14.5187	14.7387	14.9586	15.1786	60
70	15.3986	15.6186	15.8386	16.0585	16.2785	16.4985	16.7185	16.9385	17.1584	17.3784	70
80	17.5984	17.8184	18.0384	18.2583	18.4783	18.6983	18.9183	19.1383	19.3582	19.5782	80
90	19.7982	20.0182	20.2382	20.4581	20.6781	20.8981	21.1181	21.3381	21.5580	21.7780	90
100	21.9980	22.2180	22.4380	22.6579	22.8779	23.0979	23.3179	23.5379	23.7578	23.9778	100

MASS

POUNDS TO KILOGRAMS

lbs.	0	1	2	3	4	5	6	7	8	9	lbs.
	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	
—	—	0.454	0.907	1.361	1.814	2.268	2.722	3.175	3.629	4.082	—
10	4.536	4.990	5.443	5.897	6.350	6.804	7.257	7.711	8.165	8.618	10
20	9.072	9.525	9.979	10.433	10.886	11.340	11.793	12.247	12.701	13.154	20
30	13.608	14.061	14.515	14.970	15.422	15.876	16.329	16.783	17.237	17.690	30
40	18.144	18.597	19.051	19.504	19.958	20.412	20.865	21.319	21.772	22.226	40
50	22.680	23.133	23.587	24.040	24.494	24.948	25.401	25.855	26.308	26.762	50
60	27.216	27.669	28.123	28.576	29.030	29.484	29.937	30.391	30.844	31.298	60
70	31.751	32.205	32.658	33.112	33.566	34.019	34.473	34.927	35.380	35.834	70
80	36.287	36.741	37.195	37.648	38.102	38.555	39.009	39.463	39.916	40.370	80
90	40.823	41.277	41.731	42.184	42.638	43.091	43.545	43.998	44.452	44.906	90
100	45.359	45.813	46.267	46.720	47.174	47.627	48.081	48.534	48.988	49.442	100

KILOGRAMS TO POUNDS

kg	0	1	2	3	4	5	6	7	8	9	kg
	lbs.	lbs.	lbs.	lbs.	lbs	lbs	lbs.	lbs.	lbs.	lbs	
—	—	2.205	4.409	6.614	8.818	11.023	13.228	15.432	17.637	19.842	—
10	22.046	24.251	26.455	28.660	30.865	33.069	35.274	37.479	39.683	41.888	10
20	44.092	46.297	48.502	50.706	52.911	55.116	57.320	59.525	61.729	63.934	20
30	66.139	68.343	70.548	72.753	74.957	77.162	79.366	81.571	83.776	85.980	30
40	88.185	90.390	92.594	94.799	97.003	99.208	101.413	103.617	105.822	108.026	40
50	110.231	112.436	114.640	116.845	119.050	121.254	123.459	125.663	127.868	130.073	50
60	132.277	134.482	136.687	138.891	141.096	143.300	145.505	147.710	149.914	152.119	60
70	154.324	156.528	158.733	160.937	163.142	166.347	167.551	169.756	171.960	174.165	70
80	176.370	178.574	180.779	182.984	185.188	187.393	189.597	191.802	194.007	196.211	80
90	198.416	200.621	202.825	205.030	207.234	209.439	211.644	213.848	216.053	218.258	90
100	220.462	222.667	224.871	227.076	229.281	231.485	233.690	235.895	238.099	240.304	100

KILOGRAMS TO NEWTON

kgf	0	1	2	3	4	5	6	7	8	9	kgf
	N	N	N	N	N	N	N	N	N	N	
—	—	9.81	19.61	29.42	39.23	49.03	58.84	68.65	78.45	88.26	—
10	98.07	107.87	117.68	127.49	137.29	147.10	156.91	166.71	176.52	186.33	10
20	196.13	205.94	215.75	225.55	235.36	245.17	254.97	264.78	274.59	284.39	20
30	294.20	304.01	313.81	323.62	333.43	343.23	353.04	362.85	372.65	382.46	30
40	392.27	402.07	411.88	421.68	431.49	441.30	451.11	460.91	470.72	480.53	40
50	490.33	500.14	509.95	519.76	529.56	539.37	549.17	558.98	568.79	578.59	50
60	588.40	598.21	608.01	617.82	627.63	637.43	647.24	657.05	666.86	676.66	60
70	686.47	696.27	706.08	715.89	725.69	735.50	745.31	755.11	764.92	774.73	70
80	784.53	794.34	804.15	813.95	823.76	833.57	843.37	853.18	862.99	872.79	80
90	882.60	892.41	902.21	912.02	921.83	931.63	941.44	951.25	961.05	970.86	90
100	980.67	990.47	1000.28	1010.09	1019.89	1029.70	1039.50	1049.31	1059.12	1068.92	100

NEWTON TO KILOGRAMS

N	0	10	20	30	40	50	60	70	80	90	N
	kgf	kgf	kgf	kgf	kgf	kgf	kgf	kgf	kgf	kgf	
—	—	1.020	2.039	3.059	4.079	5.099	6.118	7.138	8.158	9.177	—
100	10.197	11.217	12.237	13.256	14.276	15.296	16.316	17.335	18.355	19.375	100
200	20.394	21.414	22.434	23.454	24.473	25.493	26.513	27.532	28.552	29.572	200
300	30.592	31.611	32.631	33.651	34.670	35.690	36.710	37.730	38.749	39.769	300
400	40.789	41.809	42.828	43.848	44.868	45.887	46.907	47.927	48.947	49.966	400
500	50.986	52.006	53.025	54.045	55.065	56.085	57.104	58.124	59.144	60.163	500
600	61.183	62.203	63.223	64.242	65.262	66.282	67.302	68.321	69.341	70.361	600
700	71.380	72.400	73.420	74.441	75.458	76.479	77.499	78.518	79.538	80.558	700
800	81.578	82.597	83.617	84.637	85.656	86.676	87.696	88.716	89.735	90.755	800
900	91.775	92.795	93.814	94.834	95.854	96.873	97.893	98.913	99.933	100.952	900
1000	101.972	102.992	104.011	105.031	106.051	107.071	108.090	109.110	110.130	111.148	1000

PRESSURE

POUNDS PER SQUARE INCHES TO KILOGRAMS PER SQUARE CENTIMETERS

lb/in² (psi)	0 kgf/cm²	1 kgf/cm²	2 kgf/cm²	3 kgf/cm²	4 kgf/cm²	5 kgf/cm²	6 kgf/cm²	7 kgf/cm²	8 kgf/cm²	9 kgf/cm²	lb/in² (psi)
—	—	0.0703	0.1406	0.2109	0.2813	0.3516	0.4219	0.4921	0.5625	0.6328	
10	0.7031	0.7734	0.8437	0.9140	0.9843	1.0546	1.1248	1.1902	1.2655	1.3358	10
20	1.4061	1.4764	1.5467	1.6171	1.6874	1.7577	1.8280	1.8983	1.9686	2.0389	20
30	2.1092	2.1795	2.2498	2.3201	2.3904	2.4607	2.5311	2.6014	2.6717	2.7420	30
40	2.8123	2.8826	2.9529	3.0232	3.0935	3.1638	3.2341	3.3044	3.3747	3.4450	40
50	3.5154	3.5857	3.6560	3.7263	3.7966	3.8669	3.9372	4.0075	4.0778	4.1481	50
60	4.2184	4.2887	4.3590	4.4293	4.4996	4.5700	4.6403	4.7106	4.7809	4.8512	60
70	4.9215	4.9918	5.0621	5.1324	5.2027	5.2730	5.3433	5.4136	5.4839	5.5543	70
80	5.6246	5.6949	5.7652	5.8355	5.9058	5.9761	6.0464	6.1167	6.1870	6.2573	80
90	6.3277	6.3979	6.4682	6.5386	6.6089	6.6792	6.7495	6.8198	6.8901	6.9604	90
100	7.0307	7.1010	7.1713	7.2416	7.3119	7.3822	7.4525	7.5228	7.5932	7.6635	100

KILOGRAMS PER SQUARE CENTIMETERS TO POUNDS PER SQUARE INCHES

kgf/cm²	0 lb/in²(psi)	1 lb/in²(psi)	2 lb/in²(psi)	3 lb/in²(psi)	4 lb/in²(psi)	5 lb/in²(psi)	6 lb/in²(psi)	7 lb/in²(psi)	8 lb/in²(psi)	9 lb/in²(psi)	kgf/cm²
-	—	14.22	28.45	42.67	56.89	71.12	85.34	99.56	113.78	128.01	—
10	142.23	156.45	170.68	184.90	199.12	213.35	227.57	241.79	256.01	270.24	10
20	284.46	298.68	312.91	327.13	341.35	355.58	369.80	384.02	398.24	412.47	20
30	426.69	440.91	455.14	469.36	483.58	497.81	512.03	526.25	540.47	554.70	30
40	568.92	583.14	597.37	611.59	625.81	640.04	654.26	668.48	682.70	696.93	40
50	711.15	725.37	739.60	753.82	768.04	782.27	796.49	810.71	824.93	839.16	50
60	853.38	867.60	881.83	896.05	910.27	924.50	938.72	952.94	967.16	981.39	60
70	995.61	1009.83	1024.06	1038.28	1052.50	1066.73	1080.95	1095.17	1109.39	1123.62	70
80	1137.84	1152.06	1166.29	1180.51	1194.73	1208.96	1223.18	1237.40	1251.62	1265.85	80
90	1280.07	1294.29	1308.52	1322.74	1336.96	1351.19	1365.41	1379.63	1393.85	1408.08	90
100	1422.30	1436.52	1450.75	1464.97	1479.19	1493.42	1507.64	1521.86	1536.08	1550.31	100

KILOGRAMS PER SQUARE CENTIMETERS TO KILO PASCAL

kgf/cm²	0 KPa	1 KPa	2 KPa	3 KPa	4 KPa	5 KPa	6 KPa	7 KPa	8 KPa	9 KPa	kgf/cm²
—	—	98.1	196.1	294.2	392.3	490.3	588.4	686.5	784.5	882.6	—
10	980.7	1078.7	1176.8	1274.9	1372.9	1471.0	1569.1	1667.1	1765.2	1863.3	10
20	1961.3	2059.4	2157.5	2255.5	2353.6	2451.7	2549.7	2647.8	2745.9	2843.9	20
30	2942.0	3040.1	3138.1	3236.2	3334.3	3432.3	3530.4	3628.5	3726.6	3824.6	30
40	3922.7	4020.7	4118.8	4216.9	4314.9	4413.0	4511.1	4609.1	4707.2	4805.3	40
50	4903.4	5001.4	5099.5	5197.5	5295.6	5393.7	5491.8	5589.8	5687.9	5785.9	50
60	5884.0	5982.1	6080.1	6178.2	6276.3	6374.4	6472.4	6570.5	6668.6	6766.6	60
70	6864.7	6962.7	7060.8	7158.9	7256.9	7355.0	7453.1	7551.1	7649.2	7747.3	70
80	7845.3	7943.4	8041.5	8139.5	8237.6	8335.7	8433.7	8531.8	8629.9	8727.9	80
90	8826.0	8924.1	9022.1	9120.2	9218.3	9316.3	9414.4	9512.5	9610.6	9708.6	90
100	9806.7	9904.7	10002.8	10100.8	10198.9	10297.0	10395.1	10493.1	10591.2	10689.2	100

KILO PASCAL TO KILOGRAMS PER SQUARE CENTIMETERS

KPa	0 kgf/cm²	100 kgf/cm²	200 kgf/cm²	300 kgf/cm²	400 kgf/cm²	500 kgf/cm²	600 kgf/cm²	700 kgf/cm²	800 kgf/cm²	900 kgf/cm²	KPa
—	—	1.020	2.039	3.059	4.079	5.099	6.118	7.138	8.158	9.177	
1000	10.197	11.217	12.237	13.256	14.276	15.296	16.316	17.335	18.355	19.375	1000
2000	20.394	21.414	22.434	23.454	24.473	25.493	26.513	27.532	28.552	29.572	2000
3000	30.592	31.611	32.631	33.651	34.670	35.690	36.710	37.730	38.748	39.769	3000
4000	40.789	41.809	42.828	43.848	44.868	45.887	46.907	47.927	48.947	49.966	4000
5000	50.986	52.006	53.025	54.045	55.065	56.085	57.104	58.124	59.144	60.163	5000
6000	61.183	62.203	63.223	64.242	65.262	66.282	67.302	68.321	69.341	70.361	6000
7000	71.380	72.400	73.420	74.440	75.459	76.479	77.499	78.518	79.538	80.558	7000
8000	81.578	82.597	83.617	84.637	85.656	86.676	87.696	88.716	89.735	90.755	8000
9000	91.775	92.795	93.814	94.834	95.854	96.873	97.893	98.913	99.933	100.952	9000
10000	101.972	102.992	104.011	105.031	106.051	107.071	108.090	109.110	110.130	111.149	10000

TORQUE

FOOT POUNDS TO KILOGRAMMETERS

ft. lbs.	0	1	2	3	4	5	6	7	8	9	ft. lbs.
	kgf-m	kgf m	kgf m	kgf-m	kgf-m	kgf-m	kgf m	kgf m	kgf-m	kgf m	
—	—	0.138	0.277	0.415	0.553	0.691	0.830	0.968	1.106	1.244	—
10	1.383	1.521	1.659	1.797	1.936	2.074	2.212	2.350	2.489	2.627	10
20	2.765	2.903	3.042	3.180	3.318	3.456	3.595	3.733	3.871	4.009	20
30	4.148	4.286	4.424	4.562	4.701	4.839	4.977	5.116	5.254	5.392	30
40	5.530	5.668	5.807	5.945	6.083	6.221	6.360	6.498	6.636	6.774	40
50	6.913	7.051	7.189	7.328	7.466	7.604	7.742	7.881	8.019	8.157	50
60	8.295	8.434	8.572	8.710	8.848	8.987	9.125	9.263	9.401	9.540	60
70	9.678	9.816	9.954	10.093	10.231	10.369	10.507	10.646	10.784	10.922	70
80	11.060	11.199	11.337	11.475	11.613	11.752	11.890	12.028	12.166	12.305	80
90	12.443	12.581	12.719	12.858	12.996	13.134	13.272	13.411	13.549	13.687	90
100	13.826	13.964	14.102	14.240	14.378	14.517	14.655	14.793	14.932	15.070	100

KILOGRAMMETERS TO FOOT POUNDS

kgf-m	0	1	2	3	4	5	6	7	8	9	kgf m
	ft. lbs.	ft. lbs.	ft. lbs.	ft. lbs.	ft. lbs.	ft. lbs.	ft. lbs.	ft. lbs.	ft. lbs.	ft. lbs.	
		7.23	14.47	21.70	28.93	36.17	43.40	50.63	57.86	65.10	—
10	72.33	79.56	86.80	94.03	101.26	108.50	115.73	122.96	130.19	137.43	10
20	144.66	151.89	159.13	166.36	173.59	180.83	188.06	195.29	202.52	209.76	20
30	216.99	224.22	231.46	238.69	245.92	253.16	260.39	267.62	274.86	282.09	30
40	289.32	296.55	303.79	311.02	318.25	325.49	332.72	339.95	347.18	354.42	40
50	361.65	368.88	376.12	383.35	390.58	397.82	405.05	412.28	419.51	426.75	50
60	433.98	441.21	448.45	455.68	462.91	470.15	477.38	484.61	491.84	499.08	60
70	506.31	513.54	520.78	528.01	535.24	542.48	549.71	556.94	564.17	571.41	70
80	578.64	585.87	593.11	600.34	607.57	614.81	622.04	629.27	636.50	643.74	80
90	650.97	658.20	665.44	672.67	679.90	687.14	694.37	701.60	708.83	716.07	90
100	723.30	730.53	737.77	745.00	752.23	759.47	766.70	773.93	781.16	788.40	100

KILOGRAMMETERS TO NEWTONMETERS

kgf m	0	1	2	3	4	5	6	7	8	9	kgf-m
	N m	N m	N-m	N-m	N-m	N-m	N m	N-m	N-m	N m	
—	—	9.81	19.61	29.42	39.23	49.03	58.84	68.65	78.45	88.26	
10	98.07	107.87	117.68	127.49	137.29	147.10	156.91	166.71	176.52	186.33	10
20	196.13	205.94	215.75	225.55	235.36	245.17	254.97	264.78	274.59	284.39	20
30	294.20	304.01	313.81	323.62	333.43	343.23	353.04	362.85	372.65	382.46	30
40	392.27	402.07	411.88	421.69	431.49	441.30	451.11	460.91	470.72	480.53	40
50	490.33	500.14	509.95	519.75	529.56	539.37	549.17	558.98	568.79	578.59	50
60	588.40	598.21	608.01	617.82	627.63	637.43	647.24	657.05	666.85	676.66	60
70	686.47	696.27	706.08	715.89	725.69	735.50	745.31	755.11	764.92	774.73	70
80	784.53	794.34	804.15	813.96	823.76	833.57	843.37	853.18	862.99	872.79	80
90	882.60	892.41	902.21	912.02	921.83	931.63	941.44	951.25	961.05	970.86	90
100	980.67	990.47	1000.28	1010.08	1019.89	1029.70	1039.51	1049.31	1059.12	1068.93	100

NEWTONMETERS TO KILOGRAMMETERS

N-m	0	10	20	30	40	50	60	70	80	90	N-m
	kgf-m	kgf-m	kgf m	kgf m	kgf-m	kgf-m	kgf-m	kgf m	kgf-m	kgf-m	
	—	1.020	2.039	3.059	4.079	5.099	6.118	7.138	8.158	9.177	—
100	10.197	11.217	12.236	13.256	14.276	15.296	16.315	17.335	18.355	19.374	100
200	20.394	21.414	22.433	23.453	24.473	25.493	26.512	27.532	28.552	29.571	200
300	30.591	31.611	32.630	33.650	34.670	35.690	36.709	37.729	38.749	39.768	300
400	40.788	41.808	42.827	43.847	44.867	45.887	46.906	47.926	48.946	49.965	400
500	50.985	52.005	53.024	54.044	55.064	56.084	57.103	58.123	59.143	60.162	500
600	61.182	62.202	63.221	64.241	65.261	66.281	67.300	68.320	69.340	70.359	600
700	71.379	72.399	73.418	74.438	75.458	76.478	77.497	78.517	79.537	80.556	700
800	81.576	82.596	83.615	84.635	85.655	86.675	87.694	88.714	89.734	90.753	800
900	91.773	92.793	93.812	94.832	95.852	96.872	97.891	98.911	99.931	100.950	900
1000	101.970	102.990	104.009	105.029	106.049	107.068	108.088	109.108	110.128	111.147	1000

TEMPERATURE

FAHRENHEIT TO CENTIGRADE

°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C
60	51.1	2	18.9	96	43.3	114	45.6	132	77.11	230	110.0	248	142.2	345	174.4
58	50.0	0	17.8	98	44.4	116	46.7	134	78.9	232	111.1	250	143.3	348	175.6
56	48.9	2	-16.7	00	15.6	118	47.8	136	80.0	234	112.2	252	144.4	350	176.7
-54	-47.8	4	-15.6	02	16.7	120	48.9	138	81.1	236	113.3	254	145.6	352	177.8
-52	-46.7	6	-14.4	04	17.8	122	50.0	140	82.2	238	114.4	256	146.7	354	178.9
-50	-45.6	8	-13.3	06	18.9	124	51.1	142	83.3	240	115.6	258	147.8	356	180.0
-48	-44.4	10	-12.2	08	20.0	126	52.2	144	84.4	242	116.7	260	148.9	358	181.1
-46	-43.3	12	-11.1	70	21.1	128	53.3	146	85.6	244	117.8	262	150.0	360	182.2
-44	-42.2	14	-10.0	72	22.2	130	54.4	148	86.7	246	118.9	264	151.1	362	183.3
-42	-41.1	16	-8.9	74	23.3	132	55.6	150	87.8	248	120.0	266	152.2	364	184.4
-40	-40.0	18	-7.8	76	24.4	134	56.7	152	88.9	250	121.1	268	153.3	366	185.6
-38	-38.9	20	-6.7	78	25.6	136	57.8	154	90.0	252	122.2	270	154.4	368	186.7
-36	-37.8	22	5.6	80	26.7	138	58.9	156	91.1	254	123.3	272	155.6	370	187.8
34	36.7	24	4.4	82	27.8	140	60.0	158	92.2	256	124.4	274	156.7	372	188.9
32	35.8	26	3.3	84	28.9	142	61.1	200	93.3	258	125.6	276	157.8	374	190.0
30	34.4	28	2.2	86	30.0	144	62.2	202	94.4	260	126.7	278	158.9	376	191.1
28	33.3	30	1.1	88	31.1	146	63.3	204	95.6	262	127.0	280	160.0	378	192.2
26	32.2	32	0.0	90	32.2	148	64.4	206	96.7	264	128.8	282	161.1	380	193.3
24	31.1	34	1.1	92	33.3	150	65.6	208	97.8	266	130.0	284	162.2	382	194.4
22	30.0	36	2.2	94	34.4	152	66.7	210	98.9	268	131.1	286	163.3	384	195.6
20	28.9	38	3.3	96	35.6	154	67.8	212	100.0	270	132.2	288	164.4	386	196.7
18	27.8	40	4.4	98	36.7	156	68.9	214	101.1	272	133.3	290	165.6	388	197.8
-16	-26.7	42	5.6	100	37.8	158	70.0	216	102.2	274	134.4	292	166.7	390	198.9
-14	-25.6	44	6.7	102	38.9	160	71.1	218	103.3	276	135.6	294	167.8	392	200.0
-12	-24.4	46	7.8	104	40.0	162	72.2	220	104.4	278	136.7	296	168.9	394	201.1
-10	-23.3	48	8.9	106	41.1	164	73.3	222	105.6	280	137.8	298	170.0	396	202.2
-8	-22.2	50	10.0	108	42.2	166	74.4	224	106.7	282	138.9	300	171.1	398	203.3
-6	-21.1	52	11.1	110	43.3	168	75.6	226	107.8	284	140.0	302	172.2	400	204.4
-4	-20.0	54	12.2	112	44.4	170	76.7	228	108.9	286	141.1	304	173.3	402	205.6

CENTIGRADE TO FAHRENHEIT

°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
50	58.0	18	0.4	14	57.2	46	114.8	78	172.4	110	230.0	142	287.6	174	345.2
49	56.2	17	1.4	15	59.0	47	116.6	79	174.2	111	231.8	143	289.4	175	347.0
48	54.4	16	3.2	16	60.8	48	118.4	80	176.0	112	233.6	144	291.2	176	348.8
47	52.6	15	5.0	17	62.6	49	120.2	81	177.8	113	235.4	145	293.0	177	350.6
46	50.8	14	6.8	18	64.4	50	122.0	82	179.6	114	237.2	146	294.8	178	352.4
-45	-49.0	-13	8.6	19	66.2	51	123.8	83	181.4	115	239.0	147	296.6	179	354.2
-44	-47.2	-12	10.4	20	68.0	52	125.6	84	183.2	116	240.8	148	298.4	180	356.0
-43	-45.4	-11	12.2	21	69.8	53	127.4	85	185.0	117	242.6	149	300.2	181	357.8
-42	-43.6	-10	14.0	22	71.6	54	129.2	86	186.8	118	244.4	150	302.0	182	359.6
-41	-41.8	-9	15.8	23	73.4	55	131.0	87	188.6	119	246.2	151	303.8	183	361.4
-40	-40.0	-8	17.6	24	75.2	56	132.8	88	190.4	120	248.0	152	305.6	184	363.2
-39	-38.2	-7	19.4	25	77.0	57	134.6	89	192.2	121	249.8	153	307.4	185	365.0
-38	-36.4	-6	21.2	26	78.8	58	136.4	90	194.0	122	251.6	154	309.2	186	366.8
-37	-34.6	-5	23.0	27	80.6	59	138.2	91	195.8	123	253.4	155	311.0	187	368.6
-36	-32.8	-4	24.8	28	82.4	60	140.0	92	197.6	124	255.2	156	312.8	188	370.4
-35	-31.0	-3	26.6	29	84.2	61	141.8	93	199.4	125	257.0	157	314.6	189	372.2
-34	-29.2	-2	28.4	30	86.0	62	143.6	94	201.2	126	258.8	158	316.4	190	374.0
-33	-27.4	-1	30.2	31	87.8	63	145.4	95	203.0	127	260.6	159	318.2	191	375.8
-32	-25.6	0	32.0	32	89.6	64	147.2	96	204.8	128	262.4	160	320.0	192	377.6
-31	-23.8	1	33.8	33	91.4	65	149.0	97	206.6	129	264.2	161	321.8	193	379.4
-30	-22.0	2	35.6	34	93.2	66	150.8	98	208.4	130	266.0	162	323.6	194	381.2
29	20.2	3	37.4	35	95.0	67	152.6	99	210.2	131	267.8	163	325.4	195	383.0
28	-18.4	4	39.2	36	96.8	68	154.4	100	212.0	132	269.6	164	327.2	196	384.8
27	16.6	5	41.0	37	98.6	69	156.2	101	213.8	133	271.4	165	329.0	197	386.6
26	14.8	6	42.8	38	100.4	70	158.0	102	215.6	134	273.2	166	330.8	198	388.4
25	13.0	7	44.6	39	102.2	71	159.8	103	217.4	135	275.0	167	332.6	199	390.2
24	11.2	8	46.4	40	104.0	72	161.6	104	219.2	136	276.8	168	334.4	200	392.0
23	9.4	9	48.2	41	105.8	73	163.4	105	221.0	137	278.6	169	336.2	210	410.0
22	7.6	10	50.0	42	107.6	74	165.2	106	222.8	138	280.4	170	338.0	220	428.0
21	5.8	11	51.8	43	109.4	75	167.0	107	224.6	139	282.2	171	339.8	230	446.0
-20	-4.0	12	53.6	44	111.2	76	168.8	108	226.4	140	284.0	172	341.6	240	464.0
19	2.2	13	55.4	45	113.0	77	170.6	109	228.2	141	285.8	173	343.4	250	482.0