

KOBELCO

SHOP MANUAL
MITSUBISHI DIESEL ENGINE
4D3.4DR
(For Industrial Use)

97811-03021 NA

Issued 09-1990

4D3.4DR

ENGINE Shop Manual

FOREWORD

This shop manual contains the specifications, construction, operation, adjustment and service procedures of the Model 4D31, 4D31-T, 4D32, 4DR5 diesel engine for service mechanics engaged in servicing of the Mitsubishi diesel engines.

Please make the most of this shop manual to perform correct servicing and wasteless operations.

Note that some of the contents of this shop manual are subject to change owing to improvements, etc. that may be introduced after publication of the shop manual.

SEP. 1990

Applicable Engine Models

4D31	}	For industrial use
4D31-T		
4D32		
4DR5		

GROUP INDEX

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COMPILATION OF THIS MANUAL

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COMPILATION OF THIS MANUAL – GROUP CLASSIFICATION

1. GROUP CLASSIFICATION

This manual is organized into several groups classified according to the engine basic elements.

No.	Group name	Description
00	General	External view, major specifications, engine outputs classified by application, engine numbers, name plate, caution plate, general precautions for servicing, general bolts and nuts tightening torque table
11	Engine	Engine proper (cylinder head, valve mechanism, camshaft, piston, crankshaft, timing gear, flywheel), specifications, service standards, special tools, troubleshooting
12	Lubrication	Lubrication system (oil pump, oil filter, oil cooler), specifications, service standards, special tools, troubleshooting
13	Fuel and engine control	Fuel system (injection pump, injection nozzle, fuel filter, water separator), specifications, service standards, special tools, troubleshooting
14	Cooling	Cooling system (water pump, thermostat, radiator, cooling system cleaning procedures, fan), specifications, service standards, special tools, troubleshooting
15	Intake and exhaust	Air cleaner, turbocharger, specifications, service standards, troubleshooting
16	Engine electrical	Starter, alternator, vacuum pump, preheating system, relays, automatic stop device, specifications, service standards, special tools, troubleshooting
21	Clutch	Clutch proper, clutch control (power cylinder, master cylinder, clutch lever), specifications, service standards, special tools, troubleshooting
22	Transmission	Transmission proper, bearing case, specifications, service standards, special tools, troubleshooting
61	Special equipment	Parking brake (brake drum, brake shoe), specifications, service standards, special tools, troubleshooting

COMPILATION OF THIS MANUAL – TERMS AND UNITS, TABLE OF CONVERSION RATE FOR FOOT-POUND UNITS INTO SI UNITS

2. TERMS AND UNITS

The following terms and units are used throughout the entire texts of this manual.

(1) Front and rear

The terms "front" is the fan side and "rear" the flywheel side of the engine.

(2) Right and left

The terms "right" and "left" shall be used to indicate the side as viewed from the flywheel side of the engine.

(3) Service standard terms

- **Nominal value**
Shows the nominal dimensions, dimension of an individual part, standard clearance between parts in an assembly, or the standard performance of an assembly.
- **Limit**
Shows the value of a part at which the part is no longer serviceable from the performance as well as strength viewpoints, requiring replacement or repair.

(4) Tightening torque

Over- or undertightening of bolts and nuts has critical effects on performance and functions. Tightening torque is therefore specified for some tightening points.

All tightening torque specifications may be considered as "dry" unless "wet" is specified.

Where no tightening torque is specified, use a torque value specified in the General Bolts and Nuts Tightening Torque Table.

(5) Units

For length, weight, area, and volume, the SI unit (International System of Units) is used with the metric notation jointly shown in parentheses. Temperature is shown in centigrade (°C).

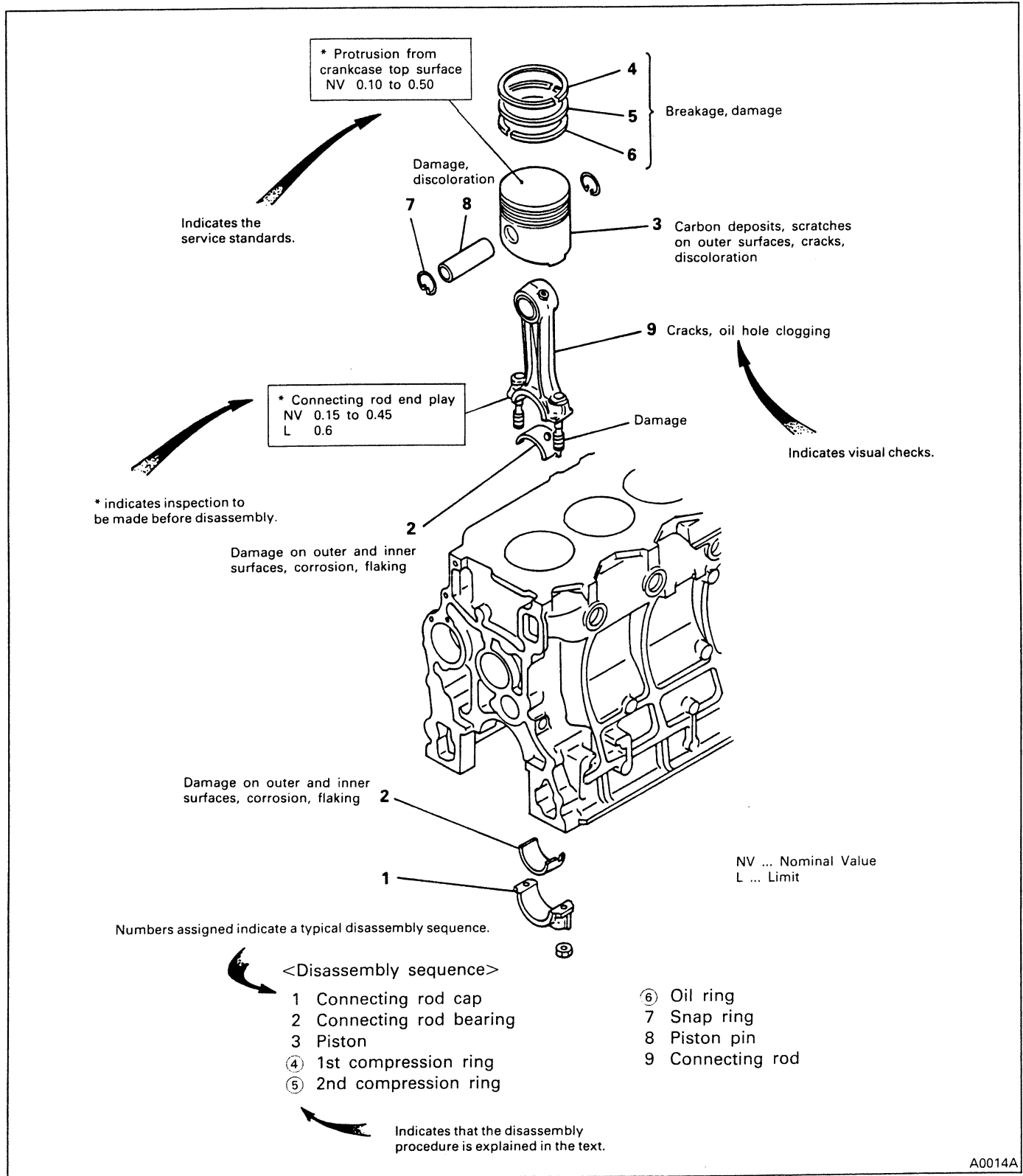
3. TABLE OF CONVERSION RATE FOR FOOT-POUND UNITS INTO SI UNITS

Unit	Sign of SI unit	Sign of foot-pound unit	Conversion rate
Mass quantity of matter	kg g	lb oz	1 kg = 2.2046 lb 1 g = 0.035274 oz
Dimension	m mm	ft. in.	1 m = 3.2808 ft. 1 mm = 0.03937 in.
Capacity	lit. cc	gal. oz	1 lit. = 0.2642 gal. (U.S.) 1 lit. = 0.220 gal. (Imp.) 1 cc = 0.033814 oz (U.S.) 1 cc = 0.035195 oz (Imp.)
Force	N (Newton)	lbf	1 N = 0.2248 lbf
Pressure	kPa (kilopascal)	lbf/in ²	1 kPa = 0.145 lbf/in ² 1 kPa = 0.2953 in.Hg
Stress	N/cm ²	lbf/in ²	1 N/cm ² = 1.45 lbf/in ²
Moment of force	N m	ft.lbf	1 N m = 0.7375 ft.lbf
Output	kW (kilowatt)	HP	1 kW = 1.34 HP
Temperature	°C	°F	t°C = (1.8t°C + 32)°F

COMPILATION OF THIS MANUAL – READING THE ILLUSTRATION

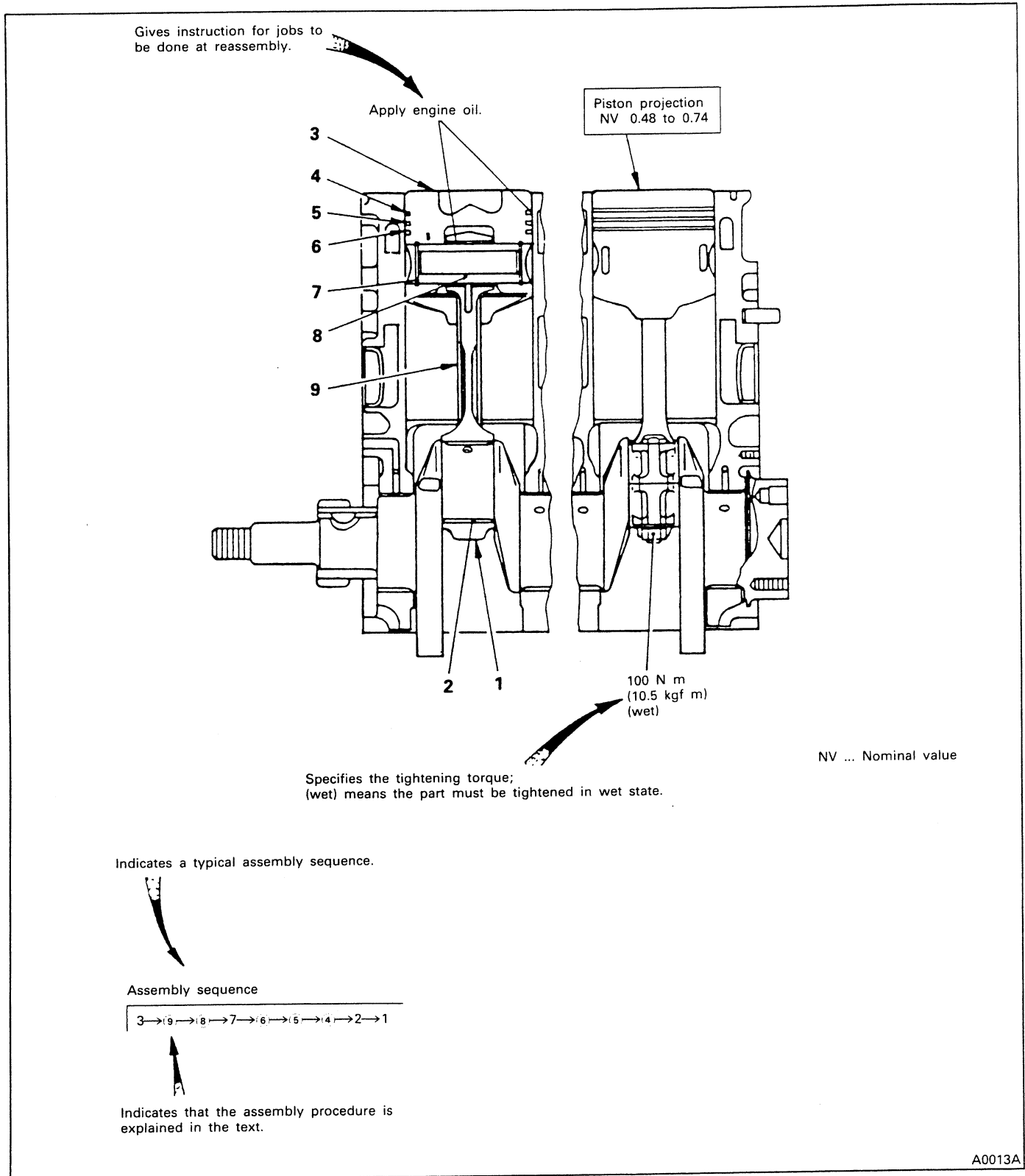
4. READING THE ILLUSTRATION

(Ex. 1: Disassembly and Inspection)



COMPILATION OF THIS MANUAL – READING THE ILLUSTRATION

(Ex. 2: Reassembly)



Illustrations (exploded views and assembly drawings) show a typical service procedures if it is identical among various types of available systems and units.

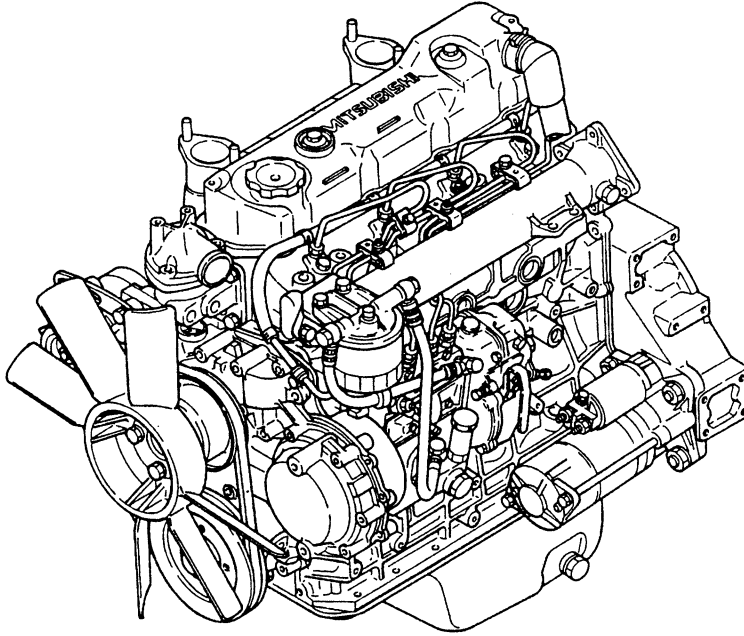
GENERAL

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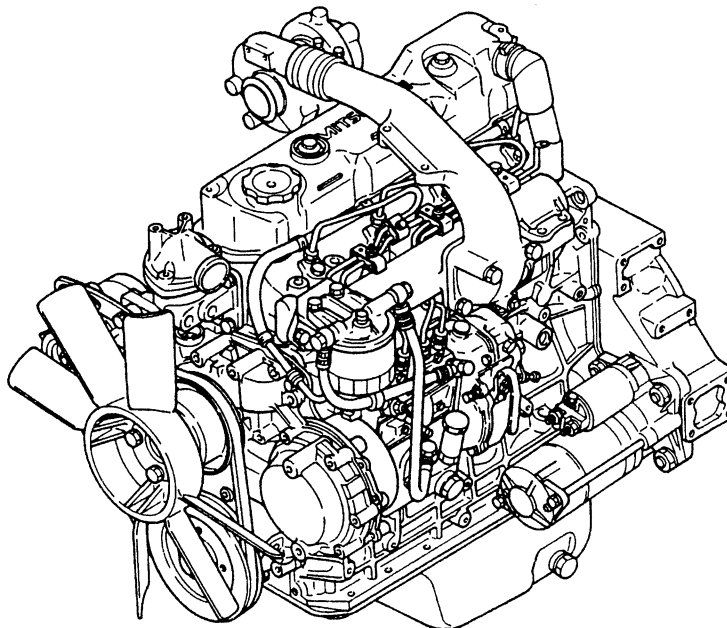
1. EXTERNAL VIEW

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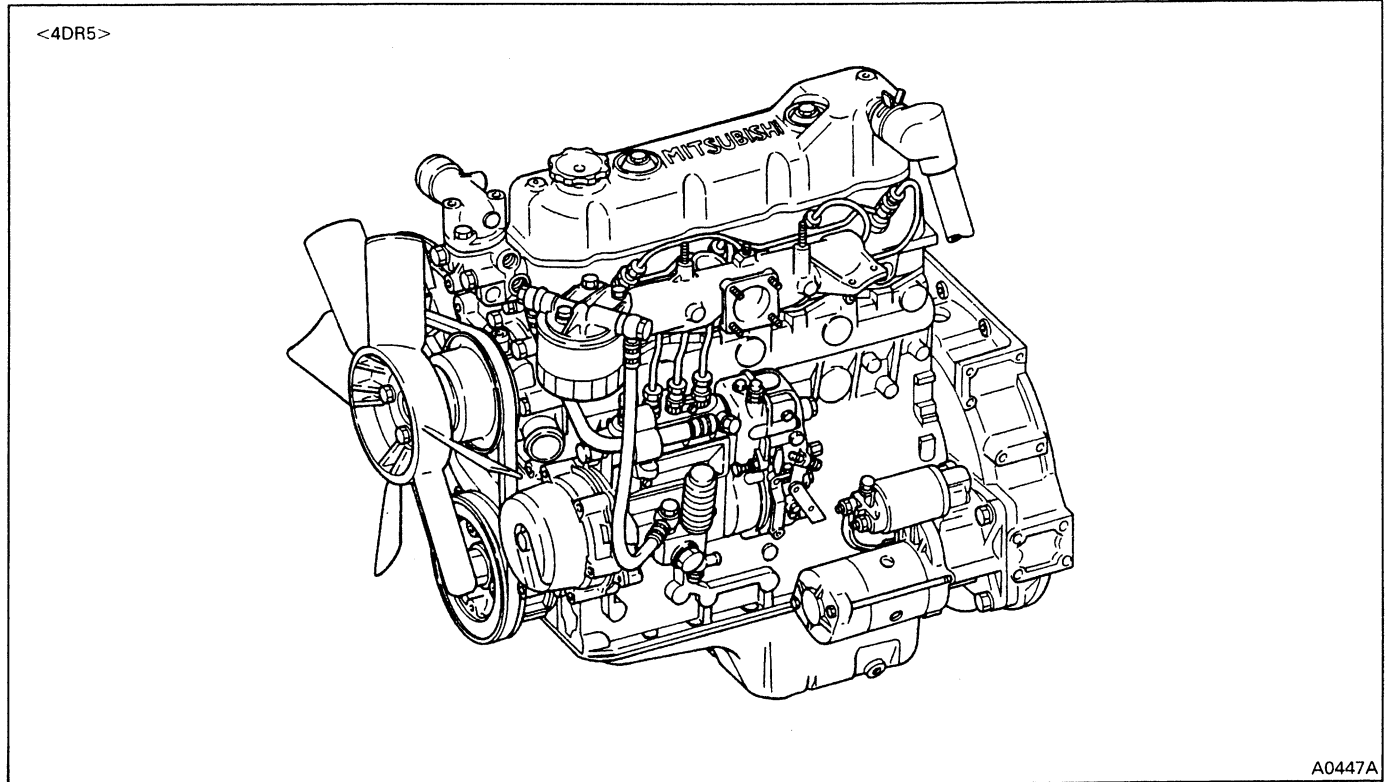


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<4D31-T>



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2. MAJOR SPECIFICATIONS

2.1 MAJOR SPECIFICATIONS

Item	Engine model	4D31	4D31-T	4D32	4DR5
Type		Water cooled, 4-cycle diesel engine			
Combustion method		Direct injection			Swirl chamber
No. and arrangement of cylinder		Four in-line			
Bore x stroke	mm	100 x 105		104 x 105	92 x 100
Total displacement	cc	3 298		3 567	2 659
Engine dimension (without fan)					
Overall length	mm	857	857	857	778
Overall width	mm	647	657	647	750
Overall height	mm	745	871	745	752
Empty weight	kg*	340	350	340	290

* Empty weight as measured according to Mitsubishi Motors Corporation standard.

2.2 ENGINE OUTPUTS CLASSIFIED BY APPLICATION

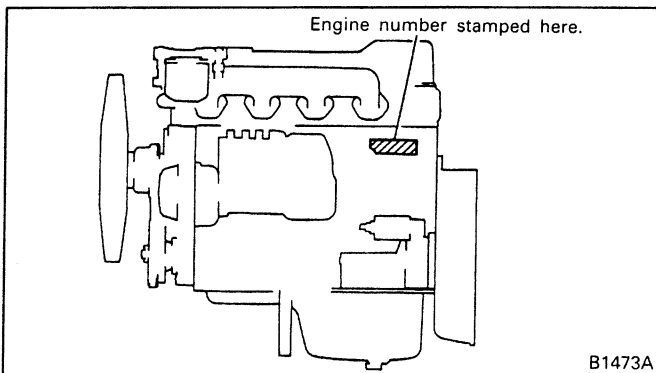
Item	Engine model	4D31	4D31-T		4DR5
			Medium speed	High speed	
Intermittent rated output kW(HP)	1 500 rpm	30(40)	46(62)	39(52)	22(29)
	1 800 rpm	36(48)	55(74)	49(66)	28(37)
	2 000 rpm	40(54)	61(82)	56(75)	31(42)
	2 200 rpm	44(59)	66(88)	62(83)	34(46)
	2 500 rpm	50(67)	71(95)	65(91)	38(51)
	2 800 rpm	55(74)	–	72(97)	42(56)
	3 000 rpm	58(78)	–	74(99)	45(60)
Continuous rated output kW(HP)	1 500 rpm	27(36)	42(56)	35(47)	20(27)
	1 800 rpm	33(44)	50(67)	44(59)	25(33)
	2 000 rpm	36(48)	55(74)	51(68)	28(37)
	2 200 rpm	40(54)	60(80)	56(75)	31(42)
	2 500 rpm	45(60)	64(86)	62(83)	34(46)
	2 800 rpm	50(67)	–	65(87)	38(51)
	3 000 rpm	53(71)	–	67(90)	41(55)

NOTE:

- The output (SAE, gross) is corrected to standard ambient conditions based on SAE J1349.**
- The continuous rated output allows 10% (one hour) overload operation.**

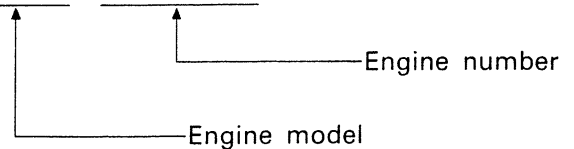
3. ENGINE NUMBER, NAME PLATE AND CAUTION PLATE

(1) Engine number



The engine number is stamped on the rear left of the crankcase as illustrated.

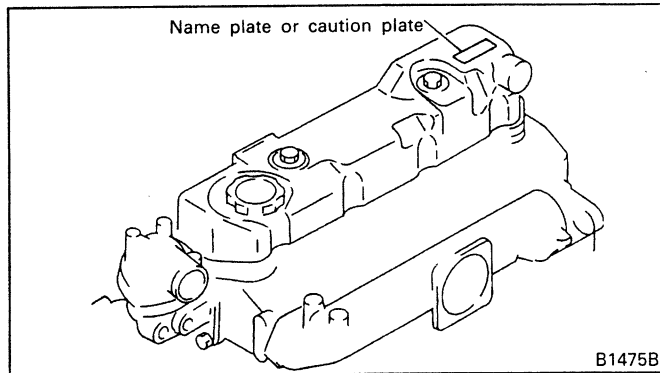
Ex.: 4 D 3 1 - 0 0 0 0 1



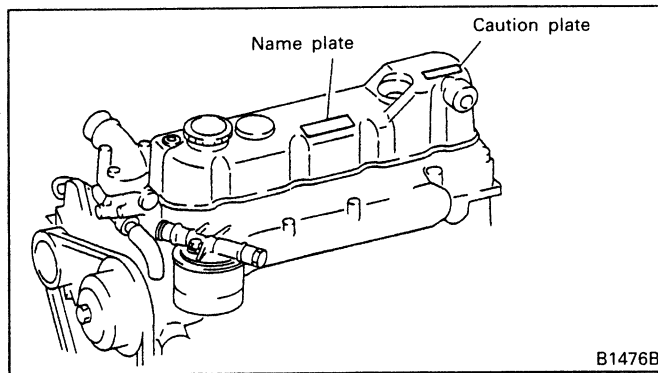
The engine number is important in knowing the history of the engine.

(2) Name plate, caution plate

<4D3>

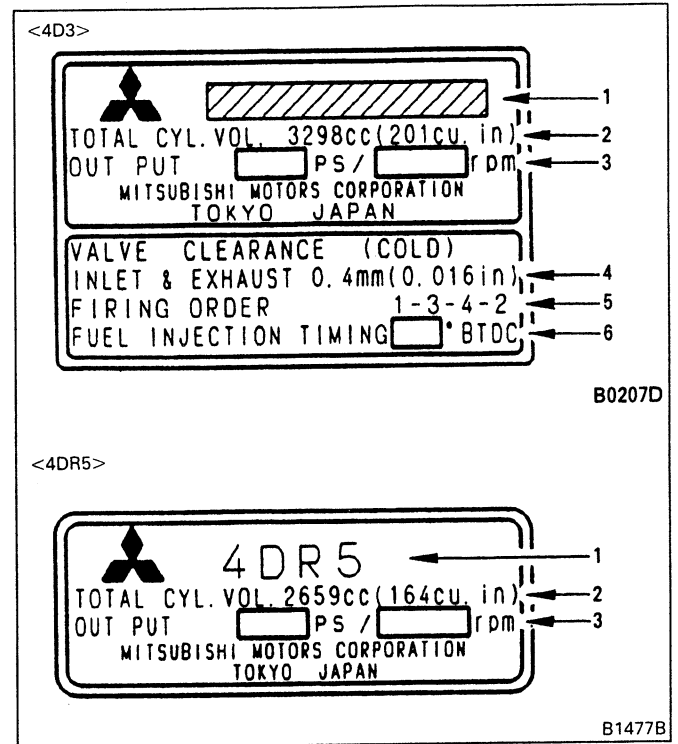


<4DR5>



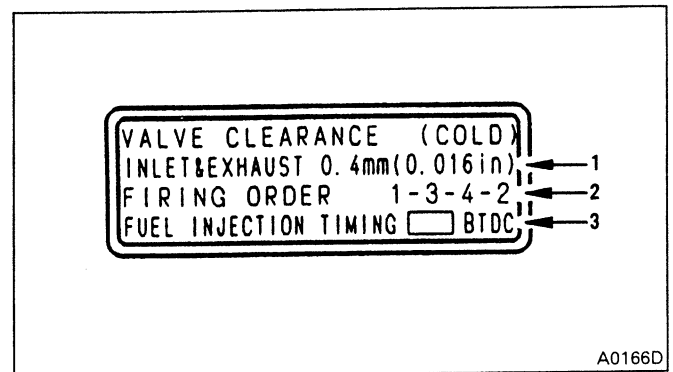
The name plate and caution plate are attached to the portion shown in the illustration, and indicate the following items.

(a) Name plate



1. Engine model
2. Total displacement
3. Maximum output
4. Valve clearance
5. Firing order
6. Fuel injection timing

(b) Caution plate

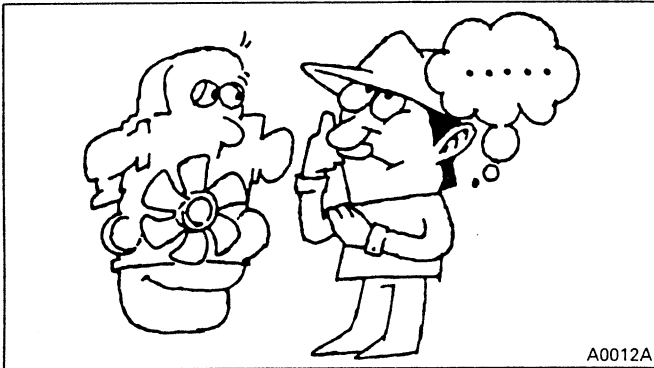


1. Valve clearance
2. Firing order
3. Fuel injection timing

4. GENERAL PRECAUTIONS FOR SERVICING

Before starting the service procedures, check for total operating hours and use conditions of the machine as well as user's complaints and requests to know exactly the engine conditions. Record information where necessary.

To ensure you are doing correct and efficient service jobs, observe the following precautions:

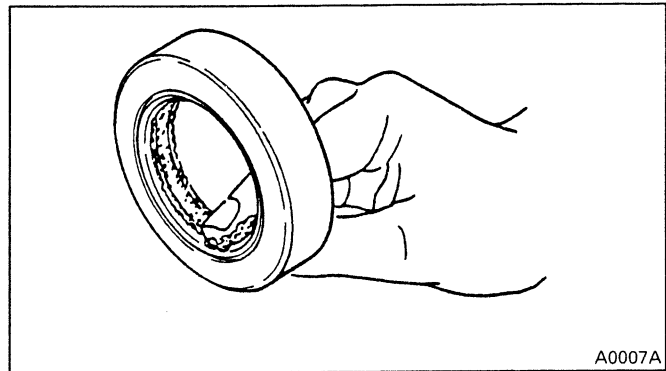


- 1) Before performing the service procedures given in this manual, know the trouble spots and isolate the possible cause to determine whether the removal or disassembly procedure is required.
- 2) Select a flat surface for the service job.
- 3) When servicing the electrical system, be sure to disconnect the (negative) cable from the battery.
- 4) Carefully check parts for oil leaks before cleaning. After cleaning, it may become difficult to spot defective areas.
- 5) Ready and make the most of the special tools required for servicing. Use the right tools (specified special tools) in the right place to prevent damages to parts and personal injury.
- 6) Make alignment marks and keep disassembled parts neatly arranged to ensure that they are reassembled into the right positions.
 - Special care must be taken for assemblies involving a number of parts, similar parts, or parts identical at right- and left-hand sides to ensure correct reassembly.
 - For alignment and punching markings, select a position that would not mar the appearance and function.
 - Clearly distinguish parts to be replaced from those reused.

**MITSUBISHI MOTORS
GENUINE PARTS**

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- 7) The oil seals, packings, O-rings, and other rubber parts, gaskets, and split pins must be replaced with a new one whenever they are removed. For replacement, use Mitsubishi Genuine parts.



- 8) Apply the specified grease to U-packings, oil seals, dust seals, and bearings before installation.
- 9) When work requires an assistant or two, always make sure of the safety each other. Never play with switches and levers.
- 10) Make sure that your shoes are free from grease and oil especially when working on a heavy item.
- 11) When checking or changing lubricants, wipe off grease and oil from parts immediately with a cloth.
- 12) Special care must be taken in handling sensors and relays which are susceptible to shocks and heat.
- 13) Use care so that hands and fingers are not injured by sharp edges or corners of the parts.
- 14) Wear safety goggles whenever handling a grinder or welding machine. Wear gloves as required to ensure utmost safety.

5. GENERAL BOLTS AND NUTS TIGHTENING TORQUE TABLE

Unless otherwise specified, the parts and equipment of vehicle must be tightened by the following standard bolts and nuts. Tightening torques for these bolts and nuts are shown below.

NOTE:

1. Threads and seat surfaces must be in dry state.
2. When there is a difference between the nut and bolt (stud) identification marks, tighten to the torque corresponding to the bolt (stud) identification mark.

Standard bolts and nuts

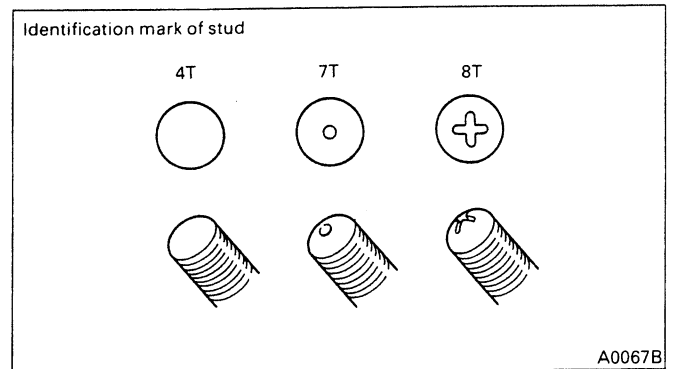
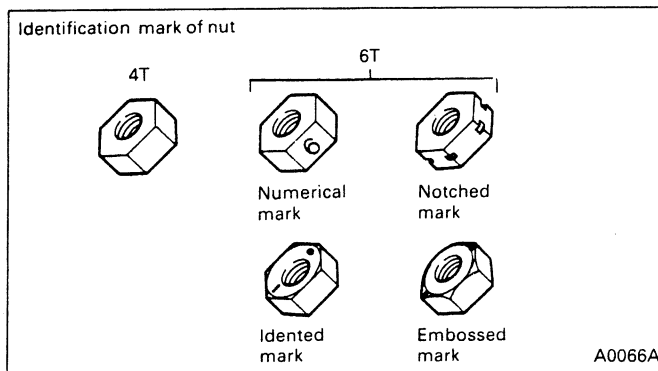
Unit: N m (kgf m)

Dia. mm	Pitch mm	4T (Head mark 4 or ○)	7T (Head mark 7 or ⊖)	8T (Head mark 8 or ⊕)
5	0.8	2.0 to 2.9 (0.2 to 0.3)	3.9 to 5.9 (0.4 to 0.6)	4.9 to 6.9 (0.5 to 0.7)
6	1.0	3.9 to 5.9 (0.4 to 0.6)	6.9 to 10.8 (0.7 to 1.1)	7.8 to 11.8 (0.8 to 1.2)
8	1.25	8.8 to 13.7 (0.9 to 1.4)	16.7 to 25.5 (1.7 to 2.6)	19.6 to 29.4 (2.0 to 3.0)
10	1.25	18.6 to 27.5 (1.9 to 2.8)	34.3 to 53.9 (3.5 to 5.5)	44.1 to 58.8 (4.5 to 6.0)
	1.5	17.7 to 26.5 (1.8 to 2.7)	32.4 to 49.0 (3.3 to 5.0)	42.1 to 58.8 (4.3 to 6.0)
12	1.25	33.3 to 49.0 (3.4 to 5.0)	68.6 to 93.2 (7.0 to 9.5)	83.4 to 108 (8.5 to 11)
	1.75	30.4 to 46.1 (3.1 to 4.7)	63.7 to 83.4 (6.5 to 8.5)	73.5 to 98.1 (7.5 to 10)
14	1.5	58.8 to 83.4 (6.0 to 8.5)	118 to 157 (12 to 16)	127 to 177 (13 to 18)
	2.0	53.9 to 73.5 (5.5 to 7.5)	108 to 137 (11 to 14)	118 to 167 (12 to 17)
16	1.5	93.2 to 127 (9.5 to 13)	177 to 235 (18 to 24)	196 to 265 (20 to 27)
	2.0	88.3 to 118 (9.0 to 12)	157 to 216 (16 to 22)	186 to 255 (19 to 26)

Flange bolts and nuts

Unit: N m (kgf m)

Dia. mm	Pitch mm	4T (Head mark 4 or ○)	7T (Head mark 7 or ⊖)	8T (Head mark 8 or ⊕)
6	1.0	3.9 to 5.9 (0.4 to 0.6)	7.8 to 11.8 (0.8 to 1.2)	8.8 to 13.7 (0.9 to 1.4)
8	1.25	9.8 to 14.7 (1.0 to 1.5)	18.6 to 27.5 (1.9 to 2.8)	21.6 to 32.4 (2.2 to 3.3)
10	1.25	20.6 to 30.4 (2.1 to 3.1)	38.2 to 58.8 (3.9 to 6.0)	49.0 to 63.7 (5.0 to 6.5)
	1.5	18.6 to 28.4 (1.9 to 2.9)	35.3 to 53.0 (3.6 to 5.4)	44.1 to 63.7 (4.5 to 6.5)
12	1.25	37.3 to 53.9 (3.8 to 5.5)	78.5 to 108 (8.0 to 11)	88.3 to 118 (9.0 to 12)
	1.75	33.3 to 51.0 (3.4 to 5.2)	68.6 to 93.2 (7.0 to 9.5)	83.4 to 108 (8.5 to 11)



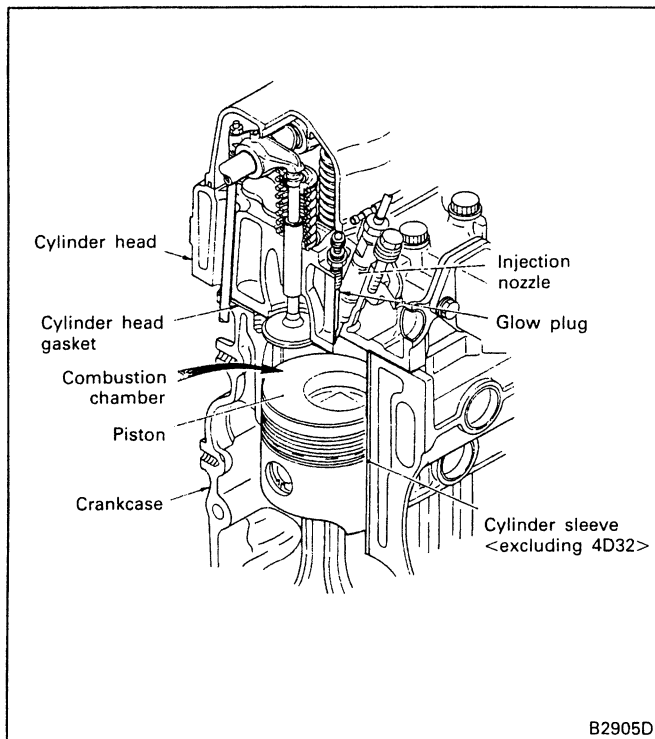
ENGINE

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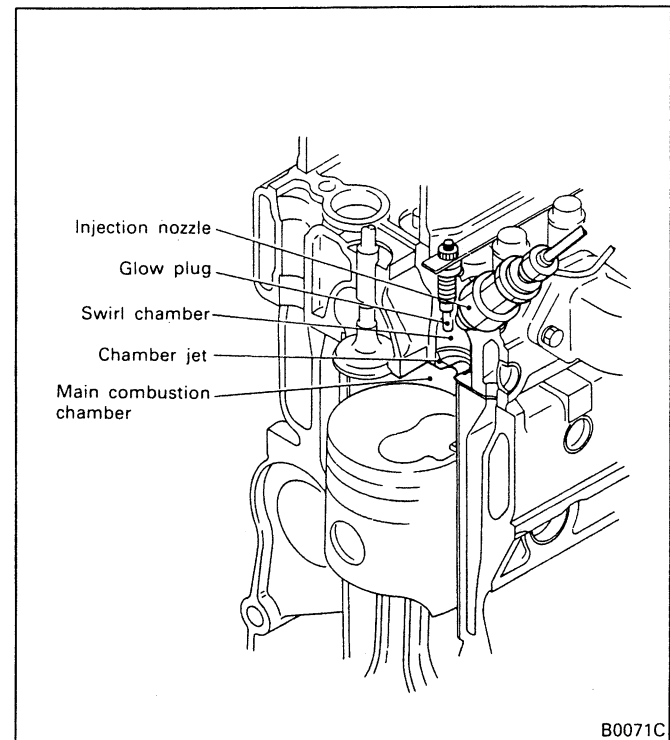
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1. GENERAL**(1) Combustion Chamber**

(a) 4D31, 4D31-T, 4D32



(b) 4DR5



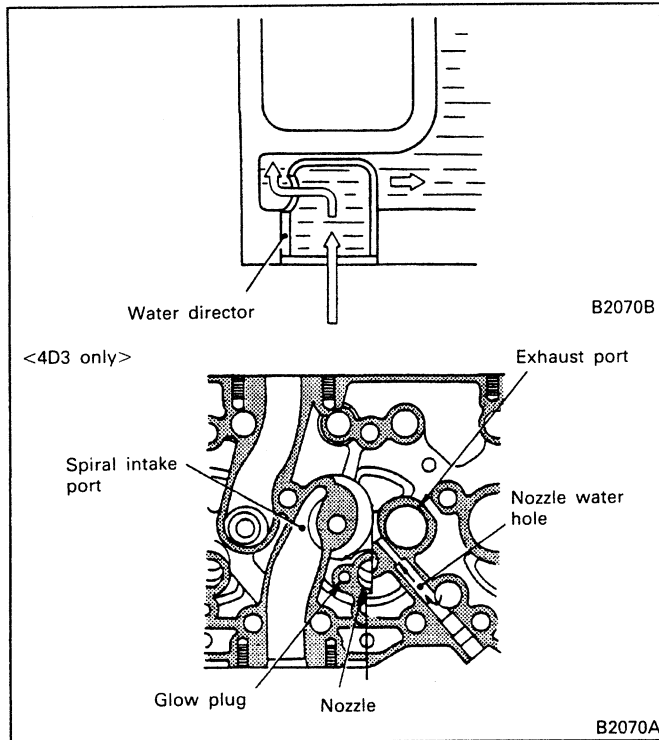
The combustion chamber consists of the cylinder head and toroidal pistons, hole type injection nozzles and sheathed type glow plugs being installed in the cylinder head.

Combustion occurs when the fuel is directly injected into the combustion chamber with the power operating the piston directly.

The combustion chamber is formed by the lobes-shaped main combustion chamber in the piston head and Mitsubishi's own bell-shaped swirl chamber.

A chamber jet is press-fitted into the swirl chamber that is made of material with little thermal expansion and good thermal conductivity. Also installed in the chamber are the sheathed glow plug and throttle injection nozzle.

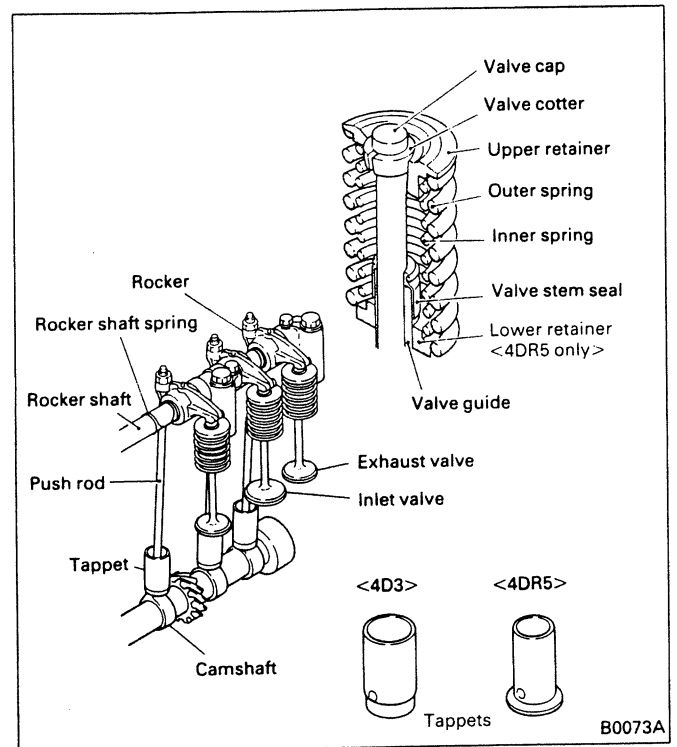
The upward movement of the piston during the compression stroke imparts a violent swirling motion to the air charged into the swirl chamber, to which fuel is injected for combustion. As the combustion goes on, the gas moves from the swirl to main combustion chamber where it is mixed with the air present. And further combustion occurs.



(c) Water Director

For more effective cooling of the combustion chamber, water directors that direct coolant flow are pressed into the bottom of the cylinder head. The 4D3 engine cylinder head has a nozzle water hole provided for higher cooling effect.

(2) Valve Mechanism



The valve mechanism is an overhead valve type.

(a) Both the inlet and exhaust valves are made of surface-treated heat-resistant steel. The valve seat angle is 45° in both valves.

Valve stem seal is mounted to the valve stem, which controls the amount of lubricant on the sliding surfaces between the valve and valve guide.

A valve guide with carbon cutter is used for the exhaust side.

(b) Two unevenly pitched valve springs are used, the inner and outer with coil directions opposite to each other.

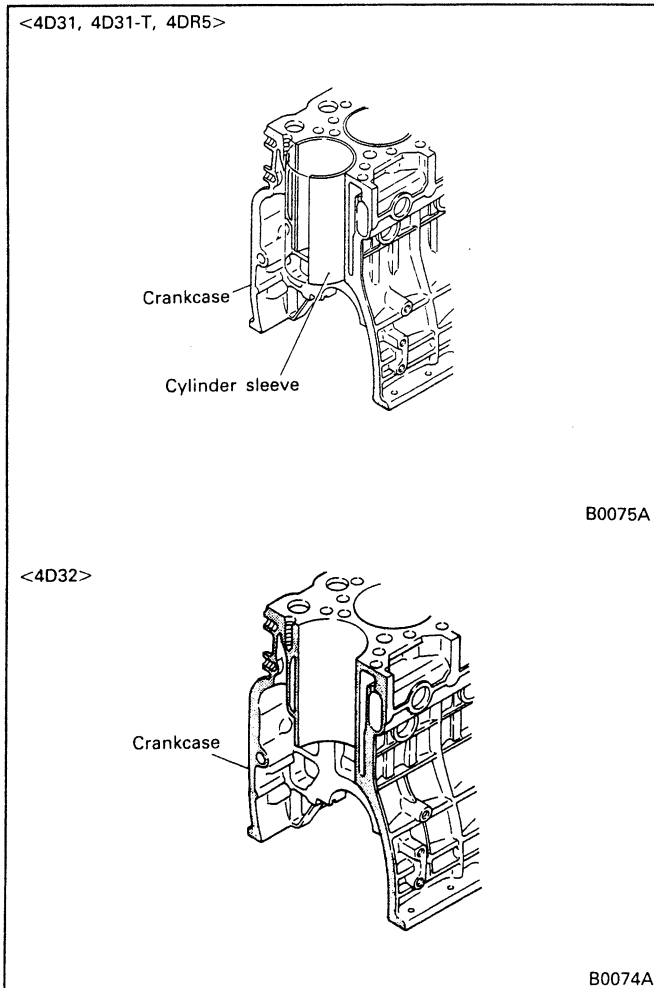
(c) The rocker has an induction-hardened surface in contact with the valve cap. A bushing is used in the hole, into which the rocker shaft is fitted. Because of them, wear resistance is improved.

(d) The rocker shaft is a hollow round rod with sealing caps at both ends to seal it off. Its inside is an engine oil passage.

(e) The push rod has a steel ball welded to its bottom end and a spherical or depressed piece welded to its top end. Both ends are carburized case-hardened.

- (f) The tappet on the 4D3 is of cylindrical shape, while that on 4DR5 of mushroom-shape. Its mating surface with the camshaft is a large-diameter sphere to prevent local wear.
- (g) The camshaft is provided with an oil pump drive gear, with its journals, cams, and gear induction-hardened.
The cam on 4D3 is a taper cam.

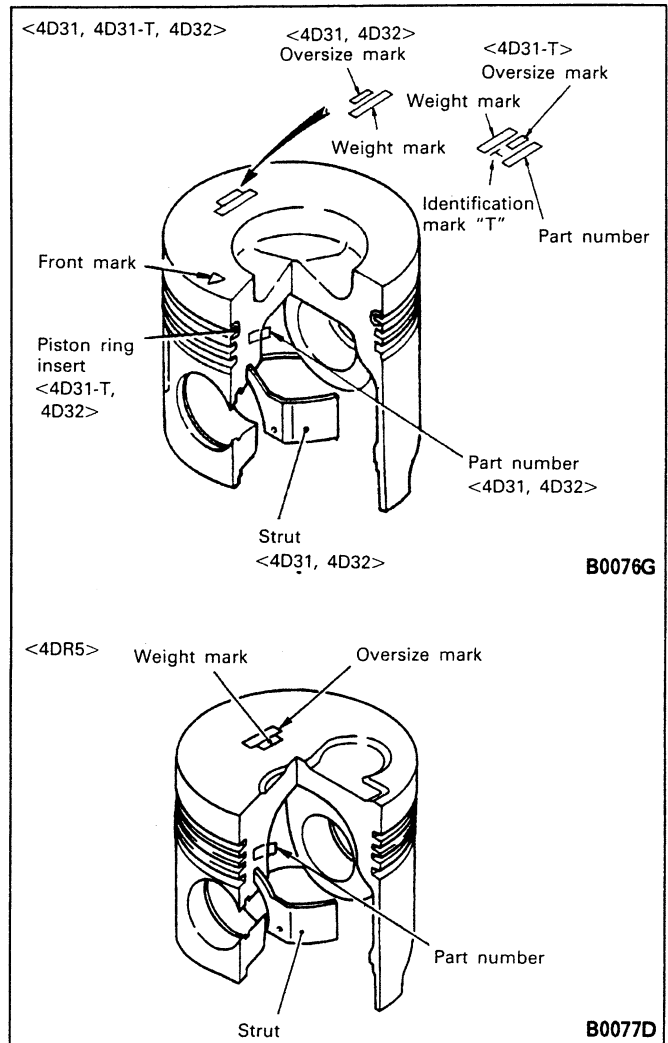
(3) Crankcase and Cylinder Sleeve



- (a) The crankcase is made of cast iron and built rigid with minimum stress concentration and deformation.
- (b) Three camshaft bushings are installed in the camshaft bearings of the crankcase. To facilitate insertion and removal of the camshaft from the front end of the crankcase, the bushing I.D. is made smaller toward the rear.
- (c) On 4D31, 4D31-T and 4DR5 engines, cylinder sleeves are press-fitted into the crankcase.

(4) Piston and Piston Ring

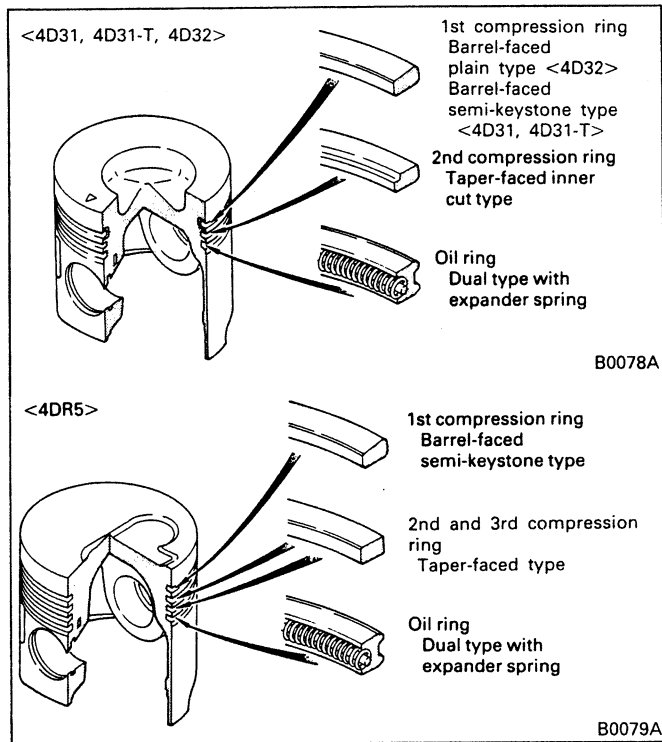
(a) Piston



The piston, made of aluminum alloy casting, has a strut inside (no strut installed on 4D31-T) that ensures an adequate clearance between the piston and cylinder sleeve.

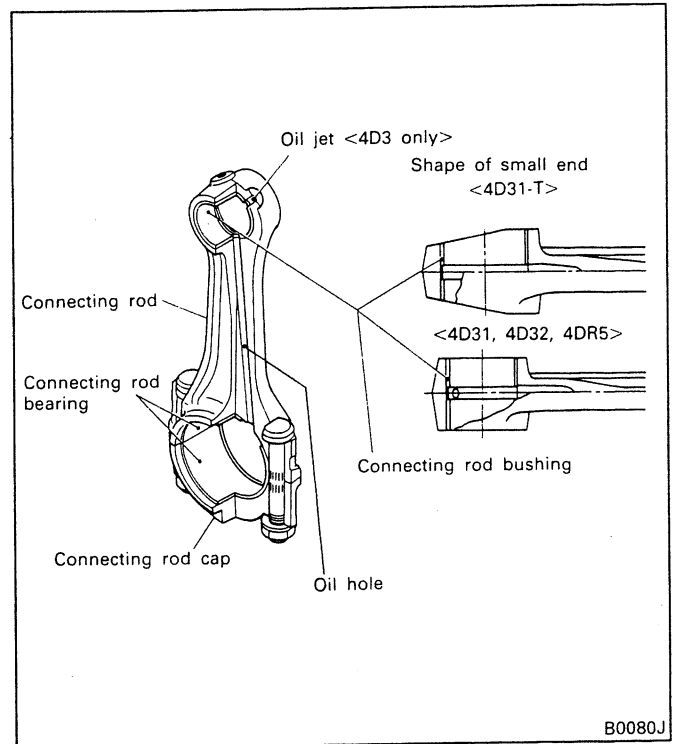
The piston pin arrangement is full-floating. The piston pin is offset toward the thrust side, which, together with the effect of the strut, minimizes piston slap. Stamped on the top surface of the piston are the piston weight mark, part number, oversize mark (oversize piston only) and the front mark "◁". On 4D31-T and 4D32, a piston ring insert is cast in the top ring groove for increased durability.

(b) Piston Ring



There are three or four piston rings installed: two compression rings (three on 4DR5) and one oil ring. Piston rings are shaped as illustrated.

(5) Connecting Rod and Connecting Rod Bearing



The connecting rod is a die forging with an I cross section ensuring high rigidity. A lead bronze bushing is press-fitted into its small end, while a split-style plain bearing is used in its big end.

An oil passage is provided obliquely through the stem and an oil jet at the small-end to lubricate the small-end bushing and cool the piston (4D3 only). The connecting rod small end of 4D31-T is wedge-shaped.

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