KOBELCO

SERVICE MANUAL

ENGINE

Mitsubishi
6D1

DIESEL

97821-02022-00 NA

APPLICABLE ENGINE MODELS:
6D14, 6D14-T
6D15, 6D15-T
6D16, 6D16-T

Issued 03-1991

6D1

ENGINE

Shop Manual

FOREWORD

This shop manual contains the specifications, construction, operation, adjustment and service procedures of the Model 6D1 series 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.

MAR. 1991

Applicable Engine Models

6D14
6D14-T
6D15
6D15-T
6D16
6D16-T

For industrial use

GROUP INDEX

COMPILATION OF THIS MANUAL

CONTENTS

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), flywheel PTO, 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, preheating system, relays, automatic stop device, specifications, service standards, troubleshooting
21	Clutch	Clutch proper, bearing case, specifications, service standards, special tools, troubleshooting
61	Special equipment	Air compressor, pressure governor, specifications, service standards, special tools

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).

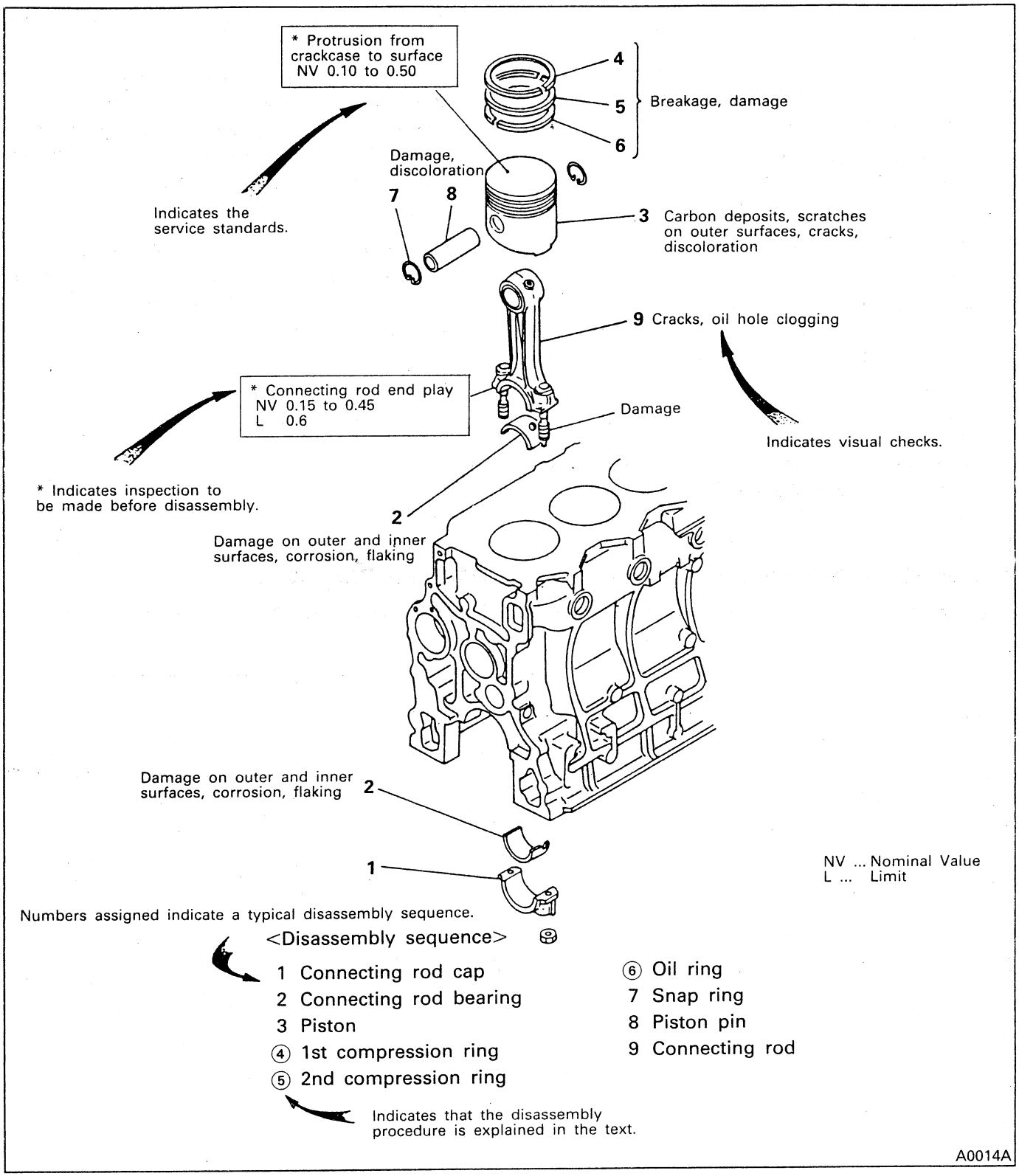
3. CONVERSION TABLE FOR SI UNITS INTO FOOT-POUND UNITS

A system of units used in this manual is SI (International System of Units). When the units are converted to those used in the foot-pound system, use the following conversion table.

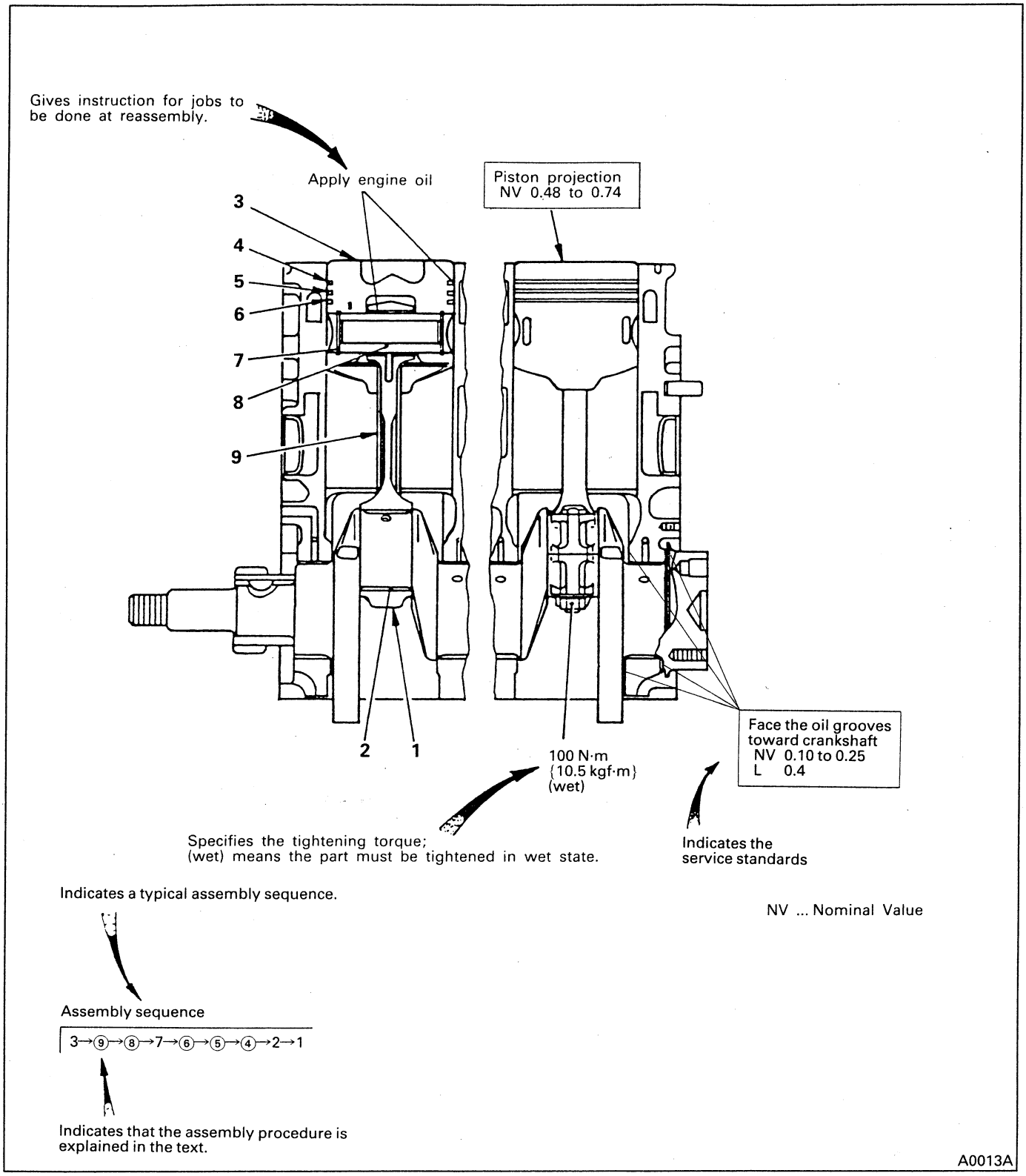
Unit	Sign of SI unit	Sign of foot-pound unit	Conversion rate
Mass quantity of matter	kg g	lb oz	1 kg = 2.2046 lb 1 g = 0.035274 oz
Dimension	m mm	ft. in.	1 m = 3.2808 ft. 1 mm = 0.03937 in.
Capacity	L cm^3 cm^3	gal. oz cu.in.	1 L = 0.2642 gal. (U.S.) 1 L = 0.220 gal. (Imp.) 1 cm^3 = 0.033814 oz (U.S.) 1 cm^3 = 0.035195 oz (Imp.) 1 cm^3 = 0.061023 cu.in.
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	lbf.ft	1 N·m = 0.7375 lbf.ft
Output	kW (kilowatt)	HP	1 kW = 1.34 HP
Temperature	°C	°F	t°C = (1.8t°C + 32)°F

4. READING THE ILLUSTRATION

(Ex. 1: Disassembly and Inspection)



(Ex. 2: Reassembly)



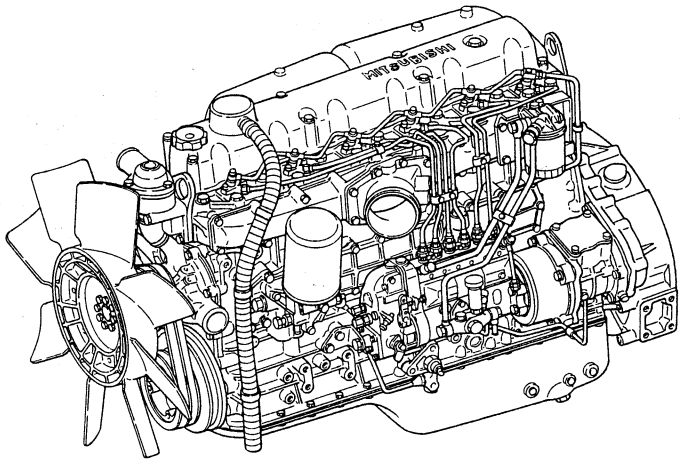
Illustrations (exploded views and assembly drawings) show a typical service procedures if it is identical among various types of available systems and units.

GENERAL

CONTENTS

1. EXTERNAL VIEW

<Engine without turbocharger>



* This illustration shows 6D14 engine.

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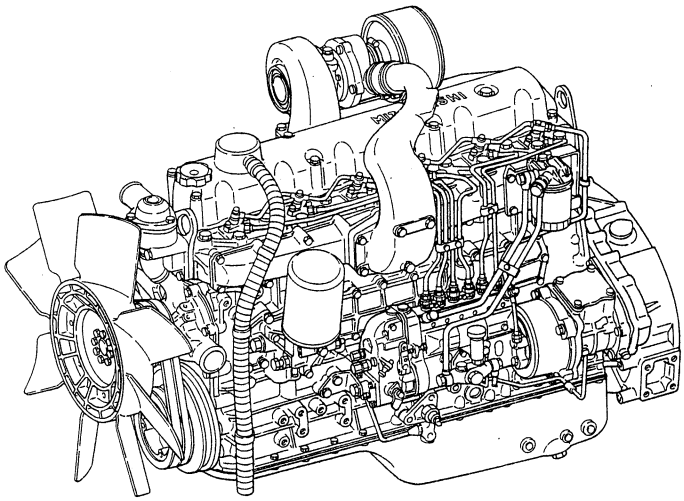
<Engine with turbocharger>



* This illustration shows 6D14-T engine.

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2. MAJOR SPECIFICATIONS

2.1 Major Specifications

Item \ Engine model	6D14	6D14-T (Turbocharged)	6D15	6D15-T (Turbocharged)	6D16	6D16-T (Turbocharged)
Type	Water cooled, 4-cycle diesel engine					
Combustion method	Direct injection					
No. and arrangement of cylinder	Six in-line					
Bore x stroke mm	110 x 115		113 x 115		118 x 115	
Total displacement cm^3	6557		6919		7545	
Engine dimension (with fan, without air cleaner)						
Overall length mm	1210					
Overall width mm	733					
Overall height mm	825					
Empty mass kg*	500	510	500	510	550	

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

2.2 Engine Outputs Classified By Application

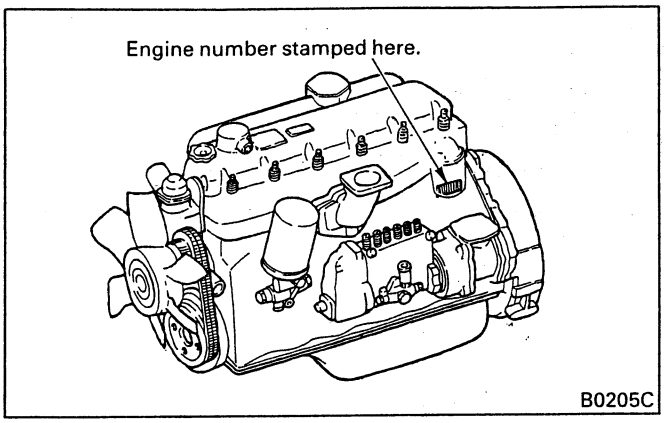
Application \ Engine model	6D14	6D14-T		6D16	6D16-T	
		Middle-speed specification	High-speed specification		Middle-speed specification	High-speed specification
Intermittent rated output kW(HP)	59 (79)/1500	83 (111)/1500	79 (106)/1500	73 (98)/1500	106 (142)/1500	101 (136)/1500
	70 (94)/1800	98 (132)/1800	95 (127)/1800	87 (116)/1800	123 (165)/1800	121 (163)/1800
	77 (103)/2000	106 (143)/2000	103 (139)/2000	95 (128)/2000	131 (176)/2000	131 (175)/2000
	82 (110)/2200	111 (150)/2200	111 (150)/2200	103 (139)/2200	140 (188)/2200	139 (186)/2200
	87 (117)/2500		120 (161)/2500	113 (152)/2500		147 (197)/2500
	92 (123)/2800		126 (168)/2800	123 (165)/2800		151 (203)/2800
Continuous rated output kW(HP)	53 (72)/1500	75 (101)/1500	72 (96)/1500	66 (89)/1500	96 (129)/1500	92 (123)/1500
	64 (86)/1800	89 (120)/1800	86 (115)/1800	79 (106)/1800	111 (149)/1800	110 (148)/1800
	70 (93)/2000	96 (129)/2000	94 (126)/2000	87 (116)/2000	119 (160)/2000	118 (158)/2000
	74 (99)/2200	101 (136)/2200	101 (136)/2500	94 (126)/2200	127 (170)/2200	125 (168)/2200
	79 (106)/2500		109 (146)/2500	103 (139)/2500		133 (178)/2500
	83 (111)/2800		114 (153)/2800	112 (150)/2800		137 (184)/2800

NOTE:

1. **The output (SAE, gross) is corrected to standard ambient conditions based on SAE J1349.**
2. **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 position shown in the illustration.

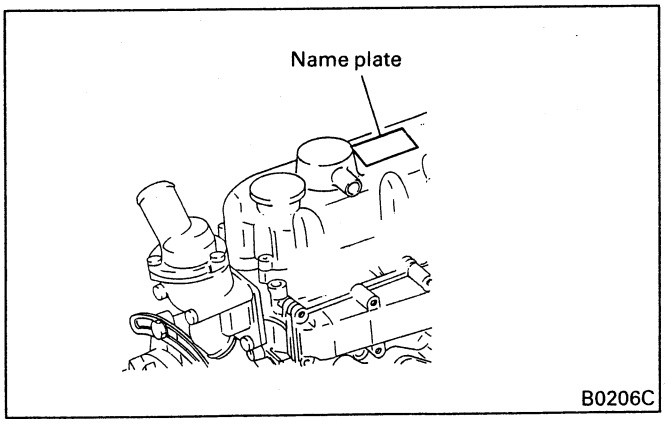
Ex.: 6 D 16 - 5 0 0 0 0 1

Engine number

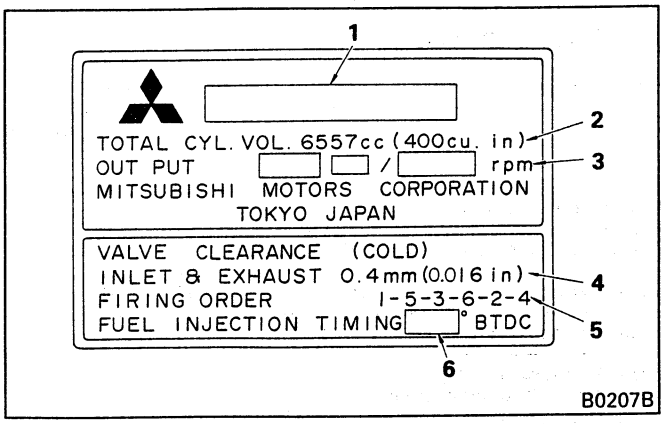
Engine model

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

(2) Name plate



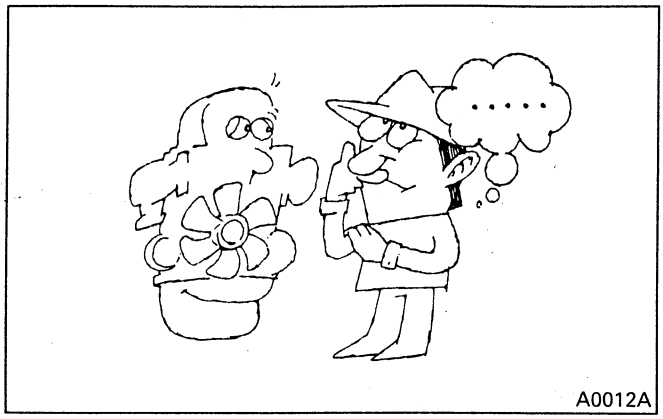
The name plate is attached to the portion shown in the illustration, and indicate the following items.



1. Engine model
2. Total displacement
3. Maximum output
4. Valve clearance
5. Firing order
6. 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: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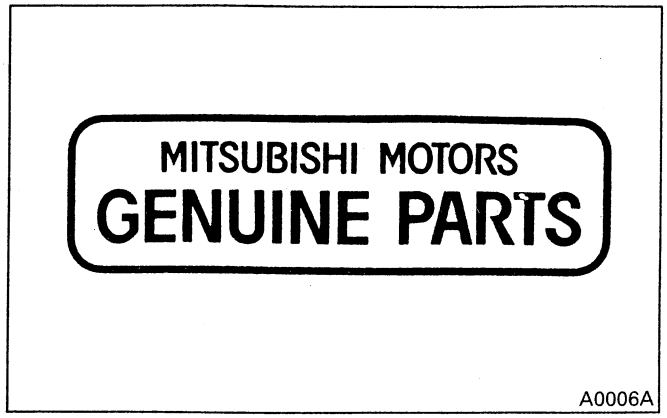
1) Before performing the service procedures given in this manual, know the trouble spots and isolate the possible cause to determine whether the removal or disassembly procedure is required.
2) Select a flat surface for the service job.
3) When servicing the electrical system, be sure to disconnect the (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.



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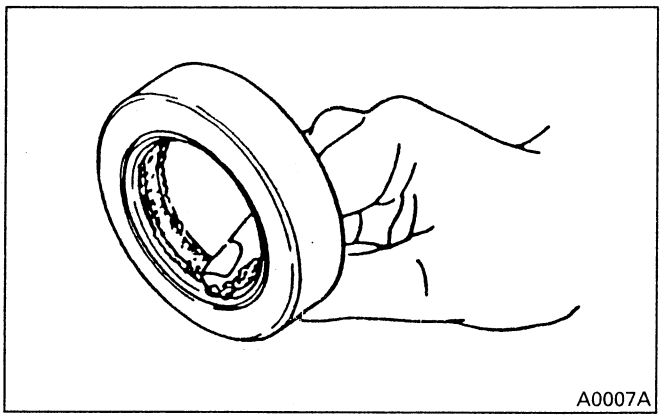
7) The oil seals, packings, O-rings, and other rubber parts, gaskets, and split pins must be replaced with a new one whenever they are removed. For replacement, use Mitsubishi Genuine parts.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8) Apply the specified grease to U-packings, oil seals, dust 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 any spattered 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

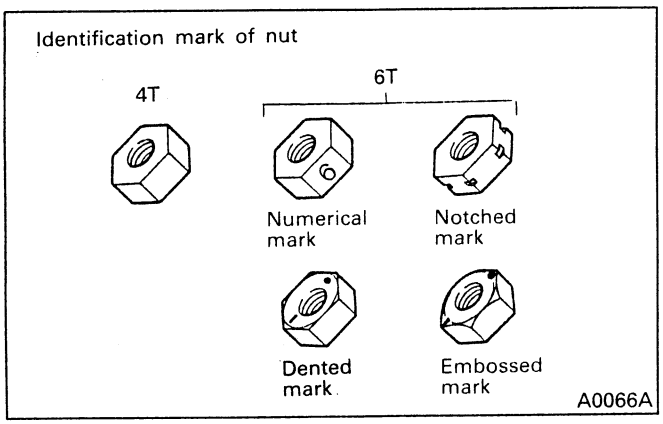
Unit: N·m {kgf·m}

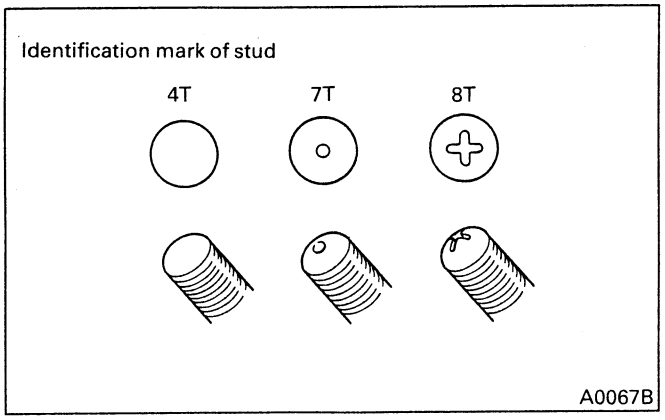
Dia. mm	Pitch mm	4T (Head mark 4 or ○)	7T (Head mark 7 or ⊖)	8T (Head mark 8 or ⊕)
5	0.8	2.0 to 2.9 {0.2 to 0.3}	3.9 to 5.9 {0.4 to 0.6}	4.9 to 6.9 {0.5 to 0.7}
6	1.0	3.9 to 5.9 {0.4 to 0.6}	6.9 to 10.8 {0.7 to 1.1}	7.8 to 11.8 {0.8 to 1.2}
8	1.25	8.8 to 13.7 {0.9 to 1.4}	16.7 to 25.5 {1.7 to 2.6}	19.6 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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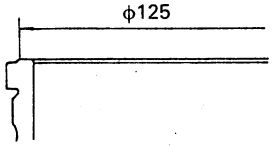
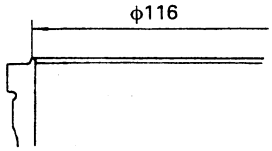
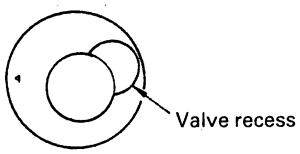
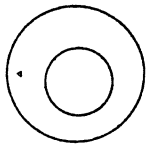
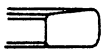
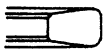
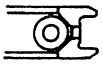
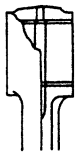
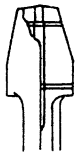
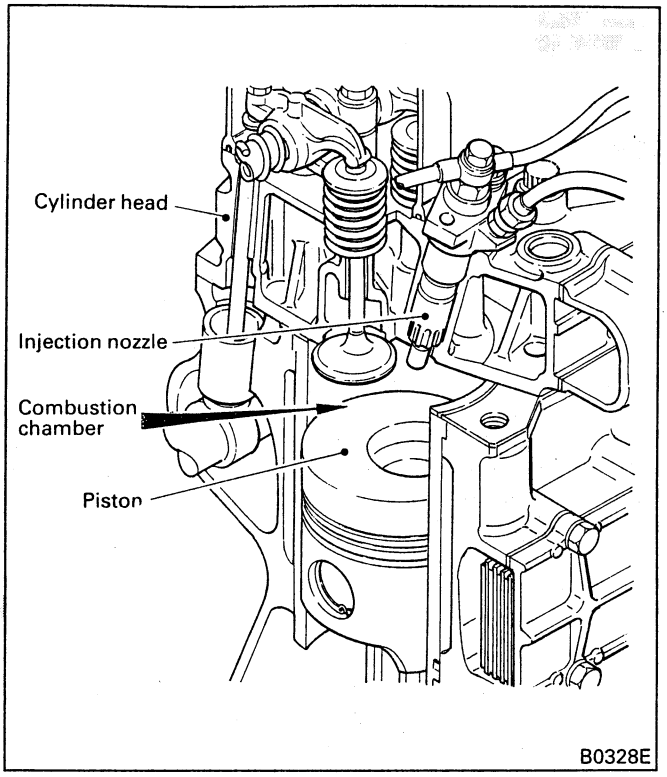
The 6D15-T engine comes in two types; types A and B which are different in specifications for piston, etc. Perform Type A or B service procedure according to the indication. (The procedure without any indication is common to both types.) The differences between the two types are shown below.

	6D15-T Type A	6D15-T Type B
Cylinder liner		
Piston		
Piston ring	 1st compression ring (semi–keystone type)  Oil ring	 1st compression ring (full–keystone type)  Oil ring
Connecting rod	 Shape of small end: Straight	 Shape of small end: Tapered

1. GENERAL

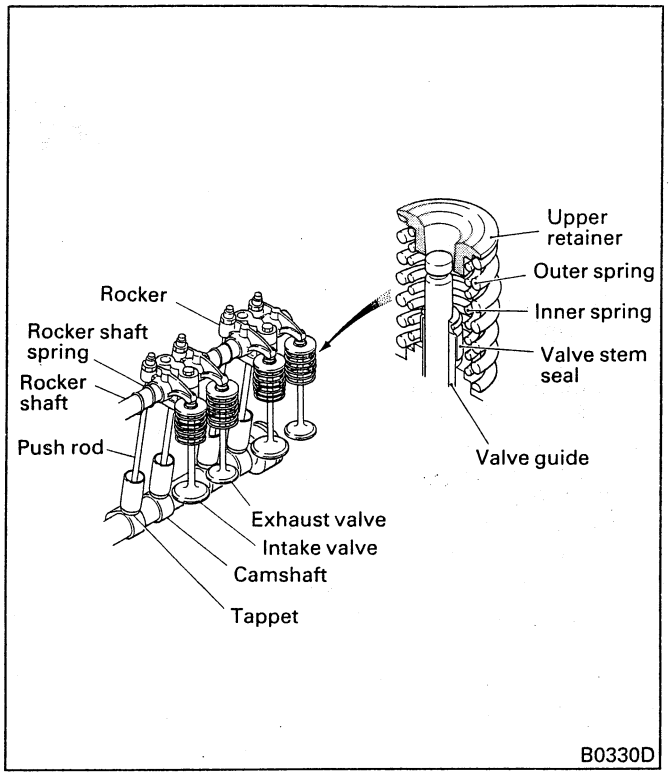
1.1 Engine Proper

(1) Combustion chamber



The combustion chamber consists of the cylinder head and piston, and the hole type injection nozzle is installed in the cylinder head.
Combustion occurs when the fuel is directly injected into the combustion chamber.

(2) Valve mechanism



(a) Both the intake 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 valve.

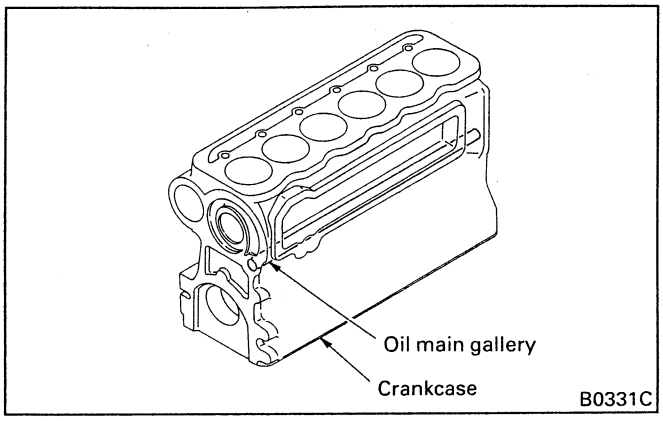
(b) Two unevenly pitched valve springs are used, the inner and outer with coil directions opposite to each other to prevent surging at high speed.

(c) The carbon-steel, precision forged rocker has an induction-hardened tip. The rocker shaft is a hollow round rod with expansion plugs at both ends to seal it off. The inside of the shaft serves as an engine oil passage.

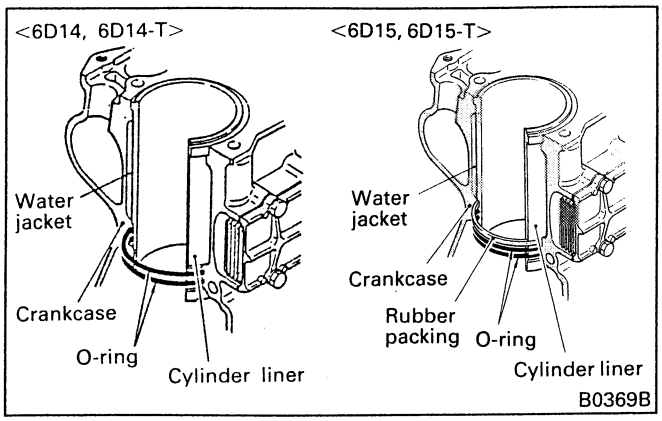
(d) The push rod has a steel ball welded to its bottom end and a spherical or depressed piece welded to its top end. Both ends are carburized case-hardened.

(e) The tappet is of cylindrical shape. Its mating surface with the camshaft is a sphere.
The tappet can be removed by removing the cylinder head without removing the camshaft.
(f) Because of the high cam design, the push rod is shorter, assuring higher rigidity and dependability for high speeds.
(g) To facilitate insertion and removal of the camshaft from the rear end of the crankcase, the camshaft bearing diameter is smaller toward the front end.

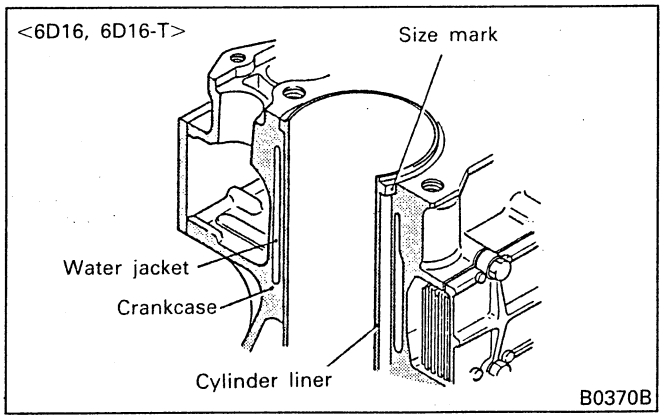
(3) Crankcase and cylinder liner



(a) The crankcase is made of cast iron, provided with ribs to improve rigidity and built rigid with minimum stress concentration and deformation.
(b) The oil main gallery is provided on the right side, facing the front, and supplies the engine oil passed through the oil filter and oil cooler to various parts.
On all engines except the 6D14 and 6D15, an oil jet is provided for each cylinder to cool the piston. [Refer to Group 12 Lubrication.]



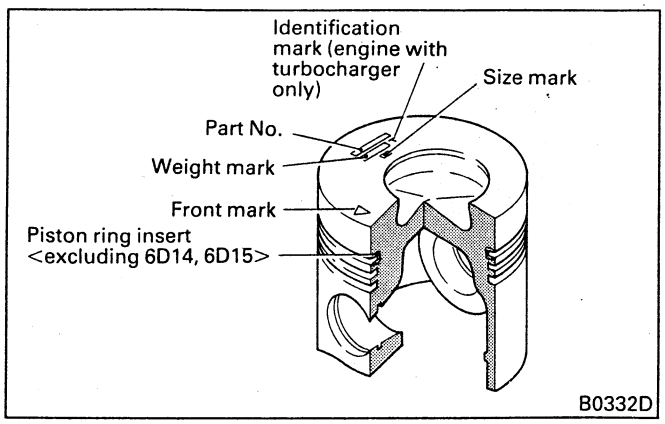
(c) The coolant that has entered the water jacket cools each cylinder and is then routed to the cylinder head.
(d) The cylinder liner except in the 6D16 and 6D16-T is a removable wet type fitted in the crankcase at the top of the crankcase and the bottom of the water jacket. To prevent water leakage, an O-ring and rubber packing are provided.
On the 6D14 and 6D14-T, an O-ring groove is provided on the crankcase side. On the 6D15 and 6D15-T, an O-ring groove is provided on the cylinder liner side.



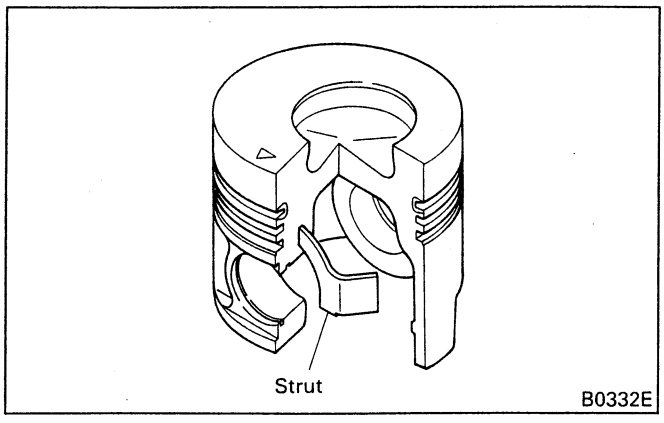
The 6D16 and 6D16-T employ a dry type cylinder liner fitted in the crankcase for ease of removal.
On the side face of the cylinder liner flange, a size mark is stamped for selective fit with the crankcase.

(4) Piston and piston ring

(a) Piston

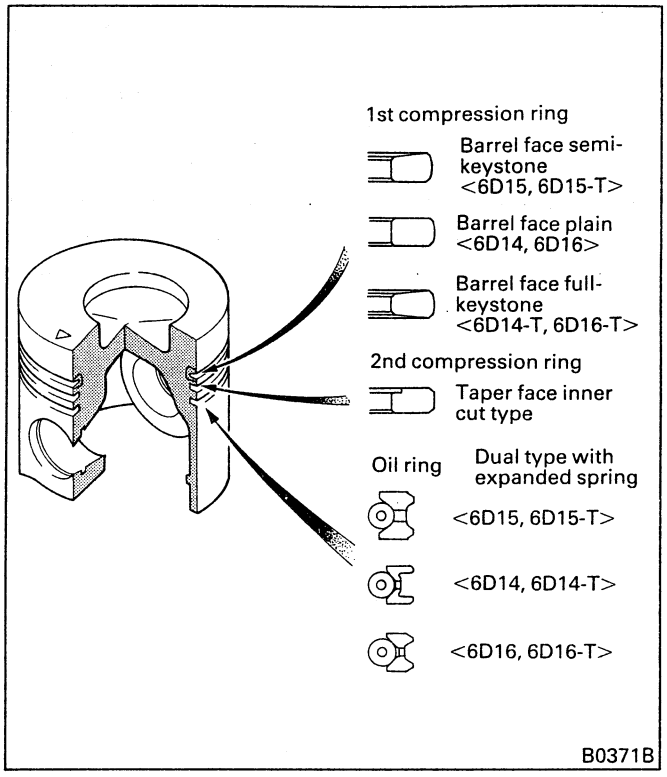


The piston is made of an aluminum alloy casting , has a combustion chamber on its top.
On all engines except the 6D14 and 6D15, a Niresist piston ring insert is cast into the 1st ring groove to provide higher durability.
Stamped on the top surface of the piston are the part number, weight mark, size mark and the front mark "△".
The piston pin is mounted using the full floating method, offset from the cylinder center.



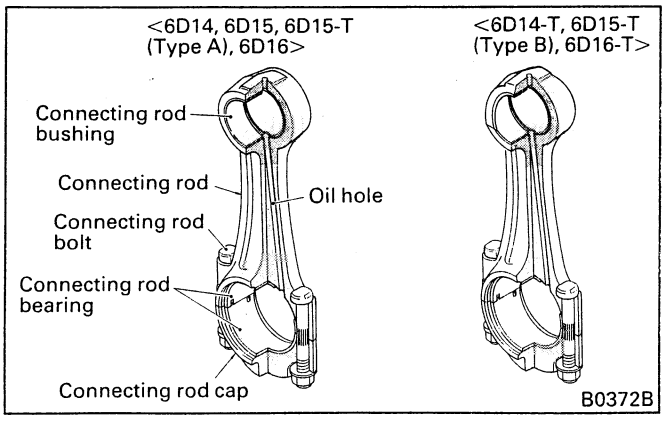
The pistons for the 6D16 engine have an internal strut to reduce piston slap noise.

(b) Piston ring



There are three piston rings installed: two compression rings and one oil ring.
These rings are hard chrome plated to improve wear resistance. Piston rings are shaped as illustrated.

(5) Connecting rod and connecting rod bearing

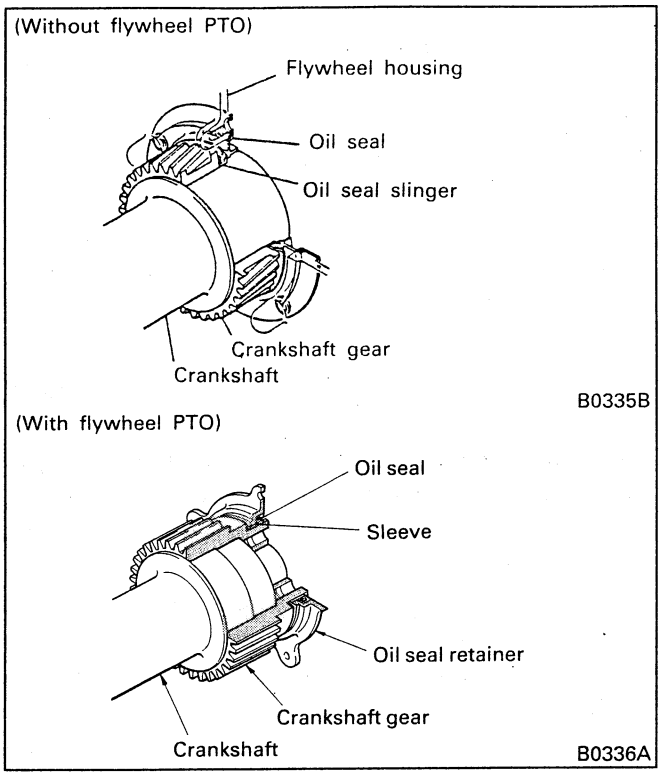


The connecting rod is a die-forged part with I-cross section, and a lead bronze bushing is press-fitted into its the small end, while a split-style plain bearing is its big end.

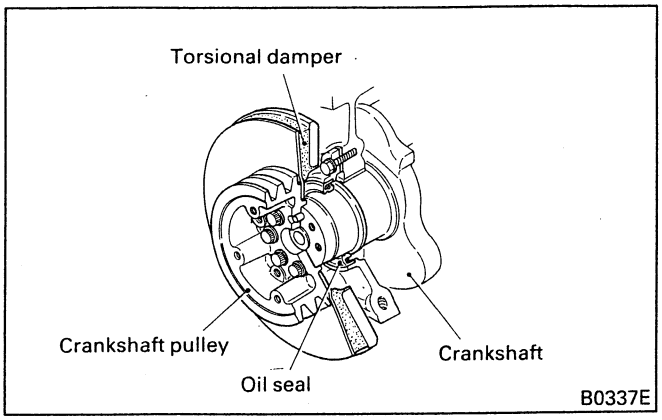
The connecting rod and connecting rod cap are coupled by a connecting rod bolt.
For forced circulation of oil through the small end bushing, a diagonal oil passage is provided in the stem portion. The 6D14-T, 6D15-T (B type) and 6D16-T employ a wedge type connecting rod small end to reduce the surface pressure of the piston pin boss, thereby reducing the mechanical stress that occurs in the piston.

(6) Crankshaft and main bearing

(a) Crankshaft

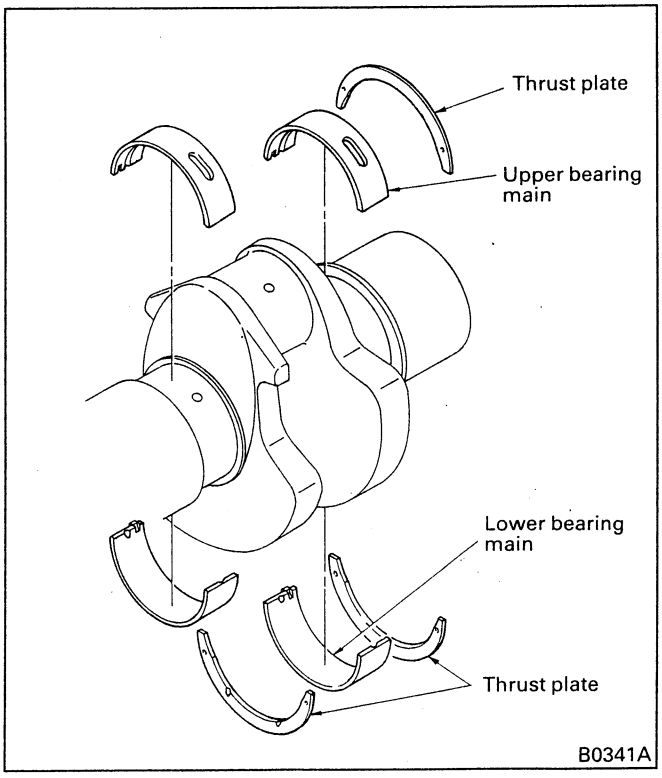


The crankshaft is integrally stamp forged with the balance weight and is supported in the crankcase by the main bearing.
The pin and journal portions are induction hardened to provide higher resistance to wear. Between each journal and pin portion, an oil hole is provided, through which some of the lubricating oil of the main bearing is routed to the pin portion to lubricate the connecting rod bearing.
The crankshaft gear which drives the timing gear is fitted in the rear of the crankshaft.
An oil seal is provided at the front and rear of the crankshaft. The rear oil seal is an axial lip type oil seal for the flywheel without a PTO, or a radial lip type oil seal for the flywheel with a PTO.



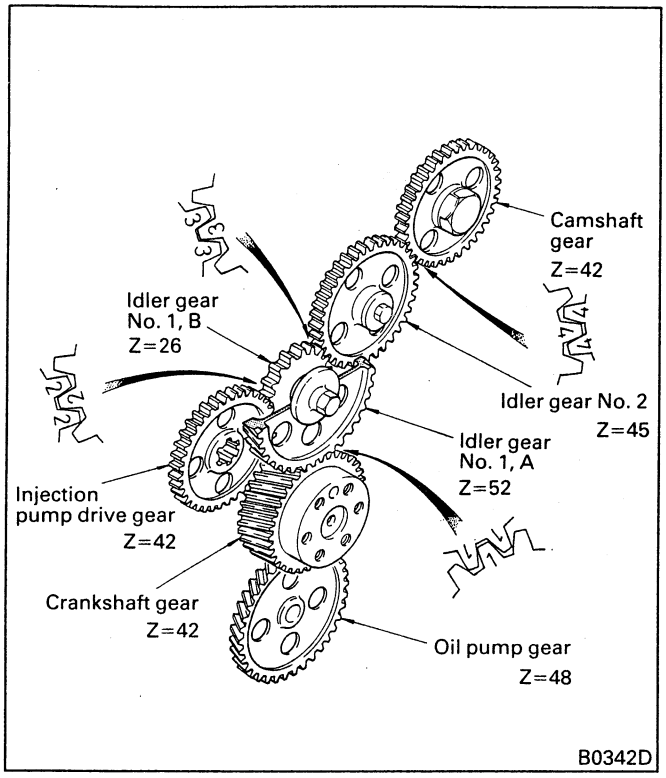
At the front of the crankshaft, a torsional damper is mounted along with the pulley to prevent torsional vibration of the crankshaft.

(b) Main bearing



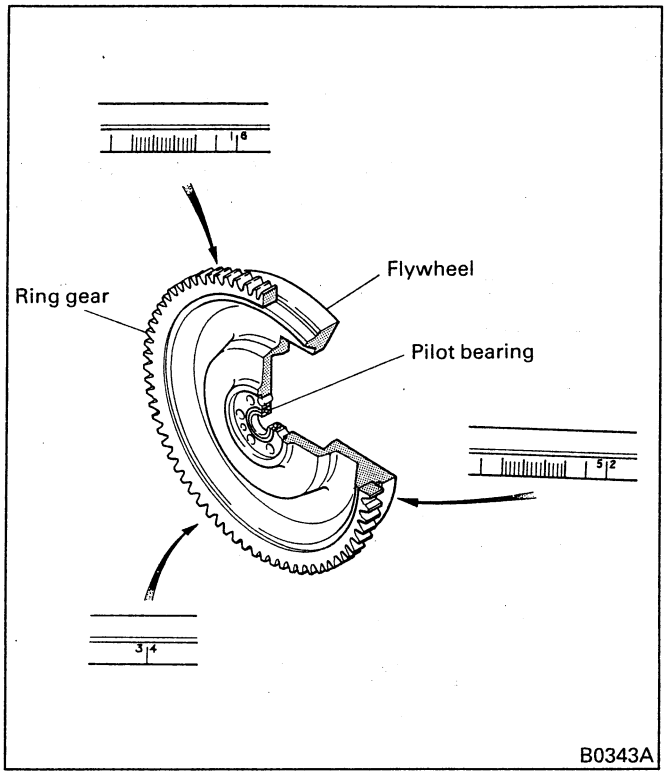
The main bearing is a split type plain bearing.
The upper main bearing has an oil groove and the lower bearing has no oil groove.
Split style thrust plate are mounted to the end of crankshaft to support the thrust force of the crankshaft.

(7) Timing gears



The timing gears are housed in the rear of the engine. Illustration shows the gear train.
The crankshaft gear drives the camshaft gear and air compressor (or injection pump) drive gear via the idler gears. It also drives the oil pump gear.
A timing mark is stamped on each gear. At reassembly, correct meshing can be achieved by aligning these marks.

(8) Flywheel



The flywheel is made of cast iron. The pilot bearing of the transmission drive pinion is installed at its center.
On its periphery, the ring gear is shrink-fitted that meshes with the starter pinion.
The ring gear tooth crests are induction-hardened for greater durability. At the same time, one side of the crests is chamfered to ensure that the starter pinion meshes easily when starter is operated.
The cylinder numbers and angle scale are stamped on the outside periphery of the flywheel.

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