

Article Text

For cyph8r pacific la ca 92101
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Sunday, September 30, 2012 05:55PM

ARTICLE BEGINNING

DIESEL ENGINES

Mitsubishi 6D14, 6D16 & 6D31 6-Cylinder

ENGINE IDENTIFICATION

Engine identification number is located on left rear side of cylinder block. See Fig. 1. Engine identification number is 8th digit of Vehicle Identification Number. See MITSUBISHI 6D14 & 6D16 6-CYLINDER TUNE-UP article for Engine Code table. For procedures requiring firing order or cylinder arrangement information, refer to the Firing Order illustration. See Fig. 2.

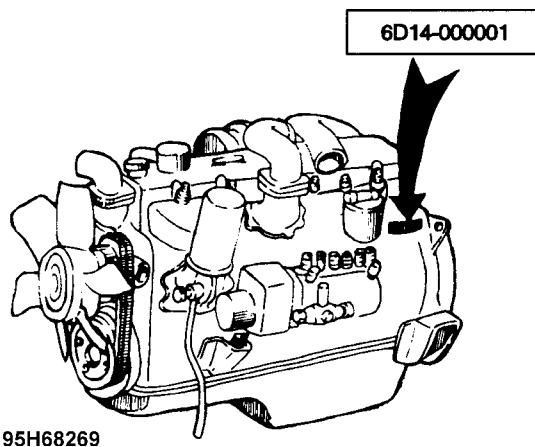


Fig. 1: Engine Identification Plate
Courtesy of Mitsubishi Fuso.

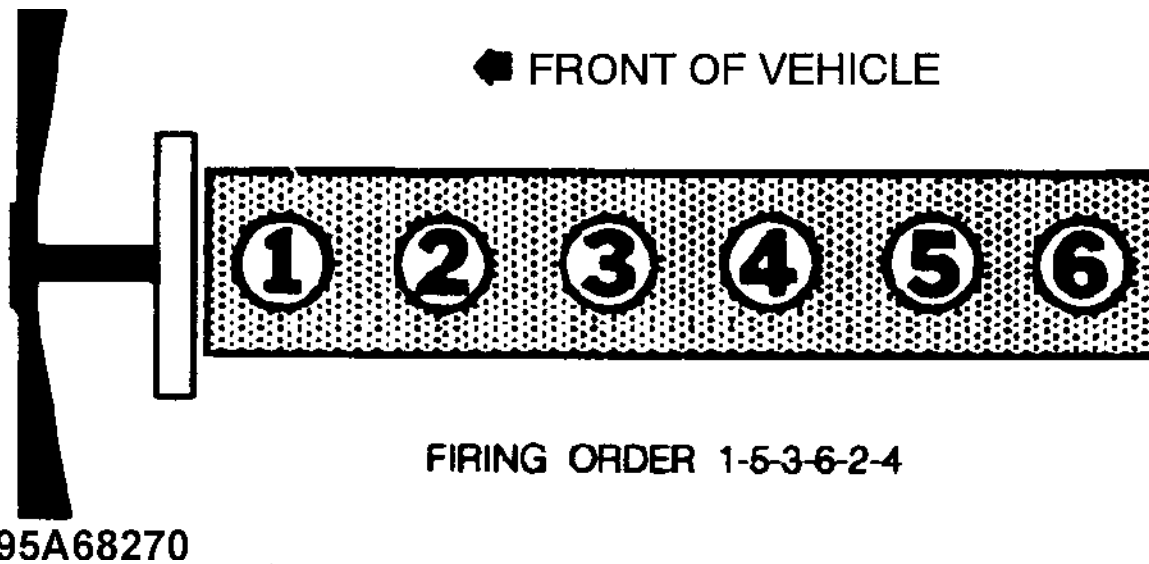


Fig. 2: Cylinder Designation & Firing Order
Courtesy of Mitsubishi Fuso.

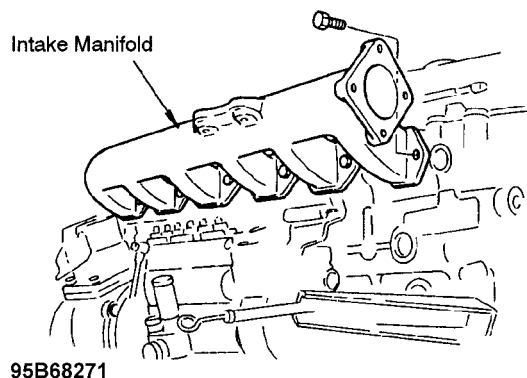
FIRING ORDER

INTAKE & EXHAUST MANIFOLDS

INTAKE MANIFOLD

Removal

Remove pipes around air compressor. Remove air intake pipes. Remove glow plug connecting plate. Remove injection pipe. Remove fuel filter. Remove intake manifold. See Fig. 3.



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Fig. 3: Removing Intake Manifold
Courtesy of Mitsubishi Fuso.

Installation

To install, reverse removal procedure.

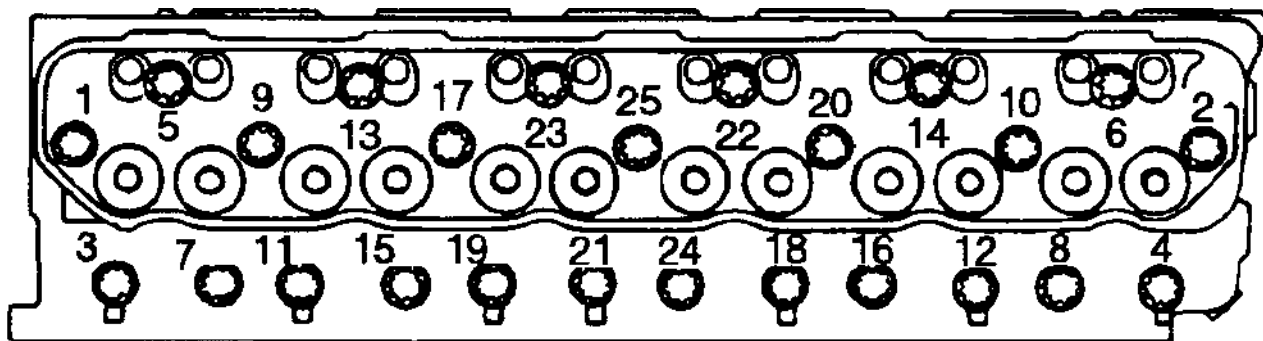
CYLINDER HEAD (REPLACEMENT)

Before disassembly of cylinder head assembly, following procedures must be performed;

- * Drain coolant.
- * Remove intake air pipe and intake manifold.
- * Remove exhaust manifold and turbocharger.
- * Remove glow plug.
- * Remove injection nozzles.

Removal

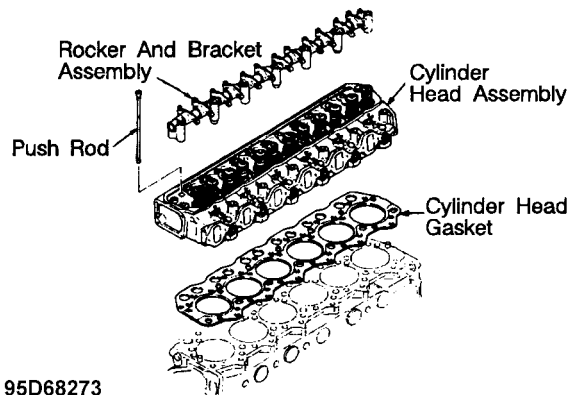
1) Before removing cylinder head bolts, loosen lock nuts and adjusting screws for cylinder in which push rods lift rockers. Loosen cylinder head bolts in sequence. Remove cylinder head bolts. See Fig. 4.



95C68272

Fig. 4: Cylinder Head Bolt Loosening Sequence
Courtesy of Mitsubishi Fuso.

2) Lift rocker and bracket assembly straight up and off. Remove cylinder head gasket. See Fig. 5.



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Fig. 5: Removing Rocker & Bracket
Courtesy of Mitsubishi Fuso.

3) Using special tool (Tappet Extractor), remove tappets from cylinder block. Inspect tappet.

Installation

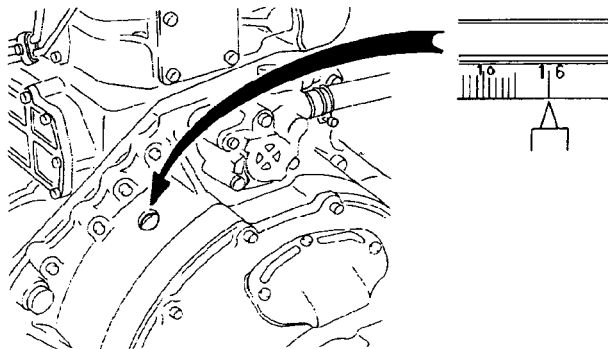
To install, reverse removal procedure.

VALVE ARRANGEMENT

I-E-I-E-I-E-I-E-I-E (Front-to-rear).

VALVE CLEARANCE ADJUSTMENT

1) Valve clearance must be checked and adjusted while engine is cold. Crank engine slowly to align inscribed line 1.6 of flywheel with pointer in flywheel housing inspection window. At time piston in cylinder, where push rod is not pushing rocker up, is at Top Dead Center (TDC) on compression stroke. See Fig. 6.



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Fig. 6: Inspection Window
Courtesy of Mitsubishi Fuso.

2) When piston in cylinder No.1 is at TDC on compression stroke, check and adjust appropriate valves. Rotate crankshaft 360°. With piston in cylinder No.6 at TDC on compression stroke, adjust remaining valves. See VALVE ADJUSTMENT SEQUENCE table. Crank engine another complete turn and check valve clearance of all valves.

VALVE ADJUSTMENT SEQUENCE TABLE

AA

Application: Cyl. 1 @ TDC Cyl. 6 @ TDC

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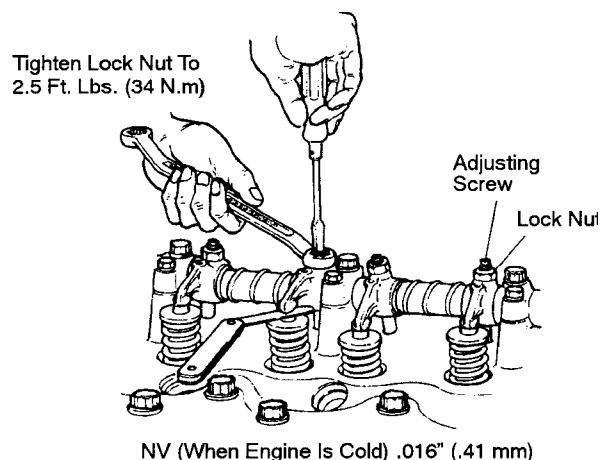
Cyl. No. 1 In/Ex N/A

Cyl. No. 2 In Ex

Cyl. No. 3	Ex	In
Cyl. No. 4	In	Ex
Cyl. No. 5	Ex	In
Cyl. No. 6	N/A	In/Ex

AA

4) Measure clearance between rocker arm and valve cap with a feeler gauge. Proper clearance is such that feeler gauge with a thickness of nominal value, about .016" (.4 mm), is slightly hard to move. If nominal value is exceeded, adjust with adjusting screw. After tightening lock nut, recheck clearance. See Fig. 7.

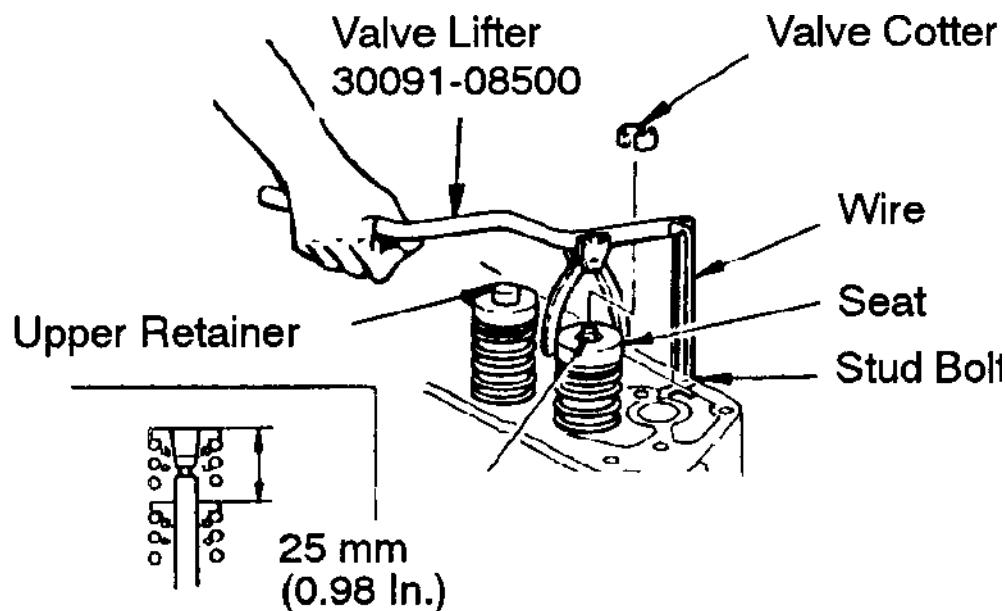


95F68275
Fig. 7: Adjusting Screw
Courtesy of Mitsubishi Fuso.

CYLINDER HEAD (OVERHAUL)

Removal

- 1) Remove valve cap. Using valve lifter, remove valve cotter as follows.
- 2) Hook wire of valve lifter onto exhaust manifold installation stud bolt. Fit seat of valve lifter onto top of upper retainer.
- 3) Press valve lifter down slowly to compress valve spring and remove valve cotter. After valve cotter has been removed, slowly release valve lifter. See Fig. 8.



95G68276

Fig. 8: Removing Valve Cotter
Courtesy of Mitsubishi Fuso.

4) Remove upper retainer, inner and outer valve springs, valve stem seal, from valve. Remove intake and exhaust valves from bottom of cylinder head. Inspect valve. Remove valve stem seal from valve guide.

Inspection

- 1) Inspect all parts of cylinder head. Clean any parts which have carbon deposits, and replace any parts that are worn or damaged.
- 2) Inspect rocker and rocker shaft clearance. Measure inside diameter of rocker and outside diameter of rocker shaft and calculate clearance. See **ROCKER SHAFT CLEARANCE** table. If clearance is greater than the limit, replace bushing inside rocker. Measure squareness of valve spring on a surface plate. If it exceeds limit, replace spring. See **VALVE SPRING LIMIT** table.

ROCKER SHAFT CLEARANCE TABLE

AA

Application In. (mm)

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Basic diameter 0.75 (19)

Nominal value 0.00039-0.0031 (0.01-0.08)

Limit 0.0079 (0.2)

AA

VALVE SPRING LIMIT TABLE

AA

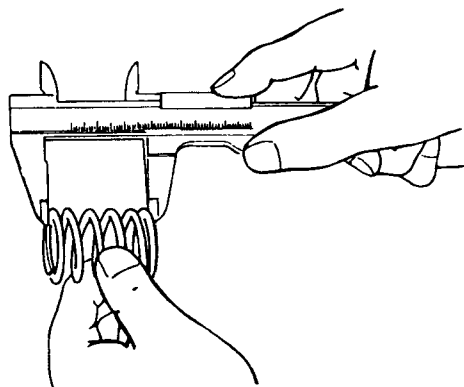
Valve Spring In. (mm)

Outer Valve Spring 0.098 (2.5)

Inner Valve Spring 0.079 (2.0)

AA

- 3) Measure free length of valve spring. See Fig. 9. If it is less than limit, replace spring. See **VALVE SPRING FREE LENGTH SPECIFICATIONS** table.



95H68277

Fig. 9: Measuring Free length
Courtesy of Mitsubishi Fuso.

VALVE SPRING FREE LENGTH SPECIFICATIONS TABLE

AA

Application	In. (mm)
-------------	----------

6D31

Free Length Outer Spring

Nominal Value	2.4 (60.8)
---------------	------------

Limit	2.3 (57.8)
-------	------------

Free Length Inner Spring

Nominal Value	2.17 (55.07)
---------------	--------------

Limit	2.05 (52.1)
-------	-------------

6D16

Free Length Outer Spring

Nominal Value	2.64 (67)
---------------	-----------

Limit	2.52 (64)
-------	-----------

Free Length Inner Spring

Nominal Value	2.17 (55.1)
---------------	-------------

Limit	2.05 (52.1)
-------	-------------

AA

4) Measure load of spring as it is compressed to its installed length using a spring tester. Replace spring if measurement is less than limit. See SPRING LOAD SPECIFICATIONS table.

SPRING LOAD SPECIFICATIONS TABLE

AA

Application	Specification
-------------	---------------

6D31

Outer Spring Valve

Installed Length	1.86" (47.25 mm)
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Nominal Value	54 lbs. (240 N)
---------------	-----------------

Limit	46 lbs. (205 N)
-------	-----------------

Inner Valve Spring

Installed Length	1.59" (40.3 mm)
------------------	-----------------

Nominal Value	21 lbs. (93 N)
---------------	----------------

Limit	18 lbs. (79 N)
-------	----------------

6D16

Outer Spring Valve

Installed Length	1.88" (47.8 mm)
------------------	-----------------

Nominal Value	73.9 lbs. (330 N)
---------------	-------------------

Limit	65.5 lbs. (290 N)
-------	-------------------

Installed Length 1.59" (40.5 mm)
Nominal Value 21 lbs. (92 N)
Limit 18 lbs. (78 N)
AA

5) Measure deflection of push rod, and if it exceeds limit,
replace push rod. See PUSH ROD DEFLECTION SPECIFICATIONS table.

PUSH ROD DEFLECTION SPECIFICATIONS TABLE
AA

Push Rod In. (mm)

Limit 0.016 (0.4)
AA

6) Measure tappet outside diameter and cylinder block tappet
hole inside diameter to determine clearance. If clearance exceeds
limit, replace tappet. See TAPPET CLEARANCE SPECIFICATIONS table.

TAPPET CLEARANCE SPECIFICATIONS TABLE
AA

Tappet In. (mm)

Basic Diameter 1.1 (28)
Nominal Value 0.0024-0.0039 (0.06-0.10)
Limit 0.0079 (0.2)
AA

7) Remove carbon deposits from bottom surface of cylinder
head. Then using a straight edge and feeler gauge, measure distortion
of cylinder head bottom surface. See Fig. 10. See
CYLINDER HEAD SPECIFICATIONS table.

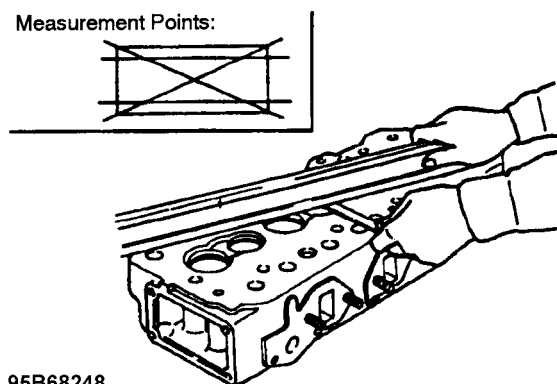


Fig. 10: Measuring Cylinder Head Bottom
Courtesy of Mitsubishi Fuso.

CYLINDER HEAD SPECIFICATIONS TABLE
AA

Cylinder Head Bottom In. (mm)

6D31
Nominal Value 0.0039 (0.1)
Limit 0.0079 (0.2)
6D16
Nominal Value 0.0031 (0.08)
Limit 0.0079 (0.2)
AA

8) If cylinder head has been ground with a surface grinder, measure height from top to bottom surface of cylinder head. If less than limit, replace cylinder head. See CYLINDER HEAD SURFACE SPECIFICATIONS table.

CYLINDER HEAD SURFACE SPECIFICATIONS TABLE

Application

In. (mm)

Nominal Value 3.73-3.74 (94.9-95.1)

Limit 3.72 (94.6)

9) Measure valve stem outside diameter. Replace valve stem if measurement exceeds limit. See VALVE STEM OUTSIDE DIAMETER SPECIFICATIONS table.

VALVE STEM OUTSIDE DIAMETER SPECIFICATIONS TABLE

Valve Stem O.D.

In.(mm)

Nominal Value (Intake) 0.352-0.353 (8.96-8.97)

Nominal Value (Exhaust) 0.351-0.352 (8.93-8.94)

Limit 0.35 (8.85)

10) Measure valve guide inside diameter and calculate difference between measurement and that taken in step 9. Replace valve guide if clearance exceeds limit. See VALVE GUIDE INSIDE DIAMETER SPECIFICATIONS table.

VALVE GUIDE INSIDE DIAMETER SPECIFICATIONS TABLE

Valve Guide I.D.

In. (mm)

Limit 0.35 (9)

Nominal Value (Intake) 0.0016-0.0024 (0.04-0.06)

Nominal Value (Exhaust) 0.0028-0.0039 (0.07-0.10)

Limit (Intake) 0.0059 (0.15)

Limit (Exhaust) 0.0079 (0.2)

11) Check valve and valve seat contact surfaces. The nominal value for valve contact surfaces is 45°.

12) After valve and valve seat have been corrected, check valve for sinkage. Make sure valve is securely installed in cylinder head. Then measure sinkage of valve, that is, distance between valve head bottom surface and cylinder head bottom surface. Replace valve seat if measurement exceeds limit. See VALVE SINKAGE SPECIFICATIONS table.

VALVE SINKAGE SPECIFICATIONS TABLE

Application

In. (mm)

6D31

Nominal Value

Intake Valve 0.030-0.049 (0.75-1.25)

Exhaust Valve	0.030-0.049 (0.75-1.25)
6D16	
Intake Valve	0.044-0.059 (1.1-1.5)
Exhaust Valve	0.052-0.066 (1.3-1.7)
AA	

ROCKER SHAFT & BRACKET ASSEMBLY

NOTE: Do not tilt rocker and bracket assembly after set screws have been removed, as doing so causes parts inside to drop off.

Removal

Remove set screws from rocker shaft brackets on both ends.
Remove rocker shaft brackets, rockers, and rocker shaft springs from rocker shaft.

NOTE: Rocker has a unique orientation. End with an oil hole is front side, opposite rear.

Installation

1) Fit rear rocker shaft bracket onto rear end of rocker shaft and secure with set screw. See Fig. 11.

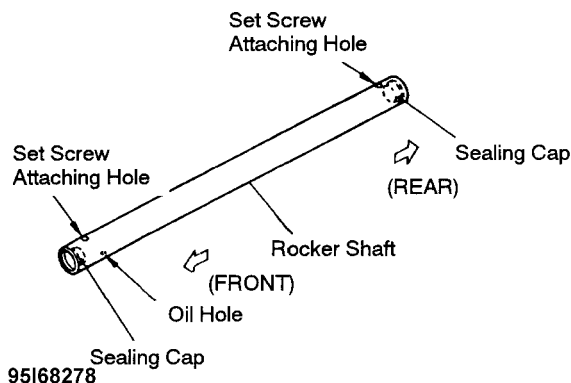


Fig. 11: Rocker Shaft
Courtesy of Mitsubishi Fuso.

2) Apply engine oil to inner surface of rocker bushing. Then mount rocker, rocker shaft spring, and rocker shaft bracket onto rocker shaft, in that order. Mount front rocker shaft bracket and secure with set screw.

Installation

- 1) Coat tappet surface, which contacts cam, with engine oil and install tappet into cylinder block.
- 2) Mount cylinder head gasket onto cylinder block ensuring that its surface with UP mark faces upward and gasket is aligned with locating pins on cylinder block.
- 3) Align cylinder head assembly with locating pins on cylinder block. Install onto cylinder block from above.

WARNING: Have a fellow worker help or use a lift, as cylinder head assembly is extremely heavy.

- 4) Apply engine oil to push rod surface which contacts tappet. Insert push rod into cylinder head installation hole.
- 5) Apply engine oil to rocker surface which contacts valve cap. Install rocker and bracket assembly to cylinder head ensuring it is aligned with locating pins on rocker shaft bracket.

6) Apply engine oil to cylinder head bolts and install bolts in sequence. See Fig. 12. Adjust valve clearance.

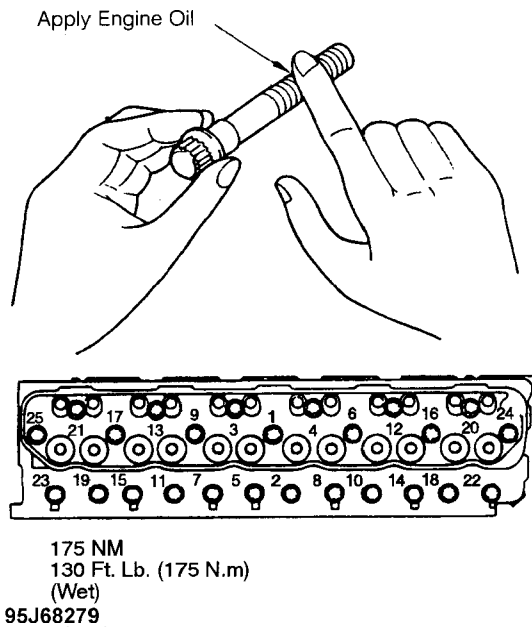


Fig. 12: Installation Of Cylinder Head Bolts
Courtesy of Mitsubishi Fuso.

7) With cylinder head assembly secured, install thermostat case, injection nozzles, glow plugs, intake and exhaust manifolds and air inlet pipe. Fill cooling system.

TIMING GEAR & CRANKSHAFT

Timing gears consist of idler gear, camshaft gear, crankshaft gear, and air compressor gear. They are housed in timing gear case at front of engine. See Fig. 13.

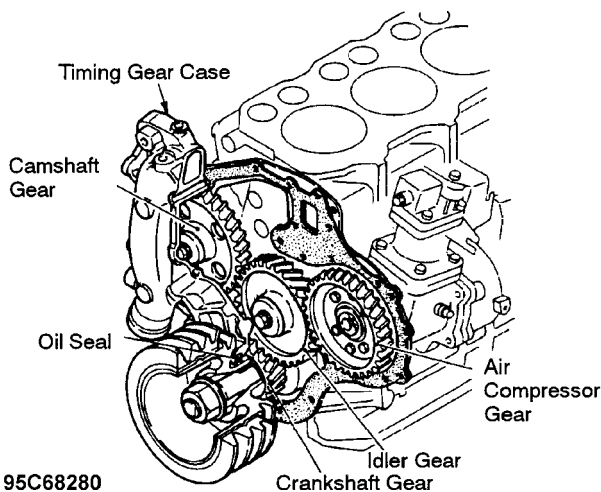
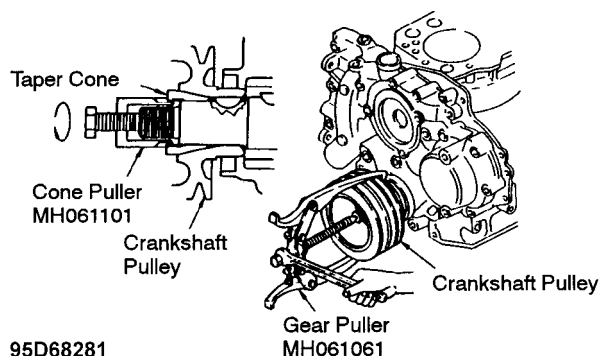


Fig. 13: Timing Gears
Courtesy of Mitsubishi Fuso.

Removal

- 1) Remove engine from vehicle. Remove water pump and bypass pipe from timing gear case. Remove alternator.
- 2) Remove nut on front end of crankshaft. Using special tool (cone puller), remove taper cone. Using special tool (gear puller), remove crankshaft pulley. See Fig. 14. Remove timing gear case.



95D68281
 Fig. 14: Removing Crankshaft Pulley
 Courtesy of Mitsubishi Fuso.

CAUTION: Do not remove oil seal unless defects are evident. Use care to prevent damage to oil seal lips during removal.

3) Measure backlash between gears. If backlash exceeds limit, replace either one or both gears. See TIMING GEARS SPECIFICATION table.

CAUTION: Measure backlash between each pair of gears at three or more locations to determine whether it is up to specification.

TIMING GEARS SPECIFICATION TABLE

~~~~~

| Application                     | In. (mm)                  |
|---------------------------------|---------------------------|
| <b>6D31</b>                     |                           |
| Idle Gear & Camshaft Gear       |                           |
| Nominal Value                   |                           |
| 1993 & Earlier .....            | 0.0047-0.0098(0.12-0.25)  |
| 1994 & Later .....              | 0.0028-0.0067 (0.07-0.17) |
| Limit                           |                           |
| 1993 & Earlier .....            | 0.016 (0.04)              |
| 1994 & Later .....              | 0.012 (0.3)               |
| Idle Gear & Crankshaft Gear     |                           |
| Nominal Value                   |                           |
| 1993 & Earlier .....            | 0.0043-0.0091(0.11-0.23)  |
| 1994 & Later .....              | 0.0024-0.0063 (0.06-0.16) |
| Limit                           |                           |
| 1993 & Earlier .....            | 0.016 (0.4)               |
| 1994 & Later .....              | 0.012 (0.3)               |
| Idle Gear & Air Compressor Gear |                           |
| Nominal Value                   |                           |
| 1993 & Earlier .....            | 0.0071-0.012 (0.18-0.31)  |
| 1994 & Later .....              | 0.0028-0.067 (0.07-0.17)  |
| Limit                           |                           |
| 1993 & Earlier .....            | 0.016 (0.4)               |
| 1994 & Later .....              | 0.012 (0.3)               |

|                                    |                           |
|------------------------------------|---------------------------|
| <b>6D16</b>                        |                           |
| Crankshaft Gear & Idle Gear #1     |                           |
| Nominal Value .....                | 0.0031-0.0071 (0.08-0.18) |
| Limit .....                        | 0.014 (0.35)              |
| Idle Gear #1 & Air Compressor Gear |                           |
| Nominal Value .....                | 0.0028-0.0071 (0.07-0.18) |
| Limit .....                        | 0.014 (0.35)              |
| Idle Gear #1 & Idle Gear #2        |                           |

|                               |                           |
|-------------------------------|---------------------------|
| Nominal Value .....           | 0.0028-0.0071 (0.07-0.18) |
| Limit .....                   | 0.014 (0.35)              |
| Idler Gear #2 & Camshaft Gear |                           |
| Nominal Value .....           | 0.0031-0.0079 (0.08-0.20) |
| Limit .....                   | 0.014 (0.35)              |
| P/S Oil Pump & Idler Gear #2  |                           |
| Nominal Value .....           | 0.0028-0.0071 (0.07-0.18) |
| Limit .....                   | 0.014 (0.35)              |

4) Remove injection pump and air compressor. Measure end play in camshaft. If measurement exceeds limit, remove camshaft gear and replace thrust plate. See CAMSHAFT END PLAY SPECIFICATIONS table.

|                                        |                          |
|----------------------------------------|--------------------------|
| CAMSHAFT END PLAY SPECIFICATIONS TABLE |                          |
| Camshaft End Play                      |                          |
| In. (mm)                               |                          |
| Nominal Value .....                    | 0.002-0.0087 (0.05-0.22) |
| Limit .....                            | 0.012 (0.3)              |

5) Measure end play in idler gear. If measurement exceeds limit, replace idler shaft or idler gear. See IDLER GEAR END PLAY SPECIFICATIONS table.

|                                          |                          |
|------------------------------------------|--------------------------|
| IDLER GEAR END PLAY SPECIFICATIONS TABLE |                          |
| Idler Gear End Play                      |                          |
| In. (mm)                                 |                          |
| Nominal Value                            |                          |
| 1993 & Earlier .....                     | 0.002-0.0098 (0.05-0.25) |
| 1994 & Later .....                       | 0.002-0.0068 (0.05-0.15) |
| Limit .....                              | 0.014 (0.35)             |

6) Align hole in camshaft gear with thrust plate installation bolt position and remove thrust plate installation bolt. Remove camshaft.

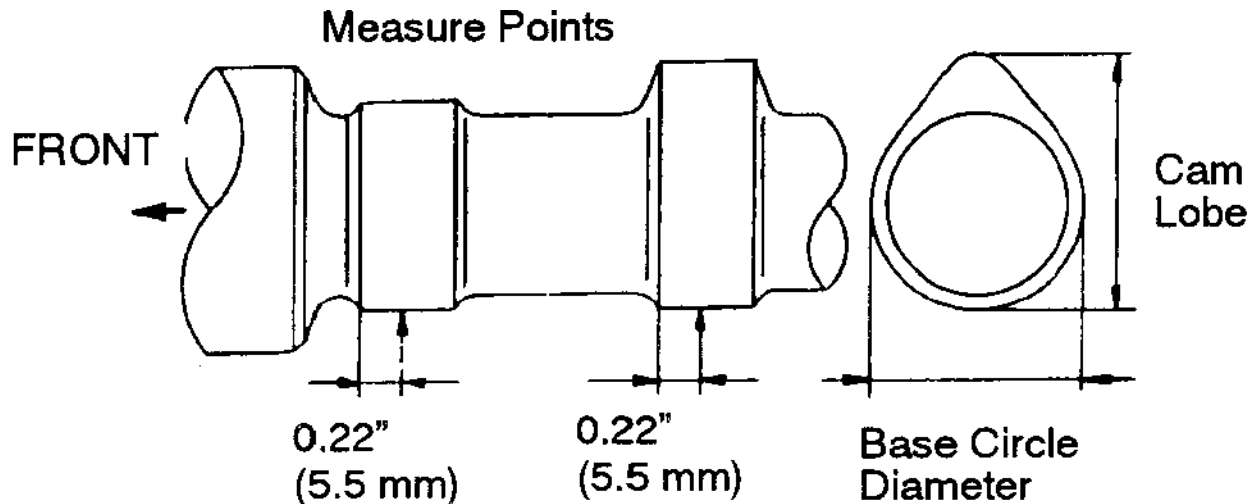
|                                                                                                                                                                                                                |                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Inspection                                                                                                                                                                                                     |                           |
| 1) Measure idler gear inside diameter and idler shaft outside diameter to determine clearance between the two. If clearance exceeds limit, replace idler gear bushing. See IDLER GEAR & SHAFT CLEARANCE table. |                           |
| IDLER GEAR & SHAFT CLEARANCE TABLE                                                                                                                                                                             |                           |
| Idler Gear & Idler Shaft                                                                                                                                                                                       |                           |
| In. (mm)                                                                                                                                                                                                       |                           |
| Basic Diameter .....                                                                                                                                                                                           | 1.6 (40)                  |
| Nominal Value .....                                                                                                                                                                                            | 0.0012-0.0028 (0.03-0.07) |
| Limit .....                                                                                                                                                                                                    | 0.0039 (0.1)              |

2) To replace idler gear bushing, use idler bushing puller. Insert removal side of special tool in idler gear bushing and hammer tool to remove.

3) To install bushing, apply a thin coat of engine oil to

outside of idler gear bushing and set it to installation side of special tool. Mount idler gear bushing onto idler gear so that oil in idler gear is aligned with that in bushing. Hammer tool to install bushing into position.

4) When clearance does not yet conform to specification after replacement, ream bushing for correction. Measure cam height and base circle diameter and replace camshaft if difference between the two exceeds limit. See Fig. 15.



95E68282

Fig. 15: Cam Profile  
Courtesy of Mitsubishi Fuso.

| CAM HEIGHT SPECIFICATIONS TABLE               |                         |
|-----------------------------------------------|-------------------------|
| Application                                   | In. (mm)                |
| 6D31                                          |                         |
| Cam Height                                    | 1.848 (46.939)          |
| Base Circle Diameter                          | 1.578 (40.080)          |
| Difference Between Cam Height And Base Circle |                         |
| Nominal Value                                 | 0.268-0.272 (6.81-6.91) |
| Limit                                         | 0.25 (6.36)             |
| 6D16                                          |                         |
| Cam Height                                    |                         |
| Intake                                        | 1.93 (49.011)           |
| Exhaust                                       | 1.94 (49.307)           |
| Base Circle Diameter                          |                         |
| Intake                                        | 1.66 (42.110)           |
| Exhaust                                       | 1.64 (41.627)           |
| Difference Between Cam Height And Base Circle |                         |
| Nominal Value                                 |                         |
| Intake                                        | 0.27 (6.90)             |
| Exhaust                                       | 0.30 (7.68)             |
| Limit                                         |                         |
| Intake                                        | 0.25 (6.40)             |
| Exhaust                                       | 0.28 (7.18)             |

5) Measure camshaft journal outside diameter and cylinder block camshaft bushing inside diameter to determine clearance between the two. If clearance exceeds limit, replace camshaft bushing. See CAMSHAFT JOURNAL & CYLINDER BLOCK CLEARANCE table. To replace camshaft bushing, use camshaft bushing installer and extractor.

[illegible]

6D31

|                |                |                   |
|----------------|----------------|-------------------|
| Basic Diameter | ..... No.1 & 2 | ..... 2.14 (54.5) |
| Basic Diameter | ..... No. 3    | ..... 2.12 (54)   |
| Basic Diameter | ..... No. 4    | ..... 2.08 (53)   |
| Nominal Value  | .....          | 0.0012-0.0031     |
|                |                | (0.03-0.08)       |
| Limit          | .....          | 0.0059 (0.15)     |

[illegible]

**CAUTION:** Use identification mark of adapter to select correct size for correct camshaft bushing.

[illegible][illegible][illegible][illegible]

9) After No. 4 camshaft bushing has been press fitted into

position, press sealing cap into rear end of cylinder block. See Fig. 16.

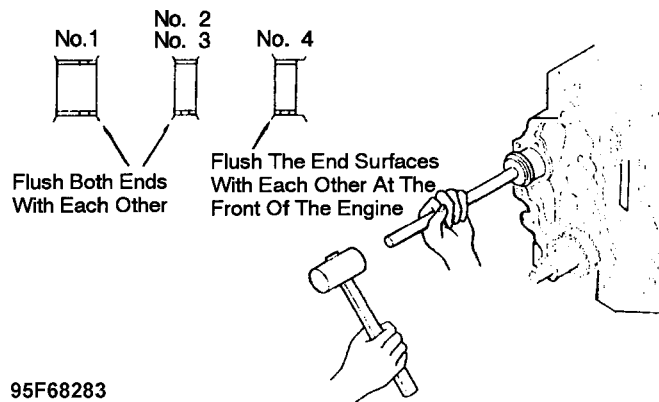


Fig. 16: Rod Position  
Courtesy of Mitsubishi Fuso.

10) Measure camshaft bend (1/2 of reading) and replace if limit is exceeded. See CAMSHAFT BEND table.

#### CAMSHAFT BEND TABLE

|               |                |
|---------------|----------------|
| Application   | In. (mm)       |
| Nominal Value | 0.00079 (0.02) |
| Limit         | 0.002 (0.05)   |

11) Replace camshaft gear only when defects are evident. To replace, use special tool (gear puller and plug).

12) Remove camshaft gear installation bolt and install plug. Remove camshaft gear.

13) Apply engine oil to both sides of thrust plate. Mount camshaft gear so that No. 2 stamped on it faces toward front of engine. Secure gear with bolt.

14) After camshaft gear has been installed, check for end play. Remove front oil seal only when defects such as oil leaks are evident.

#### Installation

1) Mount front plate and gasket, ensuring holes in each is aligned with locating pins on cylinder block. Turn crankshaft gear in advance so that position where alignment mark 1 is stamped on crankshaft gear meets idler gear teeth. See Fig. 17.

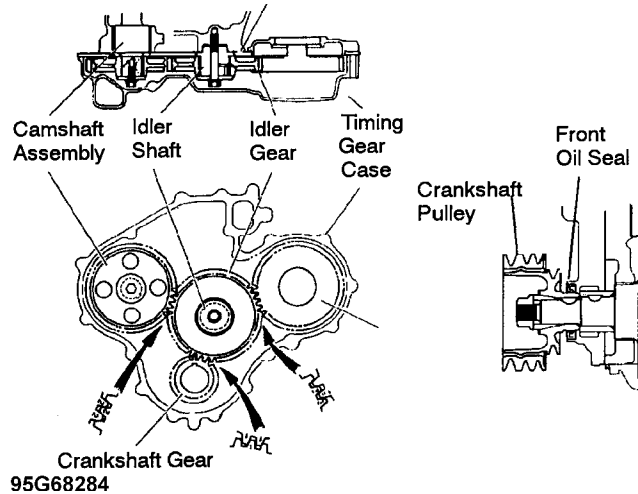


Fig. 17: Timing Gear Installation  
Courtesy of Mitsubishi Fuso.

- 2) Drive idler shaft into place so that its spring pin may enter locating hole provided in cylinder block. Apply engine oil to idler gear teeth and bushing inner surface.
- 3) Hold idler gear with its alignment marks 1 toward you and engage it with alignment mark 1 stamped on crankshaft gear. Install thrust plate to idler shaft, and tighten bolt.
- 4) Apply engine oil to camshaft journals and cams. Insert camshaft assembly into cylinder block with care not to damage cam surfaces and journals. At this time, position camshaft gear so that its alignment mark 2 is lined up with alignment mark 2 on idler gear. Secure thrust plate onto cylinder block. Make sure alignment marks on each gear are positioned correctly.
- 5) Apply a thin coat of specified grease to oil seal lips of timing gear case. Mount gasket and timing gear case, ensuring they are aligned with locating pins on cylinder block.
- 6) Fit Woodruff key into keyway in crankshaft. Insert crankshaft pulley while aligning keyway in crankshaft pulley with Woodruff Key on crankshaft. Insert taper cone into front end of crankshaft and tighten nut.
- 7) After timing gear and camshaft have been installed, perform following procedure. Mount oil pump, install tappets, install flywheel, mount alternator, install by-pass pipe and water pump, and mount engine onto vehicle.

## CYLINDER BLOCK & MAIN MOVING PARTS

Main moving parts are installed in cylinder block and include crankshaft, connecting rods, cylinder sleeve, and pistons. See Fig. 18.



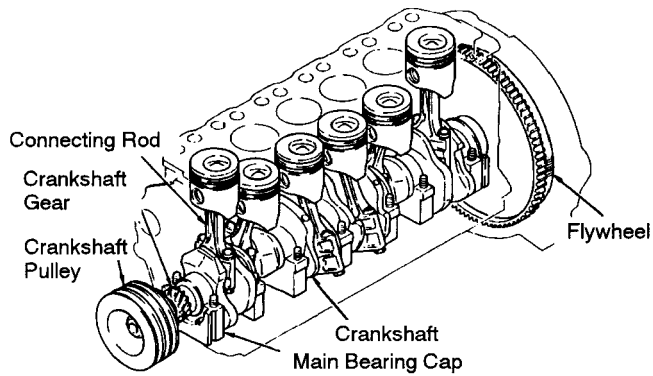
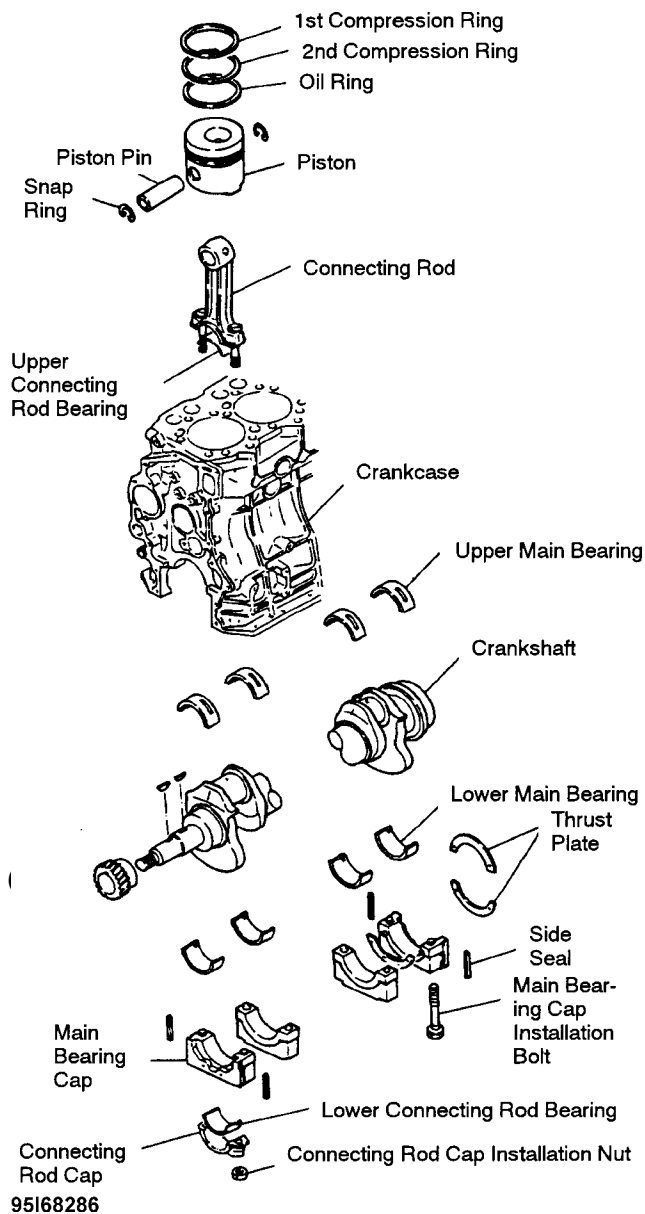


Fig. 18: Crankshaft Disassembled View  
Courtesy of Mitsubishi Fuso.

Connecting rod big end is attached to crankshaft pin by connecting rod cap. Small end is attached to piston by means of a piston pin. Piston moves up and down in cylinder. Piston is provided with 2 compression rings and one oil ring which form a seal with cylinder sleeve to prevent compression loss. See Fig. 19.



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Fig. 19: Cylinder Block Assembly

Courtesy of Mitsubishi Fuso.

Description in this section assumes that cylinder head and components have already been removed. Make following checks before disassembly.

- \* Piston Projection
- \* Connecting Rod End Play
- \* Crankshaft End Play

#### Inspection (Connecting Rod & Crankshaft)

1) Measure piston projection from cylinder block top surface

when piston is at TDC. If measurement is out of specification, a thorough check of clearances in bearings and bushings is necessary. See PISTON PROJECTION SPECIFICATIONS table.

#### PISTON PROJECTION SPECIFICATIONS TABLE

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

Piston Projection In. (mm)

6D31  
Nominal Value ..... 0.017-0.027 (0.43-0.69)

6D16  
Nominal Value ..... 0.033-0.041 (0.84-1.04)

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

2) Insert feeler gauge into gap between connecting rod and crankshaft to measure end play in connecting rod. If measurement exceeds limit, replace connecting rod. See CONNECTING ROD END PLAY SPECIFICATIONS table.

#### CONNECTING ROD END PLAY SPECIFICATIONS TABLE

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

Connecting Rod End Play In. (mm)

Nominal Value ..... 0.0059-0.018 (0.15-0.45)  
Limit ..... 0.024 (0.6)

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

3) Measure crankshaft end play. If measurement exceeds limit, replace thrust plate. See CRANKSHAFT END PLAY SPECIFICATIONS table.

#### CRANKSHAFT END PLAY SPECIFICATIONS TABLE

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

Crankshaft End Play In. (mm)

Nominal Value ..... 0.0039-0.0098 (0.1-0.25)  
Limit ..... 0.016 (0.4)

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

#### Removal (Connecting Rod & Crankshaft)

1) With piston brought to BDC, remove connecting rod cap installation nuts and remove connecting rod cap.

2) Remove connecting rod bearing from connecting rod cap.

Inspect for damage. If damaged, replace upper and lower bearings as a set.

3) With piston brought to TDC, lightly press connecting rod out toward top surface of cylinder block with wood block. See Fig. 20.

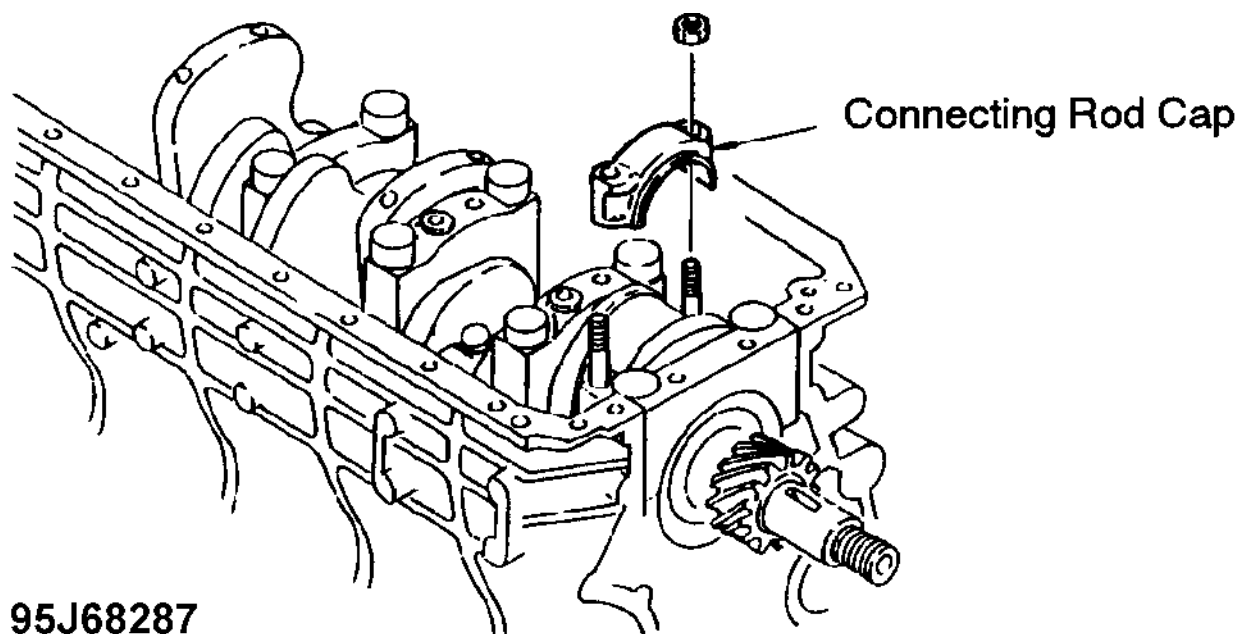


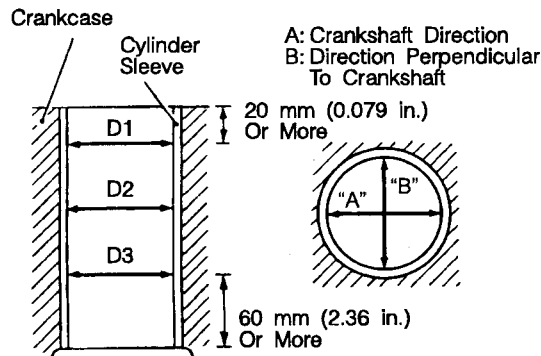
Fig. 20: Connecting Rod  
Courtesy of Mitsubishi Fuso.

- 4) Remove connecting rod bearing. Inspect for damage. If damaged, replace upper and lower bearings as a set.
- 5) To remove piston, remove piston rings, and snap ring. Clamp connecting rod in vise. Use a wood bar, hammer piston pin out to separate piston from connecting rod.
- 6) To remove main bearing caps at front and rear ends, a Bearing Cap Extractor must be installed. Remove lower main bearing, and thrust plate, from main bearing cap, (rear cap only). Inspect for damage. Remove crankshaft slowly, lifting it straight upward with a crane. Remove upper main bearing, and thrust plate (rear end only), from cylinder block.

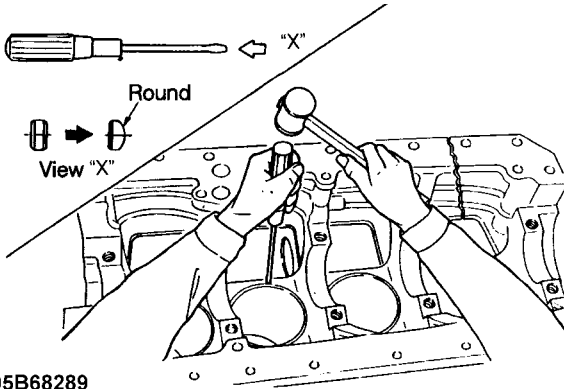
**WARNING:** Take adequate precautions when lifting crankshaft as it is extremely heavy.

#### Inspection (Cylinder Sleeve)

- 1) Measure cylinder sleeve inside diameter (in both directions A and B, at locations D1, D2, and D3). See Fig. 21. See CYLINDER SLEEVE SPECIFICATIONS table.



2) Insert a screwdriver whose end has been machined as shown in Fig. 22. Tap it to remove cylinder sleeve. Place rounded side of screwdriver against cylinder block.



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Fig. 22: Removing Cylinder  
Courtesy of Mitsubishi Fuso.

#### Installation (Cylinder Sleeve)

- 1) Apply spindle oil or equivalent to cylinder block hole into which cylinder sleeve is fitted. Face chamfered side of cylinder sleeve to cylinder block.
- 2) Install special tool (cylinder sleeve installer) to install cylinder sleeve. Using a hydraulic press, carefully press fit cylinder sleeve into position until flange in special tool contacts top of cylinder block. Remove special tool and make sure top surface of cylinder sleeve is flush with that of cylinder block.

#### Inspection (Piston)

- 1) Measure piston outside diameter. Measure cylinder sleeve to piston clearance. Measure clearance between piston and piston ring. Measure piston ring gap by inserting piston ring into a cylinder sleeve whose inside diameter is 3.937" (100 mm) or a new cylinder sleeve of a cylinder block.
- 2) Measure piston pin outside diameter and piston pin inside diameter to obtain clearance. Using a micrometer, measure piston pin outside diameter and connecting rod small end inside diameter to calculate clearance between the 2. To replace small end bushing, use Connecting Rod Bushing Puller Kit.

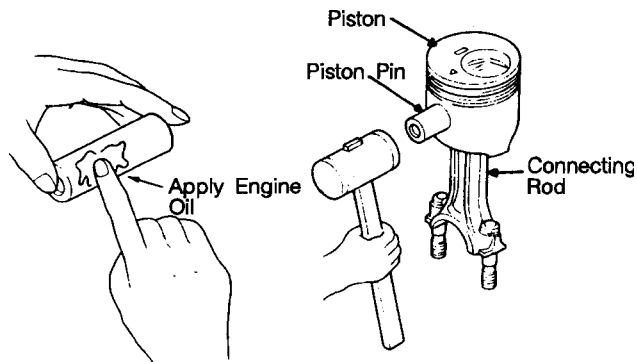
#### Removal (Piston Pin)

- 1) Remove connecting rod bearing from big end, then place connecting rod on base of connecting rod bushing puller kit. Position plate tight up against connecting rod bearing surface and secure connecting rod with bracket.
- 2) Remove nut from puller and install collar "A", then insert puller into connecting rod bushing. Using a hydraulic press, apply a load up to about 1000 lbf (49000 N) gradually to puller to remove connecting rod bushing out downward.

#### Installation (Piston Pin)

- 1) Apply a thin coat of engine oil to outside of connecting rod bushing. Assemble collar "B", connecting rod bushing, and collar A, in that order, into puller and tighten nut finger tight.
- 2) Thread chamber circumference of bushing hole. Press fit bushing into small end of connecting rod which has been secured onto base of special tool.
- 3) Gradually apply load to puller up to about 1000 lb. (49000 N) until collar B makes tight contact with connecting rod. After installation, check for clearance between piston pin and connecting rod.
- 4) Position connecting rod and insert into piston. Tap piston

pin with soft hammer to connect. Attach snap rings to both sides of piston pin. See Fig. 23.



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Fig. 23: Inserting Piston Pin  
Courtesy of Mitsubishi Fuso.

## REASSEMBLY

- 1) Fit upper main bearing so that its lug fits into lug groove in cylinder block. Fit trust plate so that its side with no oil groove faces cylinder block and fits into locating pin.
- 2) Install crankshaft onto cylinder block main bearings. Fit lower main bearing to main bearing cap so that lug in bearing fits into lug groove in cap. Attach thrust plates to both sides of rear end main bearing cap so that side of thrust plate with no oil groove faces bearing cap.
- 3) Apply sealant to surface of cylinder block, onto which main bearing caps are mounted, at front and rear of cylinder block. Install main bearing cap so that its lug groove runs in same direction as that in cylinder block.
- 4) Install piston rings. Note that white marking and manufacturer marking near face up.
- 5) Fit upper connecting rod bearing to connecting rod, ensuring its lug fits into lug groove in connecting rod. Apply engine oil to cylinder sleeves.
- 6) Bring crankshaft pins to BDC. Slowly insert piston and connecting rod assembly into cylinder sleeve from top of cylinder block. Tap piston head with wood block until connecting rod big end fits into crankshaft pin.
- 7) Attach lower connecting rod bearing to connecting rod cap, ensuring lug in bearing fits into lug groove in cap. Line up lug protrusion on connecting rod cap with that on connecting rod, and tighten nuts. Note that engine oil must be applied to connecting rod bolt threads.
- 8) Make sure connecting rod end play is up to specification. Make sure piston projection is up to specification.

## TORQUE SPECIFICATIONS

### TORQUE SPECIFICATIONS TABLE

|                              |       |               |
|------------------------------|-------|---------------|
| Application                  |       | Ft. lbs. (Nm) |
| 6D14 & 6D31                  |       |               |
| Alternator Nut               | ..... | 61 (82)       |
| Connecting Rod Cap Nut (Wet) | ..... | 76 (100)      |
| Crankshaft Pulley Nut        |       |               |

**6D16**

|                                         |               |
|-----------------------------------------|---------------|
| Crankcase Water Drain Plug .....        | 87 (115)      |
| Injection Nozzle Mounting bolt .....    | 11 (15)       |
| Rocker Cover Mounting Bolt .....        | 7 (10)        |
| Cylinder Head Bolts                     |               |
| M14 x 2 .....                           | 145 (195)     |
| M10 x 1.5 .....                         | 25 (34)       |
| Glow Plug .....                         | 11-14 (15-20) |
| Exhaust Manifold Mounting Stud .....    | 22 (29)       |
| Camshaft Gear Mounting Bolt .....       | 130 (175)     |
| Idler Gear #1 Shaft Mounting Bolt ..... | 65 (88)       |
| Idler Gear #2 Mounting Bolt .....       | 70 (95)       |
| Flywheel Housing Mounting Bolt .....    | 33 (44)       |
| Oil Seal Mounting Bolt .....            | 11 (15)       |
| Pulse Rotor .....                       | 72 (98)       |
| Tachometer Sensor .....                 | 17-26 (24-35) |
| Stiffener Mounting Bolt .....           | 58 (78)       |
| Oil Jet Check Valve .....               | 25 (34)       |
| Main Bearing Cap Mounting Bolt .....    | 130 (175)     |
| Connecting Rod Mounting Nut .....       | 94 (125)      |
| Torsional Damper Mounting Bolt .....    | 58 (78)       |
| Crankshaft Pulley Mounting Bolt .....   | 135 (185)     |
| Rocker Arm Adjust Bolt Lock Nut .....   | 25 (34)       |

| Application             | Specification          |
|-------------------------|------------------------|
| Displacement .....      | 400.1 Cu. In. (6.56 L) |
| Horsepower @ RPM .....  | 185 @ 2900             |
| Torque @ RPM .....      | 408 @ 1800             |
| Compression Ratio ..... | 16.0:1                 |
| Bore .....              | 4.33 (110 mm)          |

## ENGINE SPECIFICATIONS TABLE TABLE (6D14T2)

## ENGINE SPECIFICATIONS TABLE TABLE (6D16T2)

## ENGINE SPECIFICATIONS TABLE TABLE (6D16T4)

## ENGINE SPECIFICATIONS TABLE TABLE (6D31T2)

## CAMSHAFT SPECIFICATIONS TABLE



| Application | Specification<br>In. (mm) |
|-------------|---------------------------|
|-------------|---------------------------|

|                           |             |
|---------------------------|-------------|
| Camshaft Journal Diameter |             |
| 1993 & Earlier            |             |
| Journal Nos. 1 & 2 .....  | 2.14 (54.5) |
| Journal No. 3 .....       | 2.12 (54)   |
| Journal No. 4 .....       | 2.08 (53)   |
| 1994 & Later              |             |
| Journal No. 1 .....       | 2.27 (57.8) |
| Journal No. 2 .....       | 2.28 (58)   |
| Journal No. 3 .....       | 2.29 (58.3) |
| Journal No. 4 .....       | 2.3 (58.5)  |

|                               |                       |
|-------------------------------|-----------------------|
| Camshaft-to-Journal Clearance |                       |
| Nominal                       |                       |
| 1993 & Earlier .....          | .0016-.0035 (.04-.09) |
| 1994 & Later .....            | .0012-.0031 (.03-.08) |
| Service Limit .....           | .0059 (.15)           |

|                     |                       |
|---------------------|-----------------------|
| Camshaft End Play   |                       |
| Nominal .....       | .0020-.0087 (.05-.22) |
| Service Limit ..... | .012 (.3)             |

|                     |              |
|---------------------|--------------|
| Camshaft Warp       |              |
| Nominal .....       | .00079 (.02) |
| Service Limit ..... | .002 (.05)   |

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CRANKSHAFT, CONNECTING RODS & BEARINGS SPECS

CRANKSHAFT, CONNECTING RODS & BEARINGS SPECS TABLE

Application	Specification In. (mm)
-------------	---------------------------

Crankshaft	
End Play	
Nominal .....	.0039-.0098 (.10-.25)
Service Limit .....	.016 (.4)
Taper	
Nominal	N/A
Service Limit .....	.0012 (.03)
Maximum Out-of-Round .....	.00039 (.10)

Connecting Rods	
Bend & Twist (Limit)	
1993 & Earlier .....	.002 (.05)
1994 & Later .....	.05 (1.0)

Main Bearings	
Journal Diameter	3.1 (78)
Bearing Clearance	
1993 & Earlier	
Nominal .....	.002-.0035 (.05-.09)
Service Limit .....	.059 (.15)
1994 & Later	
Nominal .....	.0024-.0039 (.06-.10)
Service Limit .....	.059 (.15)
Minimum Bearing Uninstalled Length (1)	
Lower Half	3.25 (82.5)
Upper Half	3.24 (82.27)

Connecting Rod Bearings

Journal Diameter 2.4 (60)
Bearing Clearance
Nominal
1993 & Earlier002-.0035 (.05-.09)
1994 & Later0016-.0035 (.04-.09)
Service Limit079 (.2)
Minimum Bearing Uninstalled Length (1) 2.5 (64.3)
Shaft End Play
Nominal0059-.018 (.15-.45)
Service Limit024 (.6)

(1) - Bearing uninstalled length is measured across the ends of each half of the bearing. If this measurement is not within specification, bearing halves will not properly seat.

AA

CYLINDER BLOCK & CYLINDER LINER SPECIFICATIONS

CYLINDER BLOCK & CYLINDER LINER SPECIFICATIONS TABLE

AA

Application	Specification In. (mm)
-------------	---------------------------

Cylinder Block	
Surface Warp	
Nominal	.0028 (.07)
Service Limit	.0079 (.2)

Cylinder Liner	
Inside Diameter	
Nominal	3.937-3.938 (100-100.03)
Service Limit	3.95 (100.25)
Taper	.0012 (0.03)
Out-of-Round	.00039 (.01)
Liner-to-Cylinder Block Clearance	
Nominal	
1993 & Earlier	
Nominal	.0063-.0076 (.16-.19)
Service Limit	Less Than .0063 (.16)
1994 & Later	
Nominal	.0063-.0087 (.16-.22)
Service Limit	Less Than .0063 (.16)
Oversize	
Nominal	.0071-.0079 (.18-.20)
Service Limit	Less Than .0071 (.18)

AA

CYLINDER HEAD SPECIFICATIONS

CYLINDER HEAD SPECIFICATIONS TABLE

AA

Application	Specification In. (mm)
-------------	---------------------------

Cylinder Head Height	
Nominal	3.73-3.74 (94.9-95.1)
Service Limit	3.72 (94.6)

Cylinder Head Maximum Warpage

1993 & Earlier

Allowable **MITSUBISHI 6D14, 6D16 & 6D31 6-CYLINDER**Article Text (p. 26)For cyph8r pacific la ca 92101

Service Limit079 (2.0)
1994 & Later
Allowable0039 (1.0)
Service Limit079 (2.0)
Push Rod Deflection016 (.4)
Rocker Shaft Diameter75 (19)
Rocker Shaft Clearance00039-.00310 (.001-.08)
Valve Lifters
Diameter 1.10 (28)
Clearance
Nominal0024-.0039 (.06-.10)
Service Limit0079 (.20)
AA

PISTONS, PINS & RINGS SPECIFICATIONS

PISTONS, PINS & RINGS SPECIFICATIONS TABLE
AA

Application	Specification In. (mm)
Pistons	
Piston Diameter	3.937 (100)
Piston Projection Above	
Cylinder Block Surface .....	.022-.030 (.55-.75)
Piston-to-Liner Clearance .....	.0043-.0063 (.11-.16)

Pins	
Pin Diameter	1.3 (34)
Pin-to-Piston Clearance	
1993 & Earlier	
Nominal .....	.00016-.00075 (.004-.019)
Service Limit .....	.002 (.05)
1994 & Later	
Nominal .....	.00028-.00083 (.007-.021)
Service Limit .....	.002 (.05)
Pin-to-Connecting Rod Clearance	
Nominal .....	.00079-.0020 (.02-.05)
Service Limit .....	.0039 (.1)

Rings	
Piston-to-Ring Clearance	
Ring No. 1 (Compression)	
Nominal .....	.0024-.0047 (.06-.12)
Service Limit .....	.0079 (.20)
Ring No. 2 (Compression)	
Nominal .....	.0028-.0039 (.07-.10)
Service Limit .....	.0059 (.15)
Ring No. 3 (Oil)	
Nominal .....	.0012-.0024 (.03-.06)
Service Limit .....	.0059 (.15)
Ring End Gap	
Ring Nos. 1 & 2 (Compression)	
Nominal .....	.012-.020 (.3-.5)
Service Limit .....	.059 (1.5)
Ring No. 3 (Oil)	
Nominal .....	.012-.020 (.3-.5)
Service Limit .....	.059 (1.5)

TIMING & ACCESSORY DRIVE GEAR SPECIFICATIONS

TIMING & ACCESSORY DRIVE GEAR SPECIFICATIONS TABLE

AA

Application	Specification In. (mm)
Idler Gear #2-to-Oil Pump	
Gear Clearance	
Nominal .....	.0028-.0071 (.07-.18)
Service Limit .....	.014 (.35)
Idler Gear #1 End Play	
Nominal .....	.0020-.0059 (.05-.15)
Service Limit .....	.012 (.3)
Idler Gear #2 End Play	
Nominal .....	.0020-.0059 (.05-.15)
Service Limit .....	.012 (.3)
Idler Shaft Diameter	
.....	1.6 (40)
Idler Gear-to-Air Compressor	
Clearance	
Nominal .....	.0028-.0071 (.07-.18)
Service Limit .....	.0014 (.35)
Idler Gear #1-to-Idler Gear #2	
Clearance	
Nominal .....	.0028-.0071 (.07-.18)
Service Limit .....	.0014 (.35)
Timing Gear Clearance	
Between Idler Gear & Crankshaft Gear	
Nominal .....	.0031-.0071 (.08-.18)
Service Limit .....	.014 (.35)
Between Idler Gear #2 & Camshaft Gear	
Nominal .....	.0031-.0079 (.08-.20)
Service Limit .....	.014 (.35)
Between Idler Gear & Injection Pump Gear	
Nominal0028-.0059 (.07-.15)
Service Limit012 (.3)

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VALVES & VALVE SPRINGS

VALVES & VALVE SPRINGS SPECIFICATIONS TABLE

AA

Application	Specification In. (mm)
Intake Valves	
Valve Stem Diameter	
Nominal .....	.352-.353 (8.94-8.97)
Service Limit .....	.35 (8.85)
Valve Stem-to-Guide Clearance	
Nominal .....	.0016-.0024 (.04-.06)
Service Limit .....	.0059 (.15)
Valve Seat Angle	
.....	45°
Valve Seat Recess	
Acceptable .....	.003-.049 (.75-1.25)
Service Limit .....	.059 (1.5)
Valve Seat Width	
Nominal .....	.0071-.087 (1.8-2.2)
Service Limit	2.8 (.11)

