

WORKSHOP MANUAL

F & G SERIES

ENGINE

6SD1 · 6SD1TC MODELS

SECTION 6

ISUZU

ISUZU



International Service & Parts
Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section 00 under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL."

All material contained in this Manual is based on the latest product information available at the time of publication.

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This Manual is applicable to 1996 year model and later vehicles except those sold in the United States of America, Canada, and Thailand.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

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6A	Engine Mechanical
6B	Cooling System
6C	Fuel System
6D	Engine Electrical
6E	—
6F	Exhaust System
6G	Air Compressor
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SECTION 00

SERVICE INFORMATION

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MEMO

TROUBLESHOOTING

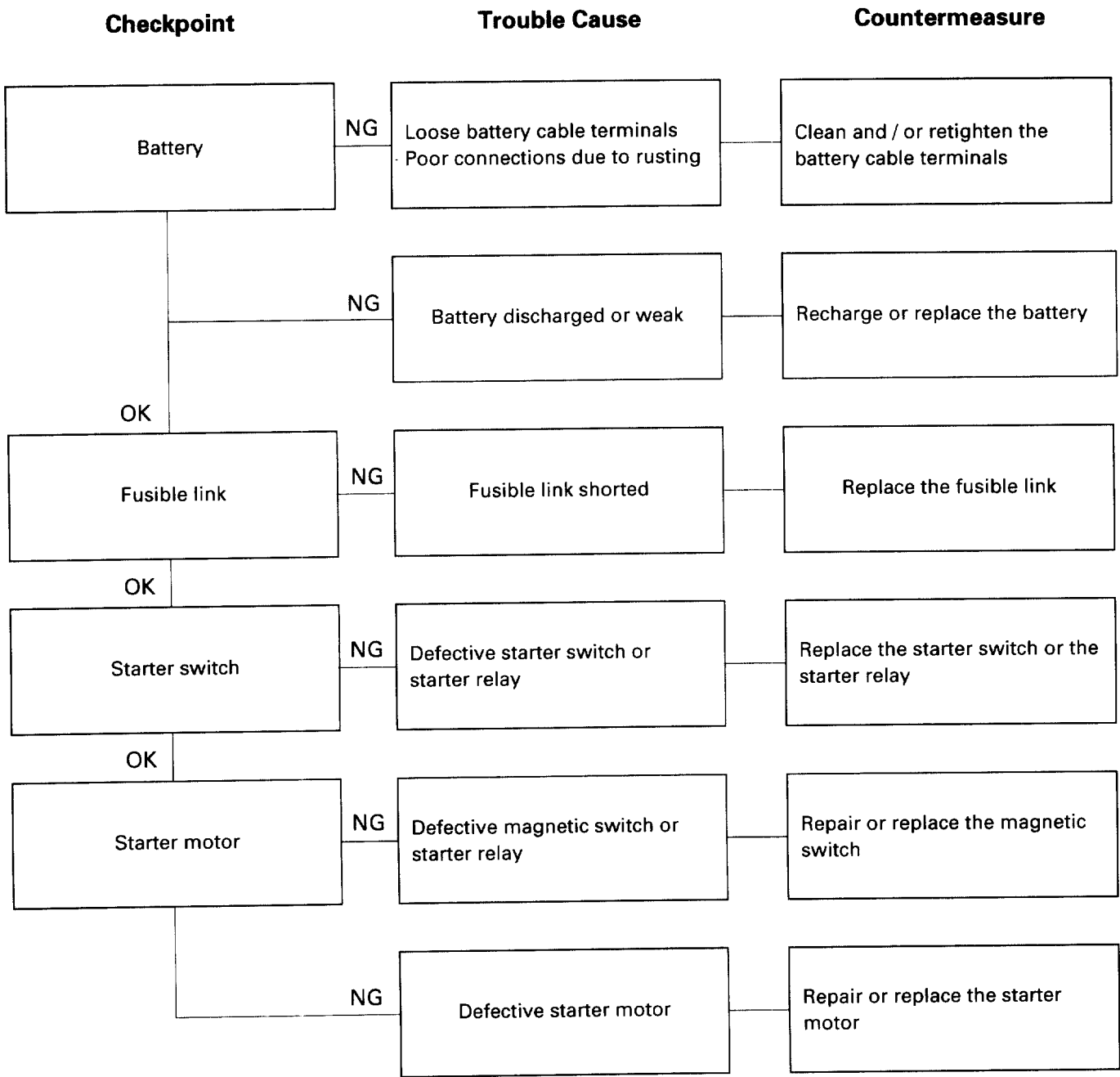
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ENGINE MECHANICAL

HARD STARTING

1) STARTER MOTOR DOES NOT OPERATE



2) STARTER MOTOR OPERATES BUT ENGINE DOES NOT TURN OVER

Checkpoint		Trouble Cause	Countermeasure
Battery	NG	Loose battery cable terminals Poor connections due to rusting	Clean and/or retighten the battery cable terminals
	OK		
Starter motor	NG	Battery discharged or weak	Recharge or replace the battery
	OK		
	NG	Defective pinion gear	Replace the pinion gear
	OK		
Engine	NG	Defective magnetic switch	Repair or replace the magnetic switch
	NG	Brush wear Weak brush spring	Replace the brush and/or the brush spring
	OK		
Engine	NG	Piston, crankshaft bearing seizure, or other damage	Repair or replace the related parts
	OK		

3) ENGINE TURNS OVER BUT DOES NOT START

Checkpoint		Trouble Cause	Countermeasure
Fuel system	NG	Air in the fuel system	Bleed the air from the fuel system
		Fuel is not being delivered to the injection pump	See next page Continued to next page
Engine stop mechanism	NG	Defective engine stop mechanism Control wire improperly adjusted	Replace the engine stop mechanism Adjust the control wire
	NG	Defective engine stop actuator	Replace the engine stop actuator

1 Fuel is Not Being Delivered to The Injection Pump

Checkpoint

Trouble Cause

Countermeasure

Continued from previous page

Fuel	NG	Fuel tank is empty	Fill the fuel tank
OK			
Fuel piping	NG	Clogged or damaged fuel lines Loose fuel line connections	Repair or replace the fuel lines Retighten the fuel line connections
OK			
Fuel filter	NG	Clogged fuel filter element	Replace the fuel filter element or the fuel filter cartridge
OK			
Fuel system	NG	Air in the fuel system	Bleed the air from the fuel system
OK			
Fuel feed pump	NG	Fuel feed pump strainer is clogged	Clean the fuel feed pump strainer
	NG	Defective feed pump	Repair or replace the feed pump

2 Fuel is Being Delivered to The Injection Pump

Checkpoint		Trouble Cause	Countermeasure
Continued from previous page			
Fuel	NG	Use of the wrong fuel	Use the correct fuel
	NG	Water particles in the fuel	Change the fuel
OK			
Fuel system	NG	Air in the injection pump	Bleed the air from the fuel system
OK			
Injection nozzle	NG	Injection nozzle sticking	Replace the injection nozzle
	NG	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
OK			
Injection pump	NG	Defective injection pump control rack operation	Repair or replace the injection pump control rack
	NG	Injection pump plunger worn or stuck	Replace the injection pump plunger assembly
	NG	Injection pump camshaft seizure or other damage	Replace the injection pump camshaft

UNSTABLE IDLING

Checkpoint		Trouble Cause	Countermeasure
Idling system	NG	Idling improperly adjusted	Adjust the idling
OK			
Idling speed control device	NG	Defective idling speed control device	Repair or replace the idling speed control device
OK			
Accelerator control system	NG	Accelerator control system improperly adjusted	Adjust the accelerator control system
OK			
Fuel system	NG	Fuel system leakage or blockage	Repair or replace the fuel system
	NG	Air in the fuel system	Bleed the air from the fuel system
	NG	Water particles in the fuel system	Change the fuel
OK			
Fuel filter	NG	Clogged fuel filter element	Replace the fuel filter element or the fuel filter cartridge

Continued on the next page

Checkpoint		Trouble Cause	Countermeasure
Continued from the previous page			
Injection nozzle	OK		
	NG	Injection nozzle sticking	Replace the injection nozzle
Injection pump	NG	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
	OK		
	NG	Defective delivery valve resulting in fuel drippage after fuel injection	Replace the delivery valve
	NG	Injection timing improperly adjusted	Adjust the injection timing
	NG	Defective inside of automatic timer	Repair or replace the automatic timer assembly
	NG	Insufficient injection volume	Adjust the injection volume
	NG	Defective idle spring	Replace the idle spring
	NG	Defective governor lever operation	Repair or replace the governor lever
Continued on the next page			

Checkpoint**Trouble Cause****Countermeasure**

Continued from the previous page

Injection pump	NG	Broken plunger spring	Replace the plunger spring
	NG	Worn plunger	Replace the plunger assembly
	NG	Worn camshaft	Replace the camshaft
	NG	Worn roller tappet	Replace the roller tappet
	OK		
Valve clearance	NG	Valve clearance improperly adjusted	Adjust the valve clearance
Compression pressure	NG	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking or broken Improper seating between the valve and the valve seat	Replace the related parts
	OK		
Engine mounting rubber	NG	Broken	Replace

Continued on the next page

Checkpoint		Trouble Cause	Countermeasure
Continued from the previous page			
OK			
Camshaft	NG	Worn camshaft lobe	Replace the camshaft

INSUFFICIENT POWER

Checkpoint		Trouble Cause	Countermeasure
Air cleaner	NG	Clogged air cleaner element	Clean or replace the air cleaner element
OK			
Fuel	NG	Water particles in the fuel	Replace the fuel
OK			
Fuel filter	NG	Clogged fuel filter element	Replace the fuel filter element or the fuel filter cartridge
OK			
Fuel feed pump	NG	Clogged strainer or defective fuel feed pump	Repair or replace the fuel feed pump
OK			
Injection nozzle	NG	Injection nozzle sticking	Replace the injection nozzle
	NG	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
OK			
Fuel injection pipes	NG	Fuel injection pipes damaged or obstructed	Replace the fuel injection pipes

Continued on the next page

Checkpoint		Trouble Cause	Countermeasure
Continued from the previous page			
Injection pump	OK		
	NG	Defective delivery valve	Replace the delivery valve
	NG	Defective automatic timer	Repair or replace the automatic timer
	NG	Improper control lever operation	Adjust or replace the control lever
	NG	Defective injection timing	Adjust the injection timing Repair or replace the injection pump timer
	NG	Weak governor spring	Replace the governor spring
	NG	Worn plunger	Replace the plunger assembly
	NG	Worn camshaft	Replace the camshaft

Continued on the next page

Checkpoint**Trouble Cause****Countermeasure**

Continued from the previous page

Injection pump	NG	Worn roller tappet	Replace the roller tappet
OK			
Turbocharger	NG	Exhaust gas leakage from the exhaust system Air leakage from the intake system	Repair or replace the related parts
	NG	Defective turbocharger assembly	Replace the turbocharger assembly
OK			
Compression pressure	NG	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking or broken Improper seating between the valve and the valve seat	Replace the related parts
OK			
Valve clearance	NG	Valve clearance improperly adjusted	Adjust the valve clearance
OK			
Valve spring	NG	Valve spring weak or broken	Replace the valve spring
OK			
Exhaust system	NG	Exhaust pipe clogged	Clear the exhaust pipe
OK			
Camshaft	NG	Worn camshaft lobe	Replace the camshaft

EXCESSIVE FUEL CONSUMPTION

Checkpoint		Trouble Cause	Countermeasure
Fuel system	NG	Fuel leakage	Repair or replace the fuel system related parts
OK			
Air cleaner	NG	Clogged air cleaner element	Clean or replace the air cleaner element
OK			
Idling speed	NG	Poorly adjusted idling speed	Adjust the idling speed
OK			
Thermostat	NG	Defective	Replace
OK			
Engine oil	NG	Improper engine oil viscosity	Correct
OK			
Injection nozzle	NG	Injection nozzle starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
OK			
Fuel injection timing	NG	Fuel injection timing improperly adjusted	Adjust the fuel injection timing

Continued on the next page

Checkpoint**Trouble Cause****Countermeasure**

Continued from the previous page

OK

Injection pump

NG

Defective delivery valve
resulting in fuel drippage after
fuel injection

Replace the delivery valve

OK

Turbocharger

NG

Air leakage from the
turbocharger intake sideRepair the turbocharger intake
side

NG

Defective turbocharger
assemblyReplace the turbocharger
assembly

OK

Valve clearance

NG

Valve clearance improperly
adjusted

Adjust the valve clearance

OK

Compression pressure

NG

Blown out cylinder head gasket
Worn cylinder liner
Piston ring sticking or broken
Improper seating between the
valve and the valve seat

Replace the related parts

OK

Valve spring

NG

Valve spring weak or broken

Replace the valve spring

EXCESSIVE OIL CONSUMPTION

Checkpoint		Trouble Cause	Countermeasure
Engine oil	NG	Engine oil unsuitable Too much engine oil	Replace the engine oil Correct the engine oil volume
OK			
Oil seal and gasket	NG	Oil leakage from the oil seal and/or the gasket	Replace the oil seal and/or the gasket
OK			
Air breather	NG	Clogged air breather	Clean the air breather
OK			
Intake and exhaust valves	NG	Worn valve stems	Replace the intake and exhaust valves and the valve guides
OK			
Valve stem oil seal	NG	Worn	Replace
OK			
Compression pressure	NG	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking or broken Improper seating between the valve and the valve seat	Replace the related parts

OVERHEATING

Checkpoint		Trouble Cause	Countermeasure
Cooling water	NG	Insufficient cooling water	Replenish the cooling water
OK			
Fan coupling (If so equipped)	NG	Oil leakage from the fan coupling	Replace the fan coupling
OK			
Fan belt	NG	Fan belt loose or cracked causing slippage	Replace the fan belt
OK			
Radiator	NG	Defective radiator cap or clogged radiator core	Replace the radiator cap or clean the radiator core
OK			
Water pump	NG	Defective water pump	Repair or replace the water pump
OK			
Cylinder head and cylinder body sealing cap	NG	Defective sealing cap resulting in water leakage	Replace the sealing cap
OK			
Thermostat	NG	Defective thermostat	Replace the thermostat

Continued on the next page

Checkpoint		Trouble Cause	Countermeasure
Continued from the previous page			
OK	NG	Cooling system clogged by foreign material	Clean the foreign material from the cooling system
Cooling system			
OK	NG	Fuel injection timing improperly adjusted	Adjust the fuel injection timing
Fuel injection timing			

WHITE EXHAUST SMOKE

Checkpoint		Trouble Cause	Countermeasure
Fuel	NG	Water particles in the fuel	Replace the fuel
OK			
Fuel injection timing	NG	Delayed fuel injection timing	Adjust the fuel injection timing
OK			
Compression pressure	NG	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking or broken Improper seating between the valve and the valve seat	Replace the related parts
OK			
Intake and exhaust valve seals	NG	Defective valve seals Worn valve stems and valve guides	Replace the valve seals, the valves, and the valve guides
OK			
Cooling system	NG	Defective thermostat	Replace

BLACK EXHAUST SMOKE

Checkpoint		Trouble Cause	Countermeasure
Air cleaner	NG	Clogged air cleaner element	Clean or replace the air cleaner element
OK			
Injection nozzle	NG	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
OK			
Fuel injection timing	NG	Advanced fuel injection timing	Adjust the fuel injection timing
OK			
Injection pump	NG	Defective delivery valve resulting in fuel drippage after fuel injection	Replace the delivery valve
	NG	Excessive injection volume	Adjust the injection volume
OK			
Camshaft	NG	Worn camshaft lobe	Replace the camshaft

OIL PRESSURE DOES NOT RISE

Checkpoint		Trouble Cause	Countermeasure
Engine oil	NG	Improper viscosity engine oil Insufficient engine oil	Replace the engine oil Correct the engine oil volume
OK			
Oil pressure gauge or unit Oil pressure indicator light	NG	Defective oil pressure gauge or unit Defective indicator light	Repair or replace the oil pressure gauge or unit Replace the indicator light
OK			
Oil filter	NG	Clogged oil filter element	Replace the oil filter element or the oil filter cartridge
OK			
Relief valve and by-pass valve	NG	Relief valve sticking and/or weak by-pass valve spring	Replace the relief valve and/or the by-pass spring
OK			
Oil pump	NG	Clogged oil pump strainer	Clean the oil pump strainer
	NG	Worn oil pump related parts	Replace the oil pump related parts
OK			
Rocker arm shaft	NG	Worn rocker arm bushing	Replace the rocker arm bushing

Continued on the next page

Checkpoint		Trouble Cause	Countermeasure
Continued from the previous page			
OK			
Camshaft	NG	Worn camshaft and camshaft brackets	Replace the camshaft and the camshaft brackets
OK			
Crankshaft and bearings	NG	Worn crankshaft and bearings	Replace the crankshaft and/or the bearings
OK			
Oiling jet joint bolts	NG	Loose	Tighten

ABNORMAL ENGINE NOISE

1) ENGINE KNOCKING

Checkpoint		Trouble Cause	Countermeasure
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Check to see that the engine has been thoroughly warmed up before beginning the troubleshooting procedure.

Fuel	NG	Use of the wrong fuel	Use the correct fuel
OK			
Fuel injection timing	NG	Fuel injection timing improperly adjusted	Adjust the fuel injection timing
OK			
Injection nozzle	NG	Improper injection nozzle starting pressure and spray condition	Adjust or replace the injection nozzle
OK			
Compression pressure	NG	Blown out head gasket Broken piston ring	Replace the head gasket or the piston ring
OK			
Injection pump	NG	Defective fuel injection nozzle resulting in fuel drippage after fuel injection	Replace the delivery valve

2) GAS LEAKAGE NOISE

Checkpoint		Trouble Cause	Countermeasure
Exhaust pipes	NG	Loosely connected exhaust pipes Broken exhaust pipes	Tighten the exhaust pipe connections Replace the exhaust pipes
OK			
Injection nozzles and/or glow plugs	NG	Loose injection nozzle and/or glow plugs	Replace the washers Tighten the injection nozzles and/or the glow plugs
OK			
Exhaust manifold	NG	Loosely connected exhaust manifold	Tighten the exhaust manifold connections
OK			
Cylinder head gasket	NG	Damaged cylinder head gasket	Replace the cylinder head gasket

3) CONTINUOUS NOISE

Checkpoint		Trouble Cause		Countermeasure
Fan belt	OK			
	NG	Loose fan belt		Readjust the fan belt tension
Cooling fan	OK			
	NG	Loose cooling fan		Tighten the cooling fan
Water pump bearing	OK			
	NG	Worn or damaged water pump bearing		Replace the water pump bearing
Generator	OK			
	NG	Defective generator		Repair or replace the generator
Valve clearance	OK			
	NG	Valve clearance improperly adjusted		Adjust the valve clearance

4) SLAPPING NOISE

Checkpoint		Trouble Cause	Countermeasure
Valve clearance	NG	Valve clearance improperly adjusted	Adjust the valve clearance
OK			
Rocker arm	NG	Damaged rocker arm	Replace the rocker arm
OK			
Flywheel	NG	Loose flywheel bolts	Tighten the flywheel bolts
OK			
Crankshaft and thrust bearings	NG	Worn or damaged crankshaft and/or thrust bearings	Replace the crankshaft and/or the thrust bearings
OK			
Crankshaft and connecting rod bearings	NG	Worn or damaged crankshaft and/or connecting rod bearings	Replace the crankshaft and/or the connecting rod bearings
OK			
Connecting rod bushing and piston pin	NG	Worn or damaged connecting rod bushing and piston pin	Replace the connecting rod bushing and/or the piston pin
OK			
Piston and cylinder liner	NG	Worn or damaged piston and cylinder liner Foreign material in the cylinder	Replace the piston and the cylinder liner

TURBOCHARGER

ENGINE HAS LESS THAN NORMAL POWER

Checkpoint		Trouble Cause	Countermeasure
Air cleaner	NG	Restricted	Clean or replace
OK			
Intake pipe and hose	NG	Restricted	Clean or replace
OK			
Compressor / intake manifold	NG	Loose (Leaking)	Repair
OK			
Exhaust manifold / turbine inlet	NG	Loose (Leaking)	Repair
OK			
Exhaust piping and silencers	NG	Restricted	Clean or replace
OK			
Air breather	NG	Restricted	Clean or replace
OK			
Boost compensator (Injection pump)	NG	Defective	Repair or replace

Continued on the next page

Checkpoint		Trouble Cause	Countermeasure
Continued from the previous page			
OK	Compressor wheel		
		NG	Impact damage
			Replace
OK	Turbine wheel		
		NG	Impact damage
			Replace
		NG	Carbon build-up
			Replace
OK	Rotating assembly		
		NG	Dragging or seized
			Replace

BLUE OR BLACK SMOKE

Checkpoint		Trouble Cause	Countermeasure
Air cleaner or intercooler	NG	Restricted	Clean, repair, or replace
OK			
Turbocharger oil seal	NG	Leakage	Replace
OK			
Turbocharger oil drain pipe	NG	Restricted	Repair or replace
OK			
PCV system	NG	Defective	Repair or replace
OK			
Crankcase	NG	Excessive pressure	Repair
OK			
Compressor wheel	NG	Impact damage	Replace
OK			
Turbine wheel	NG	Impact damage	Replace

Continued on the next page

Checkpoint		Trouble Cause		Countermeasure
Continued from the previous page				
	OK			
Center housing oil drain passage	NG	Restricted		Clean or replace

EXCESSIVE OIL CONSUMPTION

Checkpoint		Trouble Cause	Countermeasure
P.C.V system	NG	Defective	Repair or replace
OK			
Crankcase	NG	Excessive pressure	Repair
OK			
Turbocharger oil seal	NG	Leakage	Replace
OK			
Turbocharger oil drain pipe	NG	Restricted	Clean or replace
OK			
Turbine wheel	NG	Impact damaged	Replace the turbine housing
OK			
Compressor wheel	NG	Impact damage	Replace the compressor housing and rotating assembly
OK			
Oil Pressure	NG	Excessive	Repair

Continued on the next page

Checkpoint		Trouble Cause		Countermeasure
Continued from the previous page				
Center housing oil drain passage	OK			
	NG	Restricted		Clean or replace

EXCESSIVE TURBOCHARGER NOISE

Checkpoint		Trouble Cause	Countermeasure
Intake and exhaust system joints	NG	Loose	Repair
OK			
Intake and exhaust system gaskets	NG	Damaged	Repair
OK			
Turbocharger rotating parts	NG	Rough rotation	Replace
OK			
Compressor wheel	NG	Rubbing against housing	Repair or replace
	NG	Damaged	Replace
OK			
Turbine wheel	NG	Rubbing against housing	Repair or replace
	NG	Damaged	Replace

Continued on the next page

Checkpoint		Trouble Cause	Countermeasure
Continued from the previous page			
	OK		
	NG	Carbon deposits	Clean or replace
Oil Level	OK		
	NG	Too low	Correct
	OK		
	NG	Contaminated	Replace oil
Turbocharger oil feed pipe	OK		
	NG	Restricted	Repair or replace
Turbine housing	OK		
	NG	Carbon deposits	Clean
Compressor housing	OK		
	NG	Dirty	Clean
Turbine shaft bearings	OK		
	NG	Worn	Replace

EXCESSIVE ROTATING PART WEAR

Checkpoint		Trouble Cause	Countermeasure
Engine oil	NG	Contaminated	Change
OK	NG	Wrong grade or type	Change
Turbocharger oil feed pipe	NG	Restricted	Clean or replace
OK			
Turbocharger oil seal	NG	Defective	Replace
OK	NG	Restricted	Clean or replace
Turbine shaft	NG	Oil sludge and coking	Replace
OK			
Engine lubrication system	NG	Inadequate oil supply	Correct

GENERATOR

BATTERY DEAD

Checkpoint		Trouble Cause	Countermeasure
Generator drive belt	NG	Loose	Adjust
OK			
Battery fluid	NG	Low	Replenish
OK			
Battery terminal	NG	Defective (Internal short circuit)	Replace
OK			
Fuse	NG	Blown	Replace
OK			
Fuse holder and fuse	NG	Poor contact	Repair
OK			
Battery fluid specific gravity	NG	Wrong	Adjust
OK			
Starter switch and regulator terminal wire	NG	Broken or poorly connected	Repair

Continued on the next page

Checkpoint**Trouble Cause****Countermeasure**

Continued from the previous page

OK			
Regulator terminal and generator terminal wire	NG	Broken or poorly connected	Repair
OK			
Generator ground circuit	NG	Defective	Repair
OK			
Voltage regulator	NG	Defective	Replace
OK			
Diode	NG	Defective	Replace
OK			
Generator stator coil	NG	Grounded or broken	Repair or replace
OK			
Rotor coil	NG	Broken	Replace
OK			
Electrical load	NG	Excessive	Check generator output at normal driving speed

BATTERY OVERCHARGED

Checkpoint		Trouble Cause	Countermeasure
Wiring and terminals (Generator to voltage regulator)	NG	Poor connections or open circuit (B—B and/or N—N terminals)	Correct
OK			
Voltage regulator	NG	Poor ground connection	Correct
	NG	Voltage set too high	Replace
	NG	Defective	Replace

FLASHING CHARGE LIGHT OR FLUCTUATING AMMETER INDICATION

Checkpoint		Trouble Cause	Countermeasure
Fan belt	NG	Loose	Adjust
OK			
Starter switch contacts	NG	Defective	Replace
OK			
Wiring	NG	Broken or poorly connected	Replace or reconnect

CHARGE LIGHT ON BUT DIM WHILE DRIVING

Checkpoint		Trouble Cause	Countermeasure
Starter switch terminal wiring	NG	Loose	Retighten
OK			
Generator and fuse holder terminal wire	NG	Excessive resistance	Replace the wire with a larger one
OK			
Starter switch contacts	NG	Defective	Replace

GENERATOR NOISE

Checkpoint		Trouble Cause	Countermeasure
Generator bearing	NG	Defective	Replace and regrease
OK			
Generator stator coil	NG	Exposed wires	Replace
	NG	Short circuit	Replace

CHARGER CIRCUIT FUSE BLOWN

Checkpoint		Trouble Cause	Countermeasure
Terminal wiring	NG	Grounded	Repair
OK			
Generator end frame diodes	NG	Defective	Replace the end frame assembly
OK			
Battery connections	NG	Reversed	Correct

STARTER MOTOR

STARTER AND MAGNETIC SWITCH DO NOT OPERATE

Checkpoint		Trouble Cause	Countermeasure
Battery fluid level	NG	Low	Replenish
OK			
Battery specific gravity	NG	Low	Recharge or replace
OK			
Battery switches	NG	Poor contact	Replace
OK			
Starter switch	NG	Defective	Replace
OK			
Magnetic switch pull-in coil and plunger	NG	Defective	Replace
OK			
Armature coil	NG	Broken	Replace
OK			
Field coil	NG	Broken	Replace

Continued on the next page

Checkpoint		Trouble Cause	Countermeasure
Continued from the previous page			
OK			
Magnetic switch coil	NG	Broken	Replace
OK			
Holding coil	NG	Broken	Replace

MAGNETIC SWITCH CLOSSES BUT STARTER DOES NOT OPERATE

Checkpoint		Trouble Cause	Countermeasure
Battery fluid level	NG	Low	Replenish
OK			
Battery specific gravity	NG	Low	Recharge or replace
OK			
Starting circuit	NG	Poor contacts	Repair
OK			
Magnetic switch terminals	NG	Poor contact	Replace
OK			
Brushes	NG	Worn	Replace
OK			
Armature	NG	Shorted	Repair or replace

STARTER MOTOR RUNS SLOWLY

Checkpoint		Trouble Cause	Countermeasure
Magnetic terminal circuit switches	NG	Bad contact	Repair
OK			
Brushes	NG	Excessive wear	Replace
OK			
Starter motor armature	NG	Shorted	Repair or replace

STARTER MOTOR OPERATES BUT THE ENGINE DOES NOT TURN OVER

Checkpoint		Trouble Cause	Countermeasure
Pinion and ring gear	NG	No meshing	Repair or replace the running clutch and the drive lever
OK			
Overrunning clutch	NG	Slippage	Replace
OK			
Brushes	NG	Excessive wear	Replace

ABNORMAL OPERATING NOISE

Checkpoint		Trouble Cause	Countermeasure
Bushings	NG	Excessive wear	Replace
OK			
Pinion gear	NG	Excessive wear	Replace the overrunning clutch and the pinion gear
	NG	Rough sliding action	Lubricate or replace the overrunning clutch
OK			
Ring gear	NG	Excessive wear	Replace the overrunning clutch and the ring gear
OK			
Brushes	NG	Excessive wear	Replace

MAIN DATA AND SPECIFICATIONS

Engine Model		6SD1	6SD1TC (Conform in EURO-I)	6SD1TC (Conform in EURO-II)
Item				
Engine type		Four-cycle, overhead camshaft, water cooled, direct injection	←	←
Combustion chamber		Open type, in piston crown	←	←
Cylinder liner		Dry type, super tarkalloy	←	←
Timing drive system		Gear drive	←	←
No. of cylinders - Bore × stroke	mm(in)	6 - 120 × 145 (4.72 × 5.71)	←	←
No. of piston rings		Compression rings: 2 Oil ring: 1	Compression rings: 3 Oil ring: 1	←
Total piston displacement	cc(lmp.qt/US qt)	9,839 (8.657/10.3969)	←	←
Compression ratio (To 1)		16.0	16.5	←
Compression pressure at 200 rpm	kPa(kg/cm ² /psi)	More than 2,746 (28/398)	←	←
Engine weight (Dry)	kg(lb)	673 (1,484)	720 (1,588)	←
Fuel injection order		1 - 5 - 3 - 6 - 2 - 4	←	←
Fuel injection timing (BTDC)	deg	18±0.3	10±0.3 14±0.3 (For New Zealand)	5±0.3
Specified fuel type		SAE No. 2 diesel fuel	←	←
Idling speed	rpm	560 - 600	←	←
Valve clearances	Intake mm(in)	0.40 (0.016)	←	←
	Exhaust mm(in)	0.40 (0.016)	←	←
Intake valves	Open at (BTDC) deg	18	15	←
	Close at (ABDC) deg	50	39	←
Exhaust valves	Open at (BBDC) deg	54	40	←
	Close at (ATDC) deg	14	14	←
Injection pump		Bosch in-line AD-type	Bosch in-line P-type	Bosch in-line HD-TICS
Governor type		RLD variable speed mechanical governor	←	←
Injection nozzle		Hole type (Five holes) Single spring nozzle holder	Hole type (Six holes) Two spring nozzle holder	Hole type (Seven holes) ←
Injection nozzle opening pressure	MPa(kg/cm ² /psi)	22.1 (225/3,200)	1st: 17.7 (180/2,560) 2nd: 22.1 (225/3,200)	←

Item \ Engine Model	6SD1	6SD1TC (Conform in EURO-I)	6SD1TC (Conform in EURO-II)
Main fuel filter type	Cartridge type	←	←
Lubricating system			
Lubrication method	Full flow pressure circulation	←	←
Specified engine oil (API grade)	CC, CD or CE	CD or CE	←
Oil pressure kPa(kg/cm ² /psi)/rpm (at oil gallery)	More than 98 (1.0/14.2)/580	More than 68.6 (0.7/10.0)/600	←
	216 – 412 (2.2 - 4.2/31.3 – 59.7)/ 1,300	127.5 – 250.1 (1.3 - 2.55/18.5 – 36.6)/ 1,000	←
	500 – 637 (4.8 - 6.8/68.3 – 96.7)/ 2,500	372.7 – 490.3 (3.8 - 5.0/54.0 – 71.1)/ 2,200	←
	Condition: SAE 10W-30 API CD grade engine oil at an oil temperature 100°C (212°F)	← 95°C (203°F)	← ←
Oil pump type	Gear (Crankshaft drive)	←	←
Main oil filter type	Replaceable cartridge	←	←
Partial oil filter type	Replaceable cartridge	←	←
Oil capacity (Oil pan) L(imp.qt/USqt)	24 (21.1 / 25.4)	←	←
Oil cooler	Plate type - Water cooled in water jacket	←	←
Cooling system			
Radiator type	Corrugated fin with reserve tank	←	←
Coolant capacity L(imp.qt/USqt)	27.5 (24.2/29.0)	27.9 (24.5/29.5)	←
Water pump type	Centrifugal impeller	←	←
Thermostat type	Wax pellet	←	←
Air cleaner	Cyclone type with paper element	←	←
Battery Type/Voltage × No. of units	65D23R / 12 × 2	←	←
Generator capacity V-A(W)	24 – 42 (1,000) 24 – 60 (1,500) (For Australia)	←	←
Starter motor output V-kw	24 – 5.5	←	←
Turbocharger model	—	IHI RHE7 with water cooling system	←
Maximum permissible operating speed rpm	—	120,000	←
Inter cooler	—	Corrugate fin type	←

ENGINE ELECTRICAL

Generator		
Type		Brushless
Output power	W	950 1500 (For Australia)
Manufacturer		NIPPONDENSO
Rated voltage	V	24
Output current	A	40 60 (For Australia)
Load output	A/V/rpm	35/27/4,000
No-load output	V/rpm	27/720
Rotation (Viewed from the pulley)		Clockwise
Ground polarity		Negative
Pulley diameter	mm(in)	80 (3.15)
Rotor coil resistance at 20°C	Ω	9
Regulator		IC type (Built-in)

Starter motor		
Voltage	V	24
Output	KW	5.5
Number of poles		4
Manufacturer's name		NIPPONDENSO
Type		Magnetic switch controlled
Drive gears		Reduction
No. of pinion gear teeth		11
No load characteristics		
Voltage	V	23
Current	A	120 or less
Operating speed (Rotor)	rpm	3,800 or more
Rotation		Clockwise viewed from the drive pinion gear

Preheating system		
Type		Starter switch controlled
Glow plugs		
Rated voltage	V	20.5
Load current	A	4.1 - 5.1
Internal resistance	Ω	4.5
Time required to reach 800°C (1,472°F) sec		20 - 25

Control resistor		
Rated voltage	V	24
Load current	A	27.6
Internal resistance	Ω	0.04
Operating time	sec	20 - 25
Insulation resistance	M Ω	1.0 or more
Saturation temperature	°C(°F)	1,000 (1,832) or less

SERVICE STANDARD

ITEMS			SERVICE STANDARD		SERVICE LIMIT	
			6SD1	6SD1TC	6SD1	6SD1TC
Cylinder Head						
Lower Face Warpage	mm (in)		0.05 (0.002) or less		0.20 (0.008) Do not attempt to regrind the lower face.	
Valve Guide						
Valve Stem Clearance						
Intake:	mm (in)		0.04 – 0.077 (0.0016 – 0.0030)		0.15 (0.0059)	
Exhaust:	mm (in)		0.065 – 0.102 (0.0026 – 0.0040)		0.20 (0.0079)	
Valve Stem Outside Diameter						
Intake:	mm (in)		9.94 – 9.96 (0.3913 – 0.3780)		9.92 (0.3906)	
Exhaust:	mm (in)		9.91 – 9.94 (0.3902 – 0.3913)		9.90 (0.3898)	
Valve Guide Upper End Height	mm (in)		22 (0.87)		—	
Valve and Valve Seat Insert						
Valve Thickness						
Intake:	mm (in)		2.50 (0.098)		2.00 (0.079)	
Exhaust:	mm (in)		2.35 (0.093)		1.85 (0.073)	
Valve Depression A						
Intake:	mm (in)		0.48 (0.0190)		1.48 (0.0583)	
Exhaust:	mm (in)		1.6 (0.0630)		2.6 (0.1024)	
Valve Contact Width						
Intake:	mm (in)		2.7 (0.1063)		3.5 (0.1378)	
Exhaust:	mm (in)		2.4 (0.0945)		3.2 (0.1260)	
Valve Face Angle						
Intake:	deg		45	30	—	
Exhaust:	deg		45	45	—	
Valve Spring						
Spring Height						
Intake : Inner	mm (in)		62.5 (2.46)	62.5 (2.46)	60.5 (2.38)	60.5 (2.38)
: Outer	mm (in)		59.3 (2.33)	59.3 (2.33)	57.3 (2.26)	57.3 (2.26)
Exhaust : Inner	mm (in)		62.6 (2.47)	69.2 (2.72)	60.8 (2.39)	67.2 (2.65)
: Outer	mm (in)		69.6 (2.74)	80.7 (3.18)	67.6 (2.66)	78.7 (3.10)
Inner and Outer Spring Squareness						
Intake : Inner	mm (in)		2.0 (0.08)		3.0 (0.12)	
: Outer	mm (in)		2.5 (0.01)		3.5 (0.14)	

ITEMS	SERVICE STANDARD		SERVICE LIMIT	
	6SD1	6SD1TC	6SD1	6SD1TC
Valve Spring (Cont.)				
Intake Valve Spring Tension N (kg / lb)				
Compression Height at				
Inner: 46.2mm (1.82 in)	111.8 (11.4 / 25.1)	112 (11.4 / 25.14)		
Outer: 48.7mm (1.92in)	292.2 (29.8 / 65.7)	289 (29.5 / 64.5)		
Exhaust Valve Spring Tension N (kg / lb)				
Compression Height at				
Inner: 46.2mm (1.82 in)	177.5 (18.1 / 39.9)	284 (29 / 63.95)		
Outer: 48.7mm (1.92in)	414.8 (42.3 / 93.3)	500 (51 / 112.46)		
Rocker Arm Shaft and Rocker Arm				
Rocker Arm Shaft Run-Out mm (in)			0.30 (0.012)	
Rocker Arm Shaft Outside Diameter mm (in)	18.965 – 18.985 (0.7466 – 0.7474)		18.85 (0.742)	
Rocker Arm Inside Diameter mm (in)	19.01 – 19.03 (0.748 – 0.749)			
Rocker Arm Shaft and Rocker Arm Clearance mm (in)	0.01 – 0.05 (0.0004 – 0.0022)		0.20 (0.008)	
Camshaft				
Camshaft Journal Diameter mm (in)	39.915 – 39.940 (1.5715 – 1.5724)		39.890 (1.5705)	
Cam Lobe Height ^(H) mm (in)	45.47 (1.79)	45.92 (1.81)	45.05 (1.77)	45.50 (1.79)
Camshaft Run-Out mm (in)	0.05 (0.002)		0.10 (0.004)	
Camshaft Bearing Inside Diameter mm (in)	40.00 – 40.25 (1.575 – 1.585)			
Camshaft Bracket Clearance mm (in)	0.06 – 0.11 (0.0024 – 0.0043)		0.16 (0.0063)	
Camshaft Gear Back mm (in)	0.10 (0.0039)		0.30 (0.012)	
Crankshaft				
Crankshaft End Play mm (in)	0.100 – 0.285 (0.004 – 0.011)		0.40 (0.016)	
Crankshaft Run-Out mm (in)	0.08 (0.0032) or less		0.15 (0.0059)	
Crankshaft Journal Diameter	89.909 – 89.929 (3.5397 – 3.5405)		89.409 (3.5200)	

ITEMS		SERVICE STANDARD		SERVICE LIMIT	
		6SD1	6SD1TC	6SD1	6SD1TC
Crankshaft (Cont.)					
Crankshaft Journal and Bearing Clearance	mm (in)	0.045 – 0.110 (0.0018 – 0.0043)		0.16 (0.0063)	
Crankpin Diameter		79.894 – 79.914 (3.1454 – 3.1462)		79.394 (3.1257)	
Crankshaft Journal and Crankpin Uneven Wear	mm (in)	0.007 (0.0003)		0.50 (0.0020)	
Piston and Piston Ring					
Piston Grade					
Piston Ring and Piston Ring Groove Clearance	mm (in)				
1st Compression Ring		0.10 – 0.142 (0.0039 – 0.0056)		0.23 (0.0091)	
2nd Compression Ring		0.105 – 0.140 (0.0041 – 0.0055)		0.20 (0.0079)	
3rd Compression Ring			0.085 – 0.120 (0.0033 – 0.0047)		0.20 (0.0079)
Oil Ring		0.020 – 0.060 (0.0008 – 0.0024)		0.15 (0.0059)	
Piston Ring Gap	mm (in)				
1st Compression Ring		0.35 – 0.50 (0.0138 – 0.0197)		1.0 (0.0394)	
2nd-3rd Compression Ring		0.35 – 0.50 (0.0138 – 0.0197)		1.0 (0.0394)	
Oil Ring		0.25 – 0.45 (0.0098 – 0.0177)		0.8 (0.0315)	
Piston Pin					
Piston Pin Diameter	mm (in)	42.995 – 43.000 (1.6927 – 1.6929)		42.95 (1.6909)	
Piston Pin Hole Diameter	mm (in)	43.004 – 43.012 (1.6931 – 1.6934)			
Piston Pin and Piston Pin Hole Clearance	mm (in)	0.004 – 0.017 (0.00016 – 0.00067)		0.050 (0.002)	
Connecting Rod					
Connecting Rod Alignment	mm (in)	0.03 (0.0012) or less		0.10 (0.0039)	
Connecting Rod Small End Bushing Diameter	mm (in)	43.012 – 43.022 (1.6934 – 1.6938)			
Piston Pin and Connecting Rod Small End Bushing Clearance	mm (in)	0.012 – 0.027 (0.00047 – 0.00106)		0.10 (0.0039)	

ITEMS	SERVICE STANDARD		SERVICE LIMIT	
	6SD1	6SD1TC	6SD1	6SD1TC
Connecting Rod (Cont.)				
Crankpin and Bearing Clearance mm (in)	0.04 – 0.106 (0.0016 – 0.0042)		0.16 (0.0063)	
Flywheel				
Flywheel Friction Surface Depth mm (in)	48.0 (1.89) for 15 in clutch		49.0 (1.93) for 15 in clutch	
Flywheel Friction Surface Roughness mm (in)	Less than 0.06 (0.0024)		—	
Idler Gear				
Idler Gear Shaft "A", "B" and "C" Outside Diameter mm (in)	A. 40.959 – 40.980 (1.6126 – 1.6134) B. 29.959 – 29.980 (1.1795 – 1.1803) C. 31.934 – 31.950 (1.2572 – 1.2579)		40.859 (1.6086) 29.859 (1.01755) 31.834 (1.2533)	
Idler Gear Shaft (A, B, C) and Idler Gear Clearance mm (in)				
Shaft A & B	0.020 – 0.062 (0.0008 – 0.0024)		0.12 (0.0047)	
Shaft C	0.010 – 0.051 (0.0004 – 0.0020)		0.15 (0.0059)	
Oil Pump				
Gear Teeth and Cover Inner Wall Clearance mm (in)	0.10 – 0.196 (0.0039 – 0.0077)		0.20 (0.0079)	
Gear and Body Clearance mm (in)	0.040 – 0.093 (0.0016 – 0.0036)		0.120 (0.0047)	
Cylinder Body				
Cylinder Body Upper Face Warp mm (in)	less than 0.20 (0.008)		0.20 (0.008)	
Cylinder Liner Projection mm (in)	0.10 – 0.14 (0.0039 – 0.0055)		—	
Cylinder Body Bore and Cylinder Liner Outside Diameter Clearance mm (in)	0.011 – 0.029 (0.0004 – 0.0011)		—	
Cylinder Liner Grade (Reference)				

SERVICING

Servicing refers to general maintenance procedures to be performed by qualified service personnel.



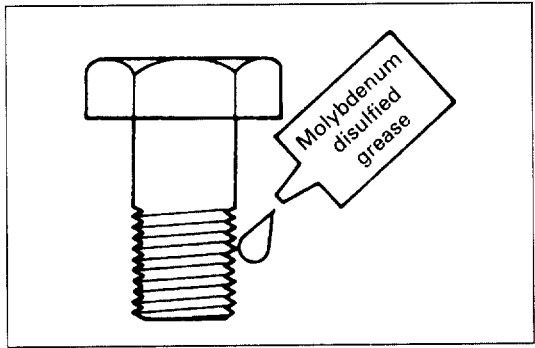
WARNING:

ALLOW THE ENGINE TO COOL BEFORE BEGINNING ANY SERVICING PROCEDURE. THIS WILL ELIMINATE THE DANGER OF FIRE AND POSSIBLE INJURY.

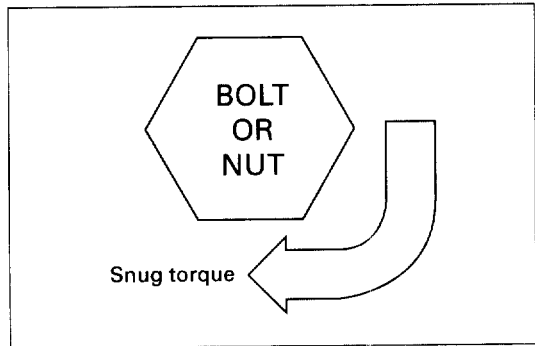
Nut and Bolt Angular Tightening Method

The angular tightening method uses the plastic region of high tensile steel nuts and bolts to precision tighten important engine fasteners.

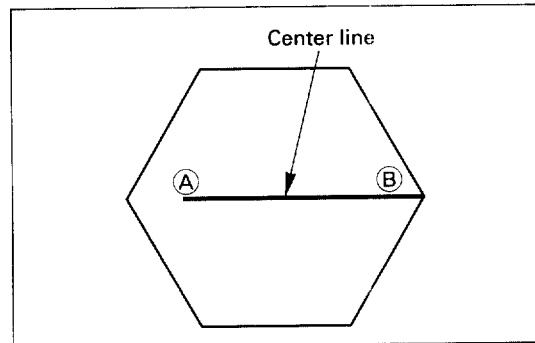
Because of the method's nature, there is a limit to the number of times a particular fastener may be reused. This limit is specified in this Manual where applicable.



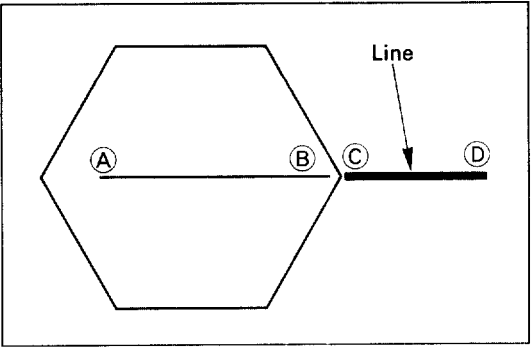
1. Carefully wash the nuts and bolts to remove all oil and grease.
2. Apply a coat of molybdenum disulfide grease to the threads and setting faces of the nuts and bolts.



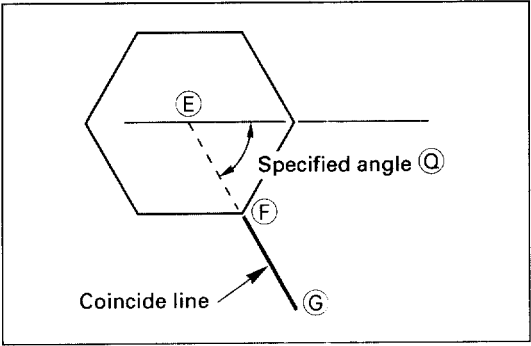
3. Tighten the nuts and bolts to the specified torque (snug torque) with a torque wrench.



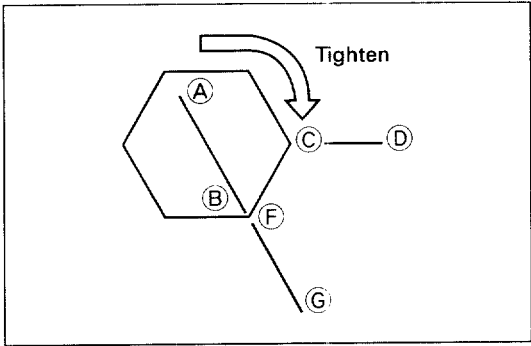
4. Draw a line (A)–(B) across the center of each bolt.



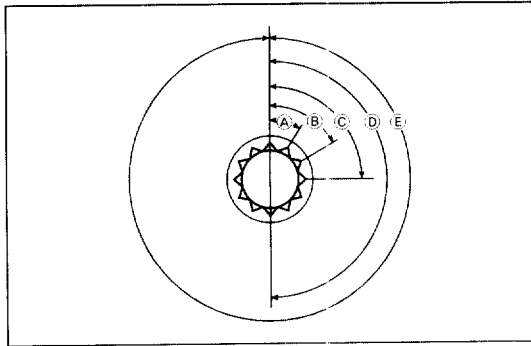
5. Draw another line C-D on the face of each of the parts to be clamped. This line should be an extension of the line A-B.



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

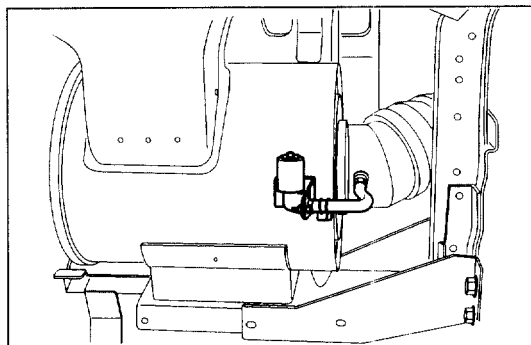
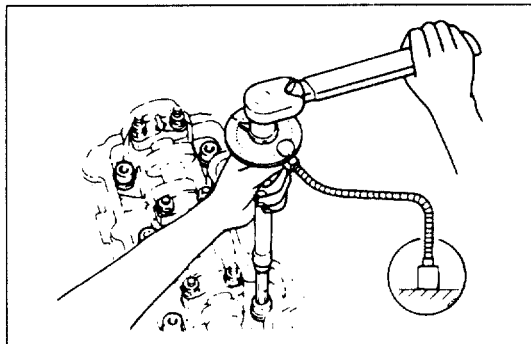
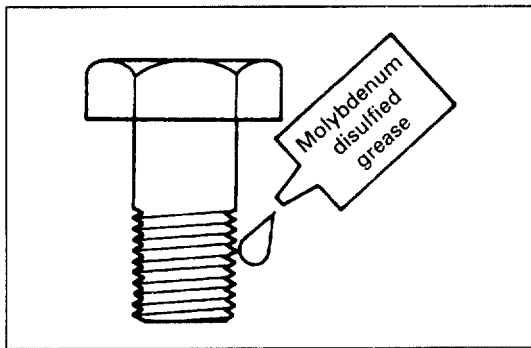


7. Use a socket wrench to tighten each nut or bolt to the point where the line A-B is aligned with the line F-G.

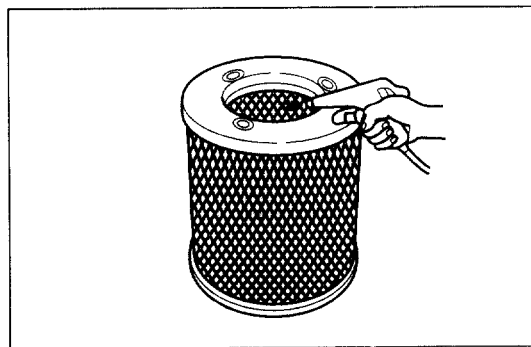


Example: Specified Angle and Tightening Rotation

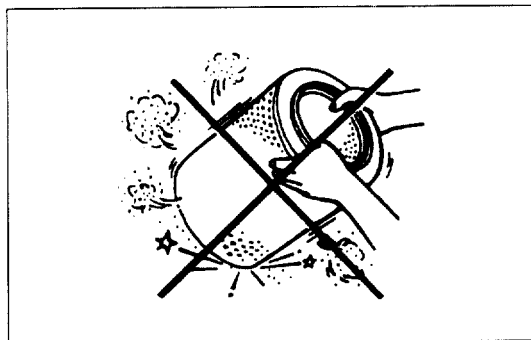
A	30°	1 / 12 of a turn
B	60°	1 / 6 of a turn
C	90°	1 / 4 of a turn
D	180°	1 / 2 of a turn
E	360°	One full turn



130MW001



130LX021



Nut and Bolt Angular Tightening Method (Using The Special Tool)



1. Carefully wash the nuts and bolts to remove all oil and grease.
2. Apply molybdenum disulfide grease to the threads and setting faces of the nuts and bolts.
3. Use a torque wrench to tighten the nuts and bolts to the specified torque (snug torque).



4. Attach the angle gauge to the socket wrench.
Angle Gauge: 5-88400-266-0



5. Attach a magnet to some part to hold the angle gauge stationary.
6. Tighten the nuts and bolts to the specified angle, noting the angle gauge indication.

Air Cleaner

Element Cleaning and Replacement

Element cleaning procedures will vary according to the condition of the element.

Washable Paper Element (Dry Type)



1. Dust Fouled Element

Rotate the element with your hand while applying compressed air to the inside of the element.

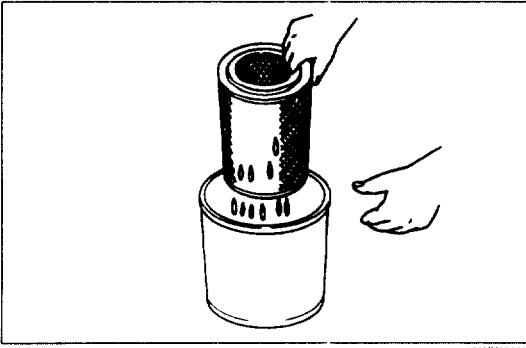
This will blow the dust free.

NOTE:

Compressed air pressure must not exceed 688kPa (7kg/cm² / 99.5psi).

If the element damaged, the element must be replaced.

Avoid giving a shock to the element when removing dust, or distortion or damage will result.



130HY00002

2. Carbon and Dust Fouled Element

- 1) Prepare cleaning solution of 300grams (0.66lb / 10.59ounces) of Donaldson ND1500 or N1400 element cleaner diluted in 20 liters (5.3US / 4.4imp gallons) of lukewarm.



- 2) Immerse the element in the solution for thirty minutes.

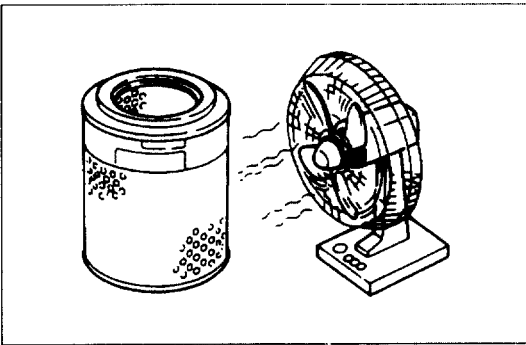
Periodically shake the element within the solution to thoroughly clean it.



- 3) Remove the element from the solution and rinse it well with running water.

NOTE:

Water pressure must not exceed 274.7kPa (2.8 kg/cm² / 39.8psi).



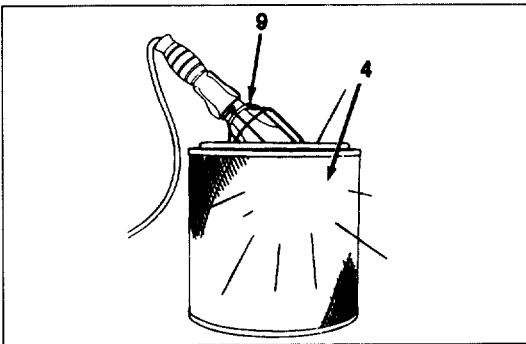
- 4) Dry the element in a well ventilated area.

An electric fan will hasten drying.

NOTE:

Do not use compressed air or an open flame to dry the element quickly. Damage to the element will result.

It will usually take one week for the element to dry completely. Therefore, it is a good idea to have a spare on hand to use in the interim.

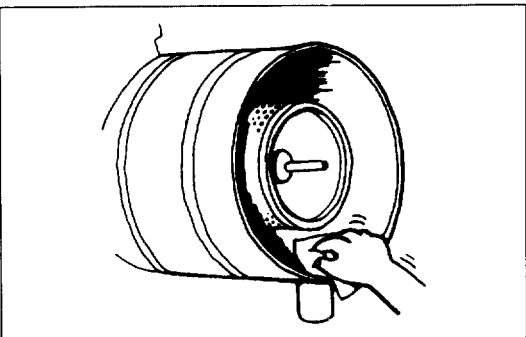


130LX00003



- 5) Use an inspection light to check the inside of the element and the gasket for damage.

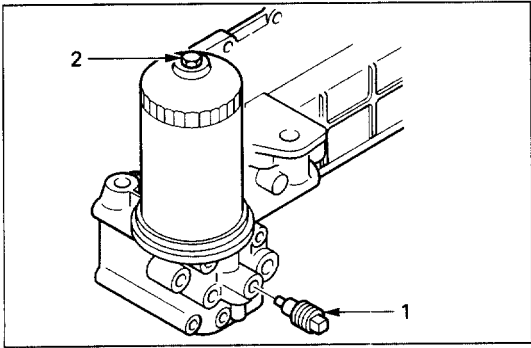
If the element damaged, the element must be replaced.



Air Cleaner Body

Wipe the air cleaner body inside surfaces and the gasket fitting surfaces free of foreign material.

Do not allow foreign material to enter the air intake pipes or the manifold.



050MT003

Lubricating System

Separate Type Main Oil Filter and Partial Oil Filter Replacement Procedure.



WARNING:

**HOT ENGINE OIL CAN CAUSE SEVERE SKIN BURNS.
ALLOW THE ENGINE TO COOL BEFORE DRAINING
THE ENGINE OIL.**

Main Oil Filter



1. Remove oil drain plug and drain oil.
2. Use a oil filter wrench to remove the main oil filter.

Drain Plug Torque	N·m (kg·m / lb·ft)
17.7 (1.8 / 13.0)	



3. Clean the main oil filter fitting face.
This will allow the new oil filter to seat properly.



4. Apply a light coat of engine oil to the O-ring.
5. Turn in the new oil filter until the filter an additional.



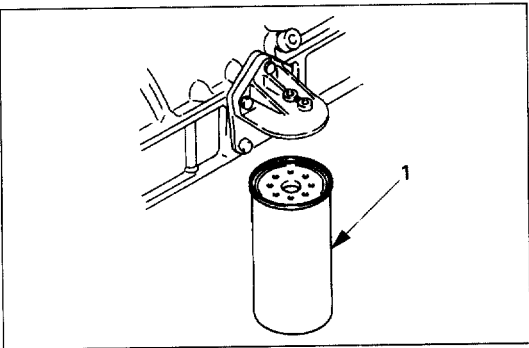
6. Use a oil filter wrench to turn in the filter an additional one full turn.

NOTE:

Oil leaks cause distortion the cartridge due to excessive tight the cartridge.



7. Check the engine oil level and replenish to the specified level if required.



Partial Oil Filter (Cartridge)



1. Remove oil drain plug and drain oil.
2. Use a oil filter wrench to remove the oil filter.



3. Clean the oil filter fitting face.
This will allow the new oil filter to seat properly.



- 4. Apply a light coat of engine oil to the O-ring.
- 5. Turn in the new oil filter until the filter O-ring is fitted against the sealing face.
- 6. Use a oil filter wrench to turn in the filter an additional one full turn.



Note:
Oil leaks cause distortion the cartridge due to excessive tight the cartridge.



- 7. Check the engine oil level and replenish to the specified level if required.

Fuel System
Fuel Filter
Cartridge Type

Remove

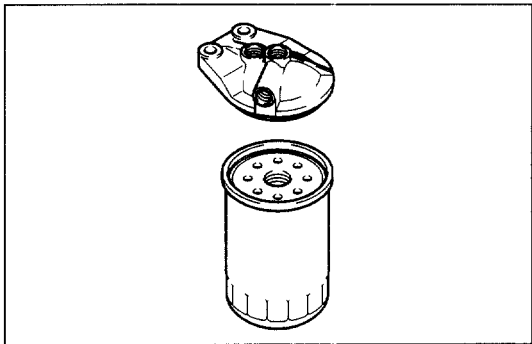
- 1. Cartridge

Installation

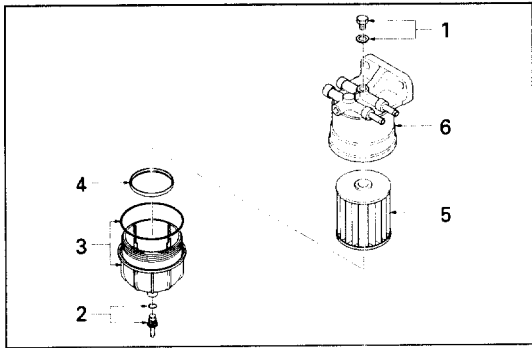


- 1. Install the cartridge to specified torque.

Cartridge Torque	N·m (kg·m / lb·ft)
17.9 (1.80 / 13.0)	



145MT003



Water Separator with Pre-Fuel Filter

Disassembly

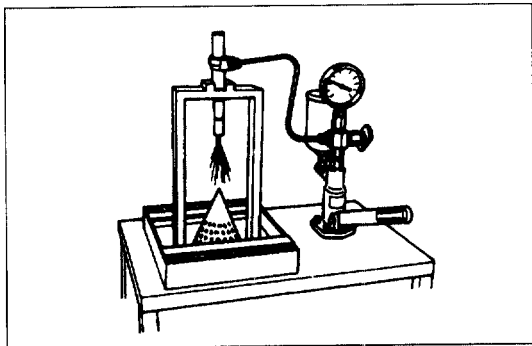
1. Plug
2. Drain plug
3. Cover
4. Float
5. Filter element
6. Body

Reassembly

To reassemble the fuel filter, follow the disassembly procedure in the reverse order.

Fix the cartridge to specified torque.

Cartridge Torque	N·m (kg·m / lb·ft)
19.6 (2.00 / 14.0)	



Injection Nozzle

Opening Pressure and Spray Condition Check

1. Use an injection nozzle tester to check the nozzle opening pressure.

If the opening pressure is above or below the specified value, the injection nozzle must be replaced or adjusted.

Refer to "Injection Nozzle Adjustment."

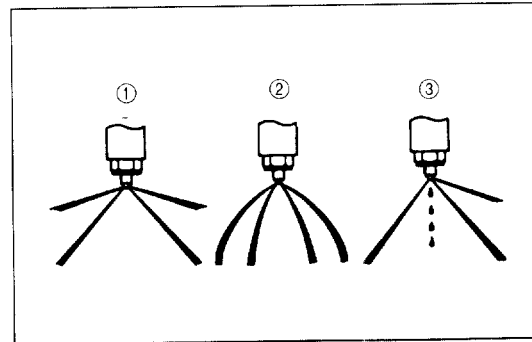
Injection Nozzle Opening Pressure	kPa (kg/cm ² / psi)
6SD1	22,100 (225 / 3,199.5)
6SD1TC	17,700 (180 / 2,559.6)



WARNING:

TEST FLUID FROM THE INJECTION NOZZLE TESTER WILL SPRAY OUT OF THE INJECTION NOZZLE UNDER GREAT PRESSURE. IT CAN EASILY PUNCTURE A PERSON'S SKIN.

KEEP YOUR HANDS AWAY FROM THE INJECTION NOZZLE AT ALL TIMES.

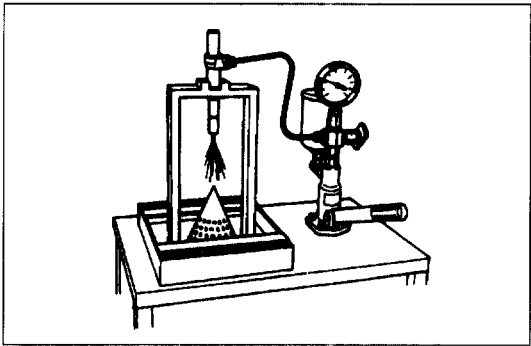


2. Check the spray condition.

If the spray condition is bad, the injection nozzle must be replaced or reconditioned.

- ① Correct
- ② Incorrect (Restrictions in orifice)
- ③ Incorrect (Dripping)

If lapping is required, refer to "FUEL SYSTEM," "Injection Nozzle" in Section 6C of this Manual.



Injection Nozzle Adjustment

For single spring type Injection nozzle

1. Attach the injection nozzle holder to the injection nozzle tester.
2. Apply pressure to the nozzle tester.
Note the pressure at which the injection nozzle opens.
3. If required, install or remove the appropriate number of adjusting shims to adjust it.

Reference:

Installing or removing 0.20mm (0.008in) will increase or decrease the nozzle opening pressure approximately 230.5kPa (2.35kg/cm² / 33.4psi).

Adjusting Shim Availability		mm (in)
Increment (0.10mm (0.004in))	0.10 (0.004), 0.20 (0.008)	
	0.30 (0.012), 0.40 (0.016)	
	0.50 (0.0196)	
Increment (0.02mm (0.008in))	0.52 (0.0205) 0.54 (0.0213)	
	0.56 (0.0220) 0.58 (0.0228)	
Total Number of Shims		9

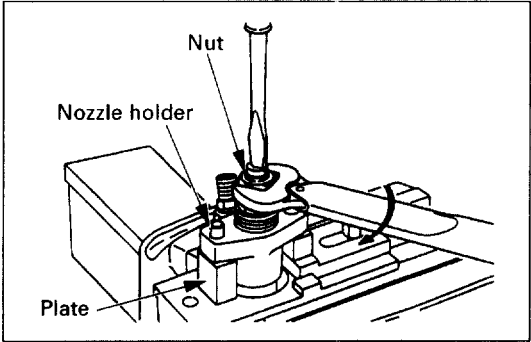
Refer to "Opening Pressure and Spray Check" immediately before this entry.

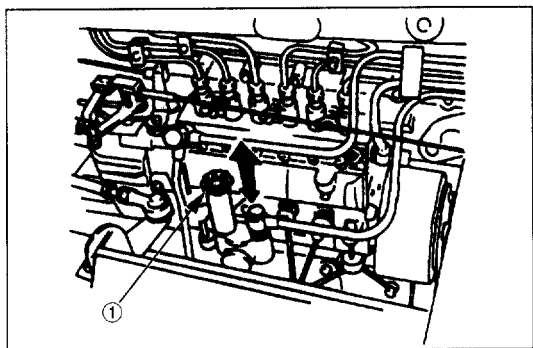
4. Clamp the injection nozzle in a vise.
5. Tighten the retaining nut to the specified torque.



Injection Nozzle Retaining Nut Torque	N·m (kg·m / lb·ft)
22 (2.25 / 16.3)	

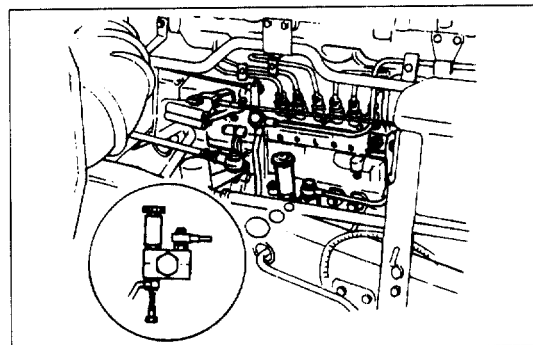
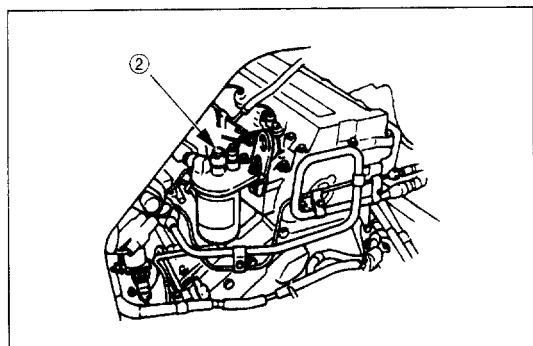
For two spring type Injection nozzle
See injection nozzle opening pressure adjustment procedure of section 6C Fuel system.





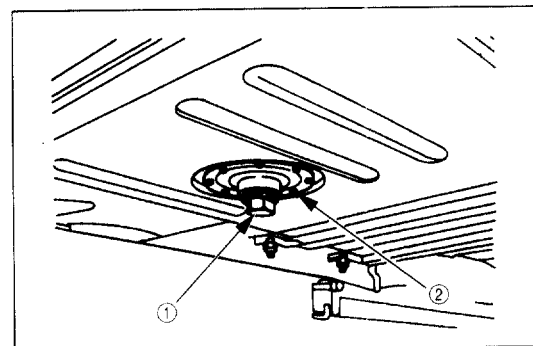
Air Bleeding

1. Loosen the priming pump cap ① on the injection pump.
2. Loosen the joint bolt ② on the fuel filter.
3. Operate the priming pump until there are no more bubbles visible in the fuel being discharged from the joint bolt.
4. Tighten the joint bolt.
5. Tighten the priming pump cap.



Feed Pump Strainer Cleaning

1. Remove the joint bolt at the inlet side of the feed pump.
The feed pump strainer is installed to the joint bolt.
2. Rotate the strainer counterclockwise to remove it from the joint bolt.
3. Clean the strainer in clean diesel fuel.
4. Reinstall the strainer and the joint bolt.



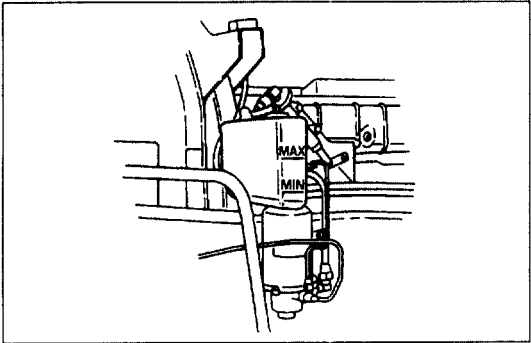
Fuel Tank Strainer Cleaning (If Required)

1. Remove the fuel tank drain plug ①.
2. Completely drain the water and sediment from the fuel tank.
3. Remove the strainer ②.
4. Wash the strainer in clean diesel oil.
5. Reinstall the strainer and the drain plug to the fuel tank.

Cooling System



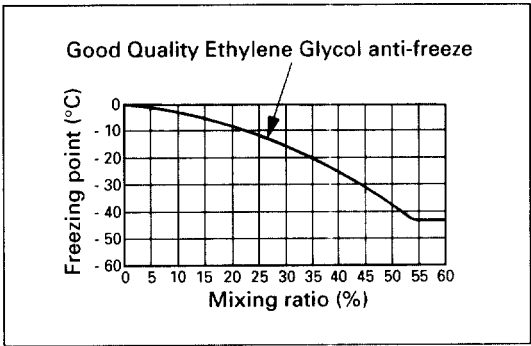
WARNING:
HOT STEAM UNDER PRESSURE MAY ESCAPE FROM THE RADIATOR IF THE RADIATOR SURGE TANK CAP IS OPENED WHILE THE ENGINE IS HOT. THIS CAN RESULT IN SERIOUS BURNS.
ALLOW THE ENGINE TO COOL BEFORE OPENING THE RADIATOR SURGE TANK CAP.



Coolant Level

Check the coolant level and replenish the radiator surge tank if necessary.
If the coolant level falls below the "MIN" line, carefully check the cooling system for leakage. Then, add additional coolant to raise the level over the "MIN" line.

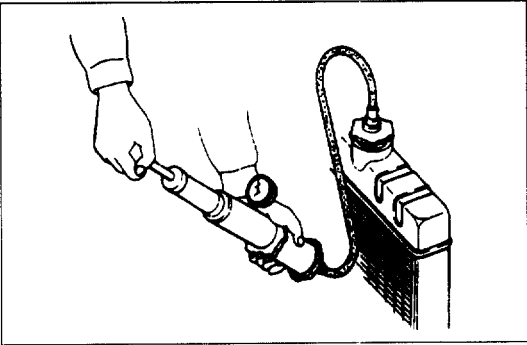
NOTE:
Do not overfill the radiator surge tank.
Remove the radiator surge tank cap only when absolutely necessary.
Always refer to the chart at the left to determine the correct cooling water to antifreeze solution mixing ratio.



Radiator Surge Tank Cap Inspection



WARNING:
HOT STEAM UNDER PRESSURE MAY ESCAPE FROM THE RADIATOR IF THE RADIATOR SURGE TANK CAP IS OPENED WHILE THE ENGINE IS HOT. THIS CAN RESULT IN SERIOUS BURNS.
ALLOW THE ENGINE TO COOL BEFORE OPENING THE RADIATOR SURGE TANK CAP.



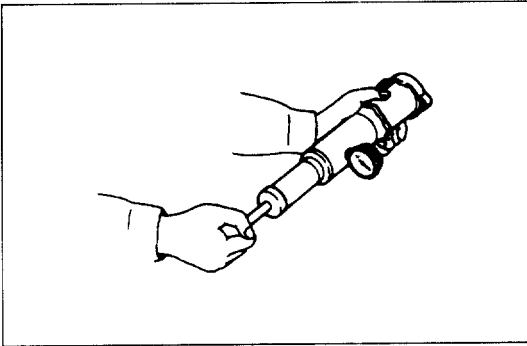
Cooling System Leakage Check

- 1. Remove the radiator filler cap from the radiator.
- 2. Install the radiator filler cap tester to the radiator.
- 3. Apply the specified test pressure to the cooling system to check for leakage.

Do not exceed the specified test pressure.

Cooling System Test Pressure	kPa (kg/cm ² / psi)
98 (1 / 14)	

Repair or replace the radiator if required.



Radiator Cap Leakage Check

The radiator filler cap maintains cooling system pressure.

It must tightly seal the cooling system.

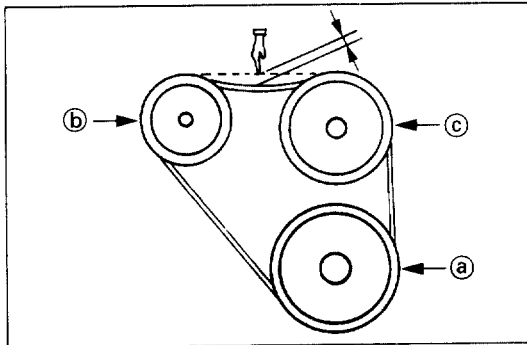
- 1. Remove the radiator filler cap from the radiator.
- 2. Install the radiator cap to the radiator filler cap tester.
- 3. Apply the specified test pressure to the cap to check for leakage.

Do not exceed the specified test pressure.

Radiator Filler Cap Test Pressure	kPa (kg/cm ² / psi)
49 – 59 (0.5 – 0.6 / 7.11 – 8.53)	

Negative Valve Pressure	kPa (kg/cm ² / psi)
2 – 5 (0.02 – 0.05 / 0.28 – 0.71)	

Replace the radiator filler cap if it fails to hold the specified test pressure.



Cooling Fan Drive Belt

- 1. Install the cooling fan drive belt.
- 2. Turn the adjusting bolt to move the alternator and adjust the cooling fan drive belt tension.
- 3. Apply a force of 98N (10kg / 22lb) to the drive belt mid-portion to check the belt deflection.

Cooling Fan Drive Belt Deflection	mm (in)
8 – 11 (0.3 – 0.4)	



Check the drive belts for cracking and other damage

- (a) Crank
- (b) Alternator pulley
- (c) Cooling fan pulley

Engine Control



Idling Speed Inspection

1. Set the vehicle parking brake and chock the drive wheels.
2. Place the transmission in neutral.
3. Start the engine and allow it to warm up.

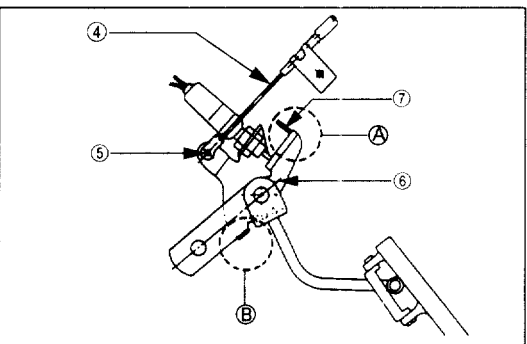
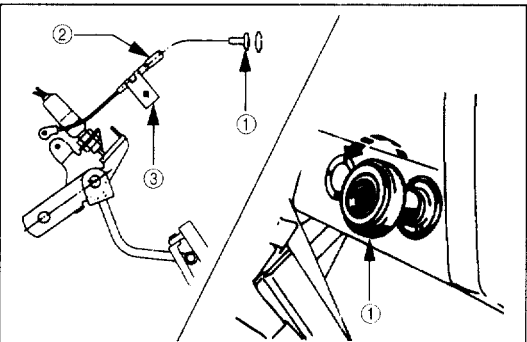
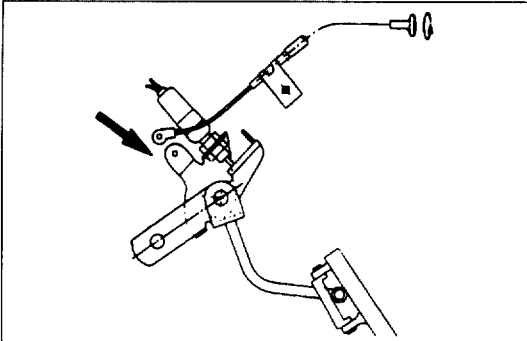
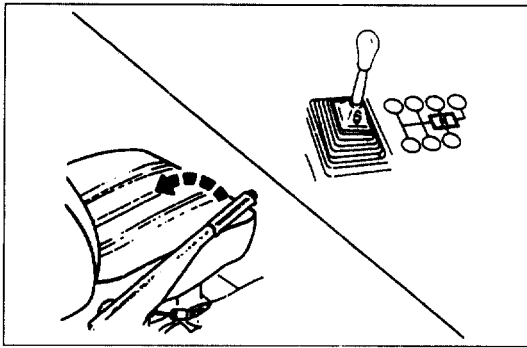
4. Disconnect the idling control cable from the idling control lever.
5. Set a tachometer to the engine.
6. Check the engine idling speed.
If the engine idling speed is outside the specified range, it must be adjusted.

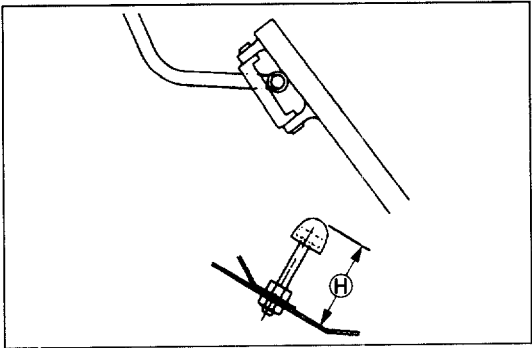
Engine Idling Speed	rpm
	560 – 600



Idling Control Cable Adjustment

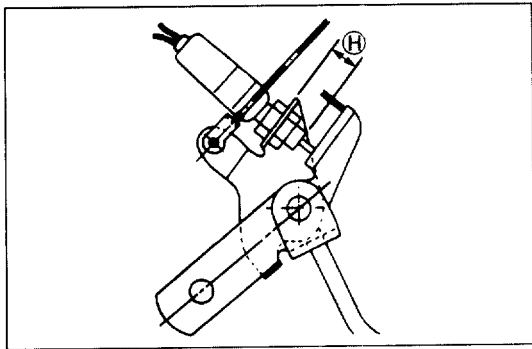
1. Disconnect the engine control cable from the injection pump control lever.
2. Rotate the idling control knob ① counterclockwise as far as possible.
3. Loosen the idling control outer cable ② at the clip ③.
4. Hold the engine control link ⑥ against the link stopper ⑦ as shown in the (A) area of the illustration.
5. Hold the idling control lever against the engine control link as shown in the (B) area of the illustration.
6. Set the idling control outer cable ② to the clip ③. There must be no slack in the inner cable.
7. Reconnect the engine control cable to the injection pump.





Accelerator Pedal Stopper Adjustment

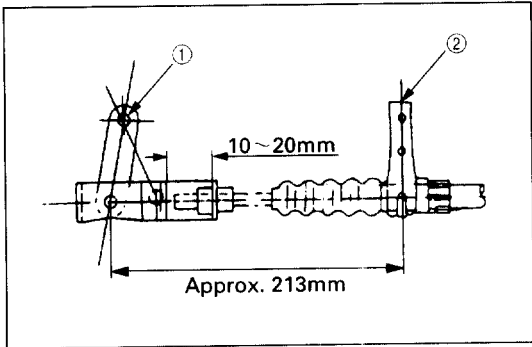
1. Set the stopper bolt cap height (H) to 79 mm (3.1 in).
2. Temporarily tighten the stopper bolt lock nut.
The lock nut will be finally tightened after completion of the engine control adjustment procedure below.



Accelerator Switch Adjustment

1. Check that the engine control link and the link stopper are in contact with each other.
2. Adjust the height (H) of the accelerator switch.

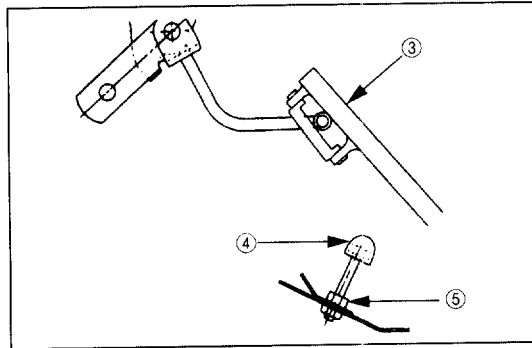
Accelerator Switch Height (H)	mm (in)
16 - 17 (0.630 - 0.669)	



Engine Control Adjustment

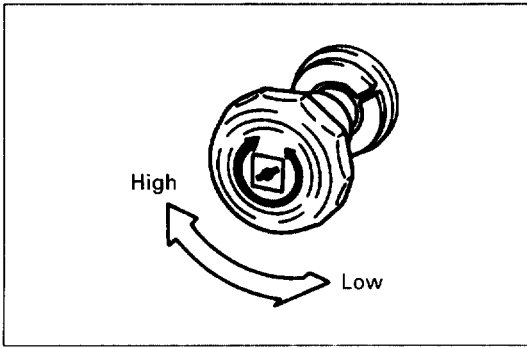
1. Connect the engine control cable to the injection pump control lever (1)
2. Adjust the cable length between the control lever and the cable clip (2) to the specified value.

	mm (in)
Control cable length (L)	213 (8.39)



3. Adjust the accelerator stopper bolt.
 - 1) Depress the accelerator pedal (3) and hold it.
 - 2) Bring the pedal stopper bolt cap (4) into contact with the full stopper.
 - 3) Turn in the pedal stopper bolt 1-1/2 turns to adjust the clearance between the accelerator pedal and the stopper bolt cap to 1-2 mm.
 - 4) Tighten the stopper bolt lock nut (5).

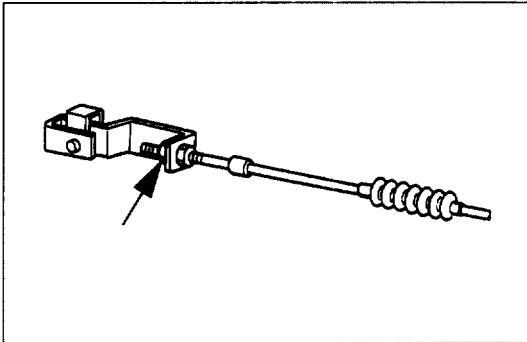
Engine Idling Speed	rpm
600	



Final Engine Control Adjustment Check

1. Start the engine and allow it to warm up.
2. Turn the idling control knob fully to the left.
3. Check that the idling speed is within the specified range.

Engine Idling Speed	rpm
600	

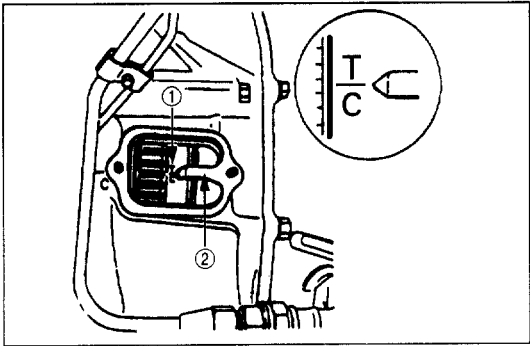


If the idling speed is outside the specified range, loosen the engine control cable end turnbuckle (arrow) to adjust it.

4. Depress the accelerator pedal until it reaches the accelerator pedal stopper.

Check that the injection pump control lever is making contact with the full load stopper.

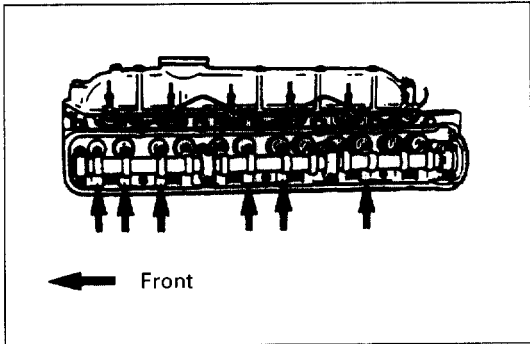
If the injection pump control lever is not making contact with the full load stopper, readjust the accelerator pedal stopper and the engine control cable.



VALVE CLEARANCE ADJUSTMENT

The following instructions assume that valve clearance is adjusted beginning with the No. 1 cylinder at top dead center (TDC) on the compression stroke followed by the No. 6 cylinder at TDC on the compression stroke.

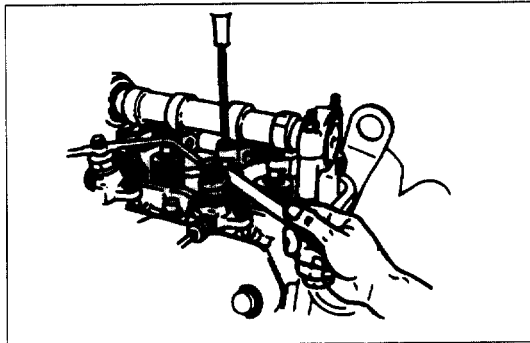
Valve clearances may be adjusted in the opposite order (No. 6 cylinder at TDC followed by No. 1 cylinder at TDC) if this is more convenient.



1. Check that the No. 1 cylinder is at TDC on the compression stroke.

If the No. 1 cylinder is at TDC, there will be play in the No. 1 cylinder valve rocker arms.

The illustration shows the valves to be adjusted with the No. 1 cylinder at TDC on the compression stroke.



2. Loosen the adjusting screw lock nut.
3. Insert a feeler gauge between the rocker arm and the valve stem end.

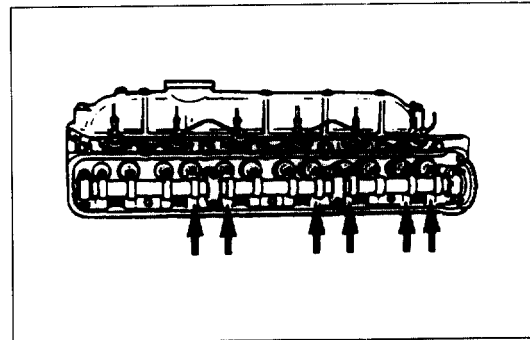


Valve clearance	mm(in)
0.4 (0.016)	

4. Turn the adjusting screw until a slight drag can be felt on the feeler gauge.
5. Tighten the adjusting screw lock nut.

Adjusting Screw Lock Nut Torque	N·m(kg·m/lb.ft)
20.0 (2.0 / 14.5)	

6. Repeat the procedure for the remaining valve clearances.



7. Rotate the crankshaft one full turn in its normal direction of rotation.

Be sure that the flywheel TDC line is aligned with the timing pointer.

The illustration shows the valves to be adjusted with the No. 6 cylinder at TDC on the compression stroke.

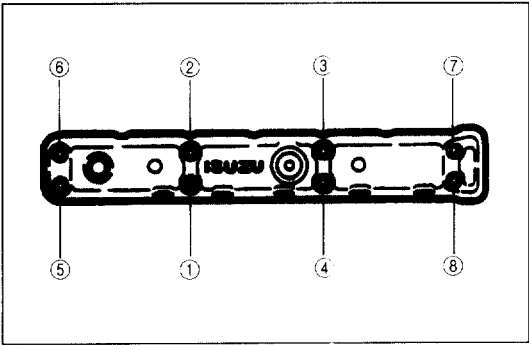
8. Repeat Steps 2 through 6 to adjust the remaining valve clearances.

Note:
Be sure to move the No. 1 cylinder to TDC on the compression stroke after completing the valve clearance adjustment procedure.
This will facilitate injection pump installation.

Intake and Exhaust Valve Arrangement

Cylinder No.	1		2		3		4		5		6	
Valve Names	I	E	I	E	I	E	I	E	I	E	I	E
No.1 cyl. at TDC on compression	○	○	○			○	○			○		
No.6 cyl. at TDC on compression				○	○			○	○		○	○

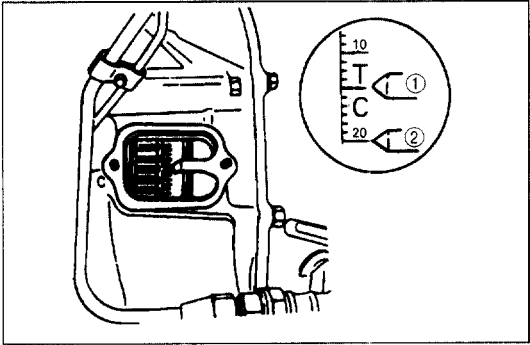
I: Intake valve E: Exhaust valve



Cylinder Head Cover with Gasket

- 1) Apply engine oil to the rocker arms and the valve springs.
- 2) Apply liquid gasket several point around to the cylinder head cover.
This will prevent the cylinder head cover gasket from falling free.
- 3) Install the cylinder head cover gasket to the cylinder head cover.
The gasket must be smooth with no loose areas.
- 4) Install the cylinder head cover to the cylinder head.
- 5) Tighten the cylinder head cover nuts to the specified torque a little at a time in the numerical order shown in the illustration.

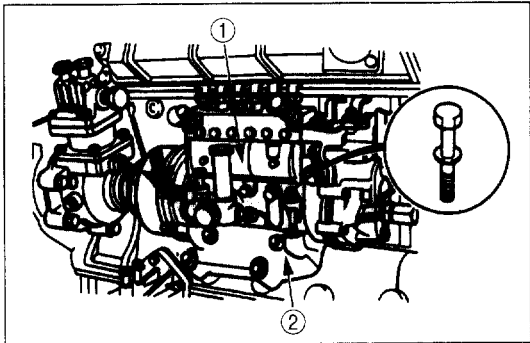
Cylinder Head Cover Nut Torque	N·m(kg·m/lb.ft)
7.8 (0.8 / 5.8)	



Injection Timing Adjustment

1. Check that No. 1 cylinder is at top dead center on the compression stroke.
2. Rotate the crankshaft in the normal direction of engine rotation to align the flywheel notched line and the flywheel housing timing pointer.

Injection Timing (Static-BTDC)		deg.
6SD1	18	
6SD1TC (EURO-I)	10	
6SD1TC (EURO-I)	14 (For New Zealand)	
6SD1TC (EURO-II)	5	



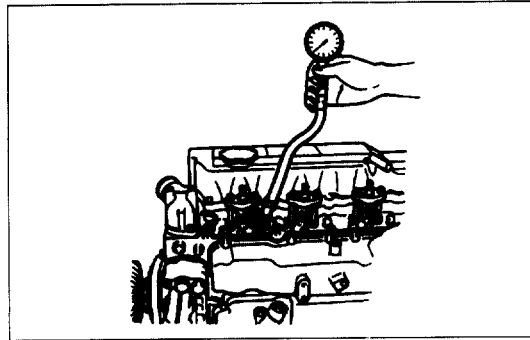
3. Install the injection pump ① to the pump bracket ②.
Semitighten the injection pump
4. Align the injection pump body notched line and the timer notched line (arrow mark).
5. Connect the injection pump drive coupling plate to the injection pump timer.



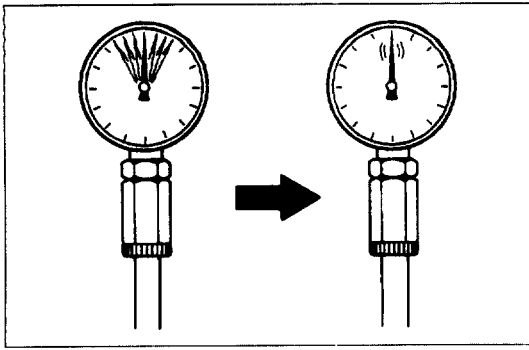
Compression Pressure Measurement

To measure the compression pressure, the engine must be cold. Engine coolant temperature should be at 20°C. Battery and starter motor condition must be normal.

1. Remove the glow plug and the injection pipe from each cylinder.



2. Install the compression gauge adapter to the No. 1 cylinder glow plug installation hole.
Compression Gauge Adapter: 5-85317-001-0
3. Install the compression gauge to the compression gauge adapter.
4. Crank the engine with the starter motor (about 200rpm) and take the compression gauge reading.



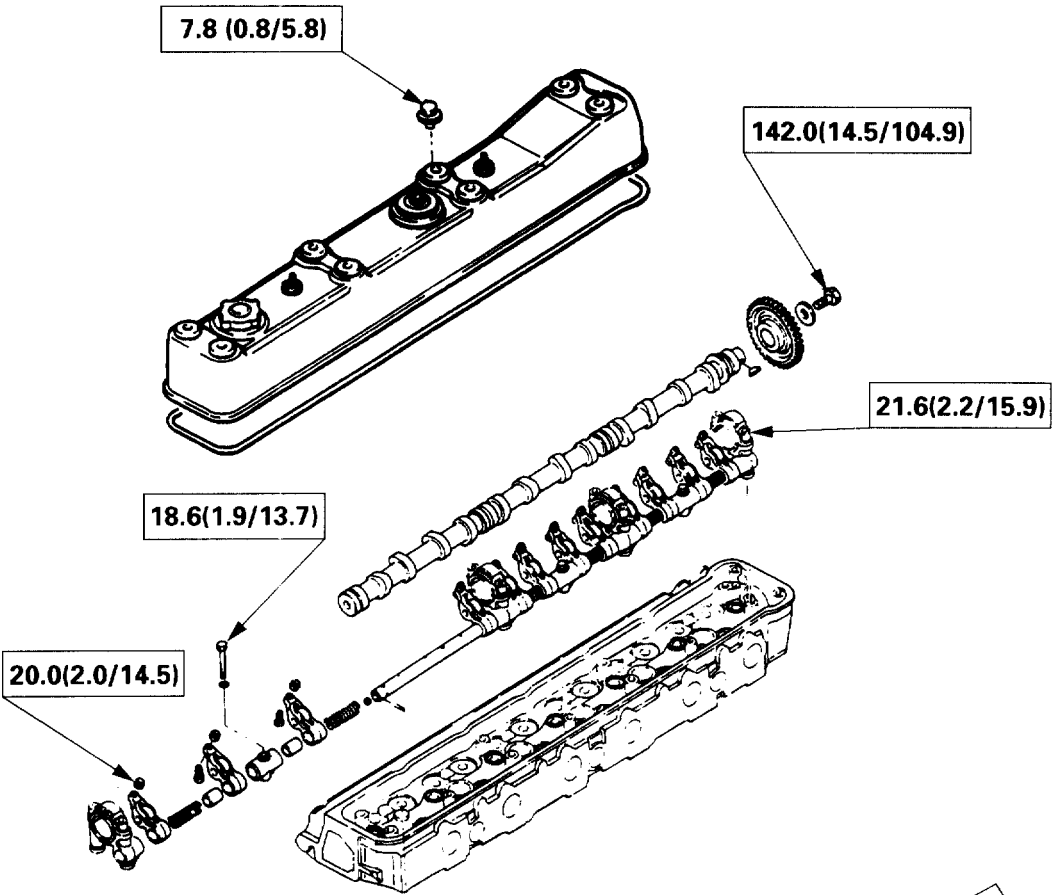
5. Repeat the procedure (Step 2-4) for the remaining cylinder.

Compression Pressure	kPa (kg/cm ² / psi)
2,746 (28 / 398)	

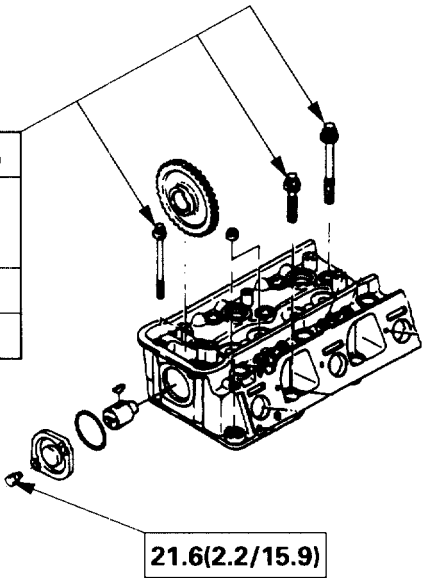
FIXING TORQUE

 **Cylinder Head Cover , Cylinder Head, and Camshaft Bracket**

N·m (kg·m / lb·ft)

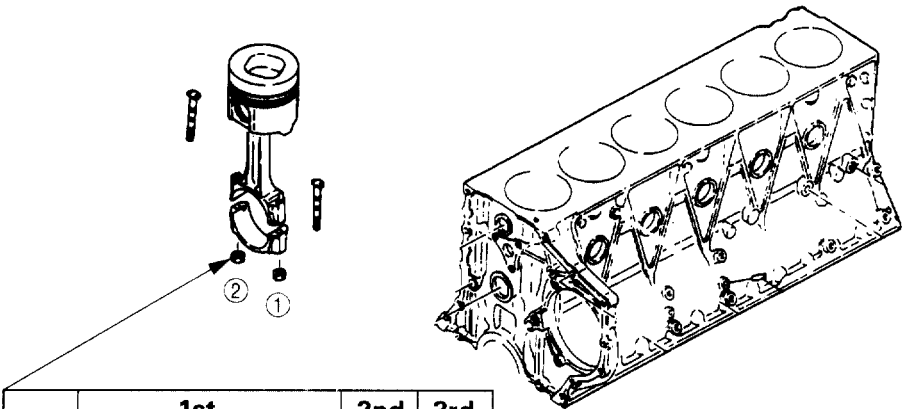


	1st Step	2nd Step	3rd Step
M14 Bolt	98.1 (10.0/72.3)	147.1 (15.0/108.5)	30° ~ 60°
M10 Bolt	—	38.3 (3.9/28.2)	—
Apply molybdenum disulfide grease			

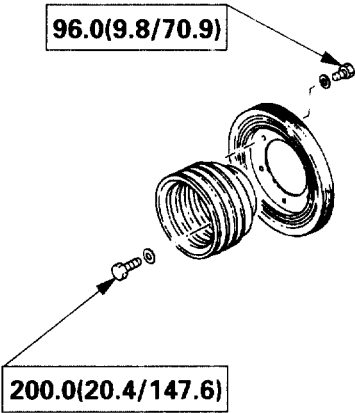
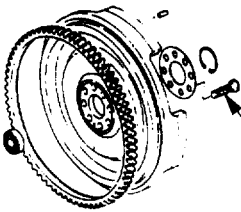


 Cylinder Body Lower Crankcase, Connecting Rod Bearing Cap, Crankshaft Damper Pulley, Flywheel, and Oil Pan

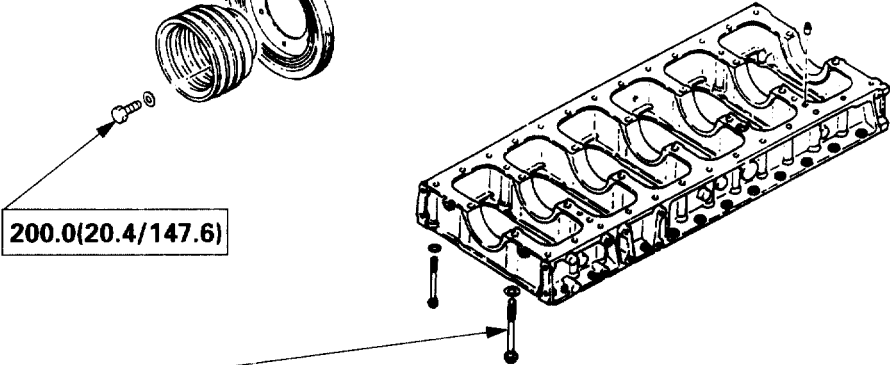
N·m (kg·m / lb·ft)



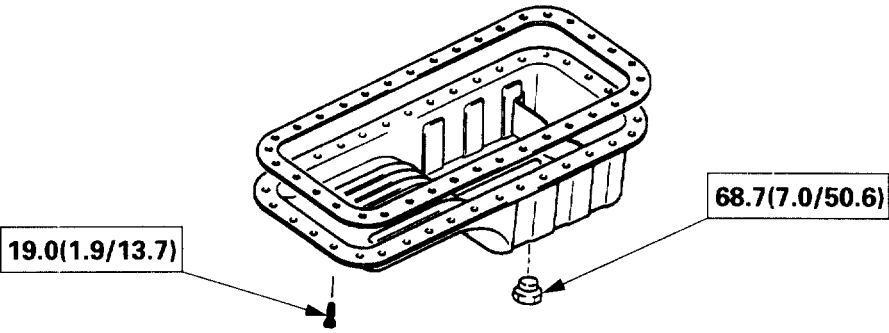
	1st	2nd	3rd
①	39.0	60°	60°
②	(4.0/28.9)	120°	—
Apply molybdenum disulfide grease			



1st	2nd	3rd
78.0 (8.0/57.9)	60°	30°
Apply molybdenum disulfide grease		

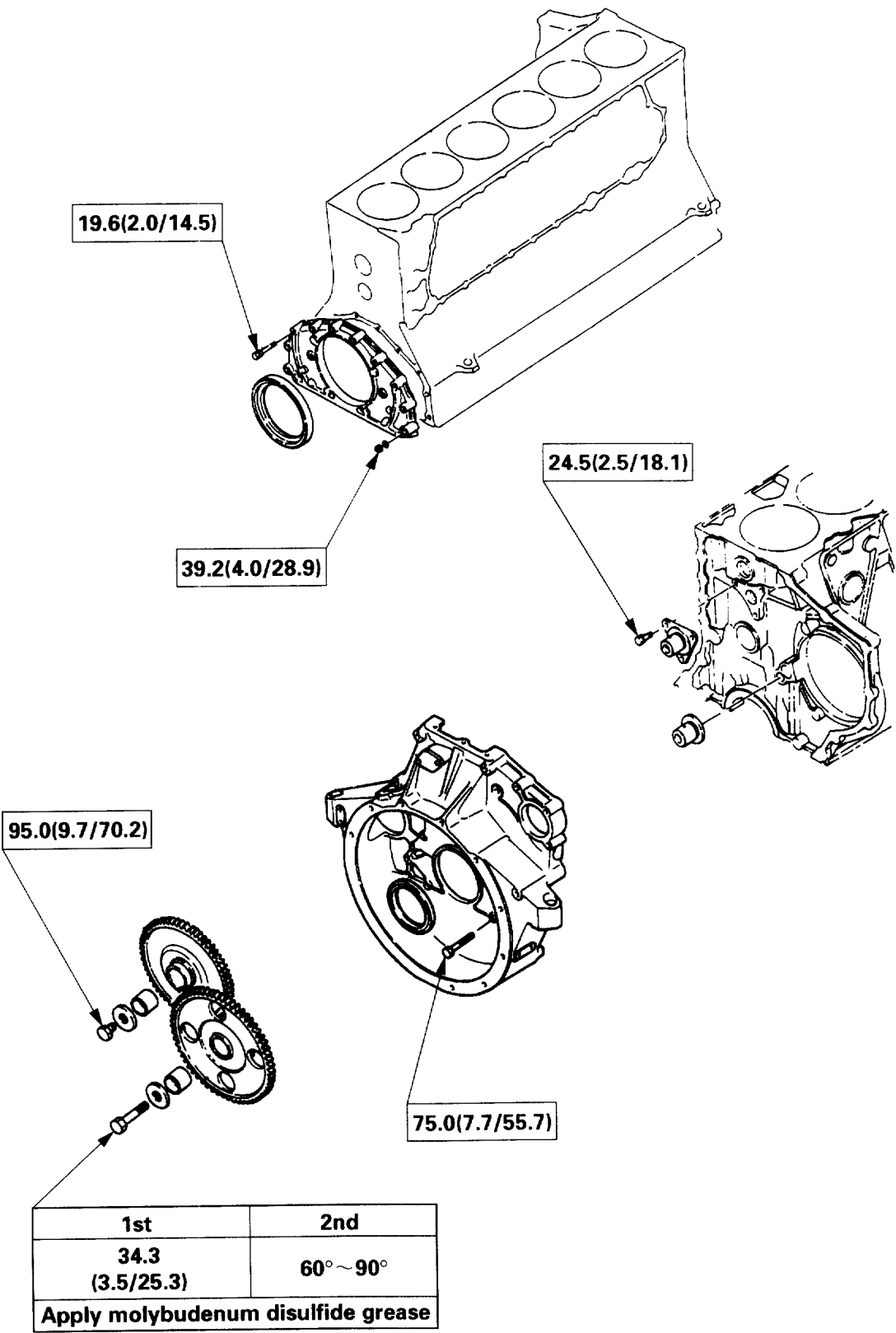


M14 Bolt			M10 Bolt
1st	2nd	3rd	38.0 (3.9/28.2)
98.0 (10.0/72.3)	132.0 (13.5/97.6)	30° ~ 60°	
Apply molybdenum disulfide grease			



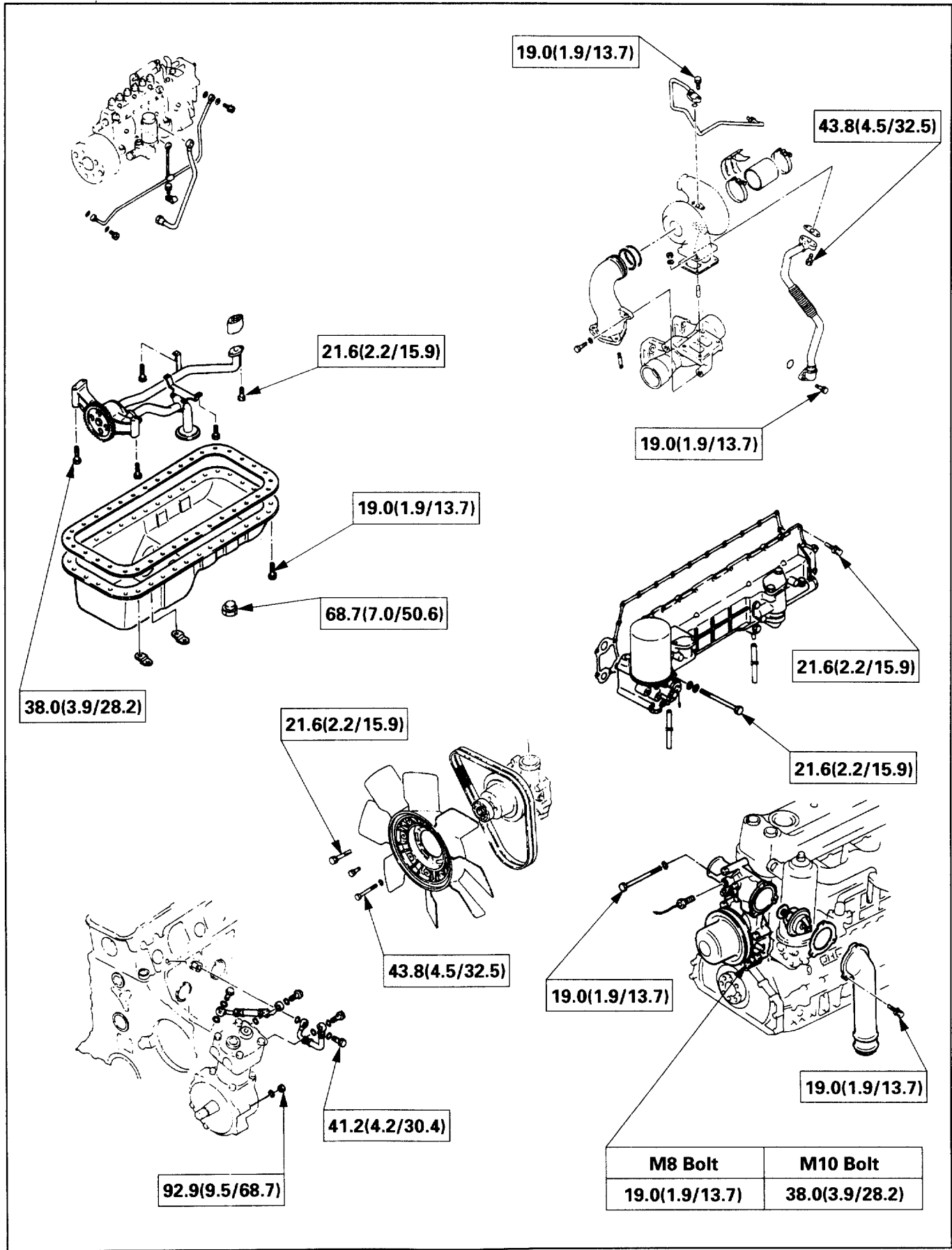
 Front Cover, Flywheel Housing, and Idler Gear

N·m (kg·m / lb·ft)



 Cooling and Lubricating System

N·m (kg·m / lb·ft)



Technical diagrams illustrating the assembly of various components in the Cooling and Lubricating System, with torque specifications provided in N·m (kg·m / lb·ft).

Top Left: Diagram of a component assembly with torque specification: 19.0(1.9/13.7).

Top Right: Diagram of a component assembly with torque specifications: 19.0(1.9/13.7) and 43.8(4.5/32.5).

Middle Left: Diagram of a component assembly with torque specifications: 21.6(2.2/15.9), 19.0(1.9/13.7), 68.7(7.0/50.6), and 38.0(3.9/28.2).

Middle Right: Diagram of a component assembly with torque specifications: 21.6(2.2/15.9) and 21.6(2.2/15.9).

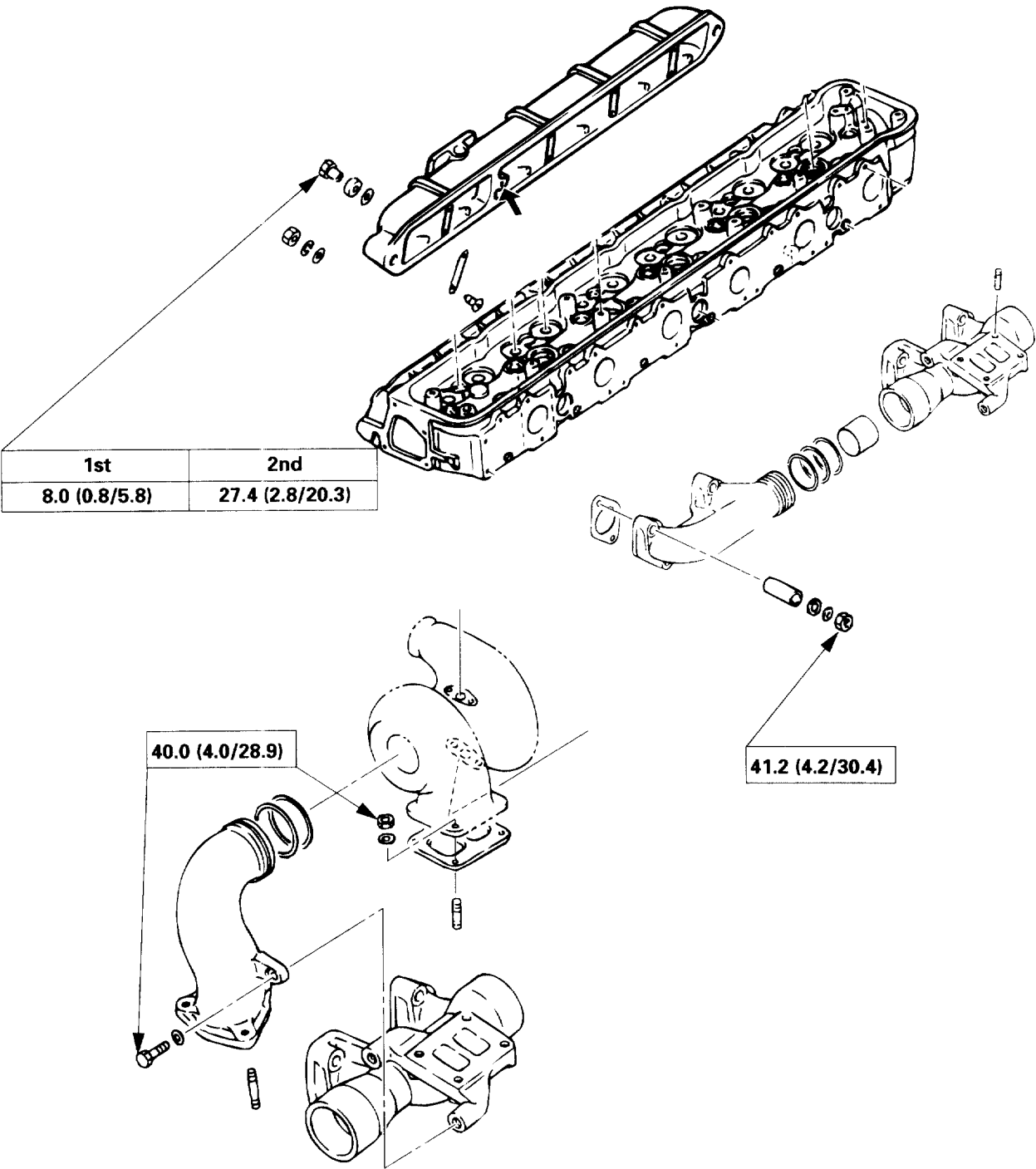
Bottom Left: Diagram of a component assembly with torque specifications: 21.6(2.2/15.9), 43.8(4.5/32.5), 41.2(4.2/30.4), and 92.9(9.5/68.7).

Bottom Right: Diagram of a component assembly with torque specifications: 19.0(1.9/13.7) and 19.0(1.9/13.7).

M8 Bolt	M10 Bolt
19.0(1.9/13.7)	38.0(3.9/28.2)

 Intake Manifold, Exhaust Manifold, and Turbocharger

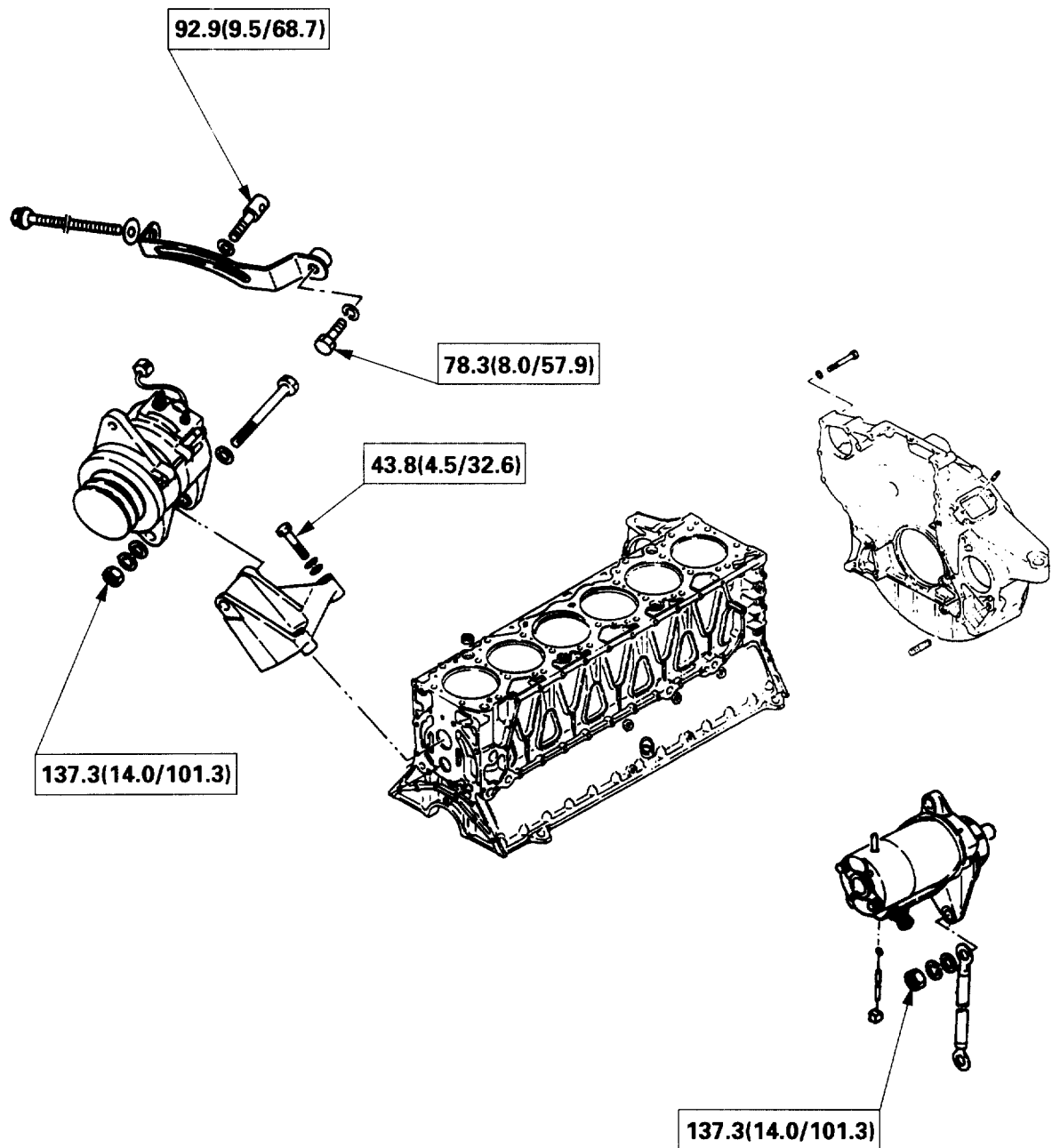
N·m (kg·m / lb·ft)





Engine Electrical

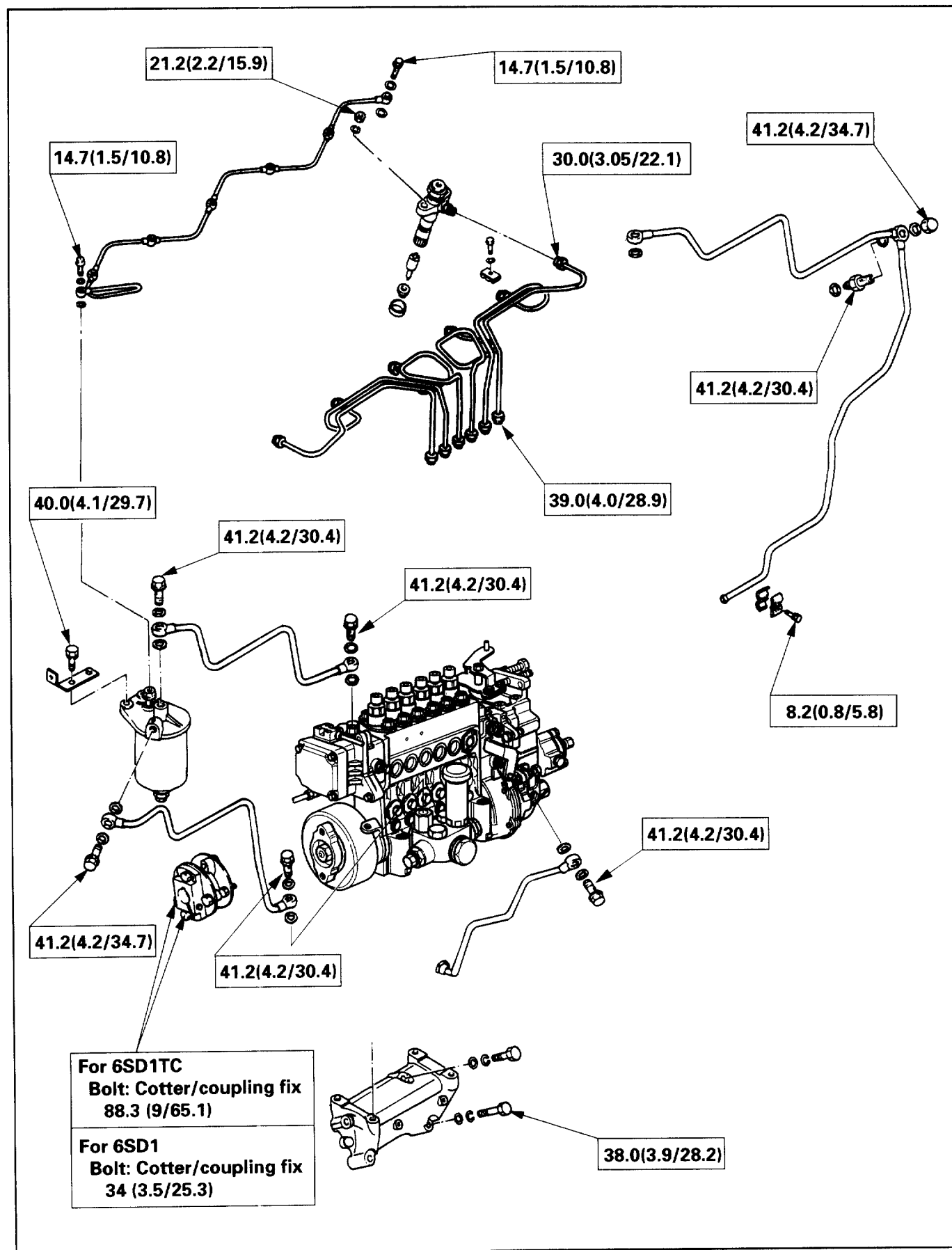
N·m (kg·m / lb·ft)





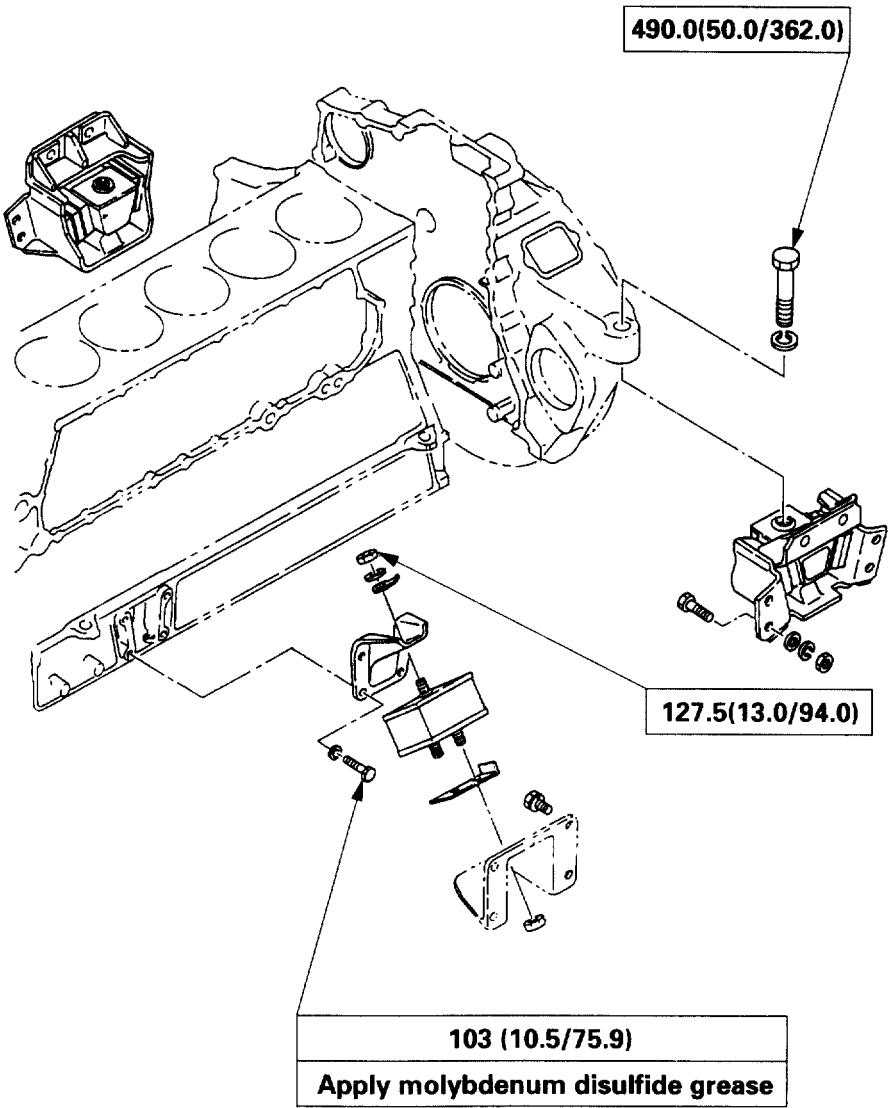
Fuel Injection System

N·m (kg·m / lb·ft)



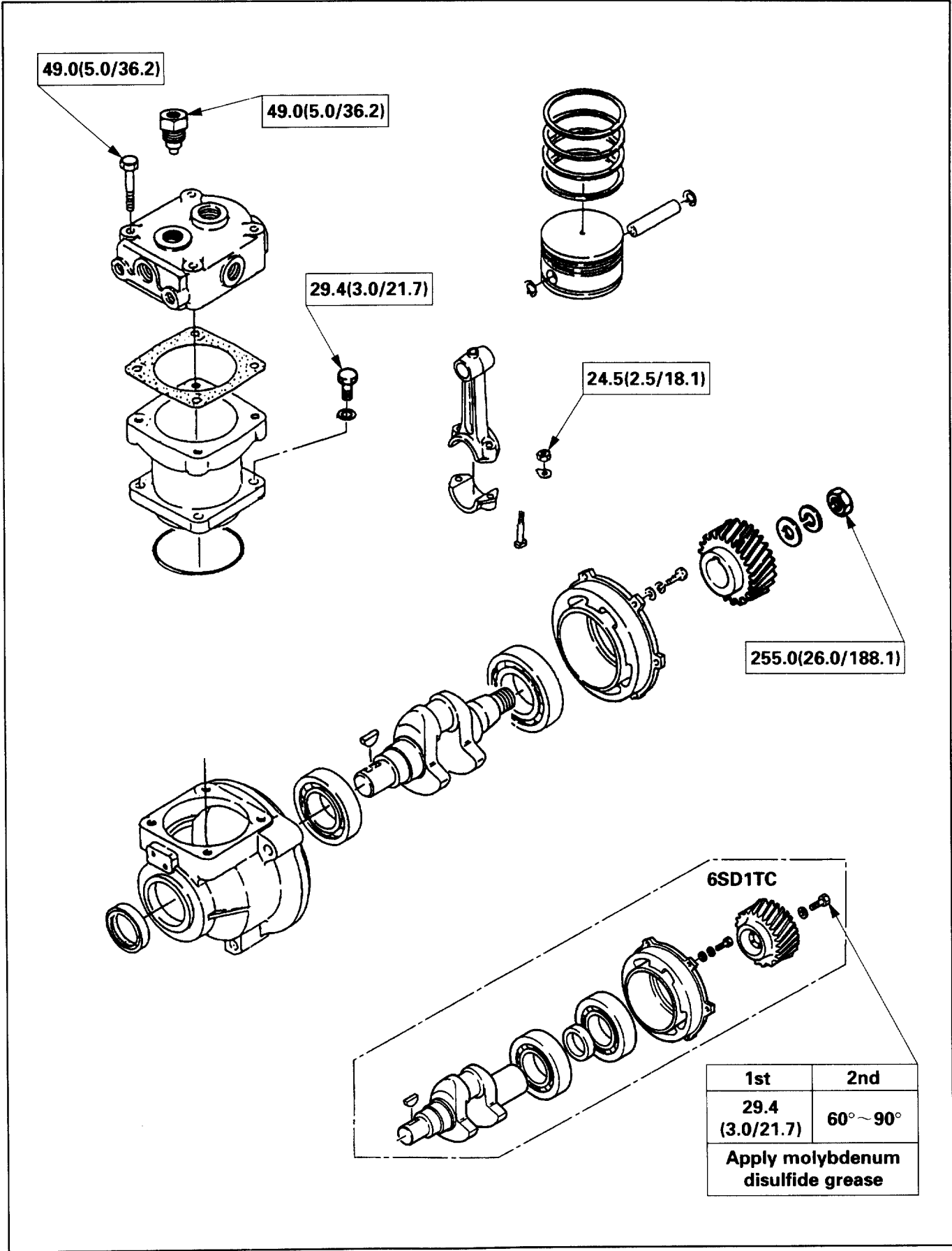
 Engine Mounting

N·m (kg·m / lb·ft)



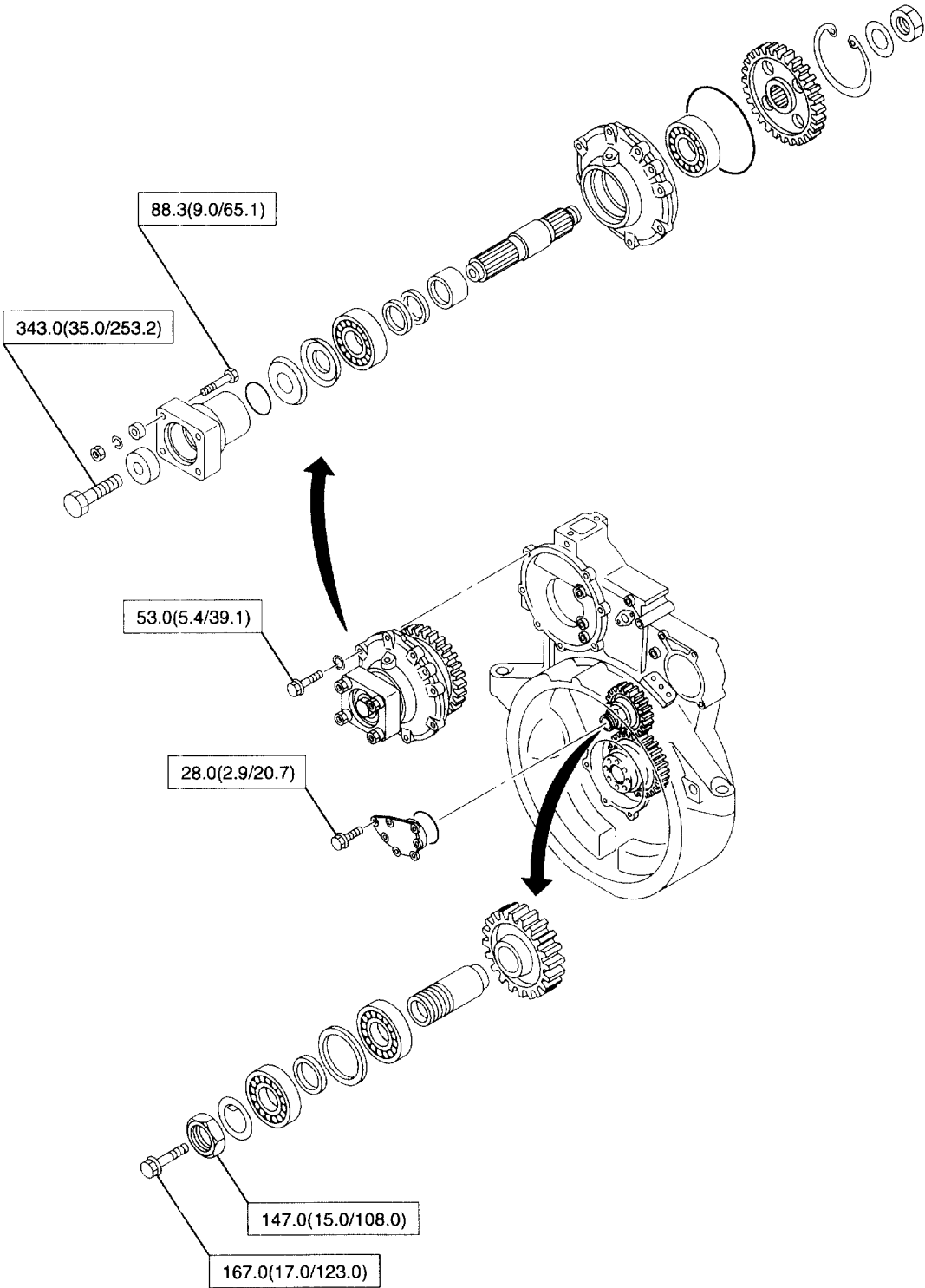
Air Compressor

N·m (kg·m / lb·ft)



Flywheel P.T.O.

N·m (kg·m / lb·ft)



SPECIAL TOOLS

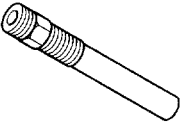
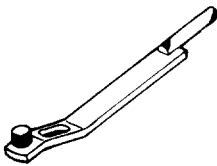
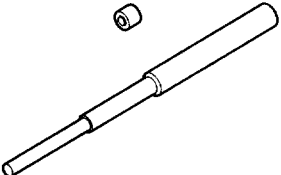
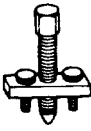
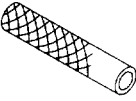
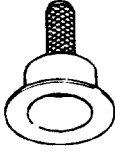
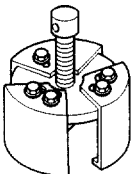
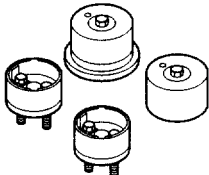
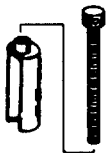
ILLUSTRATION	PART NO.	PARTS NAME
	5-85317-001-0	Compression gauge adapter
	1-85235-007-0	Valve spring compressor
	9-85231-202-2	Valve guide remover & installer
	1-85231-021-0	Cylinder liner remover
	1-85221-073-0	Cylinder liner installer
	1-85210-047-0	Water pump impeller remover
	9-85221-289-0	Valve stem oil seal installer
	1-85220-037-0	Connecting rod bushing replacer
	1-85221-072-0	Crankshaft gear installer

ILLUSTRATION	PART NO.	PARTS NAME
	1-85210-077-0	Oil seal remover
	1-85220-057-0	Crankshaft oil seal installer (Front/Rear)
	1-85210-051-0	Crankshaft gear remover

SECTION 6A

ENGINE MECHANICAL

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TORQUE SPECIFICATIONS

STANDARD BOLTS

The torque values given in the following table should be applied where a particular torque is not specified.

		N·m (kg·m / lb·ft) N·m [kg·cm / lb·in]			
Strength Class Bolt Identification Bolt Diameter × Pitch (mm)	4.8	7T	8.8		9.8
			Refined	Non-Refined	
					
	 No mark	—			
M 6×1.0	6 [60 / 52]		7 [75 / 65]		—
M 8×1.25	13 [130 / 113]		17 [175 / 152]		24 [240 / 208]
M10×1.25	27 (2.8 / 20)		37 (3.8 / 27)		50 (5.1 / 37)
M12×1.25	61 (6.3 / 45)		76 (7.8 / 56)		95 (9.7 / 70)
M14×1.5	96 (9.8 / 71)		116 (11.9 / 86)		142 (14.5 / 105)
M16×1.5	130 (13.3 / 96)		170 (17.3 / 125)		200 (20.4 / 148)
M18×1.5	188 (19.2 / 139)		244 (24.9 / 180)		287 (29.3 / 212)
M20×1.5	258 (26.3 / 190)		337 (34.4 / 249)		396 (40.4 / 292)
M22×1.5	332 (33.9 / 245)		453 (46.3 / 335)		530 (54.1 / 391)
M24×2.0	449 (45.8 / 331)		570 (58.2 / 421)		692 (70.6 / 511)
*M10×1.5	26 (2.7 / 20)		36 (3.7 / 27)		48 (4.9 / 35)
*M12×1.5	57 (5.8 / 42)		71 (7.2 / 52)		89 (9.1 / 66)
*M14×2.0	89 (9.1 / 66)		110 (11.2 / 81)		133 (13.6 / 98)
*M16×2.0	124 (12.7 / 92)		162 (16.5 / 119)		191 (19.5 / 141)

The asterisk * indicates that the bolts are used for female-threaded parts that are made of soft materials such as casting, etc.

FLARE NUTS

N·m (kg·m / lb·ft)			
Pipe diameter mm (in)	Torque	Pipe diameter mm (in)	Torque
4.76 (0.187)	16 (1.6 / 12)	10.00 (0.394)	54 (5.5 / 40)
6.35 (0.250)	26 (2.7 / 20)	12.00 (0.472)	88 (9.0 / 65)
8.00 (0.315)	44 (4.5 / 33)	15.00 (0.591)	106 (10.8 / 78)

RECOMMENDED LIQUID GASKET

TYPE	BRAND NAME	MANUFACTURER	APPLICATION PARTS (EXAMPLE)
RTV* Silicon Base	ThreeBond 1207B ThreeBond 1207C ThreeBond 1215 ThreeBond 1216 ThreeBond 1281 Silicon Form No.6	ThreeBond ThreeBond ThreeBond ThreeBond ThreeBond LOCTITE	Engine Oil Seal Retainer Rear Axle Cylinder Block Flywheel Housing Sealing Cup Front Cover Inlet Duct Turbo Charger etc.
Water Base	ThreeBond 1141E	ThreeBond	
Solvent	ThreeBond 1201 ThreeBond 1104 ThreeBond 1107C BelcoBond 4 BelcoBond 401 BelcoBond 402	ThreeBond ThreeBond ThreeBond Isuzu Isuzu Isuzu	
Anaerobic	LOCTITE 515 LOCTITE 518 LOCTITE 17430	LOCTITE LOCTITE LOCTITE	Engine Oil Seal Retainer Transaxle etc.

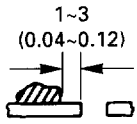
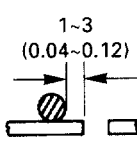
*RTV: Room Temperature Vulcanizer

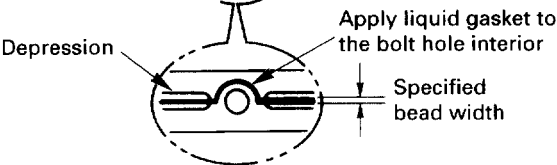
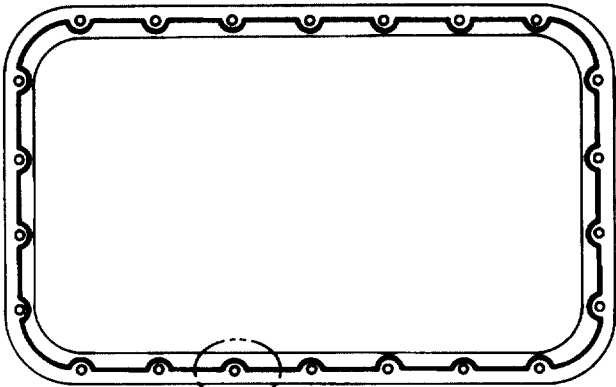
NOTE:

- It is very important that the liquid gaskets listed above or their exact equivalent be used on the vehicle.
- LOCTITE 17430, LOCTITE 515 and LOCTITE 518 harden upon contact with a metal surface.
Do not apply LOCTITE 17430, LOCTITE 515 or LOCTITE 518 between two metal surfaces having a clearance of greater than 0.25 mm (0.001 in). Poor adhesion will result.
- Be careful to use the specified amount of liquid gasket.
Follow the manufacturer’s instructions at all times.

Application Procedure

1. Completely remove lubricant and moisture from the connecting surfaces.
The surfaces must be perfectly dry.
2. Apply specified bead width of liquid gasket to one of the connecting surfaces.
There must be no gaps in the bead.

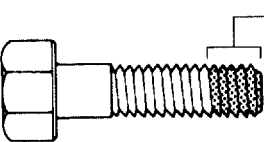
mm (in.)		
SCREW HOLE	DEPRESSION	JUDGE- MENT
		OK
		OK
		NG



Example
Anaerobic Type : 2-3mm (0.08-0.12 inch)
Others : 2-6mm (0.08-0.24 inch)

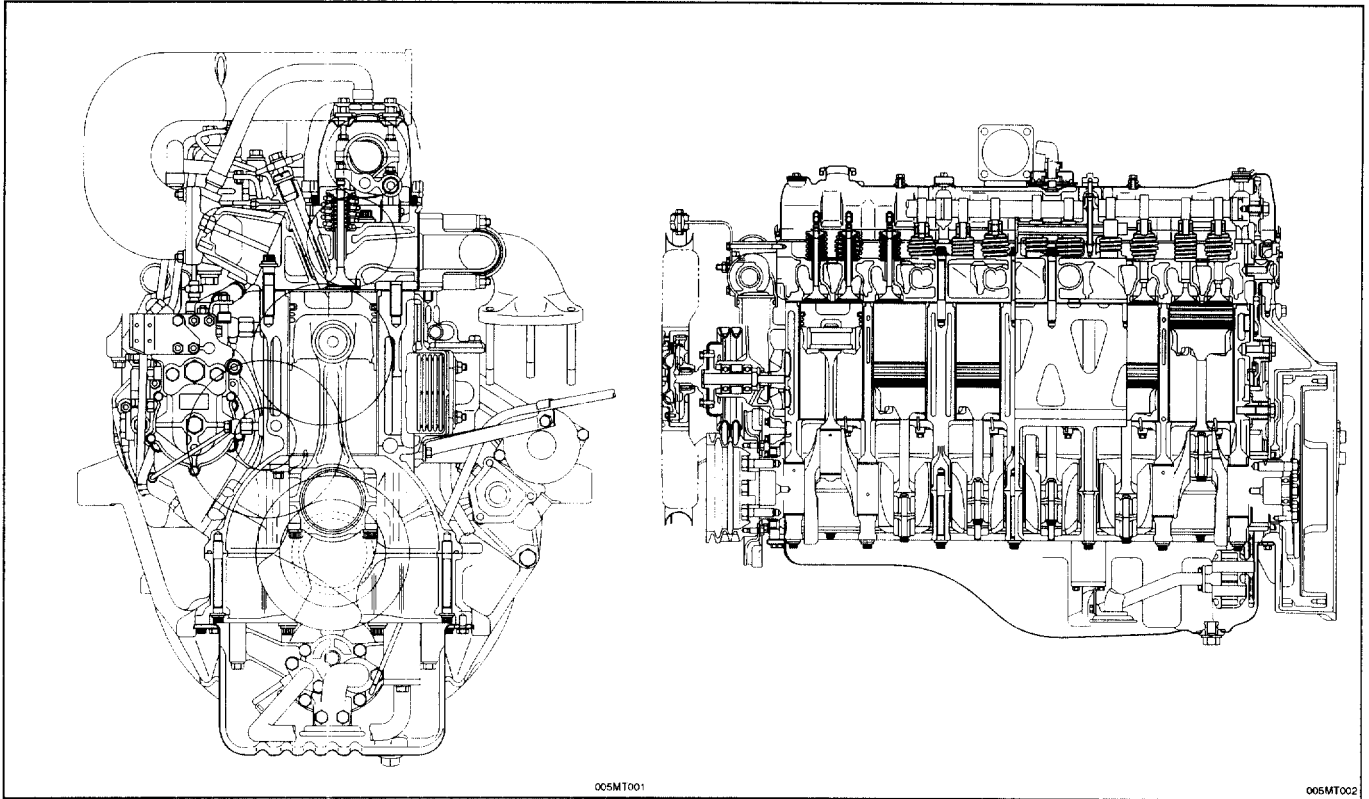
NOTE:
When the application procedures are specified in this Workshop manual, follow them.

RECOMMENDED THREAD LOCKING AGENT

TYPE	COLOR	APPLICATION STEPS
LOCTITE 242	Blue	1. Completely remove all lubricant and moisture from the bolts and the female threaded surfaces of the parts to be joined. The surfaces must be perfectly dry. 2. Apply LOCTITE to the bolts.
LOCTITE 262	Red	Apply LOCTITE to at least 1/3 of the bolt's threaded area. 3. Tighten the bolts to the specified torque.
LOCTITE 271	Red	NOTE: After tightening, be sure to keep the bolts free from vibration and torque for at least an hour until LOCTITE hardens.

GENERAL DESCRIPTION

This illustration is based on the 6SD1 engine.



The 6SD1 Series 9.8 liter diesel engine is the first medium-size diesel engine to feature an overhead camshaft. The engine is simple, symmetrical, light-weight, and compact.

The symmetrical design reduces side-to-side engine vibration and operating noise.

The 6SD1TC engine is turbocharger equipped.

The cylinder body and the lower crankcase are machined as a unit to give the engine greater strength and rigidity.

The overhead camshaft makes direct contact with the roller following rocker arms. Push rods are eliminated. Valve jump and bounce are eliminated and timing at high engine speeds is greatly improved.

Barrel-type exhaust valve outer springs are installed to allow for a higher valve setting force. This provides a twenty percent increase in exhaust brake power.

The laminated steel cylinder head gasket is highly durable and eliminates the need for cylinder head bolt retightening. The cylinder head protects against gas, oil, and water leakage and allows for closer tolerances between moving parts.

The dry-type cylinder liners are special cast iron (Super Tarkalloy). Honing treatment has been applied. This type of cylinder liner has a proven reputation for high durability.

The 6SD1 engine crankshaft may be reground if required. 0.25 mm (0.0098 in) and 0.50 mm (0.0196 in) undersize bearings are available for this purpose.

The 6SD1TC engine crankshaft is tufftrided to provide a longer service life. It cannot be reground.

The Low-Ex silicon-aluminum alloy piston heads form a square combustion chamber for ideal air-fuel mixing and combustion at all engine speeds.

Offset piston pins minimize the contact pressure between the cylinder liner and the piston to reduce piston slapping noise and cylinder liner cavitation.

Crankshaft upper and lower bearings have different oil hole and oil groove configurations.

The gear train is installed to the rear of the engine. This results in less camshaft torsion vibration and reduced gear noise. All gears are tufftrided for a longer service life except injection pump drive gears.

REMOVAL AND INSTALLATION

Read this Section carefully before performing any removal and installation procedure. This Section gives you important points as well as the order of operation. Be sure that you understand everything in this Section before you begin.



Important Operations - Removal

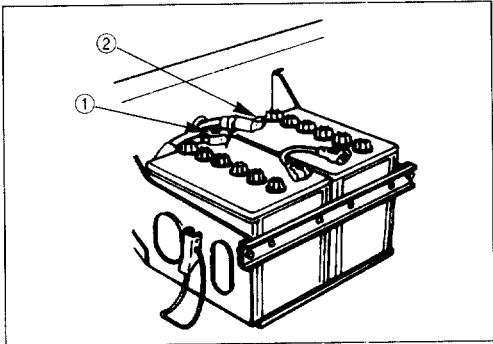
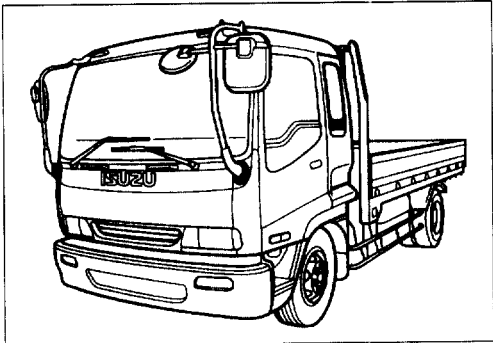
- Carefully remove the piping, hoses, wiring harness connectors, engine control cables, and control rods from the engine.
- Remove the clutch slave cylinder or minipack, the control rods, the back up light switch, and the speedometer cable from the transmission.

WARNING:

ALLOW THE ENGINE TO COOL BEFORE REMOVE ANY PARTS. THIS WILL ELIMINATE THE DANGER OF FIRE AND POSSIBLE INJURY.

Engine Application Chart

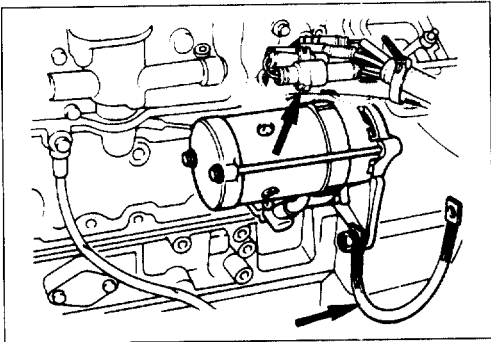
Vehicle Model	Engine Model	
FVR (4 × 2)	6SD1	6SD1TC
FVM (6 × 2)	6SD1	6SD1TC
FVZ (6 × 4)	6SD1	6SD1TC



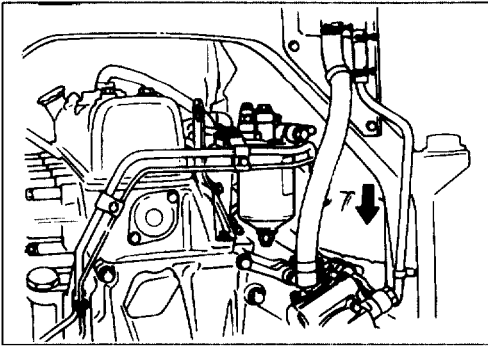
Battery

1. Disconnect the grounding cable ① and the battery cable ② from the battery terminals.

Be careful not to short the battery with your wrench or another tool at this time.

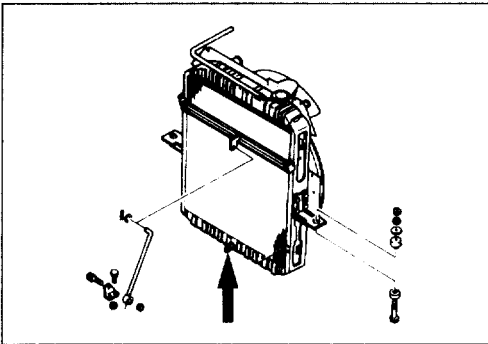


2. Disconnect the battery cable at the starter motor and the grounding cable at the chassis frame.



Air Cleaner

Remove the air outlet hose from the intake cover (engine not equipped with turbocharger) or the inlet duct (turbocharger equipped engine).



Coolant

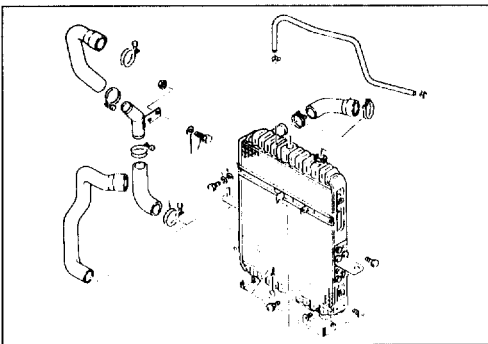
Remove the water drain plug (at the left side of the engine) and the radiator drain plug and allow the coolant to drain completely.

WARNING:

HOT STEAM UNDER PRESSURE MAY ESCAPE FROM THE RADIATOR IF THE COOLANT IS DRAINED WHILE THE ENGINE IS HOT. THIS CAN RESULT IN SERIOUS BURNS. ALLOW THE ENGINE TO COOL BEFORE DRAINING THE COOLANT.

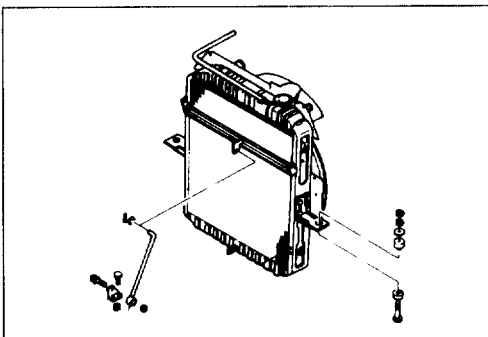
If long life coolant is used, drain the coolant into a clean container so that it can be reused.

Refer to the Maintenance Schedule in Section 00, "GENERAL INFORMATION."



Radiator

1. Disconnect the radiator overflow rubber hose from the radiator and the reserve tank.
2. Remove the radiator overflow pipe from the engine.
3. Pull the radiator upper hose and the radiator lower hose from the engine.



4. Disconnect the radiator front stay at the radiator.
5. Disconnect the radiator fan shroud stays (three positions) at the engine.
6. Remove the radiator cushion rubber nuts.
7. Remove the radiator with the fan shroud from the chassis frame.

Be careful not to damage the radiator core.

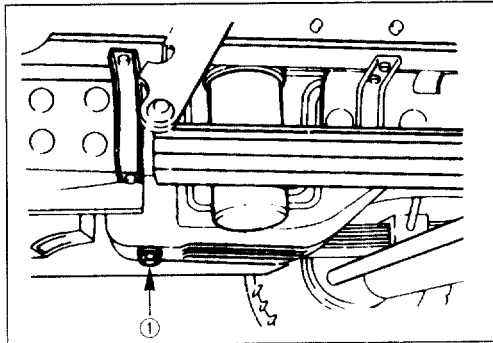
8. Remove the cooling fan and the fan spacer from the water pump.

Engine Control Rod

Disconnect the engine control rod from the injection pump.

Power Take-Off (PTO) Control Lever (If So Equipped)

1. Place the control lever in the neutral position.
2. Remove the control lever dust cover from the control lever cover.
3. Remove the control lever cover bolt along with the cover from the upper cover.
4. Pull the control lever from the PTO gear case.

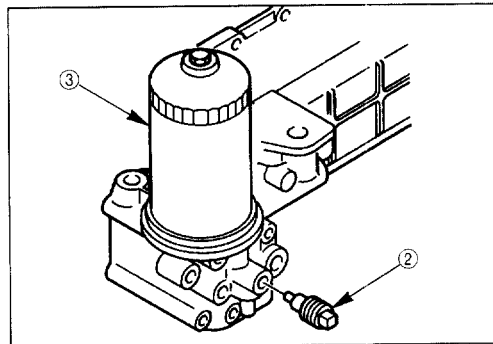


Engine Oil Draining

1. Remove the oil pan drain plug ①.

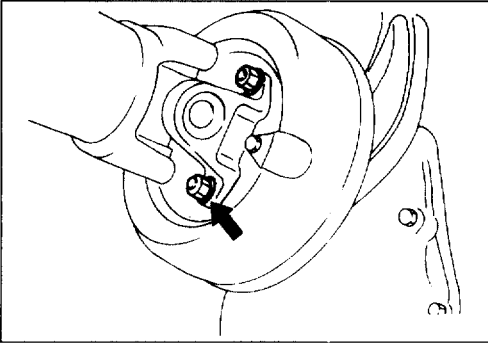
WARNING:

**HOT ENGINE OIL CAN CAUSE SEVERE SKIN BURNS.
ALLOW THE ENGINE TO COOL BEFORE DRAINING THE
ENGINE OIL.**



2. Loosen the oil filter drain plug ② to drain the engine oil.
Remove the cartridge ③.
3. Reinstall the drain plugs and tighten them to the specified torque.

Oil Pan Drain Plug Torque	N·m(kg·m/lb.ft)
68.7 (7.0 / 50.6)	
Oil Filter Drain Plug Torque	N·m(kg·m/lb.ft)
17.7 (1.8 / 13.0)	

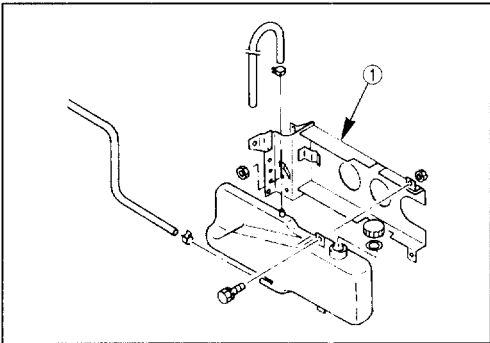


Propeller Shaft

1. Disconnect the 1st propeller shaft flange yoke from the parking brake drum.
2. Lower the propeller shaft carefully to the ground.

Parking Brake (For 4 × 2)

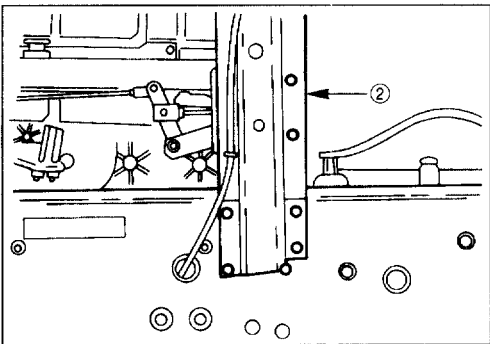
Refer to Section 05, "PARKING BRAKE," "Removal and Installation."



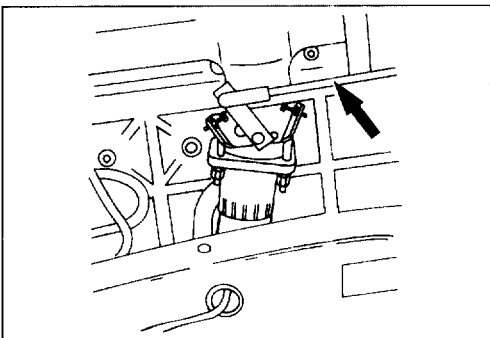
Radiator Reserve Tank

Cab Mounting Rear Member

1. Remove the radiator reserve tank with the bracket (1) from the cab mounting rear member (2).



2. Remove the cab mounting rear member from the chassis frame.

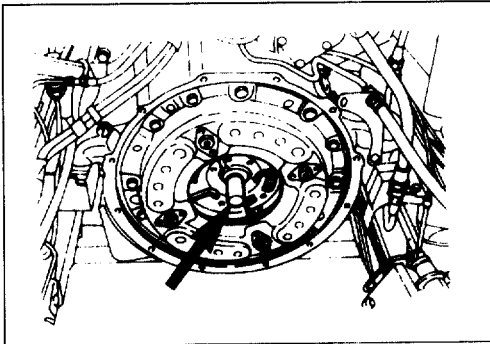


Exhaust Brake Control Rod

Disconnect the exhaust brake control rod at the exhaust brake valve lever.

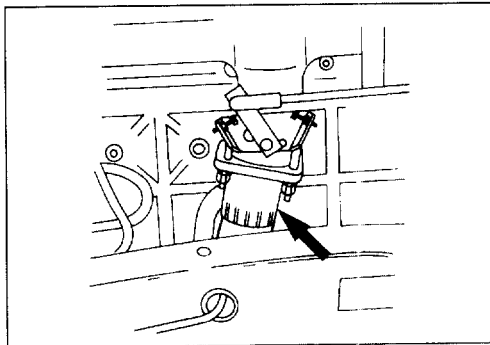
Transmission

Refer to Section 07, "TRANSMISSION".



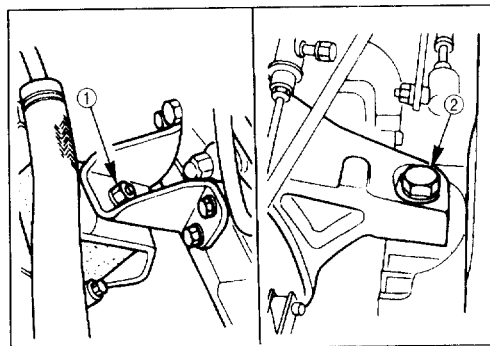
Clutch Pressure Plate and Driven Plate

Refer to Section 07, "CLUTCH," "Removal and Installation."



Exhaust Pipe

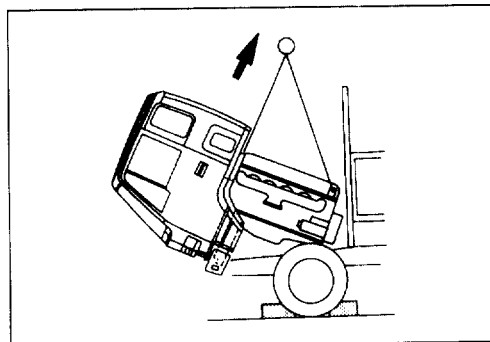
Disconnect the exhaust pipe from the exhaust manifold.



Front Engine Mounting

Rear Engine Mounting

1. Attach lifting wires to the engine lifting hangers.
2. Raise the hoist until there is no slack in the lifting wires.
3. Remove the front engine mounting nut ① and the rear mounting bolt ②.

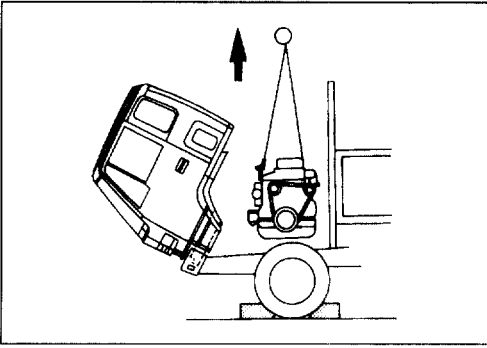


Engine

1. Operate the hoist to slowly raise the engine until it is clear of the chassis frame.

Make sure that the connecting pipes, hoses, and cables have all been removed from the engine.

The front of the engine should be held slightly higher than the rear at this time.



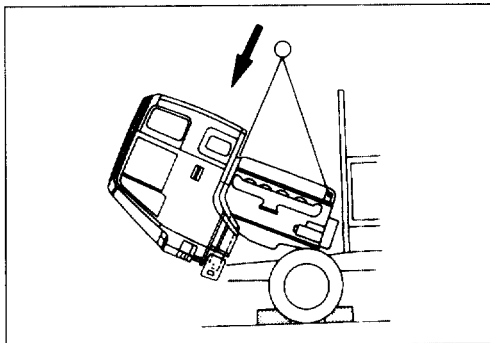
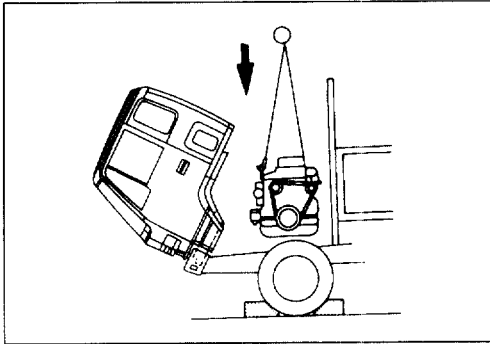
2. Rotate the engine 90 degrees.
3. Continue to lift the engine from the chassis.
4. Carefully move the hoist and engine.
5. Place the engine on an engine stand.



Important Operations - Installation

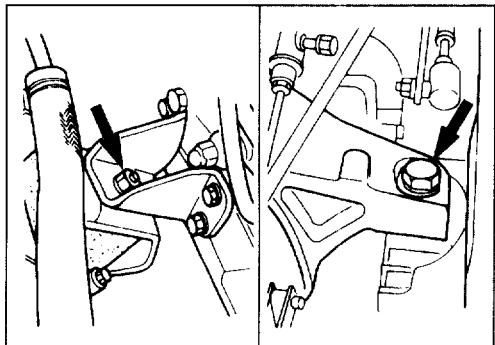
Follow the removal procedure in the reverse order to perform the installation procedure.

Pay careful attention to the important points during the installation procedure.



Engine

1. Attach a lifting wire to the engine lifting hangers.
2. Operate the hoist to position the engine above the chassis frame.
3. Carefully lower the engine until it is just above the chassis frame.
4. Rotate the engine 90 degrees to position it for final installation.
5. Carefully lower the engine into the chassis.
The front of the engine should be held higher than the rear at this time.
Be careful not to damage the exposed parts and the cab.
6. Lower the engine until it contacts the engine mounting rubbers.
7. Set the engine mounting bracket to the mounting rubbers.

**Front Engine Mounting****Rear Engine Mounting**

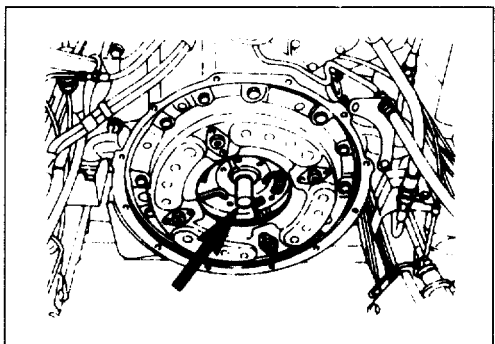
Tighten the mounting nuts and bolts to the specified torque.

Front Mounting Nut Torque	N·m(kg·m/lb.ft)
	127.5 (13.0 / 94.0)

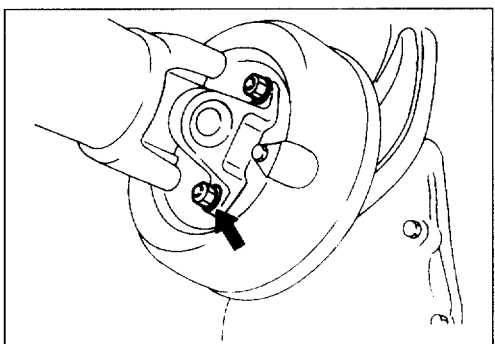
Rear Mounting Bolt Torque	N·m(kg·m/lb.ft)
	490 (50 / 362)

Clutch Pressure Plate and Driven Plate

Refer to Section 07, "CLUTCH," "Removal and Installation."

**Transmission**

Refer to Section 07, "TRANSMISSION".

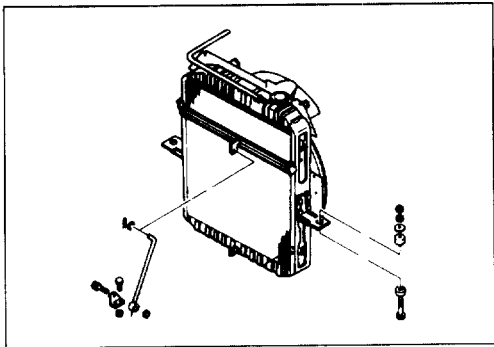
**Propeller Shaft**

1. Install the 1st propeller shaft flange yoke to the parking brake drum.
2. Tighten the propeller shaft flange nuts to the specified torque.

Propeller Shaft Flange Nut Torque	N·m(kg·m/lb.ft)
M14	134.3 (13.7 / 99.1)
M16 With spring washer	215.7 (22.0 / 159.1)
M16 With plain washer	255.7 (26.0 / 188.1)
M16 Without washer	255.7 (26.0 / 188.1)

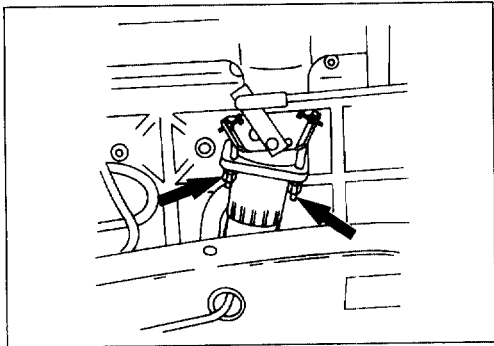
Parking Brake (For 4 × 2)

Refer to Section 05, "PARKING BRAKE," "Removal and Installation."



Radiator

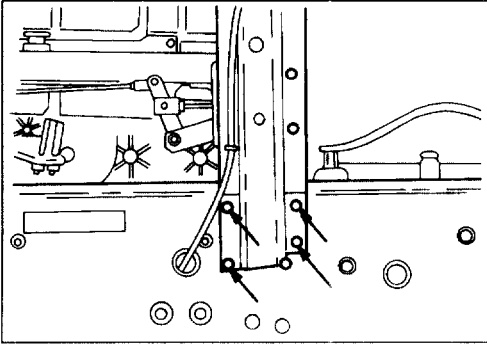
1. Install the fan spacer and the cooling fan to the water pump.
2. Install the radiator with the fan shroud to the mounting cushion rubbers.
Be careful not to damage the radiator core.
3. Connect the radiator front stay to the radiator.
4. Tighten the radiator cushion rubber nuts.
5. Connect the radiator upper and lower hoses.
6. Connect the radiator fan shroud stays (three positions) to the engine.
7. Install the radiator overflow pipe to the engine.
8. Connect the radiator overflow rubber hose to the radiator and the reserve tank.



Exhaust Pipe

1. Connect the exhaust pipe to the exhaust manifold.
2. Tighten the exhaust pipe nuts to the specified torque.

Exhaust Pipe Nut Torque	N·m(kg·m/lb.ft)
39.2 (4.0 / 28.9)	



Cab Mounting Rear Member

Radiator Reserve Tank

1. Install the cab mounting member to the chassis frame.
2. Tighten the rear member nuts to the specified torque.

Rear Member Nut Torque	N·m(kg·m/lb.ft)
68.6 (7.0 / 50.6)	

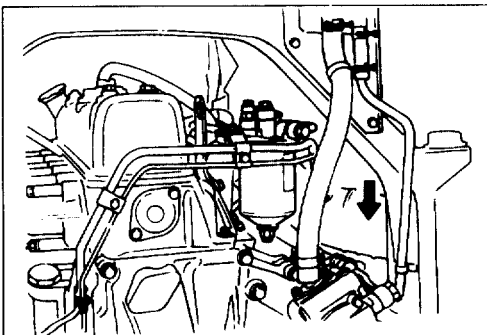
3. Install the radiator reserve tank with the bracket to the cab rear mounting member.

PTO Control Lever (If So Equipped)

1. Install the PTO control lever to the upper cover.
2. Tighten the control lever cover bolt.
3. Install the control lever dust cover to the floor panel.

Engine Control Rod

Connect the engine control rod to the injection pump.



Air Cleaner

Install the air outlet hose to the intake cover (engine not equipped with turbocharger) or the inlet duct (turbocharger equipped engine).



Coolant Replenishment

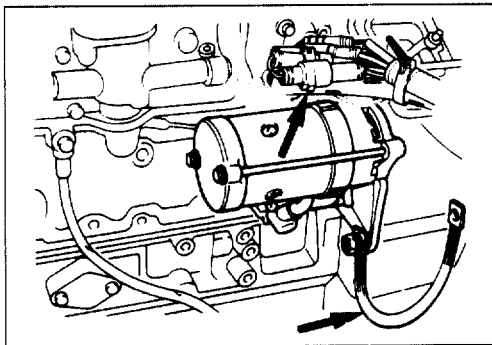
Replenish the coolant to the specified capacity.

Coolant Capacity

(Include Eng. Rad. Reserve tank)

L(Imp.qt/USqt)

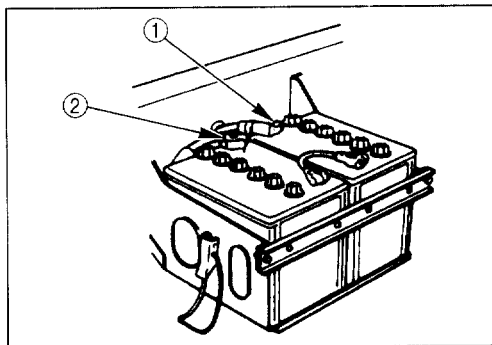
6SD1	27.5 (24.2/29.0)
6SD1TC	27.9 (24.5/29.5)



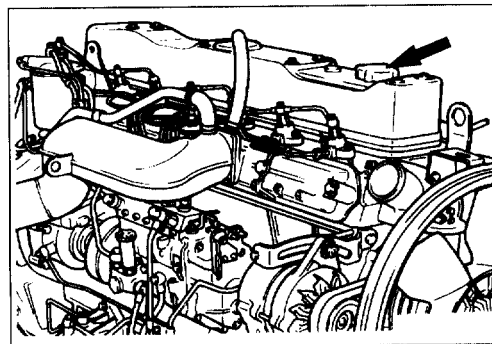
Battery



1. Check the battery fluid level and the specific gravity.
2. Connect the battery cable to the starter motor.
3. Connect the grounding cable to the chassis frame.



4. Connect the battery cable ① and the grounding cable ② to the battery terminals.
5. Apply grease to the battery terminals.



Engine Oil Replenishment

1. Replenish the engine oil pan from the filler port with new engine oil of the specified grade.

Engine Oil Capacity (Oil pan only)

L(Imp.qt/USqt)

24 (21.1/25.4)

2. Start the engine and let it idle for a few minutes.
3. Stop the engine and wait five minutes.
4. Recheck the oil level and replenish if necessary.

Engine Warm-Up

After completing the required maintenance procedures, start the engine and allow it to warm up. Then check the following:

1. Indicator warning light operation
2. Engine idling speed

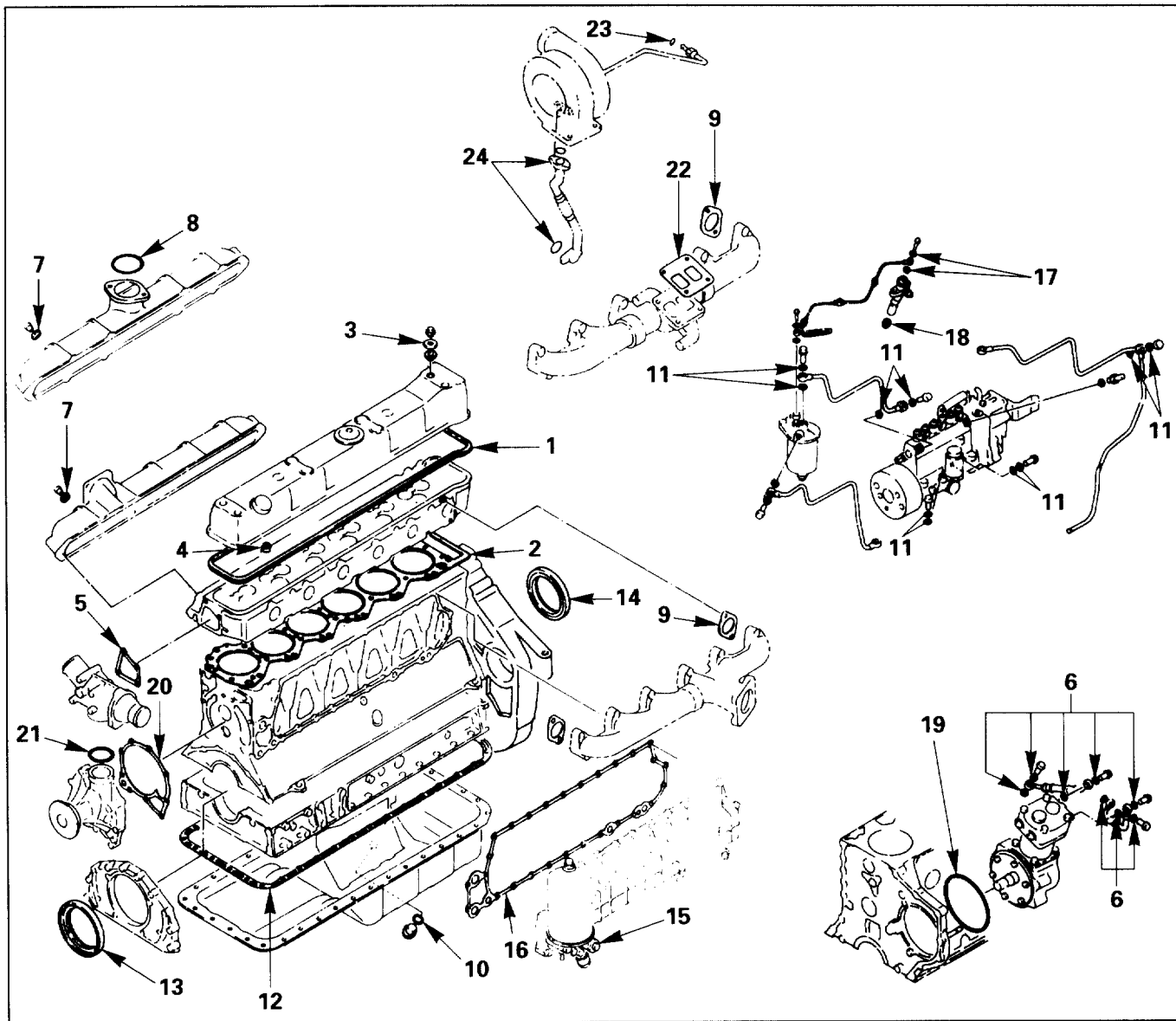
Refer to Servicing in Section 00, "GENERAL INFORMATION" for the idling speed adjustment procedure.

3. Engine noise level
4. Engine oil and coolant leakage
5. Engine control cable operation
6. Clutch engagement

ENGINE REPAIR KIT

All of the numbered parts listed below are included in the Engine Repair Kit.

The gaskets marked with an asterisk (*) are also included in the Top Overhaul Kit.



- | | |
|--|---------------------------------------|
| * 1. Head cover nut gasket | 13. Crankshaft front oil seal |
| * 2. Cylinder head gasket | 14. Crankshaft rear oil seal |
| * 3. Head cover nut gasket | 15. Oil relief valve O-ring |
| * 4. Valve stem oil seal | 16. Oil cooler gasket |
| * 5. Thermostat housing gasket | 17. Leak off pipe gasket |
| * 6. Compressor water pipe gasket | 18. Injection nozzle gasket |
| * 7. Intake cover nut gasket | 19. Air compressor gasket |
| * 8. Intake cover duct gasket (6SD1TC) | 20. Water pump gasket |
| * 9. Exhaust manifold gasket | 21. Water pump O-ring |
| 10. Drain plug gasket | * 22. Turbocharger gasket |
| 11. Fuel pipe gasket | * 23. Turbocharger feed pipe gasket |
| 12. Oil pan gasket | * 24. Turbocharger return pipe O-ring |

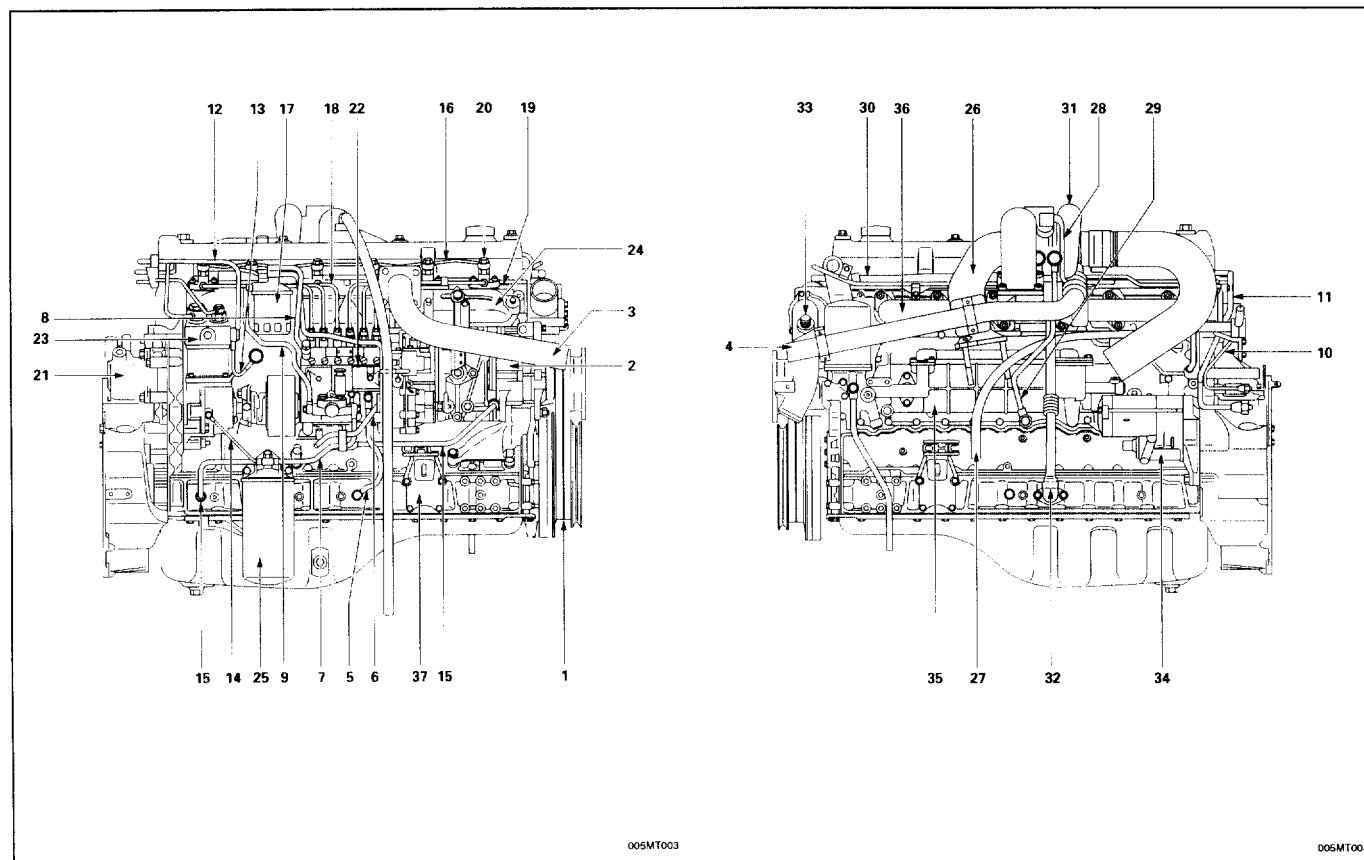
ENGINE OVERHAUL



DISASSEMBLY

EXTERNAL PARTS

These disassembly steps are based on the 6SD1TC engine.



Disassembly Steps

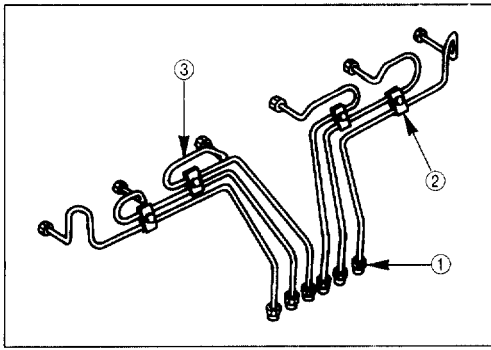
- | | |
|--|------------------------------------|
| 1. Cooling fan drive belt | ▲ 19. Glow plug and connector |
| 2. Generator and adjusting plate | ▲ 20. Injection nozzle holder |
| 3. Air duct | ▲ 21. Power steering oil pump |
| 4. Intake pipe | ▲ 22. Injection pump |
| 5. Oil pipe | ▲ 23. Air compressor |
| 6. Fuel pipe (Fuel filter leak off) | ▲ 24. Intake cover |
| 7. Fuel suction pipe | 25. Partial oil filter and bracket |
| 8. Fuel pipe (Fuel filter to injection pump) | 26. Exhaust manifold adapter |
| 9. Fuel pipe (Feed pump to fuel filter) | 27. Oil level gauge and guide tube |
| 10. Air pipe (Governor) | 28. Turbocharger oil feed pipe |
| 11. Air pipe (Charge) | 29. Turbocharger water feed pipe |
| 12. Air compressor water pipe (In) | 30. Turbocharger water return pipe |
| 13. Air compressor water pipe (Out) | ▲ 31. Turbocharger |
| 14. Body oil pipe | ▲ 32. Turbocharger oil return pipe |
| 15. Partial oil filter feed pipe and return pipe | 33. Water suction pipe |
| 16. Fuel leak off pipe | 34. Starter motor |
| 17. Fuel filter | ▲ 35. Oil cooler with oil filter |
| ▲ 18. Fuel injection pipe with clip | ▲ 36. Exhaust manifold |
| | 37. Engine foot |



Important Operations

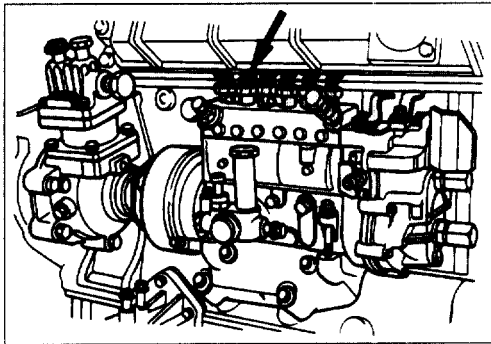
18. Fuel Injection Pipe with Clip

- 1) Loosen the injection pipe sleeve nuts at the delivery valve side ①.
- Do not apply excessive force to the injection pipes.
- 2) Loosen the injection pipe clips ②.
- 3) Remove the injection pipes ③.



Note:

Plug the delivery holder ports with the shipping caps or the equivalent to prevent the entry of foreign material.



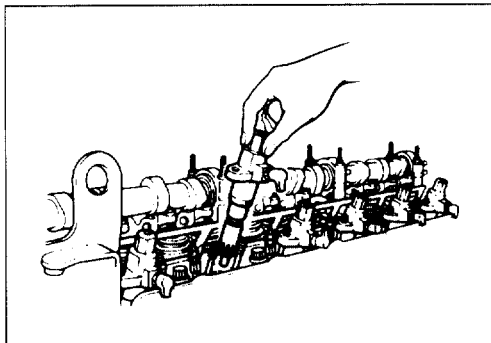
19. Glow Plug and Connector

20. Injection Nozzle Holder

The glow plugs and the injection nozzles protrude from the lower side of the cylinder head.

They are easily damaged.

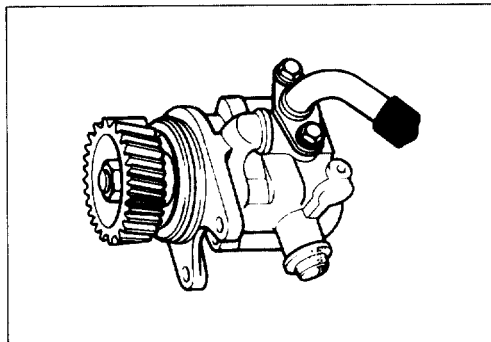
Remove the glow plugs and the injection nozzles before removing the cylinder head.



21. Power Steering Oil Pump

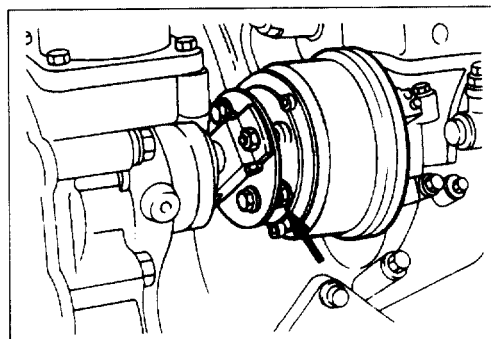
Remove the power steering oil pump.

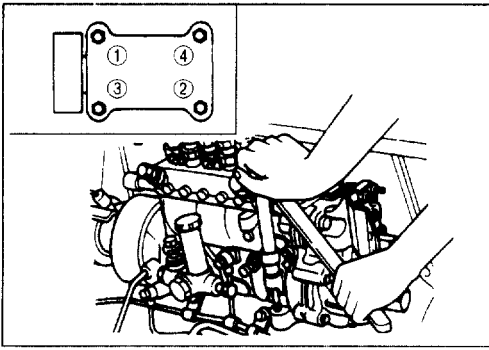
Plug the power steering oil pump to prevent the entry of foreign material.



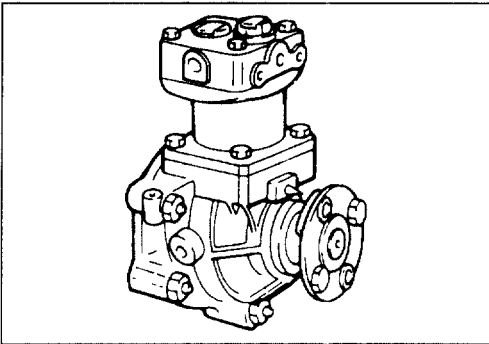
22. Injection Pump

- 1) Remove the two injection pump coupling joint bolts from the injection pump side.





- 2) Use a universal wrench to remove the four injection pump mounting bolts.
- 3) Remove the injection pump.

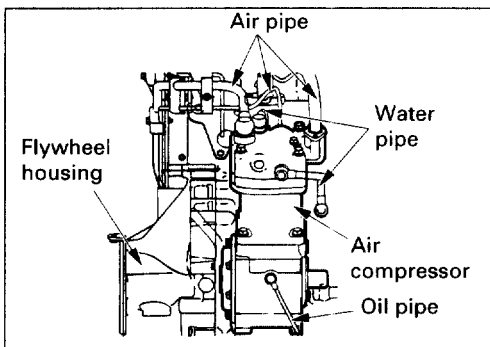


23. Air Compressor

- 1) Plug the air compressor ports to prevent the entry of foreign material.

Store the air compressor in an upright position on a flat surface.

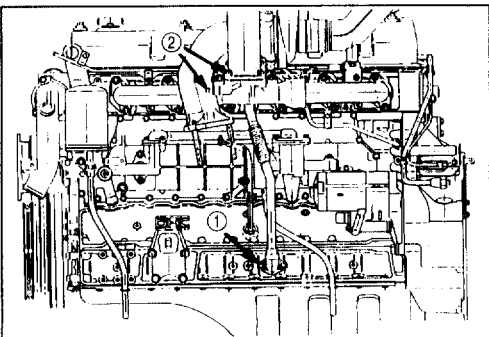
- 2) Air compressor heavy duty type (for Australia).



038HY00005

24. Intake Cover

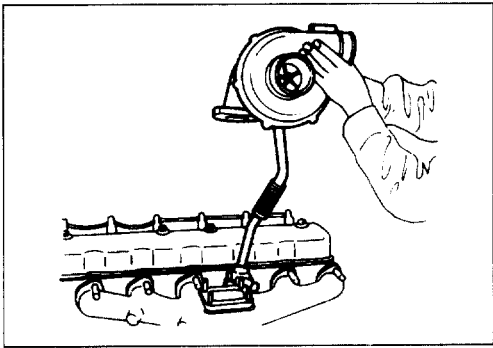
Loosen a bolt which tighten inside intake cover.



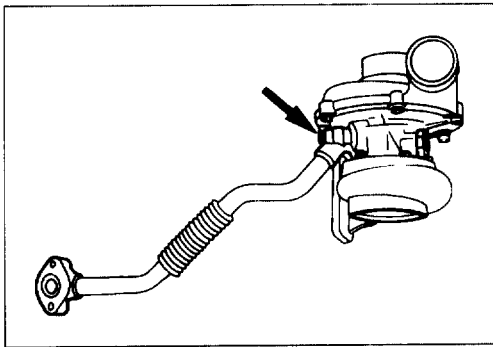
31. Turbocharger

32. Turbocharger Oil Return Pipe

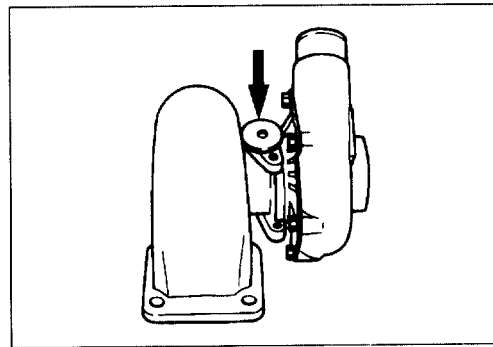
- 1) Loosen the turbocharger oil return pipe lower flange bolts ①.
- 2) Loosen the turbocharger nuts ②.



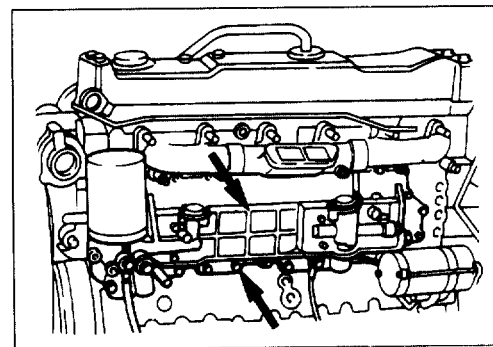
- 3) Remove the turbocharger with the oil return pipe from the exhaust manifold.
Take care not to damage the oil return pipe.



- 4) Loosen the oil return pipe upper flange bolts to remove the oil return pipe from the turbocharger.

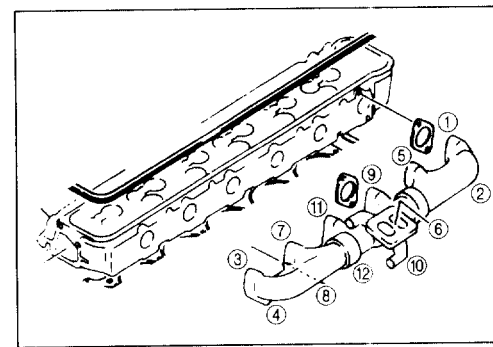


- 5) Plug the turbocharger body oil ports to prevent the entry of foreign material.



35. Oil Cooler with Oil Filter

Tap lightly around the oil cooler body edge with a mallet to remove it.



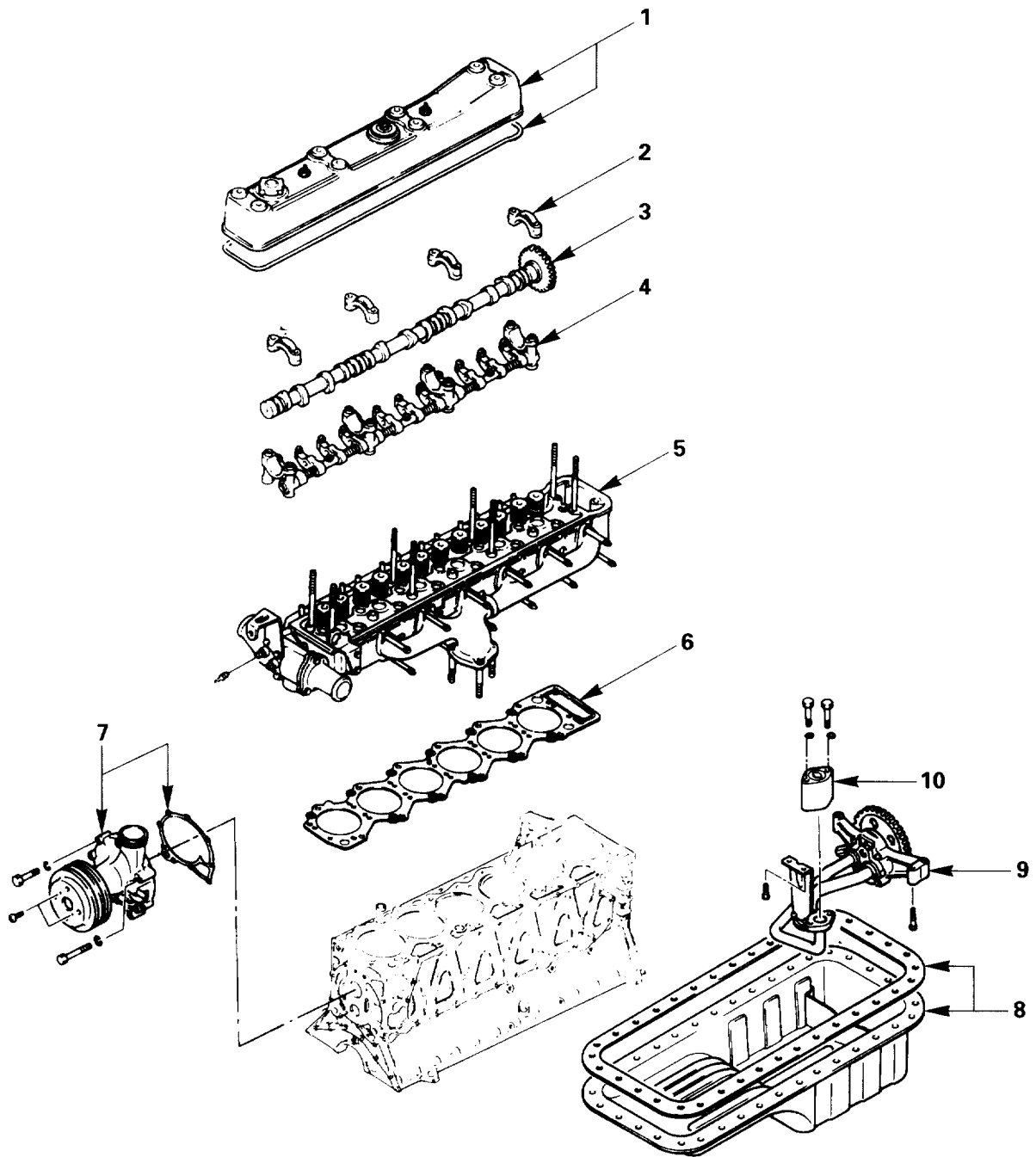
36. Exhaust Manifold

Loosen the exhaust manifold bolts a little at a time in the numerical order shown in the illustration.



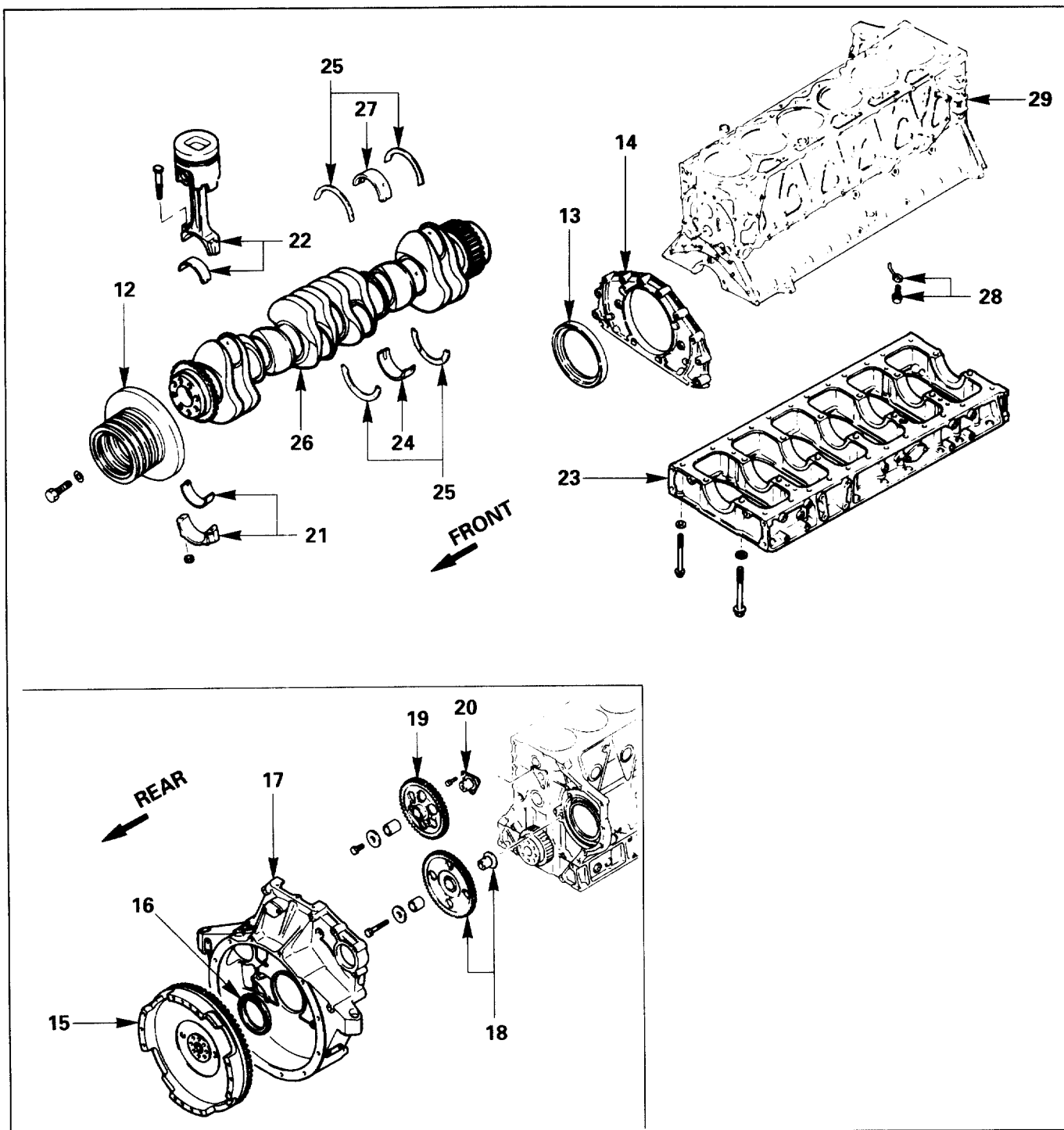
INTERNAL PARTS

MAJOR COMPONENTS



Disassembly Steps-1

- | | |
|--|--------------------------------------|
| 1. Cylinder head cover and gasket | 6. Cylinder head gasket |
| ▲ 2. Camshaft upper bracket | 7. Water pump with pulley and gasket |
| ▲ 3. Camshaft | 8. Oil pan and gasket |
| ▲ 4. Rocker arm shaft and rocker arm with camshaft lower bracket | 9. Oil pump |
| ▲ 5. Cylinder head | 10. Spacer |



Disassembly Steps-2

- ▲ 12. Crankshaft damper pulley
- ▲ 13. Oil seal front
- ▲ 14. Front cover
- ▲ 15. Flywheel
- ▲ 16. Oil seal rear
- ▲ 17. Flywheel housing
- ▲ 18. Idler gear "A" and idler shaft
- ▲ 19. Idler gear "B"
- ▲ 20. Idler gear shaft "B"
- ▲ 21. Connecting rod bearing cap with lower bearing
- ▲ 22. Piston and connecting rod with upper bearing
- ▲ 23. Cylinder body lower crankcase
- ▲ 24. Crankshaft lower bearing
- ▲ 25. Crankshaft thrust bearing
- ▲ 26. Crankshaft
- ▲ 27. Crankshaft upper bearing
- ▲ 28. Oiling jet and joint bolt
- ▲ 29. Cylinder body



Important Operations

2. Camshaft Upper Bracket

3. Camshaft

- 1) Loosen the upper bracket nuts a little at a time.
- 2) Remove the upper bracket and the camshaft.

4. Rocker Arm Shaft and Rocker Arm with Camshaft Lower Bracket

Loosen the rocker arm shaft bracket bolts evenly from outside to inside.

Note:

Failure to loosen the rocker arm shaft bracket bolts evenly from outside to inside will adversely affect the rocker arm shaft.

5. Cylinder Head

Loosen the cylinder head bolts a little at a time in the numerical order shown in the illustration.

Note:

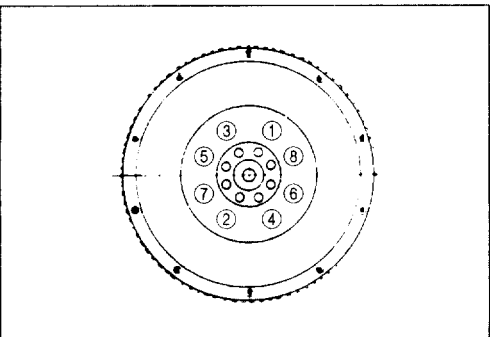
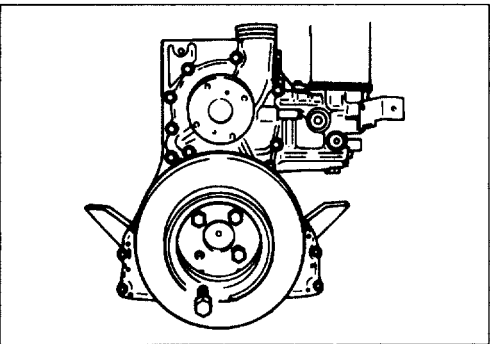
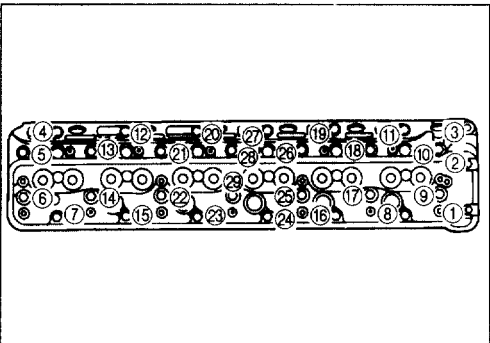
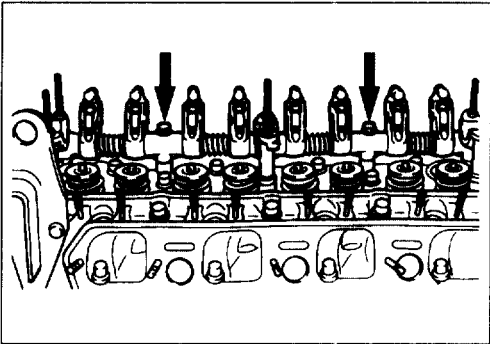
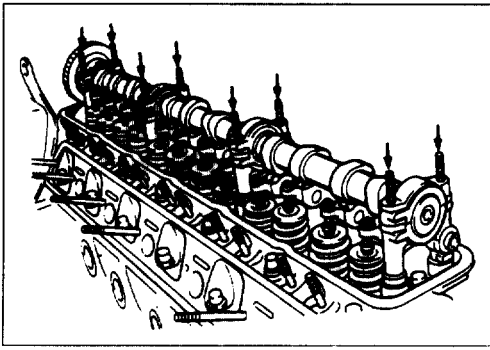
Failure to loosen the cylinder head bolts in numerical order a little at a time will adversely affect the cylinder head lower surface.

12. Crankshaft Damper Pulley

- 1) Block the crankshaft with a piece of hard wood to prevent the damper pulley from turning
- 2) Remove the crankshaft damper pulley bolts.

15. Flywheel

- 1) Block the crankshaft with a piece of hard wood to prevent the flywheel from turning.
- 2) Loosen the flywheel bolts a little at a time in the numerical order shown in the illustration.



18. Idler Gear "A" and Idler Shaft

19. Idler Gear "B"

- 1) Measure the idler gear backlash and the crankshaft gear backlash before removing the idler gear.
- 2) Measure the idler gear end play before removing the idler gear.

Note:

Refer to the following items for details on the backlash and end play measurement procedures.

Idler Gear Backlash Measurement

1. Set a dial indicator to the idler gear to be measured.
Hold both the gear to be checked and the adjoining gear stationary.
2. Move the gear to be checked as far as possible both to the right and to the left.
Take the dial indicator reading.
If the measured value exceeds the specified limit, the idler gear must be replaced.

Idler Gear Backlash		mm(in)
Standard	Limit	
0.10 (0.0039)	0.30 (0.012)	

Idler Gear End Play Measurement

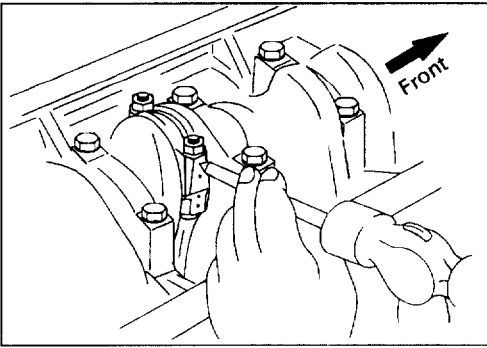
Insert a feeler gauge between the idler gear and the thrust collar to measure the gap and determine the idler gear end play.
If the measured value exceeds the specified limit, the idler gear must be replaced.

Idler Gear End Play		mm(in)
Standard	Limit	
0.04 - 0.19 (0.001 - 0.075)	0.30 (0.012)	

Connecting Rod Side Face Clearance Measurement

Insert a feeler gauge between the connecting rod big end side face and the crankpin side face.
If the measured value exceeds the specified limit, the connecting rod must be replaced.

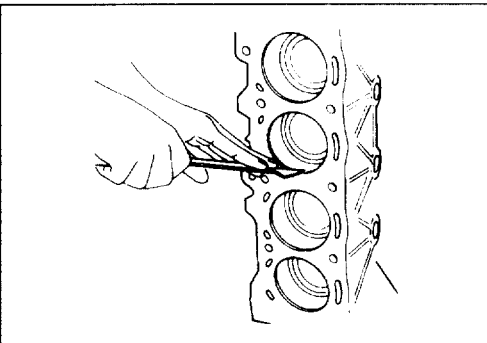
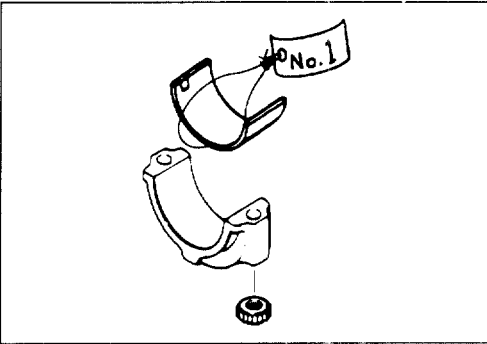
Connecting Rod Big End and Crankpin Side Face Clearance		mm(in)
Standard	Limit	
0.17 - 0.28 (0.0067 - 0.0110)	0.35 (0.0140)	



21. Connecting Rod Bearing Cap with Lower Bearing

- 1) If the connecting rod bearing assembly original marks can not be clearly seen, remark the assemblies with a punch or a numbering stamp. This will ensure reassembly to their original positions.
- 2) Loosen the connecting rod bearing cap bolts a little at a time.

If the connecting rod lower bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.



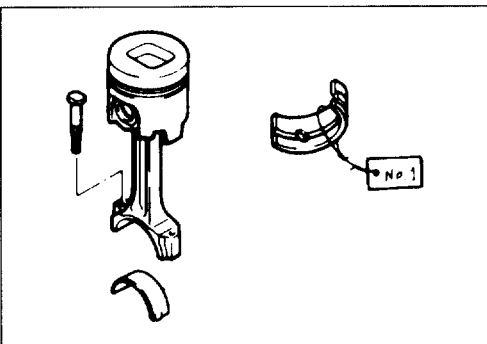
22. Piston and Connecting Rod with Upper Bearing

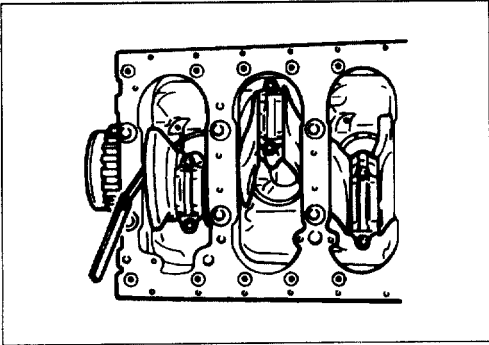
- 1) Remove carbon deposits from the upper portion of the cylinder wall with a scraper before removing the piston and connecting rod.
- 2) Move the piston to the top of the cylinder and tap it with a hammer grip or similar object from the connecting rod lower side to drive it out.

Note:

Take care not to damage the oiling jets.

If the connecting rod upper bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.



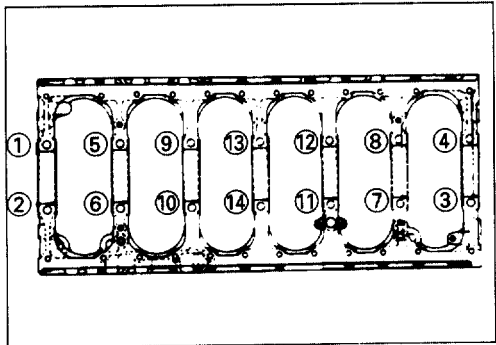


23. Cylinder Body Lower Crankcase

24. Crankshaft Lower Bearing

- 1) Measure the crankshaft end play at the No. 7 crankshaft journal.
- Do this before removing the crankshaft bearing caps.
- If the measured value exceeds the specified limit, the crankshaft thrust bearing must be replaced.

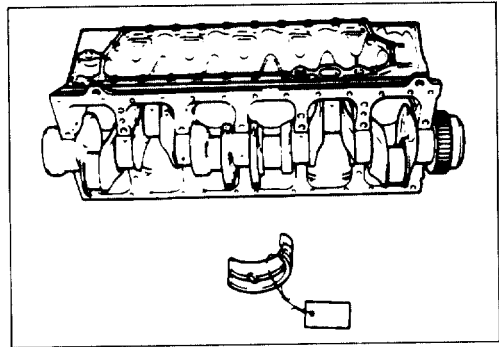
Crankshaft End Play		mm(in)
Standard	Limit	
0.100 - 0.285 (0.004 - 0.011)	0.40 (0.016)	



- 2) Loosen the cylinder body lower crankcase bolts a little at a time in the numerical order shown in the illustration.
- If the crankshaft lower bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the journal number from which it was removed.

27. Crankshaft Upper Bearing

If the crankshaft upper bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the journal number from which it was removed.



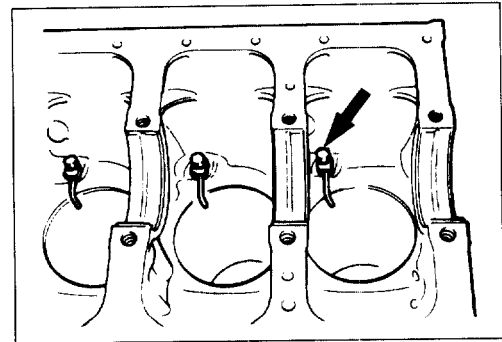
28. Oiling Jet and Joint Bolt

Carefully loosen the joint bolt and remove the oiling jet.

Note:

Take care not to bend the oiling jet steel tubing.

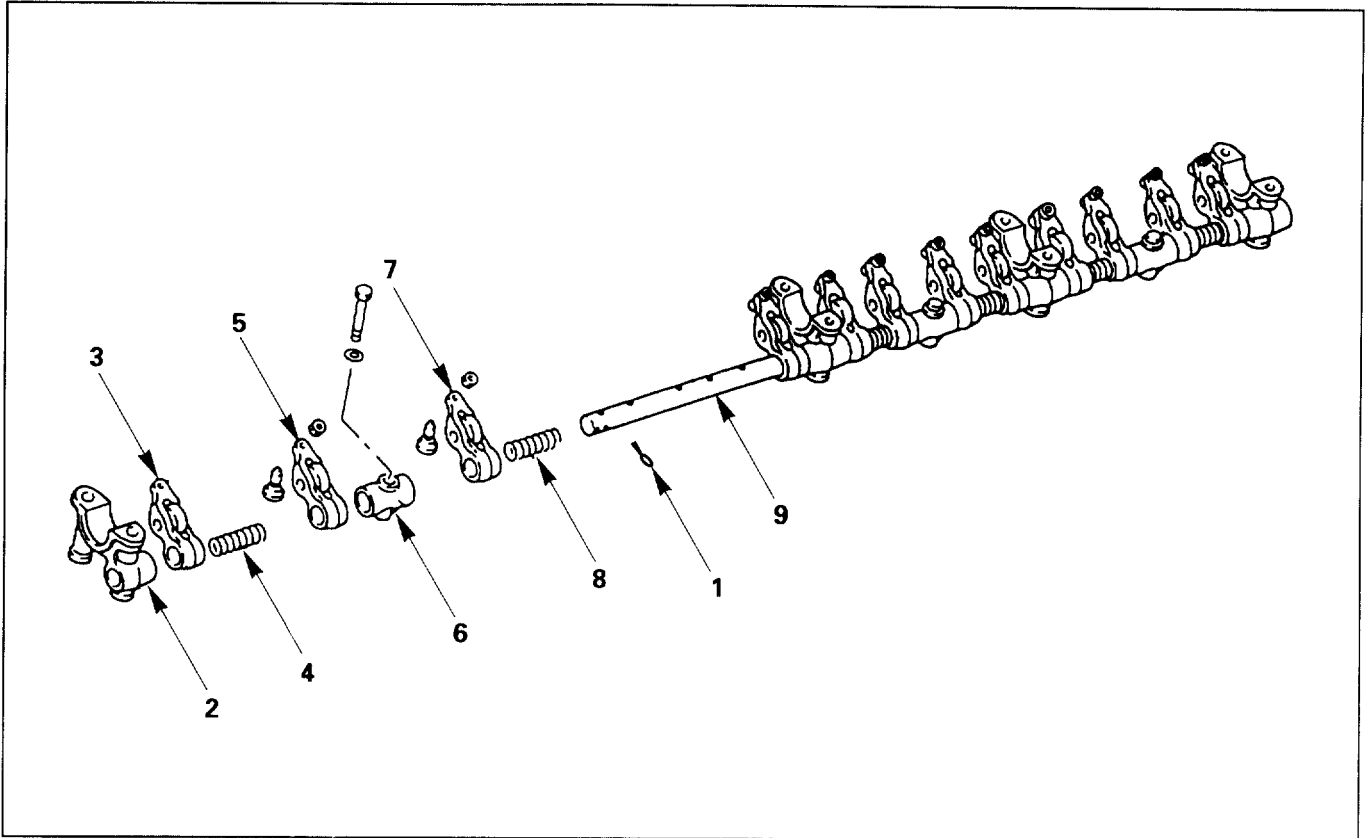
Do not attempt to repair a damaged oiling jet. Replace it with a new one.





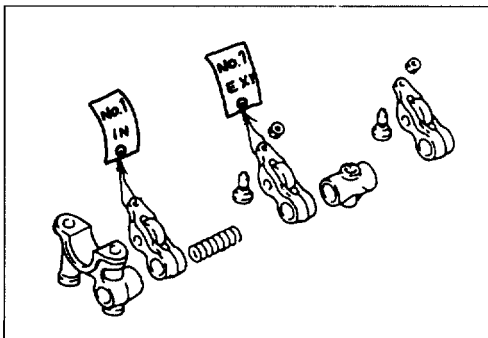
MINOR COMPONENTS

ROCKER ARM SHAFT AND ROCKER ARM WITH CAMSHAFT LOWER BRACKET



Disassembly Steps

- | | |
|----------------------------|-----------------------|
| 1. Cotter pin | 6. Rocker arm bracket |
| 2. Camshaft lower bracket | ▲ 7. Rocker arm |
| ▲ 3. Rocker arm | 8. Rocker arm spring |
| 4. Rocker arm shaft spring | 9. Rocker arm shaft |
| ▲ 5. Rocker arm | |



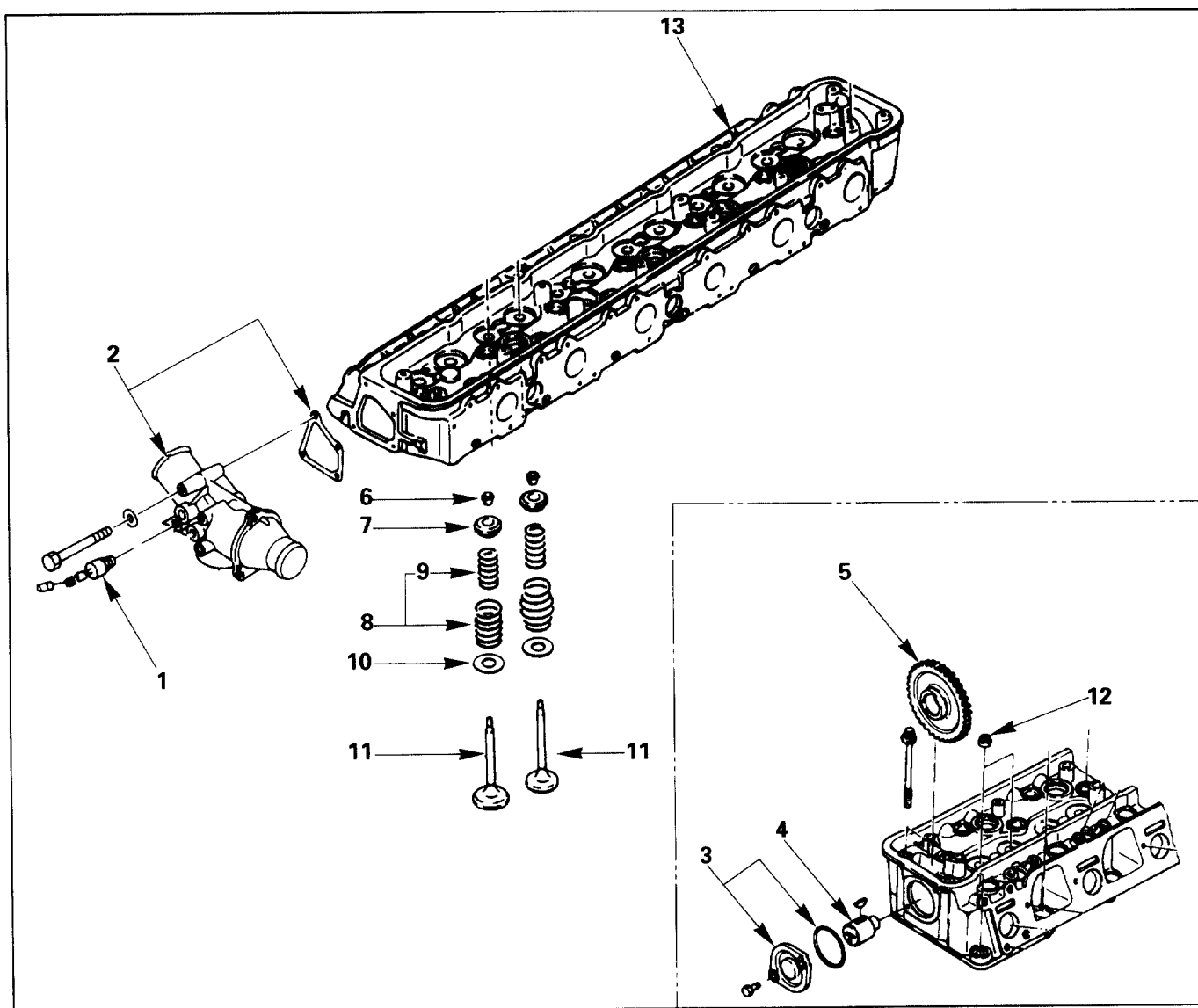
Important Operations

3. Rocker Arm
5. Rocker Arm
7. Rocker Arm

If the rocker arms are to be reinstalled, mark their installation positions by tagging each rocker arm with the cylinder number from which it was removed.

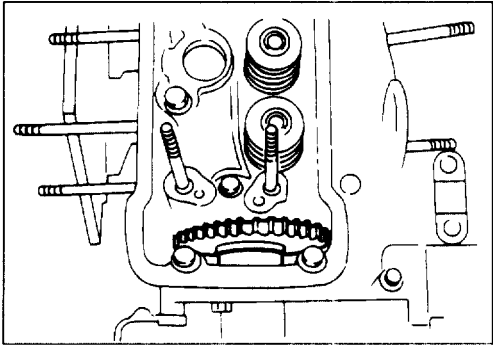


CYLINDER HEAD



Disassembly Steps

1. Thermometer unit
2. Thermostat housing and gasket
3. Idler gear cover and O-ring
4. Idler gear shaft "C"
- ▲ 5. Idler gear "C"
- ▲ 6. Split collar
7. Valve spring upper seat
8. Valve spring (Outer)
9. Valve spring (Inner)
10. Valve spring lower seat
- ▲ 11. Intake and exhaust valve
12. Valve stem oil seal
13. Cylinder head



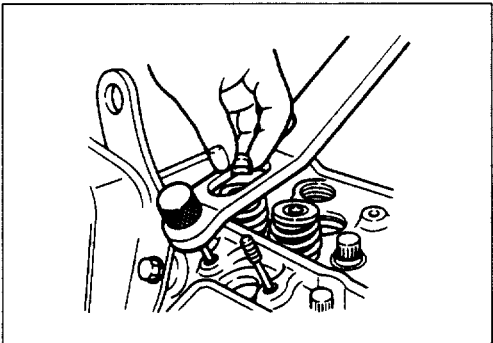
Important Operations

5. Idler Gear "C"

- 1) Measure the idler gear "C" end play before removing the idler gear shaft "C".
If the measured value exceeds the specified limit, the idler gear must be replaced.

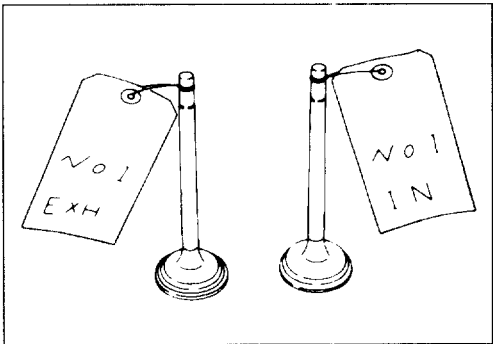
Idler Gear "C" End Play		mm(in)
Standard	Limit	
0.047 - 0.218 (0.0019 - 0.0086)	0.40 (0.016)	

- 2) Remove the idler gear shaft "C".



6. Split Collar

- 1) Place the cylinder head on a flat wooden surface.
2) Use the spring compressor to remove the split collars.
Do not allow the valve to fall from the cylinder head.
Spring Compressor: 1-85235-007-0

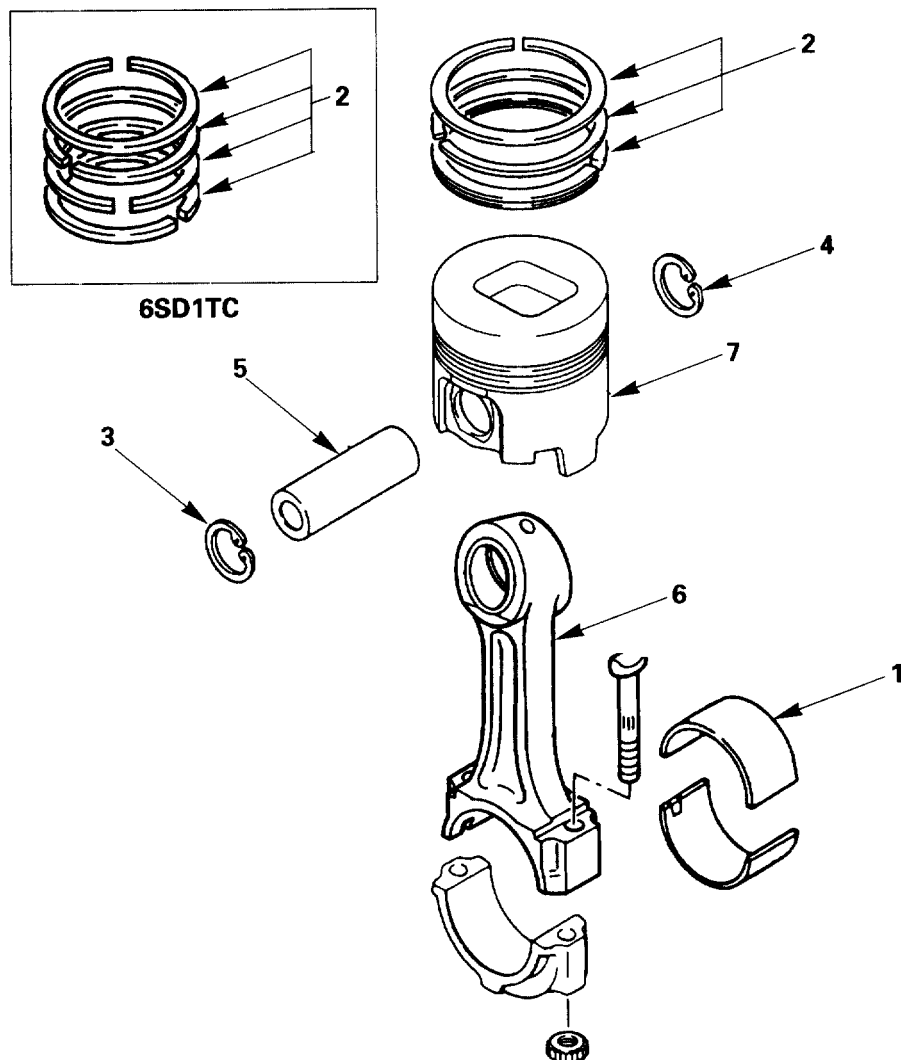


11. Intake and Exhaust Valve

If the intake and exhaust valves are to be reinstalled, mark their installation positions by tagging each valve with the cylinder number from which it was removed.
If the intake and exhaust valves are to be replaced, the valve guides must also be replaced.

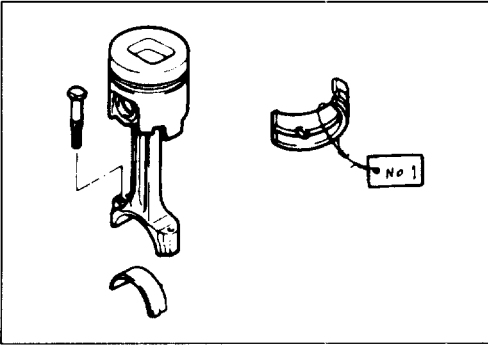


PISTON AND CONNECTING ROD



Disassembly Steps

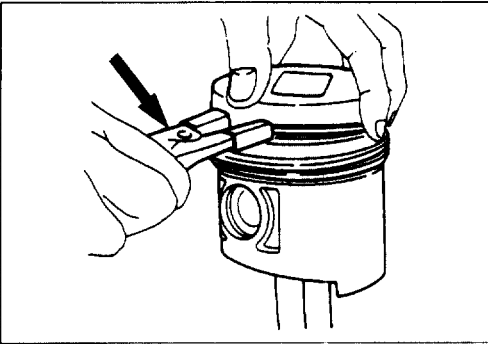
- ▲ 1. Connecting rod bearing
- ▲ 2. Piston ring
- ▲ 3. Piston pin snap ring
- ▲ 4. Piston pin snap ring
- ▲ 5. Piston pin
- ▲ 6. Connecting rod
- ▲ 7. Piston



Important Operations

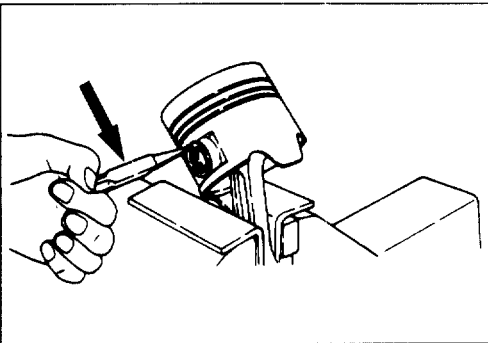
1. Connecting Rod Bearing

If the connecting rod bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.



2. Piston Ring

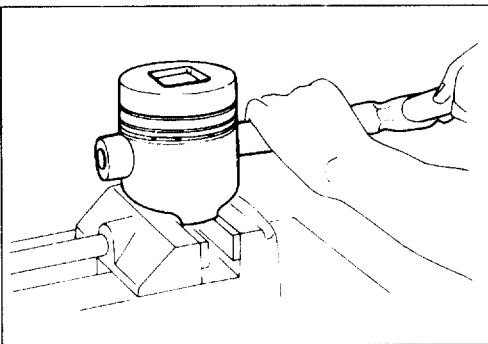
- 1) Clamp the connecting rod in a vise.
Take care not to damage the connecting rod.
- 2) Use a piston ring replacer to remove the piston rings.
Do not attempt to use some other tool to remove the piston rings. Piston ring stretching will result in reduced piston ring tension.



3. Piston Pin Snap Ring

4. Piston Pin Snap Ring

Use pliers to remove the piston pin snap rings.



5. Piston Pin

7. Piston

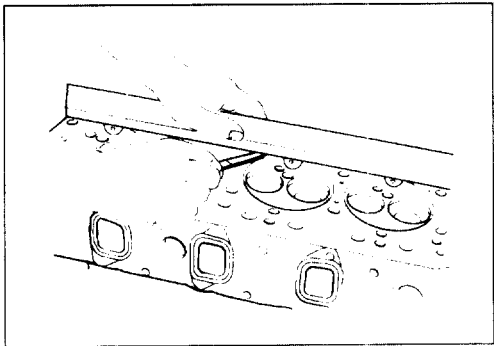
Tap the piston pin out with a hammer and a brass bar.

If the pistons and the piston pins are to be reinstalled, mark their installation positions by tagging each piston and piston pin with the cylinder number from which it was removed.



INSPECTION AND REPAIR

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



CYLINDER HEAD

Cylinder Head Lower Face Warpage

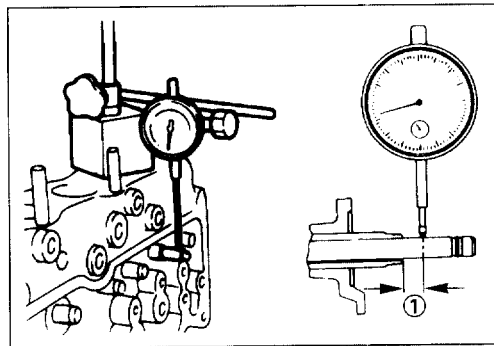
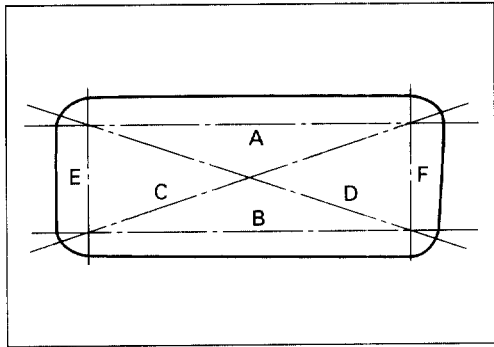
Use a straight edge and a feeler gauge to measure the four sides and the two diagonals of the cylinder head lower face.

If the measured values exceed the specified limit, the cylinder head must be replaced.

Cylinder Head Lower Face Warpage		mm(in)
Standard	Limit	
0.05 (0.002) or less	0.20 (0.008)	

Note:

Do not attempt to regrind the cylinder head lower face.



VALVE GUIDE

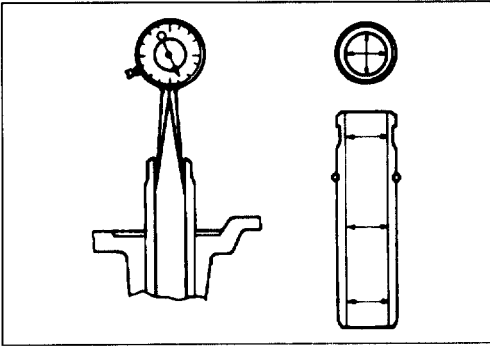
Valve Stem and Valve Guide Clearance

Measuring Method-I

1. Insert the valve to the cylinder head.
2. Set the dial indicator to the valve stem at measuring point ① as shown in the illustration.
Measuring Point ①: 10 mm (0.4 in)
3. Set the dial indicator needle to "0".
4. Move the valve head from side to side.
Read the dial indicator.
Note the highest dial indication.

If the measured values exceed the specified limit, the valve and the valve guide must be replaced as a set.

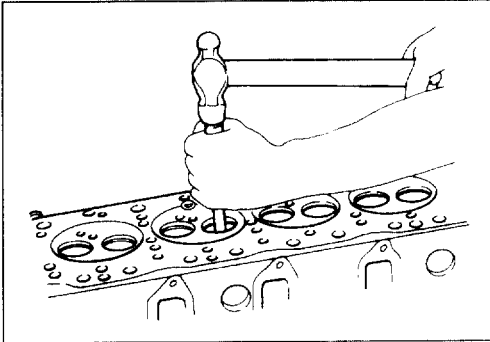
Valve Stem Clearance		mm(in)
	Standard	Limit
Intake Valve	0.04 - 0.077 (0.0016 - 0.0030)	0.15 (0.0059)
Exhaust Valve	0.065 - 0.102 (0.0026 - 0.0040)	0.20 (0.0079)



Measuring Method-II

1. Measure the valve stem outside diameter.
2. Use a caliper calibrator or a telescoping gauge to measure the valve guide inside diameter.
3. Calculate the clearance between the valve guide inside diameter and the valve stem outside diameter.

If the clearance exceeds the specified limit, the valve and the valve guide must be replaced as a set.

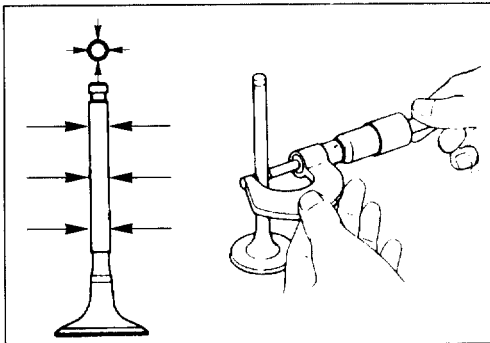


Valve Guide Replacement

Valve Guide Removal

Use a hammer and the valve guide replacer to drive out the valve guide from the cylinder head lower face.

Valve Guide Replacer: 9-85231-202-2



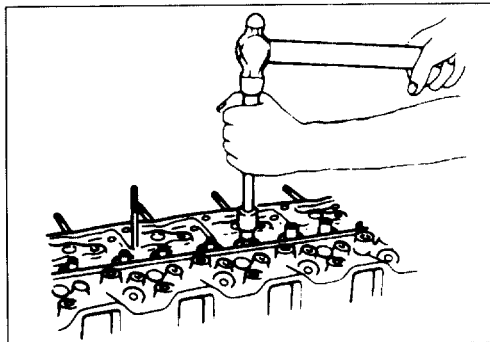
Valve Stem Outside Diameter

Measure the valve stem diameter at three points.

If the measured value is less than the specified limit, the valve and the valve guide must be replaced as a set.

Valve Stem Outside Diameter mm(in)

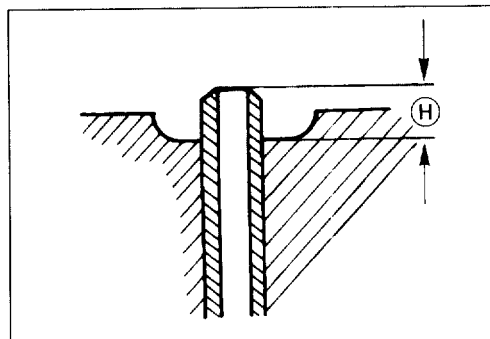
	Standard	Limit
Intake Valve	9.94 - 9.96 (0.3913 - 0.3780)	9.92 (0.3906)
Exhaust Valve	9.91 - 9.94 (0.3902 - 0.3913)	9.90 (0.3898)



Valve Guide Installation

1. Apply engine oil to the valve guide outer circumference.
2. Attach the valve guide replacer to the valve guide.
3. Use a hammer to drive the valve guide into position from the cylinder head upper face.

Valve Guide Replacer: 9-85231-202-2



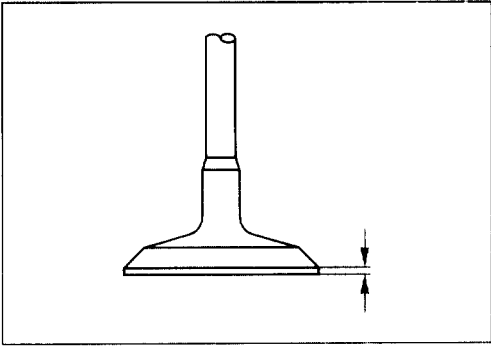
4. Measure the height of the valve guide upper end from the upper face of the cylinder head.

Valve Guide Upper End Height (H) (Reference) mm(in)

22 (0.87)

Note:

If the valve guide has been removed, both the valve and the valve guide must be replaced as a set.



VALVE AND VALVE SEAT INSERT

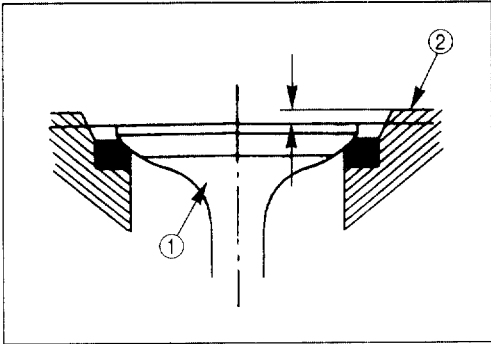
Valve Thickness

Measure the valve thickness.

If the measured value is less than the specified limit, the valve and the valve guide must be replaced as a set.

Intake and Exhaust Valve Thickness mm(in)

	Standard	Limit
Intake	2.50 (0.098)	2.00 (0.079)
Exhaust	2.35 (0.093)	1.85 (0.073)



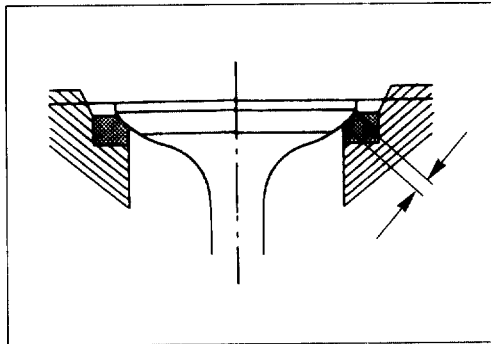
Valve Depression

1. Install the valve ① to the cylinder head ②.
2. Use a depth gauge or a straight edge with steel rule to measure the valve depression from the cylinder head lower surface.

If the measured value exceeds the specified limit, the valve seat insert must be replaced.

Valve Depression mm(in)

	Standard	Limit
Intake	0.48 (0.0190)	1.48 (0.0583)
Exhaust	1.6 (0.0630)	2.6 (0.1024)



Valve Contact Width

1. Check the valve contact faces for roughness and unevenness.

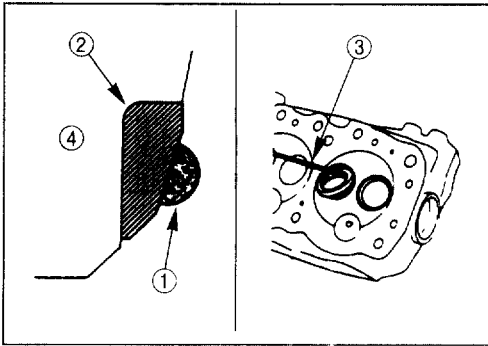
Make smooth the valve contact surfaces.

2. Measure the valve contact width.

If the measured value exceeds the specified limit, the valve seat insert must be replaced.

Valve Contact Width mm(in)

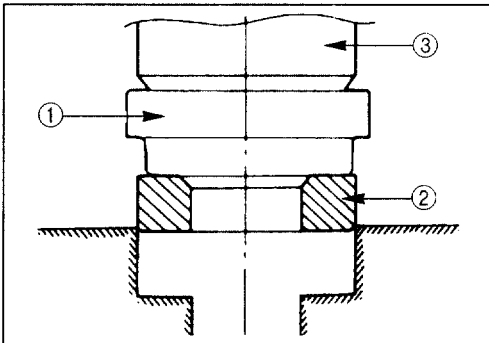
	Standard	Limit
Intake	2.7 (0.1063)	3.5 (0.1378)
Exhaust	2.4 (0.0945)	3.2 (0.1260)



Valve Seat Insert Replacement

Valve Seat Insert Removal

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



Valve Seat Insert Installation

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

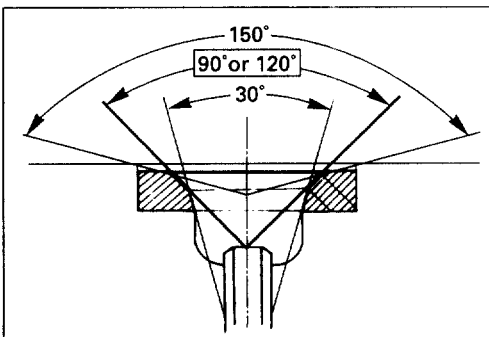
Note:

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

2. Use a bench press ③ to gradually apply pressure to the attachment and press the valve seat insert into place.

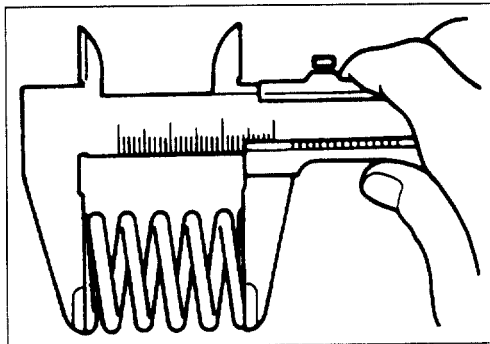
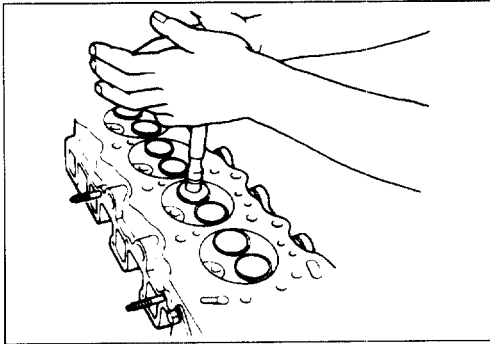
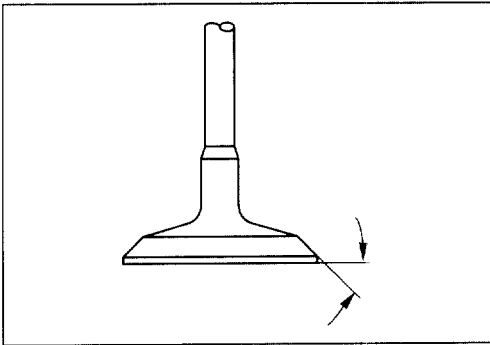
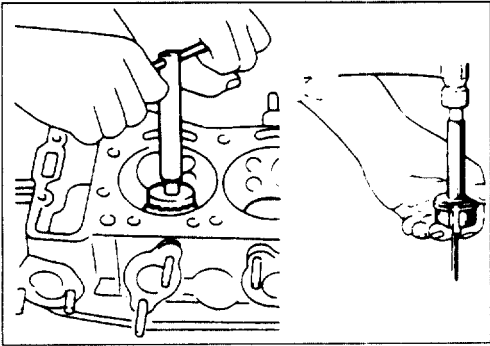
Note:

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



Valve Seat Insert Correction

1. Remove the carbon from the valve seat insert surface.



2. Use a valve cutter (15, 45, 60, and 75 degree blades) to minimize scratches and other rough areas. This will bring the contact width back to the standard value.

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

Valve Face Angle		deg
6SD1TC	Intake	30
	Exhaust	45
6SD1	Intake and exhaust	

Note:

Use an adjustable valve cutter pilot.

Do not allow the valve cutter pilot to wobble inside the valve guide.

3. Apply abrasive compound to the valve seat insert surface.
4. Insert the valve into the valve guide.
5. Turn the valve while tapping it to fit the valve seat insert.
6. Check that the valve contact width is correct.
7. Check that the valve seat insert surface is in contact with the entire circumference of the valve.



VALVE SPRING

Valve Spring Free Height

Use a vernier caliper to measure the valve spring free height.

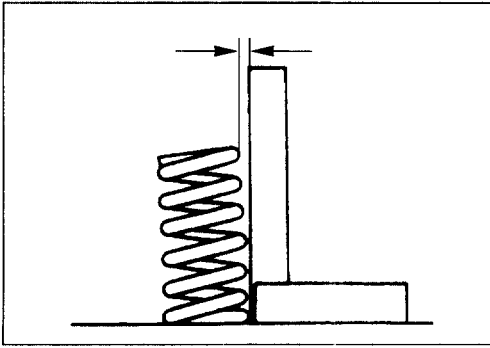
If the measured value is less than the specified limit, the valve spring must be replaced.

Spring Free Height (6SD1) mm(in)

		Standard	Limit
Intake	Inner Spring	62.5 (2.46)	60.5 (2.38)
	Outer Spring	59.3 (2.33)	57.3 (2.26)
Exhaust	Inner Spring	62.6 (2.47)	60.8 (2.39)
	Outer Spring	69.6 (2.74)	67.6 (2.66)

Spring Free Height (6SD1TC) mm(in)

		Standard	Limit
Intake	Inner Spring	62.5 (2.46)	60.5 (2.38)
	Outer Spring	59.3 (2.33)	57.3 (2.26)
Exhaust	Inner Spring	69.2 (2.72)	67.2 (2.65)
	Outer Spring	80.7 (3.18)	78.7 (3.10)



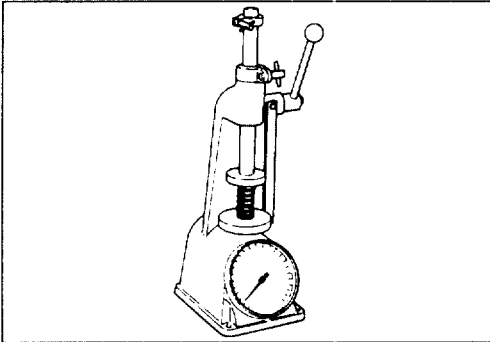
Valve Spring Squareness

Use a surface plate and a square to measure the valve spring squareness.

If the measured value exceeds the specified limit, the valve spring must be replaced.

Inner and Outer Spring Squareness mm(in)

	Standard	Limit
Inner	2.0 (0.08)	3.0 (0.12)
Outer	2.5 (0.01)	3.5 (0.14)



Valve Spring Tension

Use a spring tester to measure the valve spring tension.

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

Intake Valve Spring Tension (6SD1) N(kg/lb)

	Compressed Height	Standard
Inner	46.2 mm (1.82 in)	111.8 (11.4/25.1)
Outer	48.7 mm (1.92 in)	292.2 (29.8/65.7)

Exhaust Valve Spring Tension (6SD1) N(kg/lb)

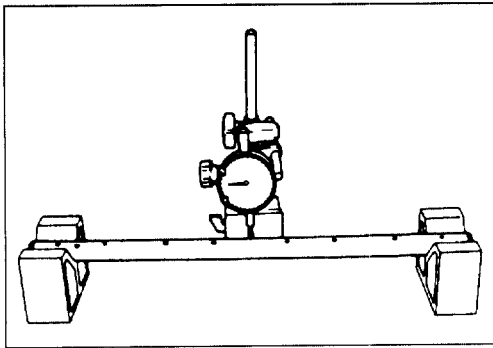
	Compressed Height	Standard
Inner	46.2 mm (1.82 in)	177.5 (18.1/39.9)
Outer	48.7 mm (1.92 in)	414.8 (42.3/93.3)

Intake Valve Spring Tension (6SD1TC) N(kg/lb)

	Compressed Height	Standard
Inner	46.2 mm (1.82 in)	112 (11.4/25.14)
Outer	48.7 mm (1.92 in)	289 (29.8/65.71)

Exhaust Valve Spring Tension (6SD1TC) N(kg/lb)

	Compressed Height	Standard
Inner	46.2 mm (1.82 in)	284 (29/63.95)
Outer	48.7 mm (1.92 in)	500 (51/112.46)



ROCKER ARM SHAFT AND ROCKER ARM

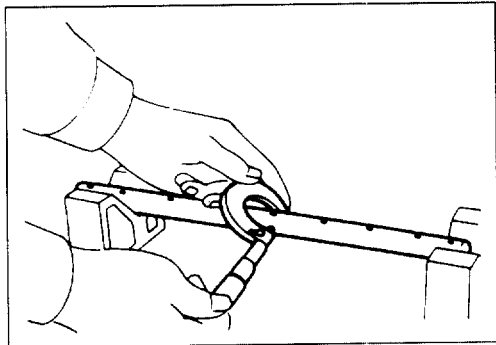
Rocker Arm Shaft Run-Out

1. Place the rocker arm shaft on a V-block.
2. Use a dial indicator to measure the rocker arm shaft central portion run-out.

If the run-out is very slight, correct the rocker arm shaft run-out with a bench press. The rocker arm must be at cold condition.

If the measured rocker arm shaft run-out exceeds the specified limit, the rocker arm shaft must be replaced.

Rocker Arm Shaft Run-Out	mm(in)
Limit	
0.3 (0.012)	

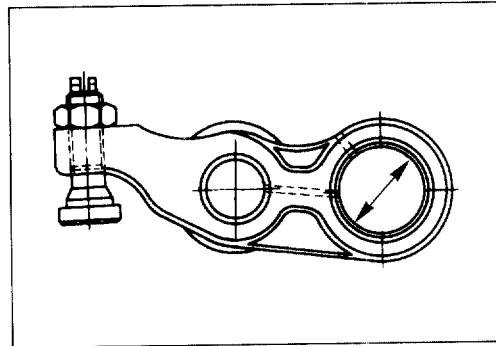


Rocker Arm Shaft Outside Diameter

Use a micrometer to measure the rocker arm fitting portion outside diameter.

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

Rocker Arm Shaft Outside Diameter	mm(in)
Standard	Limit
18.965 - 18.985 (0.7466 - 0.7474)	18.85 (0.742)



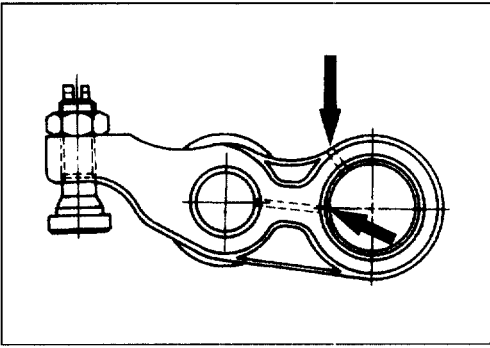
Rocker Arm Shaft and Rocker Arm Clearance

1. Use either a vernier caliper or a dial indicator to measure the rocker arm inside diameter.

Rocker Arm Inside Diameter	mm(in)
Standard	Limit
19.01 - 19.03 (0.748 - 0.749)	19.05 (0.750)

2. Measure the rocker arm shaft outside diameter.
If the measured value exceeds the specified limit, replace either the rocker arm or the rocker arm shaft.

Rocker Arm Shaft and Rocker Arm Clearance	mm(in)
Standard	Limit
0.01 - 0.05 (0.0004 - 0.0020)	0.20 (0.008)



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

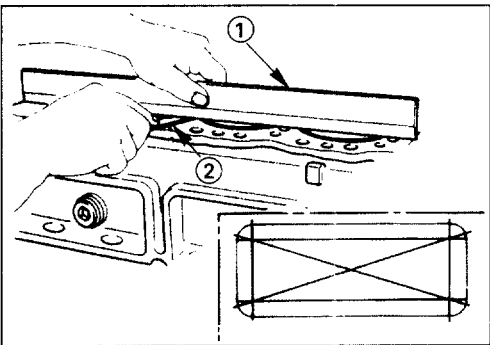
If necessary, use compressed air to clean the rocker arm oil port.



CYLINDER BODY

Cylinder Body Upper Face Warpage

1. Remove the cylinder body dowel.
 2. Remove the cylinder liner.
- Refer to "Cylinder Liner Replacement."



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

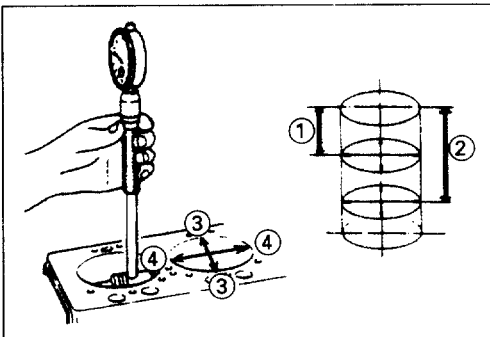
If the measured values exceed the specified limit, the cylinder body must be replaced.

Cylinder Body Upper Face Warpage		mm(in)
Standard		Limit
less than 0.20 (0.008)		0.20 (0.008)

4. Reinstall the cylinder liner.
 5. Reinstall the cylinder body dowel.
- Refer to "Cylinder Liner Replacement."

Note:

Do not attempt to grind the cylinder body upper surfaces.



Cylinder Liner Bore Measurement

Use a cylinder indicator to measure the cylinder liner bore at measuring point ① and ② in the thrust ③ - ③ and axial ④ - ④ directions of the crankshaft.

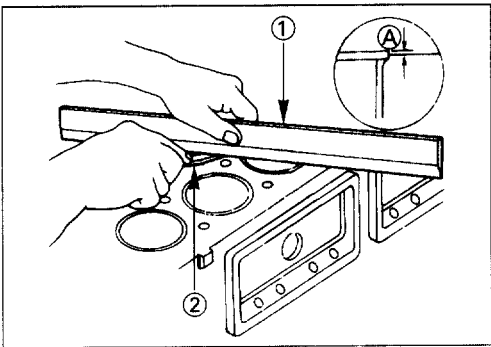
Measuring Point: ① 24 mm (0.945 in) and
② 120 mm (4.7 in)

If the measured value exceeds the specified limit, the cylinder liner must be replaced.



Cylinder Liner Bore		mm(in)
Standard		Limit
120.001 - 120.041 (4.7244 - 4.7260)		120.300 (4.7362)

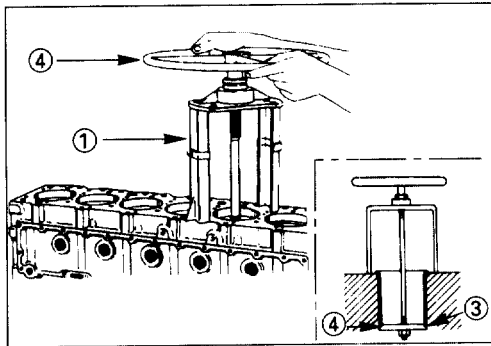
Note:
The inside of the dry type cylinder liner is super tarkalloyed with plateau honing.
It cannot be rebored or honed.
If the inside of the cylinder liner is scored or scorched, the cylinder liner must be replaced.



- Cylinder Liner Projection Inspection**
1. Hold a straight edge ① along the top edge of the cylinder liner to be measured.
 2. Use a feeler gauge ② to measure each cylinder liner projection A

Cylinder Liner Projection A		mm(in)
Standard		
0.10 - 0.14 (0.0039 - 0.0055)		

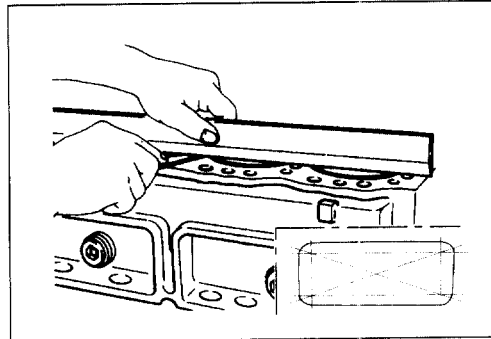
The difference in the cylinder liner projection height between any two adjacent cylinders must not exceed 0.03 mm (0.0012 in).

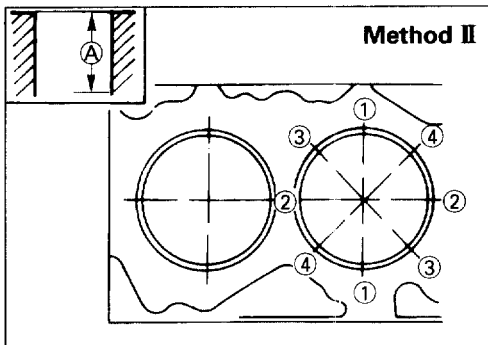
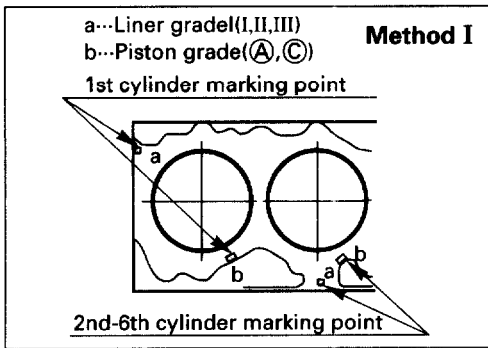


- Cylinder Liner Replacement**
- Cylinder Liner Removal**
1. Set the cylinder liner remover ① to the cylinder liner.
 2. Check that the remover shaft ankle ② is firmly gripping the cylinder liner bottom edge ③.
 3. Slowly turn the remover shaft handle ④ clockwise to pull the cylinder liner free.
- Cylinder Liner Remover: 1-85231-021-0

Note:
Take care not to damage the cylinder body bore during the cylinder liner removal procedure.

4. Measure the cylinder body upper face warpage.
Refer to "Cylinder Body Upper Face Warpage."





Cylinder Liner Grade Selection and Standard Fitting Interference

Accurately measured fitting interference and proper cylinder liner grade selection are extremely important.

If the cylinder liner fitting interference is too small, engine cooling efficiency will be adversely affected.

If the cylinder liner fitting interference is too large, it will be difficult to insert the cylinder liner into the cylinder body.

Fitting Interference	mm(in)
Standard	
0.011 - 0.029 (0.00043 - 0.00114)	

There are two methods by which liners can be selected.

Method I

The cylinder block deck has been marked during production to indicate the correct liner. The liner grade (I, II, or III) is indicated in stamp.

Replacement cylinder liners have their grade (I, II, or III) marked inside.

Select and press in the same grade of cylinder liner as are marked on the top surface of the cylinder body.

In the case of a questionable liner marking use the next method for correct liner selection.

Method II

1. Measure the cylinder body bore at measuring point A across positions ① – ①, ② – ②, ③ – ③, and ④ – ④.

Measuring Point A	mm(in)
120 (4.72)	

2. Calculate the average value of the four measurements to determine the correct cylinder liner grade.
3. Consult the following table with the resultant diameter for the correct liner application.

Liner Grade	Cylinder Bore Diameter mm (in)	Service Grade	Liner Outside Diameter mm (in)
1	123.001 - 123.010 (4.8425 - 4.8429)	1X	123.021 - 123.030 (4.8433 - 4.8437)
2	123.011 - 123.020 (4.8429 - 4.8433)	3X	123.031 - 123.040 (4.8437 - 4.8441)
3	123.021 - 123.030 (4.8433 - 4.8437)		



Cylinder Liner Installation



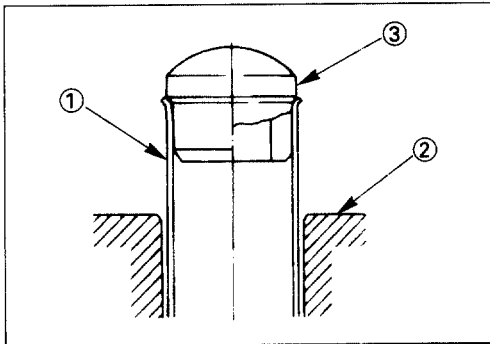
Cylinder Liner Installation Using The Special Tool

1. Use new kerosene or diesel oil to thoroughly clean the cylinder liners and bores.
2. Use compressed air to blow-dry the cylinder liner and bore surfaces.

Note:

All foreign material must be carefully removed from the cylinder liner and the cylinder bore before installation.

3. Insert the cylinder liner ① into the cylinder body ② from the top of the cylinder body.



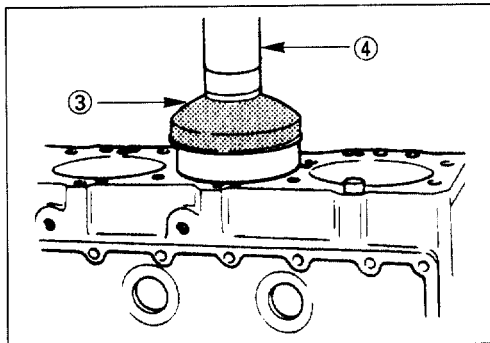
4. Set the cylinder liner installer ③ to the top of the cylinder liner.

Cylinder Liner Installer: 1-85221-073-0

5. Position the cylinder body so that the installer center ③ is directly beneath the bench press shaft center ④.

Note:

Check that the cylinder liner is set perpendicular to the bench press and that there is no wobble.

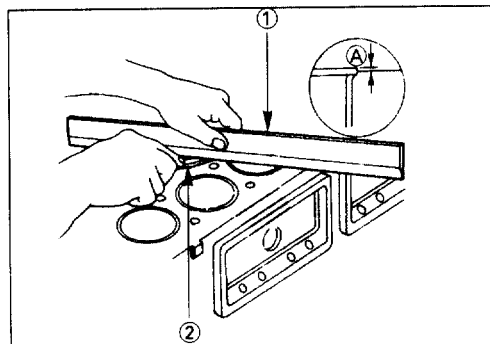


6. Use the bench press to apply a seating force of 4,900 N (500 kg/1,102 lb) to the cylinder liner.

7. Apply a force of 24,500 N (2,500 kg/5,512.5 lb) to fully seat the cylinder liner.

8. After installing the cylinder liner, measure the cylinder liner projection.

Refer to "Cylinder Liner Projection Inspection."



Cylinder Liner Installation Using Dry Ice

If the cylinder liner is a chrome plated dry type, it is advisable to use dry ice during the installation procedure.

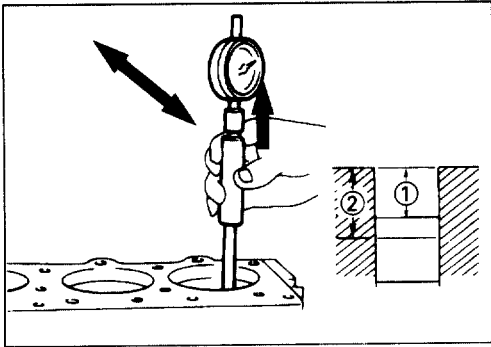
Cooling the cylinder liner with dry ice will cause the cylinder liner to contract, thus making installation easier.

Note:

It is important that the cylinder liner be inserted to the cylinder body immediately after it has been cooled.

WARNING :

DRY ICE MUST BE USED WITH GREAT CARE. CARELESS HANDLING OF DRY ICE CAN RESULT IN SEVERE FROSTBITE.



Piston Grade Selection

Measure the cylinder liner bore after installing the cylinder liner. Then select the appropriate piston grade for the installed cylinder liner.

1. Measure the cylinder liner bore.

Refer to "Cylinder Liner Bore Measurement."

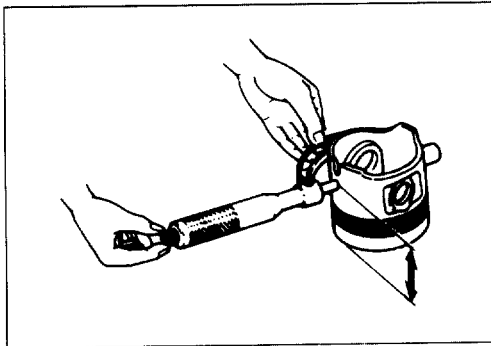
Measuring Point ① : 24 mm (0.94 in)

Measuring Point ② : 120 mm (4.7 in)

Note:

It is most important that the correct piston grade be used.

Failure to select the correct piston grade will result in engine failure. Always measure the cylinder bore and select the correct piston grade.



2. Measure the piston outside diameter.

Measuring Point 6SD1: 87.5 mm (3.44 in)

6SD1TC: 98.0 mm (3.86 in)

Cylinder Liner Bore & Piston Grade mm(in)

Liner Service Grade	Cylinder Liner Bore Diameter	Piston Service Grade	Piston Outside Diameter
AX	120.010 - 120.019 (4.7248 - 4.7251)	AX	119.859 - 119.874 (4.7185 - 4.7194)
CX	120.020 - 120.029 (4.7252 - 4.7255)	CX	119.875 - 119.890 (4.7195 - 4.7201)

Cylinder Liner and Piston Clearance mm(in)

Standard
0.137 - 0.156 (0.0054 - 0.0061)

Note:

Cylinder liner kit clearances are preset. However, the cylinder liner installation procedure may result in slight decreases in cylinder liner clearances. Always measure the cylinder liner clearance after installation to be sure that it is correct.

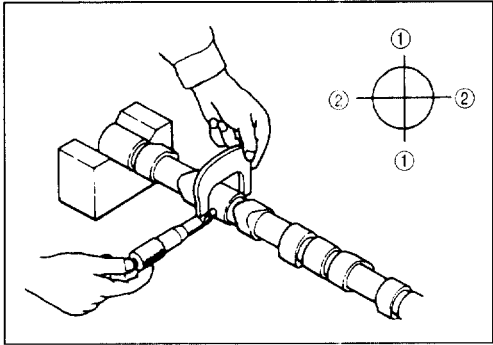
CAMSHAFT

Visually inspect the journals, the cams, and the camshaft brackets for excessive wear and damage. The camshaft and the camshaft brackets must be replaced if these conditions are discovered during inspection.

Note:

Camshaft upper and lower brackets must be replaced as a set.

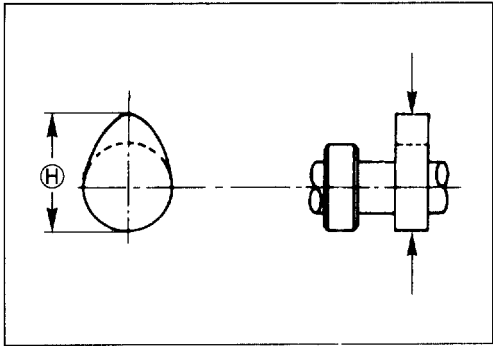
Replace all four brackets at the same time.



Camshaft Journal Diameter

Use a micrometer to measure each camshaft journal diameter in two directions (① and ②). If the measured value is less than the specified limit, the camshaft must be replaced.

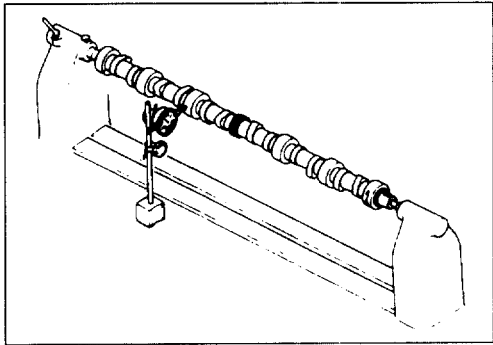
Camshaft Journal Diameter		mm(in)
Standard		Limit
39.915 - 39.940 (1.5715 - 1.5724)		39.890 (1.5705)



Cam Lobe Height

Measure the cam lobe height H with a micrometer. If the measured value is less than the specified limit, the camshaft must be replaced.

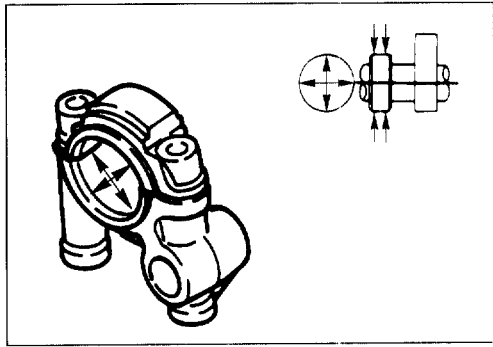
Cam Lobe Height H		mm(in)
Standard		Limit
6SD1	45.47 (1.79)	45.05 (1.77)
6SD1TC	45.92 (1.81)	45.50 (1.79)



Camshaft Run-Out

1. Mount the camshaft on V-blocks.
 2. Measure the run-out with a dial indicator.
- If the measured value exceeds the specified limit, the camshaft must be replaced.

Camshaft Run-Out		mm(in)
Standard		Limit
0.05 (0.002)		0.10 (0.004)



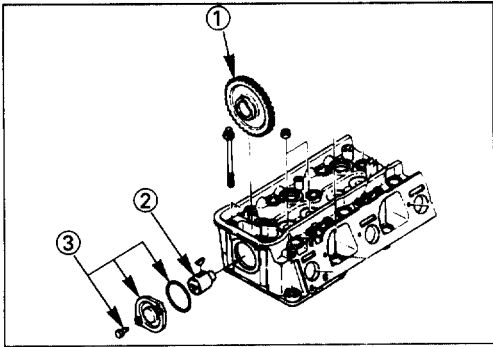
Camshaft and Camshaft Bracket Clearance

Use an inside dial indicator to measure the camshaft bracket inside diameter.

Camshaft Bracket Inside Diameter		mm(in)
Standard		
40.00 - 40.25 (1.5748 - 1.5846)		

If the clearance between the camshaft bracket inside diameter and the journal exceeds the specified limit, the camshaft bracket and/or camshaft must be replaced.

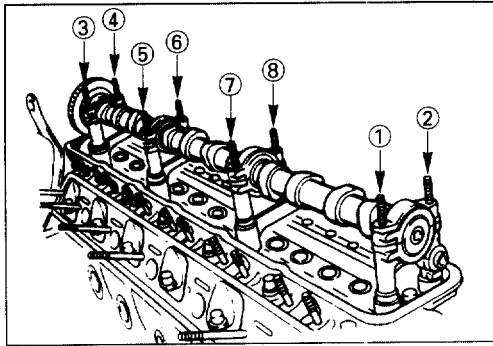
Camshaft Bracket Clearance		mm(in)
Standard		Limit
0.06 - 0.11 (0.0024 - 0.0043)		0.16 (0.0063)



Camshaft Gear Backlash Measurement

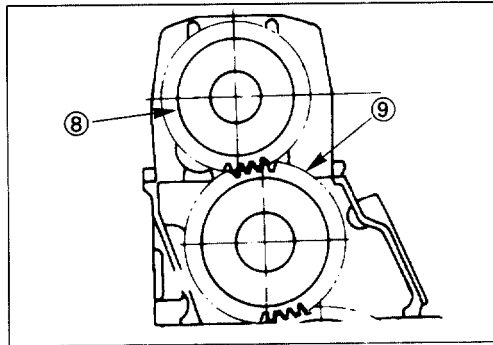
1. Install the idler gear "C" ① and the shaft ② to the cylinder head.
2. Tighten the idler gear cover bolts ③ to the specified torque.

Idler Gear Cover Bolt Torque	N·m(kg·m/lb.ft)
18.6 (1.9 / 13.7)	



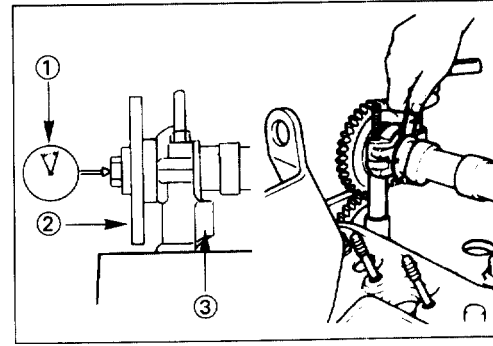
3. Install the camshaft lower bracket ④, the camshaft ⑤, and the camshaft upper bracket ⑥ to the cylinder head ⑦.
4. Tighten the camshaft bracket nuts to the specified torque a little at a time.

Camshaft Bracket Nut Torque	N·m(kg·m/lb.ft)
21.6 (2.2 / 15.9)	



5. Set a dial indicator to the camshaft gear ⑧.
Hold both the camshaft gear and the idler gear "C" ⑨ stationary.
Move the camshaft gear as far as possible both to the right and to the left.
Take the dial indicator reading.
If the measured value exceeds the specified limit, the camshaft gear must be replaced.

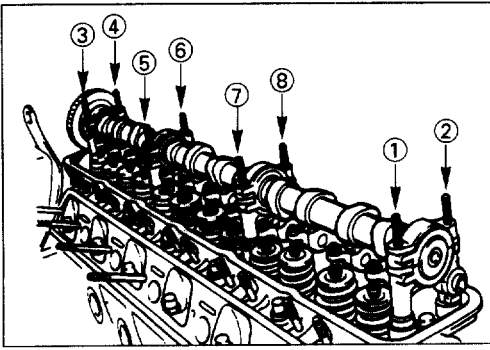
Camshaft Gear Backlash		mm(in)
Standard	Limit	
0.10 (0.0039)	0.30 (0.012)	



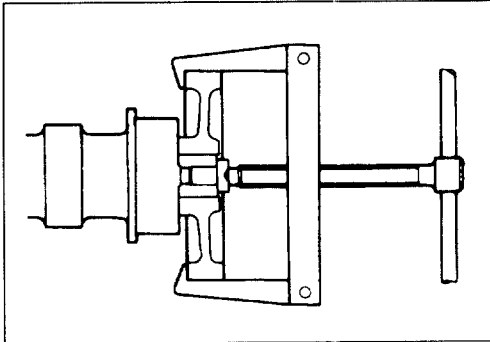
Camshaft End Play

1. Use a dial indicator ① or a feeler gauge to measure the end play between the camshaft gear ② and the lower bracket ③.
If the measured value exceeds the specified limit, the camshaft gear must be replaced.

Camshaft End Play		mm(in)
Standard	Limit	
0.047 - 0.218 (0.0019 - 0.0086)	0.400 (0.0157)	



2. Loosen the camshaft bracket nuts a little at a time.
3. Remove the camshaft upper brackets, the camshaft, and the camshaft lower brackets.
4. Remove the idler gear "C" and the shaft from the cylinder head.

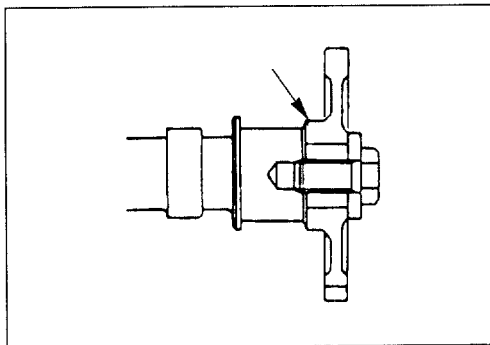


Camshaft Gear Replacement

Replace the camshaft gear if it is excessively worn or damaged or if the camshaft end play is excessive.

Camshaft Gear Removal

1. Remove the camshaft gear bolt.
2. Use a gear remover to remove the camshaft gear.



Camshaft Gear Installation

1. Fit the camshaft gear key into the camshaft key groove.
2. Install the camshaft gear to the camshaft.
The gear hub large side must be facing the camshaft.
3. Apply engine oil to the camshaft gear bolt threads and the setting faces.
4. Tighten the camshaft gear bolt to the specified torque.

Camshaft Gear Bolt Torque	N·m(kg·m/lb.ft)
	142.2 (14.5 / 104.9)

CRANKSHAFT AND BEARING

Inspect the surface of the crankshaft journals and crankpins for excessive wear and damage.

Inspect the oil seal fitting surfaces for excessive wear and damage.

Inspect the oil ports for obstructions.

6SD1TC

To increase crankshaft strength, tufftriding (Nitriding Treatment) has been applied to the 6SD1TC engine crankshaft.

The crankshaft cannot be reground. It must be replaced if it is excessively worn or damaged.

Undersize bearings are not available for the 6SD1TC crankshaft.

6SD1

6SD1 engine crankshafts are not tufftrided. They can be reground if there is excessive wear or damage.

Undersize bearings are available.

Refer to "Crankshaft Regrinding."

6SD1TC

Crankshaft Tufftriding Inspection

1. Use an organic cleaner to thoroughly clean the crankshaft.

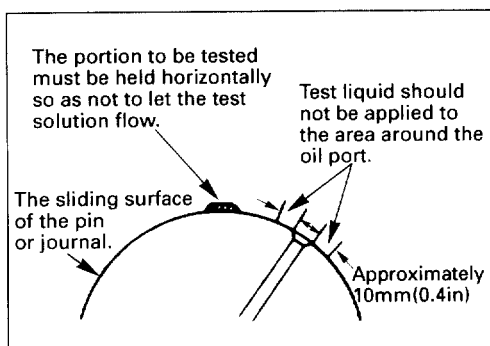
There must be no traces of oil on the surfaces to be inspected.

2. Prepare a 5-10% solution of ammonium cuprous chloride (dissolved in distilled water).
3. Use a syringe to apply the solution to the surface to be inspected.

Hold the surface to be inspected perfectly horizontal to prevent the solution from running.

Note:

Do not allow the solution to come in contact with the oil ports and their surrounding area.





Judgment

1. Wait for thirty to forty seconds.

If there is no discoloration after thirty or forty seconds, the crankshaft is usable.

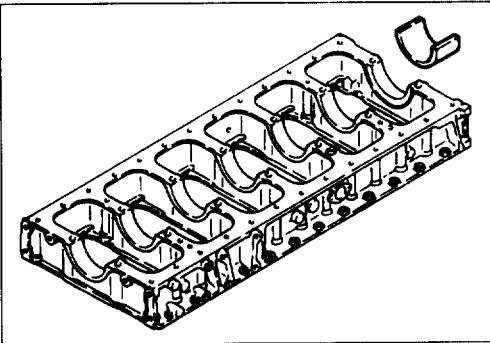
If discoloration appears (the surface being tested will become the color of copper), the crankshaft must be replaced.

2. Steam clean the crankshaft surface immediately after completing the test.

Note:

The ammonium cuprous chloride solution is highly corrosive.

Because of this, it is imperative that the surfaces being tested be cleaned immediately after completing the test.

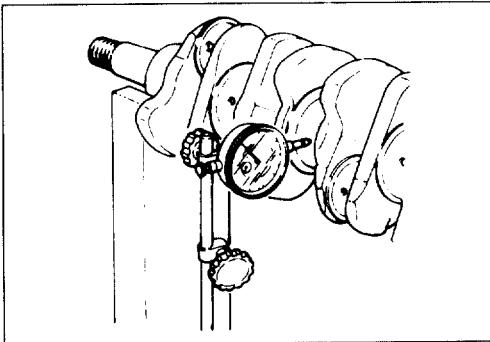


Bearing Spread

Check the bearing spread.

Finger pressure should be required to fit the bearing into position.

If the bearing fits loosely, it must be replaced.



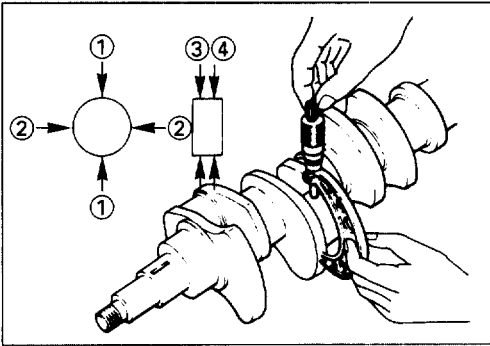
Crankshaft Run-Out

1. Set a dial indicator to the center of the crankshaft journal.
2. Gently turn the crankshaft in the normal direction of rotation.

Read the dial indicator as you turn the crankshaft.

If the measured value exceeds the specified limit, the crankshaft must be replaced.

Crankshaft Run-Out		mm(in)
Standard	Limit	
0.08 (0.0032) or less	0.15 (0.0059)	



Crankshaft Journal and Crankpin Diameter
6SD1

1. Use a micrometer to measure the crankshaft journal diameter across points ① - ① and ② - ②.
2. Use the micrometer to measure the crankshaft journal diameter at the two points (③ and ④).
3. Repeat Steps 1 and 2 to measure the crankpin diameter.

If the measured values are less than the specified limit, the crankshaft must be reground or replaced.

Crankshaft Journal Diameter mm(in)

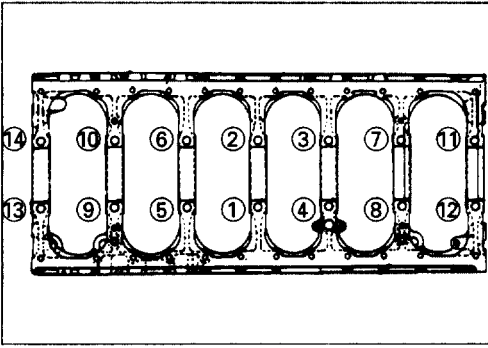
Standard	Limit
89.909 - 89.929 (3.5397 - 3.5405)	89.409 (3.5200)

Crankpin Diameter mm(in)

Standard	Limit
79.894 - 79.914 (3.1454 - 3.1462)	79.394 (3.1257)

Crankshaft Journal and Crankpin Uneven Wear mm(in)

Standard	Limit
0.007 (0.0003)	0.050 (0.0020)



Crankshaft Bearing Inside Diameter

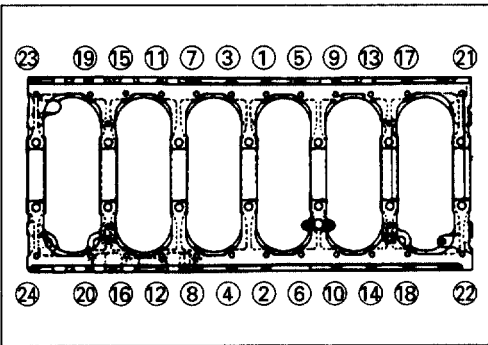
1. Clean the cylinder body journals, the lower crankcase, the bearing fitting surfaces, and the bearing contact surfaces.
2. Install the lower crankcase with the bearings to the cylinder body.
3. Apply molybdenum disulfide grease to the lower crankcase bolt threads and setting faces.
4. Tighten the lower crankcase M14 bolts in three steps using the angular tightening method.

Lower Crankcase M14 Bolt Torque N·m(kg·m/ft.lb)

1st step	2nd step	3rd step
98.0 (10.0/72.3)	132.0 (13.5 / 97.64)	30° – 60°

Note:

Ladder frame fixing bolts can be reused up to 7 times.

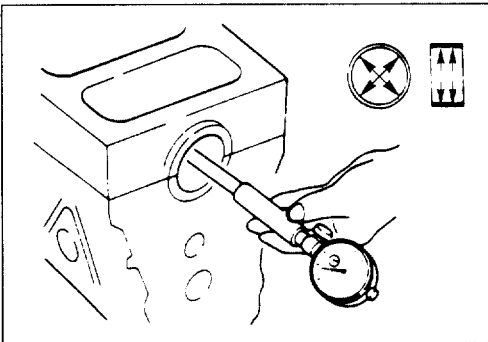


5. Tighten the lower crankcase M10 bolts to the specified torque.

Lower Crankcase M10 Bolt Torque N·m(kg·m/ft.lb)

38 (3.9 / 28.2)

6. Use an inside dial indicator to measure the crankshaft bearing inside diameter.



Crankshaft Journal and Bearing Clearance

6SD1TC

If the clearance between the measured bearing inside diameter and the crankshaft journal diameter exceeds the specified limit, the crankshaft and/or the bearing must be replaced.

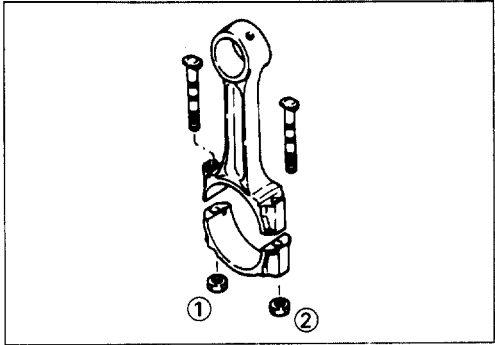
6SD1

If the clearance between the measured bearing inside diameter and the crankshaft journal diameter exceeds the specified limit, the crankshaft must be either reground or replaced.

If the crankshaft is reground, undersize bearings must be installed.

Crankshaft Journal and Bearing Clearance mm(in)

Standard	Limit
0.045 - 0.110 (0.0018 - 0.0043)	0.16 (0.0063)



Connecting Rod Bearing Inside Diameter

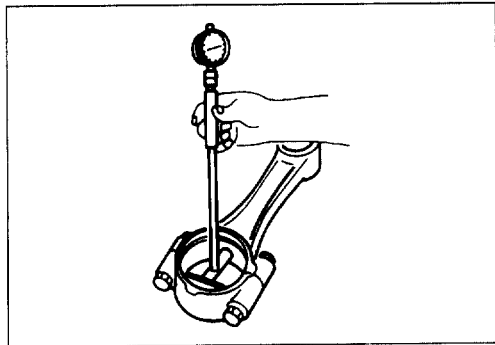
1. Install the bearing to the connecting rod big end.
2. Apply molybdenum disulfide grease to the bearing cap bolts.
3. Tighten the connecting rod bearing cap nuts in three steps using the angular tightening method.

Connecting Rod Bearing Cap Nut

Torque	N·m(kg·m/ft.lb)		
	1st step	2nd step	3rd step
Nut ①	39.0 (4.0 / 28.9)	60°	60°
Nut ②		60°	60°

Note:

Connecting rod bearing cap bolts can be reused up to 7 times.



4. Use an inside dial indicator to measure the connecting rod bearing inside diameter.

Crankpin and Bearing Clearance

6SD1TC

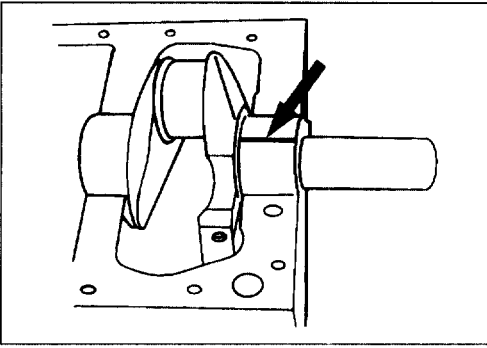
If the clearance between the measured bearing inside diameter and the crankpin exceeds the specified limit, the crankshaft and/or the bearing must be replaced.

6SD1

If the clearance between the measured bearing inside diameter and the crankpin exceeds the specified limit, the crankshaft must be either reground or replaced.

If the crankshaft is reground, undersize bearings must be installed.

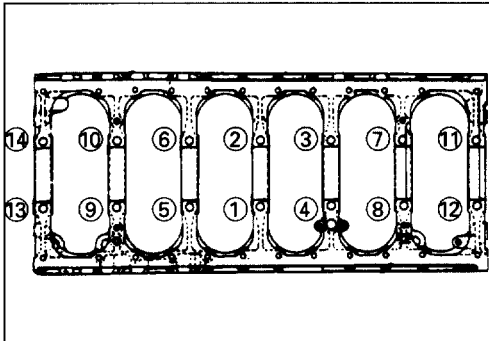
Crankpin and Bearing Clearance		mm(in)
Standard		Limit
0.040 - 0.106 (0.0016 - 0.0042)		0.16 (0.0063)



Clearance Measurements (With Plastigage)

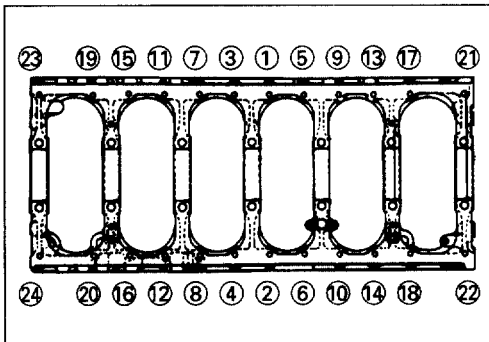
Crankshaft Journal and Bearing Clearance

1. Clean the cylinder body, the journal bearing fitting surface, the lower crankcase, and the bearings.
2. Install the upper bearings to the cylinder body.
3. Carefully place the crankshaft on the bearings.
4. Rotate the crankshaft approximately 30 degrees to seat the bearing.
5. Place the Plastigage (arrow) over the crankshaft journal across the full width of the bearing.
6. Set the lower bearings to the lower crankcase.



7. Install the lower crankcase with the lower bearings to the cylinder body.
8. Apply molybdenum disulfide grease to the bearing cap bolts.
9. Tighten the lower crankcase M14 bolts in three steps using the angular tightening method.

Lower Crankcase M14 Bolt Torque		N·m(kg·m/lb·ft)
1st step	2nd step	3rd step
98.0 (10.0 / 72.3)	132.0 (13.5 / 97.64)	30° – 60°

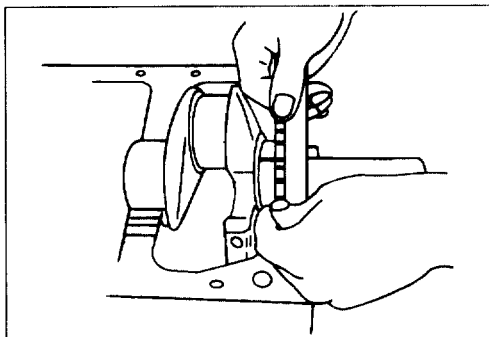


10. Tighten the lower crankcase M10 bolts to the specified torque.

Lower Crankcase M10 Bolt Torque	N·m(kg·m/lb·ft)
38.0 (3.9 / 28.2)	

Do not allow the crankshaft to turn during lower crankcase installation and tightening.

11. Remove the lower crankcase.
12. Compare the width of the Plastigage attached to either the crankshaft or the lower crankcase against the scale printed on the Plastigage container.
If the measured value exceeds the limit, perform the following additional steps.
 - 1) Use a micrometer to measure the crankshaft outside diameter.





- 2) Use an inside dial indicator to measure the bearing inside diameter.

For 6SD1TC

If the crankshaft journal and bearing clearance exceeds the specified limit, the crankshaft and/or the bearing must be replaced.

For 6SD1

If the crankshaft journal and bearing clearance exceeds the specified limit, the crankshaft must be either reground or replaced.

If the crankshaft is reground, undersize bearings must be installed.

Crankshaft Journal and Bearing Clearance		mm(in)
Standard		Limit
0.045 - 0.110 (0.0018 - 0.0043)		0.16 (0.0063)



Crankpin and Bearing Clearance

1. Clean the crankshaft, the connecting rods, the bearing caps, and the bearings.
2. Install the bearings to the connecting rods and the bearing caps.



3. Attach the Plastigage to the crankpins.

Apply engine oil to the Plastigage to keep it from falling.



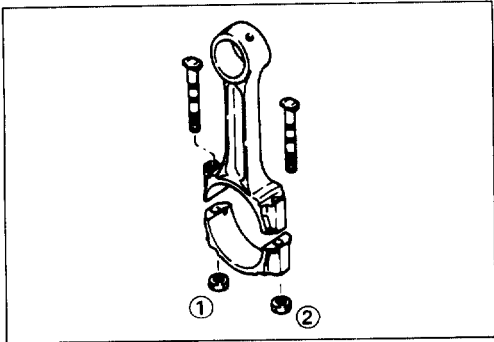
4. Install the bearing cap with bearing to the connecting rod big end.
5. Apply molybdenum disulfide grease to the bearing cap bolts.
6. Tighten the connecting rod bearing cap nuts in three steps using the angular tightening method.

Connecting Rod Bearing Cap Nut Torque N·m(kg·m/ft.lb)			
	1st step	2nd step	3rd step
Nut ①	39.0	90°	30°
Nut ②	(4.0 / 28.9)	120°	—

Note:

Do not allow the connecting rod to move when installing and tightening the bearing cap.

Connecting rod bearing cap bolts can be reused up to 7 times.





7. Remove the bearing cap.
8. Compare the width of the Plastigage attached to either the crankshaft or the bearing against the scale printed on the Plastigage container.

If the measured value exceeds the specified limit, perform the following additional steps.

- 1) Use a micrometer to measure the crankpin outside diameter.

- 2) Use an inside dial indicator to measure the bearing inside diameter.

For 6SD1TC

If the crankpin and bearing clearance exceeds the specified limit, the crankshaft and/or the bearing must be replaced.

For 6SD1

If the crankpin and bearing clearance exceeds the specified limit, the crankshaft must be either reground or replaced.

If the crankshaft is reground, undersize bearings must be installed.

Crankpin and Bearing Clearance		mm(in)
Standard		Limit
0.040 - 0.106 (0.0016 - 0.0042)		0.16 (0.0063)

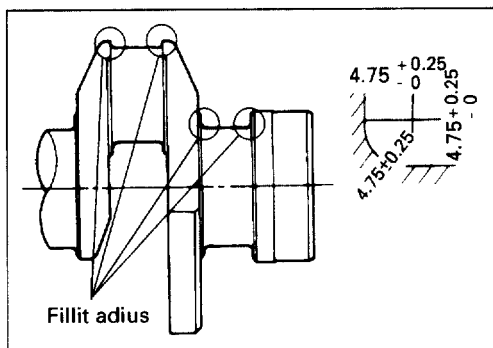
Crankshaft Regrinding (6SD1)

To ensure crankshaft reliability, pay close attention to the following items during and after the crankshaft journal and crankpin regrinding procedure.

Undersize Bearing Availability	mm(in)
0.25 (0.01)/0.50 (0.02)	

Crankshaft Journal and Crankpin Grinding Limit (Reference)

	mm(in)
Other Crankshaft Journals	89.409 (3.5200)
Crankpins	79.394 (3.1257)



Crankshaft Regrinding Procedure (except 6SD1TC engine)

1. Regrind the crankshaft journals and the crankpins.
2. Fillet the crankshaft journal and the crankpin radiuses to a minimum of $R\ 4.75 \pm 0.25\text{ mm}$ ($0.1870 \pm 0.0098\text{ in}$).

There must be no stepping around the fillet area.

3. Finish the crankshaft journals, the crankpins, and the oil port corners to a smooth surface having a chamfer radius of 1 mm (0.04 in).

Crankshaft Journal and Crankpin Roughness

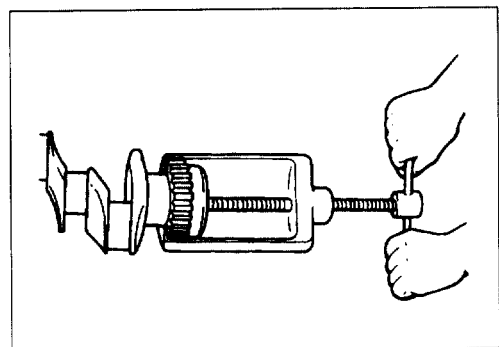
0.4 μ or less

4. Check the crankshaft journal and crankpin clearance.

Refer to "Crankshaft Journal and Bearing Clearance" and "Crankpin and Bearing Clearance."

5. Check the crankshaft run-out.

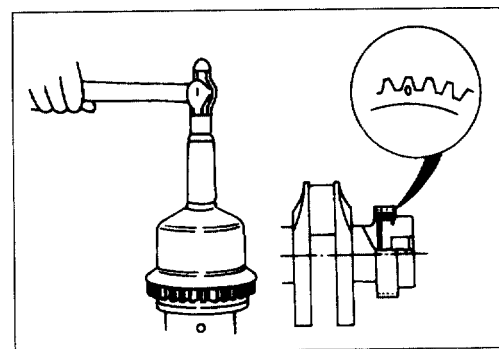
Refer to "Crankshaft Run-Out."



Crankshaft Gear Replacement

Crankshaft Gear Removal

1. Use a gear puller to remove the crankshaft gear.
Crankshaft Gear Remover: 1-85210-051-0



Crankshaft Gear Installation

1. Heat up the crankshaft gear by oil heater (the oil temperature is 170 - 180°C).
2. Install the crankshaft gear.
3. Use the crankshaft gear installer to install the crankshaft gear.

Crankshaft Gear Installer: 1-85221-072-0

The crankshaft gear timing mark "O" must be facing the flywheel.

Take care not to damage the crankshaft and the crankshaft gear.

CRANKSHAFT PILOT BEARING

Check the pilot bearing for excessive wear and damage and replace it if necessary.



Crankshaft Pilot Bearing Replacement

Crankshaft Pilot Bearing Removal

Use a pilot bearing remover to remove the pilot bearing.

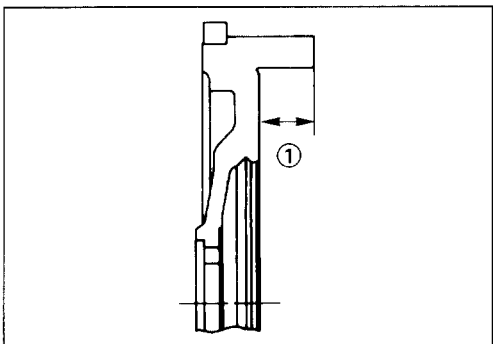


Crankshaft Pilot Bearing Installation

1. Place the pilot bearing horizontally across the pilot bearing installation hole.
2. Tap around the edges of the pilot bearing outer races with a brass hammer to drive the bearing into the pilot bearing installation hole.

Note:

Strike only the pilot bearing outer races with the hammer. Do not strike the bearing inner races. Bearing damage and reduced bearing service life will result.



FLYWHEEL AND RING GEAR

Flywheel

1. Inspect the flywheel friction surface for excessive wear and heat cracks.
2. Measure the flywheel friction surface depth ① or the flywheel friction surface thickness ②.

If the measured value is between the standard and the specified limit, the flywheel may be reground.

If the measured value exceeds the specified limit, the flywheel must be replaced.

Flywheel Friction Surface Depth ① mm(in)

Clutch Size	Standard	Limit
380 (15)	48.0 (1.89)	49.0 (1.93)

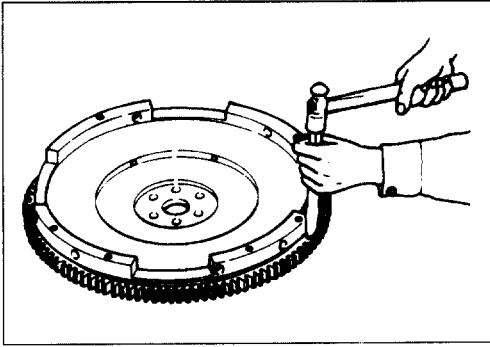
Flywheel Friction Surface Roughness mm(in)

Less than 0.006 (0.00024)

Ring Gear

Inspect the ring gear.

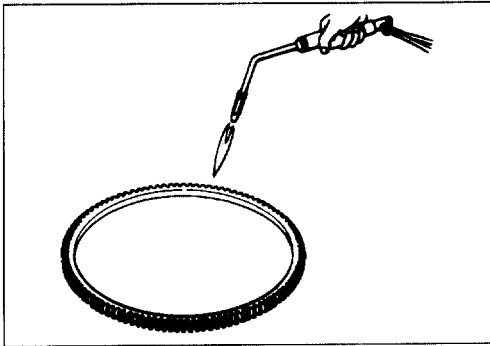
If the ring gear teeth are broken or excessively worn, the ring gear must be replaced.



Ring Gear Replacement

Ring Gear Removal

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



Ring Gear Installation

1. Heat the ring gear evenly with a gas burner to invite thermal expansion.

Do not allow the temperature of the gas burner to exceed 200°C (390°F).

WARNING:

TAKE CARE NOT TO BURN YOURSELF ON THE HEATED RING GEAR.

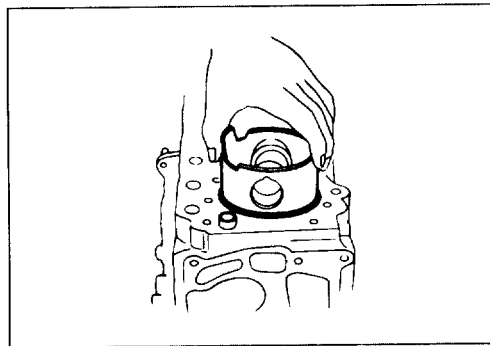
2. Install the ring gear when it is sufficiently heated.
The ring gear must be installed with the chamfer facing the clutch.



PISTON

Piston Grade Selection and Cylinder Liner Bore Measurement

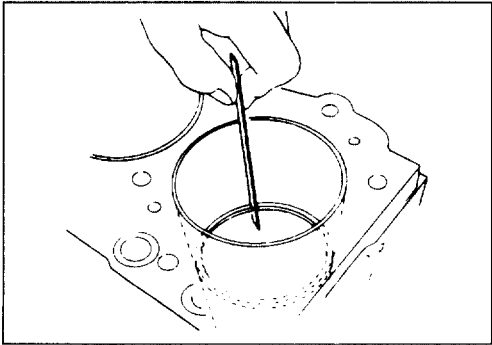
Refer to "CYLINDER BODY", "Cylinder Liner Bore Measurement" for details on piston grade selection and cylinder liner bore measurement.



PISTON RING

Piston Ring Gap

1. Insert the piston ring horizontally (in the position it would assume if it were installed to the piston) into the cylinder liner.



2. Push the piston ring into the cylinder liner bore until it reaches the measuring point (where the cylinder liner bore is the smallest).

Do not allow the piston ring to slant to one side or the other. It must be perfectly horizontal.

Measuring Point: 195 mm (7.67 in)

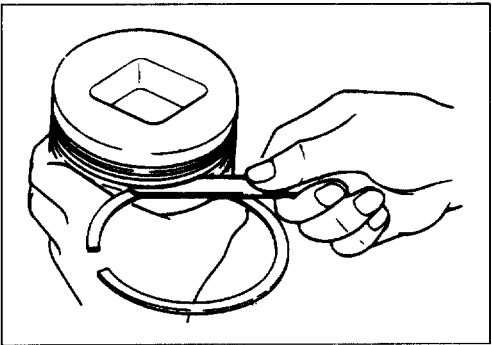


3. Use a feeler gauge to measure the piston ring gap.
If the measured value exceeds the specified limit, the piston ring must be replaced.

Piston Ring Gap		mm(in)
	Standard	Limit
1st	0.35 - 0.50 (0.0138 - 0.0197)	1.0 (0.0394)
2nd	0.35 - 0.50 (0.0138 - 0.0197)	1.0 (0.0394)
3rd	0.35 - 0.50 (0.0138 - 0.0197)	1.0 (0.0394)
Oil	0.25 - 0.45 (0.0098 - 0.0177)	0.8 (0.0315)

Note:

Four piston rings are only provided for 6SD1TC.



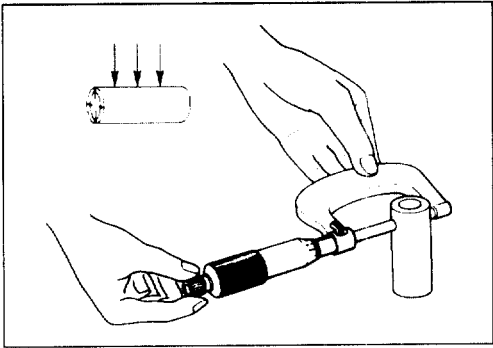
Piston Ring and Piston Ring Groove Clearance

1. Use a feeler gauge to measure the clearance between the piston ring and the piston ring groove at several points around the piston.

If the clearance between the piston ring and the piston ring groove exceeds the specified limit, the piston ring must be replaced.

Piston Ring and Piston Ring Groove Clearance		mm(in)
	Standard	Limit
1st	0.10 - 0.142 (0.0039 - 0.0056)	0.23 (0.0091)
2nd	0.105 - 0.140 (0.0041 - 0.0055)	0.20 (0.0079)
3rd	0.085 - 0.120 (0.0033 - 0.0047)	0.20 (0.0079)
Oil	0.020 - 0.060 (0.0008 - 0.0024)	0.150 (0.0059)

2. Visually inspect the piston ring grooves.
If a piston ring groove is damaged or distorted, the piston must be replaced.



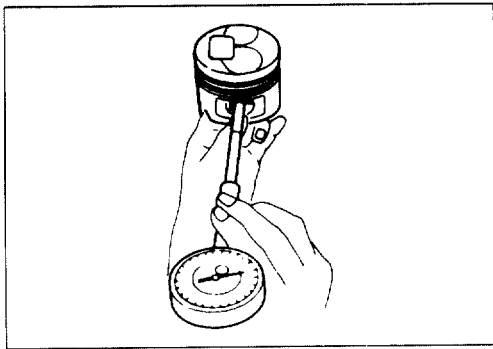
PISTON PIN

Piston Pin Diameter

Use a micrometer to measure the piston pin diameter at several points.

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

Piston Pin Diameter		mm(in)
Standard		Limit
42.995 - 43.000 (1.6927 - 1.6929)		42.95 (1.6909)

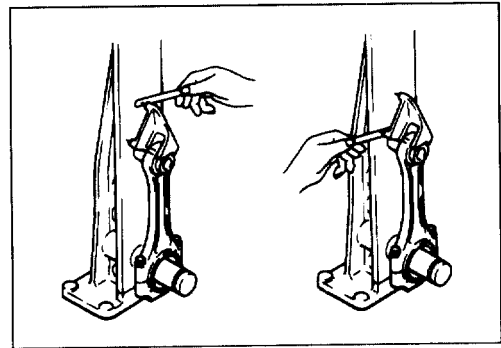


Piston Pin and Piston Pin Hole Clearance

Use an inside dial indicator to measure the piston pin hole diameter (in the piston).

Piston Pin Hole Diameter		mm(in)
Standard		
43.004 - 43.012 (1.6931 - 1.6934)		

Piston Pin and Piston Pin Hole Clearance		mm(in)
Standard		Limit
0.004 - 0.017 (0.00015 - 0.00067)		0.050 (0.002)



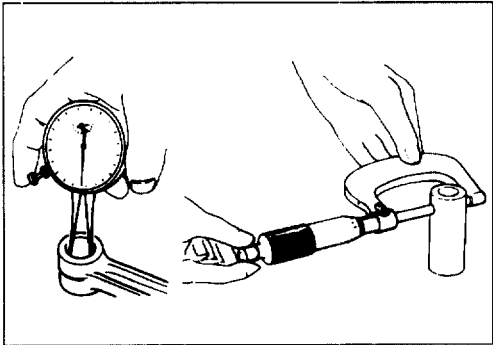
CONNECTING ROD

Connecting Rod Alignment

Use a connecting rod aligner to measure the distortion and the parallelism between the connecting rod big end hole and the connecting rod small end hole.

If either the measured distortion or parallelism exceed the specified limit, the connecting rod must be replaced.

Connecting Rod Alignment			mm(in)
Per length of 100 mm (3.94 in)			
	Standard	Limit	
Distortion and Parallelism	0.03 (0.0012) or less	0.10 (0.0039)	



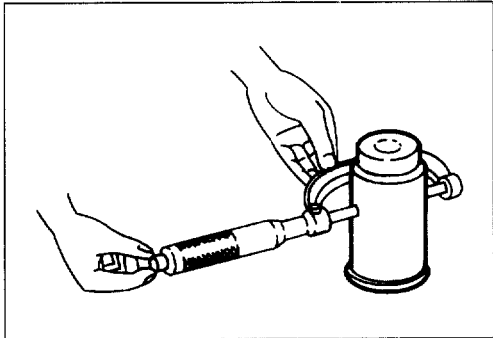
Piston Pin and Connecting Rod Small End Bushing Clearance

Use a caliper calibrator and a dial indicator to measure the piston pin and connecting rod small end bushing clearance.

Connecting Rod Small End Bushing Diameter	mm(in)
Standard	
43.012 - 43.022 (1.6934 - 1.6938)	

If the clearance between the piston pin and the connecting rod small end bushing exceeds the specified limit, replace the piston pin and/or the connecting rod bushing.

Piston Pin and Connecting Rod Small End Bushing Clearance		mm(in)
Standard		Limit
0.012 - 0.027 (0.00047 - 0.00110)		0.10 (0.0039)



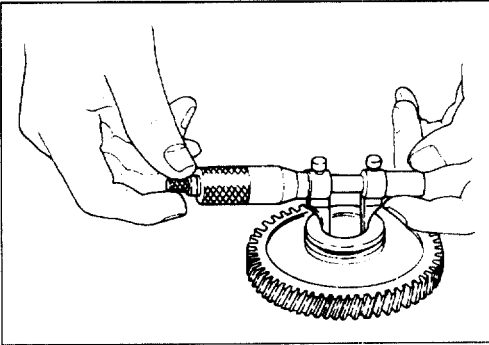
IDLER GEAR SHAFT AND IDLER GEAR

Idler Gear Shaft Outside Diameter

Use a micrometer to measure the idler gear shaft outside diameter.

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

Idler Gear Shaft Outside Diameter		mm(in)
	Standard	Limit
Shaft "A"	40.959 - 40.980 (1.6126 - 1.6134)	40.859 (1.6086)
Shaft "B"	29.959 - 29.980 (1.1795 - 1.1803)	29.859 (1.1755)
Shaft "C"	31.934 - 31.950 (1.2572 - 1.2579)	31.834 (1.2533)

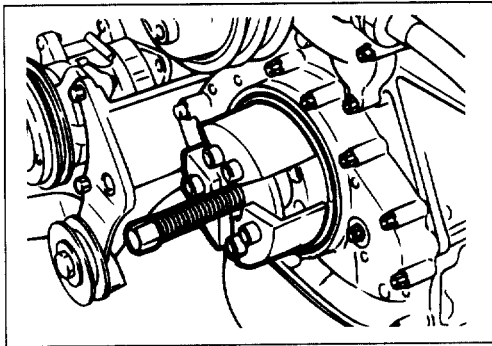


Idler Gear Inside Diameter

Use an inside dial indicator or an inside micrometer to measure the idler gear inside diameter.

If the clearance between the idler gear shaft outside diameter and the idler gear inside diameter exceeds the limit, the idler gear must be replaced.

Idler Gear Shaft and Idler Gear Clearance		mm(in)
	Standard	Limit
Shaft "A"	0.020 - 0.062 (0.0008 - 0.0024)	0.12 (0.0047)
Shaft "B"		
Shaft "C"	0.010 - 0.051 (0.0004 - 0.0020)	0.15 (0.0059)



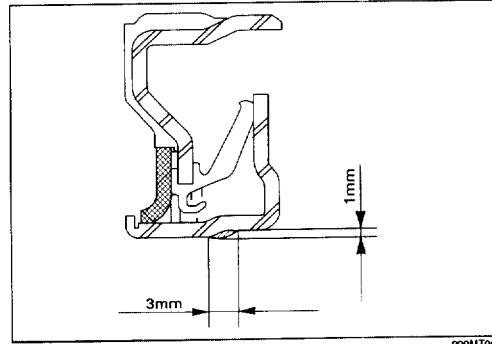
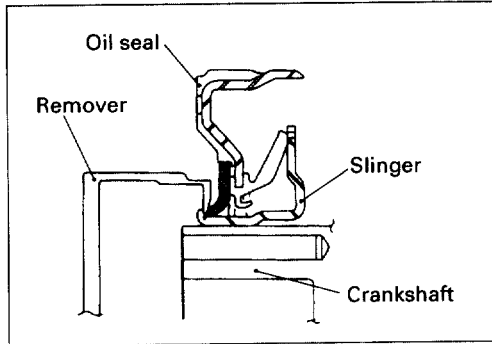
FRONT COVER

Front Cover Oil Seal Replacement

Oil Seal Removal

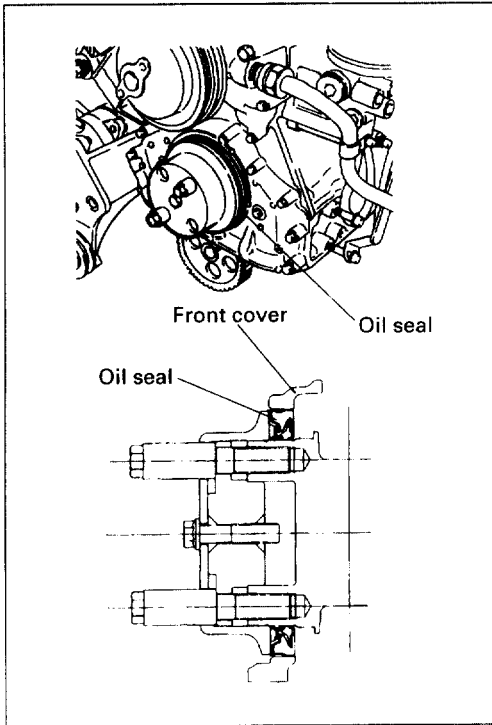
Set oil seal remover on slinger of oil seal.

Oil seal remover: 1-85210-077-0



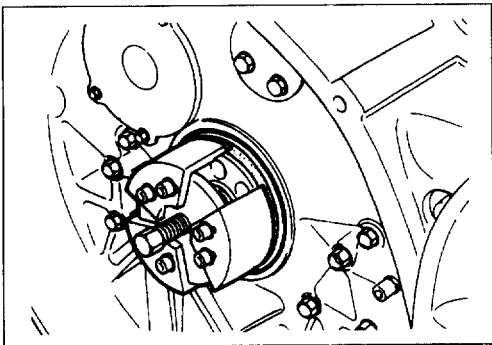
Oil Seal Installation

1. If there is some small scratch on the crankshaft after remove the oil seal, apply Threebond 1207C or equivalent on the slinger as shown in the illustration.



2. Use the oil seal installer and tight the center bolt of installer until touch the installer to guide.

Oil Seal Installer: 1-85220-057-0



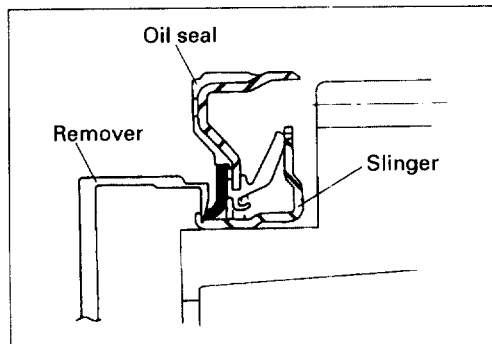
FLYWHEEL HOUSING

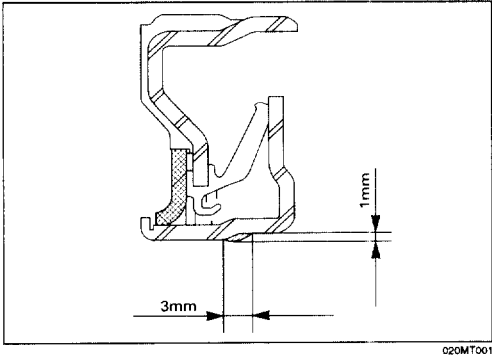
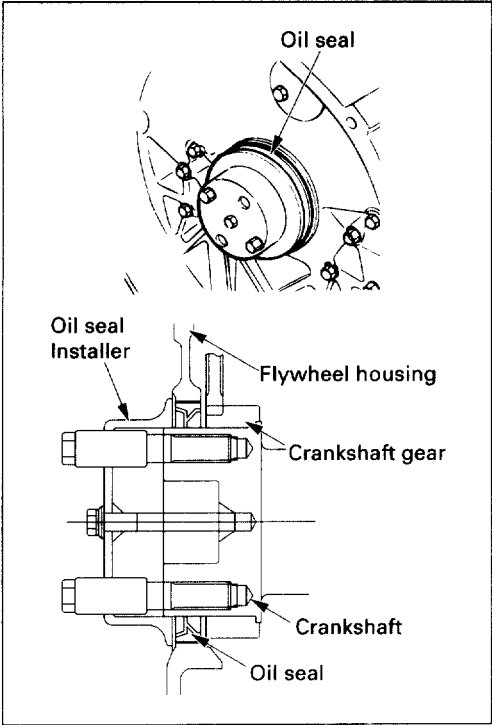
Crankshaft Rear Oil Seal Replacement

Oil Seal Removal

Use the oil seal remover on slinger of oil seal.

Oil Seal Remover: 1-85210-077-0





Oil Seal Installation

Use the oil seal installer to install the oil seal as same manner front oil seal.

Oil Seal Installer: 1-85220-057-0

If there is some small scratch on the crankshaft after remove the oil seal, apply Threebond 1207C or equivalent on the slinger as shown in the illustration.

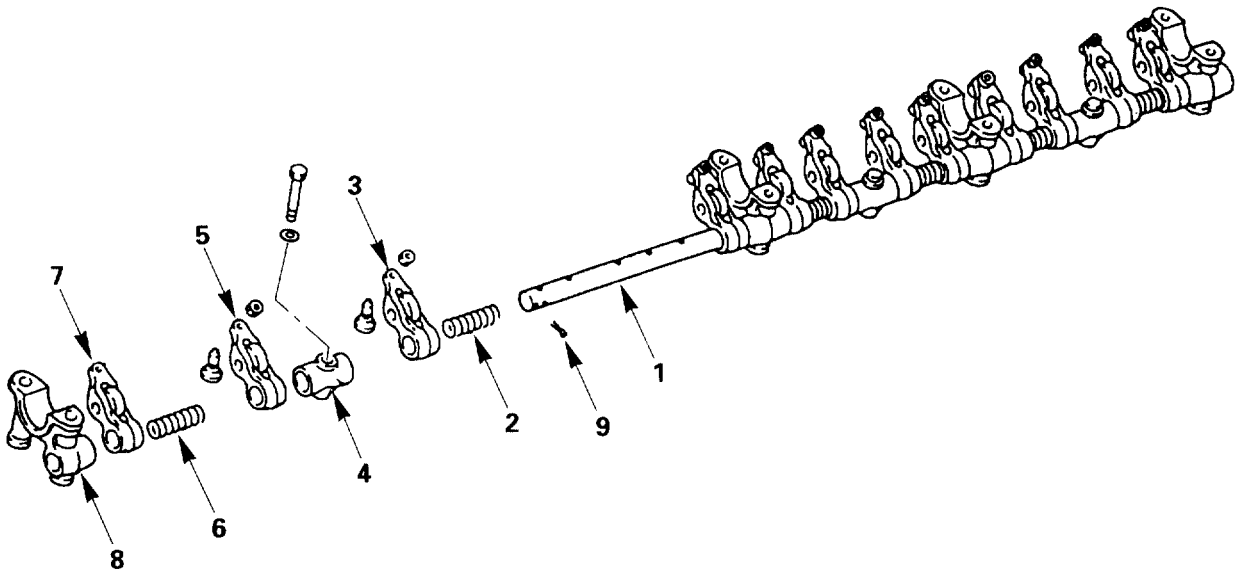


REASSEMBLY

INTERNAL PARTS

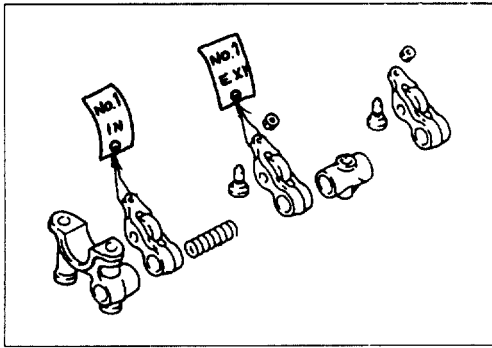
MINOR COMPONENTS

ROCKER ARM SHAFT AND ROCKER ARM WITH CAMSHAFT LOWER BRACKET



Reassembly Steps

- | | |
|-----------------------|-----------------------------|
| 1. Rocker arm shaft | 6. Rocker arm spring |
| 2. Rocker arm spring | ▲ 7. Rocker arm |
| ▲ 3. Rocker arm | ▲ 8. Camshaft lower bracket |
| 4. Rocker arm bracket | 9. Cotter pin |
| ▲ 5. Rocker arm | |



Important Operations

3. **Rocker Arm**
5. **Rocker Arm**
7. **Rocker Arm**

Rocker arms must be reinstalled to their original positions.

Note the tags attached at disassembly if the removed rocker arms are to be reused.

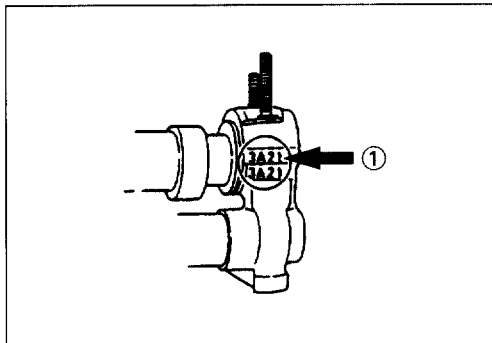
8. Camshaft Lower Bracket

- 1) Camshaft upper and lower brackets may be reinstalled if they are not damaged or excessively worn.

Each bracket must be reinstalled to its original position.

Refer to the original part setting marks to determine each bracket's original installation position.

Original part setting marks are stamped at the side ① or at the front ② of the camshaft brackets.

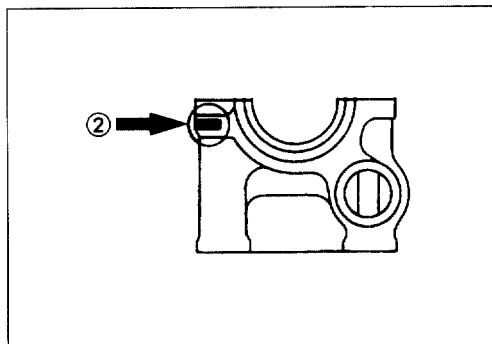


① Setting Marks (For Original Parts)

- | | | |
|---|-----|-------|
| 1 | A21 | Front |
| 2 | A21 | Inner |
| 3 | A21 | Inner |
| 4 | A21 | Rear |

Original part lot number

Camshaft bracket installation position number

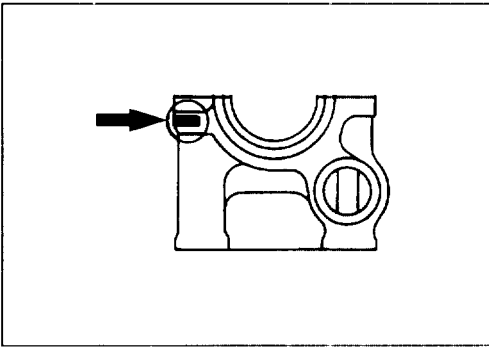


② Setting Marks (For Original Parts)

- | | | |
|---|----|-------|
| 1 | AA | Front |
| 2 | AA | Inner |
| 3 | AA | Inner |
| 4 | AA | Rear |

Original part lot designation

Camshaft bracket installation position number



- 2) Damaged or excessively worn camshaft lower brackets must always be replaced as a set together with the camshaft upper brackets.

Refer to the stamped setting mark at the front of the new camshaft brackets (replacement parts) to determine the installation position.

Setting Marks (For Replacement Parts)

1 21 Front

2 21 Inner

3 21 Inner

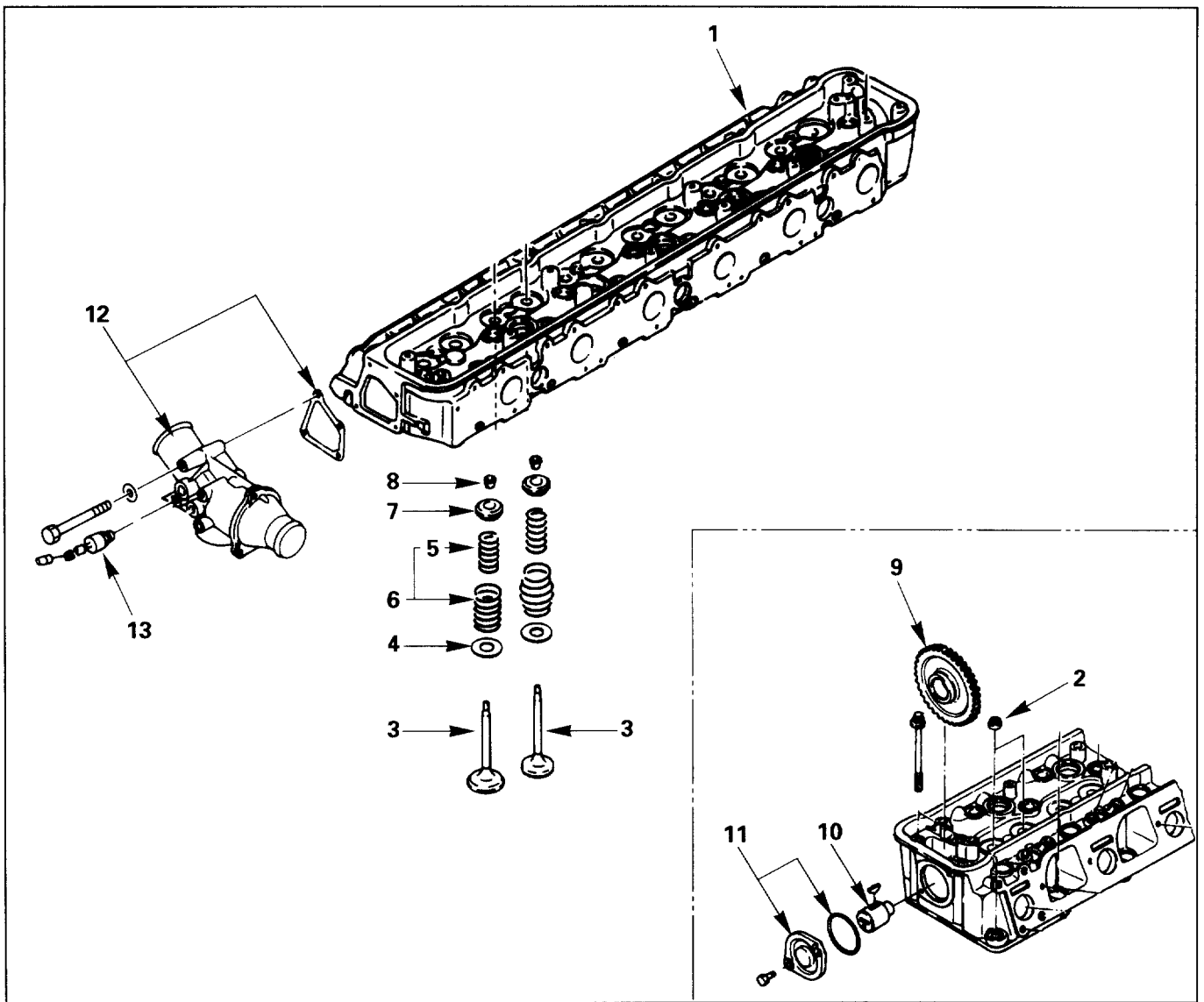
4 21 Rear

— Production lot number (00 – 99)

— Camshaft bracket installation position number

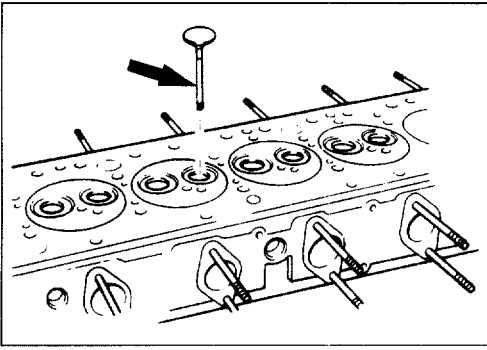


CYLINDER HEAD



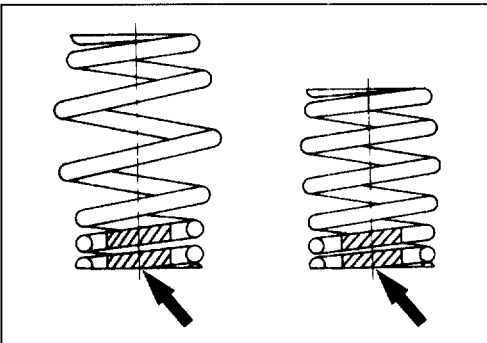
Reassembly Steps

1. Cylinder head
2. Valve stem oil seal
- ▲ 3. Intake and exhaust valve
- ▲ 4. Valve spring lower seat
- ▲ 5. Valve spring (Inner)
- ▲ 6. Valve spring (Outer)
7. Valve spring upper seat
- ▲ 8. Split collar
9. Idler gear "C"
10. Idler gear shaft "C"
- ▲ 11. Idler gear cover and O-ring
- ▲ 12. Thermostat housing and gasket
- ▲ 13. Thermometer unit

**Important Operations****3. Intake and Exhaust Valve****5. Valve Spring (Inner)****6. Valve Spring (Outer)**

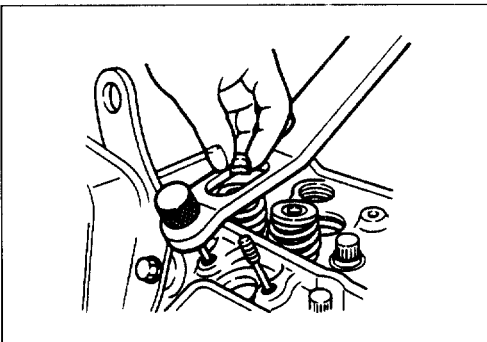
- 1) Apply engine oil to each valve stem before installation.
- 2) Install the intake and exhaust valves.
- 3) Turn the cylinder head up to install the valve springs.

Take care not to allow the installed valves to fall free.



- 4) Install the inner and outer valve springs with their fine pitched end (painted) facing down.

- ① Outer spring
- ② Inner spring

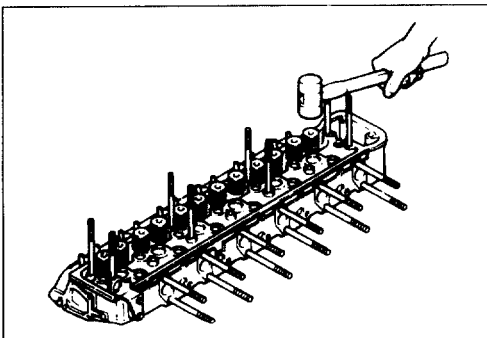
**8. Split Collar**

- 1) Use the spring compressor to compress the valve spring.

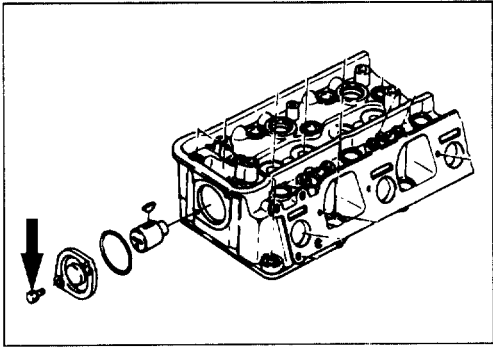
Spring Compressor: 1-85235-007-0

- 2) Install the split collars to the valve stem.

Do not allow the valve to fall from the cylinder head.



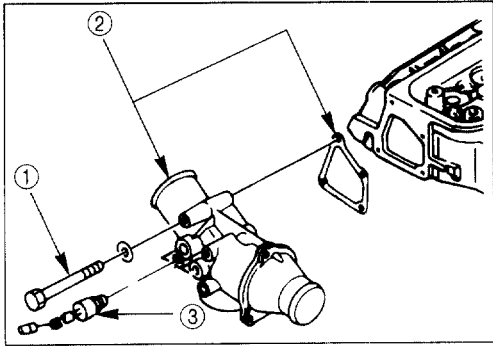
- 3) Set the split collars by tapping around the head of each collar with a rubber hammer.



11. Idler Gear Cover and O-Ring

- 1) Apply engine oil to the O-ring.
- 2) Install the gear cover with the O-ring to the cylinder head.
- 3) Tighten the gear cover bolts to the specified torque.

Gear Cover Bolt Torque	N·m(kg·m/lb.ft)
21.6 (2.2 / 15.9)	



12. Thermostat Housing and Gasket

13. Thermometer Unit

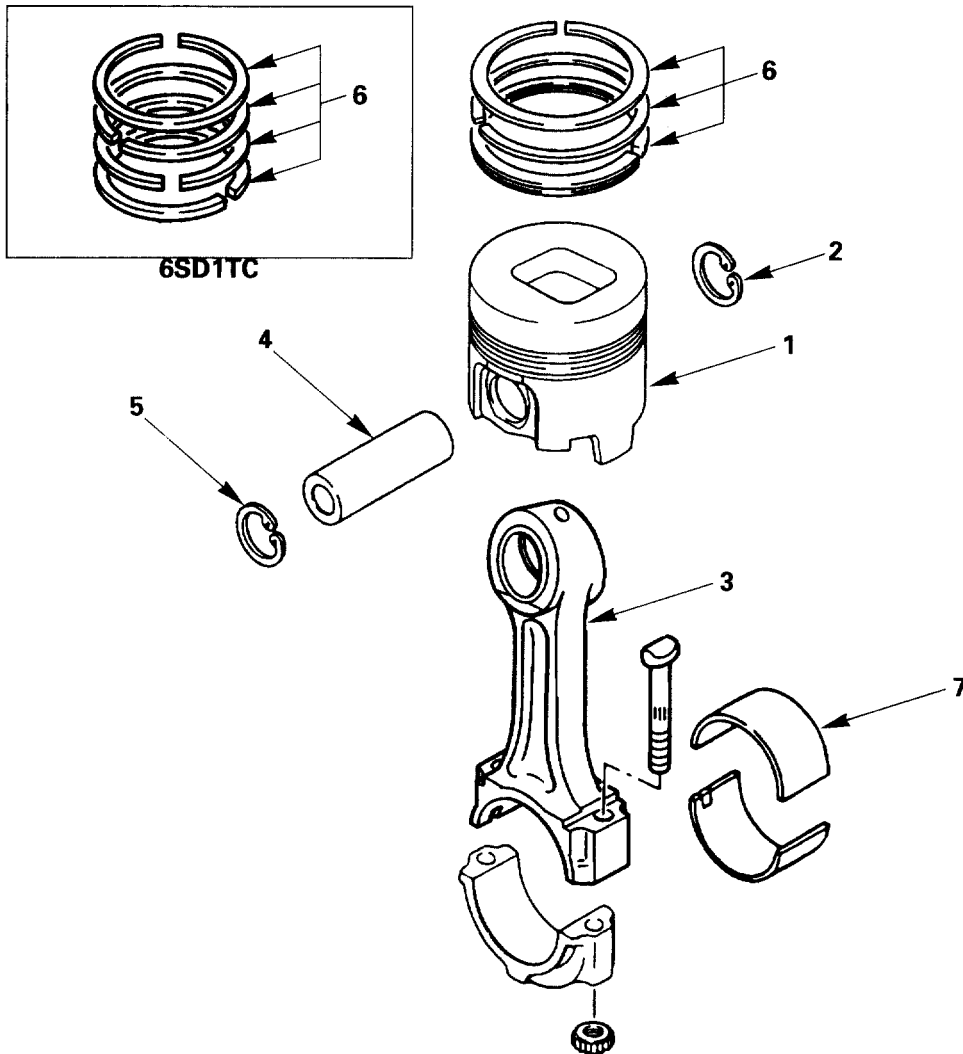
- 1) Apply the recommended liquid gasket or its equivalent to the thermostat housing bolt threads ①.
- 2) Install the thermostat housing and gasket ② and the thermometer unit ③.
- 3) Tighten the thermostat housing bolts and the thermometer unit to the specified torque.

Thermostat Housing Bolt Torque	N·m(kg·m/lb.ft)
18.6 (1.9 / 13.7)	

Thermometer Unit Torque	N·m(kg·m/lb.ft)
19.6 (2.0 / 14.5)	

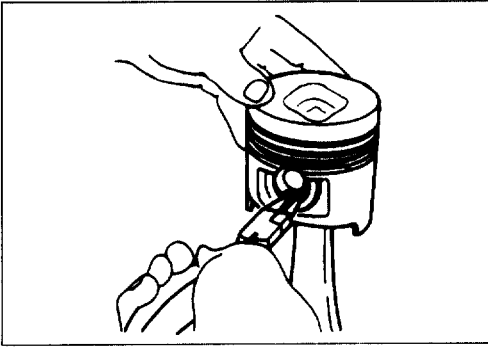


PISTON AND CONNECTING ROD



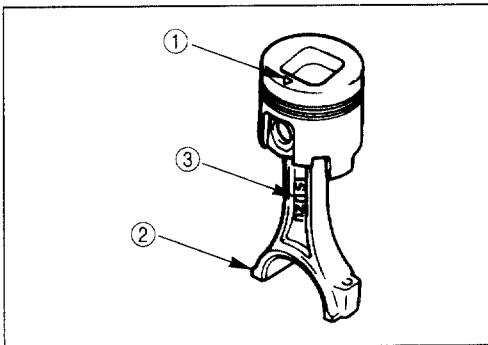
Reassembly Steps

- ▲ 1. Piston
- ▲ 2. Piston pin snap ring
- ▲ 3. Connecting rod
- ▲ 4. Piston pin
- ▲ 5. Piston pin snap ring
- ▲ 6. Piston ring
- ▲ 7. Connecting rod bearing



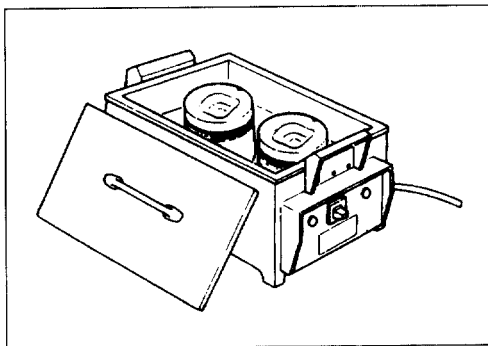
Important Operations

1. **Piston**
2. **Piston Pin Snap Ring**
3. **Connecting Rod**
 - 1) Clamp the connecting rod in a vise.
Take care not to damage the connecting rod.
 - 2) Use pliers to install a piston pin snap ring to one side of each piston.
- 3) Install the piston to the connecting rod.



The piston head arrow or dot mark ① must be facing to the "ISUZU" casting mark ③ on the connecting rod.

The connecting rod "ISUZU" casting mark ③ must be facing the front of the engine.



4. **Piston Pin**
5. **Piston Pin Snap Ring**

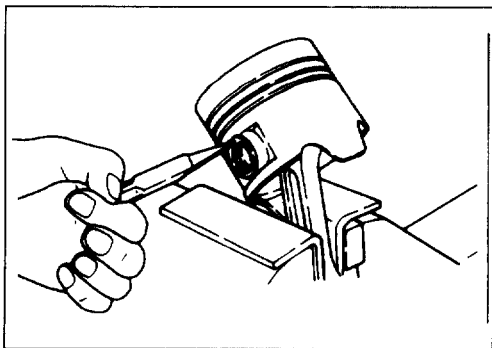
If could not be removed piston pin, it is recommended to remove it by following procedure.

- 1) Use a piston heater to heat the piston to approximately 80°C (176°F).

WARNING:

TAKE CARE NOT TO BURN YOURSELF ON THE HEATED PISTON.

- 2) Apply engine oil to the piston pin.

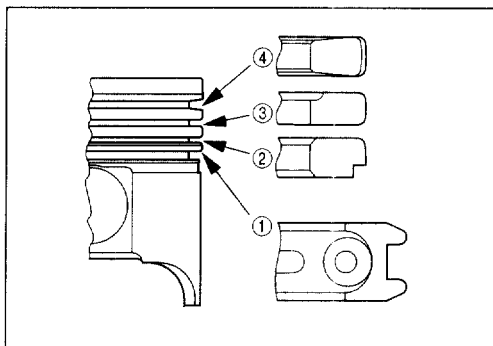


- 3) Use pliers to force the piston pin into the piston until it makes contact with the snap ring.
- 4) Use pliers to install the other snap ring.

Note:

Take care not to damage the piston and the piston pin.

- 5) Check that the connecting rod moves smoothly on the piston pin.



015HY00062

6. Piston Ring

- 1) Use a piston ring replacer to install the three or four (for 6SD1TC) piston rings.

Install the piston rings in the numerical order shown in the illustration.

- ① Oil ring
- ② 3rd compression ring (for 6SD1TC)
- ③ 2nd compression ring
- ④ 1st compression ring



Note:

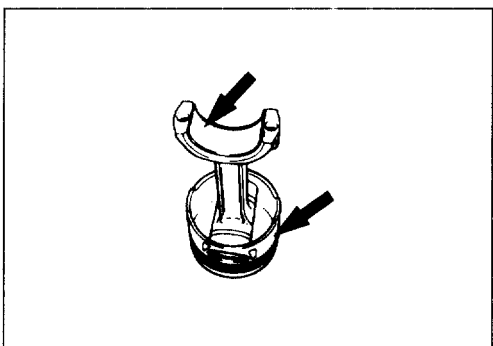
Install the compression rings with the stamped side facing up.



Insert the expander coil into the oil ring groove so that there is no gap on either side of the expander coil before installing the oil ring.



- 2) Apply engine oil to the piston ring surfaces.
- 3) Check that the piston rings rotate smoothly in the piston ring grooves.



7. Connecting Rod Bearing

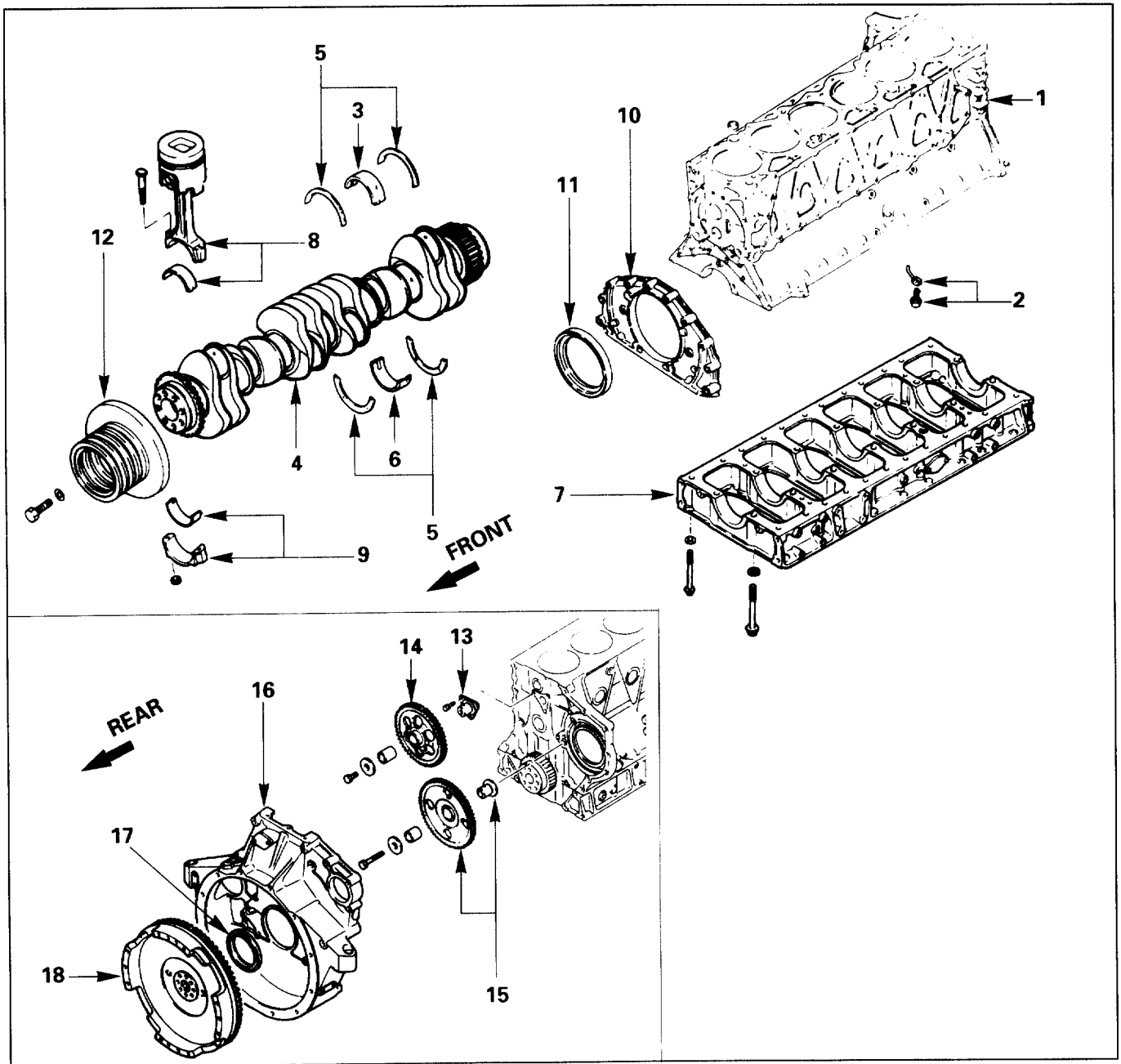
Carefully wipe any oil or other foreign material from the connecting rod bearing back face and the connecting rod bearing fitting surface.

Note:

Do not apply engine oil to the connecting rod bearing back faces and the connecting rod bearing fitting surfaces.

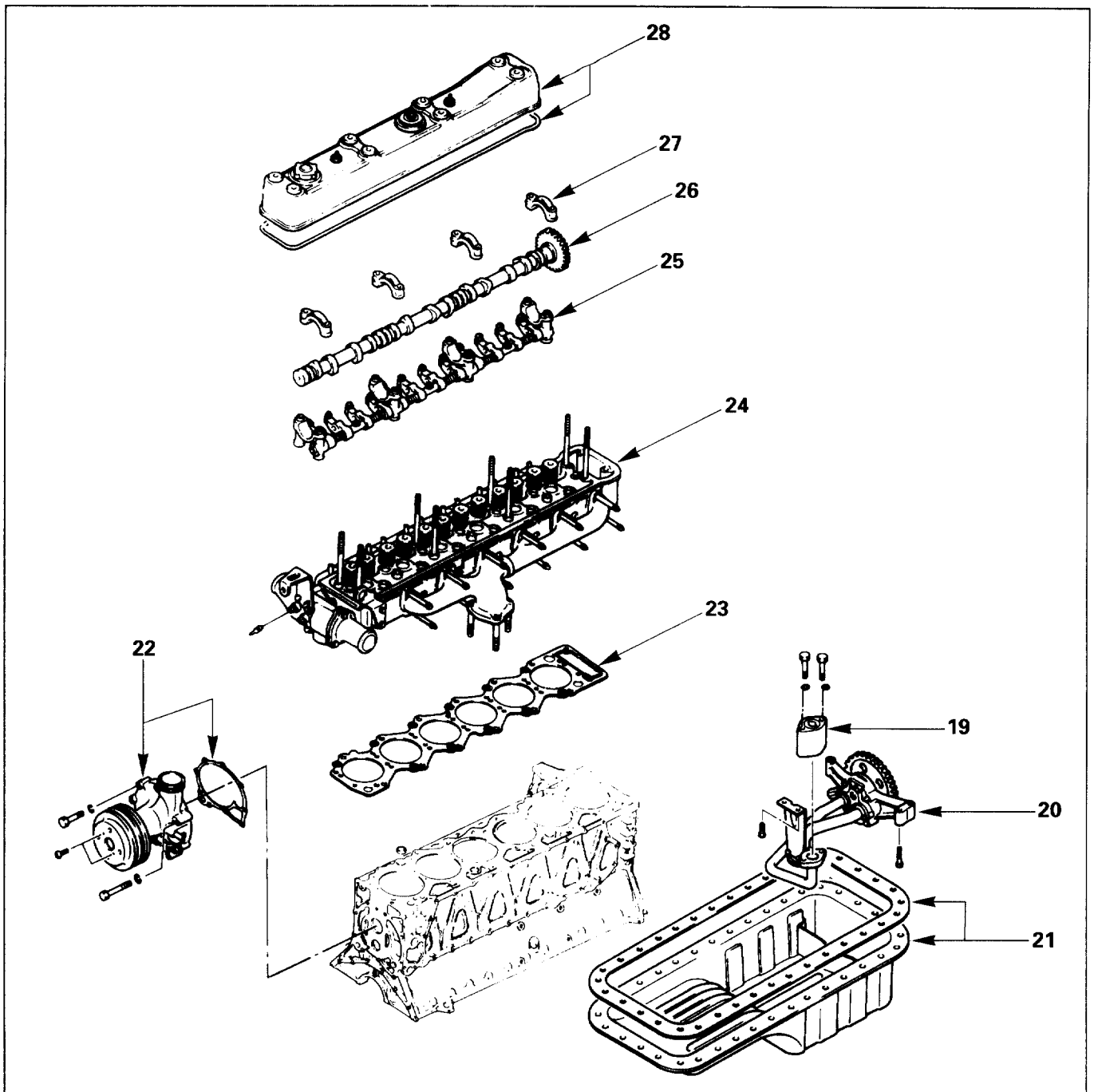


MAJOR COMPONENTS



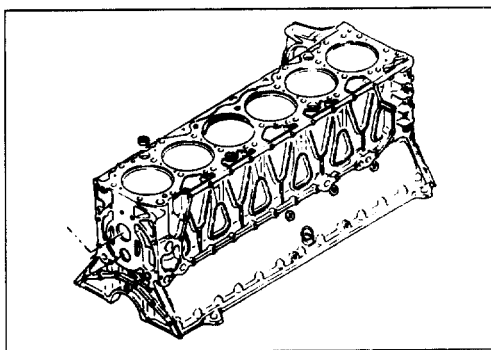
Reassembly Steps-1

- | | |
|--|---|
| ▲ 1. Cylinder body | ▲ 10. Front cover |
| ▲ 2. Oiling jet and joint bolt | ▲ 11. Oil seal front |
| ▲ 3. Crankshaft upper bearing | ▲ 12. Crankshaft damper pulley |
| ▲ 4. Crankshaft | ▲ 13. Idler gear shaft "B" |
| ▲ 5. Crankshaft thrust bearing | ▲ 14. Idler gear "B" |
| ▲ 6. Crankshaft lower bearing | ▲ 15. Idler gear "A" and idler gear shaft "A" |
| ▲ 7. Cylinder body lower crankcase | ▲ 16. Flywheel housing |
| ▲ 8. Piston and connecting rod with upper bearing | ▲ 17. Oil seal rear |
| ▲ 9. Connecting rod bearing cap with lower bearing | ▲ 18. Flywheel |



Reassembly Steps-2

- ▲ 19. Spacer
- ▲ 20. Oil pump
- ▲ 21. Oil pan and gasket
- ▲ 22. Water pump with pulley and gasket
- ▲ 23. Cylinder head gasket
- ▲ 24. Cylinder head
- ▲ 25. Rocker arm shaft and rocker arm with camshaft lower bracket
- ▲ 26. Camshaft
- ▲ 27. Camshaft upper bracket
- ▲ 28. Cylinder head cover with gasket

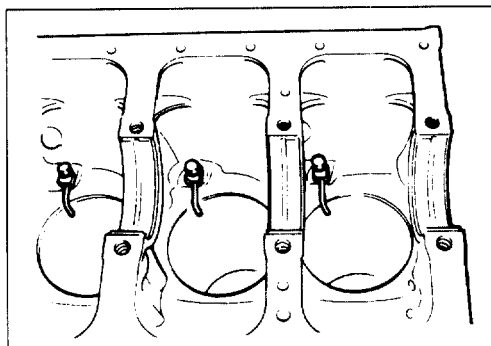


Important Operations



1. Cylinder Body

Use compressed air to thoroughly clean the inside and outside surfaces of the cylinder body, the oil holes, and the water jackets.



2. Oiling Jet and Joint Bolt

- 1) Apply a thin coat of engine oil to the oiling jet and the joint bolt installation surfaces.
- 2) Install the oiling jets together with the joint bolts to the cylinder body.



Note:

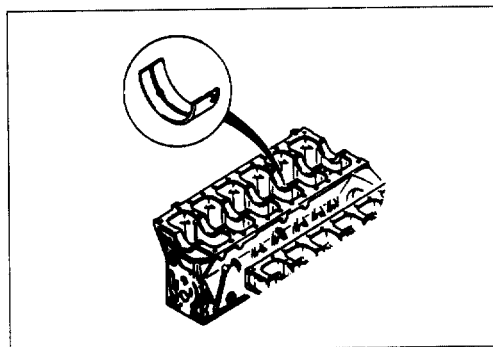
The oiling jet must be carefully installed in the specified position to prevent it from being damaged by the piston. Accidental contact between the oiling jet and the cylinder body, piston, or a tool will damage the oiling jet. Never attempt to repair a damaged oiling jet. Replace it with a new one.

- 3) Tighten the joint bolts to the specified torque.

Joint Bolt Torque

N·m(kg·m/lb.ft)

20.6 (2.1 / 15.2)



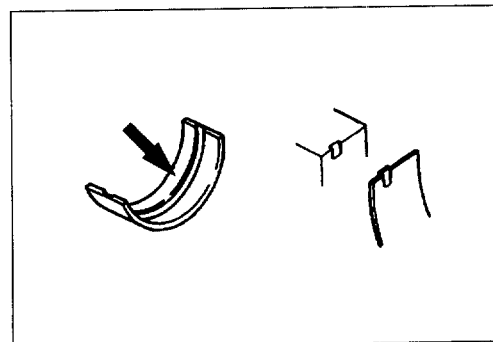
3. Crankshaft Upper Bearing

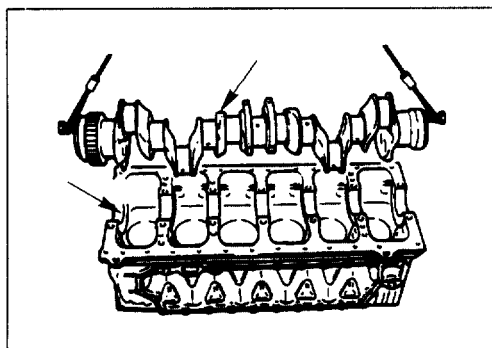
The crankshaft upper bearings have an oil hole and an oil groove. The lower bearings have only a partial oil groove.

- 1) Carefully wipe any foreign material from the crankshaft upper bearing back and the sliding surfaces.

- 2) Install the upper bearings to the cylinder body.

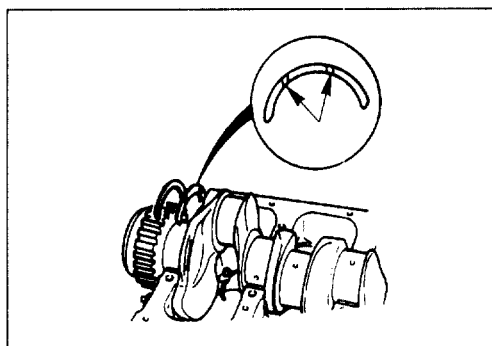
Note the tags attached at disassembly if the removed crankshaft upper bearings are to be reused.





4. Crankshaft

Apply engine oil to the crankshaft journals and the crankshaft bearing sliding surfaces before installing the crankshaft.

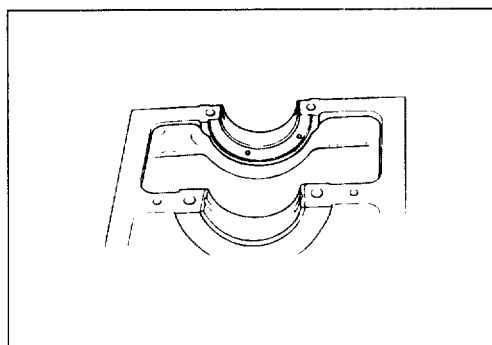


5. Crankshaft Thrust Bearing

- 1) Apply engine oil to the thrust bearings before installation.
- 2) Install the thrust bearings to the crankshaft No.7 journal.



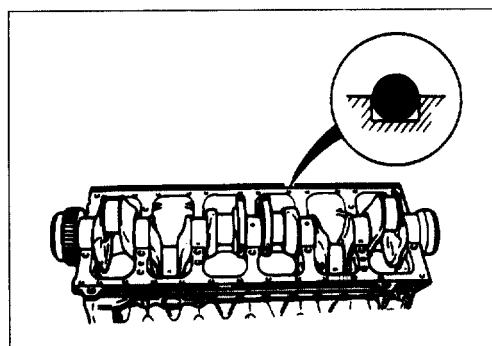
The thrust bearing oil grooves must be facing the sliding faces to crankshaft side.



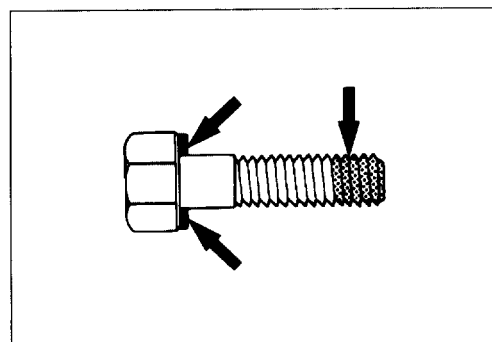
6. Crankshaft Lower Bearing

7. Cylinder Body Lower Crankcase

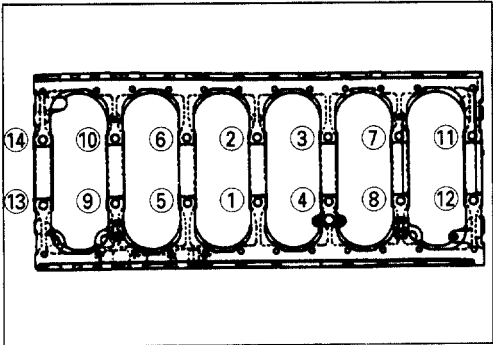
- 1) Carefully wipe any foreign material from the crankshaft lower bearing back and the sliding surfaces.
- 2) Install the lower bearings to the lower crankcase.
Note the tags attached at disassembly if the removed crankshaft lower bearings are to be reused.
- 3) Apply engine oil to the lower bearing sliding surfaces.



- 4) Install the gasket into the cylinder body groove as shown in the illustration.



- 6) Apply molybdenum disulfide grease to the cylinder body lower crankcase bolt threads and setting faces.



7) Tighten the lower crankcase M14 bolts in three steps using the angular tightening method.

Lower Crankcase M14 Bolt Torque		N·m(kg·m/lb.ft)
1st step	2nd step	3rd step
98.0 (10.0/72.3)	132.0 (13.5 / 97.6)	30° – 60°

8) Check that the crankshaft rotates smoothly.

Note:

Cylinder body lower crankcase M14 bolts can be reused seven (7) times.

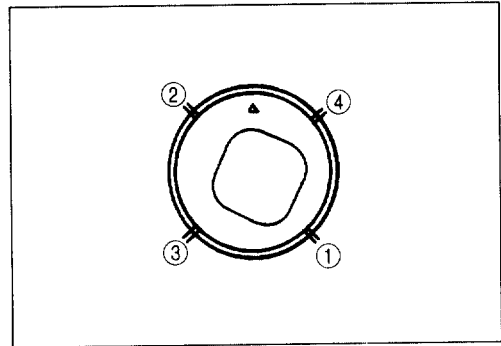
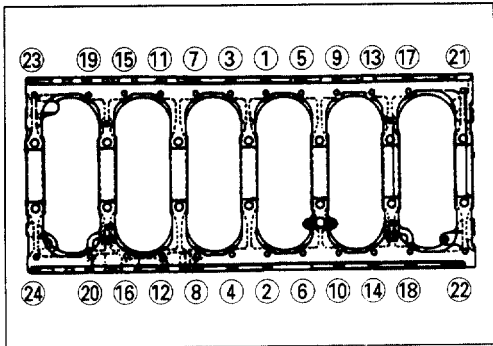
9) Tighten the lower crankcase M10 bolts a little at a time in the numerical order shown in the illustration.

Lower Crankcase M10 Bolt Torque	N·m(kg·m/lb.ft)
38.0 (3.9 / 28.2)	

Note:

The lower crankcase and the cylinder body are machined as a single unit. They cannot be replaced as separate units.

Always replace the lower crankcase and the cylinder body as a set.



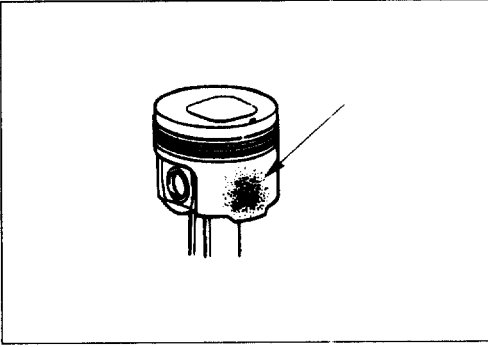
8. Piston and Connecting Rod with Upper Bearing

9. Connecting Rod Bearing Cap with Lower Bearing

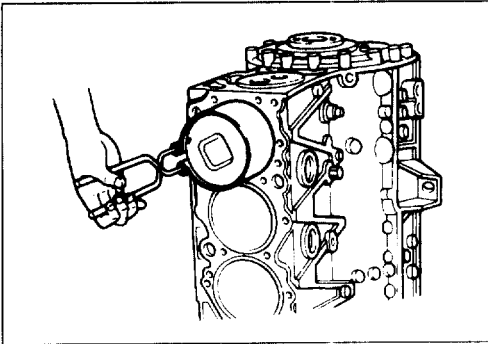
1) Apply engine oil to the circumference of each piston ring and piston.

2) Position the piston ring gaps as shown in the illustration.

- ① 1st compression ring
- ② 2nd compression ring
- ③ 3rd compression ring (for 6SD1TC)
- ④ Oil ring



- 3) Apply molybdenum disulfide grease to the piston skirts.
This will facilitate smooth break-in when the engine is first started after reassembly.
- 4) Apply engine oil to the upper bearing surfaces.
- 5) Apply engine oil to the cylinder wall.



- 6) Use a piston ring compressor to compress the piston rings.

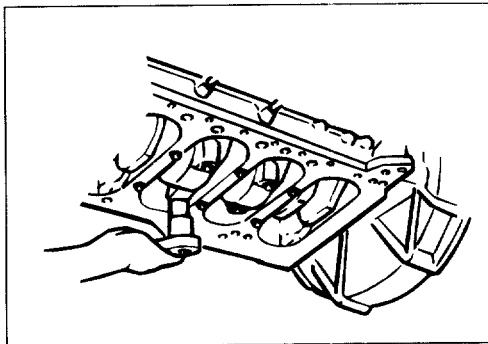
- 7) Use a hammer grip to push the piston in until the connecting rod makes contact with the crankpin.

At the same time, rotate the crankshaft until the crankpin is at BDC (Bottom Dead Center).

Note:

Take care not to strike the oiling jet with the connecting rod big end during the installation procedure.

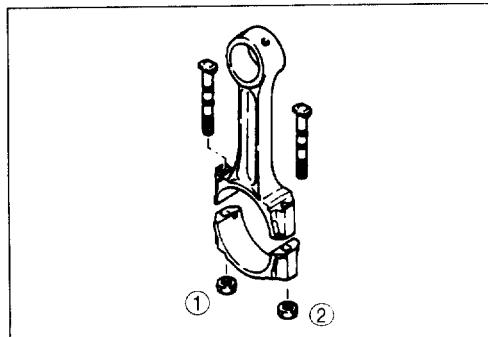
Damage to the oiling jet will result.



01SHY00052



- 8) Install the connecting rod bearing caps.
- 9) Align the bearing cap cylinder number marks and the connecting rod cylinder number marks.
The cylinder number marks must be turned toward the exhaust manifold side.
- 10) Apply molybdenum disulfide grease to the threads and setting faces of each connecting rod cap bolt.



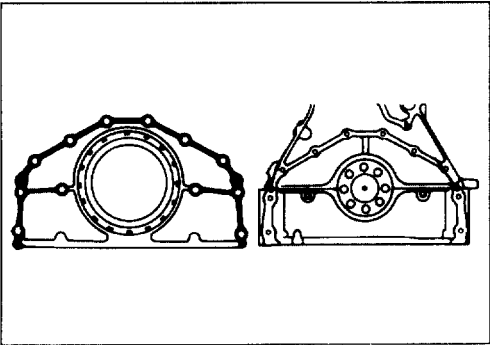
- 12) Tighten the connecting rod bearing cap nuts in three steps using the angular tightening method.

Connecting Rod Bearing Cap Nut Torque N·m(kg·m/lb.ft)

	1st step	2nd step	3rd step
Nut ①	39.0	60°	60°
Nut ②	(4.0 / 28.9)	120°	—

Note:

Check to see that the crankshaft turns smoothly by rotating it manually.

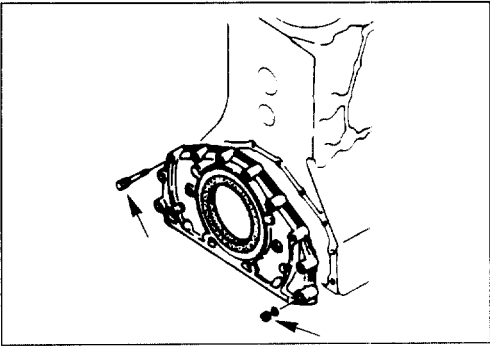


10. Front Cover

- 1) Apply the recommended liquid gasket or its equivalent to the front cover fitting faces as shown the illustration.

11. Oil Seal Front

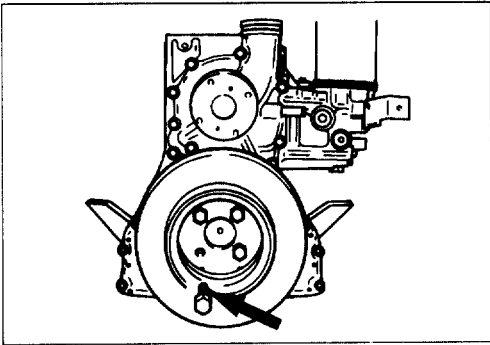
See front cover oil seal replacement.



- 2) Tighten the front cover nuts and bolts to the specified torque.

Front Cover Nut and Bolt Torque		N·m(kt·m/lb.ft)
Bolt	19.6 (2.0 / 14.5)	
Nut	39.2 (4.0 / 28.9)	

Note:
Take care not to damage the oil seal.



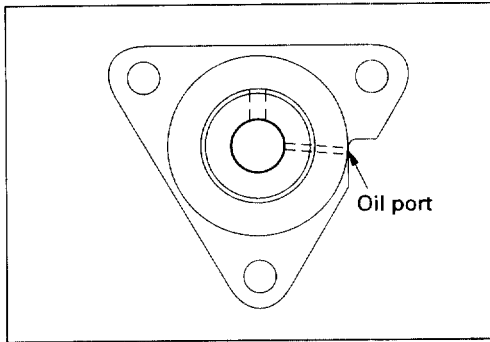
12. Crankshaft Damper Pulley

- 1) Apply engine oil to the threads and setting faces of the crankshaft damper pulley bolts.
- 2) Block the crankshaft with a piece of hard wood to prevent the damper pulley from turning.
- 3) Diagonally tighten the crankshaft damper pulley bolts to the specified torque.

Crankshaft Damper Pulley Bolt Torque		N·m(kg·m/lb.ft)
		200 (20.4 / 147.6)

Note:
Removal of the damper from the pulley is not usually required.
If the damper is removed and reinstalled to the pulley, the damper bolts must be tightened to the specified torque.

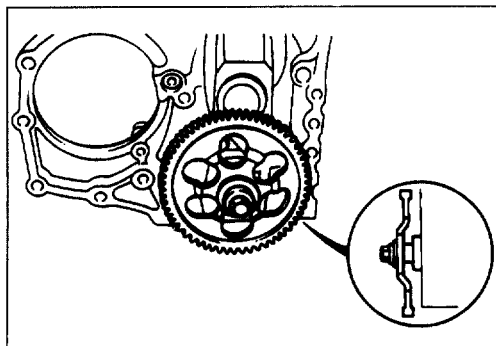
Pulley Damper Bolt Torque		N·m(kg·m/lb.ft)
		96 (9.8 / 70.9)



13. Idler Gear Shaft "B"

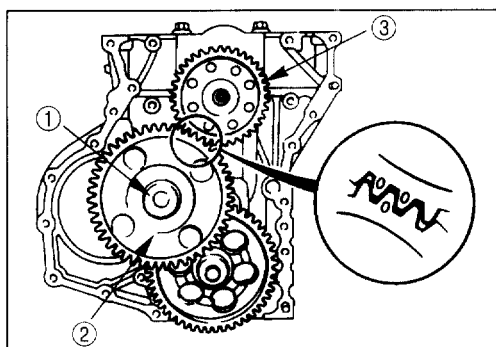
- 1) Install the idler gear shaft "B" to the cylinder body.
The idler gear shaft oil port must be facing the injection pump gear.
- 2) Tighten the idler gear shaft bolt to the specified torque.

Idler Gear Shaft "B" Bolt Torque		N·m(kg·m/lb.ft)
		24.5 (2.5 / 18.1)

**14. Idler Gear "B"**

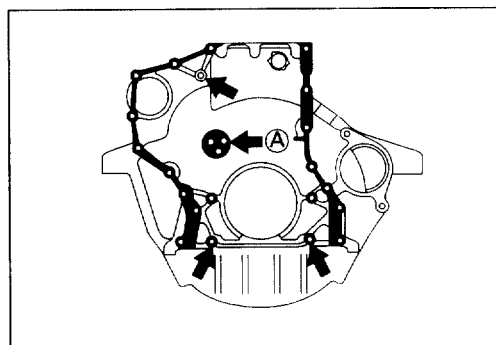
- 1) Apply engine oil to the idler gear "B" inside and thrust areas.
- 2) Install the idler gear to the idler gear shaft.
- 3) Tighten the idler gear bolt to the specified torque.

Idler Gear "B" Bolt Torque	N·m(kg·m/lb.ft)
95.0 (9.7 / 70.2)	

**15. Idler Gear "A" and Idler Gear Shaft "A"**

- 1) Install the idler gear "A" ② to the idler gear shaft ①.
- 2) Install the thrust washer with align the dowel pin.
- 3) Align the crankshaft gear ③ and idler gear "A" ② "O" timing marks.
- 4) Tighten the idler gear "A" Bolt to the specified torque.

Idler Gear "A" Bolt Torque	N·m(kg·m/lb.ft)
1st	2nd
34.3 (3.5 / 25.3)	60° – 90°
Apply molybdenum disulfide grease	



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**16. Flywheel Housing**

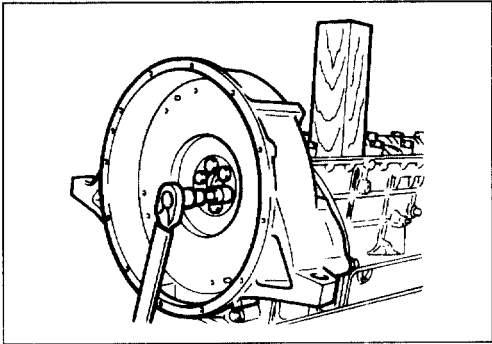
- 1) Apply the recommended liquid gasket or its equivalent to the flywheel housing fitting faces and the four areas marked with arrows in the illustration.
- 2) Tighten the flywheel housing bolts to the specified torque a little at a time.

Flywheel Housing Bolt Torque	N·m(kg·m/lb.ft)
75.0 (7.7 / 55.7)	

Flywheel Housing Bolt ① Torque	N·m(kg·m/lb.ft)
24.5 (2.5 / 18.1)	

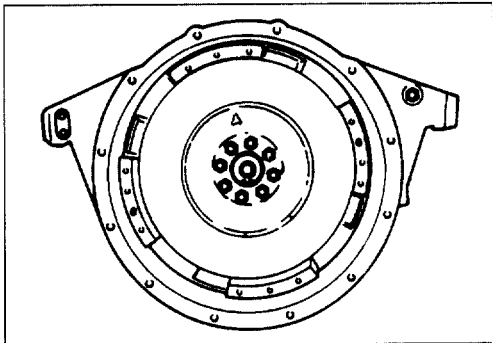
17. Oil Seal Rear

See crankshaft oil seal replacement.



18. Flywheel

- 1) Block the crankshaft with a piece of hard wood to prevent the flywheel from turning.
- 2) Apply molybdenum disulfide grease to the flywheel bolt threads.
- 3) Align the flywheel with the crankshaft dowel pin.

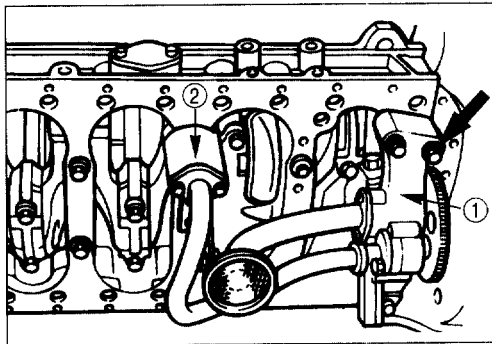


- 4) Tighten the flywheel bolts to the specified torque in three steps using the angular tightening method.
Follow the numerical order shown in the illustration.

Flywheel Bolt Torque		N·m(kg·m/lb.ft)
1st step	2nd step	3rd step
78.0 (8.08 / 57.9)	60°	30°

Note:

The flywheel bolts can be reused six (6) times.

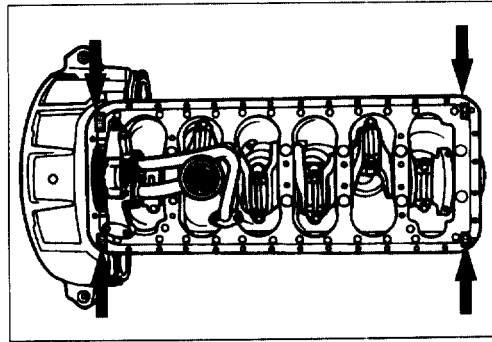


19. Spacer

20. Oil Pump

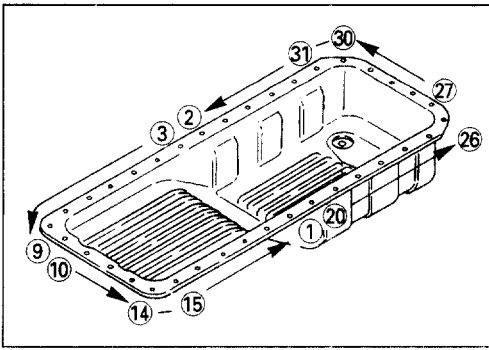
- 1) Install the oil pump ① together with the anti drain valve ②.
- 2) Tighten the oil pump and spacer bolts to the specified torque.

Oil Pump Bolt Torque		N·m(kg·m/lb.ft)
Oil pump ①	38.0 (3.9 / 28.2)	
Anti drain valve ②	21.6 (2.2 / 15.9)	



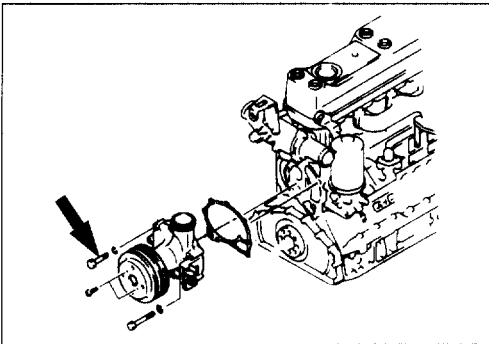
21. Oil Pan and Gasket

- 1) Apply the recommended liquid gasket or its equivalent to the No. 1 and No. 7 bearing caps at the positions shown in the illustration.
- 2) Install the oil pan and gasket to the cylinder body.



- 3) Tighten the oil pan bolts to the specified torque a little at a time in the numerical order shown in the illustration.

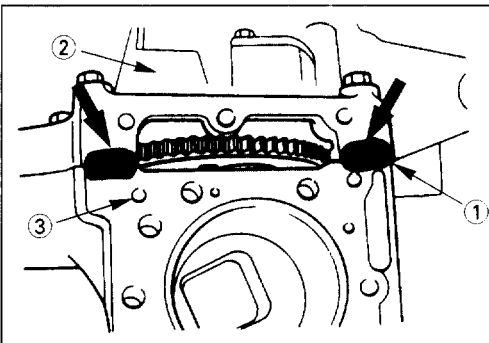
Oil Pan Bolt Torque	N·m(kg·m/lb.ft)
	19.0 (1.9 / 13.7)



22. Water Pump with Pulley and Gasket

- 1) Install the water pump to the cylinder body.
- 2) Tighten the water pump bolts to the specified torque.

Water Pump Bolt Torque	N·m(kg·m/lb.ft)
M8 Bolt	19.0 (1.9 / 13.7)
M10 Bolt	38.0 (3.9 / 28.2)

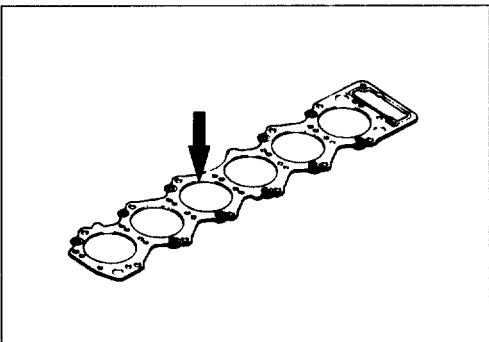


23. Cylinder Head Gasket

- 1) Apply the recommended liquid gasket or its equivalent to the cylinder body fitting faces ① and the flywheel housing ②.

The liquid gasket must be 2.0 mm (0.08 in) thick and 3.0 mm (0.12 in) wide.

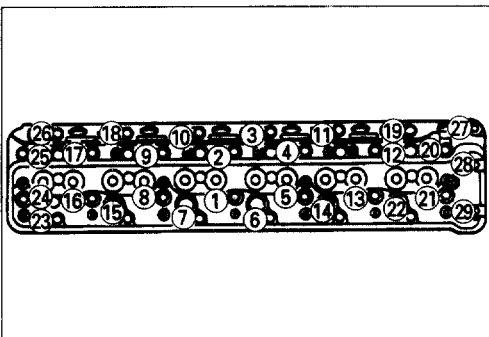
The liquid gasket must not obstruct the cylinder oil ports ③.



- 2) Install the cylinder head gasket to the cylinder body.

The part number (indicated by the arrow in the illustration) must be facing up.

- 3) Use the dowel pins to align the cylinder head gasket.



24. Cylinder Head

- 1) Align the cylinder body dowels and the cylinder head dowel holes.

Carefully place the cylinder head on the cylinder head gasket.



- 2) Apply molybdenum disulfide grease to the cylinder head bolt threads and setting faces.

- 3) Tighten the M14 cylinder head bolts in three steps using the angular tightening method.

Follow the numerical order shown in the illustration.



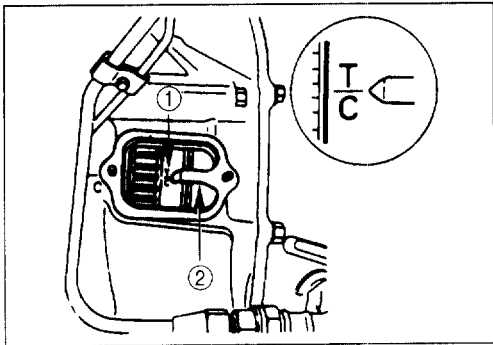
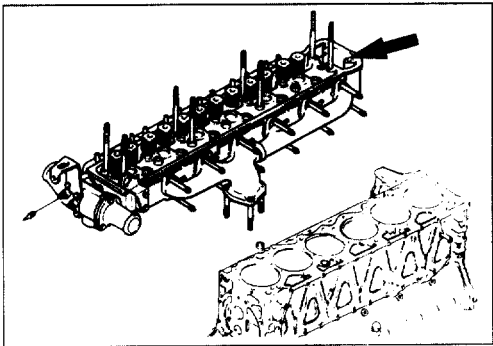
Cylinder Head Bolt Torque		N·m(kg·m/lb.ft)
1st step	2nd step	3rd step
98.1 (10.0 / 72.3)	147.1 (15.0 / 108.5)	30° – 60°

- 4) Tighten the M10 cylinder head bolts to the specified torque.

Cylinder Head Bolt Torque	N·m(kg·m/lb.ft)
38.0 (3.9 / 28.2)	

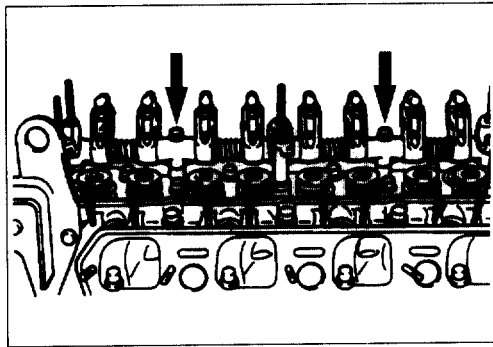
Note:

- 1) Cylinder head M14 bolts can be reused four (4) times.
- 2) After tightening the cylinder head bolts, plug the timing gear hole with a clean rag to prevent dirt and other foreign material from entering the engine.



25. Rocker Arm Shaft and Rocker Arm with Camshaft Lower Bracket

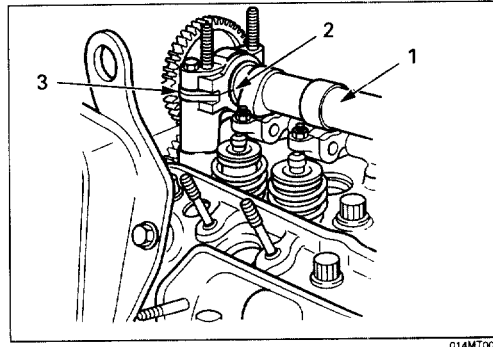
- 1) Align the flywheel "T/C" mark with the flywheel housing pointer by rotating the crankshaft counterclockwise.



- 2) Apply engine oil to the rocker arm roller portion.
- 3) Install the rocker arm shaft and rocker arm with camshaft lower bracket.
- 4) Tighten the rocker arm shaft bracket bolts to the specified torque evenly from the inside to the outside.



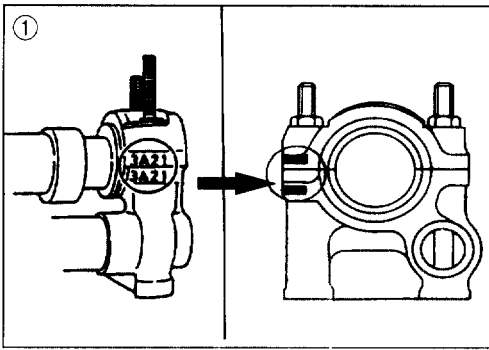
Rocker Arm Shaft Bracket Bolt Torque	N·m(kg·m/lb.ft)
21.6 (2.2 / 15.9)	



26. Camshaft
27. Camshaft Upper Bracket

- 1) Apply engine oil to the camshaft lower bracket sliding surfaces and the camshaft journal.
- 2) Set the camshaft ① so that the camshaft thrust boss V-groove ② is aligned with the camshaft fitting face ③ (intake manifold side).





- 3) Install the camshaft upper bracket to the camshaft lower bracket.

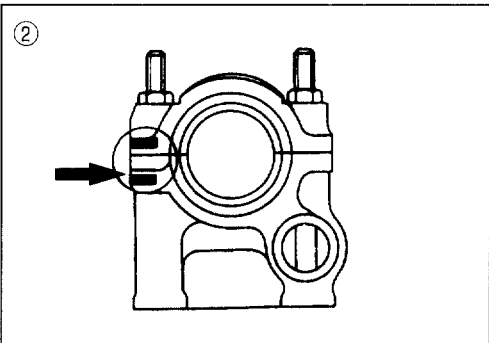
The upper bracket and lower bracket setting marks must be aligned.

① Setting Marks (For Original Parts)

- | | | |
|---|-----|-------|
| 1 | A21 | Front |
| 2 | A21 | Inner |
| 3 | A21 | Inner |
| 4 | A21 | Rear |

Original part lot number

Camshaft bracket installation position number

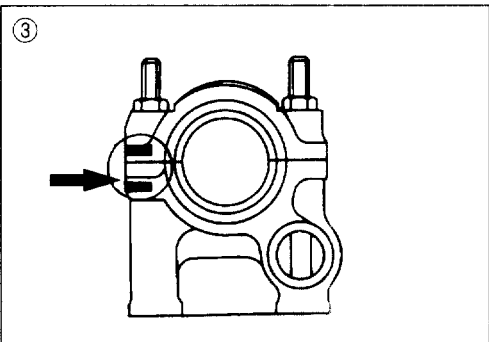


② Setting Marks (For Original Parts)

- | | | |
|---|----|-------|
| 1 | AA | Front |
| 2 | AA | Inner |
| 3 | AA | Inner |
| 4 | AA | Rear |

Original part lot designation

Camshaft bracket installation position number

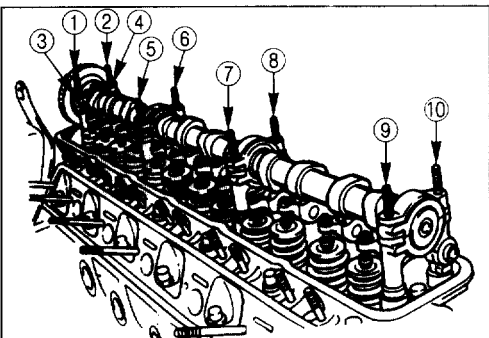


③ Setting Marks (For Replacement Parts)

- | | | |
|---|----|-------|
| 1 | 21 | Front |
| 2 | 21 | Inner |
| 3 | 21 | Inner |
| 4 | 21 | Rear |

Production lot number (00 – 99)

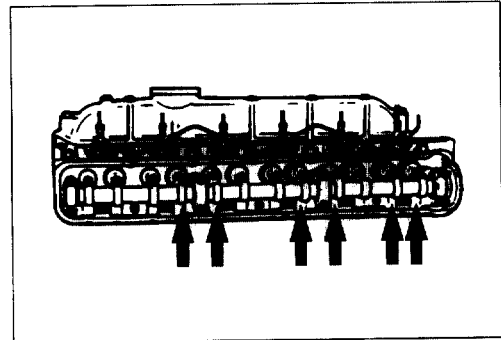
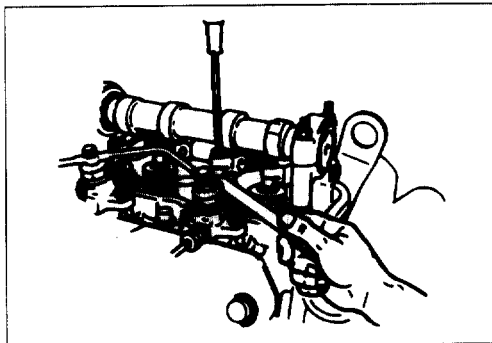
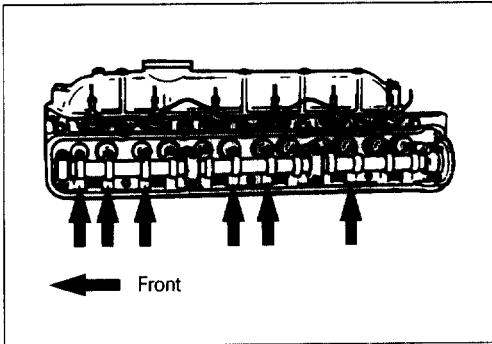
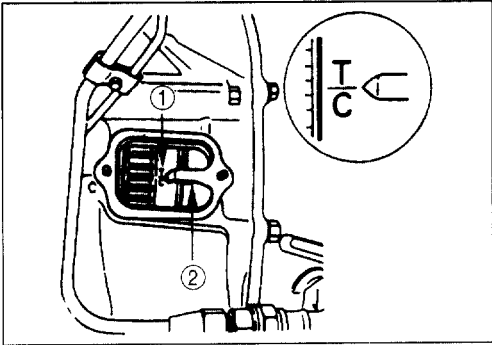
Camshaft bracket installation position number



- 4) Temporarily tighten the camshaft upper bracket nuts a little at a time in the numerical order shown in the illustration.

- 5) Final tighten the camshaft upper bracket nuts to the specified torque a little at a time in the numerical order shown in the illustration.

Camshaft Upper Bracket Nut Torque	N·m(kg·m/lb.ft)
21.6 (2.2 / 15.9)	



VALVE CLEARANCE ADJUSTMENT

The following instructions assume that valve clearance is adjusted beginning with the No. 1 cylinder at top dead center (TDC) on the compression stroke followed by the No. 6 cylinder at TDC on the compression stroke.

Valve clearances may be adjusted in the opposite order (No. 6 cylinder at TDC followed by No. 1 cylinder at TDC) if this is more convenient.



1. Check that the No. 1 cylinder is at TDC on the compression stroke.

If the No. 1 cylinder is at TDC, there will be play in the No. 1 cylinder valve rocker arms.

The illustration shows the valves to be adjusted with the No. 1 cylinder at TDC on the compression stroke.



2. Loosen the adjusting screw lock nut.
3. Insert a feeler gauge between the rocker arm and the valve stem end.

Valve clearance	mm(in)
0.4 (0.016)	

4. Turn the adjusting screw until a slight drag can be felt on the feeler gauge.
5. Tighten the adjusting screw lock nut.

Adjusting Screw Lock Nut Torque	N·m(kg·m/lb.ft)
20.0 (2.0 / 14.5)	

6. Repeat the procedure for the remaining valve clearances.



7. Rotate the crankshaft one full turn in its normal direction of rotation.

Be sure that the flywheel TDC line is aligned with the timing pointer.

The illustration shows the valves to be adjusted with the No. 6 cylinder at TDC on the compression stroke.

8. Repeat Steps 2 through 6 to adjust the remaining valve clearances.

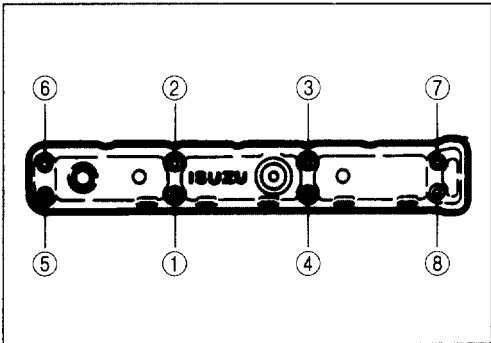
Note:

Be sure to move the No. 1 cylinder to TDC on the compression stroke after completing the valve clearance adjustment procedure.
This will facilitate injection pump installation.

Intake and Exhaust Valve Arrangement

Cylinder No.	1		2		3		4		5		6	
Valve Names	I	E	I	E	I	E	I	E	I	E	I	E
No.1 cyl. at TDC on compression	○	○	○			○	○			○		
No.6 cyl. at TDC on compression				○	○			○	○		○	○

I: Intake valve E: Exhaust valve

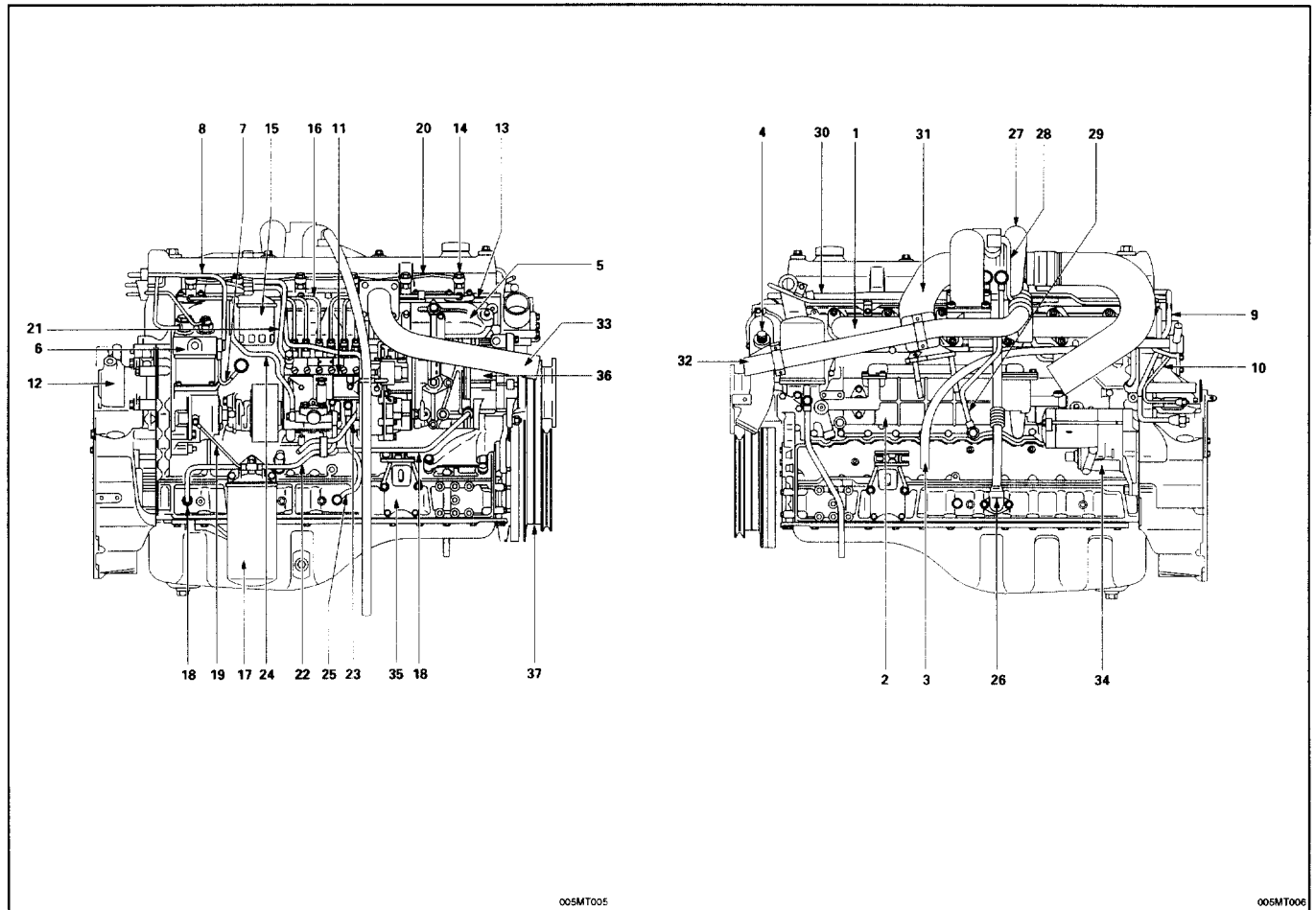


28. Cylinder Head Cover with Gasket

- 1) Apply engine oil to the rocker arms and the valve springs.
- 2) Apply liquid gasket several point around to the cylinder head cover.
This will prevent the cylinder head cover gasket from falling free.
- 3) Install the cylinder head cover gasket to the cylinder head cover.
The gasket must be smooth with no loose areas.
- 4) Install the cylinder head cover to the cylinder head.
- 5) Tighten the cylinder head cover nuts to the specified torque a little at a time in the numerical order shown in the illustration.

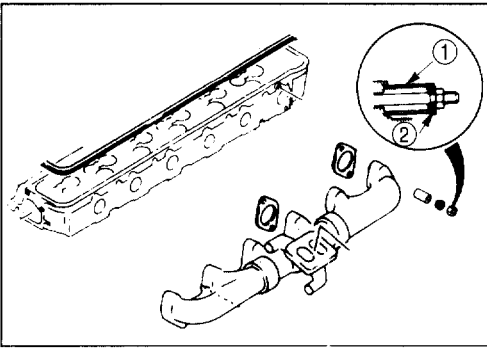
Cylinder Head Cover Nut Torque	N·m(kg·m/lb.ft)
7.8 (0.8 / 5.8)	

EXTERNAL PARTS



Reassembly Steps

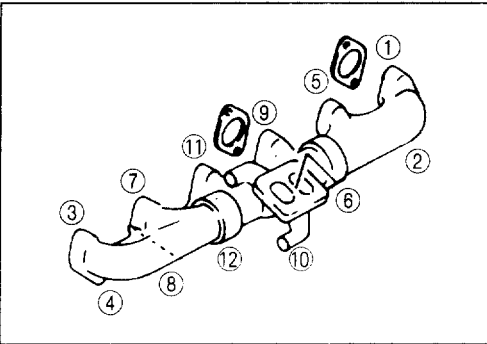
- ▲ 1. Exhaust manifold
- ▲ 2. Oil cooler with oil filter
- ▲ 3. Oil level gauge and guide tube
- ▲ 4. Water suction pipe
- ▲ 5. Intake cover
- ▲ 6. Air compressor
- ▲ 7. Air compressor water pipe (Out)
- ▲ 8. Air compressor water pipe (In)
- ▲ 9. Air pipe (Charge)
- ▲ 10. Air pipe (Governor)
- ▲ 11. Injection pump
- ▲ 12. Power steering oil pump
- ▲ 13. Glow plug and connector
- ▲ 14. Injection nozzle holder
- ▲ 15. Fuel filter
- ▲ 16. Fuel injection pipe with clip
- ▲ 17. Partial oil filter with bracket
- ▲ 18. Partial oil filter feed pipe and return pipe
- ▲ 19. Body oil pipe
- ▲ 20. Fuel leak off pipe
- ▲ 21. Fuel pipe (Fuel filter to injection pump)
- ▲ 22. Fuel suction pipe
- ▲ 23. Fuel pipe (Fuel filter leak off)
- ▲ 24. Fuel pipe (Feed pump to fuel filter)
- ▲ 25. Injection pump oil drain pipe
- ▲ 26. Turbocharger oil return pipe
- ▲ 27. Turbocharger
- ▲ 28. Turbocharger oil feed pipe
- ▲ 29. Turbocharger water feed pipe
- ▲ 30. Turbocharger water return pipe
- ▲ 31. Exhaust manifold adapter
- ▲ 32. Intake pipe
- ▲ 33. Air duct
- ▲ 34. Starter motor
- ▲ 35. Engine foot
- ▲ 36. Generator and adjusting plate
- ▲ 37. Cooling fan drive belt



Important Operations

1. Exhaust Manifold

- 1) Install the exhaust manifold gasket.
The "TOP" mark must be facing out.
- 2) Install the exhaust manifold.
- 3) Install the distance tube ① and the washer ②.

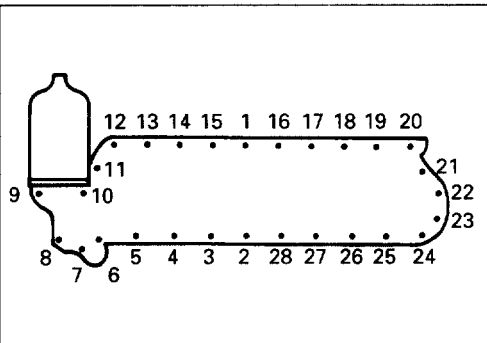


- 4) Tighten the exhaust manifold nuts to the specified torque a little at a time in the sequence shown in the illustration.

Exhaust Manifold Nut Torque

N·m(kg·m/lb.ft)

41.2 (4.2 / 30.4)



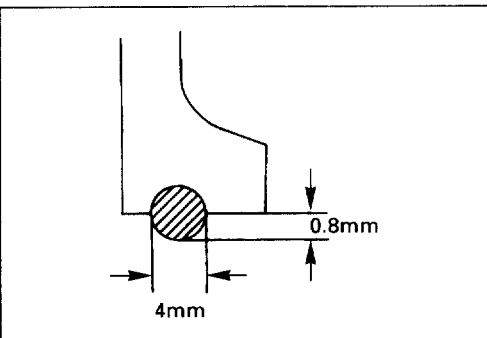
2. Oil Cooler with Oil Filter

- 1) Apply liquid gasket to several points around the oil cooler case.
This will hold the case in place during installation.
- 2) Install the oil cooler case with oil filter and gasket to the cylinder body.
- 3) Tighten the oil cooler bolts to the specified torque a little at a time in the numerical order shown in the illustration.

Oil Cooler Bolt Torque

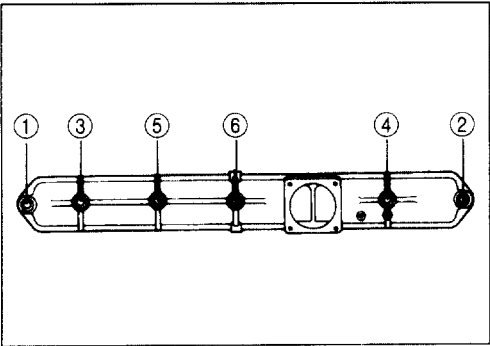
N·m(kg·m/lb.ft)

21.6 (2.2 / 15.9)

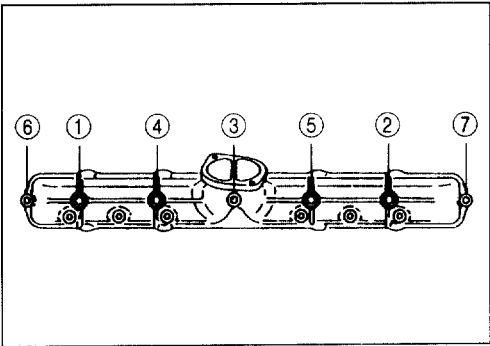


5. Intake Cover

- 1) Apply an unbroken strip of the recommended liquid gasket (ThreeBond 1207C) or its equivalent to the intake cover grooves as shown in the illustration.
- 2) Immediately (within five minutes of applying the liquid gasket) set the intake cover to the cylinder body.

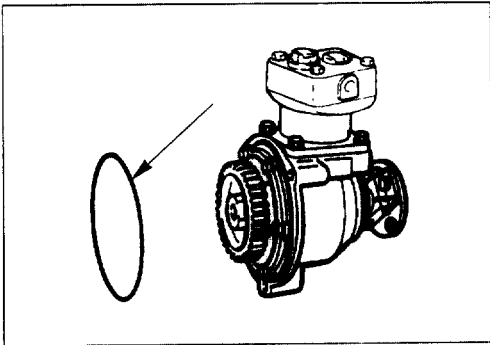


3) Tighten the intake cover nuts.



Tighten the intake cover nuts in two steps a little at a time in the numerical order shown in the illustration.

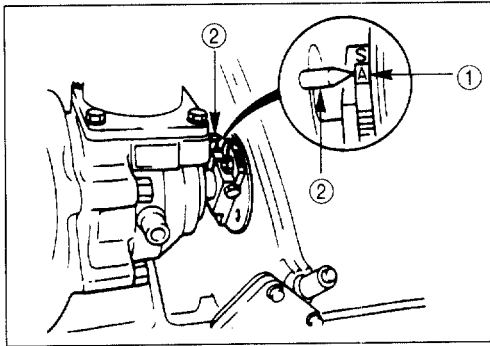
Intake Cover Nut Torque		N·m(kg·m/lb.ft)
1st Step	2nd Step	
8.0 (0.8 / 5.8)	27.4 (2.8 / 20.3)	



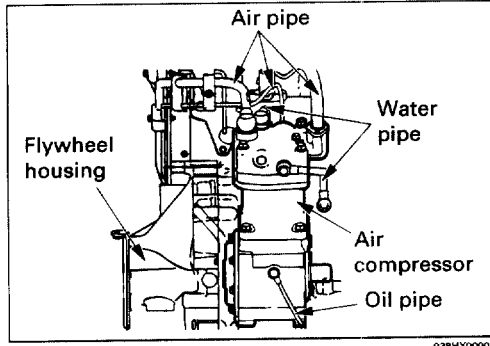
6. Air Compressor

- 1) Apply liquid gasket to the O-ring.
This will hold the O-ring in place during installation.
- 2) Install the O-ring to the air compressor body groove.
- 3) Tighten the air compressor bolts to the specified torque.

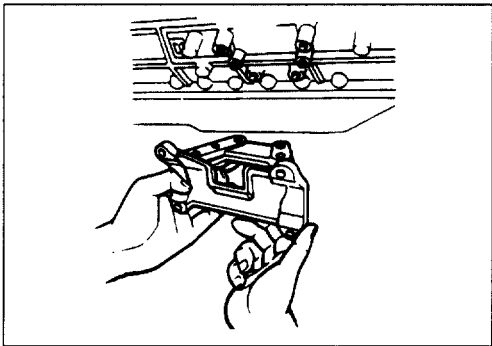
Air Compressor Bolt Torque	N·m(kg·m/lb.ft)
92.9 (9.5 / 68.7)	



- 4) Check that the No. 1 cylinder is at TDC.
- 5) Align the coupling "A" mark ① with the air compressor body pointer ②.
- 6) Check alignment mark "S" with the air compressor body pointer after install the air compressor.



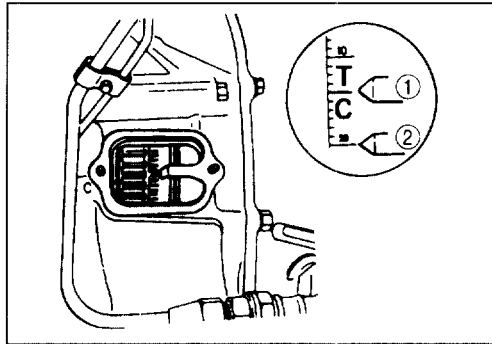
7) Air compressor heavy duty type (for Australia).



11. Injection Pump

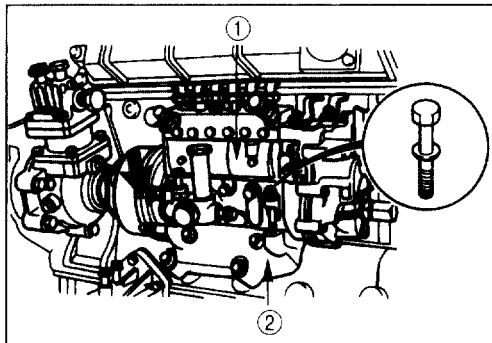
- 1) Align the injection pump bracket with the cylinder body dowel pin.
- 2) Install the injection pump bracket to the cylinder body.
- 3) Tighten the injection pump bracket bolts to the specified torque.

Injection Pump Bracket Bolt Torque	N·m(kg·m/lb.ft)
38.0 (3.9 / 28.2)	

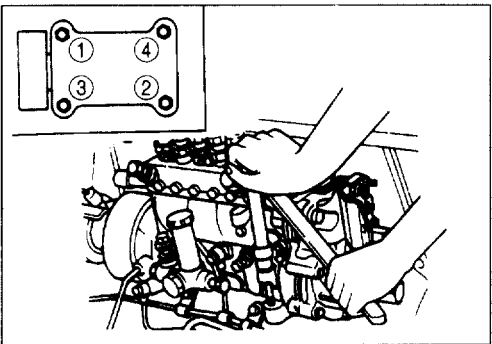


- 4) Check that No. 1 cylinder is at top dead center on the compression stroke.
- 5) Rotate the crankshaft in the normal direction of engine rotation to align the flywheel notched line and the flywheel housing timing pointer.

Injection Timing (Static - BTDC)		deg
6SD1	18	
6SD1TC (EURO-I)	10	
6SD1TC (EURO-II)	5	

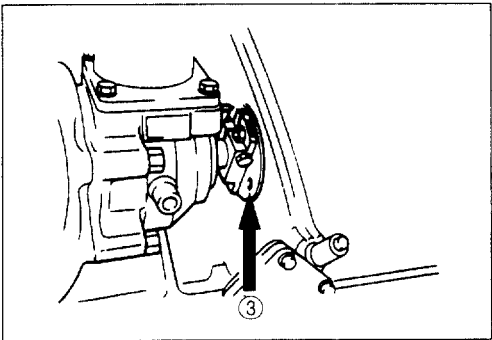


- 6) Install the injection pump ① to the pump bracket ②.



- 7) Use a wrench to tighten the injection pump bolts to the specified torque a little at a time in the numerical order shown in the illustration.

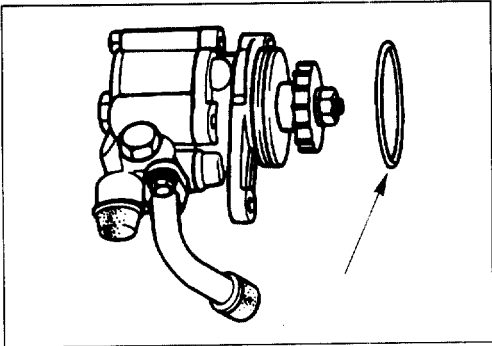
Injection Pump Bolt Torque	N·m(kg·m/lb.ft)
38.0 (3.9 / 28.2)	



- 9) Connect the injection pump drive coupling plate to the injection pump timer.
- 10) Tighten the two coupling plate bolts ③ to the specified torque.

Coupling Plate Bolt Torque		N·m(kg·m/lb.ft)
6SD1	34 (3.5 / 25.3)	
6SD1TC	88.3 (9.0 / 65.1)	

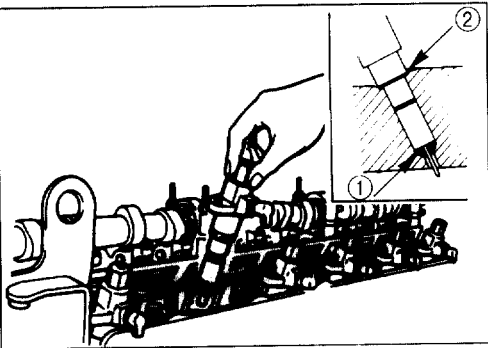
- 11) Rotate the crankshaft two turns in the normal direction of engine rotation.
- 12) Recheck the injection timing.



12. Power Steering Oil Pump

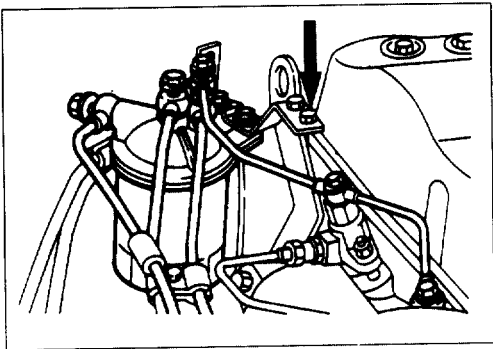
- 1) Install the O-ring to the pump body.
- 2) Apply grease to the O-ring.
- 3) Tighten the power steering oil pump bolts to the specified torque.

Power Steering Oil Pump Bolt Torque	N·m(kg·m/lb.ft)
75.0 (7.7 / 55.7)	



14. Injection Nozzle Holder

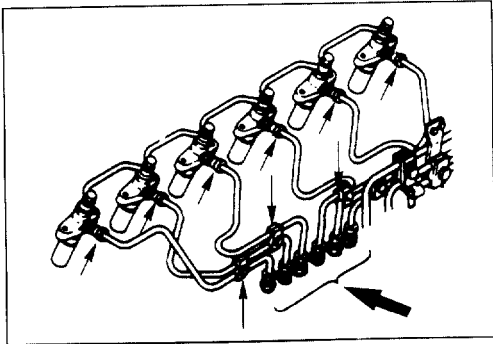
- 1) Install the injection nozzle hold with the new gaskets ① and the dust cover ② to the cylinder head.
- 2) Temporarily tighten the injection nozzle holder.
The holder will be finally tightened after injection pipe installation.



15. Fuel Filter

- 1) Install the fuel filter to the cylinder head.
- 2) Tighten the fuel filter bolts to the specified torque.

Fuel Filter Bolt Torque	N·m(kg·m/lb.ft)
40.0 (4.1 / 29.7)	



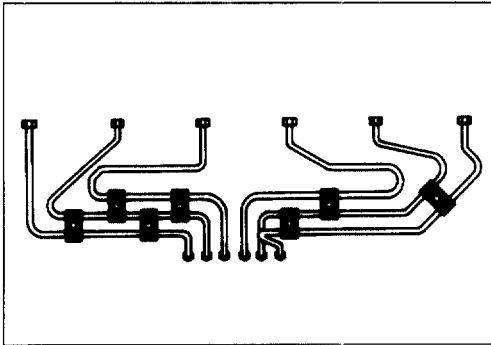
16. Fuel Injection Pipe with Clip

- 1) Temporarily tighten the injection pipe sleeve nut.
- 2) Set the clip in the prescribed position.

Note:

Make absolutely sure that the clip is correctly positioned.

An improperly positioned clip will result in injection pipe breakage and fuel pulsing noise.



- 3) Tighten the injection pipe clip bolts to the specified torque.

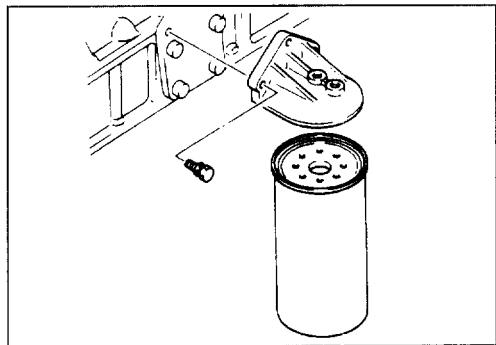
Injection Pipe Clip Bolt Torque	N·m(kg·m/lb.ft)
8.2 (0.8 / 5.8)	

- 4) Tighten the injection pipe sleeve nuts to the specified torque.

Injection Pipe Sleeve Nut Torque	N·m(kg·m/lb.ft)
Nozzle side	30.0 (3.05 / 22.1)
Inj. pump side	39.0 (4.0 / 28.9)

- 5) Final tighten the injection nozzle holder to the specified torque.

Injection Nozzle Holder Torque	N·m(kg·m/lb.ft)
21.2 (2.2 / 15.9)	



17. Partial Oil Filter and Bracket

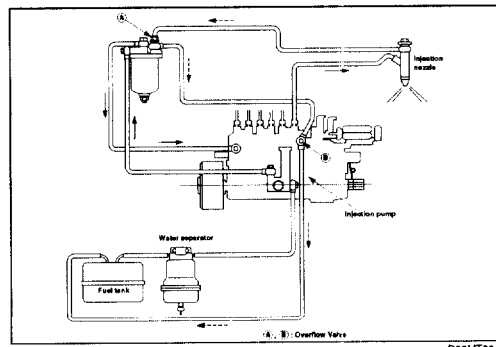
- 1) Install the oil filter bracket to the cylinder body.
2) Tighten the oil filter bracket bolts to the specified torque.

Oil Filter Bracket Bolt Torque	N·m(kg·m/lb.ft)
39.2 (4.0/28.9)	

- 3) Apply grease to the oil filter element fitting portion.
4) Install the oil filter element to the bracket and screw it into place.

Turn the element until resistance is felt.

After resistance is felt, turn the element an additional one full turn.



20. Fuel Leak Off Pipe

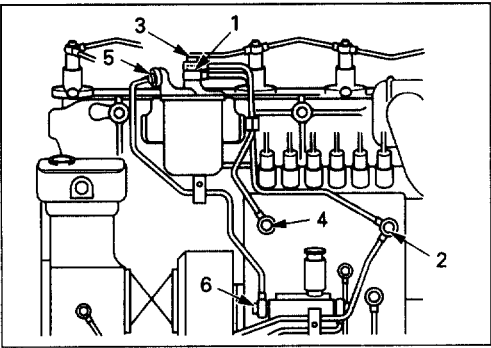
21. Fuel Pipe (Fuel Filter to Injection Pump)

22. Fuel Suction Pipe

23. Fuel Pipe(Fuel Filter Leak Off)

24. Fuel Pipe (Feed Pump to Fuel Filter)

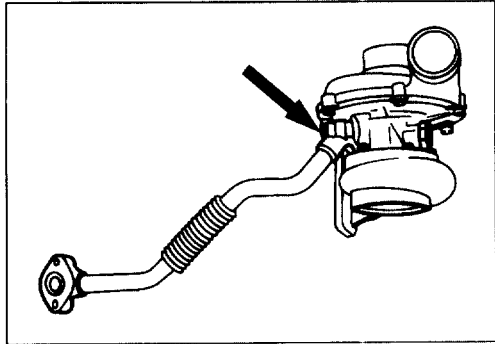
- 1) Set the fuel pipes to the injection pump and the fuel filter.
2) Temporarily tighten the joint bolts.



- 3) Tighten the fuel pipe joint bolts to the specified torque.

Fuel Pipe Joint Bolt Torque	N·m(kg·m/lb.ft)
Joint Bolt ①②	41.2 (4.2 / 30.4)
Joint Bolt ③	14.7 (1.5 / 10.8)
Joint Bolts ④⑤⑥	41.2 (4.2 / 30.4)

- 4) Set the clip to the prescribed position.



26. Turbocharger Oil Return Pipe



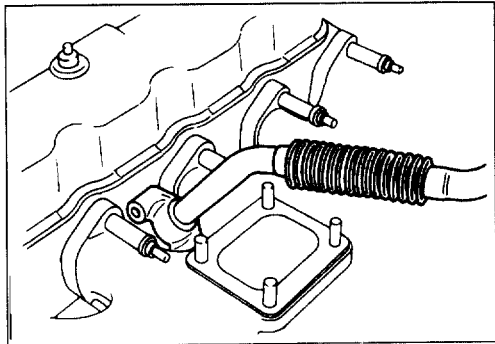
27. Turbocharger

- 1) Install the turbocharger oil return pipe to the turbocharger.

The oil return pipe lower flange surface must be facing the cylinder body.

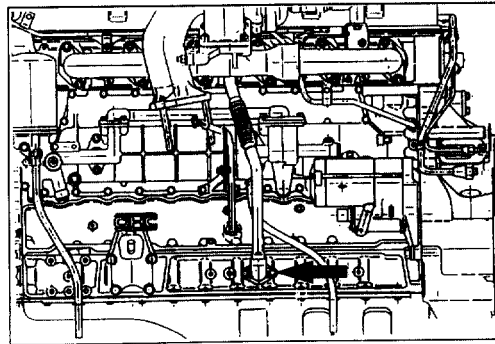
- 2) Tighten the turbocharger oil return pipe bolts to the specified torque.

Turbocharger Oil Return Pipe Bolt Torque	N·m(kg·m/lb.ft)
	43.8 (4.5 / 32.5)



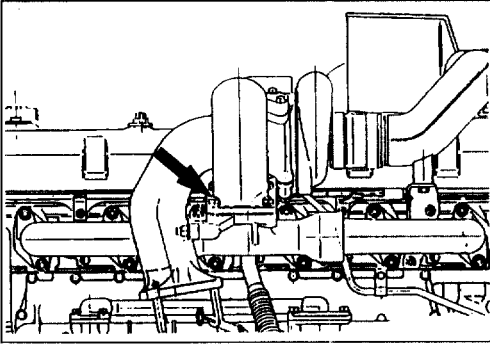
- 3) Set the turbocharger with the oil return pipe to the exhaust manifold.

Take care not to damage the oil return pipe.



- 4) Tighten the oil return pipe cylinder body bolts to the specified torque.

Oil Return Pipe Cylinder Body Bolt Torque	N·m(kg·m/lb.ft)
	19.0 (1.9 / 13.7)



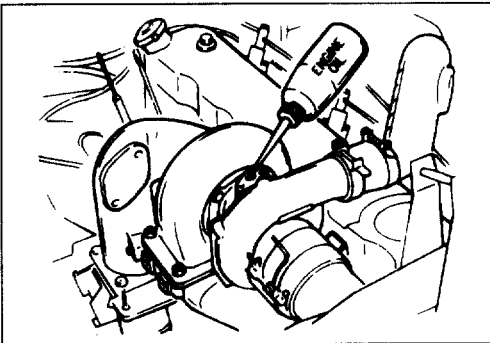
- 5) Apply an anti-seizing agent (LOCTITE ANTISEIZE LUBRICANT or its equivalent) to the new turbocharger nuts.
- 6) Install the turbocharger nuts to the exhaust manifold.

Note:

Turbocharger nuts are made of special heat-resistant steel. Never replace the heat-resistant nuts with ordinary nuts.

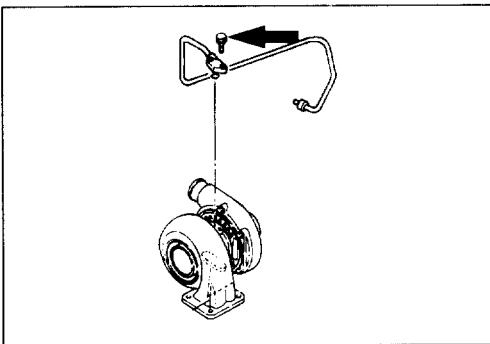
- 7) Tighten the turbocharger nuts to the specified torque.

Turbocharger Nut Torque	N·m(kg·m/lb.ft)
40.0 (4.0 / 28.9)	



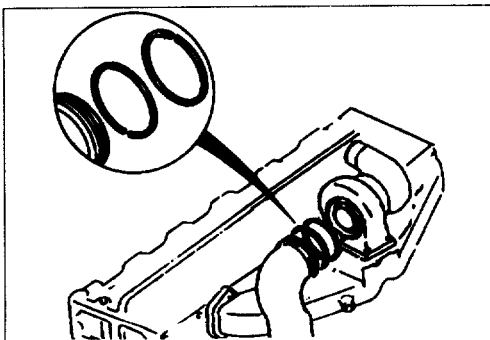
28. Turbocharger Oil Feed Pipe

- 1) Pour 120 - 150 cc (7.2 - 9.2 cu.in) of clean engine oil into the turbocharger center housing through the oil feed opening.
- 2) Turn the rotating assembly with your hand to thoroughly lubricate the internal parts.



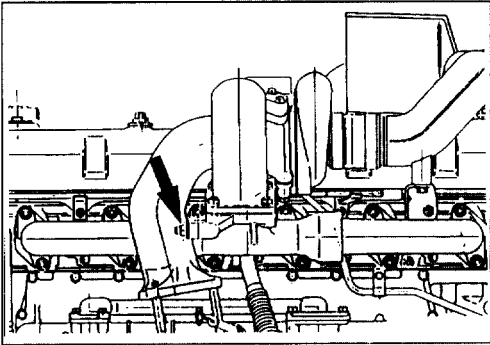
- 3) Apply a thin coat of engine oil to the O-ring.
- 4) Tighten the turbocharger oil feed pipe bolts to the specified torque.

Turbocharger Oil Feed Pipe Bolt Torque	N·m(kg·m/lb.ft)
19.0 (1.9 / 13.7)	



31. Exhaust Manifold Adapter

- 1) Use a screwdriver to set the three seal ring gaps at 120 degree intervals.
- 2) Install the adapter to the turbocharger body.
The seal ring "RH" marks must be facing the front of the engine.



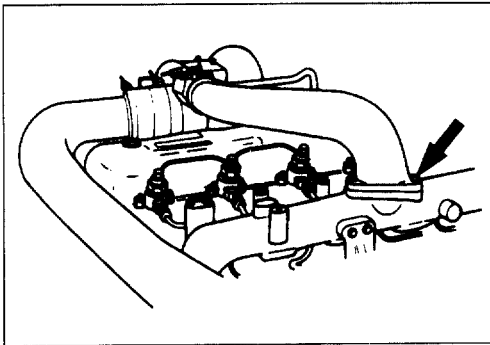
- 3) Apply an anti-seizing agent (LOCTITE ANTISEIZE LUBRICANT or its equivalent) to the manifold adapter bolts.

Note:

Manifold adapter bolts are made of special heat-resistant steel. Never replace the heat-resistant bolts with ordinary bolts.

- 4) Tighten the manifold adapter bolts to the specified torque.

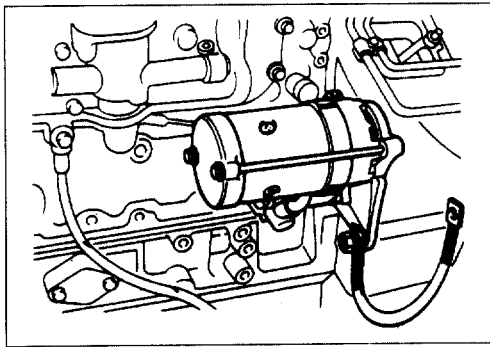
Manifold Adapter Bolt Torque	N·m(kg·m/lb.ft)
40.0 (4.0 / 28.9)	



32. Intake Pipe

Tighten the intake pipe bolts to the specified torque.

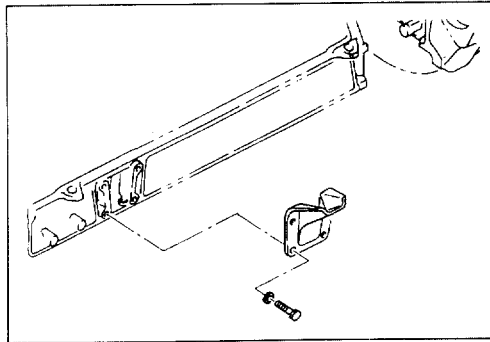
Intake Pipe Bolt Torque	N·m(kg·m/lb.ft)
40.0 (4.0 / 28.9)	



34. Starter Motor

- 1) Install the starter motor to the flywheel housing.
2) Tighten the starter motor nuts to the specified torque.

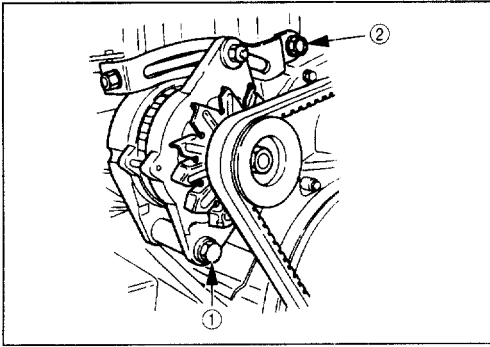
Starter Motor Nut Torque	N·m(kg·m/lb.ft)
126.4 (12.9 / 93.3)	



35. Engine Foot

- 1) Apply molybdenum disulfide grease to the engine foot bolt threads.
2) Tighten the engine foot bolts to the specified torque.

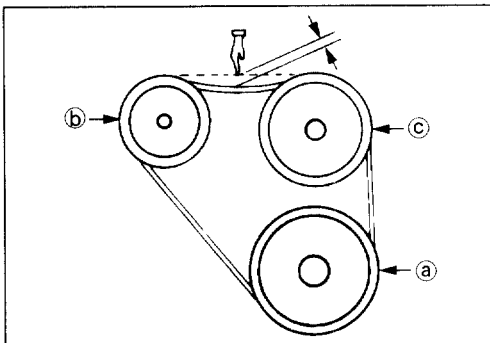
Engine Foot Bolt Torque	N·m(kg·m/lb.ft)
103 (10.5 / 75.9)	



36. Generator and Adjusting Plate

- 1) Install the generator and adjusting plate to the engine.
- 2) Temporarily tighten the generator bolt ①.
The bolt will be finally tightened after installing and adjusting the cooling fan belt.
- 3) Tighten the cooling fan drive belt adjusting plate bolt ② to the specified torque.

Adjusting Plate Bolt Torque	N·m(kg·m/lb.ft)
78.3 (8.0 / 57.9)	



37. Cooling Fan Drive Belt

- 1) Install the cooling fan drive belt.
- 2) Turn the adjusting bolt ① to move the generator and adjust the cooling fan drive belt tension.
Apply a force of 98 N (10 kg/22 lb) to the drive belt mid-portion to check the belt deflection.

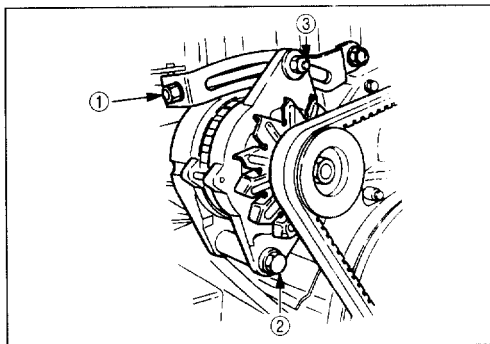
Cooling Fan Drive Belt Deflection	mm(in)
8 - 11 (0.3 - 0.4)	

- ① Crankshaft pulley
- ② Generator pulley
- ③ Cooling fan pulley

- 3) Tighten the generator bolt ② and the adjusting plate nut ③ to the specified torque.

Generator Bolt Torque	N·m(kg·m/lb.ft)
137.3 (14.0 / 101.2)	

Adjusting Plate Nut Torque	N·m(kg·m/lb.ft)
92.9 (9.5 / 68.7)	

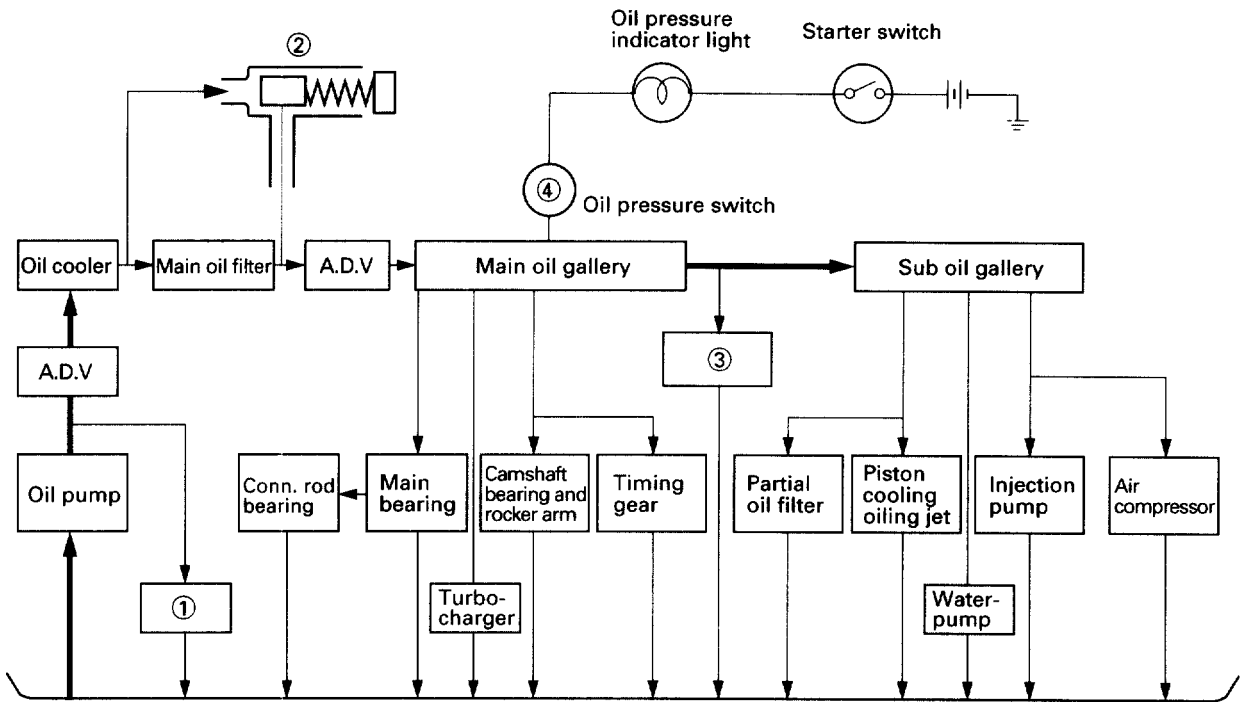


LUBRICATING SYSTEM
MAIN DATA AND SPECIFICATIONS

Item		6SD1 & 6SD1TC
Oil pump type		Gear
Relief valve opening pressure	kPa (kg/cm ² /psi)	1060 (10.8/154)
Oil filter type		Cartridge type
Bypass valve opening pressure	kPa (kg/cm ² /psi)	196.0 (2.0/28.4)
Partial oil filter type		Cartridge type
Oil cooler		Plate type, water cooled

GENERAL DESCRIPTION

LUBRICATING OIL FLOW



Pressure Unit = kPa (kg/cm²/psi)

- ① Relief Valve Opening Pressure: 1,079.0 (11.0/156.4)
- ② Bypass Valve Opening Pressure: 196.0 (2.0/28.4)
- ③ Relief Valve Opening Pressure: 539.4 (5.5/78.2)
- ④ Oil Pressure Switch Operating Pressure: 24.5 - 49.0 (0.25 - 0.5/3.6 - 7.1)

A.D.V : Anti - drain back valve

CO6HWO05

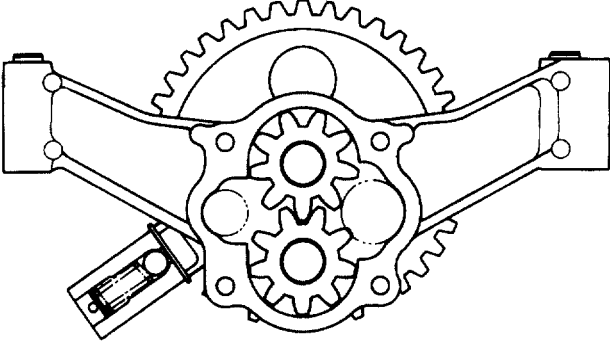
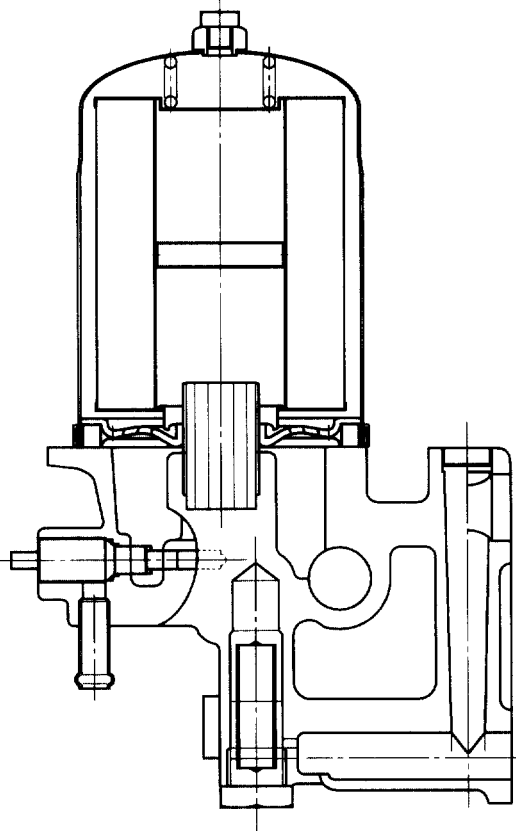
The engine uses a full flow lubricating system.

Lubricating oil is pumped from the oil pump to the cylinder body oil gallery through the oil cooler and the oil filter . It is then delivered to the vital parts of the engine from the cylinder body oil gallery.

The engine has oiling jets installed on the cylinder body that spray oil to the piston inside faces to achieve maximum cooling effect.

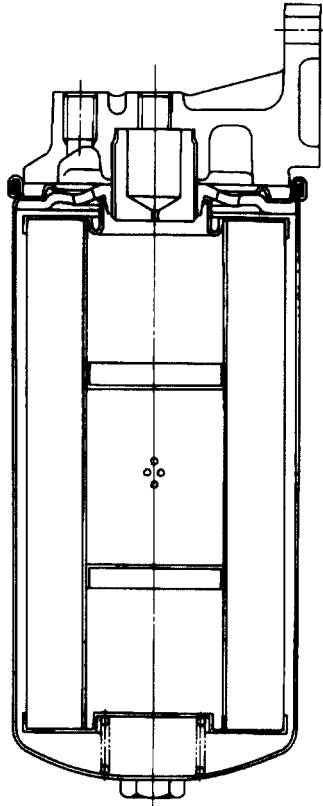
The engine is equipped with a partial oil filter. The partial oil filter protects against oil deterioration and provides longer lubricant life.

OIL PUMP AND MAIN OIL FILTER

OIL PUMP	CARTRIDGE TYPE OIL FILTER
	

D50MT004

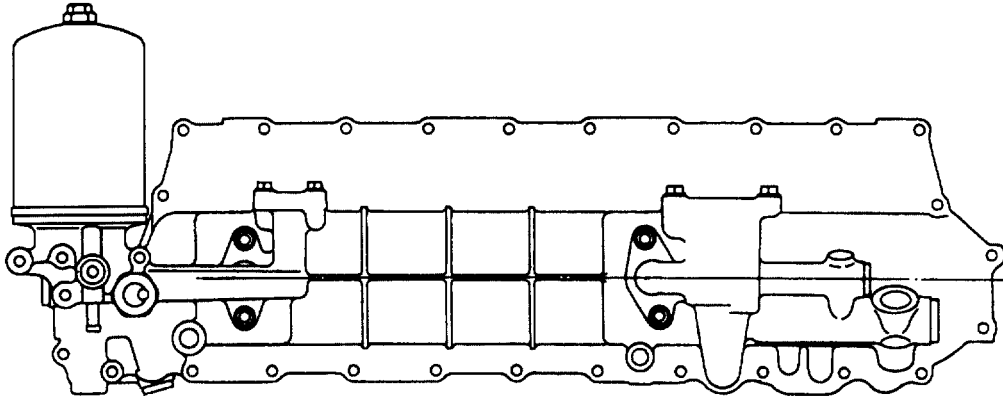
The gear type oil pump is driven by the crankshaft oil pump drive gear.
The oil pump forces oil through the oil cooler to the oil filter. The oil filter cleans the oil.
A replaceable cartridge type full flow main oil filter is used.

PARTIAL OIL FILTER**CARTRIDGE TYPE**

A replaceable cartridge type partial oil filter is used.

A portion of the oil is diverted to the partial oil filter before reaching the main oil filter. This oil is cleaned and delivered to the oil pan.

OIL COOLER



The temperature of the engine oil circulating through the lubricating system tends to rise with an accompanying decrease in lubricating efficiency.

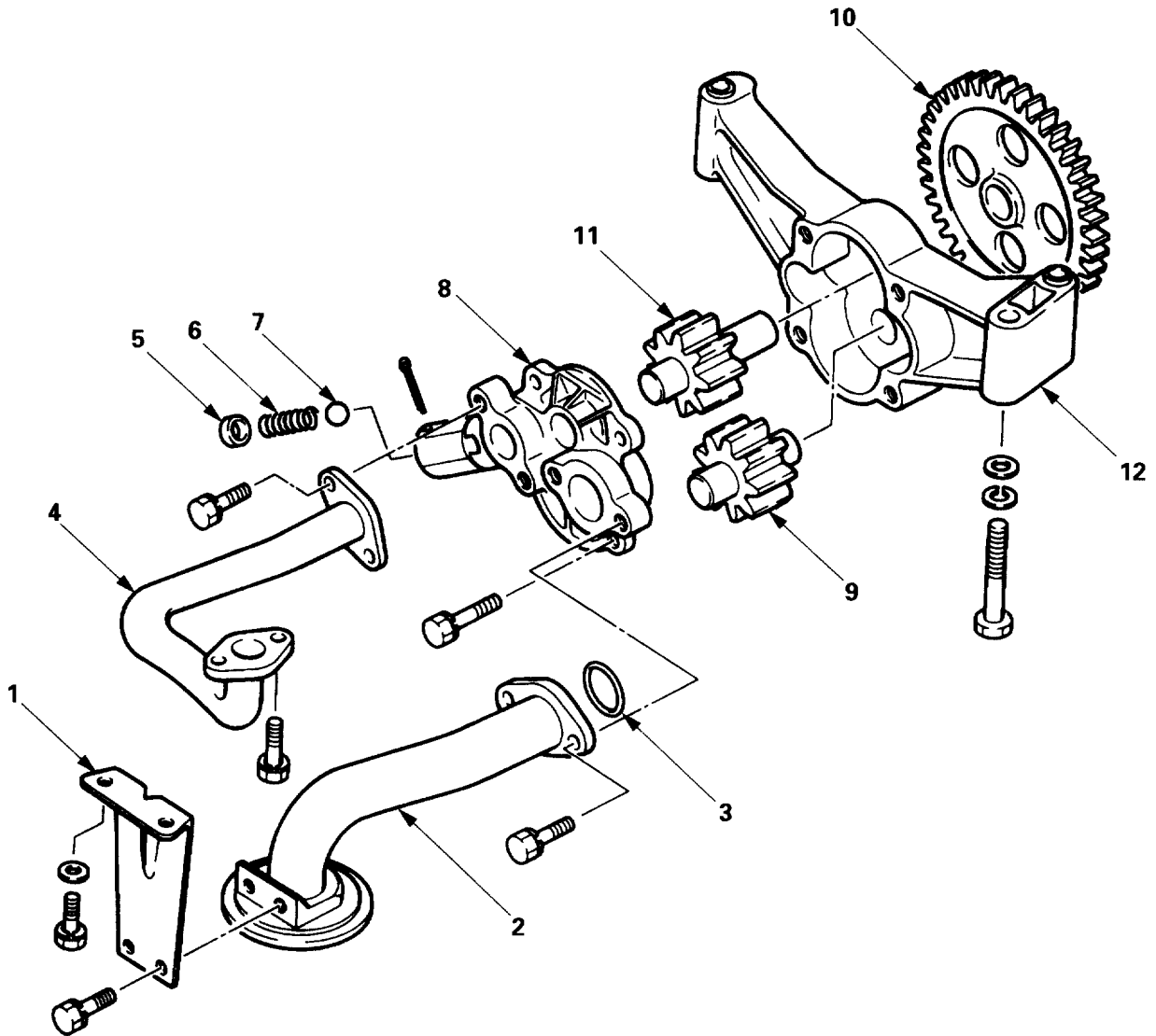
The oil cooler maintains the oil temperature at the optimum level for effective engine lubrication.

The oil cooler consists of the body and the cooling element.

OIL PUMP



DISASSEMBLY

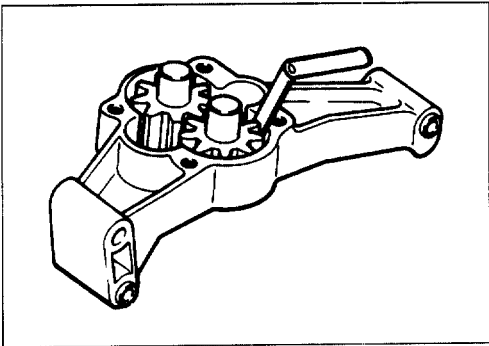
**Disassembly Steps**

- | | |
|------------------------------|-------------------------|
| 1. Oil strainer stay | 7. Oil relief valve |
| 2. Oil strainer and oil pipe | 8. Oil pump body cover |
| 3. O-ring | 9. Driven gear |
| 4. Oil pipe | 10. Oil pump drive gear |
| 5. Spring seat | 11. Drive gear shaft |
| 6. Spring | 12. Oil pump body |



INSPECTION AND REPAIR

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

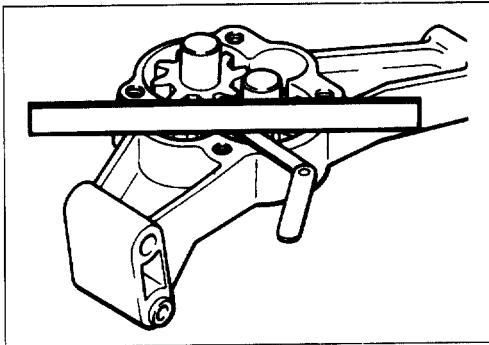


Gear Teeth and Body Inner Wall Clearance

Use a feeler gauge to measure the clearance between the gear teeth and the body inner wall.

If the clearance between the gear teeth and the body inner wall exceeds the specified limit, the gears and/or the body must be replaced.

Gear Teeth and Cover Inner Wall Clearance		mm(in)
Standard		Limit
0.10 - 0.196 (0.0039 - 0.0077)		0.20 (0.0079)

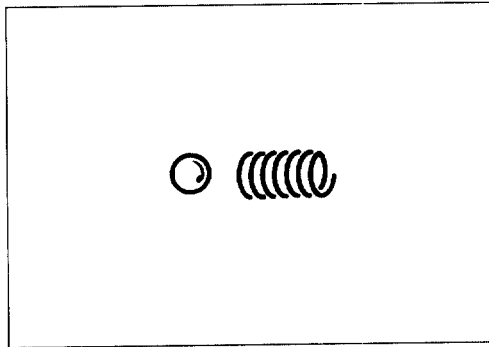


Gear and Body Clearance

Use a feeler gauge to measure the clearance between the body and the gear side surfaces.

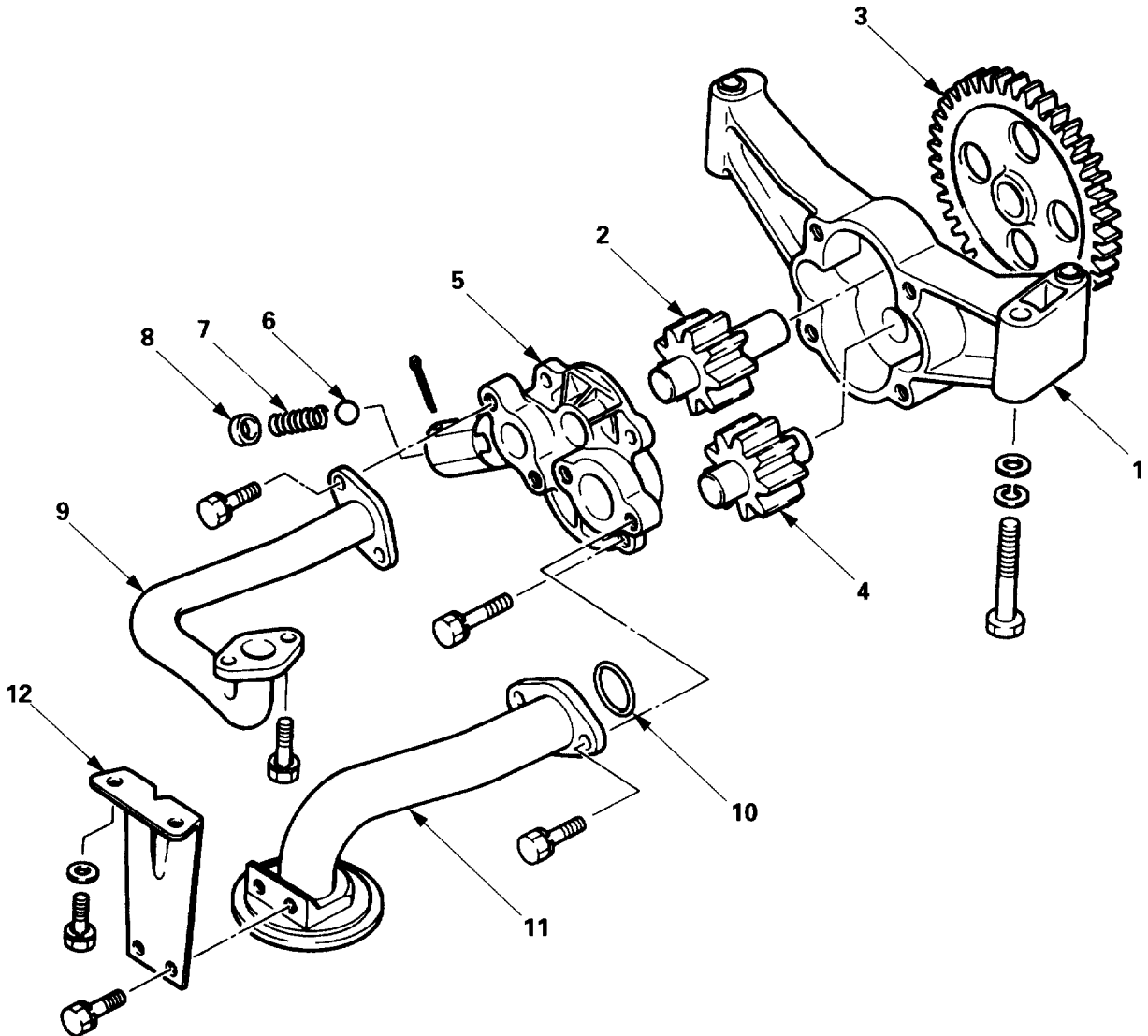
If the clearance between the gears and the body exceeds the specified limit, the gears and/or the body must be replaced.

Gear and Body Clearance		mm(in)
Standard		Limit
0.040 - 0.093 (0.0016 - 0.0036)		0.120 (0.0047)



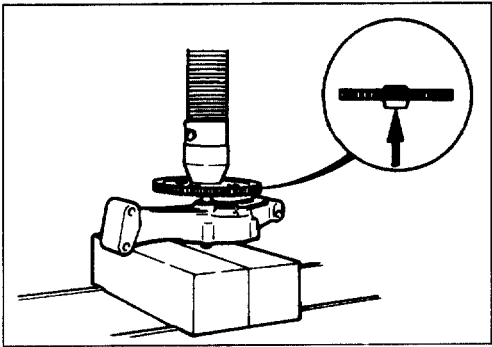
Oil Relief Ball Valve and Valve Spring

Check the oil relief ball valve and the valve spring for excessive wear and damage.

**REASSEMBLY****Reassembly Steps**

- 1. Oil pump body
- ▲ 2. Drive gear shaft
- ▲ 3. Oil pump drive gear
- ▲ 4. Driven gear
- ▲ 5. Oil pump body cover
- 6. Oil relief valve

- 7. Spring
- 8. Spring seat
- ▲ 9. Oil pipe
- ▲ 10. O-ring
- ▲ 11. Oil strainer and oil pipe
- 12. Oil strainer stay

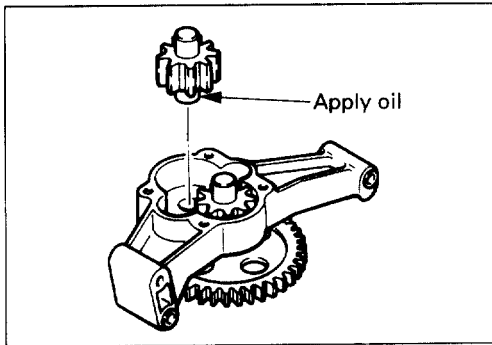


Important Operations

2. Drive Gear Shaft

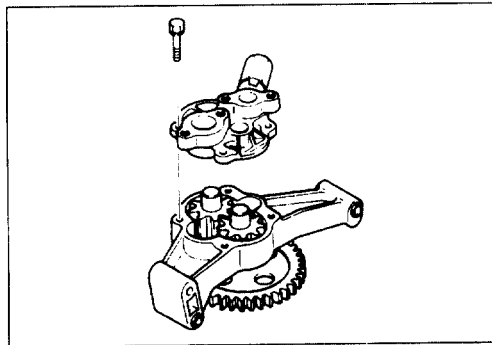
3. Oil Pump Drive Gear

- 1) Apply engine oil to the drive gear shaft.
- 2) Install the key to the drive gear shaft.
- 3) Turn the drive gear boss toward the oil pump body as shown in the illustration.
- 4) Use a press to install the drive gear.



4. Driven Gear

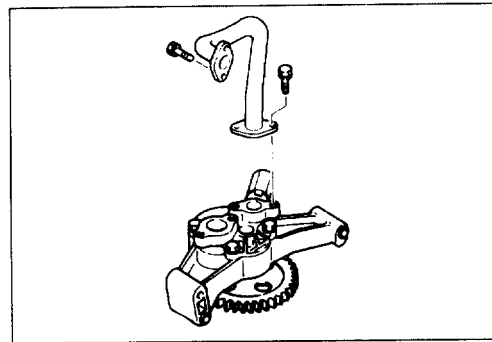
- 1) Apply engine oil to the driven gear.
- 2) Install the driven gear to the oil pump body.



5. Oil Pump Body Cover

- 1) Install the oil pump body cover to the oil pump body.
- 2) Tighten the oil pump body cover bolts to the specified torque.

Oil Pump Body Cover Bolt Torque	N·m(kg·m/lb.ft)
17.7 (1.8 / 13.0)	



9. Oil Pipe

- 1) Install the oil pipe and the O-ring to the oil pump body.
- 2) Tighten the oil pipe to the specified torque.

Oil Pipe Torque	N·m(kg·m/lb.ft)
18.6 (1.9 / 13.7)	

**10. O-Ring****11. Oil Strainer and Oil Pipe**

- 1) Apply engine oil to the O-ring.
- 2) Install the oil strainer and oil pipe and the O-ring to the oil pump body.
- 3) Tighten the oil pipe to the specified torque.

Oil Pipe Torque

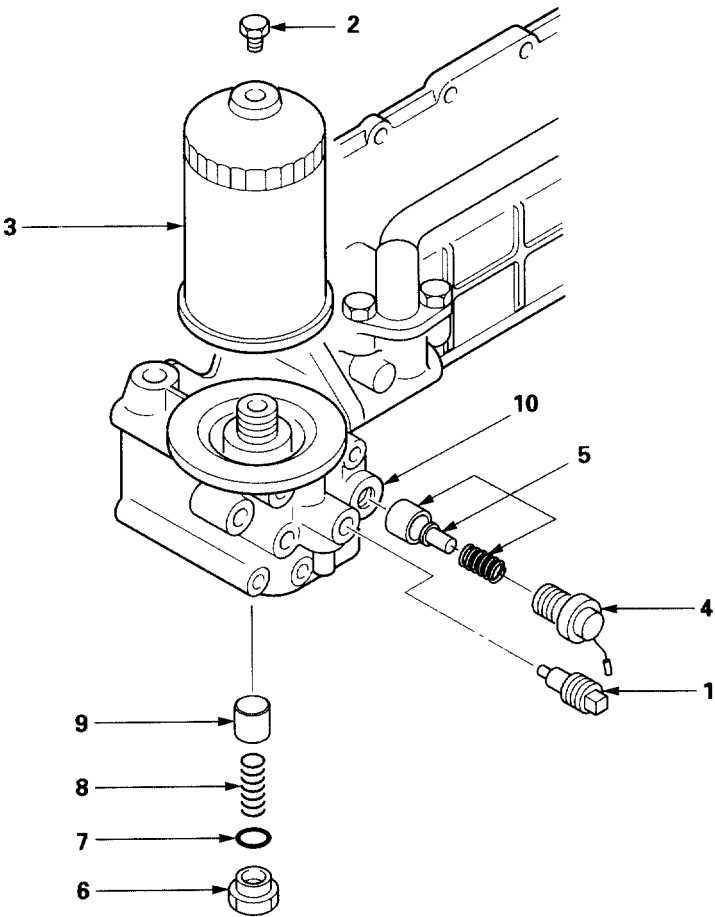
N·m(kg·m/lb.ft)

18.6 (1.9 / 13.7)

REPLACEABLE CARTRIDGE TYPE MAIN OIL FILTER



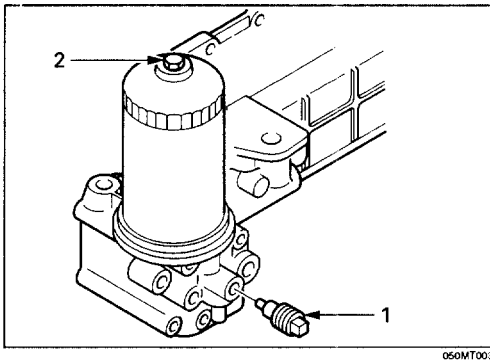
DISASSEMBLY



050MT002

Disassembly Steps

- ▲ 1. Oil filter drain plug
- ▲ 2. Plug
- 3. Oil filter cartridge
- 4. Oil filter warning switch
- 5. Bypass valve assembly
- 6. Plug
- 7. O-ring
- 8. Spring
- 9. Anti drain valve
- 10. Oil filter and cooler case



Important Operations

1. Oil Filter Drain Plug
2. Plug

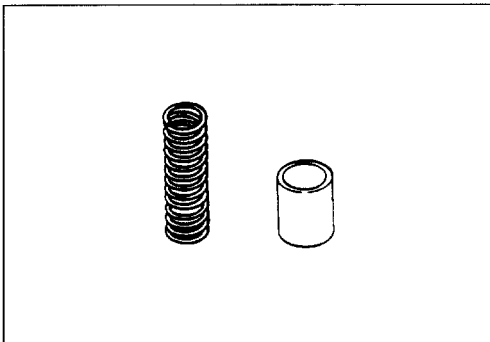
The following procedure is used when the oil filter element is changed with the engine on the vehicle. It will prevent engine oil spillage.

- 1) Loosen the oil filter drain plug ①.
- 2) Remove the plug ②.
- 3) Drain the engine oil from the oil filter.



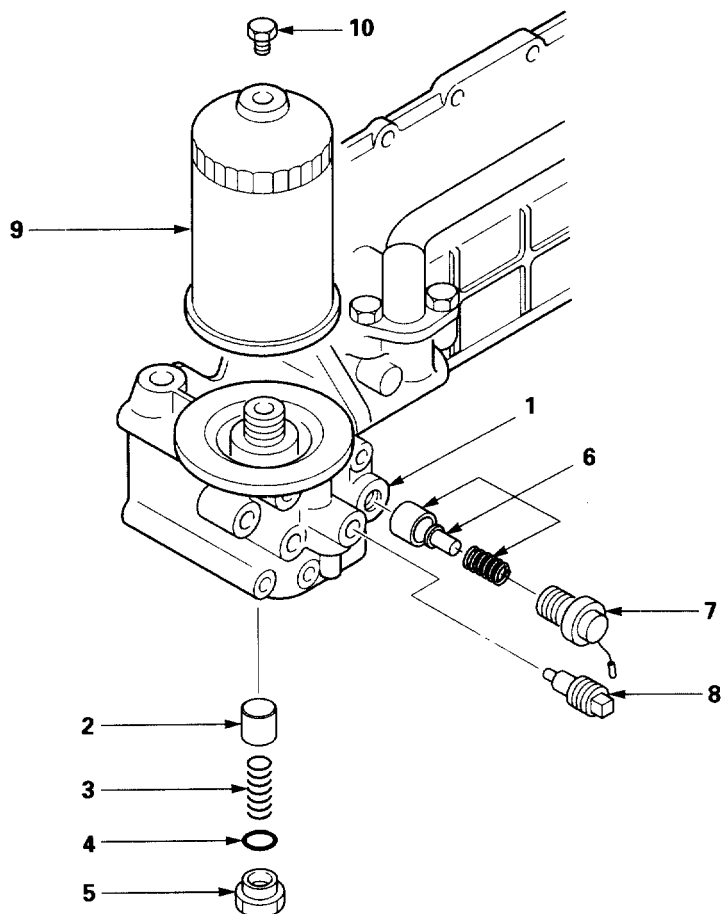
INSPECTION AND REPAIR

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



Bypass Valve Assembly

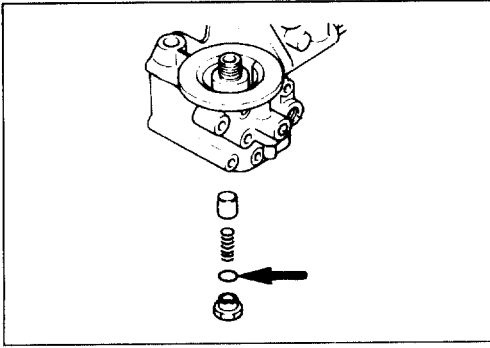
1. Check the bypass valve seat fitting surfaces for excessive wear and damage.
2. Check the valve spring for deterioration.

**REASSEMBLY**

050MT005

Reassembly Steps

- | | |
|-----------------------------------|--------------------------------|
| 1. Oil filter and oil cooler case | 6. Bypass valve assembly |
| 2. Anti drain valve | ▲ 7. Oil filter warning switch |
| 3. Spring | ▲ 8. Oil filter drain plug |
| 4. O-ring | ▲ 9. Oil filter cartridge |
| ▲ 5. Plug | 10. Plug |



Important Operations

5. Plug

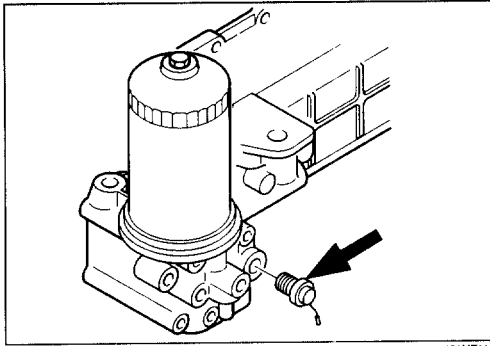
- 1) Apply engine oil to the O-ring.
- 2) Tighten the bypass valve plug to the specified torque.



Plug Torque

N·m(kg·m/lb.ft)

34.3 (3.5 / 25.3)



050MT006



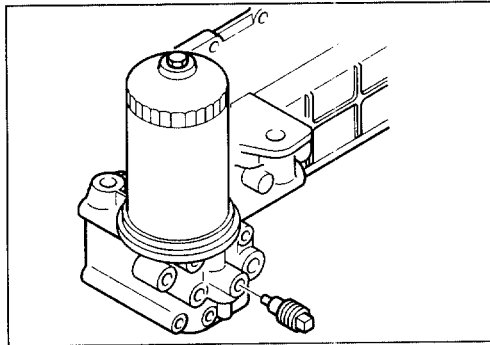
7. Oil Filter Warning Switch

Tighten the oil filter warning switch to the specified torque.

Oil Filter Warning Switch Torque

N·m(kg·m/lb.ft)

39.2 (4/28.9)



050MT007



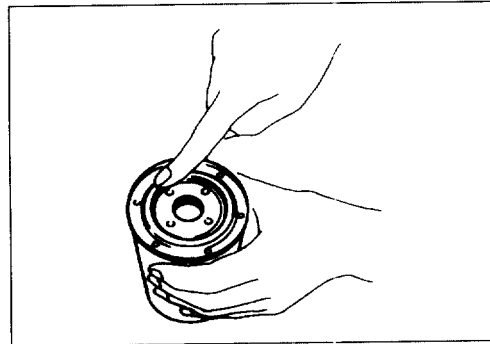
8. Oil Filter Drain Plug

Tighten the oil filter drain plug to the specified torque.

Oil Filter Drain Plug Torque

N·m(kg·m/lb.ft)

17.7 (1.8 / 13.0)



9. Oil Filter Cartridge

- 1) Apply engine oil to the O-ring.
- 2) Turn in the oil filter element until the filter sealing face makes contact with the O-ring.
- 3) Tighten the cartridge to the specified torque.

Oil Filter Cartridge Torque

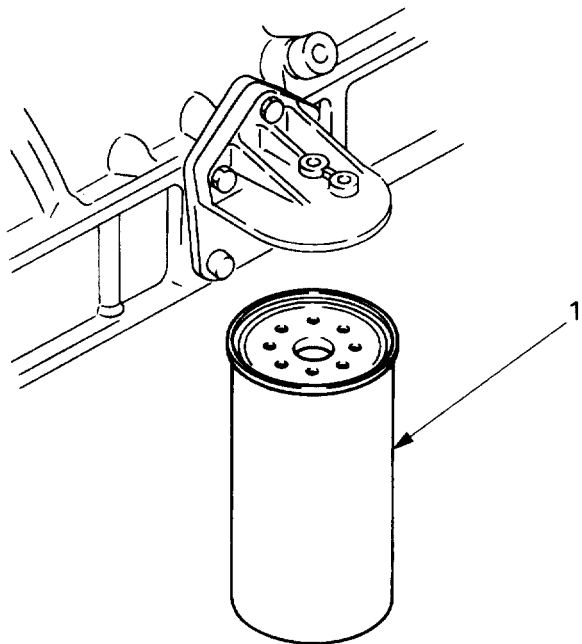
N·m(kg·m/lb.ft)

29 (3.0 / 21.7)

REPLACEABLE CARTRIDGE TYPE PARTIAL OIL FILTER



DISASSEMBLY

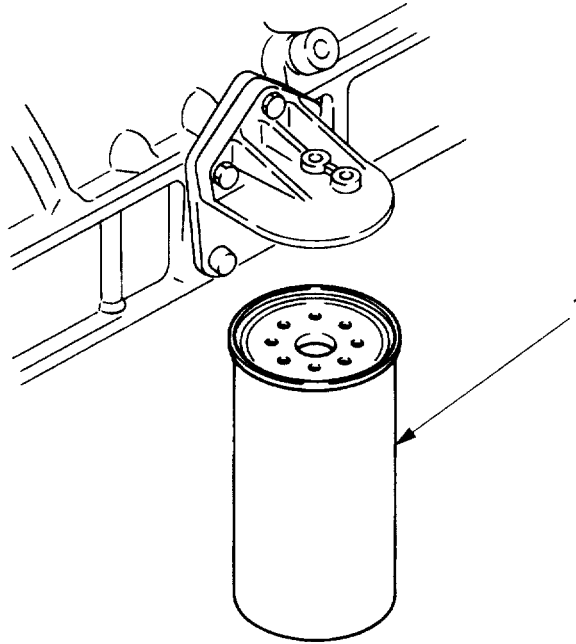


Disassembly Steps

1. Partial oil filter cartridge

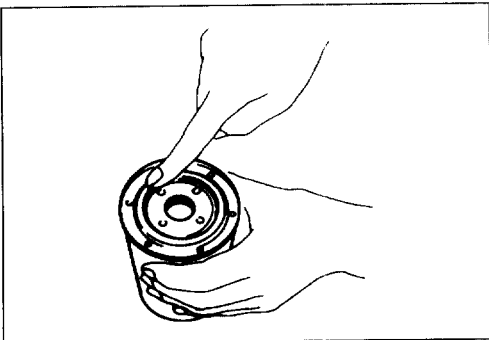


REASSEMBLY



Reassembly Steps

- ▲ 1. Partial oil filter cartridge



Important Operations

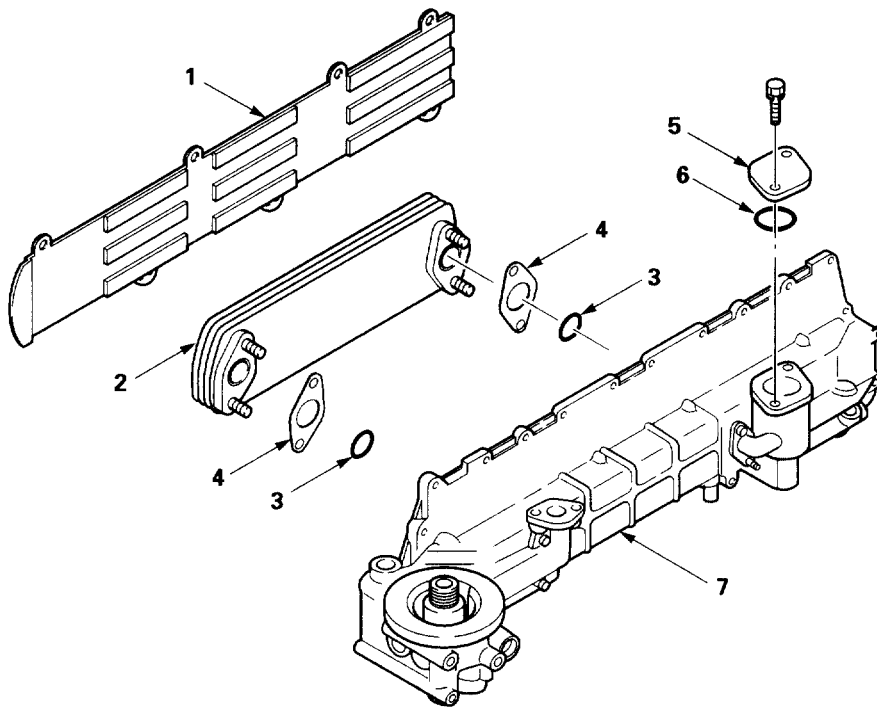
1. Oil Filter Cartridge

- 1) Apply engine oil to the O-ring.
- 2) Turn in the oil filter cartridge until the filter sealing face makes contact with the O-ring.
- 3) Turn in the oil filter cartridge an additional one turn.

OIL COOLER



DISASSEMBLY



050MT001

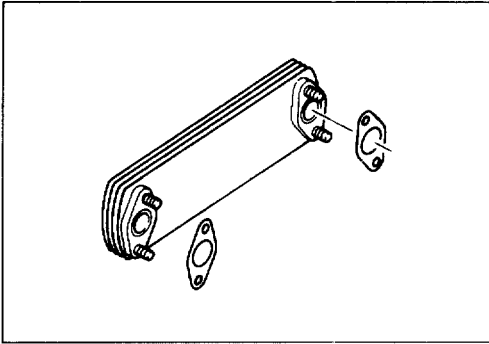
Disassembly Steps

- | | |
|-----------------------|-----------------------------------|
| 1. Water guide | 5. Cover |
| 2. Oil cooler element | 6. O-ring |
| 3. O-ring | 7. Oil filter and oil cooler case |
| 4. Gasket | |



INSPECTION AND REPAIR

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



Oil Cooler Element Cleaning Procedure

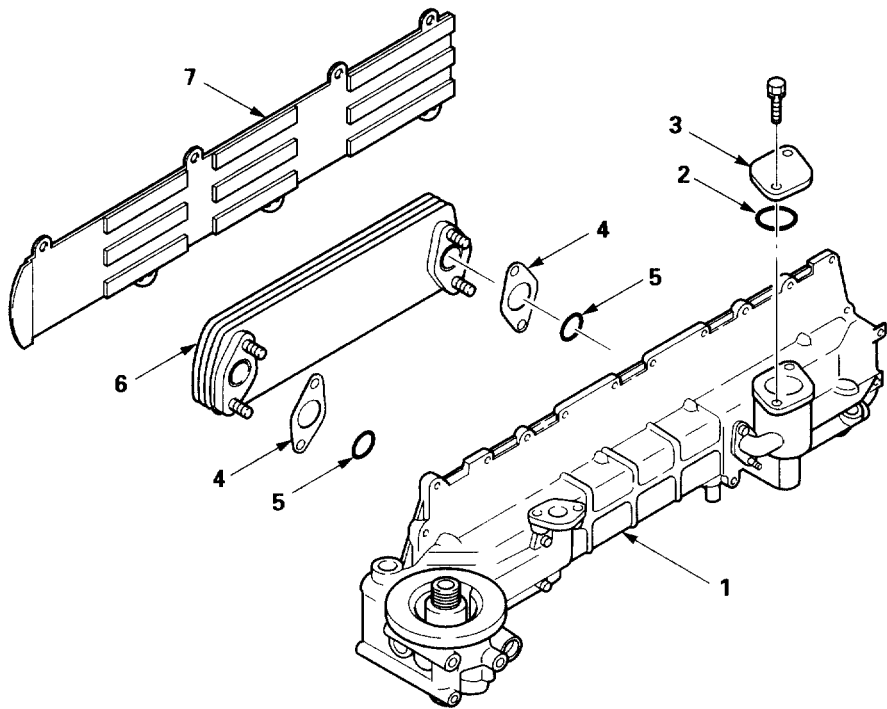
1. Use a funnel to pour cleaning solution into the oil cooler element.
Add cleaning solution until it overflows.
2. Allow the oil cooler element to stand for ten hours (with the cleaning solution inside).
3. Pour off approximately 1/3 of the cleaning solution from the element.
4. Apply compressed air at 196.2 kPa (2.0 kg/cm²/28.4 psi) to the element through the oil port.
Continue to apply compressed air until all of the cleaning solution has been forced from the element.

Note:

As long as the oil cooler element is not damaged or excessively dirty, it may be cleaned repeatedly at periodic intervals.



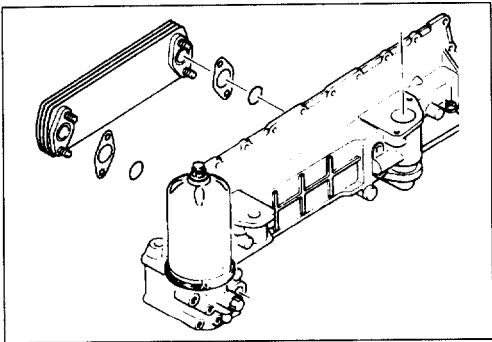
REASSEMBLY



050MT008

Reassembly Steps

- 1. Oil filter and oil cooler case
- 2. O-ring
- 3. Cover
- 4. Gasket
- 5. O-ring
- ▲ 6. Oil cooler element
- 7. Water guide



Important Operations

6. Oil Cooler Element

Install the oil cooler element to the oil cooler case and tighten it to the specified torque.

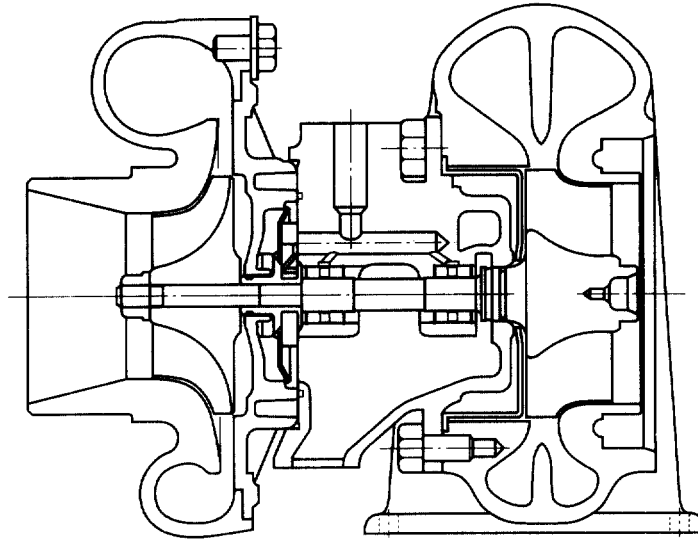
Oil Cooler Element Nut Torque	N·m(kg·m/lb.ft)
	19.6 (2.0 / 14.5)

TURBOCHARGER
MAIN DATA AND SPECIFICATIONS

Item	6SD1TC
Model	IHI RHE7
Turbine type	Radial, inward flow
Compressor type	Radial, outward flow
Maximum permissible speedrpm	120,000
Maximum air deliverykg(lb)/min	22 (48.4)
Maximum pressure ratioTo 1	3
Exhaust gas temperature*°C(°F)	750 (1,382)
Housing installation positiondeg	
Compressor	$\alpha = 115$
Turbine	$\beta = 45$
Weightkg(lb)	Approximately 12 (26.5)
Manufacturer	Ishikawajima Harima Industry (IHI)

* Maximum allowable exhaust gas temperature measured at the turbocharger exhaust gas inlet.

GENERAL DESCRIPTION



037MT002

Major turbocharger components are the Center Housing and Rotating Assembly (CHRA), the compressor housing, and the turbine housing.

Rotating parts include the turbine shaft, the compressor wheel, the shaft bearings, the thrust washers, and the oil seal rings.

These parts are supported by the center housing.

The turbocharger increases air intake efficiency. This results in increased engine power, reduced fuel consumption, and minimal engine noise.

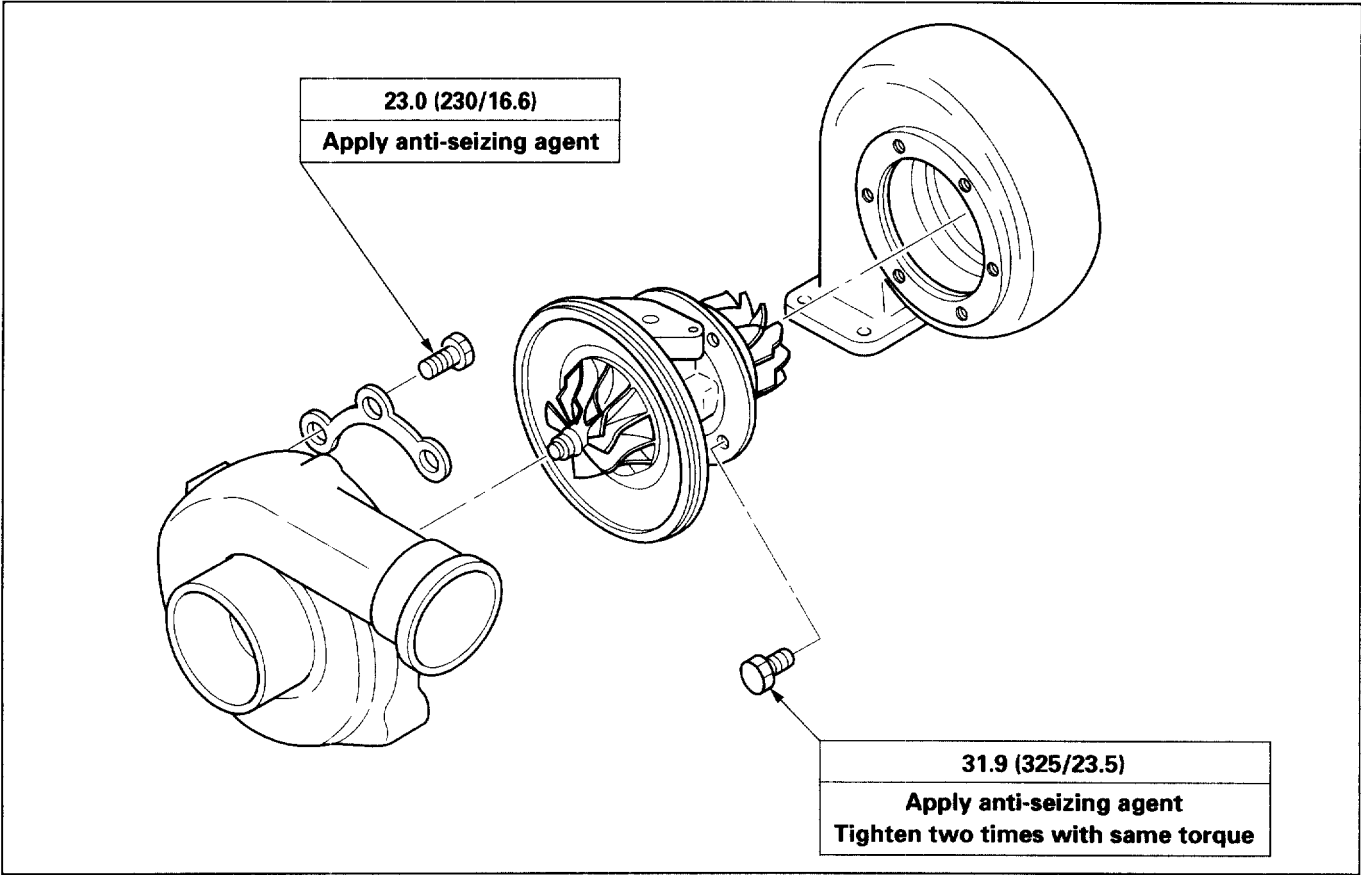
Turbocharger rotating parts operate at very high speeds and temperatures. Part materials have been carefully selected and machined to extremely high precision.

Turbocharger nuts and bolts are based on the inch system.



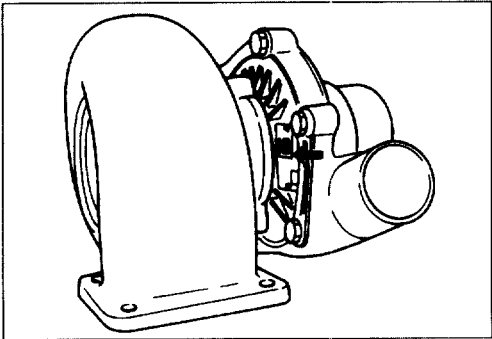
TORQUE SPECIFICATIONS

N·m(kg·cm/lb.ft)



037M/T001

IDENTIFICATION PLATE AND ASSEMBLY NUMBER



The turbocharger nameplate gives the date of manufacture and other important information required to identify the unit when service inquiries are made.

Name plate example

Turbo Spec.	①
Serial No.RHE7	②
Parts No.	③

F06MT012

The turbocharger nameplate has the following information stamped on it. Refer to the illustration.

- ① Turbocharger specification, production year and production month.
Example: VIBM 9512
- ② Production date, serial number and production line name.
Example: RHE7 12003C
- ③ Part number assigned by ISUZU MOTORS LIMITED.
Example: 1144003560

Part numbers ③ indicate specific designs or configurations.

TURBOCHARGER SERVICING

1. Refer to TROUBLESHOOTING in this Manual to determine whether or not turbocharger repair or overhaul is required.
2. The following procedures should also be performed (either with the turbocharger on the vehicle or removed from the vehicle but not disassembled) to determine whether or not turbocharger repair or overhaul is required.
 - * Visual checks
 - * Clearance measurements
 - * End play measurements

Refer to INSPECTION AND REPAIR.

3. The turbocharger compressor and turbine housing may be removed from the center housing and rotating assembly (CHRA) for further visual inspection.
Refer to DISASSEMBLY and REASSEMBLY.

PRECAUTIONS

Turbocharger servicing requires great care and expertise.

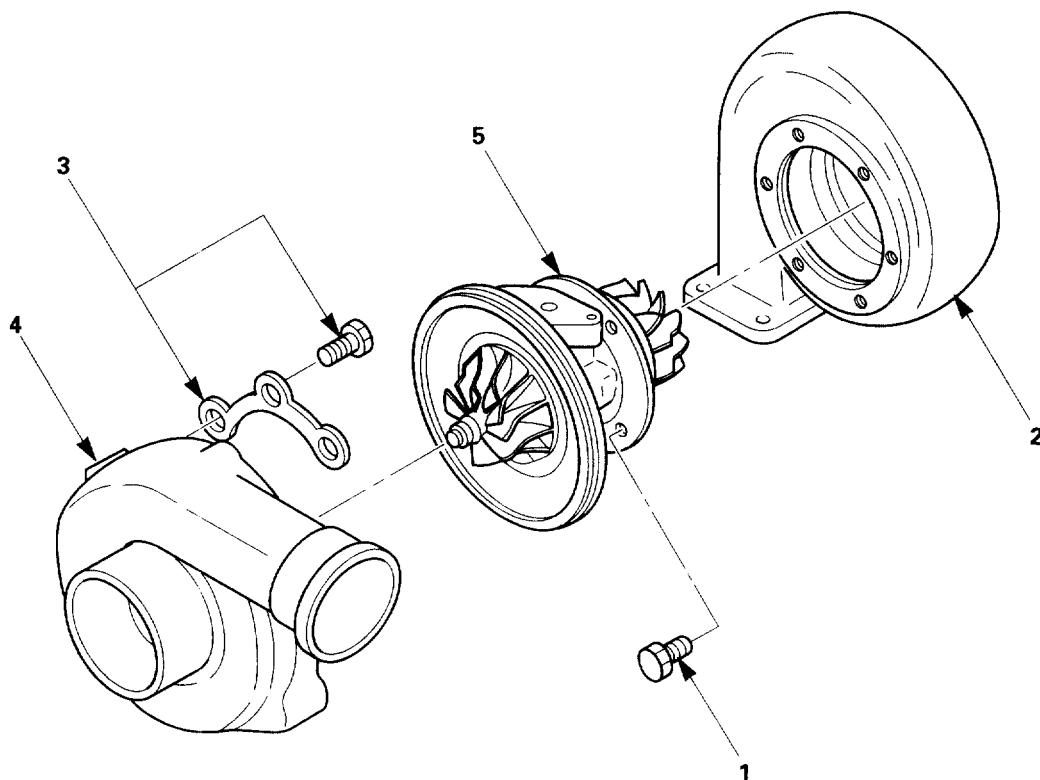
Faulty turbocharger servicing procedures can result in serious damage to pistons, valves, cylinder liners, and other important engine parts.

ISUZU does not recommend the performance of any servicing procedure not specifically described in this Manual.

Contact your nearest IHI service facility to have the turbocharger assembly repaired or overhauled.

The identification plate and assembly number will be required by the service facility.

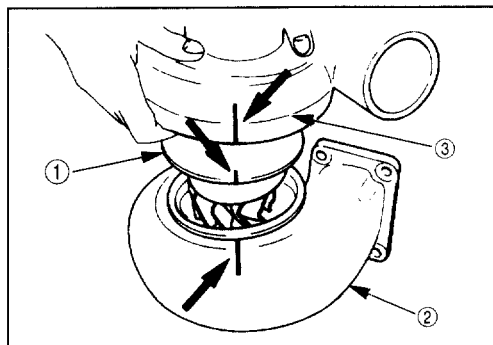
A list of IHI Turbocharger Service Network locations is given at the end of this Section.

**DISASSEMBLY**

037MT004

Disassembly Steps

- 1. Bolt
- ▲ 2. Turbine housing
- 3. Clamp and bolt
- ▲ 4. Compressor housing
- ▲ 5. Center housing and rotating assembly



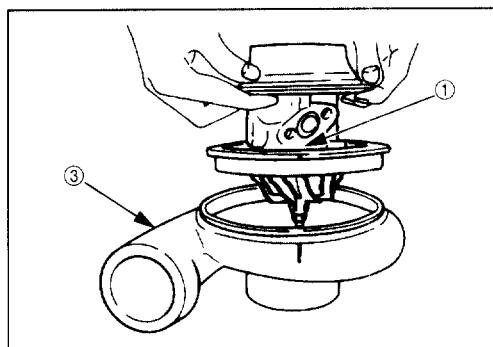
Important Operations

2. Turbine Housing

4. Compressor Housing

5. Center Housing and Rotating Assembly

- 1) Apply a setting mark across the center housing and rotating assembly ①, the turbine housing ②, and the compressor housing ③.



- 2) Disassemble the parts.

Handle the parts with extreme care.

Be particularly careful not to damage the turbine wheel blades and the compressor wheel blades.

Take care not to allow foreign material to enter the center housing.

Note:

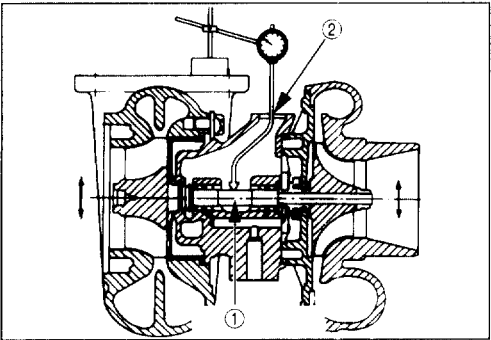
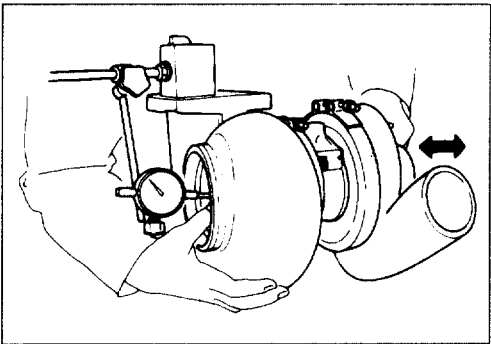
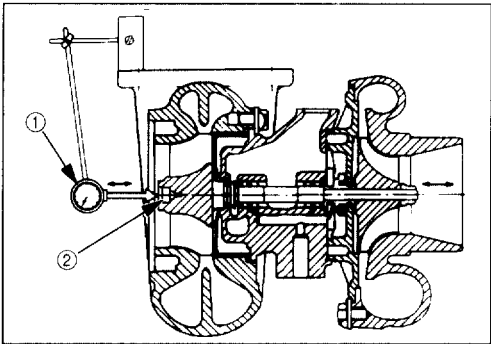
Disassembly and servicing of the center housing and rotating assembly is not recommended.



INSPECTION AND REPAIR

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

Minor servicing operations are described in this Section.
Contact the nearest IHI SERVICE FACILITY for major repairs and maintenance.
Refer to IHI SERVICE NETWORK at the end of this Section for the location of your area's IHI SERVICE FACILITY.



Turbine Shaft End Play

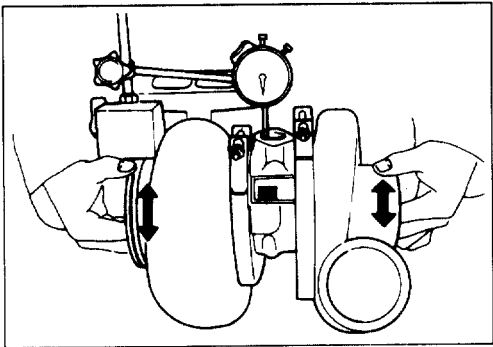
1. Set a dial indicator ① to the turbine shaft end ②.
2. Apply a force of 1.2 kg (2.6 lb/11.76 N) alternately to the compressor wheel end and the turbine wheel end.
3. Read the dial indicator.

Turbine Shaft End Play	mm(in)
Standard	
0.06 - 0.09 (0.0024 - 0.0035)	



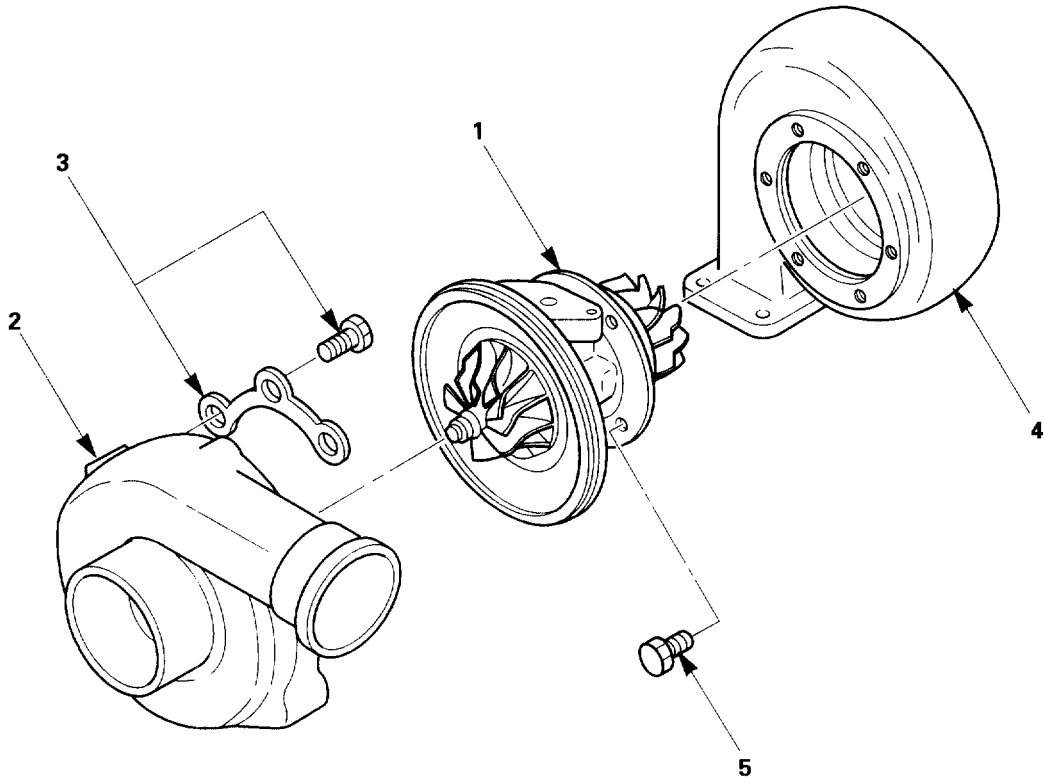
Turbine Shaft and Bearing Clearance

1. Set a dial indicator to the turbine shaft center ① through the center housing oil drain port ②.



- 2. Move the turbine shaft from side to side.
- 3. Read the dial indicator.

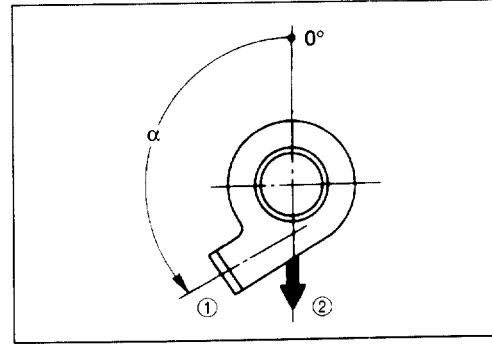
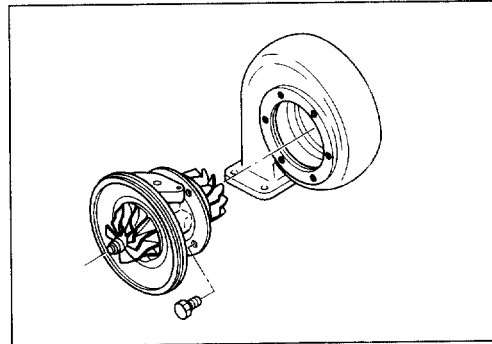
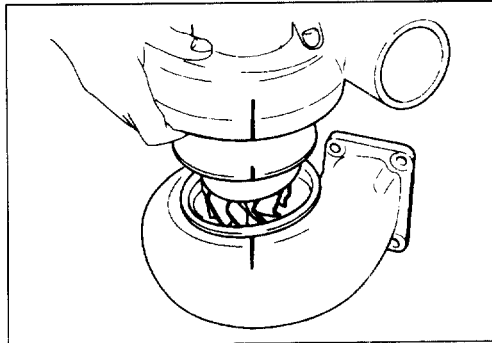
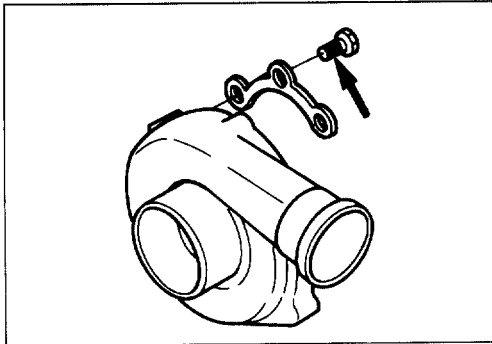
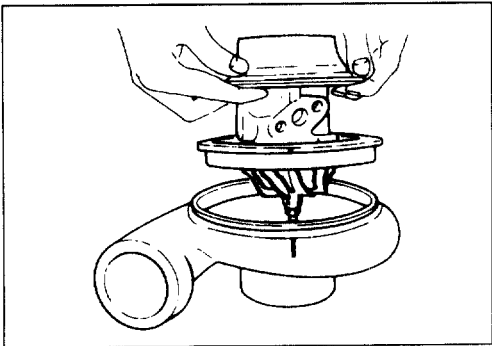
Turbine Shaft and Bearing Clearance	mm(in)
Standard	
0.11 - 0.18 (0.0043 - 0.0071)	

**REASSEMBLY**

037MT003

Reassembly Steps

- ▲ 1. Center housing and rotating assembly
- ▲ 2. Compressor housing
- ▲ 3. Clamp and bolt
- ▲ 4. Turbine housing
- ▲ 5. Bolt



Important Operations

1. **Center Housing and Rotating Assembly**
2. **Compressor Housing**
3. **Clamp and Bolt**

- 1) Align the setting marks (applied at disassembly) on the center housing and rotating assembly and the compressor housing.

Handle the parts with extreme care to avoid damaging the compressor wheel blades.



- 2) Apply an anti-seizing agent (LOCTITE ANTISEIZE LUBRICANT or the equivalent) to the new bolt threads.
- 3) Install the clamp and bolts to the compressor housing.
- 4) Tighten the bolts to the specified torque.

Compressor Housing Bolt Torque	N·m(kg·cm/lb.ft)
23.0 (230.0 0/ 16.6)	



4. **Turbine Housing**
5. **Bolt**

- 1) Align the setting marks (applied at disassembly) on the center housing and rotating assembly and the turbine housing.

Handle the parts with extreme care to avoid damaging the turbine shaft wheel blades.



- 2) Apply an anti-seizing agent (LOCTITE ANTISEIZE LUBRICANT or the equivalent) to the new bolt threads.
- 3) Install the bolts to the turbine housing.
- 4) Tighten the bolts to the specified torque.

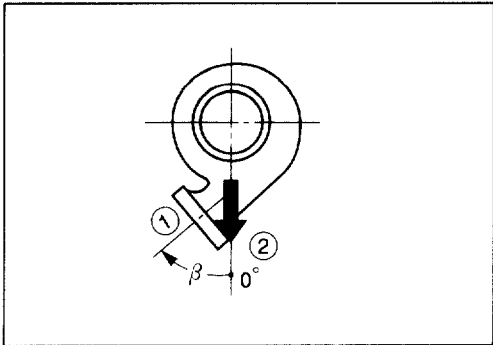
Turbine Housing Bolt Torque	N·m(kg·cm/lb.ft)
31.9 (325 / 23.5)	

- 5) Check that the rotating assembly turns smoothly.

Compressor Housing Installation Position

Installation Angle (Reference) shown from comp. side		deg
α	115	

- ① Air outlet port
- ② Oil drain port (CHRA)



Turbine Housing Installation Position

Installation Angle (Reference)
shown from turbine side

β	deg
	45

- ① Exhaust gas inlet port
- ② Oil drain port (CHRA)

IHI SERVICE NETWORK

For inquiries relating to turbochargers, please contact your ISUZU distributor or the nearest IHI Turbocharger Service Facility.

HEADQUARTERS

ISHIKAWAJIMA HARIMA HEAVY INDUSTRIES CO., LTD. (IHI)

General Machinery Division
Tokyo Chuo Building 1-6-2 Marunouchi Chiyoda-ku
Tokyo 100-0005 JAPAN
TEL: 81-(3)-3286-2405 to 2407 (3 lines)
FAX: 81-(3)-3286-2430

CHINA

IHI BEIJING OFFICE

Room 705, China World Trade Center, No.1 Jian Guo Men Wai Avenue
Beijing, People's Republic of CHINA
TEL: 86-(1)-505-4997, 0408
FAX: 86-(1)-505-4350
TLX: 210343 IHIPK CN

TAIWAN

IHI TAIPEI OFFICE

Room 1202, Chia Hsin Building, No.96 Chung Shan
North Road, Section 2, Taipei, TAIWAN
TEL: 886-(2)-542-5520, 5521, 5523
FAX: 886-(2)-542-4362
TLX: 11320 IHICO

THAILAND

IHI BANGKOK OFFICE

8th Floor, Thaniya Building, 62 Silom Road, Bangkok, THAILAND
TEL: 66-(2)-236-3490, 7356, 9099
FAX: 66-(2)-236-7340
TLX: 82375 IHICO TH

MALAYSIA

IHI KUALA LUMPUR OFFICE

Letter Box No.52, 22nd Floor, UBN Tower,
10 Jin. P. Ramlee 50250 Kuala Lumpur, MALAYSIA
TEL: 60-(3)-232-1255, 1271
FAX: 60-(3)-232-1418
TLX: IHI KLMA 20257

INDONESIA

IHI JAKARTA OFFICE

9th Floor, Skyline Building Jl. M.H. Thamrin, No.9, Jakarta, INDONESIA
TEL: 62-(21)-32-2147, 390-2211
FAX: 62-(21)-32-3273
TLX: 44175 IHIJKT

SECTION 6B

COOLING SYSTEM

TABLE OF CONTENTS

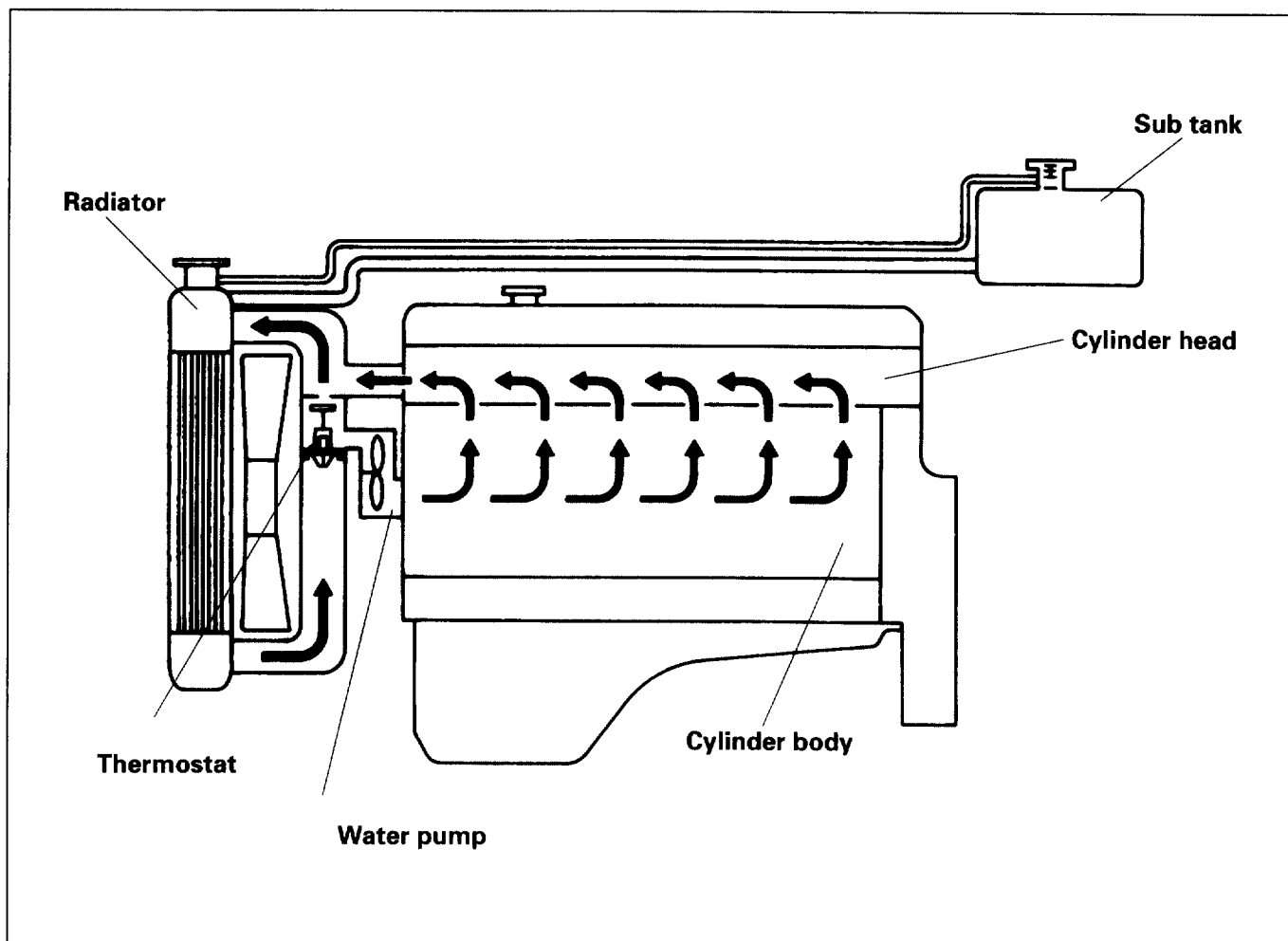
	PAGE
Main Data and Specifications	6B – 2
General Description	6B – 3
Water Pump Repair Kit	6B – 6
Water Pump	6B – 7
Disassembly	6B – 7
Inspection and Repair	6B – 9
Reassembly	6B – 11
Thermostat	6B – 14
Inspection and Repair	6B – 14

MAIN DATA AND SPECIFICATIONS

Item	Description
Water pump type	Centrifugal impeller (Engine oil lubricating system)
Thermostat type	Wax pellet
Valve initial opening temperature °C (°F)	74.5 - 78.5 (166 - 173)
Valve full opening temperature °C (°F)	90 (194)
Valve lift at fully open position mm(in)	10 (0.39) or more

GENERAL DESCRIPTION

COOLANT FLOW



The engine cooling system consists of the radiator, the reserve tank, the water pump, the cooling fan, and the thermostat.

To quickly increase cold engine coolant temperature for smooth engine operation, the coolant is circulated by the water pump and the thermostat through the radiator bypass and directly back to the cylinder body. The coolant does not circulate through the radiator at this time.

When the coolant temperature reaches 74.5°C (166°F), the thermostat will begin to open and a gradually increasing amount of coolant will circulate through the radiator.

The thermostat will be fully open when the coolant temperature reaches 90°C (194°F). All of the coolant is now circulating through the radiator for effective engine cooling.

Engine coolant change procedure.

1. To change engine coolant, make sure that the engine is cool.

WARNING

When the coolant is heated to a high temperature, be sure not to loosen or remove the radiator cap. Otherwise you might get scalded by hot vapor or boiling water. To open the radiator cap, put a piece of thick cloth on the cap and loosen the cap slowly to reduce the pressure when the coolant has become cooler.

2. Open radiator cap and drain the cooling system by loosening the drain valve on the radiator and on the cylinder body.

NOTE

For best result it is suggested that the engine cooling system be flushed at least once a year. It is advisable to flush the interior of the cooling system including the radiator before using anti-freeze (ethylene-glycol based).

Replace damaged rubber hoses as the engine anti-freeze coolant is liable to leak out even minor cracks. Isuzu recommends to use Isuzu genuine anti-freeze (ethylene-glycol based) or equivalent, for the cooling system and not add any inhibitors or additives.

CAUTION

A failure to correctly fill the engine cooling system in changing or topping up coolant may sometimes cause the coolant to overflow from the filler neck even before the engine and radiator are completely full. If the engine runs under this condition, shortage of coolant may possibly result in engine overheating. To avoid such trouble, the following precautions should be taken in filling the system.

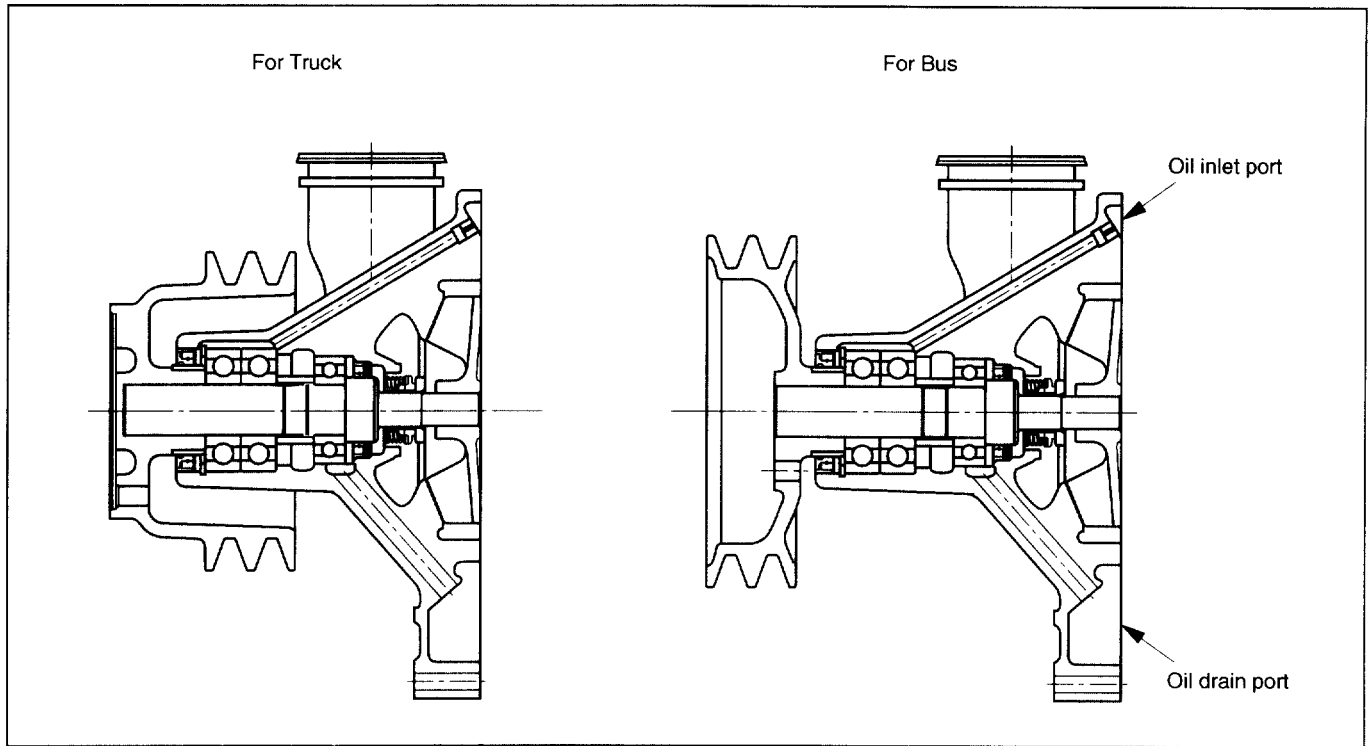
3. To refill engine coolant, pour coolant up to filler neck using a filling hose which is smaller in outside diameter of the filler neck. Otherwise air between the filler neck and the filling hose will block entry, preventing the system from completely filling up.
4. Keep a filling rate of 9 liter/min. or less. Filling over this maximum rate may force air inside the engine and radiator.
And also, the coolant overflow will increase, making it difficult to determine whether or not the system is completely full.
5. After filling the system to the full, pull out the filling hose and check to see if air trapped in the system is dislodged and the coolant level goes down. Should the coolant level go down, repeat topping-up until there is no more drop in the coolant level.
6. After directly filling the radiator, fill the reservoir to the maximum level.
7. Install and tighten radiator cap and start the engine. After idling for 2 to 3 minutes, stop the engine and reopen radiator cap. If the water level is lower, replenish.

WARNING

When the coolant is heated to a high temperature, be sure not to loosen or remove the radiator cap. Otherwise you might get scalded by hot vapor or boiling water. To open the radiator cap, put a piece of thick cloth on the cap and loosen the cap slowly to reduce the pressure when the coolant has become cooler.

8. After tightening radiator cap, warm up the engine at about 2,000 rpm.
Set heater adjustment to the highest temperature position, and let the coolant circulate also into heater water system.
9. Check to see the thermostat has opened through the needle position of water thermometer, conduct a 5-minute idling again and stop the engine.
10. When the engine has been cooled, check filler neck for water level and replenish if required. Should extreme shortage of coolant is found, check the coolant system and reservoir tank hose for leakage.
11. Fill the coolant into the reservoir tank up to "MAX" line.

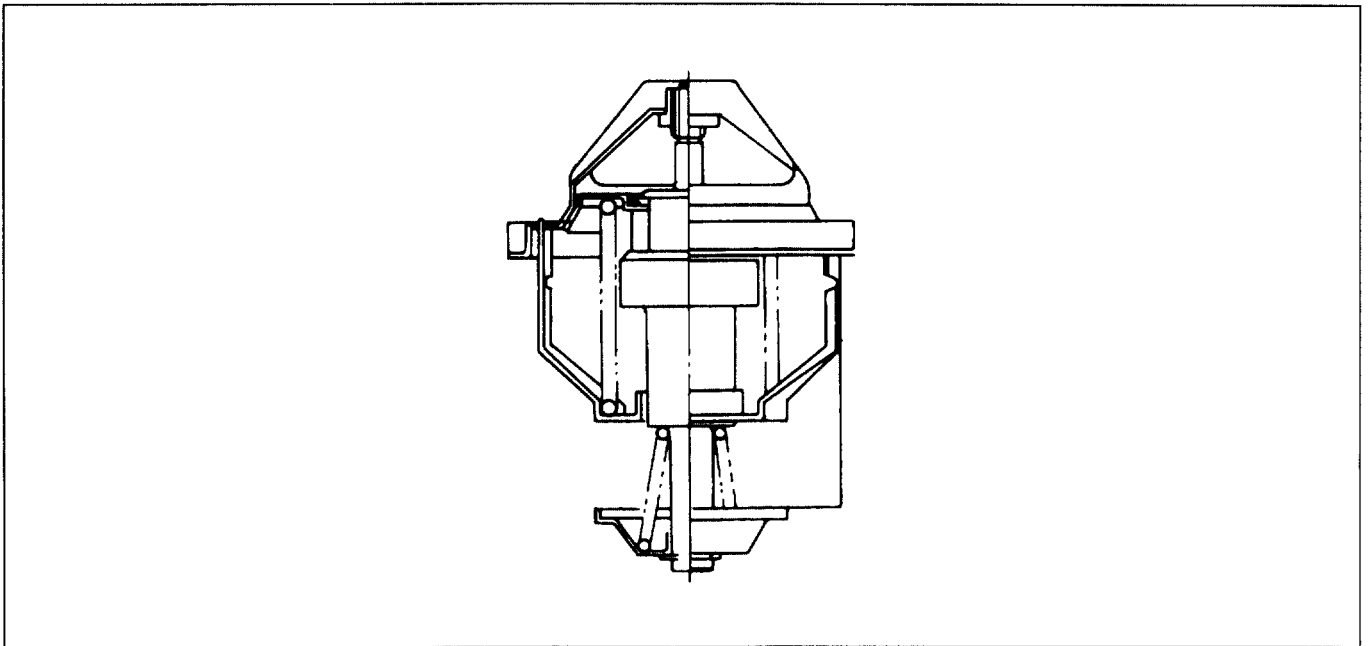
WATER PUMP



A centrifugal type water pump circulates the coolant through the cooling system.

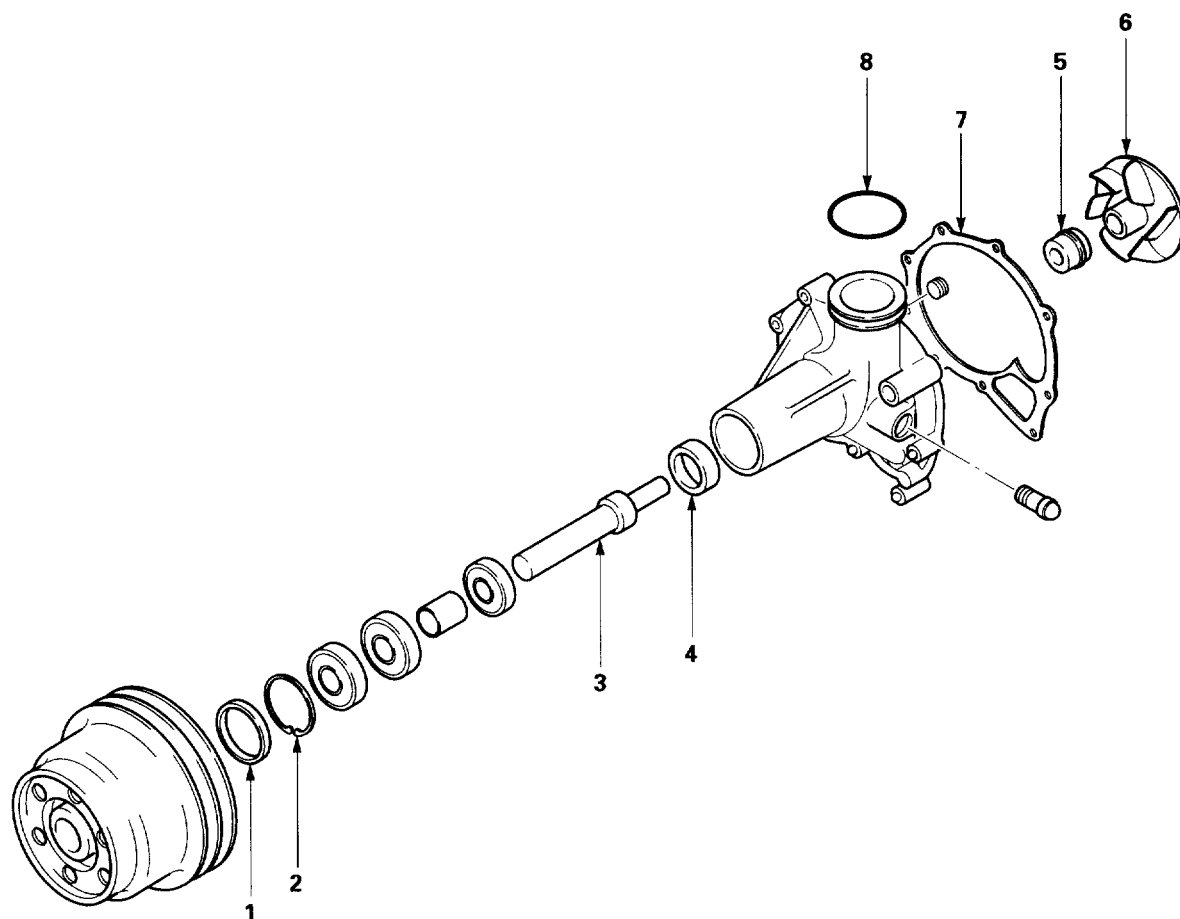
The water pump has an engine oil lubricating system no need greasing. Maintenance must be performed at the specified intervals.

THERMOSTAT



A wax pellet type thermostat is used.

WATER PUMP REPAIR KIT



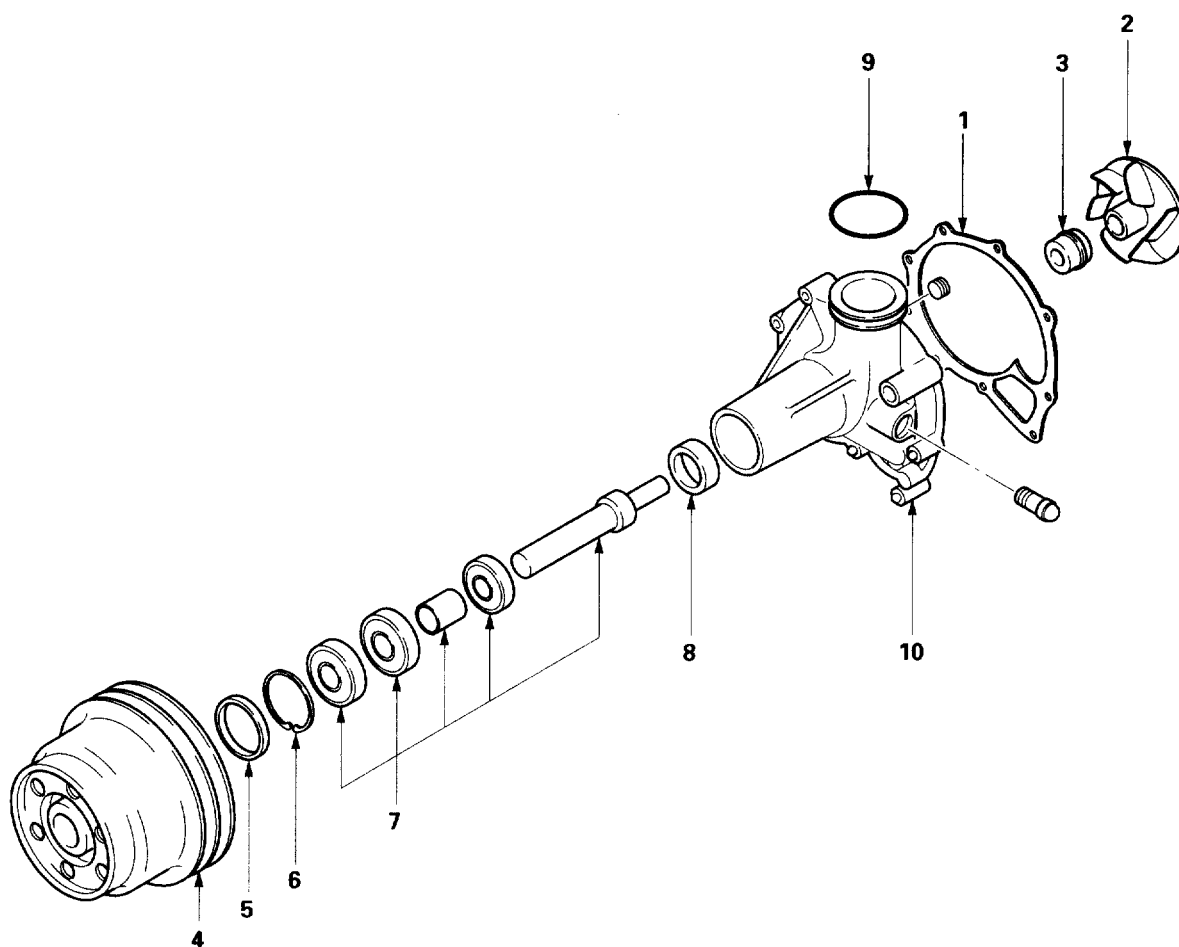
1. Oil seal
2. Snap ring
3. Water pump shaft
4. Oil seal

5. Seal unit
6. Impeller
7. Gasket
8. O-ring

WATER PUMP



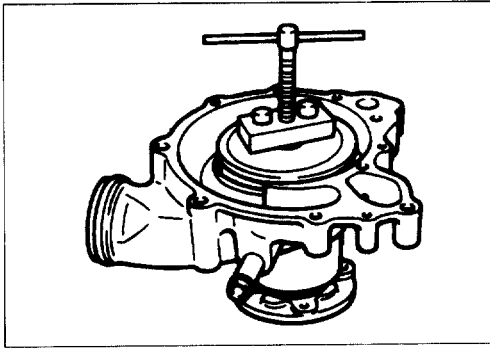
DISASSEMBLY



030MT004

Disassembly Steps

- | | |
|-------------------------|--|
| 1. Gasket | ▲ 7. Water pump shaft and ball bearing |
| ▲ 2. Impeller | 8. Oil seal |
| 3. Seal unit | 9. O-ring |
| ▲ 4. Cooling fan pulley | 10. Water pump body |
| 5. Oil seal | |
| 6. Snap ring | |



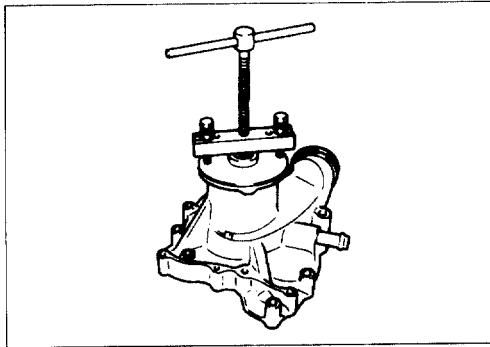
Important Operations



2. Impeller

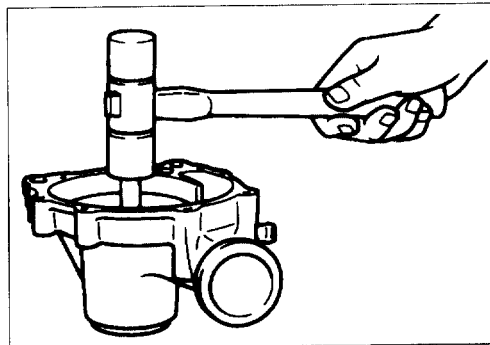
- 1) Clamp the pump body in a vise.
- 2) Use the water pump impeller remover to remove the impeller.

Water Pump Impeller Remover: 1-85210-047-0



4. Cooling Fan Pulley

Use a remover to remove the fan pulley.



7. Water Pump Shaft and Ball Bearing

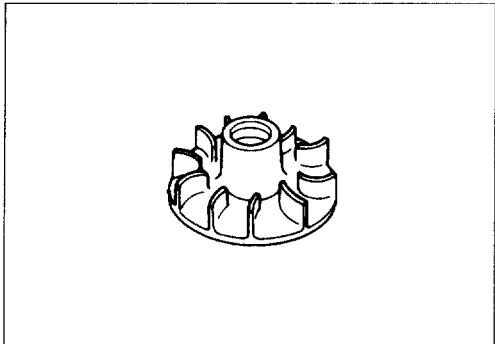
Use a plastic hammer to lightly tap the water pump shaft free.

Tap on the shaft from the impeller side.



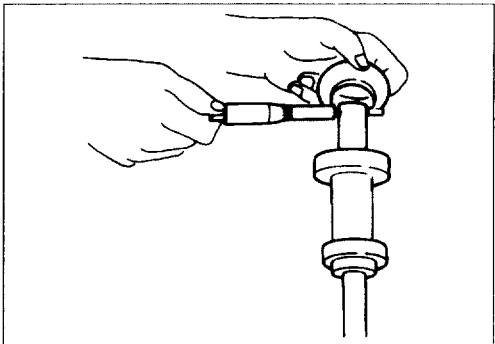
INSPECTION AND REPAIR

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



Water Pump Impeller

1. Check the impeller for corrosion.
2. Check the seal unit fitting faces for excessive wear and other damage.



Water Pump Shaft and Ball Bearing

1. Check the oil seal fitting faces for excessive wear and damage.
2. Measure the water pump shaft and impeller interference.

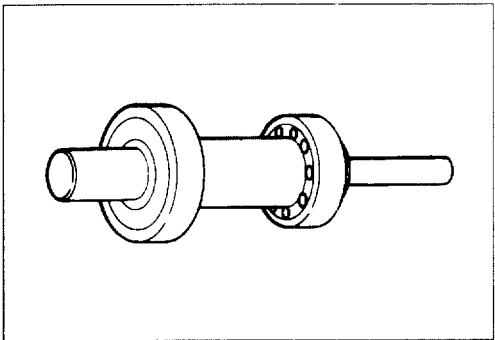
If the measured interference is less than the specified limit, the pump shaft and/or the impeller must be replaced.

Pump Shaft and Impeller Interference	mm(in)
Limit	
0.06 (0.0024)	

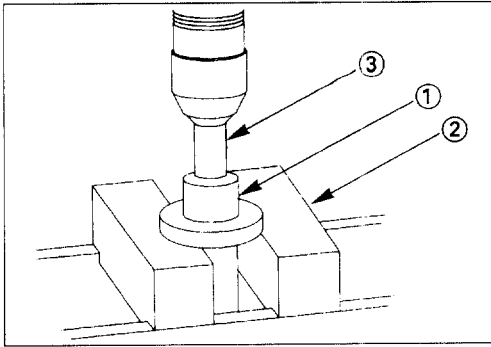
3. Measure the water pump shaft and fan pulley interference.

If the measured interference is less than the specified limit, the pump shaft and/or the fan pulley must be replaced.

Pump Shaft and Fan Pulley Interference	mm(in)
Limit	
0.048 (0.0019)	



4. Carefully clean the bearings.
5. Listen for excessive bearing operating noise.
Excessive bearing operating noise indicates severe bearing wear.

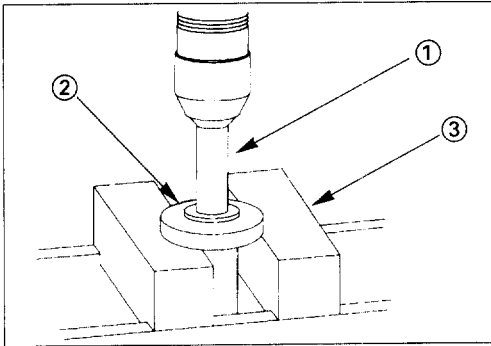


Ball Bearing Replacement

Ball Bearing Removal

1. Place the water pump shaft ① with the bearings attached between the base plates ② of a bench press.
2. Use the bench press and a rod ③ to gradually apply pressure to the water pump shaft to remove the ball bearings from the water pump shaft.

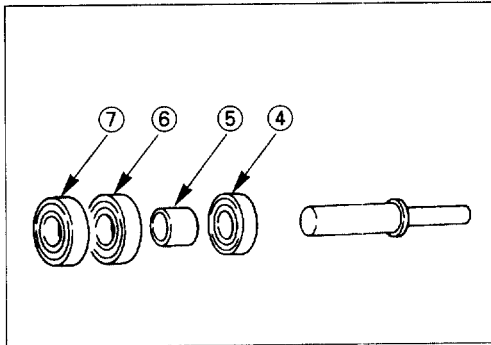
Take care not to damage the water pump shaft.



Ball Bearing Installation

1. Place the water pump shaft ① and the bearings ② between the base plates ③.

Place soft brass or copper sheets between the base plates and the water pump shaft for protect to make damage the water pump shaft.



2. Install (in order), the small ball bearing ④, the spacer ⑤, and the large ball bearings ⑥ and ⑦ to the water pump shaft.

3. Use the bench press to gradually press the water pump shaft down until the ball bearings are seated correctly.

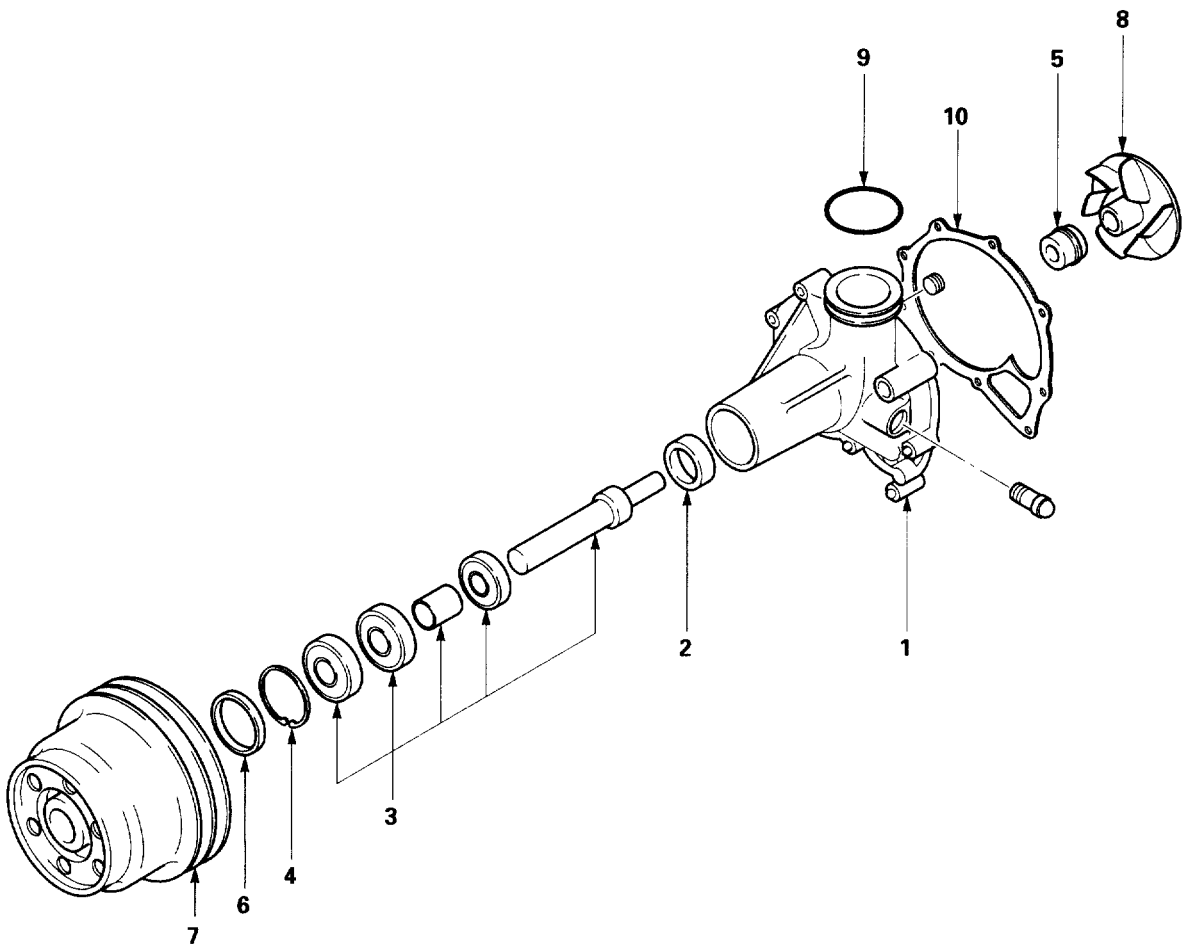
Be absolutely sure that the bearing inner race is supported by the base plates.

Cooling Fan Pulley

Check the fan pulley for excessive wear and damage.



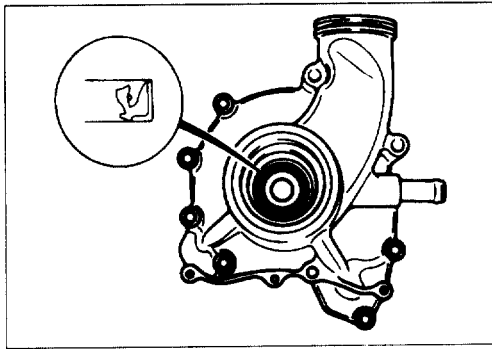
REASSEMBLY



030MT002

Reassembly Steps

- | | |
|--|-------------------------|
| ▲ 1. Water pump body | ▲ 6. Oil seal |
| ▲ 2. Oil seal | ▲ 7. Cooling fan pulley |
| ▲ 3. Water pump shaft and ball bearing | ▲ 8. Impeller |
| ▲ 4. Snap ring | ▲ 9. O-ring |
| ▲ 5. Seal unit | ▲ 10. Gasket |



Important Operations



1. Water Pump Body

2. Oil Seal



1) Clean the water pump body.

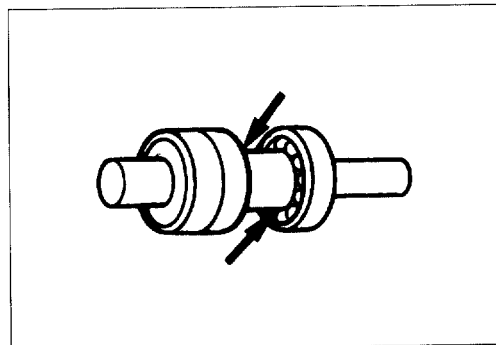
Be absolutely sure that the oil ports are free of restrictions.



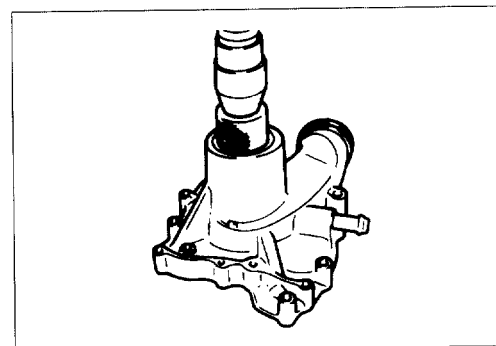
2) Apply engine oil to the oil seal lip and outside circumference.

3) Position the oil seal so that the oil seal lip is facing the ball bearing.

4) Press the oil seal into water pump body.



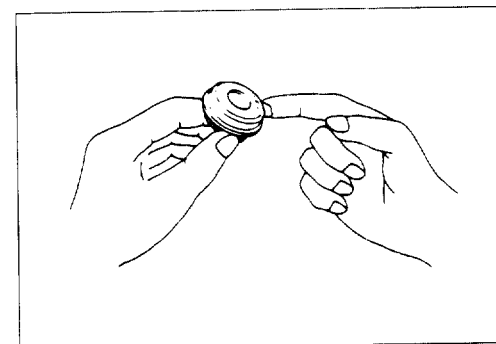
3. Water Pump Shaft and Ball Bearing



1) Place the water pump body on the bench press base plate.

2) Position the pump shaft and the bearing to the pump body.

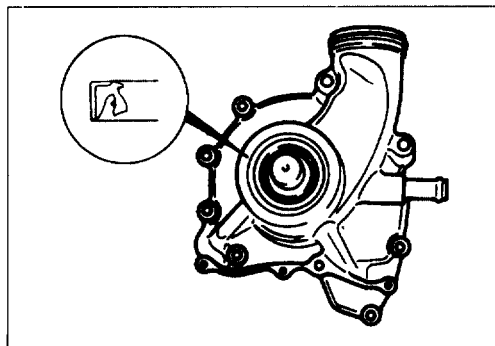
3) Use a bench press to gradually press the water pump shaft and bearings into the water pump body.



5. Seal Unit

1) Apply the recommended liquid gasket or its equivalent to the seal unit water pump body contact surfaces.

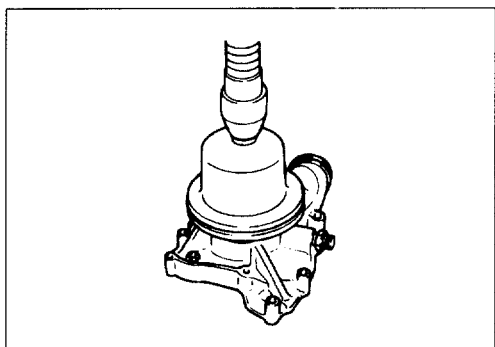
2) Use a bench press and an installer to install the seal unit to the pump shaft and the body.



6. Oil Seal

- 1) Apply engine oil to the oil seal lip and outside circumference.
- 2) Install the oil seal.

The oil seal lip must be facing the ball bearing.



7. Cooling Fan Pulley

Use a bench press to install the fan pulley to the water pump shaft.

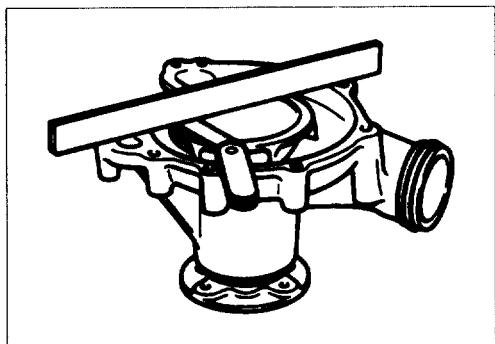
Press the fan pulley onto the shaft until it makes contact with the ball bearing.

Note:

The fan pulley and the impeller are installed to the water pump shaft with a press.

Never attempt to remove and reinstall the fan pulley and the impeller a second time. Replace the entire water pump assembly.

Removing and reinstalling the fan pulley and the impeller a second time may result in the breakdown of the water pump during engine operation and subsequent serious overheating problems.



8. Impeller

- 1) Use a bench press to install the water pump impeller to the pump body.
- 2) Measure the clearance between the pump body and the impeller.

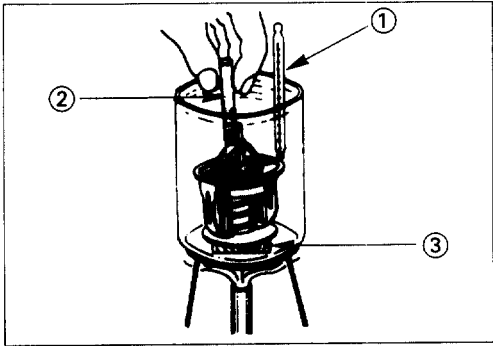
Pump Body and Impeller Clearance	mm(in)
0.3 - 1.1 (0.0120 - 0.0430)	

THERMOSTAT



INSPECTION AND REPAIR

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



Operating Test

- 1. Completely submerge the thermostat in water.
- 2. Heat the water.
Stir the water constantly to avoid direct heat being applied to the thermostat.
- 3. Measure the thermostat initial opening temperature.

Thermostat Initial Opening Temperature	°C(°F)
74.5 - 78.5 (166 - 173)	

- 4. Measure the thermostat full opening temperature.

Thermostat Full Opening Temperature	°C(°F)
90 (194)	

- 5. Measure the valve lift at the valve's fully open position.

Valve Lift At Fully Open Position	mm(in)
Approximately 10 (0.39)	

- ① Thermometer
- ② Agitating rod
- ③ Wooden piece

SECTION 6C

FUEL SYSTEM

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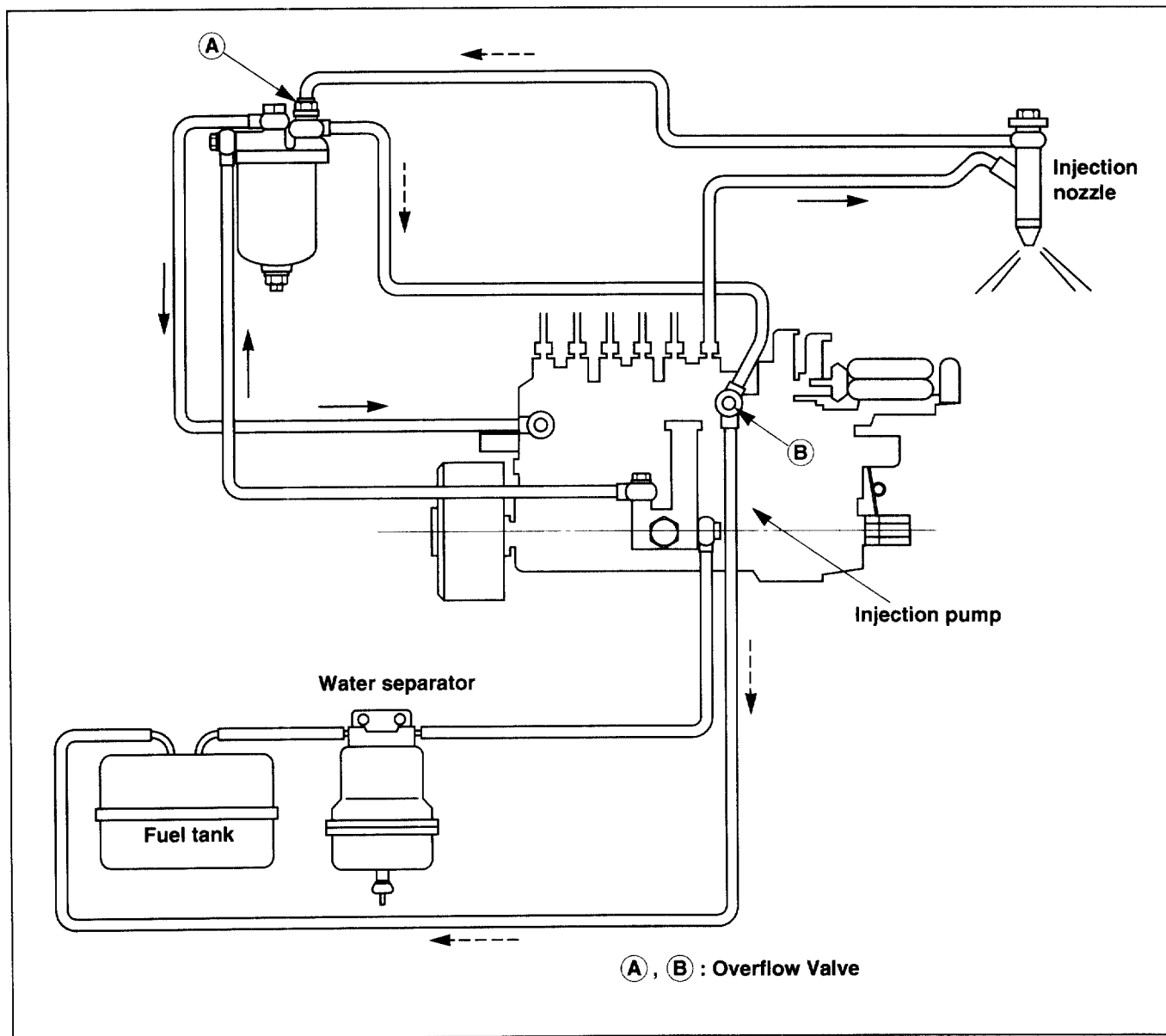
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Disassembly	6C – 60
Reassembly	6C – 60

MAIN DATA AND SPECIFICATIONS

Item	6SD1	6SD1TC (Conform in EURO I)	6SD1TC (Conform in EURO II)
Injection pump type	Bosch in-line AD type	Bosch in-line P type	Bosch in-line HD-TICS
Plunger outside diameter mm(in)	10.5 (0.413)	12.0 (0.472)	←
Governor type	RLD	←	←
Timer	SA	SP	Electronic Variable
Fuel feed pump	Single acting	Dual acting	←
Injection nozzle type	Hole	←	←
Number of injection nozzle orifices	5	6	7
Opening pressure MPa(kg/cm ² /psi)	22.1 (225/3,200)	1st: 17.7 (180/2,560) 2nd: 22.1 (225/3,200)	← ←
Fuel filter and separator			
Main fuel filter	Cartridge type	←	←
Water separator w/pre-fuel filter	Gravity type with replaceable paper element	←	←

GENERAL DESCRIPTION

FUEL FLOW



The fuel system consists of the fuel tank, the water separator with the pre-fuel filter, the fuel filter, the injection pump, and the injection nozzle.

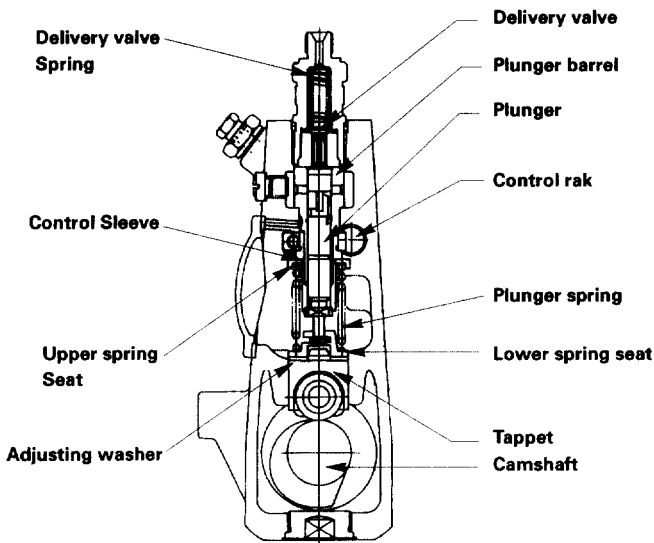
The fuel from the fuel tank passes through the water separator, the pre-fuel filter, and the fuel filter. Water particles and other foreign material are removed from the fuel.

Fuel, fed by the injection pump plunger, is delivered to the injection nozzle in the measured volume at the optimum timing for efficient engine operation.

6SD1TC has two springs injection nozzle system for more efficient fuel control.

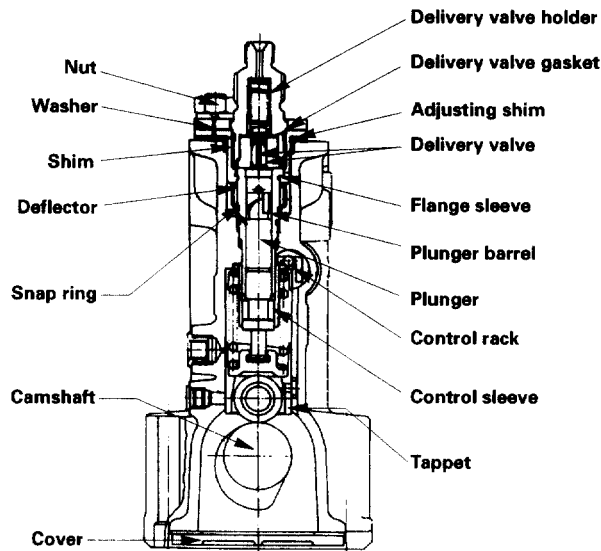
INJECTION PUMP

6SD1



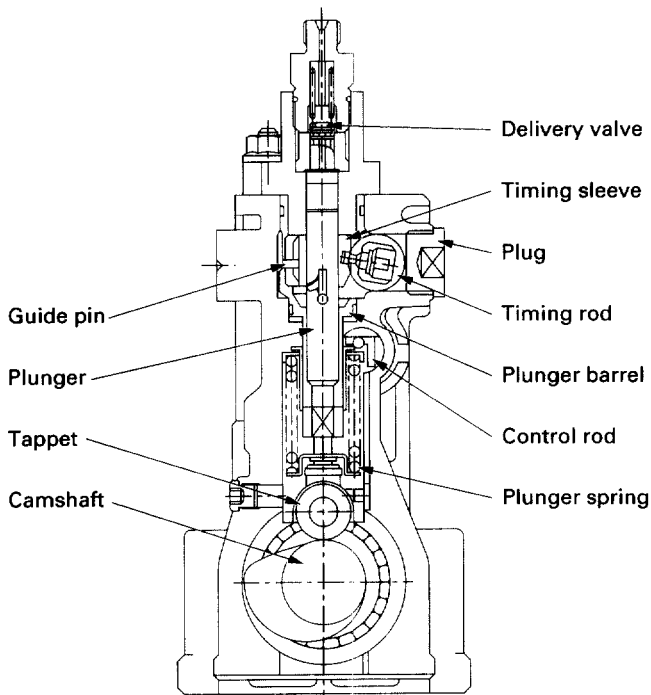
BOSCH IN-LINE AD TYPE

6SD1TC (EURO-I)



BOSCH IN-LINE P TYPE

6SD1TC (EURO-II)



IN LINE TICS TYPE

BOSCH IN-LINE HD-TICS

Major components of the injection pump are the pump body and plunger unit, the governor, the timer, and the feed pump.

A boost compensator is available as an option for turbocharged engines and provide aneroid compensator as an option for both type of engines.

The injection pump is the nucleus of the diesel engine fuel system. It pressurizes and delivers a metered volume of fuel to the engine cylinders at the optimum time for the current engine load and speed.

The injection pump plungers are pushed up by cam lobes. They are returned to their original position by the plunger springs. This action creates a reciprocal motion.

The plunger barrel receives fuel from the feed pump and fuel filter through its inlet port when the injection pump plunger is on the down stroke.

Surplus fuel is delivered to the injection pump fuel chamber through the plunger outlet port when the plunger is on its up stroke.

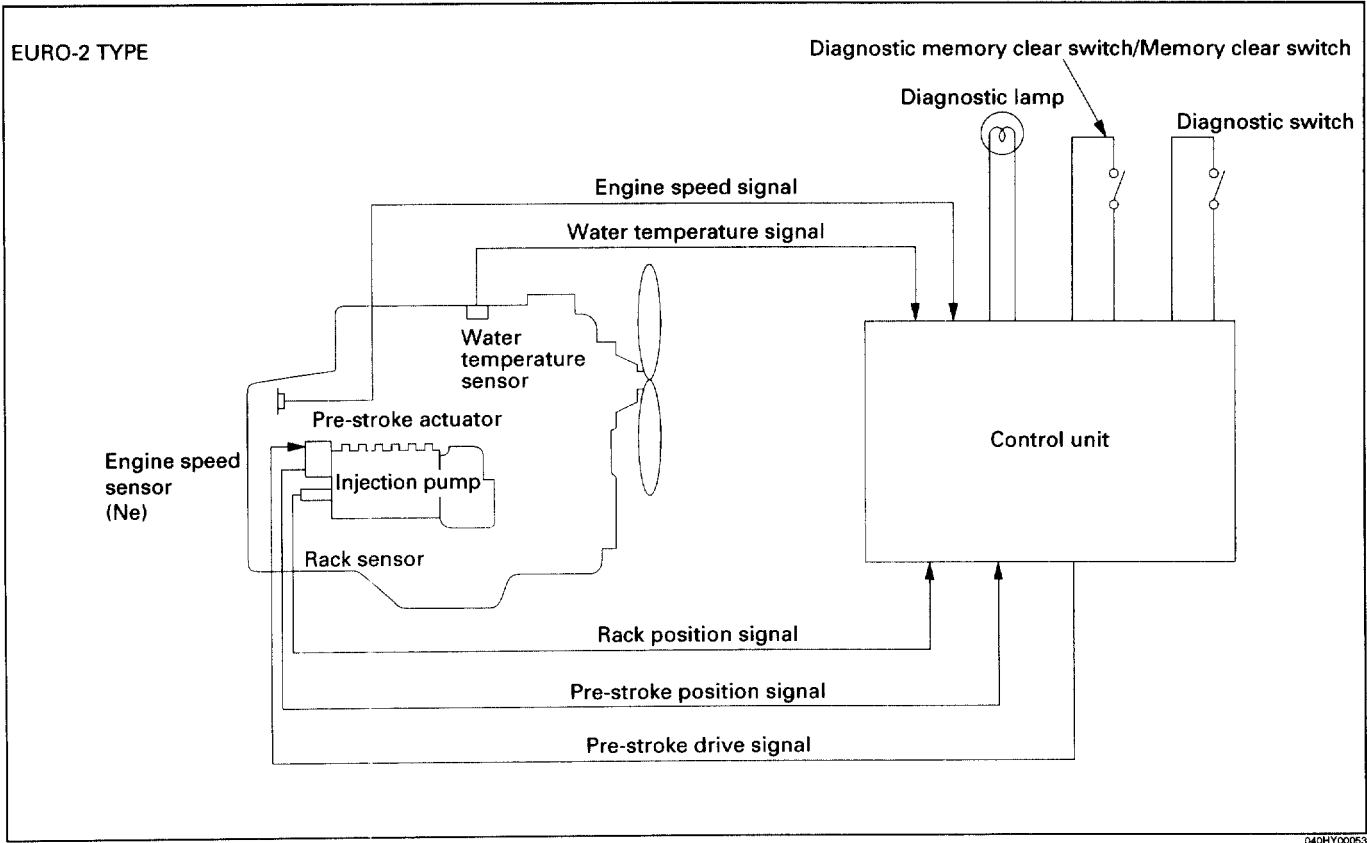
A further development is the Timing and Injection rate Control System (TICS).

TICS controls the injection timing and injection rate by varying the pre-stroke position (start of static injection). This enables high injection rates in the low- and medium-speed ranges through a short injection interval, thus contributing to higher torque and cleaner exhaust emissions and improving the performance of direct-injection diesel vehicles.

Note:

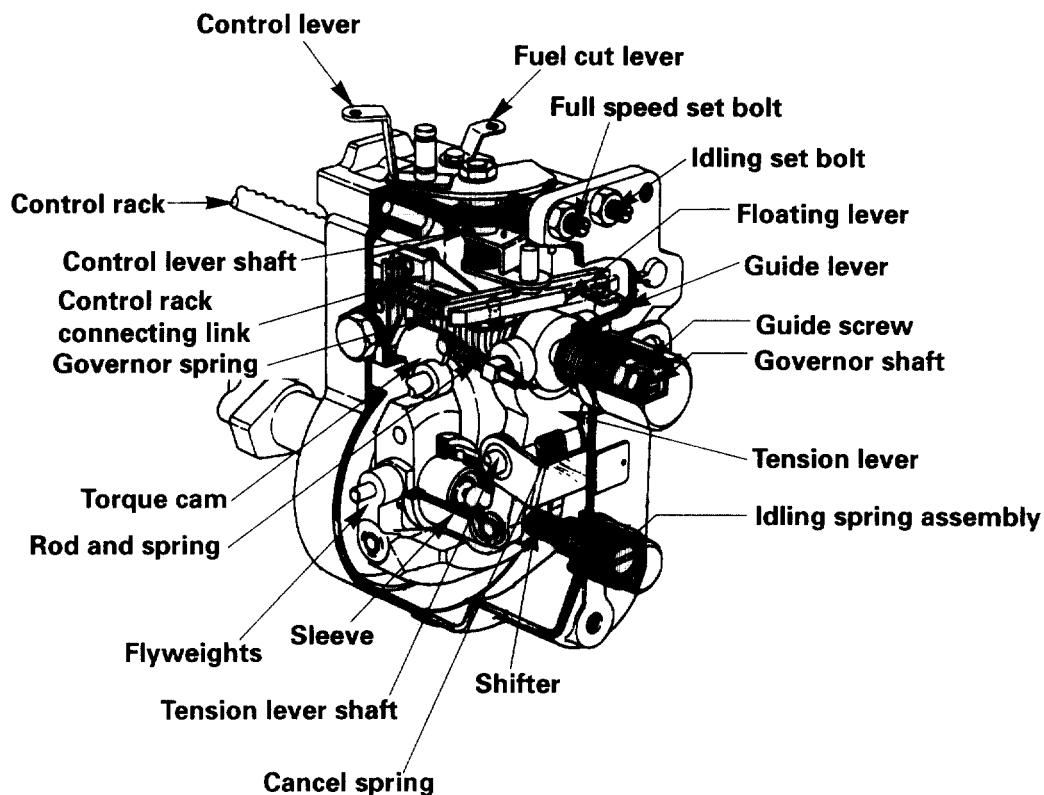
Injection rate is the fuel injection quantity injected from the nozzle per cam angle one degree.

SYSTEM OVERVIEW



The illustration shows a diagram of the TICS system combined with the RLD Type governor. There are slight differences depending on customer specifications.

GOVERNOR

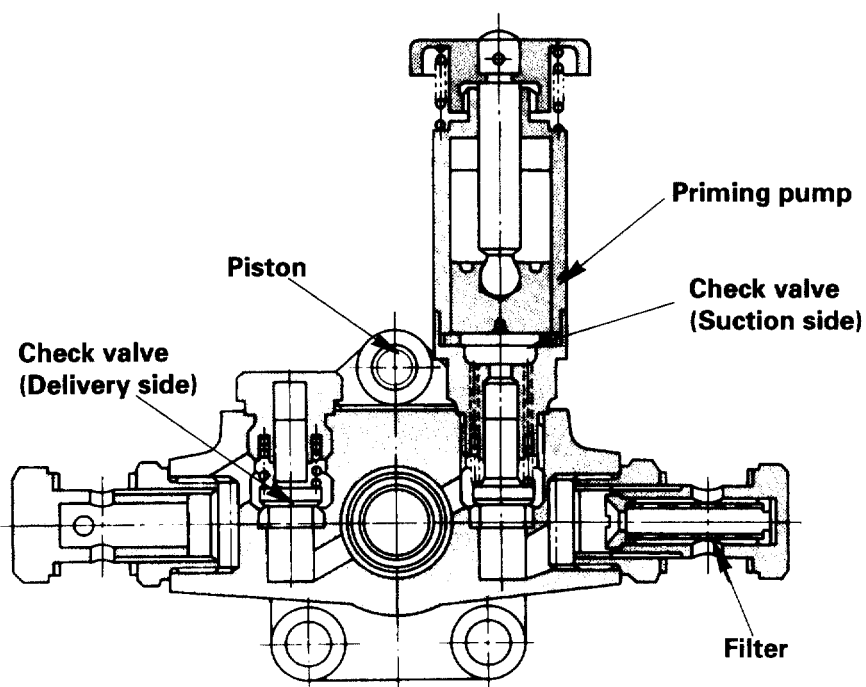


6SD1 and 6SD1TC engines are equipped with an RLD type variable-speed mechanical governor.

Diesel engine operating speed and load will vary widely during the course of normal driving. If the engine speed falls too low, the engine may run sluggishly or stall. If the engine speed becomes too high, engine overrun will result.

The governor acts to maintain engine speed within acceptable limits, thus protecting against engine stall and/or overrun.

FUEL FEED PUMP



The fuel feed pump tappet is driven by an eccentric cam on the injection pump camshaft. Tappet movement is relayed to the piston through the pushrod.

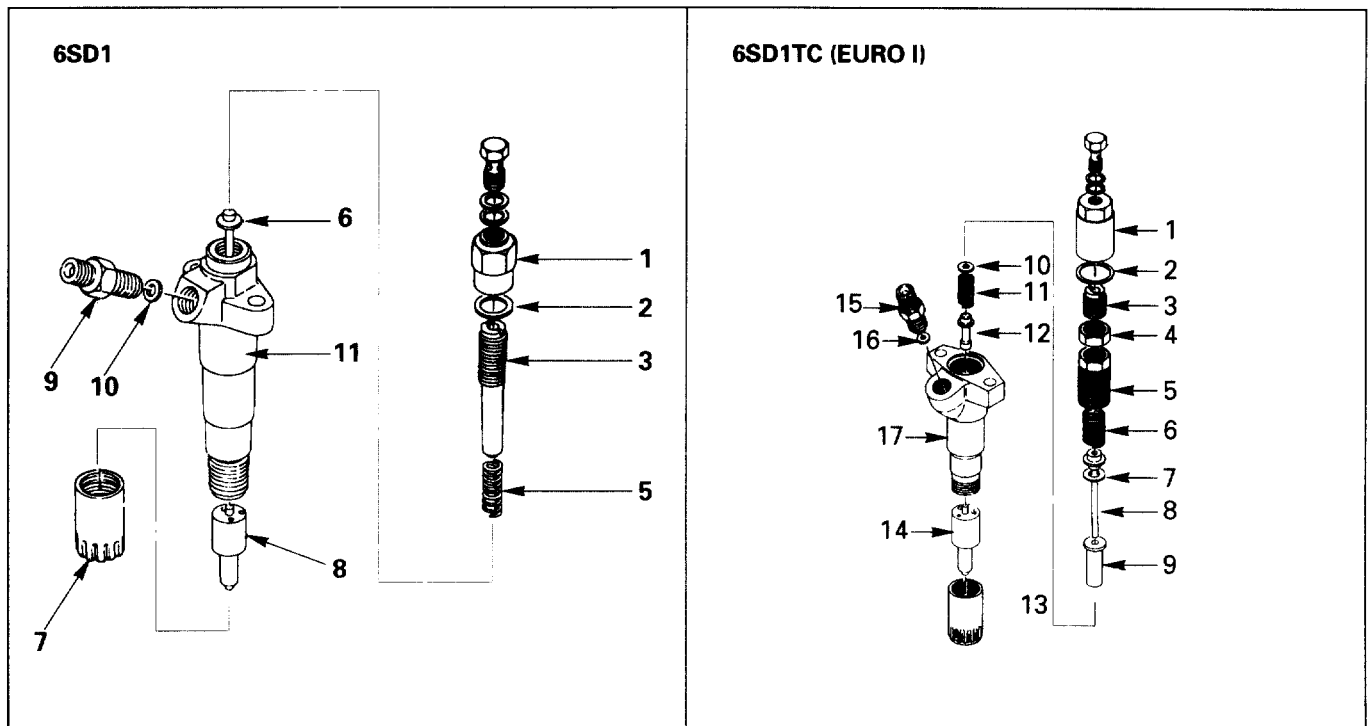
The fuel feed pump draws fuel from the fuel tank through the fuel filter. It delivers the fuel, under pressure, to the injection pump.

An independent priming pump permits manual fuel feed when the engine is not running.

INJECTION NOZZLE



DISASSEMBLY



Disassembly Steps (For 6SD1)

1. Nozzle holder cap nut
2. Gasket
3. Nozzle adjusting screw
5. Spring
6. Push rod

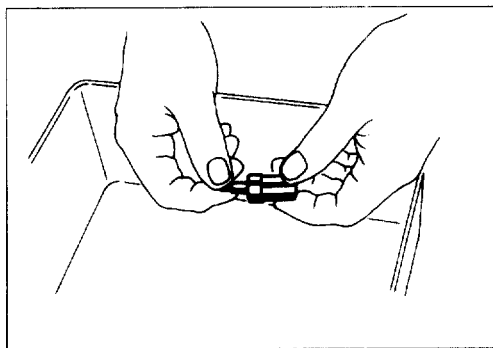
7. Retaining nut
- ▲ 8. Injection nozzle
9. Connector
10. Gasket
11. Nozzle holder

CONFORM IN "EURO I"

Disassembly Steps (For 6SD1TC)

1. Cap nut
2. Gasket
3. Lock nut
4. Adjusting screw
5. Set screw
6. Spring (second)
7. Push rod (second)
8. Shim (pre-lift)
9. Spacer

10. Shim (first nozzle opening pressure adjustment)
11. Spring (first)
12. Push rod (first)
13. Retaining nut
- ▲ 14. Injection nozzle
15. Connector
16. Gasket
17. Nozzle holder



Important Operations

8.&14. Injection Nozzle

- 1) Remove the injection nozzle assemblies from the nozzle holders.

Tag the nozzle assemblies and the nozzle holders so that they can be reinstalled to their original positions.

Nozzle assembly and nozzle holder combinations must not be changed.

- 2) Dip the injection nozzles in a tool tray filled with clean diesel fuel.

This will protect the nozzles from dust.



INSPECTION AND REPAIR

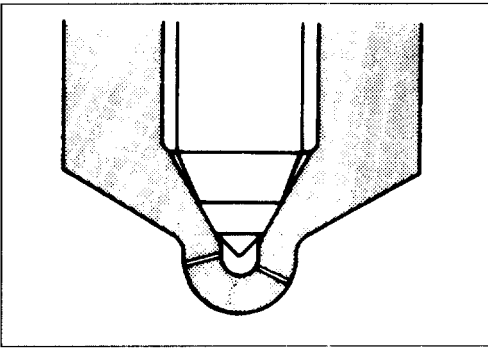
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Push Rod Spring

Check the push rod spring for excessive wear, weakness, and corrosion.

Push Rod

Check the push rod and needle valve contact surfaces for excessive wear and poor contact.



Injection Nozzle

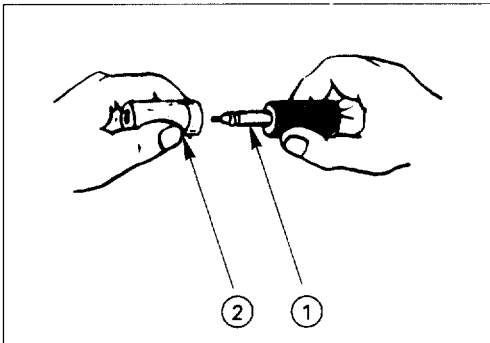
1. Check the injection nozzle needle valve, the valve seat, and the injection nozzle hole for carbon deposits.

If carbon deposits are present, the injection nozzle and the needle valve must be cleaned or replaced.

2. Hold the nozzle body vertically.
3. Lift the needle valve about 1/3 of the way out of the nozzle body.
4. Release the needle valve.

The needle valve should fall back into the nozzle body as far as the valve seat.

If the needle valve does not fall back into the nozzle body as far as the valve seat, the injection nozzle and the needle valve must be replaced.



Nozzle Lapping Procedure

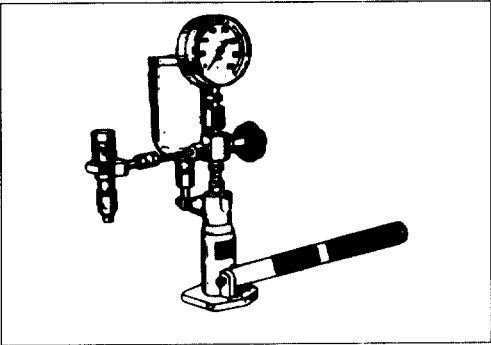
1. Lap the injection nozzle needle ① and the injection nozzle body ② by applying a compound of oxidized chrome and animal oil.

Note:

Do not apply an excessive amount of the oxidized chrome and animal oil compound to the injection needle valve seat area.

Applying too much compound will cause the injection nozzle needle and the injection nozzle body cavity to wear excessively.

2. Carefully wash the injection needle valve and the injection nozzle body in clean diesel fuel after lapping.



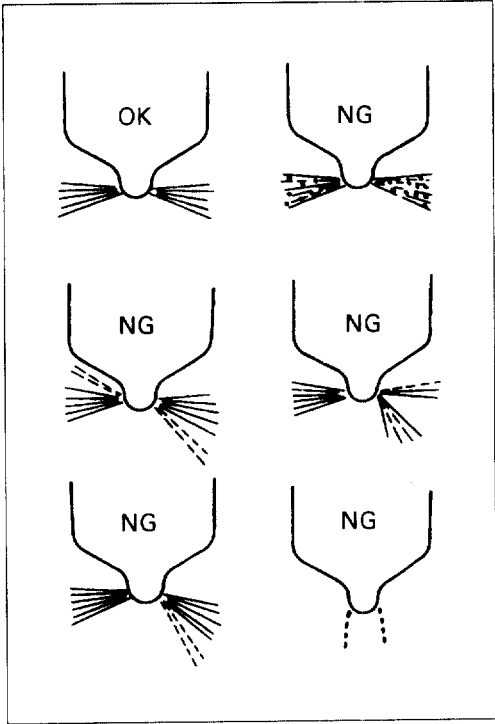
Injection Nozzle Operating Test
Opening Pressure and Spray Condition Check

1. Use a nozzle tester to check the injection nozzle opening pressure.
- If the opening pressure is above or below the specified value, the injection nozzle must be replaced or adjusted.
- Refer to "Injection Nozzle Adjustment."

Injection Nozzle Opening Pressure	MPa(kg/cm ² /psi)
6SD1	22.1 (225/3,199.5)
6SD1TC (1st)	17.7 (180/2,559.6)

WARNING:

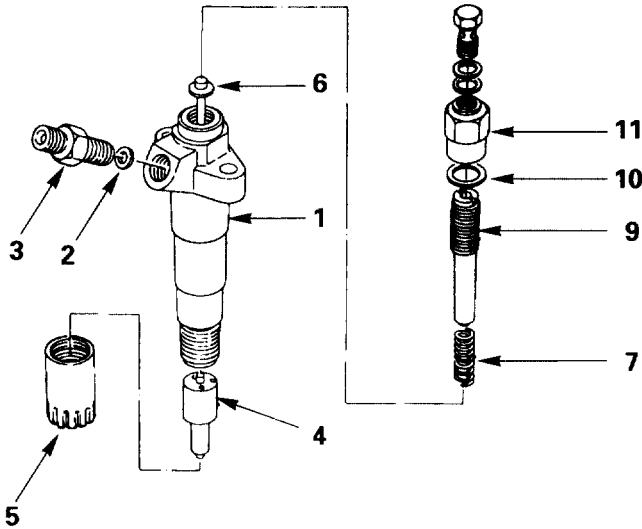
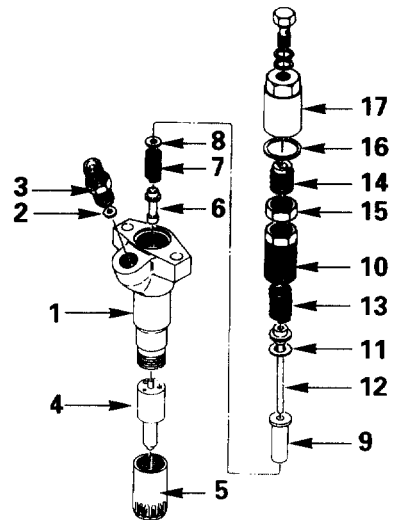
TEST FLUID FROM THE INJECTION NOZZLE TESTER WILL SPRAY OUT OF THE INJECTION NOZZLE UNDER GREAT PRESSURE. IT CAN EASILY PUNCTURE A PERSON'S SKIN. KEEP YOUR HANDS AWAY FROM THE INJECTION NOZZLE AT ALL TIMES.



2. Check the spray condition.
- If the spray condition is bad, the injection nozzle must be replaced or reconditioned.
- The spray condition shown as illustration.
- If lapping is required, refer to "Nozzle Lapping Procedure" above.



REASSEMBLY

6SD1

6SD1TC (EURO I)


Reassembly Steps (For 6SD1)

- | | |
|-----------------------|---------------------------|
| 1. Nozzle holder | 6. Push rod |
| 2. Gasket | 7. Spring |
| ▲ 3. Connector | 9. Nozzle adjusting screw |
| ▲ 4. Injection nozzle | 10. Gasket |
| ▲ 5. Retaining nut | 11. Nozzle holder cap nut |

CONFORM IN "EURO I"

Reassembly Steps (For 6SD1TC)

- | | |
|--|-----------------------|
| 1. Nozzle holder | 9. Spacer |
| 2. Gasket | 10. Set screw |
| ▲ 3. Connector | 11. Shim (pre-lift) |
| ▲ 4. Injection nozzle | 12. Push rod (second) |
| ▲ 5. Retaining nut | 13. Spring (second) |
| 6. Push rod (first) | 14. Adjusting screw |
| 7. Spring (first) | 15. Lock nut |
| 8. Shim (first nozzle opening pressure adjustment) | 16. Gasket |
| | 17. Cap nut |



Important Operations



3. Connector

Tighten the connector to the specified torque.

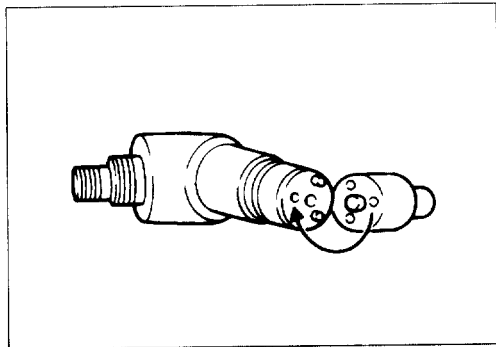
Connector Torque	N·m(kg·m/lb.ft)
54 (5.5 / 39.8)	



4. Injection Nozzle

Carefully clean the injection nozzle and the injection nozzle holder contact surfaces before installation.

The contact surfaces must be perfectly clean.



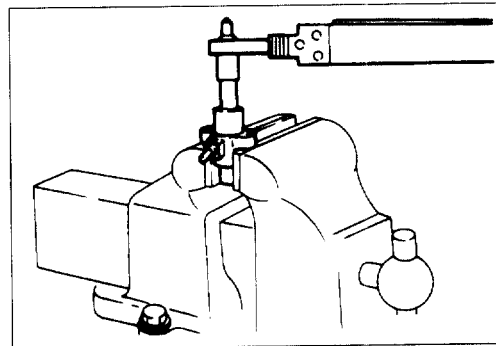
5. Retaining Nut

- 1) Clamp the injection nozzle holder in a vise.
- 2) Set the injection nozzle to the injection nozzle holder.

The nozzle locating pin must be aligned with the nozzle holder locating hole.

- 3) Install the retaining nut to the nozzle holder.
- 4) Tighten the retaining nut to the specified torque.

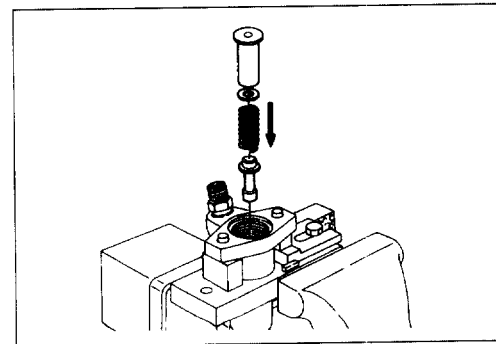
Retaining Nut Torque	N·m(kg·m/lb.ft)
69 (7 / 50.6)	

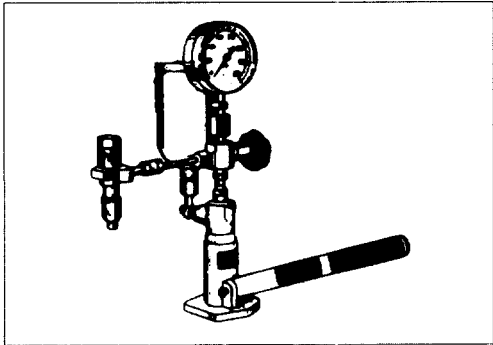


For 6SD1TC

- 5) Install the first push rod ⑥, first spring ⑦, and shim ⑧.
- 6) Install the spacer ⑨.
- 7) Tighten the set screw ⑩ to the specified torque.

Set Screw Torque	N·m(kg·m/lb.ft)
54 (5.5 / 39.8)	





Injection Nozzle Adjustment (6SD1)

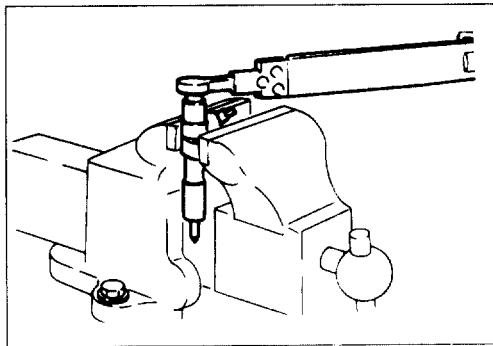
1. Attach the injection nozzle holder to the injection nozzle tester.
2. Apply pressure to the nozzle tester.
Note the pressure at which the injection nozzle opens.
3. If required, adjust the injection nozzle opening pressure.
Turn the adjusting screw clockwise while operating the injection nozzle tester hand lever.

Injection Nozzle Opening Pressure	kPa(kg/cm ² /psi)
6SD1	22,100 (225/3,199.5)

WARNING:

TEST FLUID FROM THE INJECTION NOZZLE TESTER WILL SPRAY OUT OF THE INJECTION NOZZLE UNDER GREAT PRESSURE. IT CAN EASILY PUNCTURE A PERSON'S SKIN. KEEP YOUR HANDS AWAY FROM THE INJECTION NOZZLE AT ALL TIMES.

4. Remove the injection nozzle holder from the nozzle tester.



5. Clamp the injection nozzle holder in a vise.
6. Install the washer and the cap nut.
7. Tighten the cap nut to the specified torque.

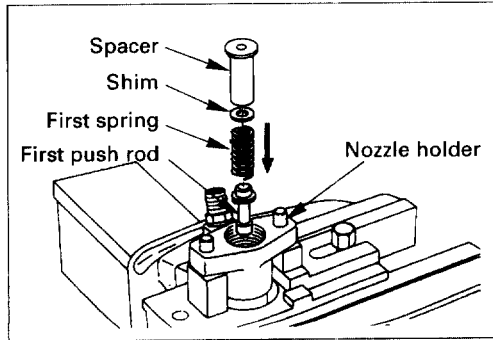
Cap Nut Torque	N·m(kg·m/lb.ft)
6SD1	44.0 (4.5 / 32.5)

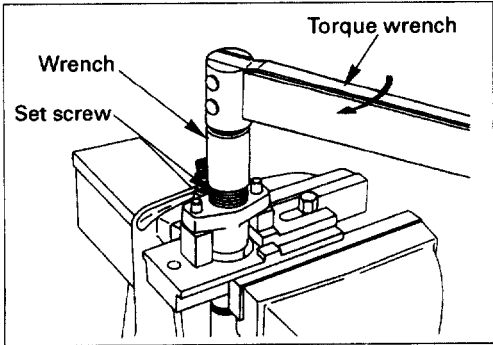
CONFORM IN "EURO 1"

Injection Nozzle Adjustment (6SD1TC)

First Nozzle Opening Pressure Adjustment

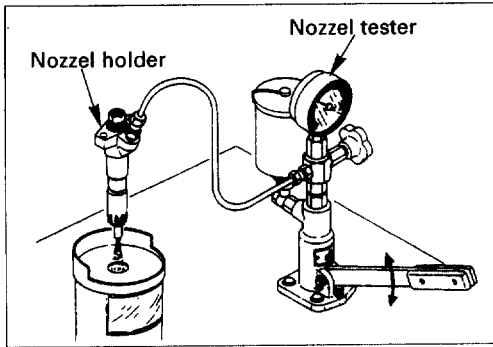
1. Install the first push rod, first spring, shim and spacer in the nozzle holder.





2. Insert the set screw and tighten specified torque.

Set Screw Torque	N·m(kg·m/lb.ft)
54.0 (5.5 / 39.8)	



3. Confirm that the first nozzle opening pressure is with the adjusted range using the nozzle tester.
When the pressure is not as specified, replace the shim and readjust. Adjusting shims are shown below.

First Nozzle Opening Pressure	MPa(kg/cm ² /psi)
6SD1TC	17.7 (180/2,559.6)

Note:

A shim thickness of 0.02 mm corresponds to a nozzle opening pressure 230.5 kPa (2.35 kg/cm²/33.4 psi).

Nozzle Tester: 1-85311-001-0

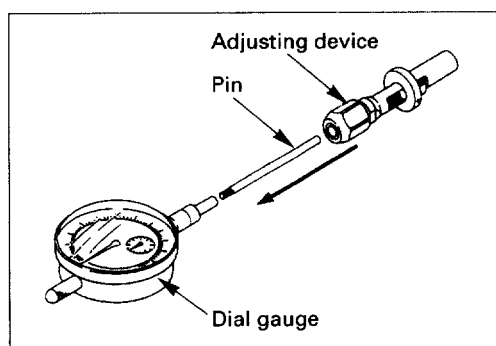
WARNING:

TEST FLUID FROM THE INJECTION NOZZLE TESTER WILL SPRAY OUT OF THE INJECTION NOZZLE UNDER GREAT PRESSURE. IT CAN EASILY PUNCTURE A PERSON'S SKIN KEEP YOUR HANDS AWAY FROM THE INJECTION NOZZLE AT ALL TIMES.

Adjusting shims

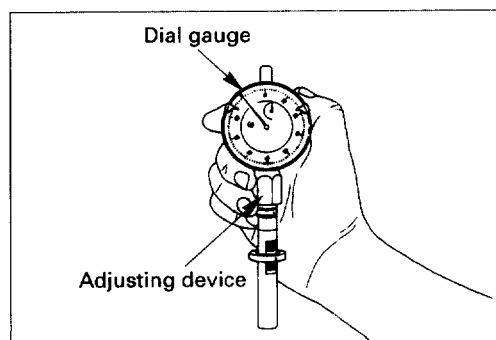
		mm
Thickness	Part number	
0.50	5-15339-007-0	
0.52	5-15339-018-0	
0.54	5-15339-019-0	
0.56	5-15339-020-0	
0.58	5-15339-021-0	
0.60	5-15339-008-0	
0.70	5-15339-009-0	
0.80	5-15339-010-0	
0.90	5-15339-011-0	
1.00	5-15339-012-0	
0.10	8-94128-982-0	
0.20	8-94128-983-0	
0.30	8-94128-984-0	
0.40	8-94128-985-0	

Remove the injection nozzle holder from the nozzle tester.

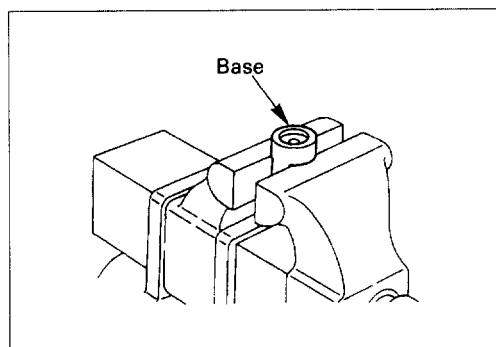


Selection of Pre-lift Adjusting Shim

1. Insert 60.5 mm pin into the dial gauge.
Dial Gauge: 1-85317-015-0

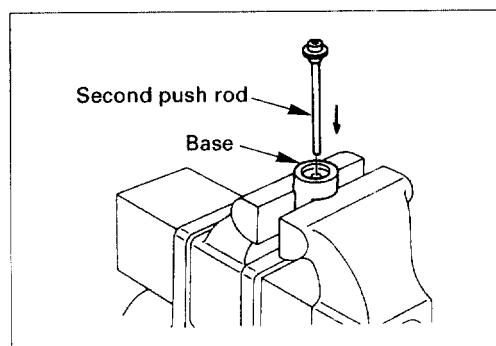


2. Set the dial gauge on the adjusting device.
Adjusting Device: 1-85317-013-0
Adjusting Device Assy
(Including dial gauge with 60.5 mm pin):
1-85317-012-0

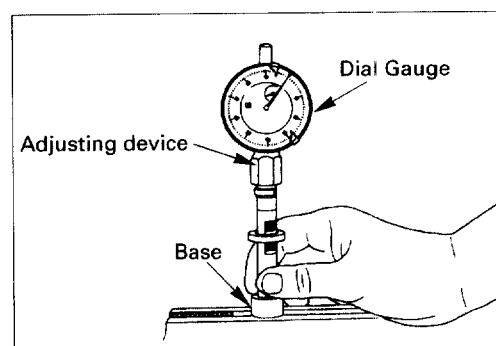


3. Fix the base in the vise.

Base: 1-85317-014-0



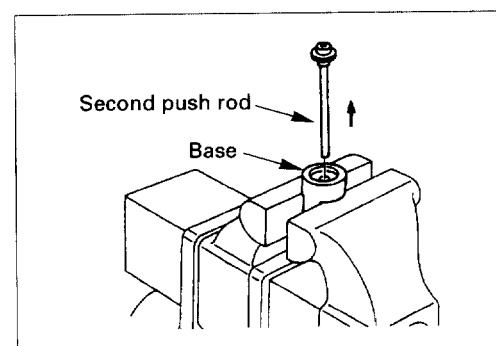
4. Insert the second push rod 12 into the base.



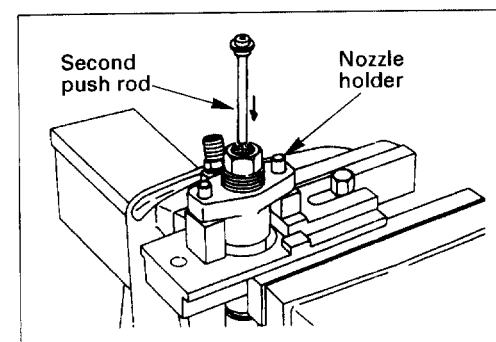
5. Set the adjusting device on the base and set the dial gauge to "0" while pressing the adjusting device to the base.

Note:

1. **Confirm the "0" setting several times.**
2. **After setting the "0" point, handle the adjusting device carefully so that "0" point will not be moved.**



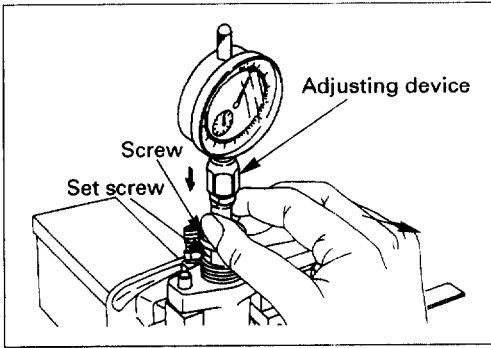
6. Remove the second push rod 12 from base.



7. Insert the second push rod 12 into the nozzle holder.

Note:

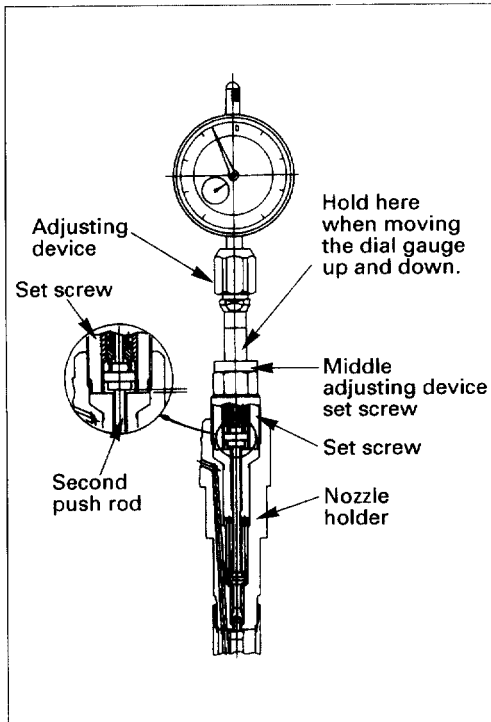
Do not insert the second spring 13 and pre-lift shim 11 at this time.



8. Insert the adjusting device into the set screw 10 until touch between the adjusting device and spacer 9, then tighten screw the adjusting device at the intermediate position and confirm the dial gauge moving smoothly.
9. Push the adjusting device down and measure the pre-lift (h).

Note:

Measure the value to within 0.01 mm.



10. Calculate the thickness (T) of the pre-lift shim to be installed, as shown below.

T: Thickness of actual selected shim.

$$T = t \pm 0.015$$

$$t = l + h$$

t: Thickness of shim (measured value)

l: Pre-lift (specified value).

h: value measured in step 2-9 above.

(Example)

$$h = 0.98 \text{ mm.}$$

$$l = 0.1 \text{ mm}$$

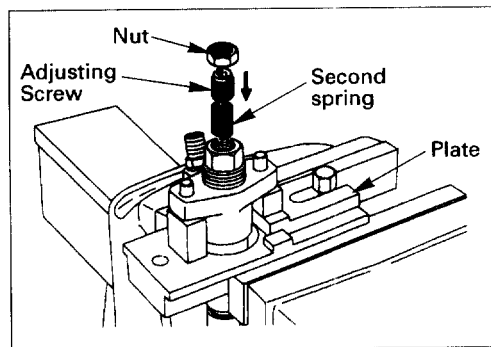
$$t = 0.1 + 0.98 = 1.08$$

$$T = 1.08 \pm 0.015 = 1.065 \text{ to } 1.095$$

The shim (part No.) 5-15339-007-0 and 5-15339-021-0, which together are made 1.08 mm thick.

Note:

1. Two shims can be used.
2. Do not insert the shim(s) at this time.



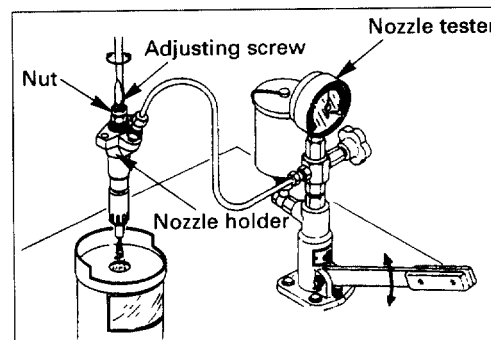
Second Nozzle Opening Pressure Adjustment

1. Insert the second spring 13, adjusting screw 14 and lock nut 15. In this condition, the first push rod contacts the second push rod.



Note:

Do not insert the pre-lift adjusting shim 11 at this time.

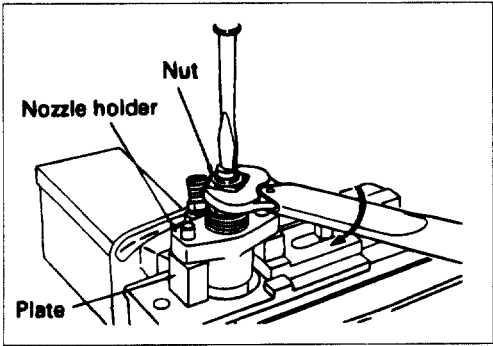


2. Set the second nozzle opening pressure to the adjusted value using the nozzle tester.

After setting the pressure, secure the lock nut 15.

Opening Pressure 6SD1TC	MPa(kg/cm ² /psi)
27.4 – 28.0 (279 – 286 / 3,967 – 4,067)	

Nozzle Tester: 1-85311-001-0



3. Tighten the lock nut 15 to the specified torque.

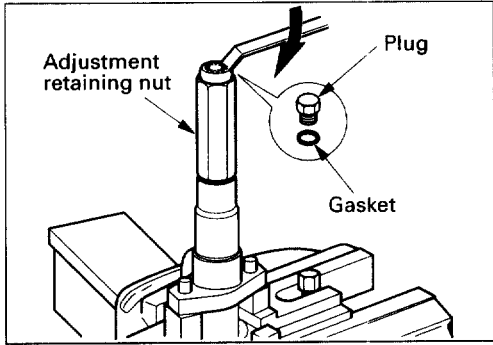
Lock Nut Torque	N·m(kg·m/lb.ft)
22.0 (2.25 / 16.3)	

4. Check the second nozzle opening pressure. If the pressure is not in adjusting range, repeat adjustment.

Note:

The pressure must be rechecked since the second nozzle opening pressure may change when the lock nut 15 is tightened.

5. Remove the nozzle holder from the nozzle tester.

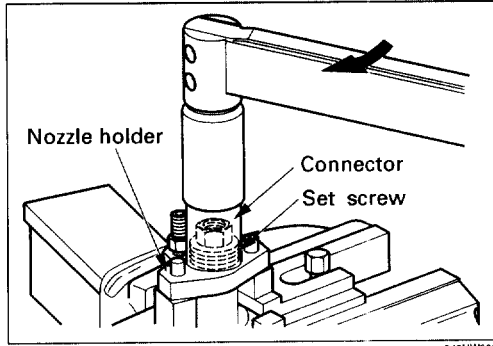


Needle Valve Overall Lift Check

1) Install connector to set screw on the nozzle holder then tighten to the specified torque. Install gasket and plug to adjustment retaining nut.

Gasket : 026508-1140 (ZEXEL)

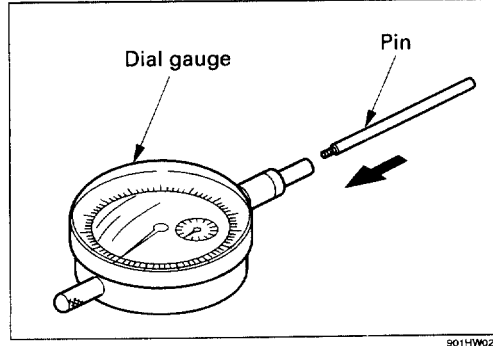
Plug : 157892-1600 (ZEXEL)



2) Install connector to set screw on the nozzle holder then tighten to the specified torque.

Set Screw Torque	N·m (kg·m / lb·ft)
44 (4.5 / 33)	

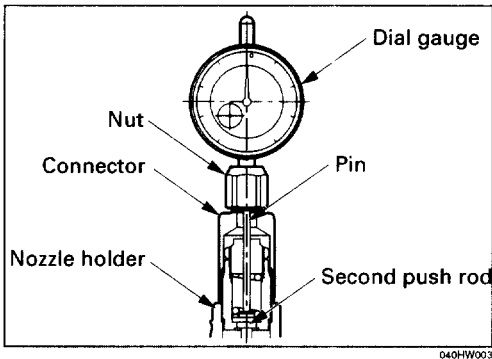
Connector : 157892-1320 (ZEXEL)



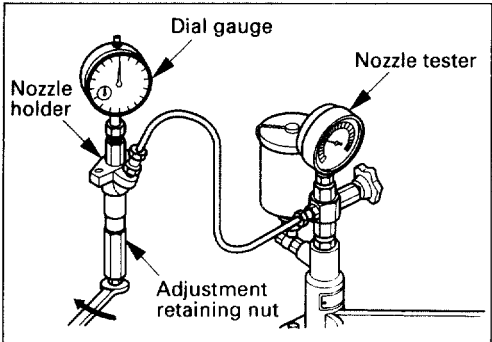
3) Insert 50mm pin into the dial gauge.

Dial Gauge : 1-83531-7015-0

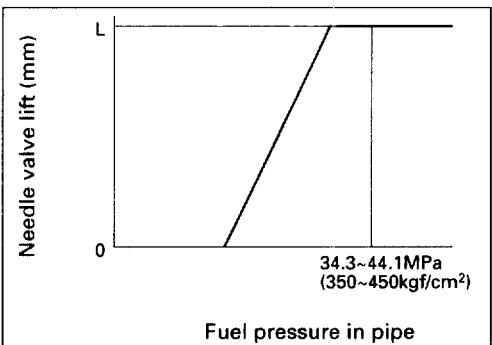
Pin : 157892-1200 (ZEXEL)



040HW003



040HW004



040HW005

- 4) Install the dial gauge to nozzle holder so that pin may come into contact with the upper end surface of 2nd push rod, and fix nut.

Note:

- Fix dial gauge so that it may measure a stroke of 2mm.
- Do not tighten the nut to excess, since excess tightening could fasten the shaft of the dial gauge. (Make sure of the smooth move of the shaft of the dial gauge.)

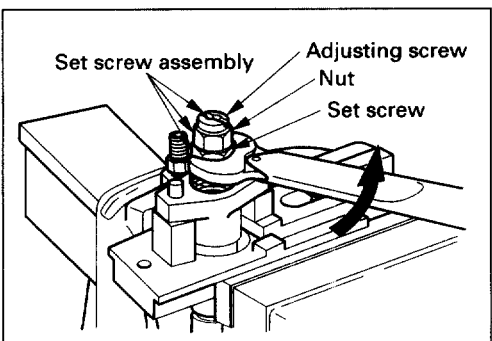
- 5) Connect a nozzle holder to nozzle tester and set the dial gauge needle to the "0" position.
- 6) Operate the nozzle tester, bleed air from the adjustment retaining nut, and check if there is no fuel leakage.

- 7) Operate the nozzle tester to increase the fuel pressure to 34.3 - 44.1 MPa (350 - 450 kg/cm²), in this time the nozzle needle valve will lift fully. Record the overall lift "L".

Note:

This check is conducted to make sure that the nozzle seat is abnormally worn or that a normal nozzle assembly is used.

- 8) Disconnect the nozzle holder from the nozzle tester.



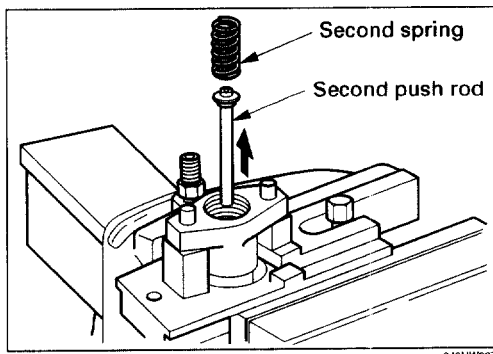
040HW006

Installation of Pre-Lift Shim

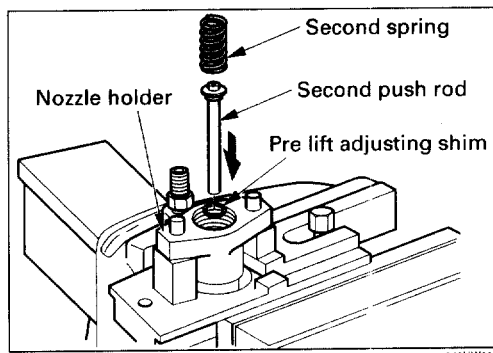
- 1) Remove the dial gauge with connector.
- 2) Remove the set screw assembly. (An assembly of set screw, adjusting screw and nut.)

Note:

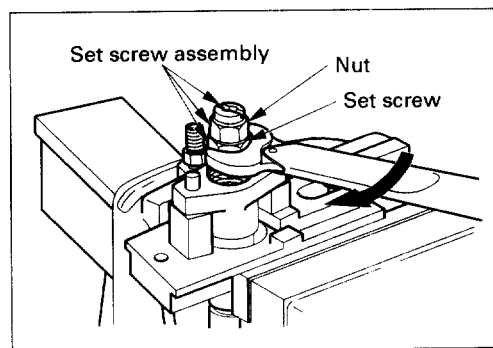
Do not tighten the nut at this time.



040HW007



040HW008



040HW009



3) Remove the second spring and second push rod.

4) Set the pre lift adjusting shim which selected before steps (refer to selection of pre-lift adjusting shim in this section) in the second push rod, and install the second spring, second push rod in the nozzle holder.

5) Install and tighten the set screw assembly to the specified tightening torque.

Set Screw Torque	N·m (kg·m / lb·ft)
54 (5.5 / 40)	

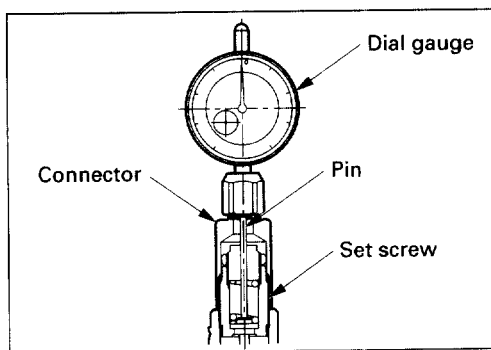
Note:

- Under this condition there is a clearance for pre lift between the first push rod and second push rod.
- Do not tighten the nut at this time.

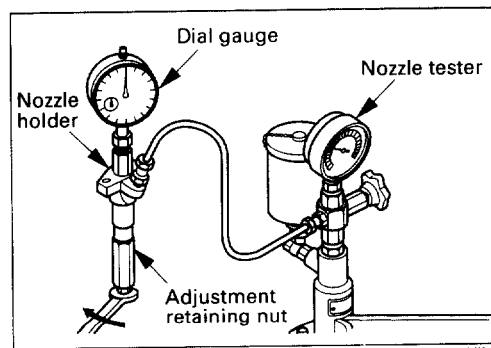
Confirm the Pre lift

1) Reinstall the connector and dial gauge (with a 50mm length pin) to the set screw.

Connector Torque	N·m (kg·m / lb·ft)
44 (4.5 / 33)	



040HW010

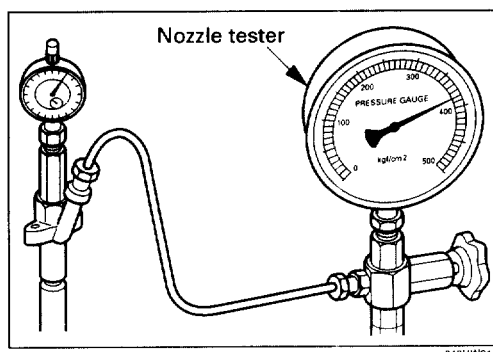
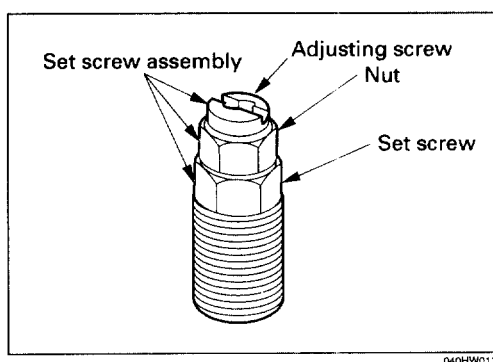
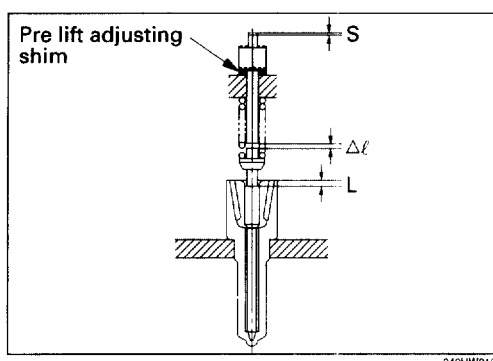
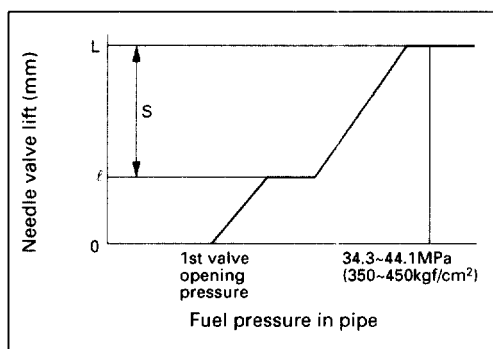


040HW004

2) Install the nozzle holder to a nozzle tester

3) Set the dial gauge to the "0" position.

4) Operate the nozzle tester to bleed air from the adjustment retaining nut.



- 5) When the nozzle tester is operated to raise fuel pressure in pipe to 34.3 - 44.1 MPa (340 - 450 kg/cm²), the nozzle needle valve is lifted to full. Read needle valve lift value "S" on the dial gauge.

Note:

"S" shows the lift of the second push rod, equal to "L" (overall lift of needle valve) minus "l" (pre lift).

- 6) Calculate pre lift "l" from "L" (refer to needle valve overall check in this section and "S" (refer to confirm the pre lift in this section) and check if it satisfies the standard: (Unit : mm)

$$\Delta l = L - S$$

$$l - 0.02 \leq \Delta l \leq l + 0.02$$

Δl : Pre lift value (measurement)

l : Pre lift value (standard)

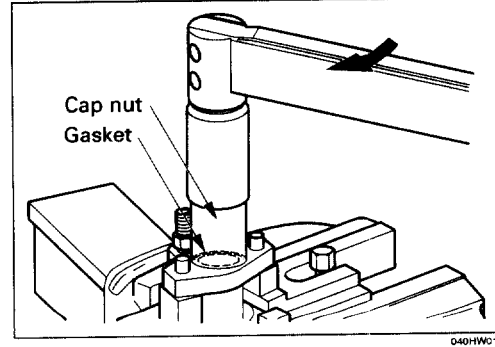
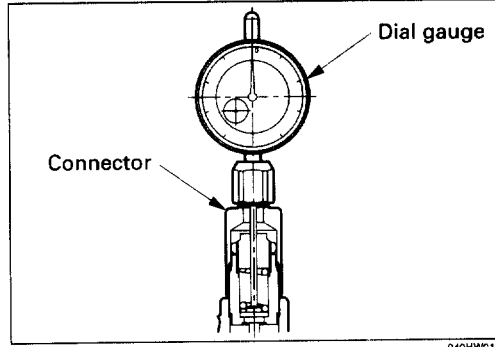
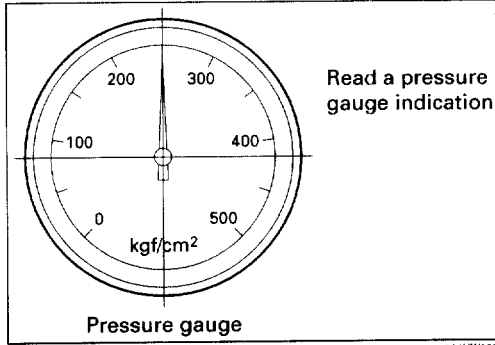
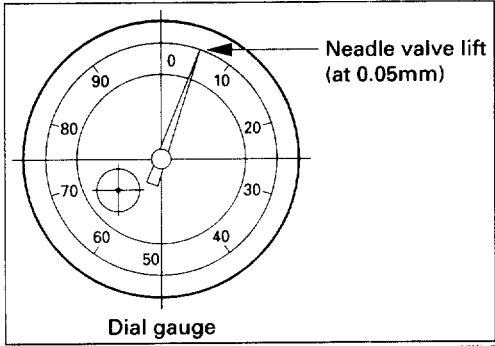
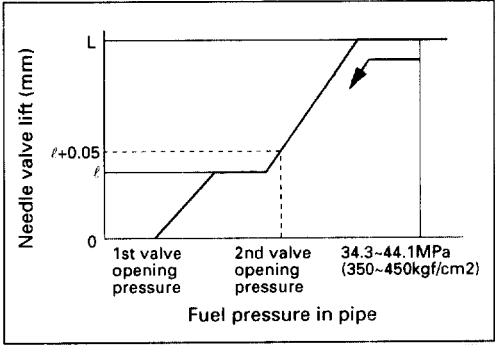
L : Overall lift of needle valve (measurement)

S : Overall lift minus pre lift of needle valve (measurement)

- 7) If Δl is not in the range of " $l \pm 0.02$ ", remove the set screw assembly from the nozzle holder and replace with an appropriate thickness pre lift adjusting shim.
- 8) Make sure of pre lift again.

Confirm the Second Valve Opening Pressure

- 1) After making sure of pre lift, operate the nozzle tester to raise fuel pressure in pipe to 34.3 - 44.1 MPa (340 - 450 kg/cm²), thereby lifting the nozzle needle valve to full.



2) If the nozzle tester handle is released, the fuel pressure in pipe will drop and needle valve lift (dial gauge indication) will come down.

3) On the moment the dial gauge needle indicates a specified needle valve lift (usually, pre lift “ ℓ ” plus 0.05mm), read the pressure gauge indication.

4) Make sure that the pressure value meets the standard for cover system.

Note:

Cover system is a pressure adjusting method available with the end plug of the adjustment retaining nut being installed.

5) If the second valve opening pressure is not a specified value, adjust the pressure by open system (refer to step 11. second nozzle opening pressure adjustment in this section). Then make sure again of the second valve opening pressure by cover system.

Note:

When adjusting the second valve opening pressure by open system, be sure not to put in a pre lift adjusting shim.

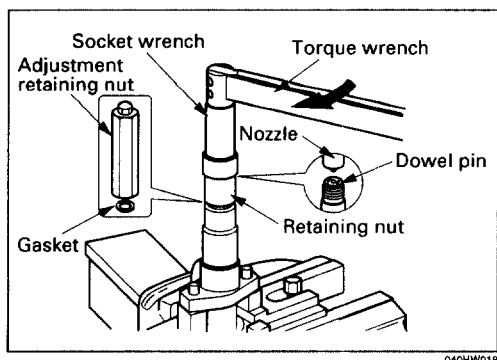
6) Remove the dial gauge (together with the connector).

7) Install the gasket and cap nut.

8) Tighten the cap nut to the specified tightening torque.

Set Nut Torque	N·m (kg·m / lb·ft)
44 (4.5 / 33)	



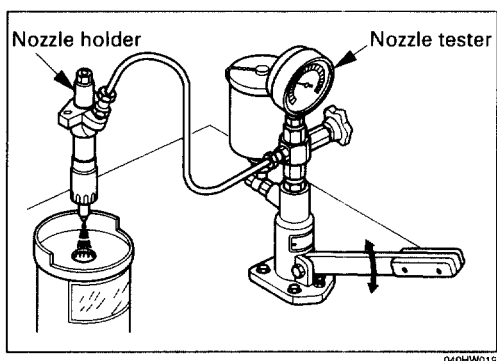


Final Inspection

- 1) Remove the adjustment retaining nut and gasket.
- 2) After making sure that the dowel pin is completely in the nozzle, tighten the retaining nut manually and then tighten it to specified tightening torque.

Socket wrench : 157914-2800 (ZEXEL)

Retaining Nut Torque	N·m (kg·m / lb·ft)
69 (7.0 / 51)	



- 3) Set the assembled two spring nozzle holder to the nozzle tester, check the first nozzle opening pressure, spray pattern, chatter and leakage etc. If any abnormalities are found, disassemble and inspect the nozzle holder, then repeat reassembly and readjustment the nozzle opening pressure.

Note:

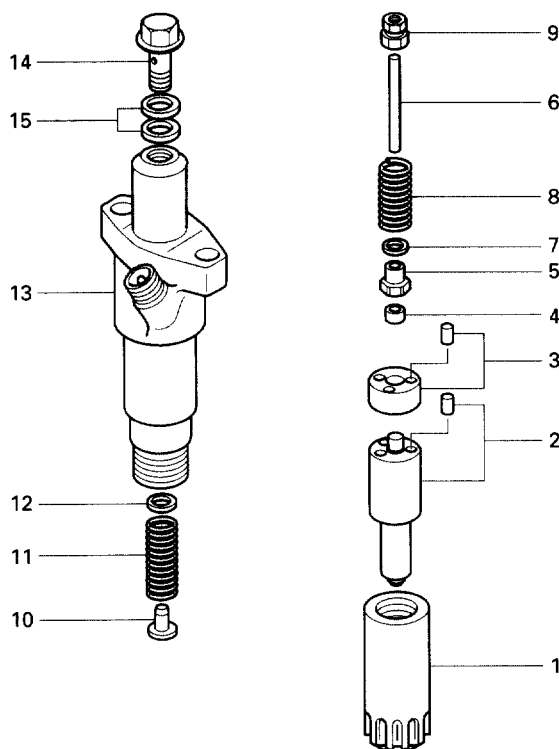
For nozzle spraying condition check, refer to "spray condition check" for inspection and repair in this section.

CONFORM IN "EURO II"

INJECTION NOZZLE



DISASSEMBLY

6SD1TC
(EURO II)

090MV010

Disassembly Steps

- | | |
|---|---|
| 1. Retaining nut | 10. Spring seat |
| 2. Nozzle & pin | 11. First spring |
| 3. Spacer & pin | 12. Shim (First nozzle opening pressure adjustment) |
| 4. Lift piece | 13. Nozzle holder body |
| 5. Spring seat | 14. Eye bolt |
| 6. Push rod | 15. Gasket |
| 7. Shim (Second nozzle opening pressure adjustment) | |
| 8. Second spring | |
| 9. Collar | |

- (1) Before disassembly remove carbon deposit from nozzle and nozzle holder using a wire brush and wash the outside nozzle holder assembly.

Caution: Do not touch nozzle holes with the wire brush during cleaning it.

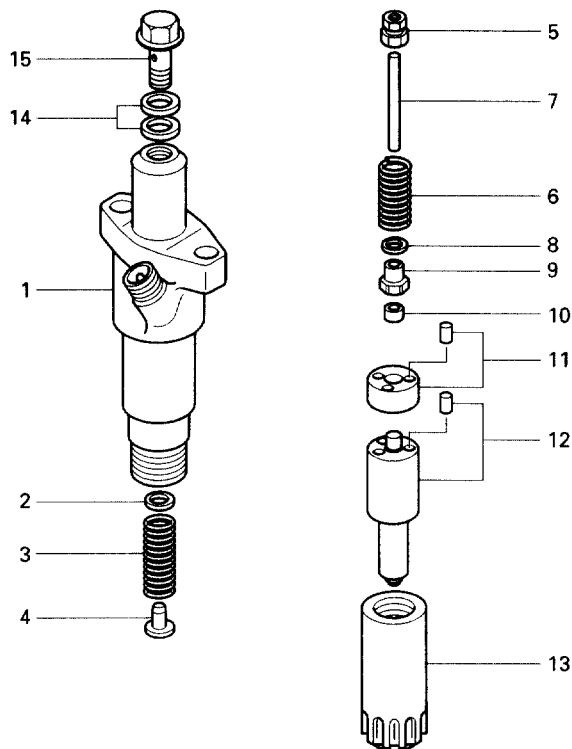
- (2) Disassemble the nozzle holder assembly to numerical order.

CONFORM IN “EURO II”



REASSEMBLY AND OPENING PRESSURE ADJUSTMENT

6SD1TCN, 6SD1TCR
(EURO II)



090MV011

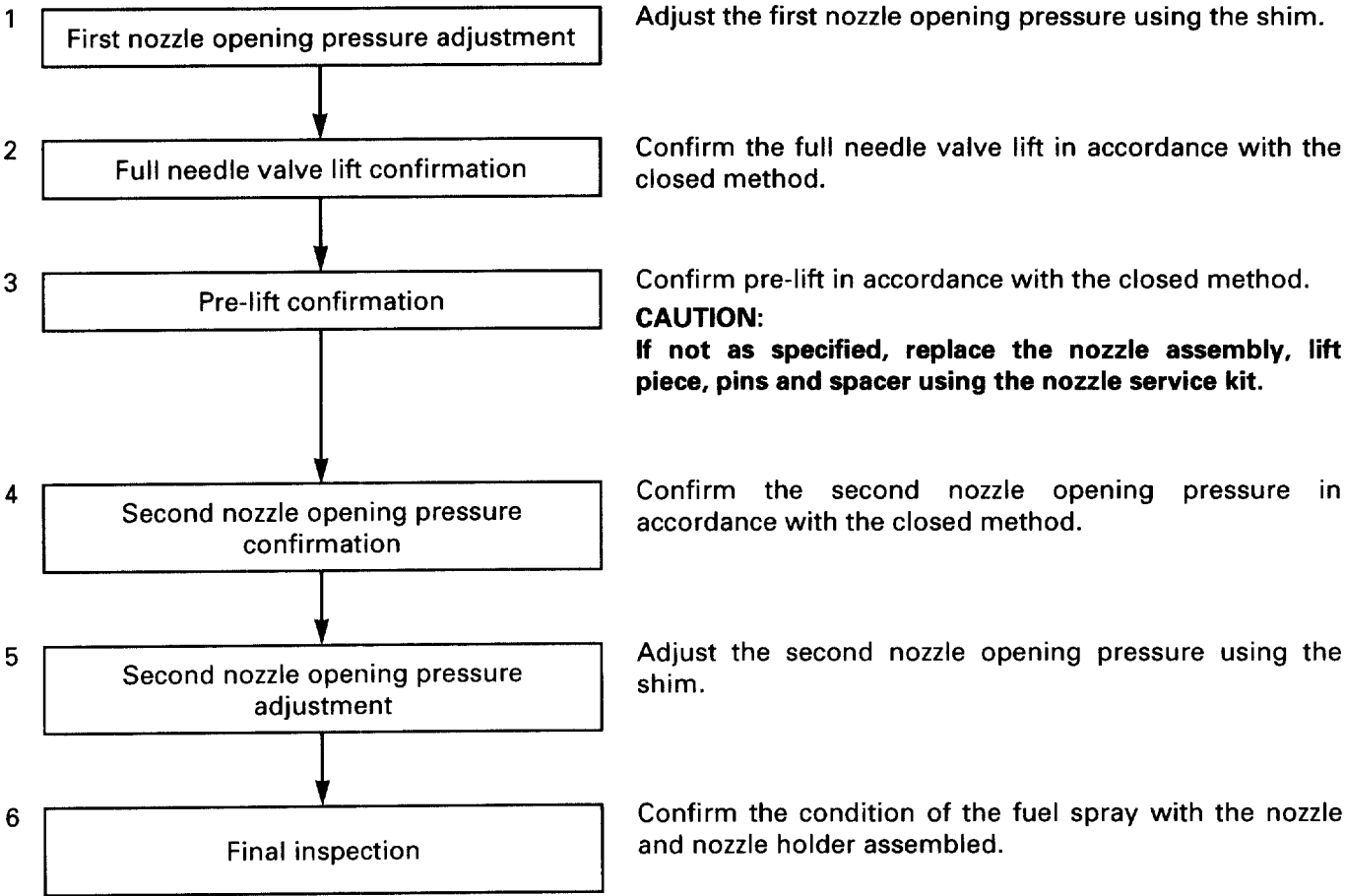
Reassembly Steps

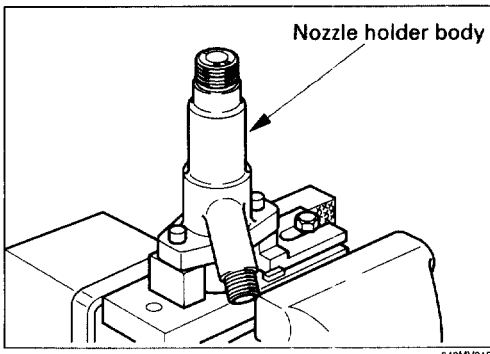
- | | |
|--|-------------------|
| 1. Nozzle holder body | 9. Spring seat |
| 2. Shim (First opening pressure adjustment) | 10. Lift piece |
| 3. First spring | 11. Spacer & pin |
| 4. Spring seat | 12. Nozzle & pin |
| 5. Collar | 13. Retaining nut |
| 6. Second spring | 14. Gasket |
| 7. Push rod | 15. Eye bolt |
| 8. Shim (Second opening pressure adjustment) | |

The nozzle holder is adjusted as the components are reassembled in the sequence above.

As adjustment of the two-spring nozzle holder is made in hundredths of a millimeter, clean the parts thoroughly in light oil to completely remove any dirt or foreign matter.

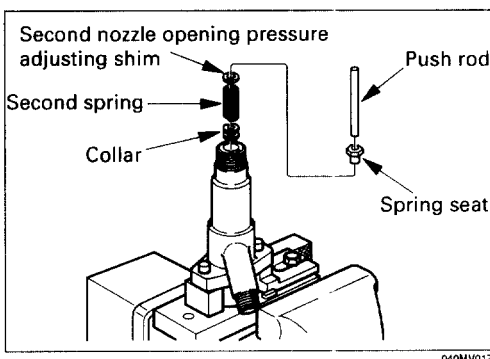
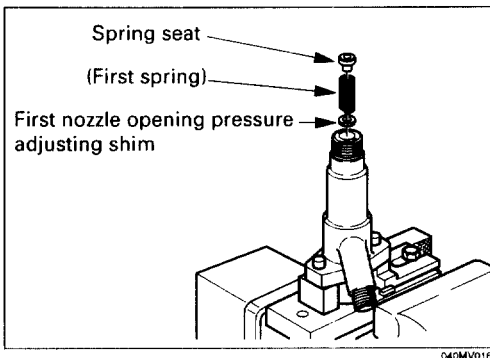
REASSEMBLY AND ADJUSTMENT PROCEDURE



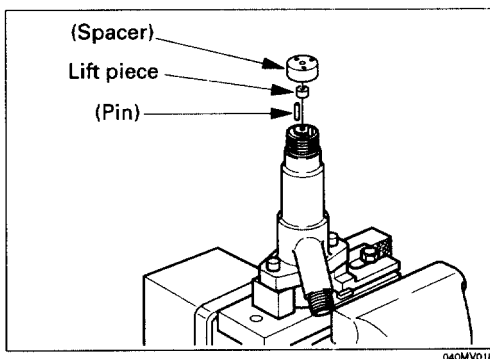


First nozzle opening pressure adjustment

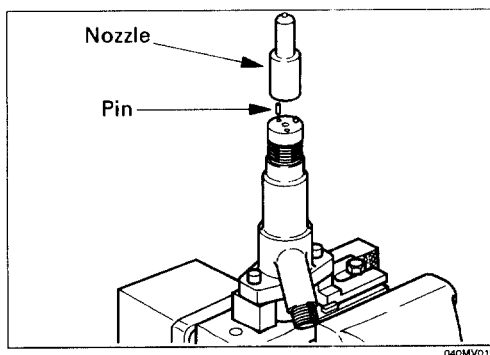
1. Clamp the nozzle holder in a vise.
2. Install the shim, first spring and spring seat in the nozzle holder.



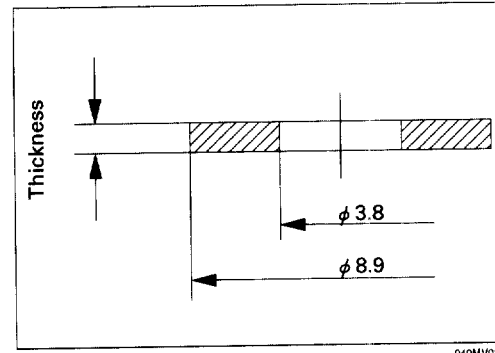
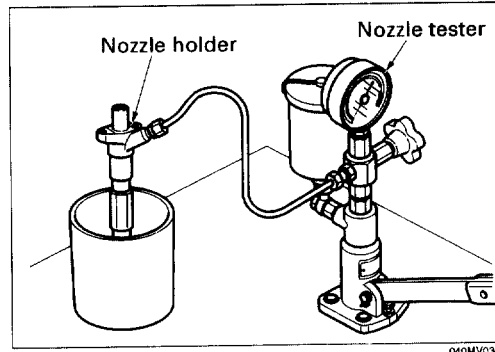
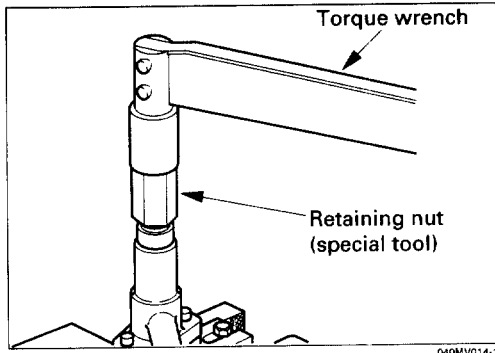
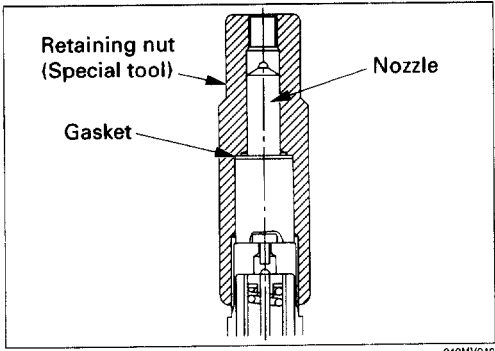
3. Install the collar, second spring, shim, spring seat and pushrod in the nozzle holder.



4. Install the pins, lift piece and spacer in the nozzle holder.



5. Install the pins in the spacer.
6. Install the nozzle on the spacer.



7. Hand-tighten the adjustment retaining nut together with the gasket to the nozzle holder.

Retaining nut: 157892-4000 (ZEXEL)

Gasket: 157892-1500 (ZEXEL)

8. Tighten the adjustment retaining nut to the specified torque.

Torque: 29 – 39 N·m (3.0 – 4.0 kg·m)

9. Set the nozzle holder to the nozzle tester.

10. Operate the nozzle tester and measure the first nozzle opening pressure.

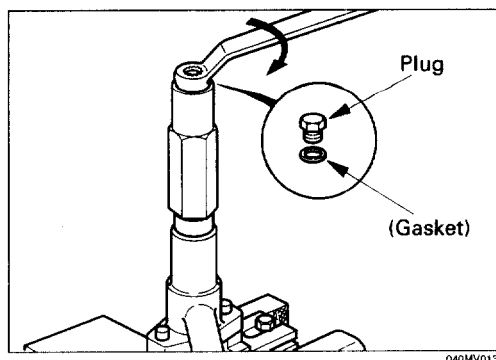
11. If the first nozzle opening pressure is not as specified, disassemble the nozzle holder and replace the shim until the pressure is as specified.

CAUTION:

Use a micrometer to measure shim thickness.

• First nozzle opening pressure adjusting shims

Part No. (ZEXEL)	Thickness (mm)
150539-0700	0.40
150539-0800	0.50
150539-0900	0.52
150539-1000	0.54
150539-1100	0.56
150539-1200	0.58
150539-1300	0.60
150539-1400	0.70

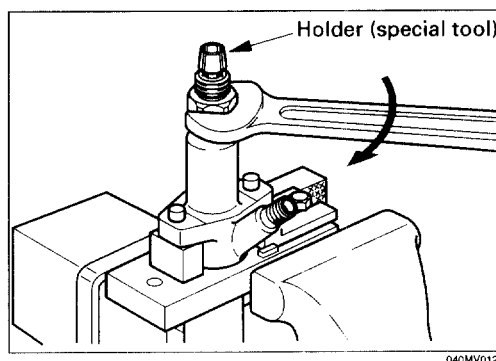


Full needle valve lift confirmation

1. Install the gasket and plug on the adjustment retaining nut.

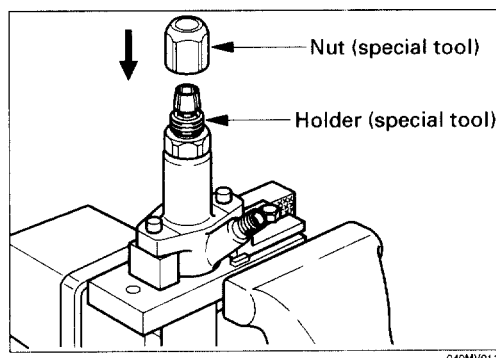
Gasket: 026508-1140 (ZEXEL)

Plug: 157892-1600 (ZEXEL)



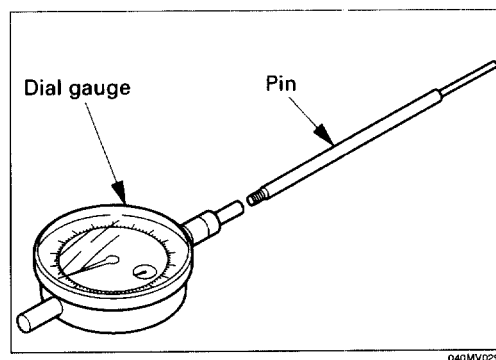
2. Position the nozzle holder with the nozzle facing down and install the dial gauge holder on the nozzle holder.

Dial gauge holder: 157892-5000 (ZEXEL)



3. Install the nut on the dial gauge holder.

Nut: 157892-1000 (ZEXEL)



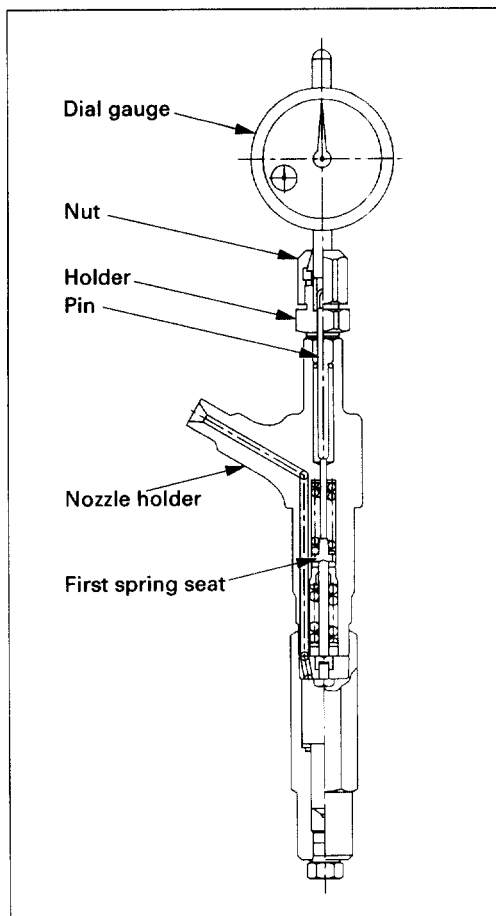
4. Install the pin to the dial gauge.

Note:

The lengths of the pins do not include the threaded portions.

Pin ($\ell=85$ mm): 157892-4700 (ZEXEL)

Dial gauge: 157954-3800 (ZEXEL)

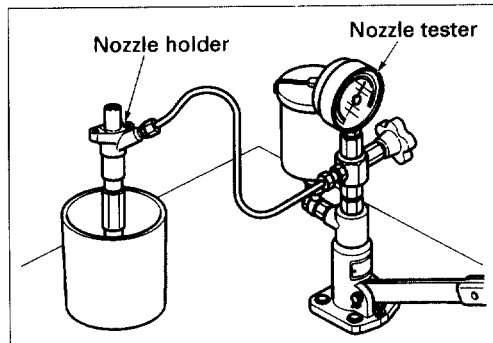


040MV009

5. Secure the dial gauge to the nozzle holder using the nut so that the pin contacts the tip of the first spring seat.

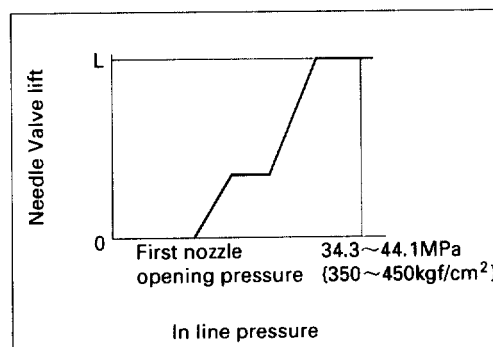
CAUTION:

- Secure the dial gauge so that a stroke of 2 mm can be measured.
- Do not over-tighten the nut as the dial gauge shaft may jam. (Confirm from the dial gauge that the shaft moves smoothly.)



040MV030

6. Set the nozzle holder to the nozzle tester and put needle to zero on the dial gauge.
7. Operate the nozzle tester to bleed any air from inside the retaining nut and to confirm that no fuel leaks.

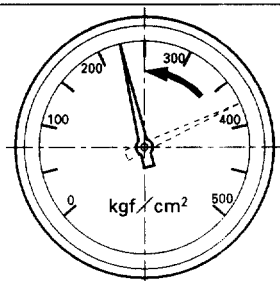


040MV008

8. Operate the nozzle tester and increase the in-line pressure to 34.3 – 44.1 MPa (350 – 450 kg/cm²) so that the nozzle's needle valve moves through its full lift.
Record full lift 'L'. (Read dial gauge)

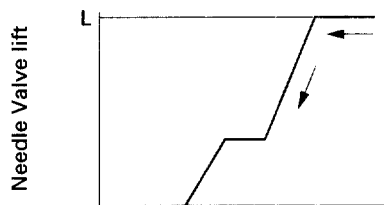
Note:

The above operation is used to determine whether the nozzle seat is worn and whether the nozzle assembly is in good condition.



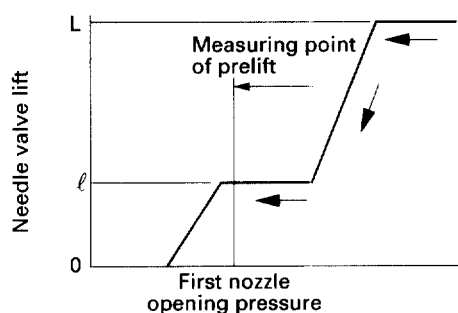
Pressure gauge

040MV007

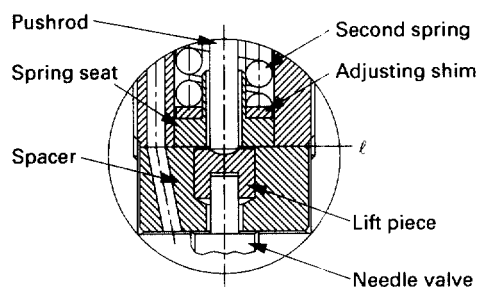


In line pressure

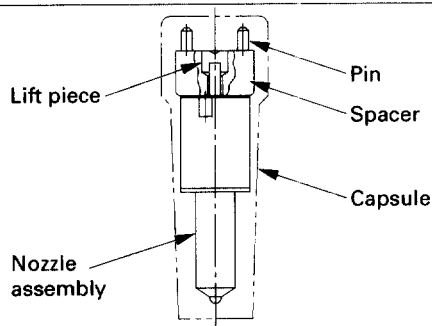
040MV006



040MV025-1



040MV005



040MV031

Pre-lift confirmation

1. With the needle valve at full lift, release the nozzle tester handle.

Note:

The in-line pressure will decrease and needle valve lift (as indicated on the dial gauge) will also decrease a little.

2. Read the needle valve lift ' ℓ ' from the dial gauge indication (once the needle valve has descended when the second spring has stopped operating). Refer to the pre-lift measuring point for ' ℓ '.

Pre-lift measuring point:

Read the dial gauge at first nozzle opening pressure + approx 1 MPa (10 kg/cm²).

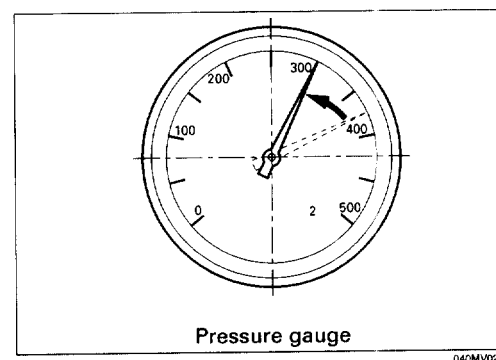
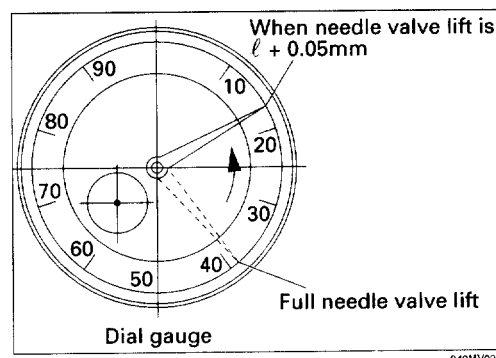
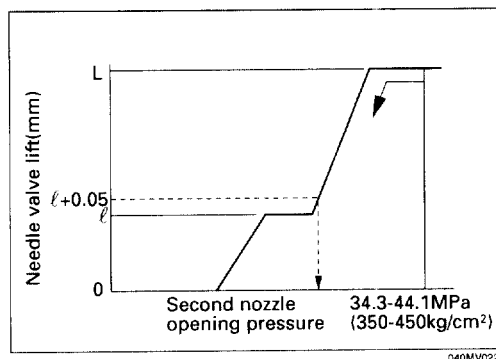
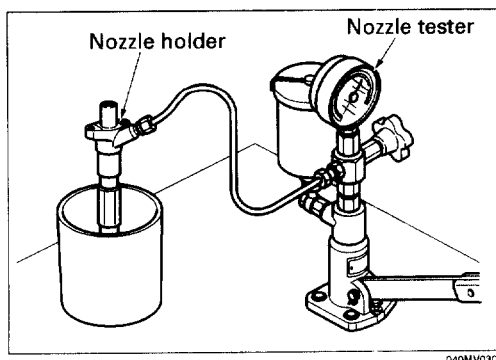
Note:

This point can be found while the pressure is decreasing.

3. Confirm that pre-lift ' ℓ ' is as specified.

4. If pre-lift is not as specified, replace the pins, lift piece, spacer and nozzle assembly as a set with the service kit.

Service kit: 105019-0290 (ZEXEL)



Second nozzle opening pressure confirmation

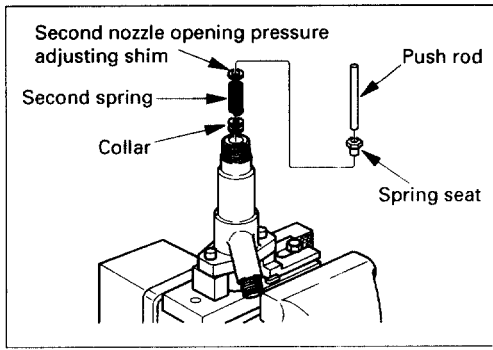
1. After pre-lift confirmation, operate the nozzle tester to increase in-line pressure to 34.3 – 44.1 MPa (350 – 450 kg/cm²) so that the nozzle's needle valve moves through its full lift.

2. Release the nozzle tester handle so that in-line pressure decreases.

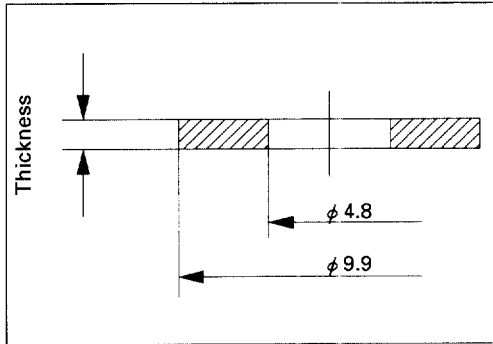
Note:

The in-line pressure will decrease and needle valve lift (as indicated on the dial gauge) will also decrease a little.

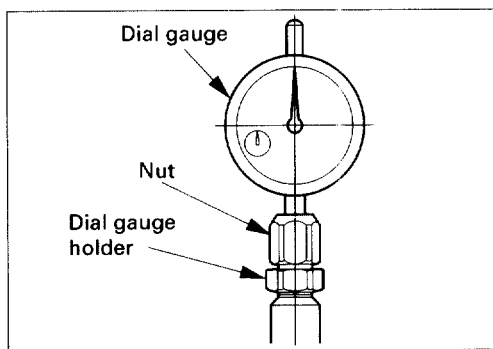
3. Then, read the pressure gauge indication (second nozzle opening pressure) the instant that the dial gauge indicates the specified needle valve lift (usually pre-lift $\ell + 0.05$ mm).



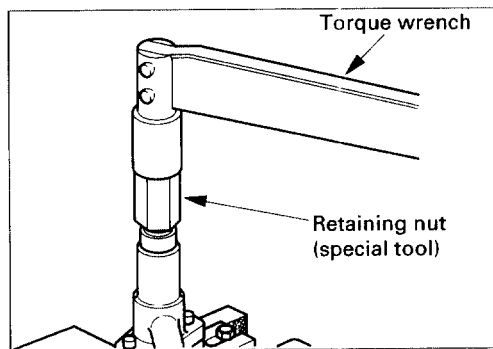
040MV017



040MV027



040MV028



040MV014-1

Second nozzle opening pressure adjustment

If the second nozzle opening pressure is not as specified, disassemble the nozzle from the nozzle holder and replace the shim until the pressure is as specified.

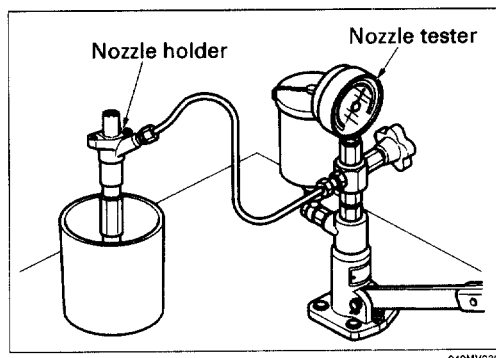
CAUTION:

- Because the second opening pressure changes when the first opening pressure changes, the second opening pressure must be adjusted when the first opening pressure changes.
- Use a micrometer to measure shim thickness.
- Second nozzle opening pressure adjusting shims

Part No. (ZEXEL)	Thickness (mm)
150590-0600	0.40
150590-0700	0.50
150590-0800	0.52
150590-0900	0.54
150590-1000	0.56
150590-1100	0.58
150590-1200	0.60
150590-1300	0.70

Final inspection

1. Remove the dial gauge, nut and dial gauge holder.
2. Remove the adjustment retaining nut and gasket.
3. Install the original retaining nut, confirm that the pins are inserted fully into the nozzle, and then hand-tighten the retaining nut. Then, tighten the original retaining nut to the specified torque.
Torque: 59 – 79 N·m (6.0 – 8.0 kg·m)

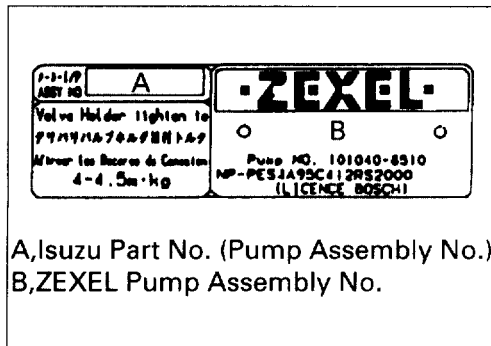


4. Set the nozzle holder to the nozzle tester and check first nozzle opening pressure, spray condition, seat oil tightness and each part for oil leaks.
5. When replacing the nozzle, replace the nozzle, lift piece, pins and spacer as a set with the nozzle service kit.

CAUTION:

Pre-lift will not be as specified if only the nozzle is replaced.

INJECTION PUMP



IDENTIFICATION PLATE AND ASSEMBLY NUMBER

1. It is important that you refer to the Injection Pump Assembly Number on the identification plate to determine the applicable calibration data in this Section for the injection pump being serviced.
2. In the event this Section does not contain calibration data applicable to the injection pump being serviced, contact the nearest manufacturer's authorized service facility (ZEXEL Corporation or Robert Bosch GMBH).
3. Refer to the Isuzu Injection Pump Assembly Number stamped on the injection pump assembly Identification Plate to order a replacement injection pump.

FUEL INJECTION VOLUME RATIO AND SYMBOL MARK

In order for a diesel engine to operate at full efficiency, fuel must be injected into the combustion chamber in such a way that it burns completely.

When a vehicle is operated at high altitudes of 1,000 meters (3,200 feet) or more, the air is thinner. To maintain an optimum air-fuel ratio, fuel injection volume must be reduced.

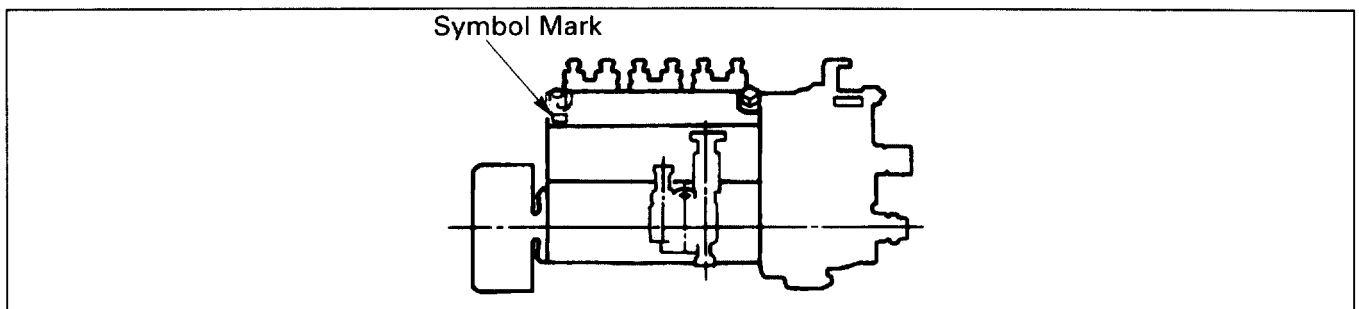
Some vehicles are operated in regions or countries where a grade of fuel having a higher specific gravity is used. Because this fuel creates more heat in the combustion chamber, the fuel injection volume must be proportionately reduced.

Injection pump adjustment requires that careful attention be given to engine operating conditions. Failure to do so will result in black exhaust smoke, increased fuel consumption, reduced engine power, and shorter engine life.

Injection volume is initially set at the Isuzu factory according to the anticipated fuel and altitude related operating conditions of the area to which the vehicle is to be delivered. A symbol mark indicating the injection volume setting is then stamped on the injection pump assembly. This is done to prevent the above engine problems after vehicle delivery.

Injection pumps whose injection volume is set to 100% of the basic volume do not have a symbol mark.

SYMBOL MARK LOCATION



Symbol Mark	Altitude (m)	Fuel Specific Gravity	Q-Set Rating
R	—	Less than 0.85	105%
Not marked	0 - 1,000	—	100%
S	1,001 - 2,000	—	86%
T	2,001 - 3,000	—	73%
U	3,001 - 4,000	—	59%

DETERMINING THE APPLICABLE CALIBRATION DATA AND FUEL INJECTION VOLUME

All calibration data contained in this Section is calculated at 100% of the basic injection volume.
 Should readjustment of the injection volume be required, check the symbol mark (stamped on the injection pump body) to determine further injection volume settings applicable to your area of operations.

- * No Symbol Mark
Follow the application data completely.
- * Symbol Mark
 1. Set the fuel injection volume as shown in the calibration data.
 2. Adjust the governor.
 3. Use the full load stopper bolt (smoke set screw) to adjust the fuel injection volume at control rack position A mm only according to the symbol mark.
Refer to the example below:

Example:

6SD1 Engine Pump Assembly

Isuzu Assembly No.	1-15603-025-1
ZEXEL Assembly No.	101603-8771

Symbol Mark	Basic Volume	Q-Set Ratio	Final Adjusted Volume
R	88.80-90.80 cc/1,000 strokes	105%	93.24-95.34 cc/1,000 strokes
No mark	"	100%	88.80-90.80 cc/1,000 strokes
S	"	86%	76.37-78.09 cc/1,000 strokes
T	"	73%	64.82-66.28 cc/1,000 strokes
U	"	59%	49.73-53.57 cc/1,000 strokes

Note:

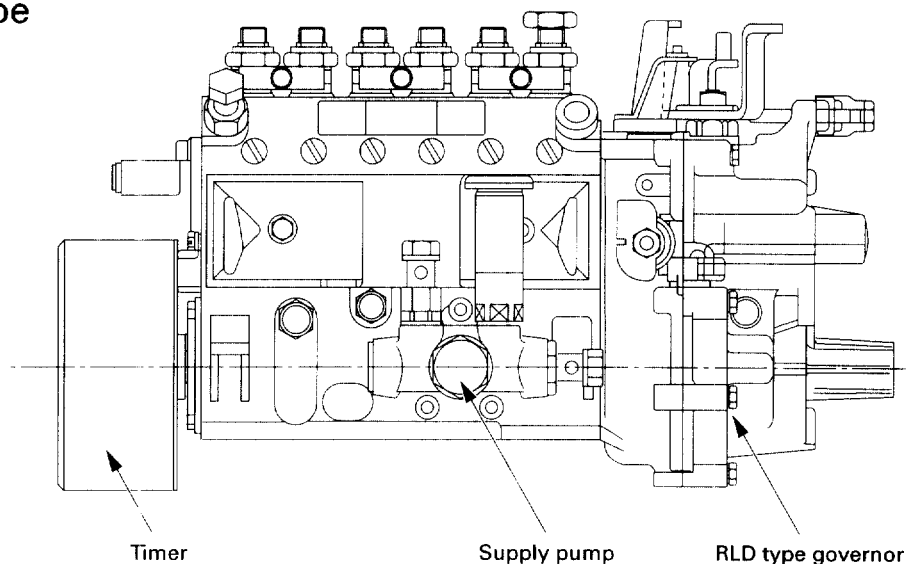
Replacement injection pumps do not have symbol marks.

Replacement injection pump volume must be adjusted according to the applicable calibration data.

After injection volume adjustment (but before installation of the injection pump to the engine), stamp the original injection pump symbol mark on the replacement injection pump body.

6SD1 ENGINE INJECTION PUMP DATA

PE-AD type



040HY00028

INJECTION PUMP CALIBRATION DATA TEST CONDITIONS

	6SD1
Injection nozzle	ZEXEL No. 105780-0000 Bosch No. DN12SD12T
Injection nozzle holder	ZEXEL No. 105780-2080 Bosch No. EF8511/9A
Injection starting pressure	17.2 MPa (175 kg/cm ² /2,485.5 psi)
Injection line dimensions	Inside diameter = 2 mm Outside diameter = 6 mm Length = 600 mm
Transfer pump pressure	156.9 kPa (1.6g/cm ² /22.7 psi)
Test diesel fuel	ISO4113 or SAE standard test oil (SAE J967d)
Fuel temperature	39° - 41°C (102° - 116°F)
Pump rotation	Counterclockwise viewed from the drive side

CAUTION:

Strictly observe the above test conditions during injection pump fuel injection volume adjustment. Failure to observe the test conditions will result in misadjustment of the injection pump fuel injection volume. Misadjustment of the fuel injection volume will result in serious engine damage.

INJECTION TIMING

	6SD1
Pre-stroke	3.7 ± 0.05 mm (0.1457 ± 0.002 in)
Injection order and interval	1 - 5 - 3 - 6 - 2 - 4 ($60^\circ \pm 30'$) Plungers are numbered from the drive side.

INJECTION VOLUME AND GOVERNOR PERFORMANCE DIAGRAM

6SD1 Engine
Injection Pump Assembly Number

ISUZU No.	ZEXEL No.	Remarks	ISUZU No.	ZEXEL No.	Remarks
1-15603-025-1	101603-8771	General Export			
1-15603-035-0	101603-8790	Central & South America Altide Compensator & Tamper Proof			
1-15603-036-0	101603-8800	Altide Compensator			
1-15603-2360-0	101603-8960	Tamper Proof			
1-15603-272-0	101603-8980	Altide Compensator & Tamper Proof			

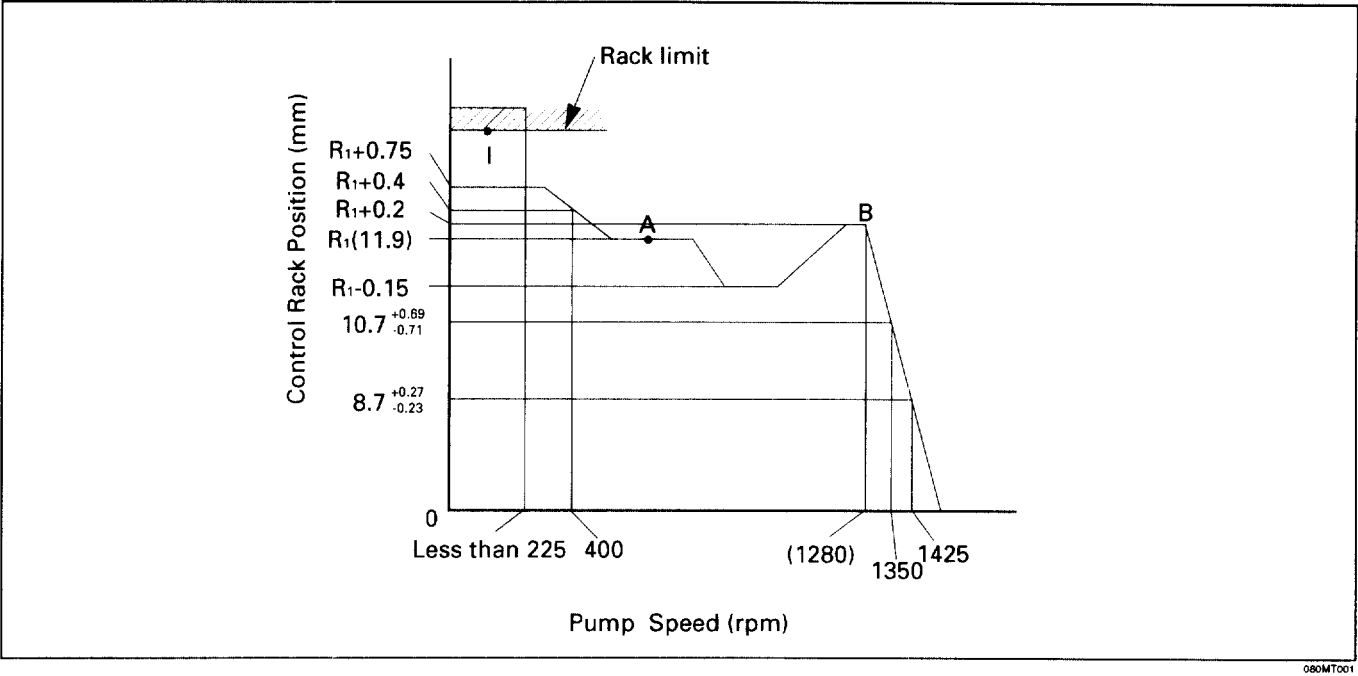
Injection Volume

Adjusting point	Control rack position mm	Pump speed rpm	Injection volume cc/1,000 strokes	Variance %	Fixed	Remarks
/	11.9	650	89.8±1.6	± 2.5	Rack	Basic (each cylinder)
H	About 9.5	290	11.2±2	±14	Rack	
A	R1(11.9)	650	89.8±1	—	Lever	Basic
I	—	100	88±5	—	Lever	Control rack limit

Timing Advance

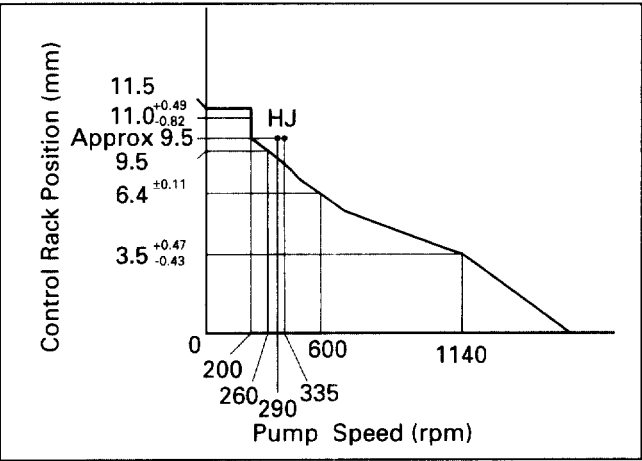
Pump speed/rpm	500	550	Controlled linearly	1,250
Lead angle/deg	Less than 0.5	Start		4.0 ± 0.5

Governor Adjustment



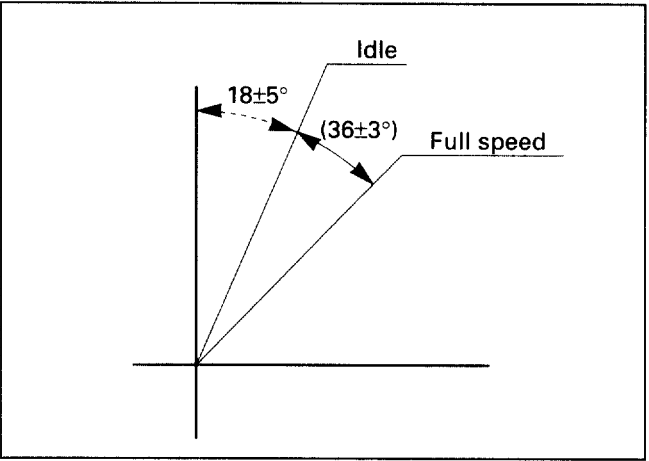
080MT001

Idle Adjustment



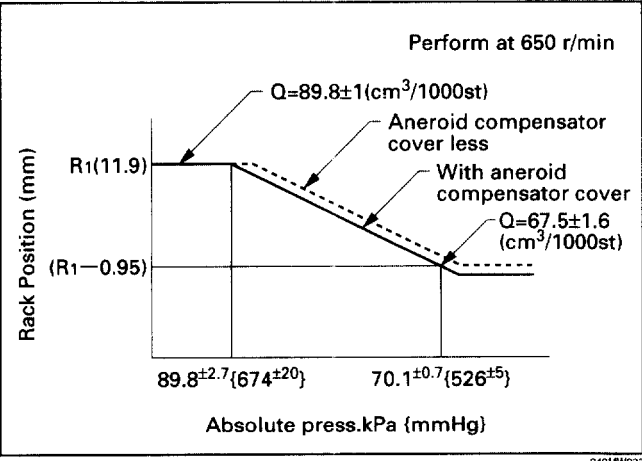
080MT002

Speed Control Lever Angle



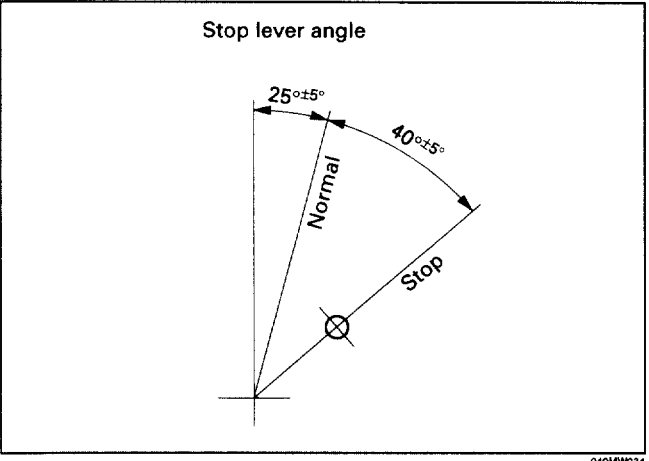
080MT003

Load Control Lever Full Load Position



040MW033

Stop Lever Angle



040MW034

INJECTION VOLUME AND GOVERNOR PERFORMANCE DIAGRAM

6SD1 Engine

Injection Pump Assembly Number

ISUZU No.	ZEXEL No.	Remarks	ISUZU No.	ZEXEL No.	Remarks
1-15603-026-1	101603-8781	Saudi Arabia W. Malaysia			

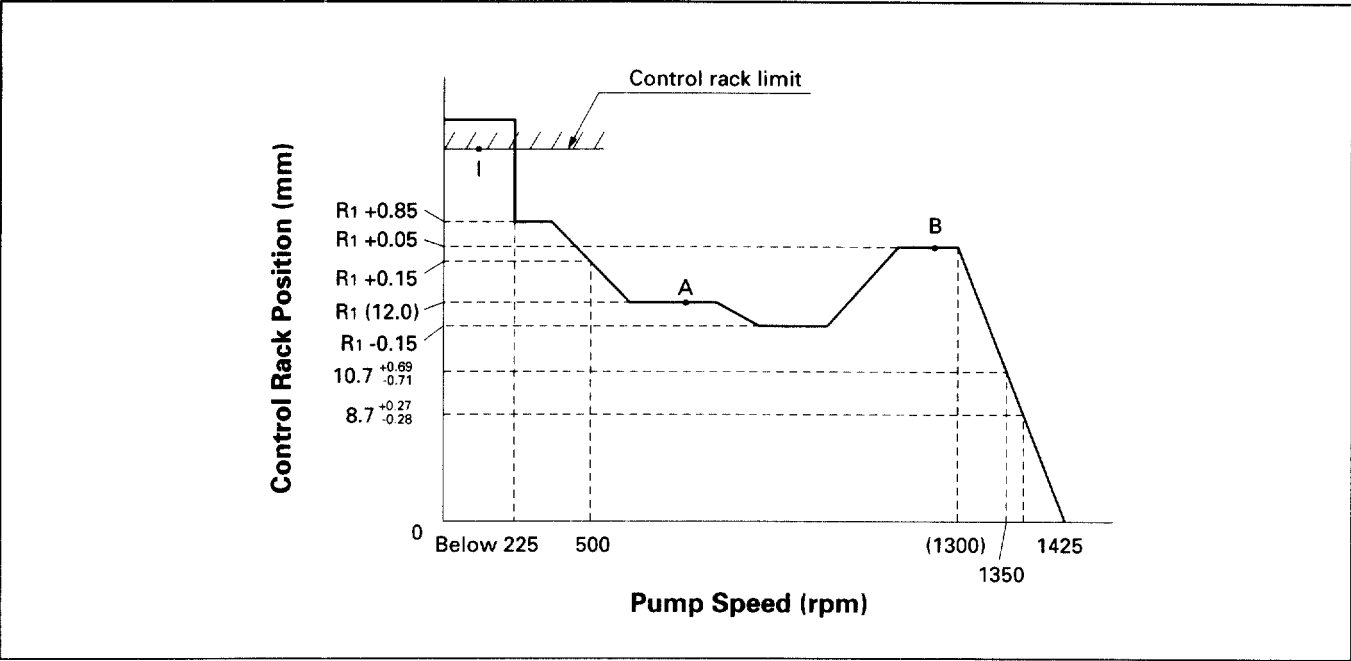
Injection Volume

Adjusting point	Control rack position mm	Pump speed rpm	Injection volume cc/1,000 strokes	Variance %	Fixed	Remarks
/	12.0	650	108.4-111.6	± 2.5	Rack	Basic
H	About 9.5	290	8.4-12.4	± 14	Rack	
A	R1(12.0)	650	109-111	—	Lever	Basic
I	—	150	150-160	—	Lever	Control rack limit

Timing Advance

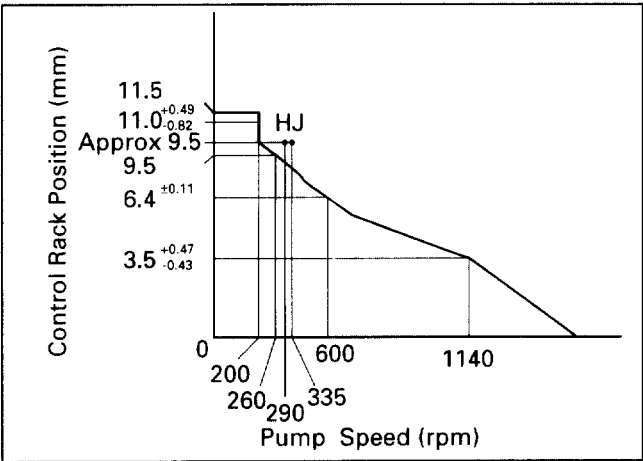
Pump speed/rpm	Less than 550	500	1,250
Lead angle/deg	Start	Less than 0.5	Finish 4.0 ± 0.5

Governor Adjustment



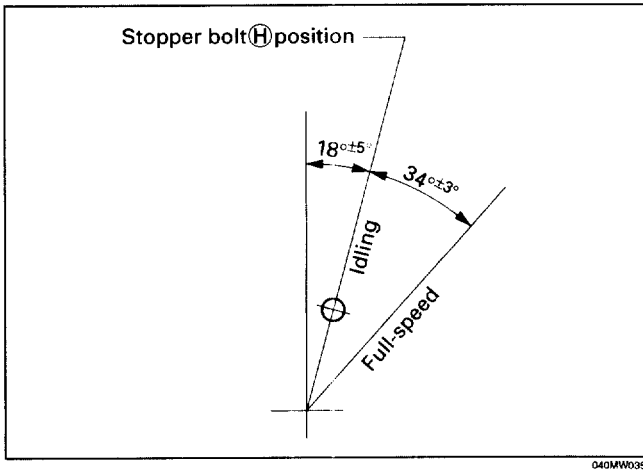
060MT007

Idle Adjustment



060MT002

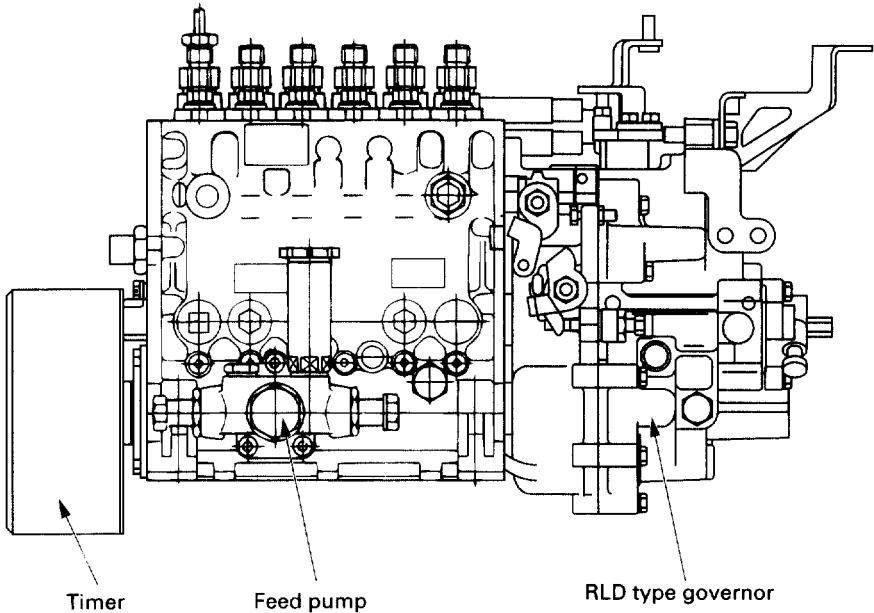
Speed Control Lever Angle



040MW035

6SD1TC (EURO I) ENGINE INJECTION PUMP DATA

PE-P type



INJECTION PUMP CALIBRATION DATA
TEST CONDITIONS

	6SD1TC (EURO I)
Injection nozzle	ZEXEL No. 105780-0000 Bosch No. DN12SD12T
Injection nozzle holder	ZEXEL No. 105780-2080 Bosch No. EF8511/9A
Injection starting pressure	17.2 MPa (175 kg/cm ² /2,485.5 psi)
Injection line dimensions	Inside diameter = 3 mm Outside diameter = 8 mm Length = 600 mm
Transfer pump pressure	156.9 kPa (1.6g/cm ² /22.7 psi)
Test diesel fuel	ISO4113 or SAE standard test oil (SAE J967d)
Fuel temperature	39° - 41°C (102° - 116°F)
Pump rotation	Counterclockwise viewed from the drive side

CAUTION:

Strictly observe the above test conditions during injection pump fuel injection volume adjustment.

Failure to observe the test conditions will result in misadjustment of the injection pump fuel injection volume.

Misadjustment of the fuel injection volume will result in serious engine damage.

INJECTION TIMING

	6SD1TC (EURO I)
Pre-stroke	4.5 ± 0.03 mm (0.1772 ± 0.0012 in)
Injection order and interval	1 - 5 - 3 - 6 - 2 - 4 (60° ± 30') Plungers are numbered from the drive side.

INJECTION VOLUME AND GOVERNOR PERFORMANCE DIAGRAM

6SD1TC Engine
Injection Pump Assembly Number

ISUZU No.	ZEXEL No.	Remarks	ISUZU No.	ZEXEL No.	Remarks
1-15603-051-3	106671-6042	General Export			

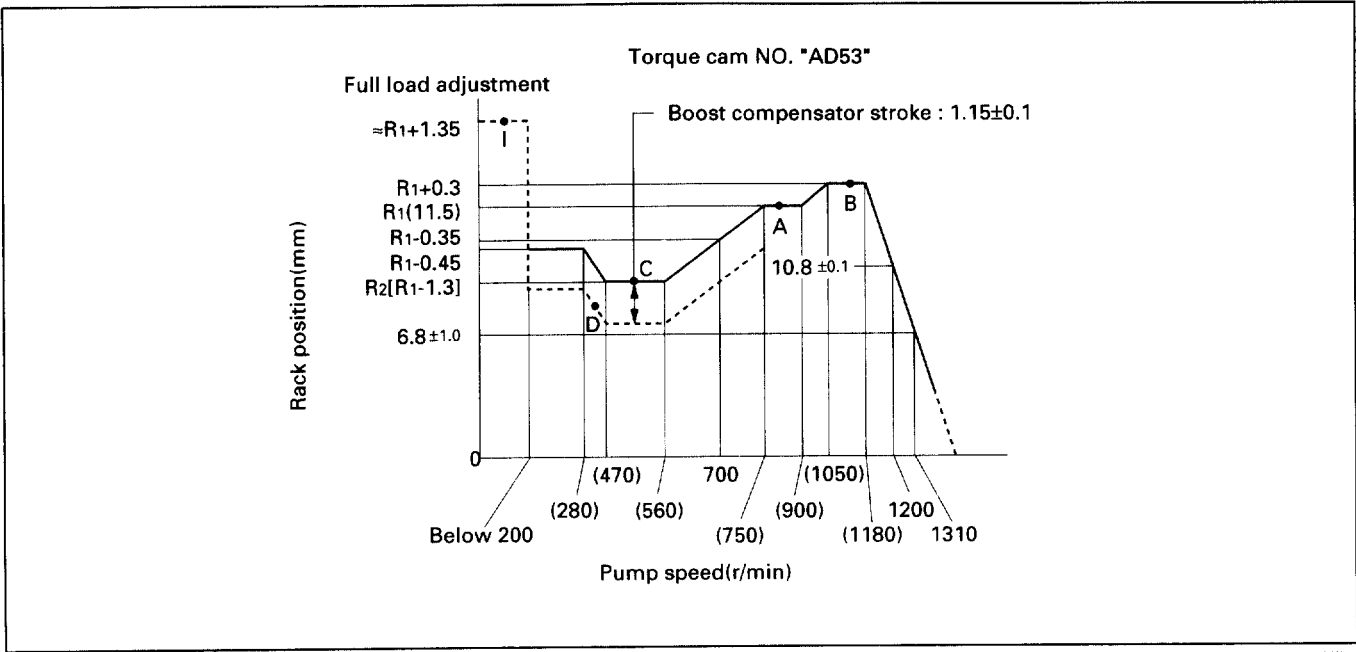
Injection Volume

Adjusting point	Control rack position mm	Pump speed rpm	Injection volume cc/1,000 strokes	Variance %	Fixed	Boost pressure kPa (mmHg)
	11.5	800	155.5-159.5	± 3.0	Rack	
H	About 6.4	290	11.8-18.2	± 13	Rack	28.7 (215)
A	R1 (11.5)	800	155.5-159.5	–	Rack	28.7 (215)
B	R1+0.3	1100	(150-156)	–	Rack	28.7 (215)
C	R2 (R1-1.3)	500	(122.5)	–	Rack	
D	(R1-1.6)	300	(106.5)	–	Rack	
I	About R1+1.35	150	(185)	–	Rack	

Timing Advance

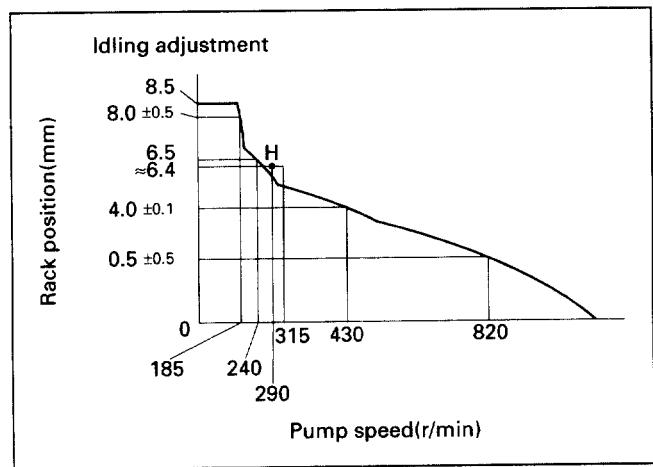
Pump speed/rpm	800	Less than 850	875
Lead angle/deg	Less than 0.5	Start	Finish 1.5 ± 0.5

Governor Adjustment



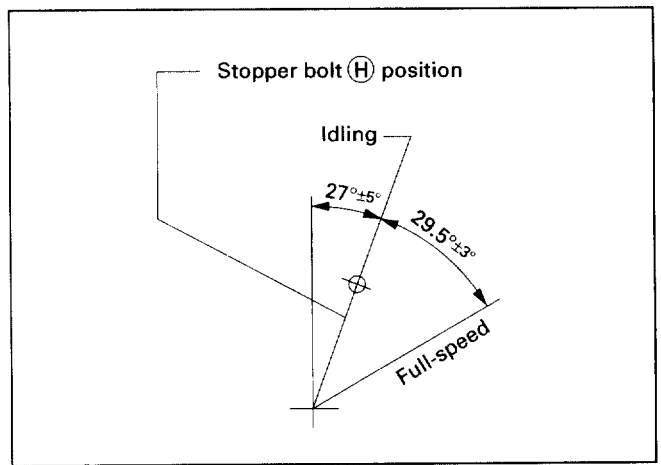
040MW021

Idle Adjustment



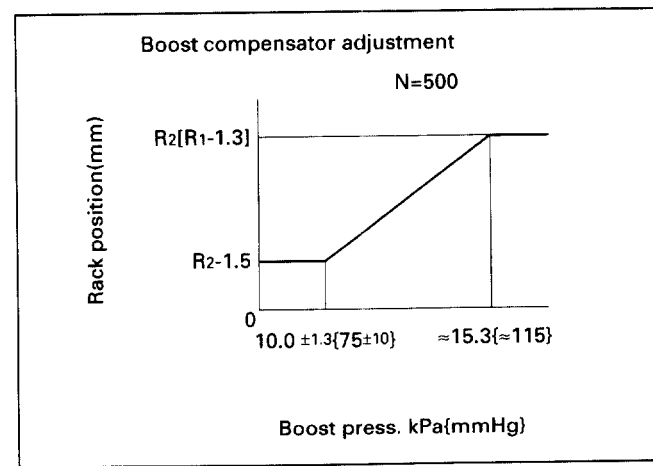
040MW022

Speed Control Lever Angle



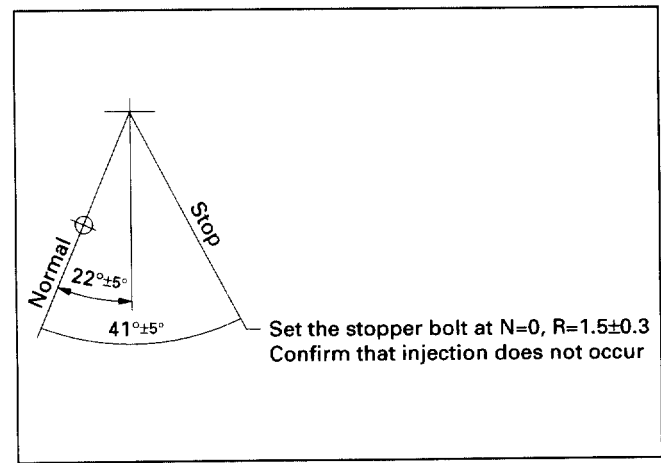
040MW030

Boost Compensator Adjustment



040MW029

Stop Lever Angle



040MW031

INJECTION VOLUME AND GOVERNOR PERFORMANCE DIAGRAM

6SD1TC Engine

Injection Pump Assembly Number

ISUZU No.	ZEXEL No.	Remarks
1-15603-213-4	106671-6254	General Export
☆1-15603-215-4	106671-6273	Altide Compensator
☆1-15603-216-4	106671-6283	Central & South America Altide Compensator & Tamper Proof
1-15603-214-4	106671-6263	
1-15603-217-4	106671-6293	Speed Limiter
1-15603-246-3	106671-6363	New Zealand
1-15603-257-3	106671-6323	Australia

ISUZU No.	ZEXEL No.	Remarks
1-15603-258-3	106671-6343	Australia, Speed Limiter
1-15603-2861	106671-6411	Australia, Transmission-Automatic
1-15603-2871	106671-6421	Australia, Transmission-Automatic & Speed Limiter

Injection Volume

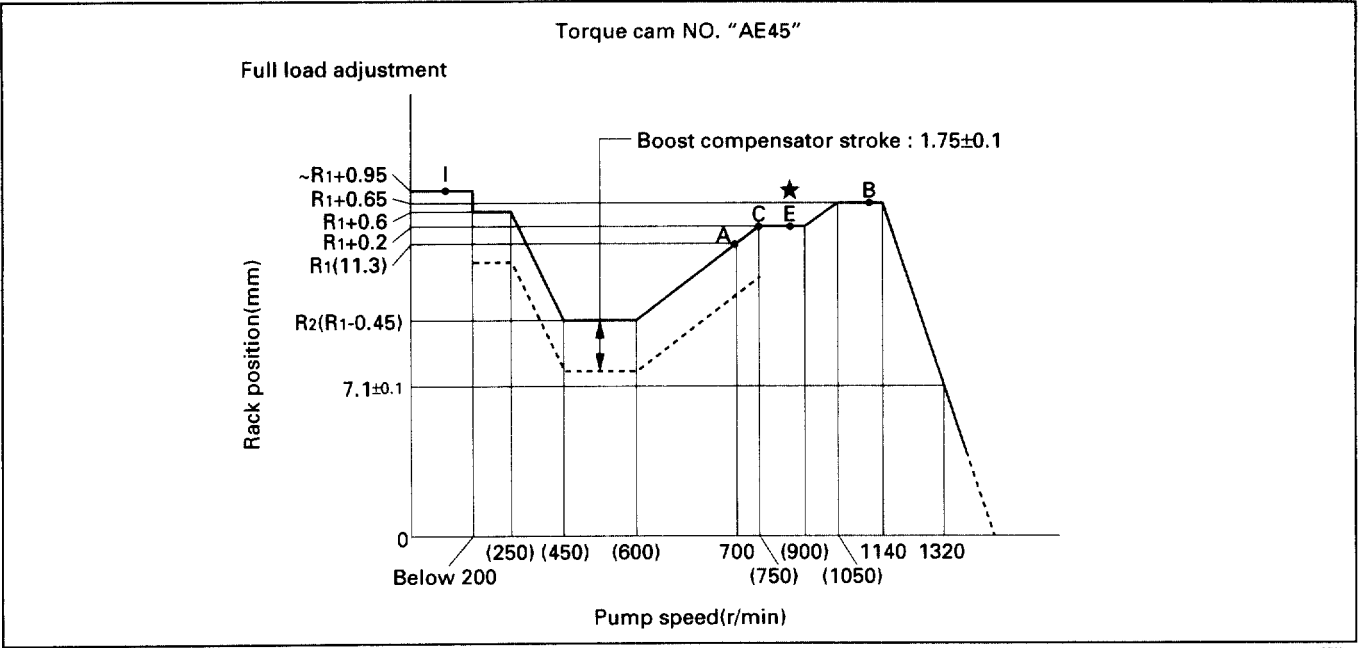
Adjusting point	Control rack position mm	Pump speed rpm	Injection volume cc/1,000 strokes	Variance %	Boost pressure kPa (mmHg)	Remarks
	11.3	700	154	± 3.0		Basic
H	About 6.4	290	15	± 13		
A	R1 (11.3)	700	154	–	60.0 (450) or more	Basic
B	R1+0.65	1100	(152)	–	60.0 (450) or more	
C	(R1+0.2)	750	(157.5)	–	60.0 (450) or more	
I	About R1+0.95	150	(165)	–	0	
☆ E	R1+1.15	1100	–	–	60.0 (450) or more	

Asterisk mark (☆) is adapted to specified parts number only.

Timing Advance

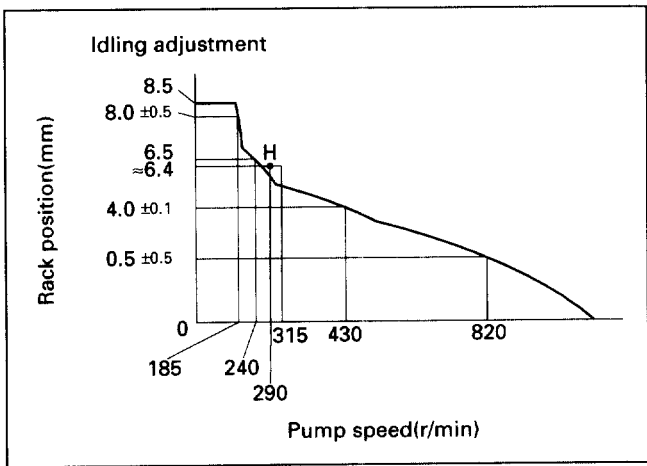
Pump speed/rpm	800	Less than 850	875
Lead angle/deg	Less than 0.5	Start	Finish 1.5 ± 0.5

Governor Adjustment



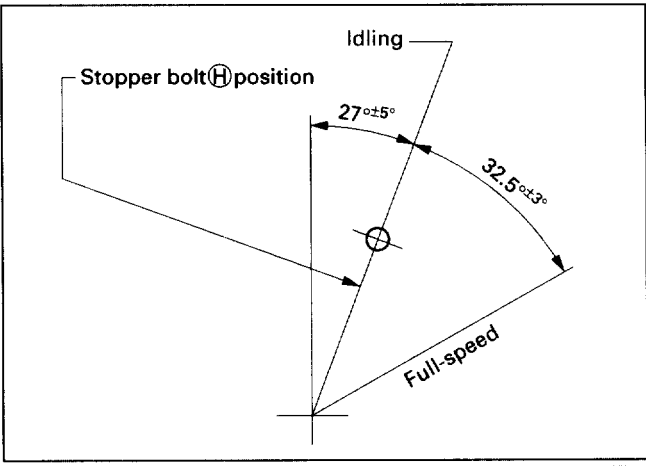
040MW020

Idle Adjustment



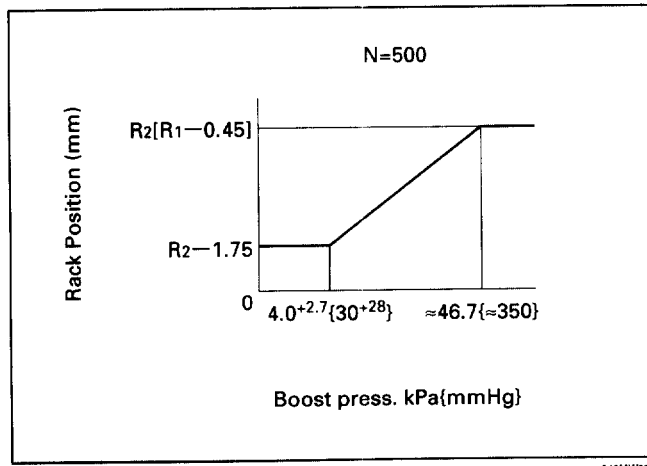
040MW022

Speed Control Lever Angle



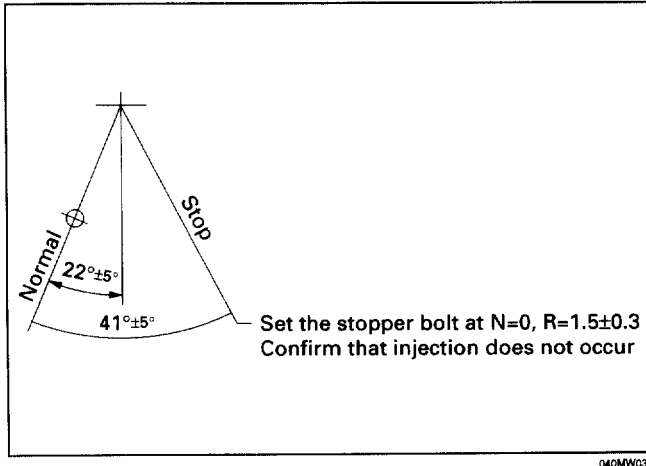
040MW028

Boost Compensator Adjustment

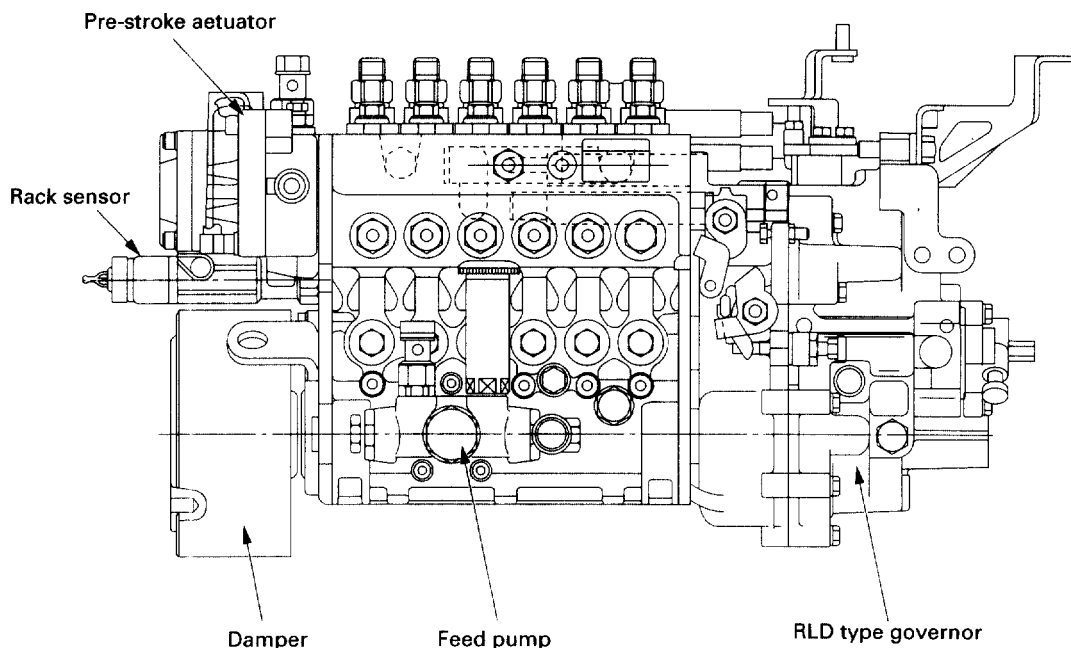


040MW027

Stop Lever Angle



040MW031

6SD1TC (EURO II) ENGINE INJECTION PUMP DATA**HD-TICS type**

040HY00029

**INJECTION PUMP CALIBRATION DATA
TEST CONDITIONS**

	6SD1TC (EURO II)
Injection nozzle	ZEXEL No. 105780-0120 Bosch No. 1688901990
Injection nozzle holder	ZEXEL No. 105780-2190
Injection starting pressure	20.7 MPa (211 kg/cm ² /3,000.4 psi)
Injection line dimensions	Inside diameter = 3 mm Outside diameter = 8 mm Length = 600 mm
Transfer pump pressure	156.9 kPa (1.6g/cm ² /22.7 psi)
Test diesel fuel	ISO4113 or SAE standard test oil (SAE J967d)
Fuel temperature	39° - 41°C (102° - 116°F)
Pump rotation	Counterclockwise viewed from the drive side

CAUTION:

Strictly observe the above test conditions during injection pump fuel injection volume adjustment. Failure to observe the test conditions will result in misadjustment of the injection pump fuel injection volume. Misadjustment of the fuel injection volume will result in serious engine damage.

INJECTION TIMING

	6SD1TC (EURO II)
Pre-stroke	8.5 ± 0.03 mm (0.3346 ± 0.0012 in)
Injection order and interval	1 - 5 - 3 - 6 - 2 - 4 (60° ± 30°) Plungers are numbered from the drive side.

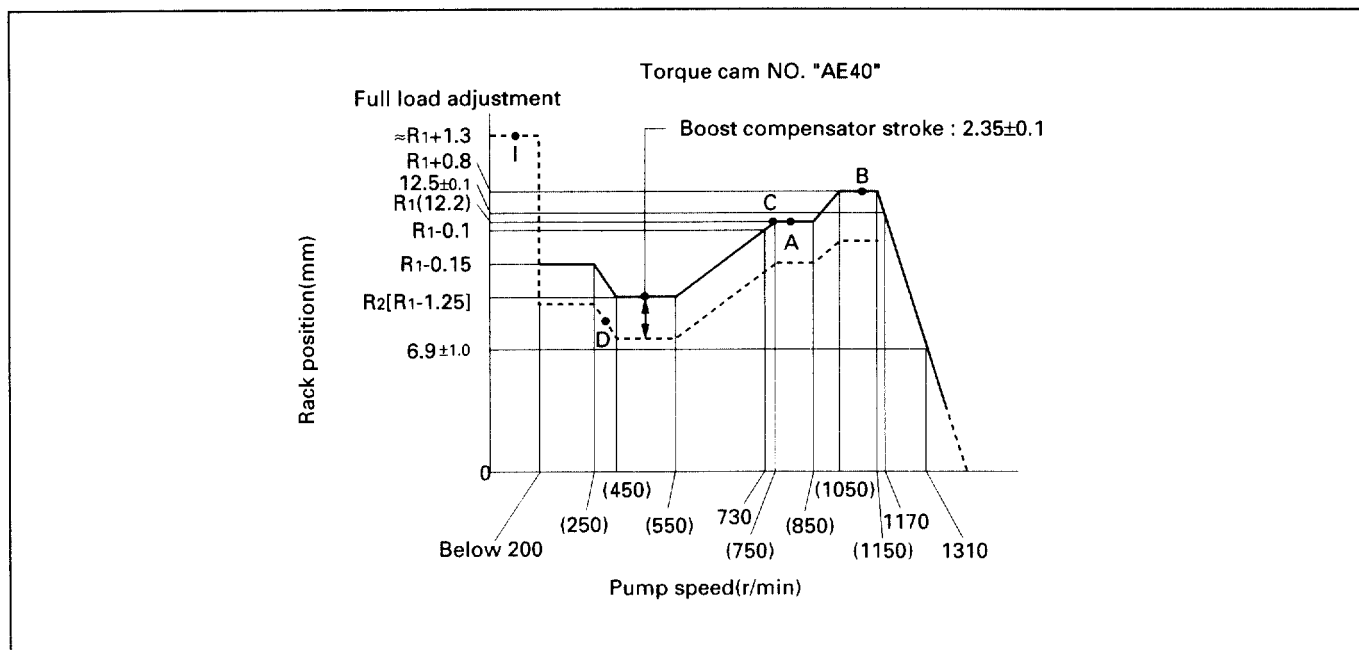
INJECTION VOLUME AND GOVERNOR PERFORMANCE DIAGRAM**6SD1TC (Conform in EURO-II) Engine****Injection Pump Assembly Number**

ISUZU No.	ZEXEL No.	Remarks
1-15603-264-1	108622-1031	General Export
1-15603-305-0	108622-1160	Hong Kong Speed Limiter A/T

Injection Volume

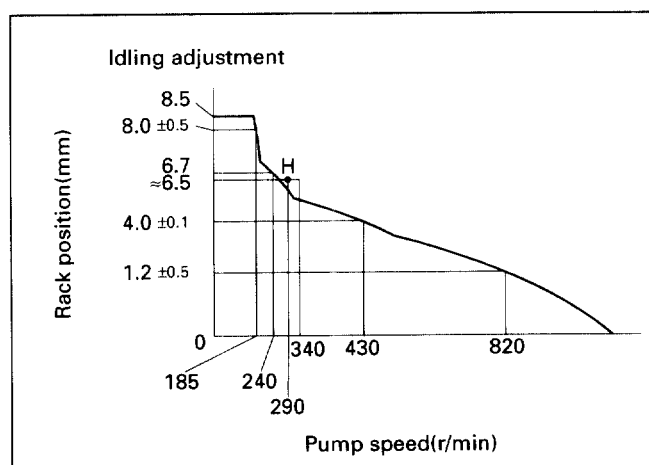
Adjusting point	Rack Position (mm)	Pump speed (rpm)	Injection q'ty (cm ³ /1,000 strokes)	Max. var bet. cyl (%)	Fixed	Remarks
	12.2	800	146.5 ± 2	± 3	Rack	Basic
Z	Approx. 6.7	355	15 ± 3.2	± 13	Rack	Adjust injection q'ty at N=355 Adjust governor as per gov. adj. spec.
A	R (12.2)	800	146.6 ± 2	–	Lever	Basic Boost press. kPa (mmHg) Above 54.7 (Above 410)
B	R1 + 0.8	1,100	(144.5)	–	Lever	Boost press. kPa (mmHg) Above 54.7 (Above 410)
C	(R1)	750	(151)	–	Lever	Boost press. kPa (mmHg) Above 54.7 (Above 410)
I	Approx. R1 + 1.3	150	(290)	–	Lever	Boost press. 0

Governor Adjustment



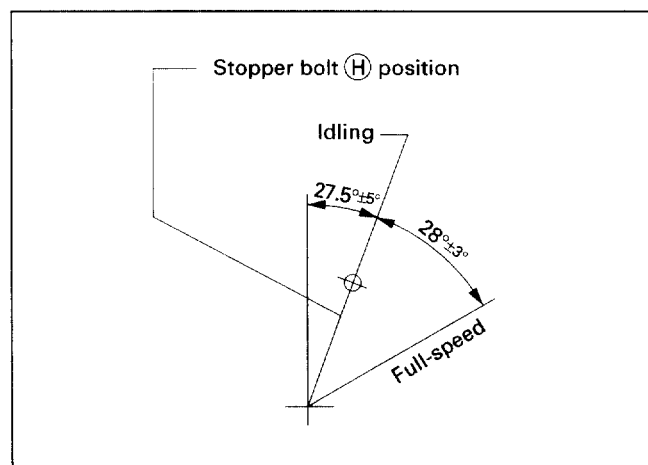
040HY00031

Idle Adjustment



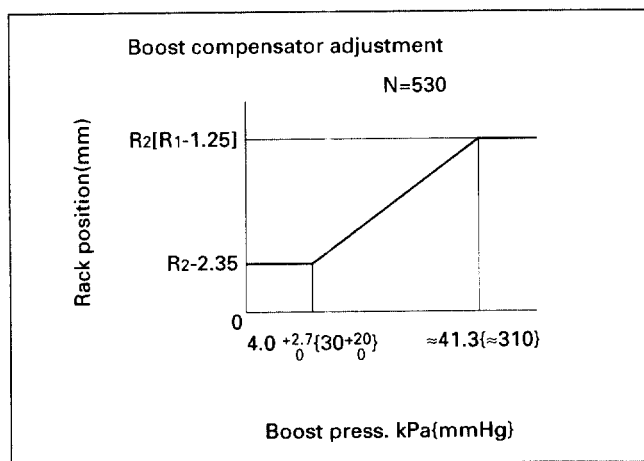
040HY00032

Speed Control Lever Angle



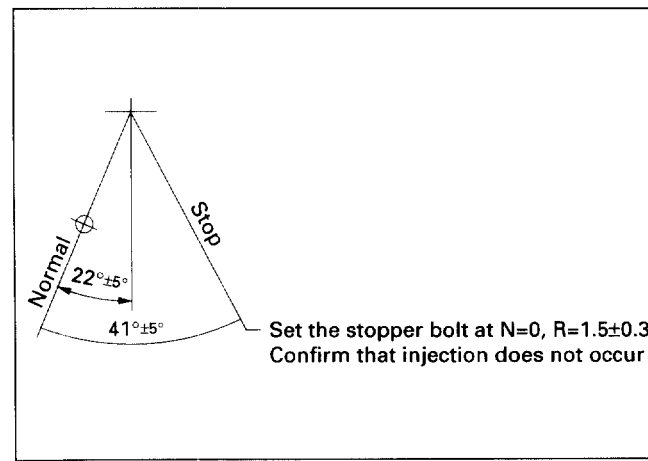
040HY00034

Boost Compensator Adjustment



040HY00033

Stop Lever Angle

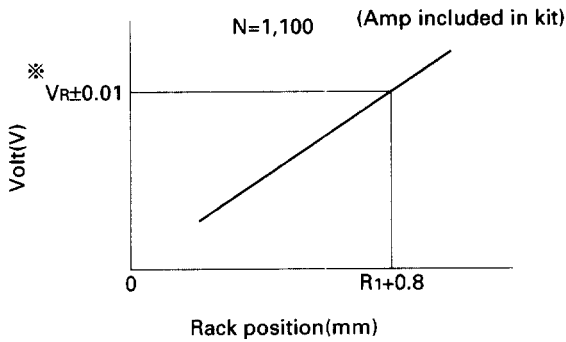


040MW031

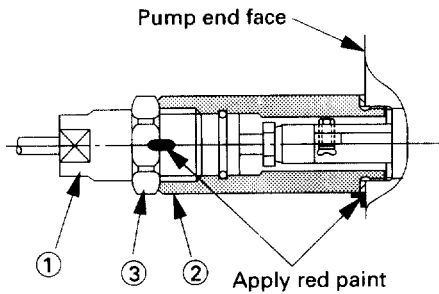
Rack sensor adjustment

※Adjust the rack sensor after determining VR from the control unit parts no.

VR	Control unit parts no.
2V	407912-1742
	105782-6320
3V	407910-3032
	407910-6010
	407910-7210



040HY00036



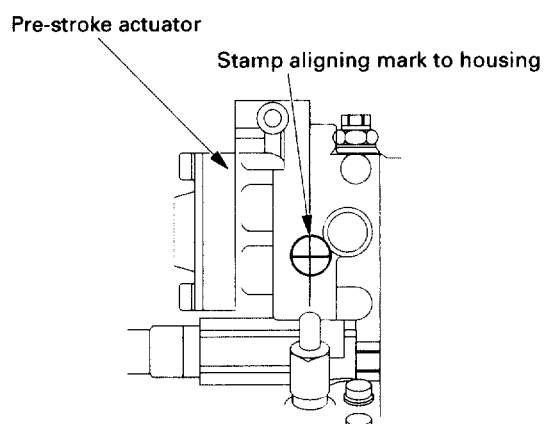
F06MV035

- Do not operate the aneroid compensator if installed.
Secure the speed control lever in the full position and set the pump speed at 1,100 r/min.
(If equipped with a boost compensator, first apply boost pressure.)
- Adjust the bobbin ① so that the rack sensor's output voltage is $V_R \pm 0.01$.
- After adjustment, mark the area where the joint ② and the nut ③ contact and the area where the joint 2 and the pump housing contact with red paint.

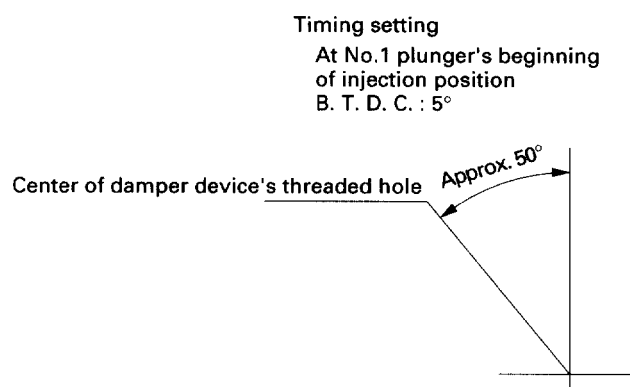
Pre-stroke actuator adjustment

- Pre-stroke : $h1 = 8.5 \pm 0.03$ mm (When the timing sleeve is pushed up using the jig)
- Connector angle when tightening the eccentric pin : $8^{\circ}30' \pm 30'$
- Power supply voltage : $24 \pm 0.5V$
- Ambient temperature : $23 \pm 5^{\circ}C$
- Adjustment and confirmation

	Adjustment	Confirmation	Confirmation	Confirmation
Pre-stroke (mm)	6.1 ± 0.05	$h1 = 8.5 \pm 0.03$	Below 5.5	Operation
Sensor output (V)	2.45 ± 0.01	$V1 = 1.2 \pm 0.2$	$3 - 0.02$	Above 3.05



040HY00037



040HY00035

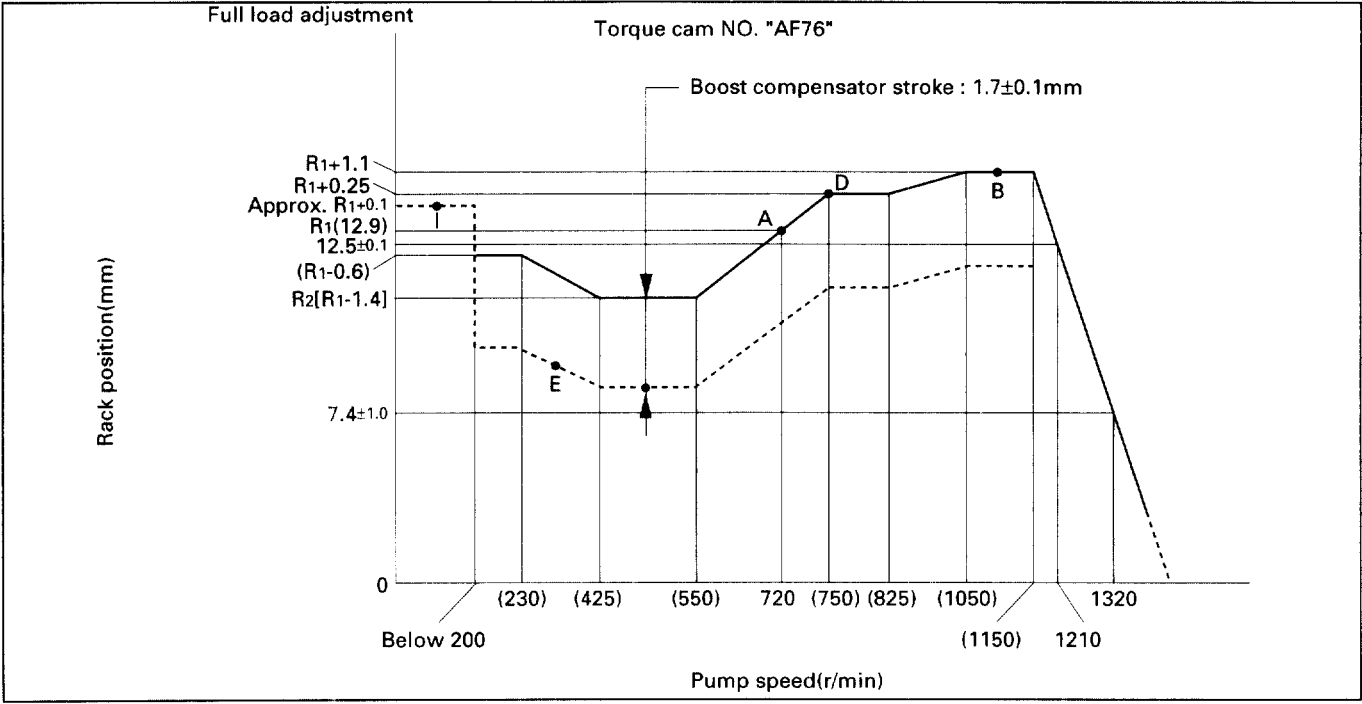
INJECTION VOLUME AND GOVERNOR PERFORMANCE DIAGRAM
6SD1TC (Conform in EURO-II) Engine
Injection Pump Assembly Number

ISUZU No.	ZEXEL No.	Remarks
1-15603-294-0	108622-1140	General Export & China Altide Compensator
1-15603-276-1	108622-1101	
1-15603-366-1	108622-1211	

Injection Volume

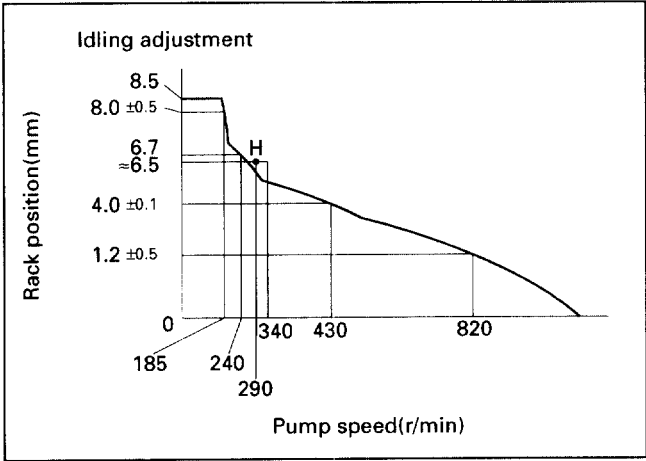
Adjusting point	Rack Position (mm)	Pump speed (rpm)	Injection q'ty (cm ³ /1,000 strokes)	Max. ver bet. cyl (%)	Fixed	Remarks
	12.9	720	156.5 ± 2	± 3	Rack	Basic
Z	Approx. 6.7	365	14.5 ± 3.2	± 13	Rack	Adjust injection q'ty at N=365 Adjust governor as per gov. adj. spec.
A	R (12.9)	720	156.5 ± 2	–	Lever	Basic Boost press. kPa (mmHg) Above 53.3 (Above 400)
B	R1 + 1.1	1,100	(141.5)	–	Lever	Boost press. kPa (mmHg) Above 53.3 (Above 400)
D	(R1+0.25)	750	(157.5)	–	Lever	Boost press. kPa (mmHg) Above 53.3 (Above 400)
E	(R2 –1.15)	300	(125.5)	–	Lever	Boost press. 0
I	Approx. R1 + 0.1	150	(255)	–	Lever	Boost press. 0

Governor Adjustment



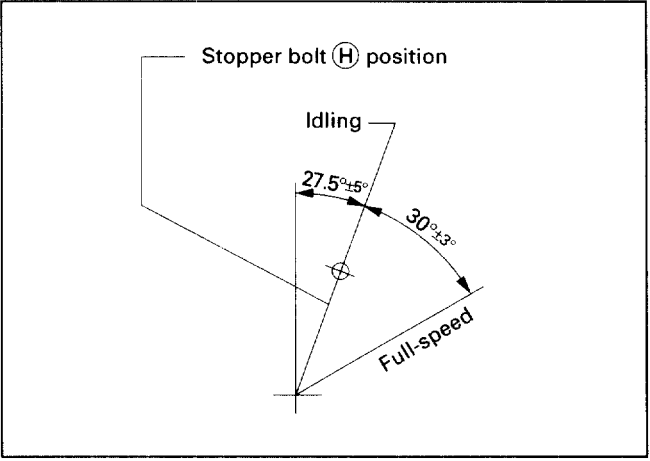
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Idle Adjustment



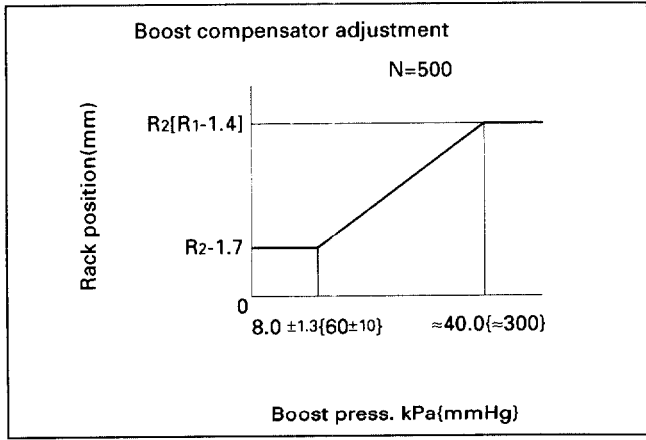
040HY00032

Speed Control Lever Angle



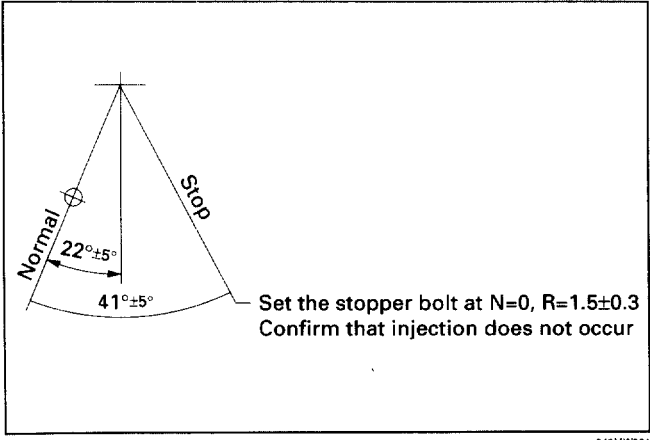
040HY00041

Boost Compensator Adjustment



040HY00040

Stop Lever Angle



040MW031

Amp-equipped rack sensor adjustment (154610-5*20)

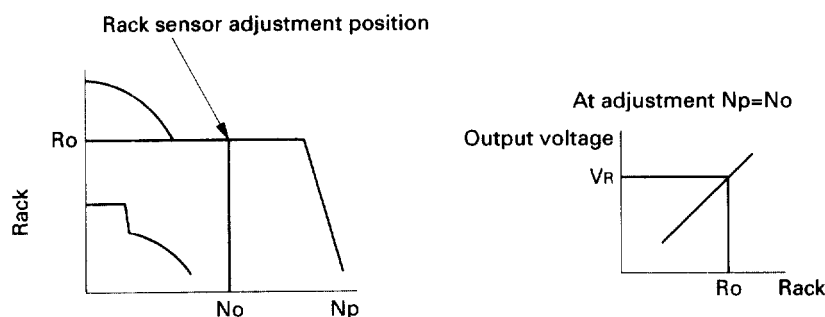
- Threaded type rack sensor (without rack limit : for P type, TICS)

Supply voltage 5 ± 0.01 (V)

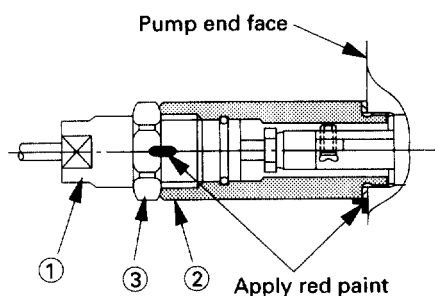
Speed $N_o = 1100$ (r/min)
 Rack position $R_o = R_1 + 1.1$ (mm)
 Output voltage $V_R = 3.00 \pm 0.01$ (V)

- Rack sensor adjustment

- Screw in bobbin ① until it contacts the joint ②.
- Fix the pump lever at full and at $N_p = N_o$ and $R = R_o$, screw in the bobbin ① to adjust the depth so that the amp's output voltage $V = V_R$.
 Then, fix the rack sensor using the nut ③.
- Move the pump lever 2 or 3 times, reset at full and confirm that the amp's output voltage $V = V_R$
- Attach the caution plate to the top of the joint ② and apply red paint to the joint ② – nut ③ joint, and the pump end face – joint ② joint.



040MY00025

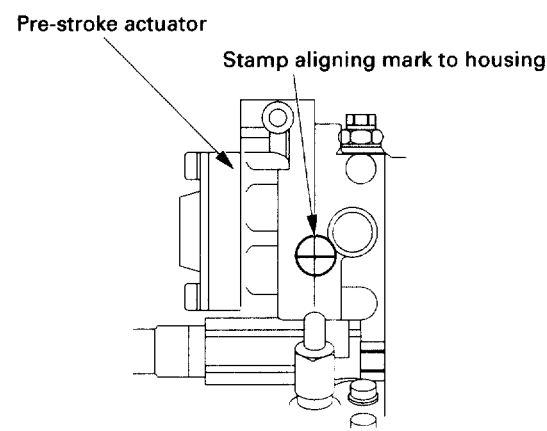


FO6MV035

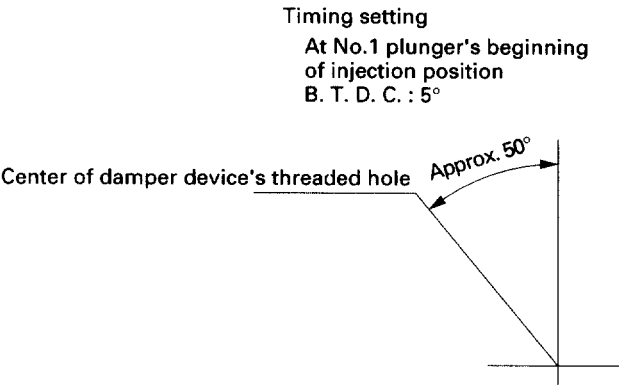
Pre-stroke actuator adjustment

- Pre-stroke : $h1 = 8.5 \pm 0.03$ mm (When the timing sleeve is pushed up using the jig)
- Connector angle when tightening the eccentric pin : $8^{\circ}30' \pm 30'$
- Power supply voltage : $24 \pm 0.5V$
- Ambient temperature : $23 \pm 5^{\circ}C$
- Adjustment and confirmation

	Adjustment	Confirmation	Confirmation	Confirmation
Pre-stroke (mm)	6.1 ± 0.05	$h1 = 8.5 \pm 0.03$	Below 5.5	Operation
Sensor output (V)	2.45 ± 0.01	$V1 = 1.2 \pm 0.2$	$3 - 0.02$	Above 3.05



040HY00037



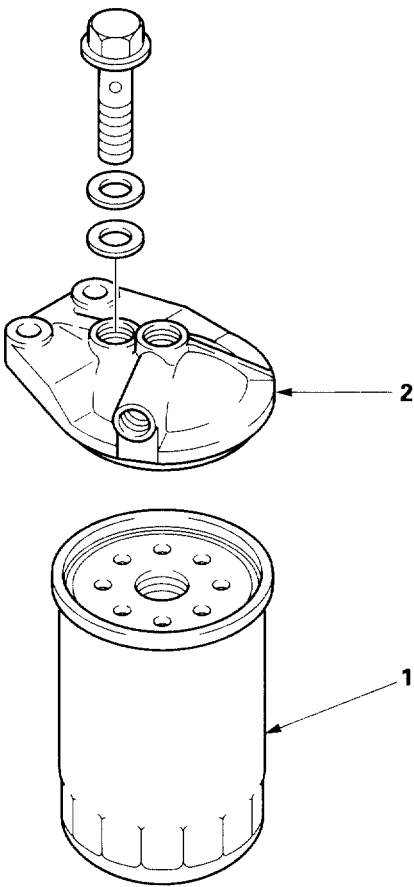
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FUEL FILTER



DISASSEMBLY



145MT002

Disassembly Steps

- 1. Cartridge
- 2. Filter cover



REASSEMBLY

To reassemble the fuel filter, follow the disassembly procedure in the reverse order.

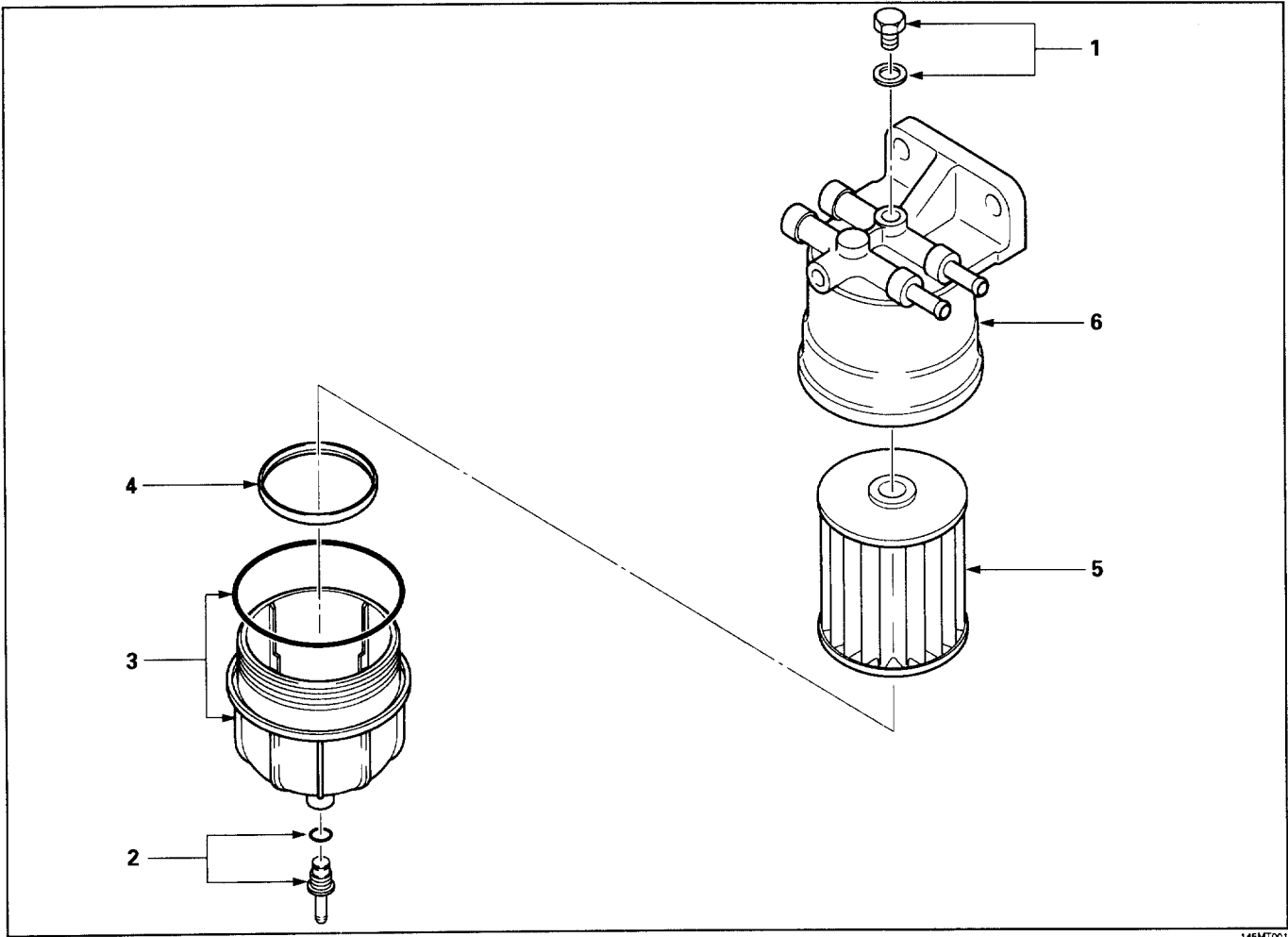
Fix the cartridge to specified torque.

Cartridge Torque	N·m(kg·cm/lb.ft)
17.9 (180.0 / 1.3)	

WATER SEPARATOR
WITH PRE-FUEL FILTER



DISASSEMBLY



145MT001

Disassembly Steps

- | | |
|---------------|-------------------|
| 1. Plug | 4. Float |
| 2. Drain plug | 5. Filter element |
| 3. Cover | 6. Body |



REASSEMBLY

To reassemble the fuel filter, follow the disassembly procedure in the reverse order.

Fix the cartridge to specified torque.

Cartridge Torque	N·m(kg·cm/lb.ft)
19.6 (200.0 / 1.4)	

SECTION 6D

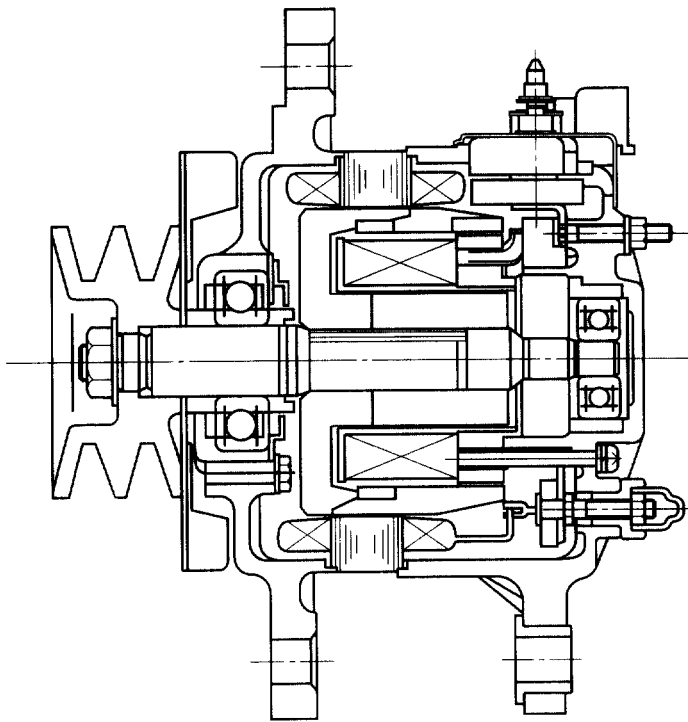
ENGINE ELECTRICAL

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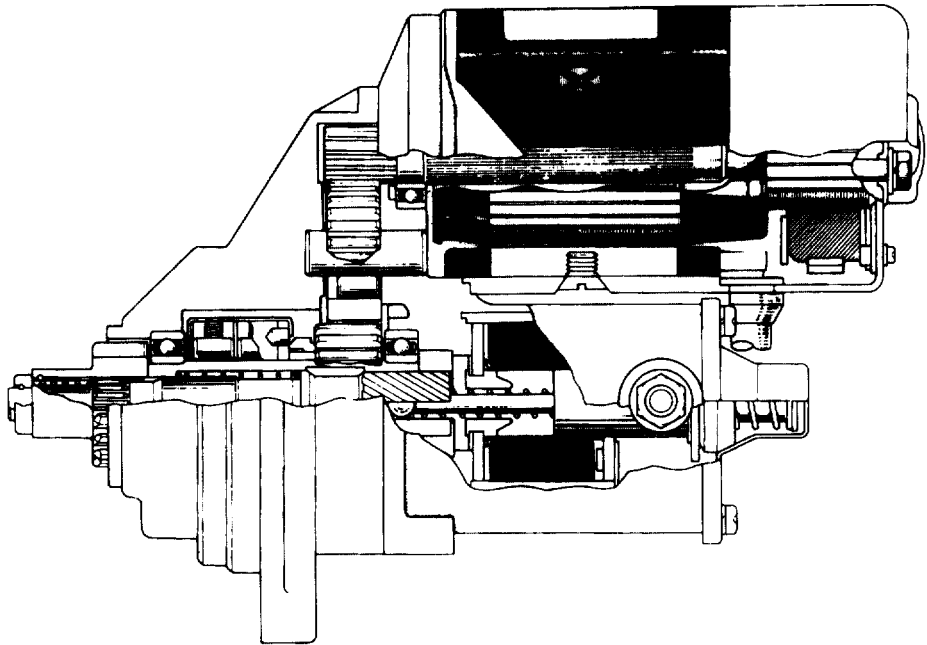
GENERAL DESCRIPTION

GENERATOR



066MT002

STARTER MOTOR

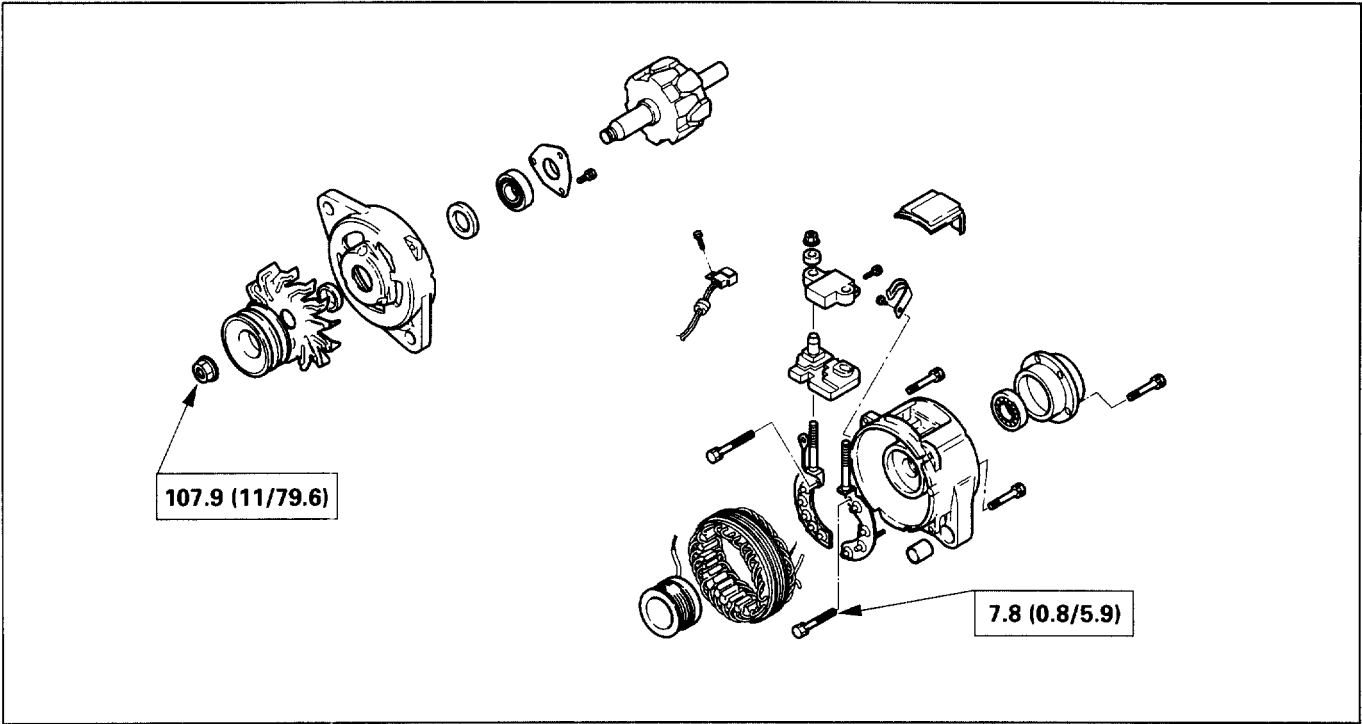




TORQUE SPECIFICATIONS

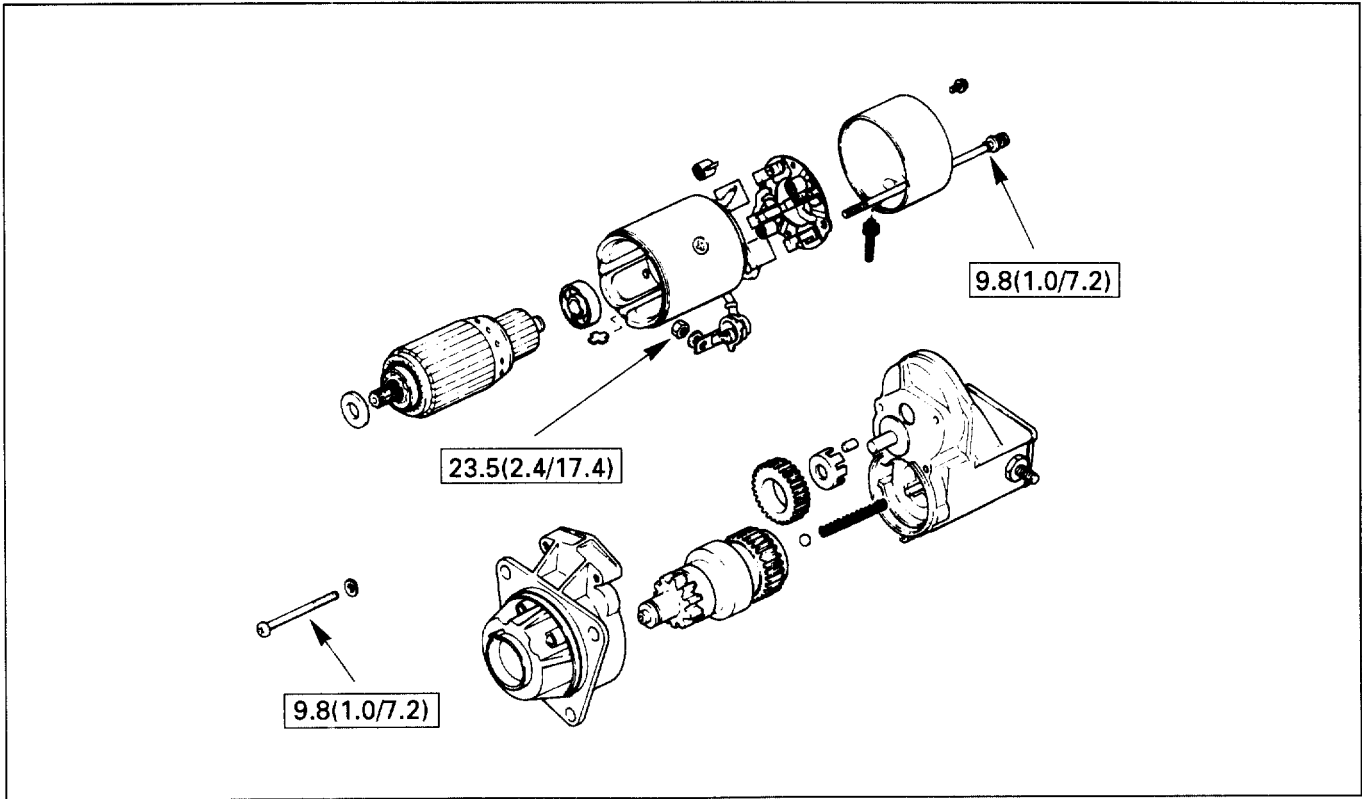
GENERATOR

N·m(kg·m/lb.ft)

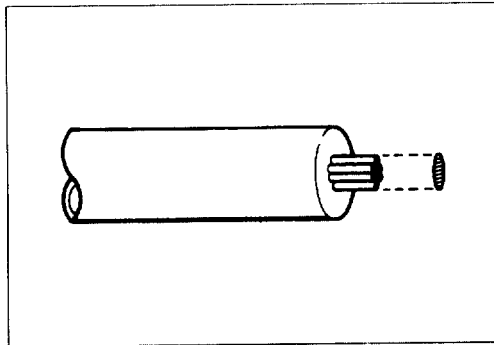
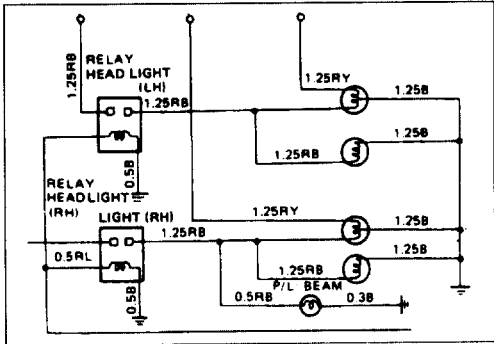


STARTER MOTOR

N·m(kg·m/lb.ft)



WIRE CODING



DESCRIPTION

Codes used in the circuit diagram represent wire size and color.

Example: 0.5 R

Wire color (Red)

Wire size (0.5 mm²)

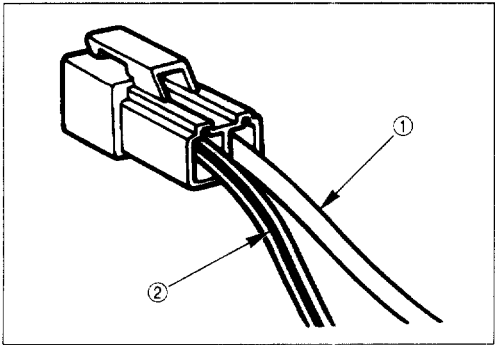
WIRE SIZE

Wire size is specified in the metric system.

The metric system gives the wire size in cross-sectional area measured in square millimeters.

WIRE SIZE SPECIFICATIONS

Wire size		Number of wires/ Wire diameter mm/(in)	Resistance at normal room temperature Ω/m(Ω/ft)	Maximum allowable current A
mm ²	AWG			
0.5	20	7/0.32(0.013)	0.03250(0.00910)	11.3
0.85	18	11/0.32(0.013)	0.02050(0.00625)	14.8
1.25	16	16/0.32(0.013)	0.01410(0.00430)	18.8
2	14	26/0.32(0.013)	0.00867(0.00264)	25.4
3	12	41/0.32(0.013)	0.00550(0.00158)	34.2
5	10	65/0.32(0.013)	0.00347(0.00106)	45.9
8	8	50/0.45(0.018)	0.00228(0.00070)	59.8
15	6	84/0.45(0.018)	0.00136(0.00042)	82.8
20	4	41/0.80(0.031)	0.00087(0.00027)	110.9
30	2	70/0.80(0.031)	0.00051(0.00016)	147.0



Wire Color

All wires have color-coded insulation.

Wires belonging to a system's main harness have a single color ①.

Wires belonging to a system's sub-circuits have a colored stripe (tracer) ②.

Striped wires use the following code to show wire size and colors.

Example: 0.5 G R

Red (Stripe (tracer) color)

Green (Base color)

Wire size (0.5 mm²)

Abbreviations are used to indicate wire color within a circuit diagram.

Refer to the following table.

WIRE COLOR-CODING

Color-coding	Meaning	Circuits
B	Black	Starter circuit and grounding circuit
W	White	Charging circuit
R	Red	Lighting circuit
G	Green	Signal circuit
Y	Yellow	Instrument circuit
L	Blue	Wiper circuit
O	Orange	Other circuits
Br	Brown	
Lg	Light green	
Gy	Gray	
P	Pink	
Sb	Sky blue	
V	Violet	

SYMBOLS AND ABBREVIATIONS

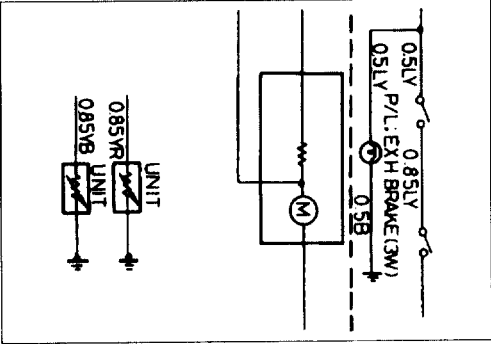
DESCRIPTION

The symbols and abbreviations used in the circuit diagram make the diagram easier to read and understand.

SYMBOLS

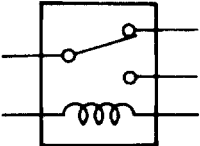
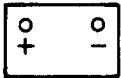
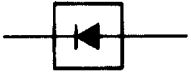
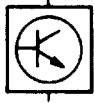
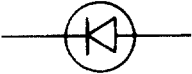
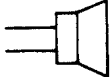
The illustration at the left shows typical symbols used in circuit diagrams.

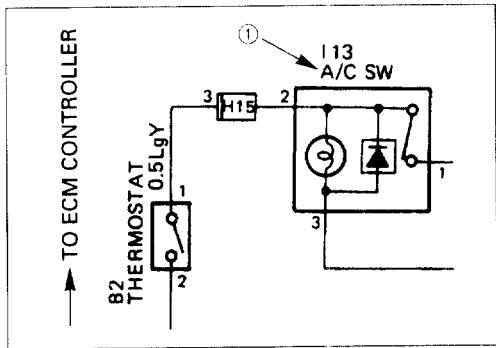
These same symbols may also appear in the text.
Refer to the following table.



SYMBOL AND MEANING

Symbol	Meaning	Symbol	Meaning
	Fuse		Single filament bulb
	Main fuse		Double filament bulb
	Fusible link wire		Motor
	Switch		Variable resistor
	Switch		Coil(Inductor)

Symbol	Meaning	Symbol	Meaning
	Contact wiring		Relay Note: Relay contact shown in the wiring diagram indicates condition before actuation.
	Battery		
	Diode		Connector
	Electronic part		Light emitting diode
	Resistor		Reed switch
	Speaker		Condenser
	Ground		
			



ABBREVIATIONS

The illustration at the left shows typical abbreviations used in the circuit diagrams.

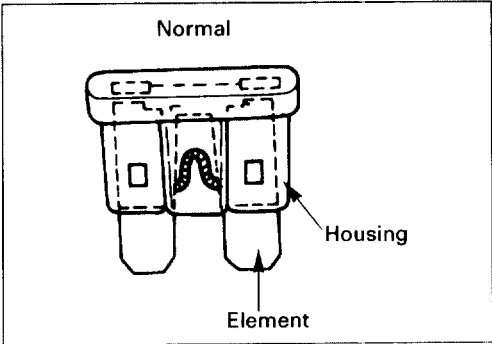
These same abbreviations may also appear in the text.

Refer to the following table.

ABBREVIATION AND MEANING

Abbreviation	Meaning	Abbreviation	Meaning
RH	Right-hand side	STD	Standard equipment
LH	Left-hand side	OPT	Optional equipment
SW	Switch	W/	With
M/T	Manual transmission	WO/	Without
A/T	Automatic transmission	OD	Overdrive
FT	Front	ACC	Accessories
RR	Rear	A/C	Air conditioner
FLW	Fusible link wire	ATF	Automatic transmission fluid
TEMP	Temperature	VSV	Vacuum switch valve

FUSES



FUSE (BLADE-TYPE WITH POLYMERIC HOUSING)

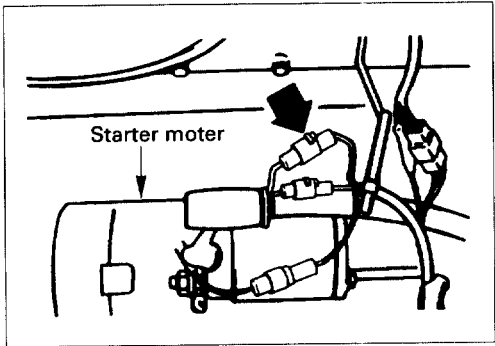
Fuses are located in the fuse box.

This type of fuse is highly resistant to both heat and shock. It is lighter in weight than conventional glass tube fuses.

All fuses are transparent so that a blown fuse is easily identified.

Fuse Specifications

Current (A)	Housing Color
5	Yellow-brown
7.5	Brown
10	Red
15	Blue
20	Yellow



FUSIBLE LINK WIRES

Fusible link wires are connected near the starter motor.

Fusible link wires are designed to melt in the event of circuit overload. This protects the wiring harnesses from damage.

Melted fusible links cannot be visually identified. A circuit tester is required to check them.

Precautions

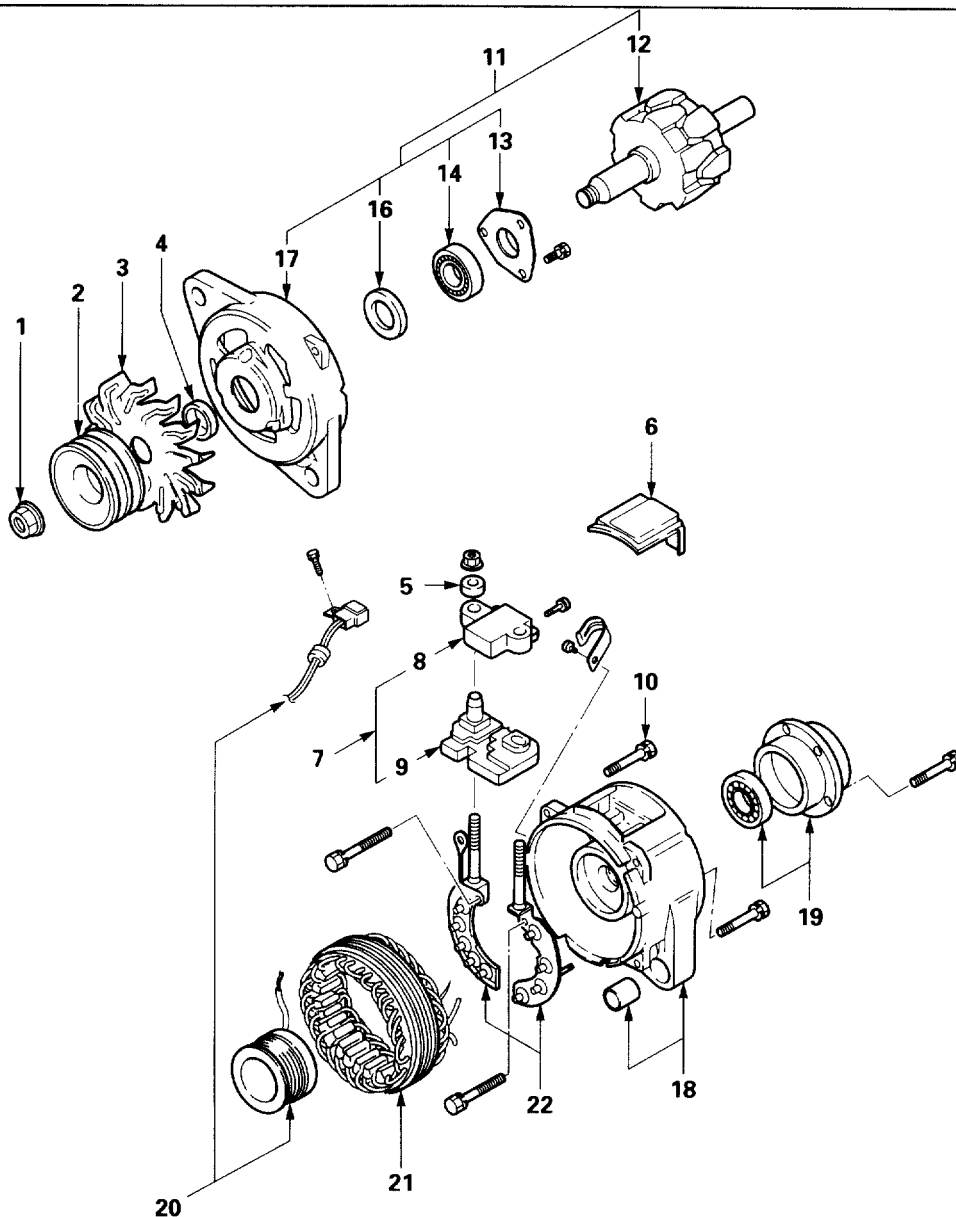
1. Always determine the cause of an overload before replacing a fuse.
2. Always replace a blown fuse with a new fuse of the same amperage rating.

Never replace a blown fuse with a new fuse of a different amperage rating. An electrical fire with serious circuit damage can result.

GENERATOR



DISASSEMBLY



066MT004

Disassembly Steps

- | | |
|------------------------------------|---------------------------------|
| 1. Pulley nut | 12. Rotor assembly |
| 2. Pulley | 13. Bearing retainer |
| 3. Fan | 14. Ball bearing |
| 4. Collar | 16. Ring felt |
| 5. Bushing | 17. Front frame |
| 6. Cover | 18. Rear end frame assembly |
| 7. Rectifier holder assembly | 19. Rear cover and ball bearing |
| 8. Regulator | 20. Rotor coil and lead wire |
| 9. Rectifier holder | 21. Stator assembly |
| 10. Through bolt | 22. Rectifier assembly |
| 11. Front frame and rotor assembly | |

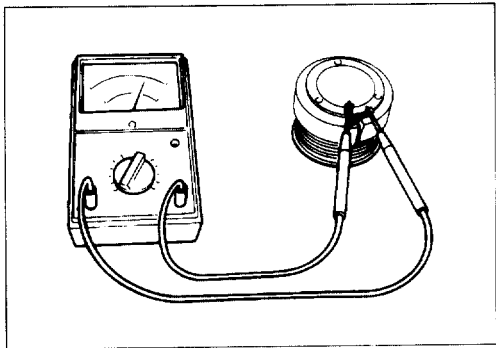


INSPECTION AND REPAIR

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

It is most important that electrical components be kept clean and dry at all times.

Always visibly check the fusible links, the fuses, and the indicator lights for damage as the first step in the inspection and repair procedure.



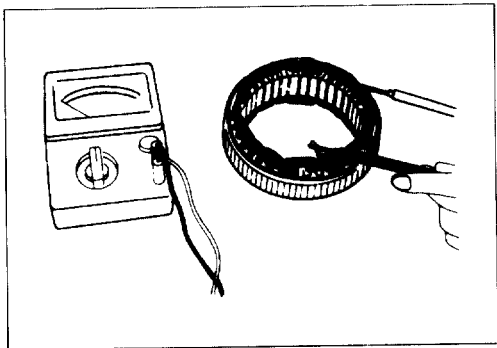
ROTOR COIL

Rotor Coil Resistance

Use a circuit tester to measure the rotor coil resistance between the terminals.

Rotor Coil Resistance	ohm
Standard	
	9

If the measured resistance is above or below the specified standard, the rotor coil assembly must be replaced.

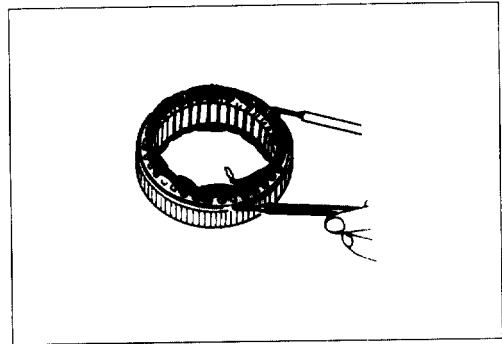


STATOR

Stator Continuity

Check for continuity across the stator coils.

If there is no continuity, the stator assembly must be replaced.



Stator Insulation

Use a circuit tester to check that there is no continuity between the stator coils and the core.

If there is continuity between the stator coils and the core, the stator assembly is defective and must be replaced.

RECTIFIER HOLDER ASSEMBLY**Rectifier Check**

Use a circuit tester to check the battery side rectifiers (+) and the ground side rectifiers (-).

1. Touch one circuit tester lead to the battery side terminal (+).
2. Touch the other circuit tester lead to one of the battery side rectifiers.

Note the circuit tester gauge reading (continuity or infinite resistance).

3. Reverse the position of the circuit tester leads.

The circuit tester gauge reading should be the opposite of Step 2.

4. Continue the procedure for the remaining battery side rectifiers.

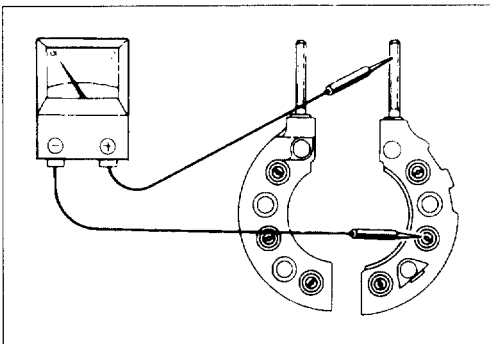
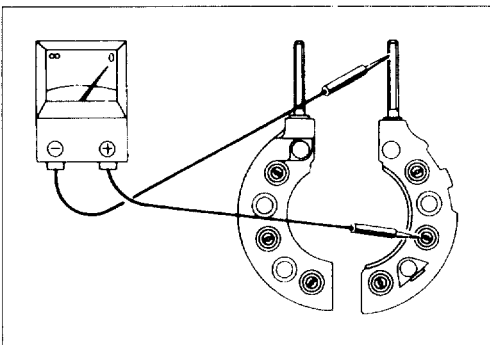
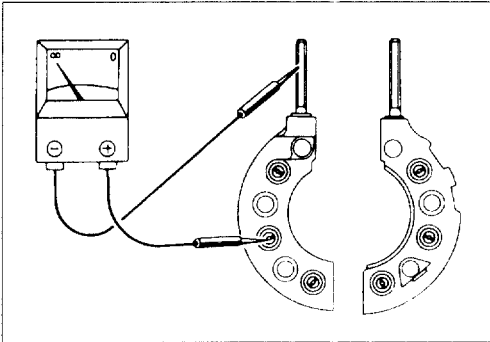
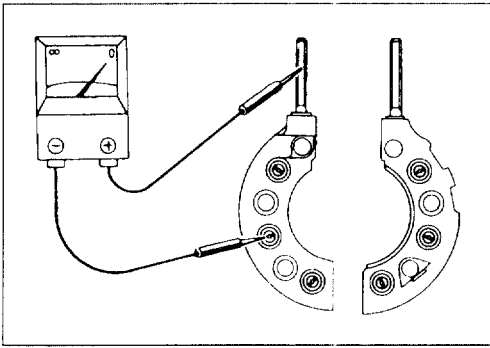
If the circuit tester gauge reading at any point is abnormal, the rectifier holder assembly must be replaced.

5. Touch one circuit tester lead to the ground side terminal (-).

6. Touch the other circuit tester lead to one of the ground side rectifiers.

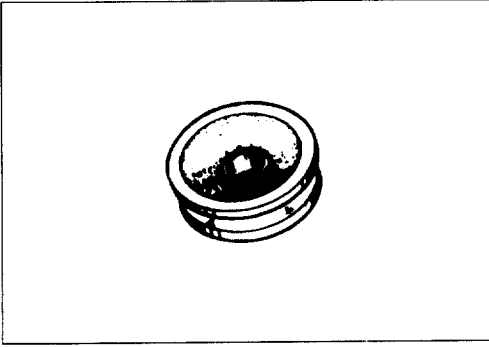
Note the circuit tester gauge reading (continuity or infinite resistance).

7. Continue as in Steps 3 - 4 above for the remaining ground side rectifiers.



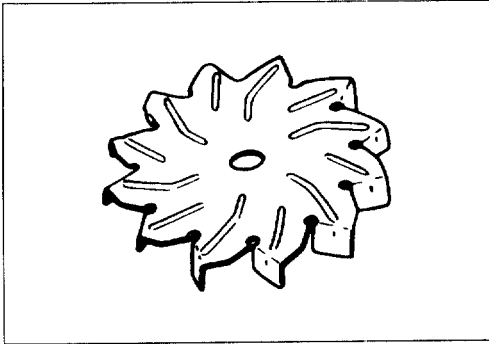
PULLEY

Check the pulley for excessive wear and cracking.



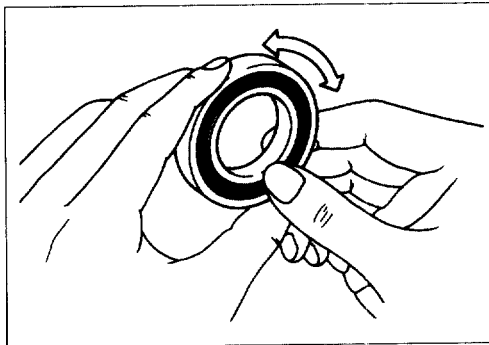
FAN

Check the fan for cracking and distortion.



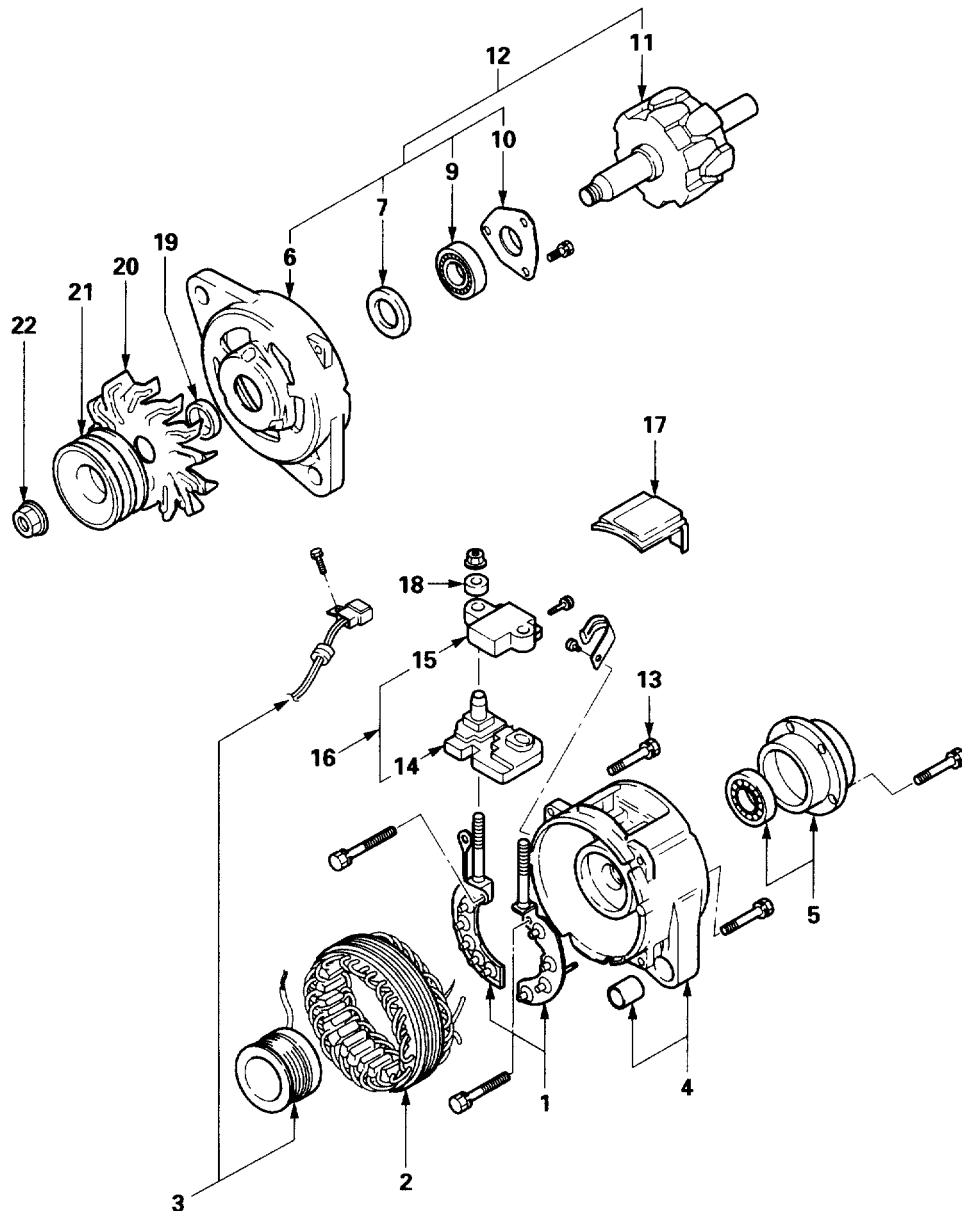
BALL BEARING

Check the ball bearings for binding, drag, roughness, and noise.





REASSEMBLY



066MT001

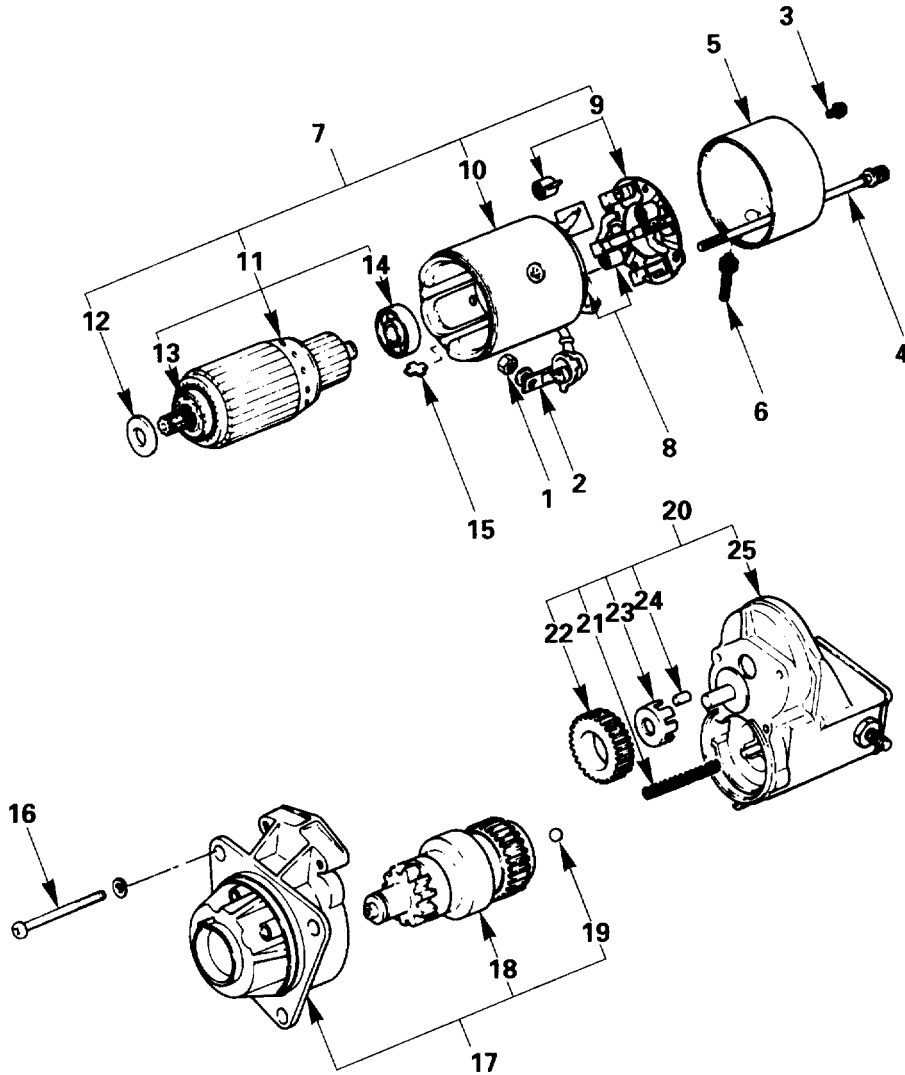
Reassembly Steps

- | | |
|------------------------------------|-------------------------------|
| 1. Rectifier assembly | 13. Through bolt |
| 2. Stator assembly | 14. Rectifier holder |
| 3. Rotor coil and lead wire | 15. Regulator |
| 4. Rear end frame assembly | 16. Rectifier holder assembly |
| 5. Rear cover and ball bearing | 17. Cover |
| 6. Front frame | 18. Bushing |
| 7. Ring felt | 19. Collar |
| 9. Ball bearing | 20. Fan |
| 10. Bearing retainer | 21. Pulley |
| 11. Rotor assembly | 22. Pulley nut |
| 12. Front frame and rotor assembly | |

STARTER MOTOR

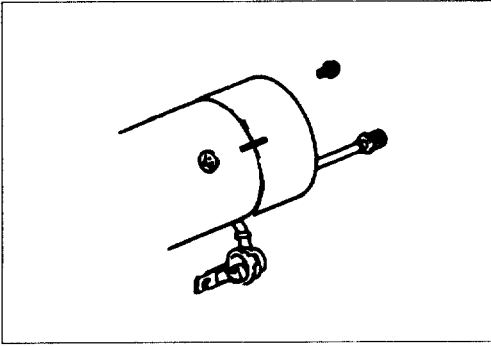


DISASSEMBLY



Disassembly Steps

- | | |
|---------------------------------|--|
| 1. Nut | 14. Ball bearing |
| 2. Lead wire | 15. Lock plate |
| 3. Bolt | 16. Bolt |
| ▲ 4. Through bolt | ▲ 17. Pinion case and clutch assembly |
| ▲ 5. End frame | 18. Clutch assembly |
| 6. Dust cover | 19. Steel ball |
| ▲ 7. Yoke and armature assembly | 20. Magnetic switch and idle gear assembly |
| ▲ 8. Brush | 21. Return spring |
| ▲ 9. Brush holder and spring | 22. Idler gear |
| 10. Yoke assembly | 23. Retainer |
| 11. Armature assembly | 24. Roller |
| 12. Washer | 25. Magnetic switch assembly |
| 13. Ball bearing | |



Important Operations

4. Through Bolt

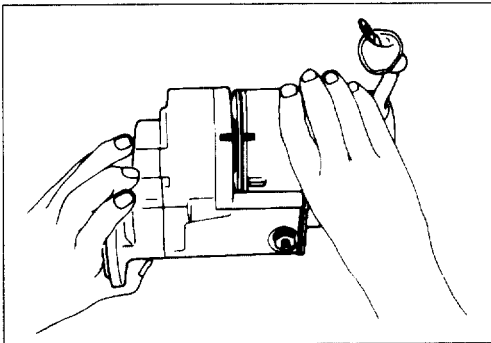
5. End Frame

- 1) Apply setting marks across the end frame and the yoke assembly.
- 2) Loosen the through bolts.
- 3) Use a plastic hammer to lightly tap around the end frame.

This will loosen the end frame.

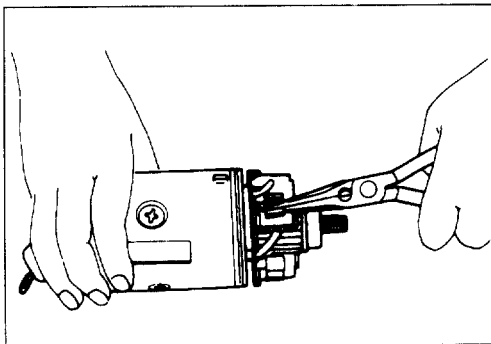
Note:

If the armature rear ball bearing and the end frame are stuck together, remove the rear end frame, the brush holder, the yoke, and the armature (as an assembly) from the magnetic switch assembly.



7. Yoke and Armature Assembly

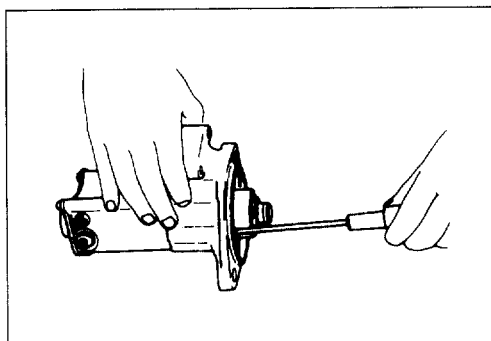
- 1) Apply setting marks across the yoke assembly and the magnetic switch assembly.
- 2) Use a plastic hammer to tap around the yoke assembly.
This will loosen the assembly.
- 3) Remove the yoke and armature assembly from the magnetic switch assembly.



8. Brush

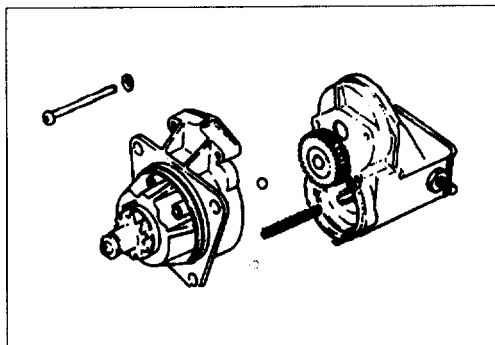
9. Brush Holder and Spring

- 1) Use pliers to compress the brush spring end.
Remove the brushes from the brush holder cage.
- 2) Remove the brush holder.



17. Pinion Case and Clutch Assembly

- 1) Loosen the pinion case screws.
- 2) Use a plastic hammer to tap around the pinion case assembly.
This will loosen the assembly.



- 3) Remove the pinion case assembly from the magnetic switch assembly.

Take care not to lose the ball and spring.

Do not allow the idler gear to fall free.



INSPECTION AND REPAIR

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

It is most important that electrical components be kept clean and dry at all times.

Always visibly check the fusible links, the fuses, and the indicator lights for damage as the first step in the inspection and repair procedure.

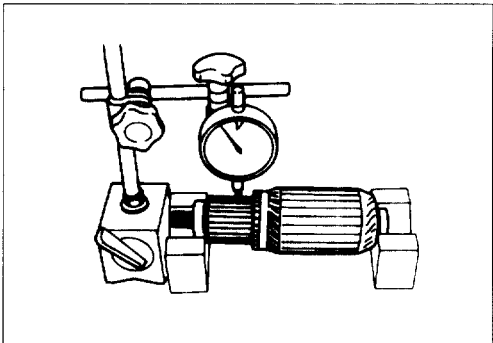
ARMATURE

Commutator Face

Check the commutator face for roughness.

If necessary, dress the commutator face with fine sandpaper (#500 or #600).

Be absolutely sure that there are no metal filings in the segment gaps.



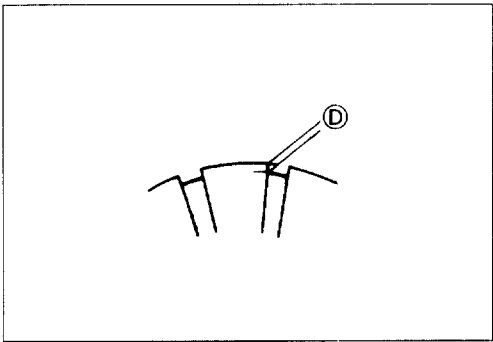
Commutator Run-Out

1. Mount the armature assembly on V-blocks.
2. Use a dial indicator to measure the commutator run-out.

If the run-out is greater than the specified standard but less than the specified limit, the commutator may be turned on a lathe to correct it.

If the run-out exceeds the specified limit, the armature assembly must be replaced.

Commutator Run-Out		mm(in)
Standard	Limit	
0.05 (0.002) or less	0.4 (0.016)	

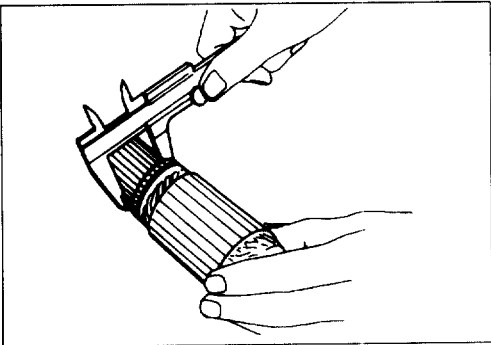


Commutator Segment Groove Depth

Use the V-blocks and the dial indicator to measure the depth ① of each of the commutator segment grooves.

Replace the armature assembly if the commutator segment groove depth is less than the specified limit.

Commutator Segment Groove Depth ①	mm(in)
Standard	
0.5 - 0.8 (0.020 - 0.032)	



Commutator Outside Diameter

Use a vernier caliper to measure the commutator outside diameter.

If the commutator outside diameter is less than the specified standard but greater than the specified limit, the commutator may be turned on a lathe to correct it.

Replace the armature assembly if the commutator outside diameter is less than the specified limit.

Commutator Outside Diameter		mm(in)
Standard	Limit	
36 (1.42)	35 (1.38)	

Armature Coil

1. Place the armature in a growler tester.
2. Hold a hacksaw blade against the armature core.

Slowly rotate the armature.

If the armature is shorted, the hacksaw blade will vibrate.

Replace the armature assembly if it is shorted.

Armature Continuity

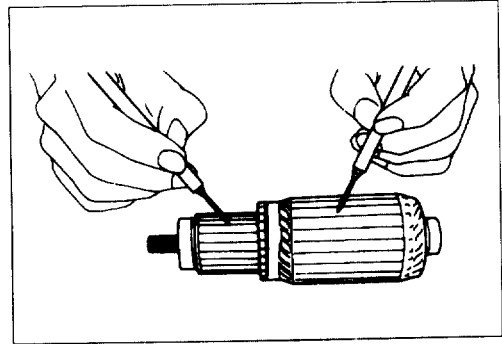
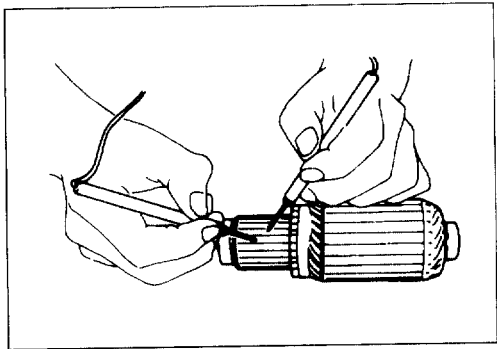
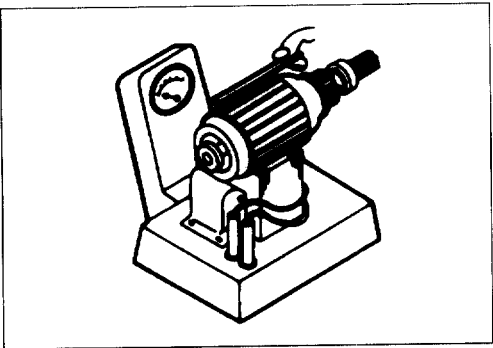
Use a circuit tester to check for continuity between the commutator segments.

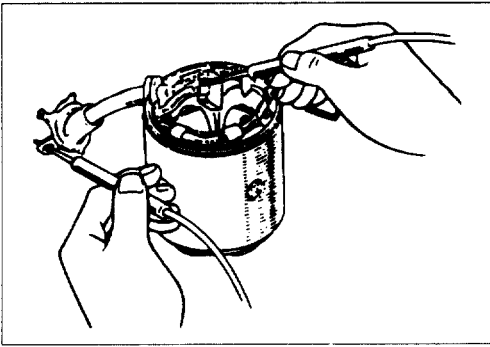
If there is no continuity between any two points on the commutator, the armature assembly must be replaced.

Armature Insulation

Use a circuit tester to check that there is no continuity between the commutator segments and the coil core.

If there is continuity between the commutator segments and the coil core, the armature assembly is defective and must be replaced.



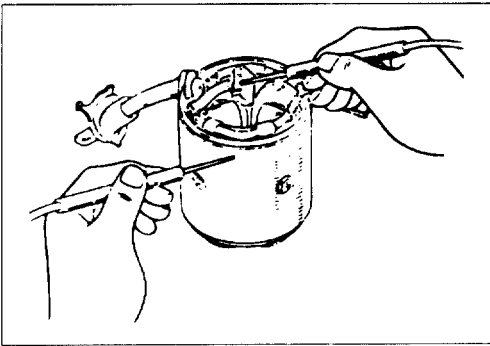


YOKE

Field Coil Continuity

Use a circuit tester to check for continuity between the connecting leads and the brushes.

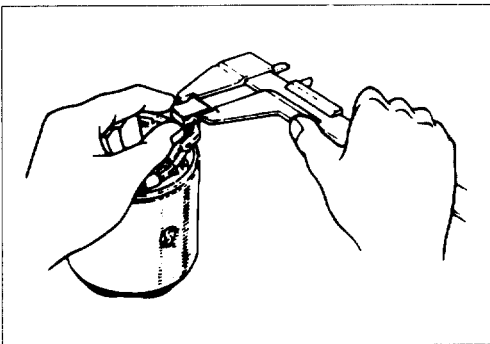
Replace the yoke assembly if there is no continuity at any point.



Yoke Insulation

Use a circuit tester to check that there is no continuity between the field coil and the yoke body.

If there is continuity between the field coil and the yoke body, the yoke assembly is defective and must be replaced.



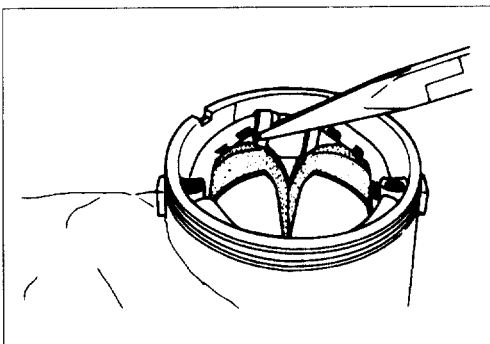
BRUSH AND BRUSH HOLDER

Brushes

Use a vernier caliper to measure the brush lengths (four brushes).

Replace the brushes as a set if one or more of the brush lengths is less than the specified limit.

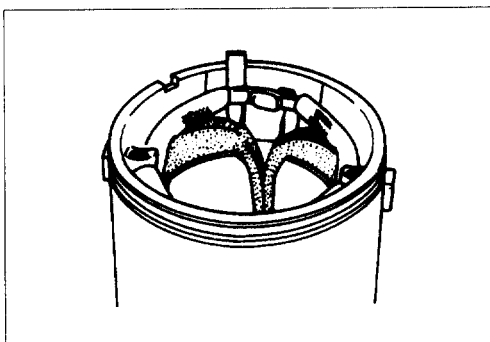
Brush Length	mm(in)
	Limit
	5.5(0.217)



Brush Replacement

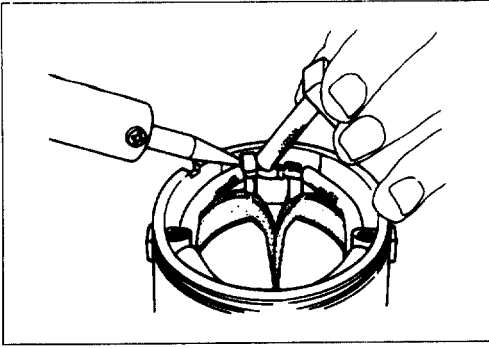
Brush Removal

1. Use wire cutters to cut the lead wires from the brushes.
2. File away any foreign matter clinging to the edge of the lead wires.
3. Remove the brushes from the brush holder.

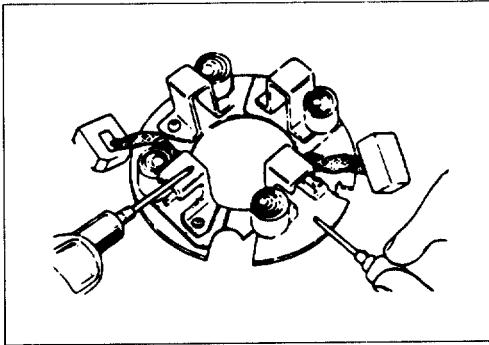


Brush Installation

1. Straighten the bent portion of the clips.
2. File away any foreign matter clinging to the clip surfaces.
3. Install the new brushes.



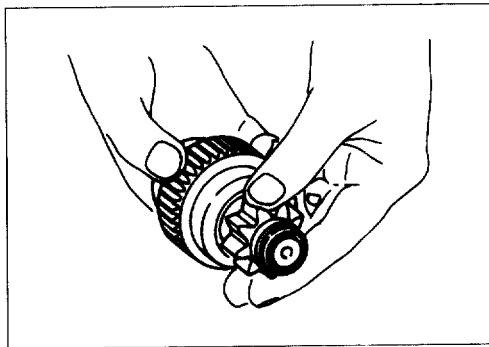
4. Insert the lead wires to the clips.
5. Bend the clips shut.
6. Solder the brush leads.



Brush Holder Insulation

Use a circuit tester to check that there is no continuity between the battery side brush cages and the holder plate.

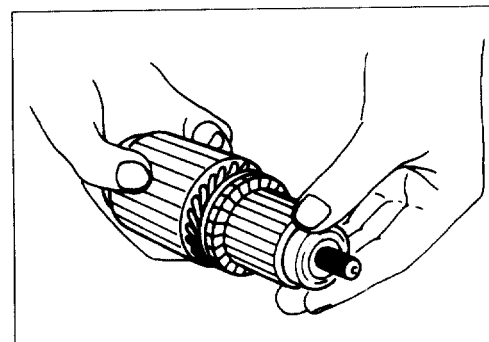
If there is continuity between the battery side brush cages and the holder plate, the brush holder assembly is defective and must be replaced.



PINION CLUTCH

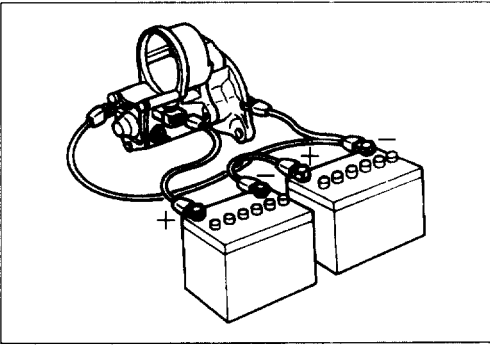
1. Clean the pinion clutch with a clean rag.
2. Check the pinion clutch and pinion gear for excessive wear and damage.
3. Turn the pinion gear clockwise.
The gear should turn smoothly with no resistance.
If the gear does not turn smoothly, the pinion clutch assembly must be replaced.

4. Turn the pinion gear counterclockwise.
The gear should lock firmly.
If the gear does not lock firmly, the pinion clutch assembly must be replaced.



BEARING

Inspect the bearings for excessive wear and damage.
Replace the bearings if necessary.



MAGNETIC SWITCH

Pull-In Coil Test and Hold-In Coil Test

Note:

Do not apply voltage to the magnetic switch for longer than five seconds when performing the following tests.

1. Connect test leads from the negative pole of a 24-volt battery to the magnetic switch body and the "C" terminal.

2. Touch the test lead from the battery positive pole to the "50" terminal.

If the pull-in coil is functioning correctly, the pinion will move away from its home position.

Replace the magnetic switch assembly if the pinion does not move.

3. Remove the negative test lead from the "C" terminal.

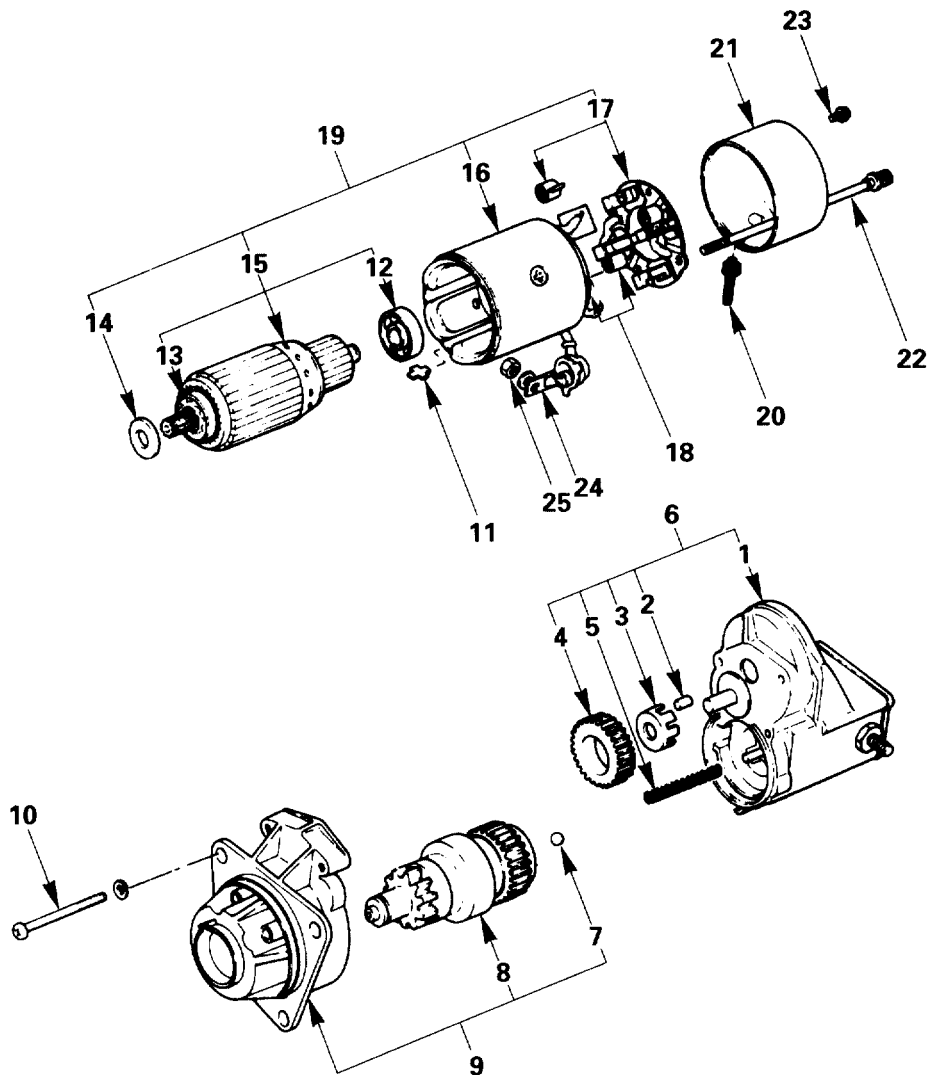
If the hold-in coil is functioning correctly, the pinion will remain in place.

If the pinion returns to its home position, the hold-in coil is not functioning correctly.

The magnetic switch assembly must be replaced.

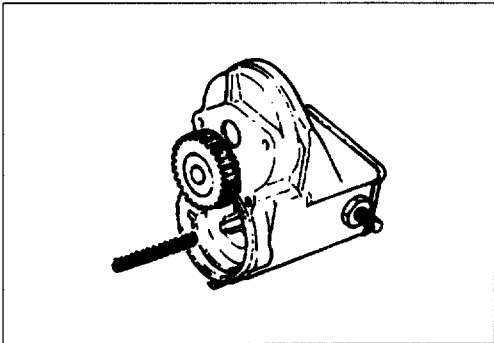


REASSEMBLY



Reassembly Steps

- | | |
|---|----------------------------------|
| ▲ 1. Magnetic switch assembly | ▲ 13. Ball bearing |
| ▲ 2. Roller | 14. Washer |
| ▲ 3. Retainer | ▲ 15. Armature assembly |
| ▲ 4. Idler gear | ▲ 16. Yoke assembly |
| ▲ 5. Return spring | ▲ 17. Brush holder and spring |
| 6. Magnetic switch and idle gear assembly | ▲ 18. Brush |
| ▲ 7. Steel ball | ▲ 19. Yoke and armature assembly |
| ▲ 8. Clutch assembly | 20. Dust cover |
| ▲ 9. Pinion case and clutch assembly | ▲ 21. End frame |
| 10. Bolt | ▲ 22. Through bolt |
| 11. Lock plate | 23. Bolt |
| ▲ 12. Ball bearing | ▲ 24. Lead wire |



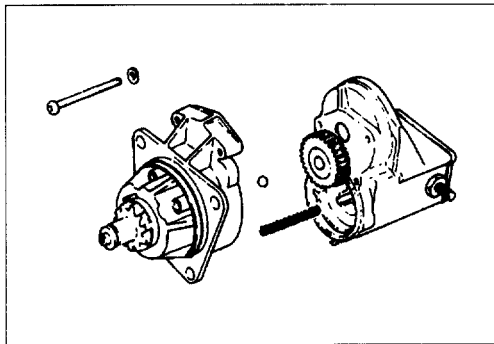
Important Operations



1. **Magnetic Switch Assembly**
2. **Roller**
3. **Retainer**
4. **Idler Gear**
5. **Return Spring**

Apply molybdenum disulfide grease to the return spring, the roller, the retainer, the spindle, and the idler gear circumference.

The grease will hold the springs to the guide pin.

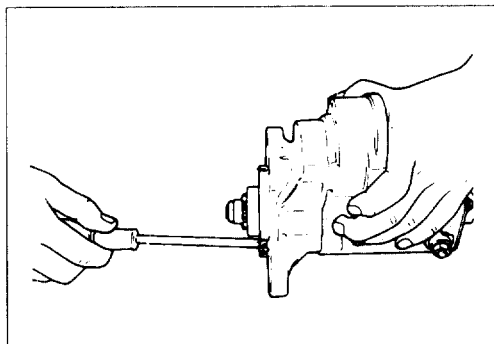


7. **Steel Ball**
8. **Clutch Assembly**
9. **Pinion Case and Clutch Assembly**

- 1) Apply molybdenum disulfide grease to the clutch assembly circumference and the steel ball.
The grease will hold the ball to the clutch assembly.
- 2) Install the clutch assembly and the pinion case and clutch assembly to the magnetic switch and idle gear assembly.

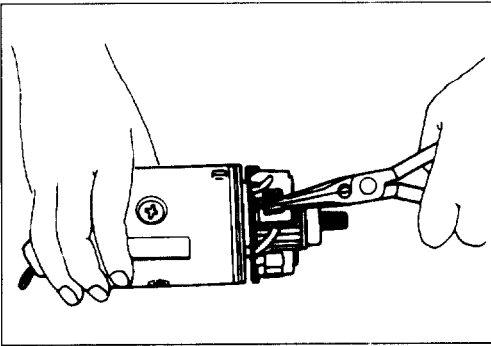
- 3) Tighten the pinion case screws to the specified torque.

Pinion Case Screw Torque	N·m(kg·m/lb.ft)
9.8 (1.0 / 7.2)	



12. **Ball Bearing**
13. **Ball Bearing**
15. **Armature Assembly**

- 1) Use a bench press to install the ball bearings to the armature shaft.
Take care not to damage the commutator and the coil leads.
- 2) Apply molybdenum disulfide grease to the armature shaft drive gear teeth.
- 3) Install the armature assembly to the magnetic switch assembly.



17. Brush Holder and Spring

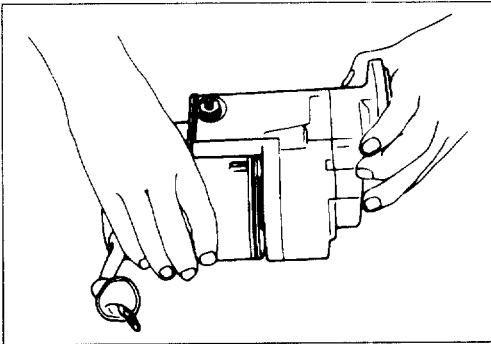
18. Brush

- 1) Set the brush holder to the commutator.
- 2) Use pliers to compress the brush holder spring end.

Install the brushes to the brush holder cage.

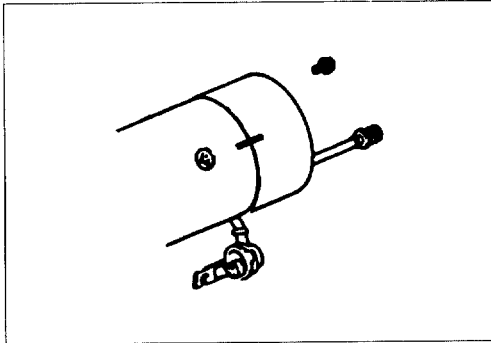
Note:

Be sure to keep the brushes and the commutator clean and dry.



19. Yoke and Armature Assembly

Align the setting marks (applied at disassembly) to install the yoke assembly to the magnetic switch assembly.



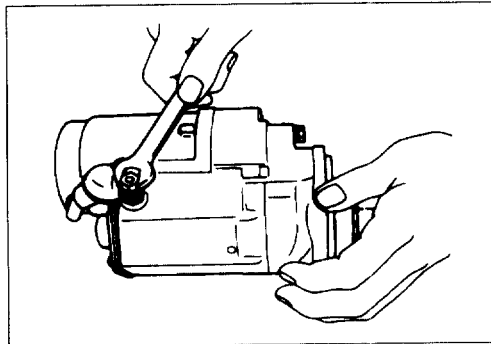
21. End Frame

22. Through Bolt

- 1) Align the setting marks (applied at disassembly) to install the end frame to the yoke assembly.
- 2) Tighten the through bolts to the specified torque.



Through Bolt Torque	N·m(kg·m/lb.ft)
9.8 (1.0 / 7.2)	



24. Lead Wire

25. Nut

- 1) Connect the lead wire to the terminal.
- 2) Tighten the nut to the specified torque.

Nut Torque	N·m(kg·m/lb.ft)
23.5 (2.4 / 17.4)	

[illegible]

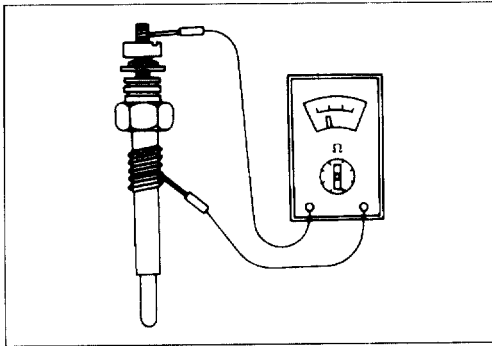


INSPECTION AND REPAIR

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

It is most important that electrical components be kept clean and dry at all times.

Always visibly check the fusible links, the fuses, and the indicator lights for damage as the first step in the inspection and repair procedure.

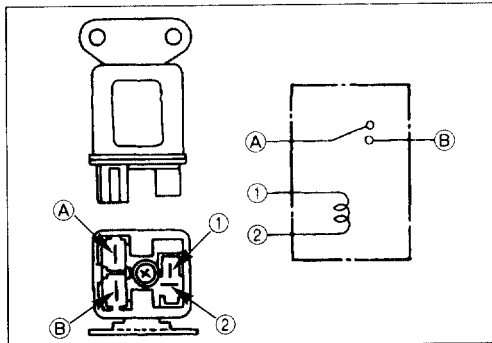


PREHEATING SYSTEM

Glow Plug

Check each of the glow plugs for continuity.

Replace the glow plugs as a set if one or more of the glow plugs does not have continuity.

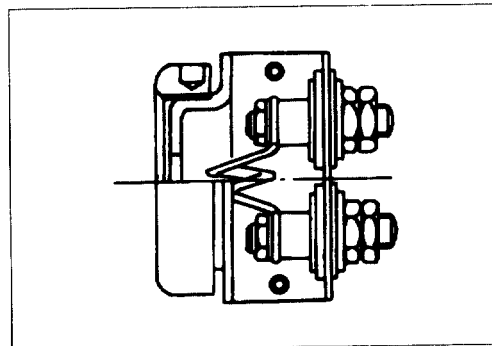


Glow Relay

Check the glow relay operation.

Terminal Positions

- (A) From the fusible link
- (B) To the control resistor
- (1) From the fuse box
- (2) To ground



Control Resistor

Check the heat coil for breakage and fusing.

Replace the control resistor if the heat coil is broken or fused.

Note:

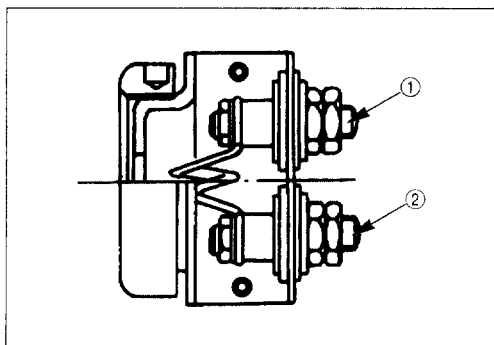
Common control resistor problems are:

1. Broken wires caused by vibration
2. Fusing caused by overheating

This is usually the result of mismatching the glow plug and the control resistor.

When installing the control resistor:

1. Be sure that you are installing a control resistor of the proper rating.
2. Be sure that the glow plug is compatible with the control resistor.
3. Be sure that the control resistor is securely connected.



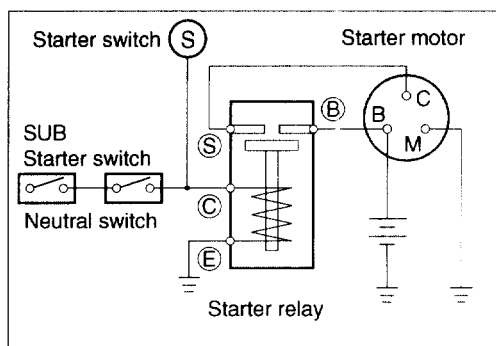
Control Resistor Continuity

Use a circuit tester to check that there is continuity between terminal ① and terminal ②.

If there is no continuity between terminal ① and terminal ②, the control resistor is defective and must be replaced.

STARTING SYSTEM

Circuit diagram terminal positions are shown in the illustration.



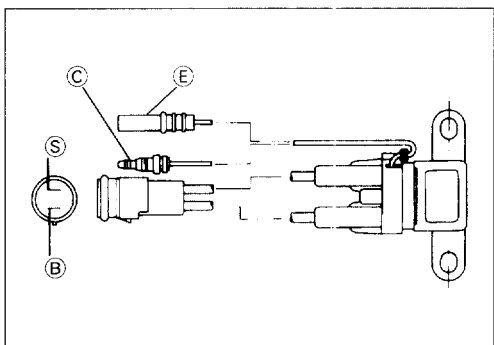
D06MT004

Starter Relay

Check the starter relay operation.

Terminal Positions

- ⑤ To starter terminal "C"
- ⑥ To starter terminal "B"
- ⑦ To starter switch
- ⑧ To ground

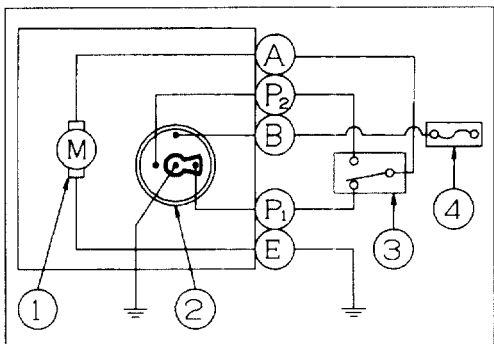


ELECTRICAL ENGINE CONTROL SYSTEM

Stop Control Motor and Actuator Cable Assembly

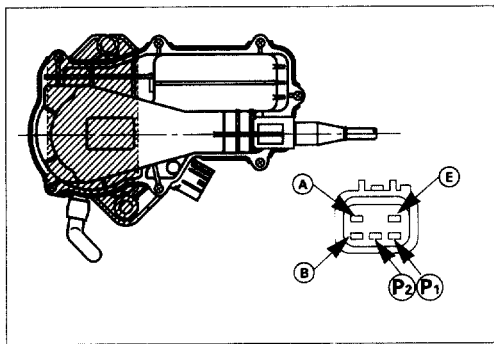
Check the stop control motor operation.

- ① Armature assembly
- ② Worm wheel assembly
- ③ Starter switch
- ④ Fuse

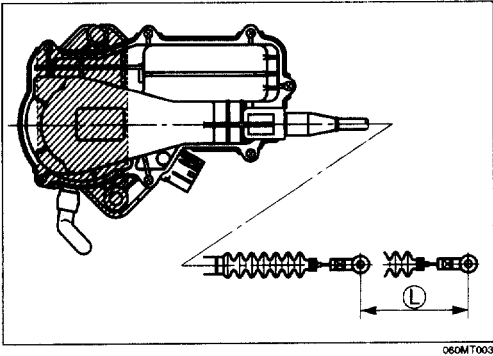


Connector Terminal Positions

- ① To actuator "L"
- ② To fuse box "LR"
- ③ To actuator ground "BL"
- ④ To actuator "LY"
- ⑤ To actuator "LW"



D06MT006



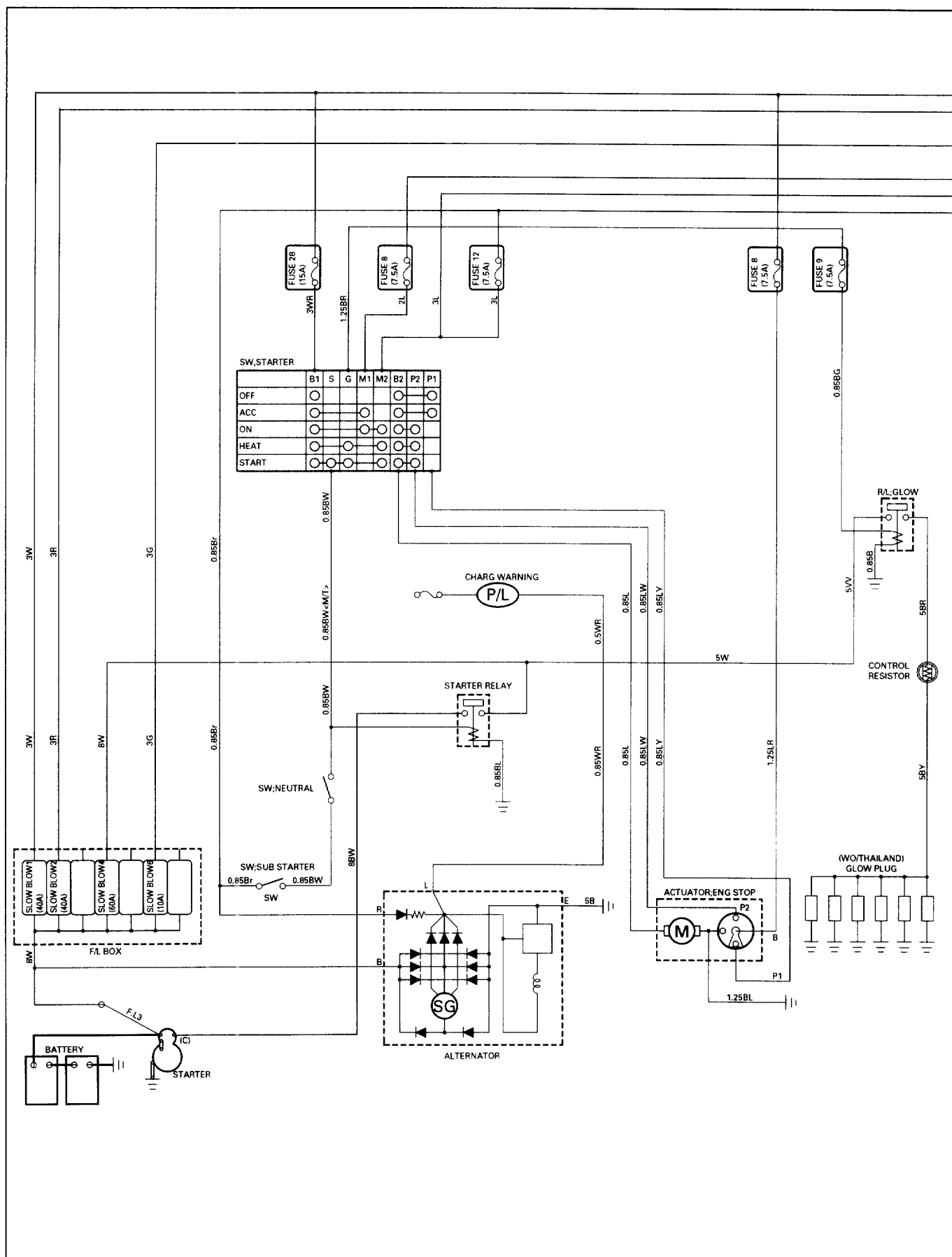
Actuator Cable

1. Check that the actuator cable moves smoothly when the stop control motor is operating.
If the cable does not move smoothly, the stop control motor and actuator cable assembly must be replaced.
2. Check the actuator cable end stroke $\textcircled{L}$ during stop control motor operation.

Actuator Cable End Stroke $\textcircled{L}$	mm(in)
35 (1.37795) or more	

If the cable end stroke is less than the specified value, the stop control motor and actuator cable assembly must be replaced.

WIRING DIAGRAM



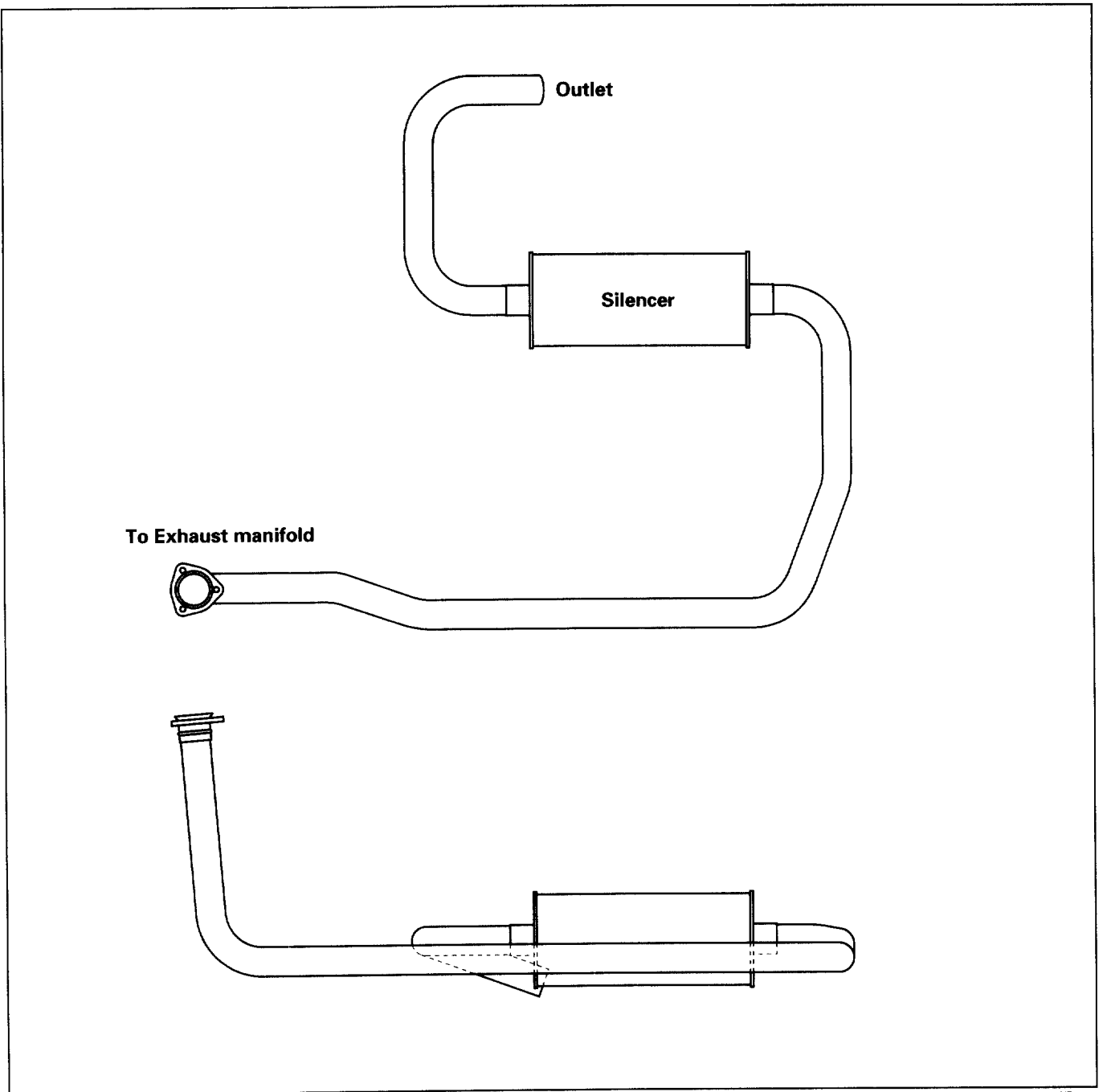
SECTION 6F

EXHAUST SYSTEM

TABLE OF CONTENTS

	PAGE
General Description	6F – 2
Removal and Installation.	6F – 3
Inspection and Repair	6F – 4

GENERAL DESCRIPTION



150MT003

The exhaust system consists of the exhaust pipes and the silencer.

In the horizontal exhaust system, the exhaust pipes run from the exhaust manifold, beneath the vehicle frame, to the rear of the vehicle.

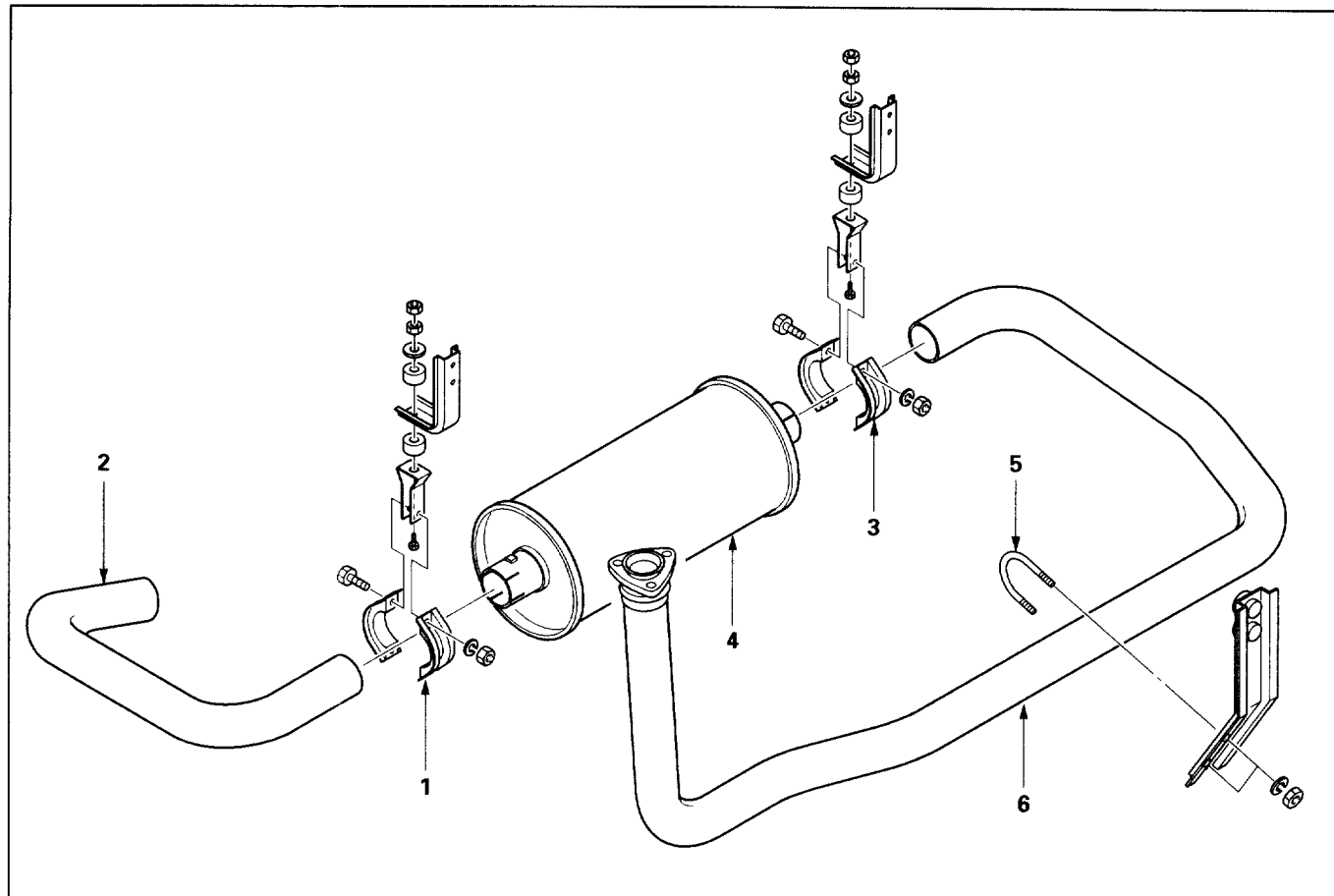
In the vertical exhaust system, the exhaust pipes run from the exhaust manifold, beneath the vehicle frame, to the top of the vehicle just behind the cab.

The exhaust pipes are connected to each other by a series of sleeve clamps and/or flange bolts. They are attached to the vehicle frame by clamps and brackets. Rubber bushings are used at support points.



REMOVAL AND INSTALLATION

HORIZONTAL TYPE EXHAUST SYSTEM



150MT0002

Removal Steps

1. Rear exhaust pipe clamp
2. Rear exhaust pipe
3. Front exhaust pipe clamp
4. Silencer
5. Bracket front exhaust pipe
6. Front exhaust pipe

Installation Steps

- ▲ 6. Front exhaust pipe
5. Bracket front exhaust pipe
- ▲ 4. Silencer
- ▲ 3. Front exhaust pipe clamp
- ▲ 2. Rear exhaust pipe
- ▲ 1. Rear exhaust pipe clamp



INSPECTION AND REPAIR

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

Exhaust Pipes and Exhaust Silencer

1. Check the exhaust pipes and the exhaust silencer for corrosion and damage.
Repair or replace as required.
2. Check the pipe and silencer connections for looseness and misalignment.
Align and tighten as required.
3. Check the pipe support rubber rings for deterioration.
Replace as required.



Important Operations - Installation

Silencer

Apply muffler sealer to the exhaust pipe and exhaust silencer joints.

The sealer should extend approximately 50 mm (2 in) from each side of the joint.



Exhaust Pipes and Exhaust Pipe Clamps

Be absolutely sure that the exhaust pipe clamps and/or the flange bolts are securely fastened to the exhaust pipes and the silencer.

If the vehicle is equipped with an exhaust brake, be absolutely sure that the exhaust brake valve is correctly installed to the exhaust pipes.



Exhaust System Check

1. Start the engine and allow it to idle.
2. Check for gas leakage from the exhaust pipe joints.
3. Check for noise and vibration.

SECTION 6G

AIR COMPRESSOR

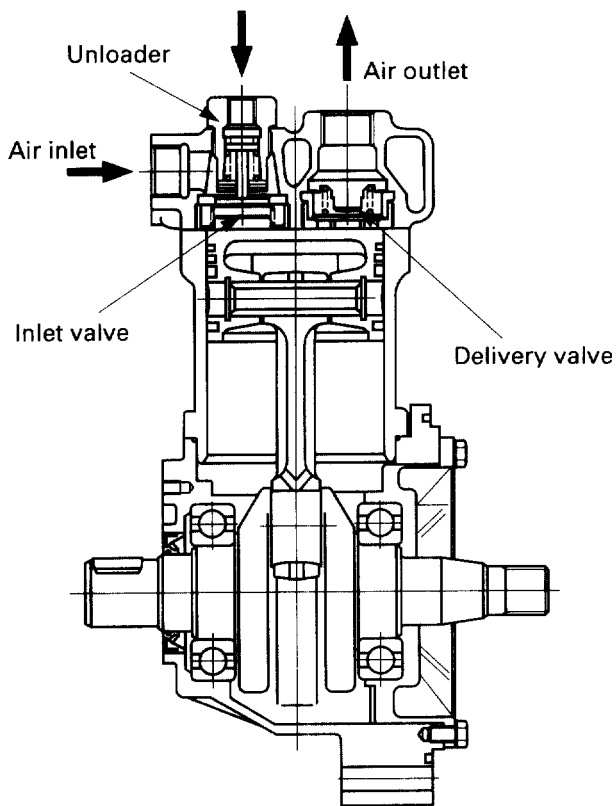
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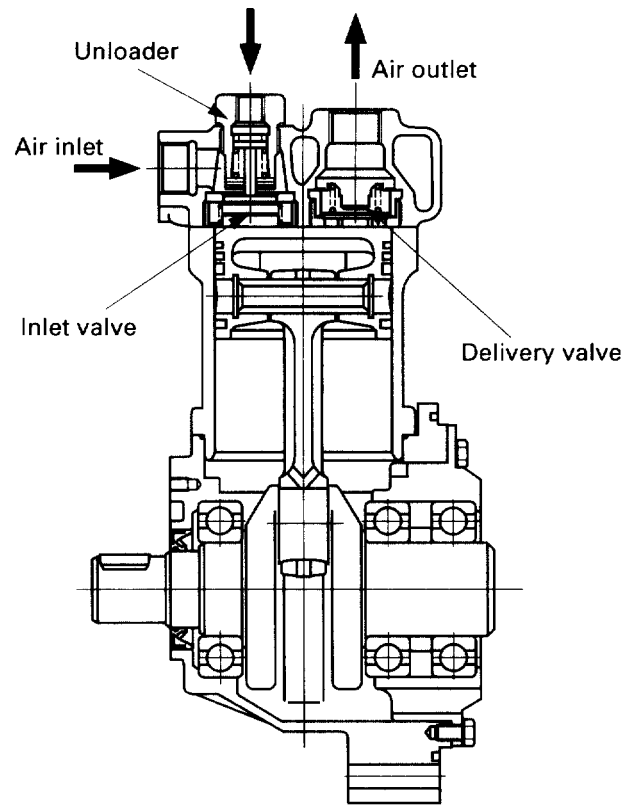
MAIN DATA AND SPECIFICATIONS

Item		Description
Type		Reciprocating
Cooling method		Water
Bore X stroke	mm(in)	85 X 60 (3.3465 X 2.3622)
Number of piston rings		Compression: 2 / Oil: 2
Capacity	L(in ³)/rev.	0.34 (20.7)
Drive method		Gear
Ratio	To 1	0.5
Unloader valve operation		
Governor pressure	kPa(kg/cm ² /psi)	529.6 - 617.8 (5.4 - 6.3/76.8 - 89.6)

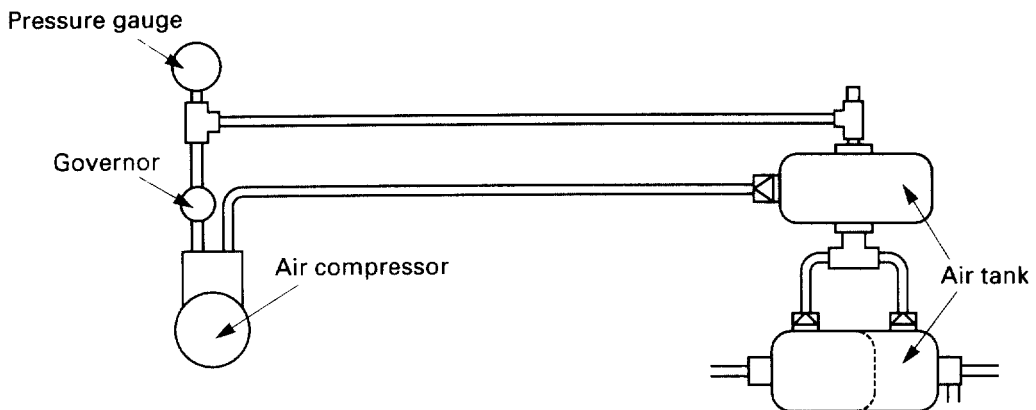
GENERAL DESCRIPTION



AIR COMPRESSOR FOR 6SD1



AIR COMPRESSOR FOR 6SD1 TC



039MT004

The air compressor is directly mounted to the cylinder body rear right side.

The air compressor is a reciprocating type driven by the injection pump timing gear.

The air compressor delivers air to the air tank where the air pressure is regulated by the air governor.

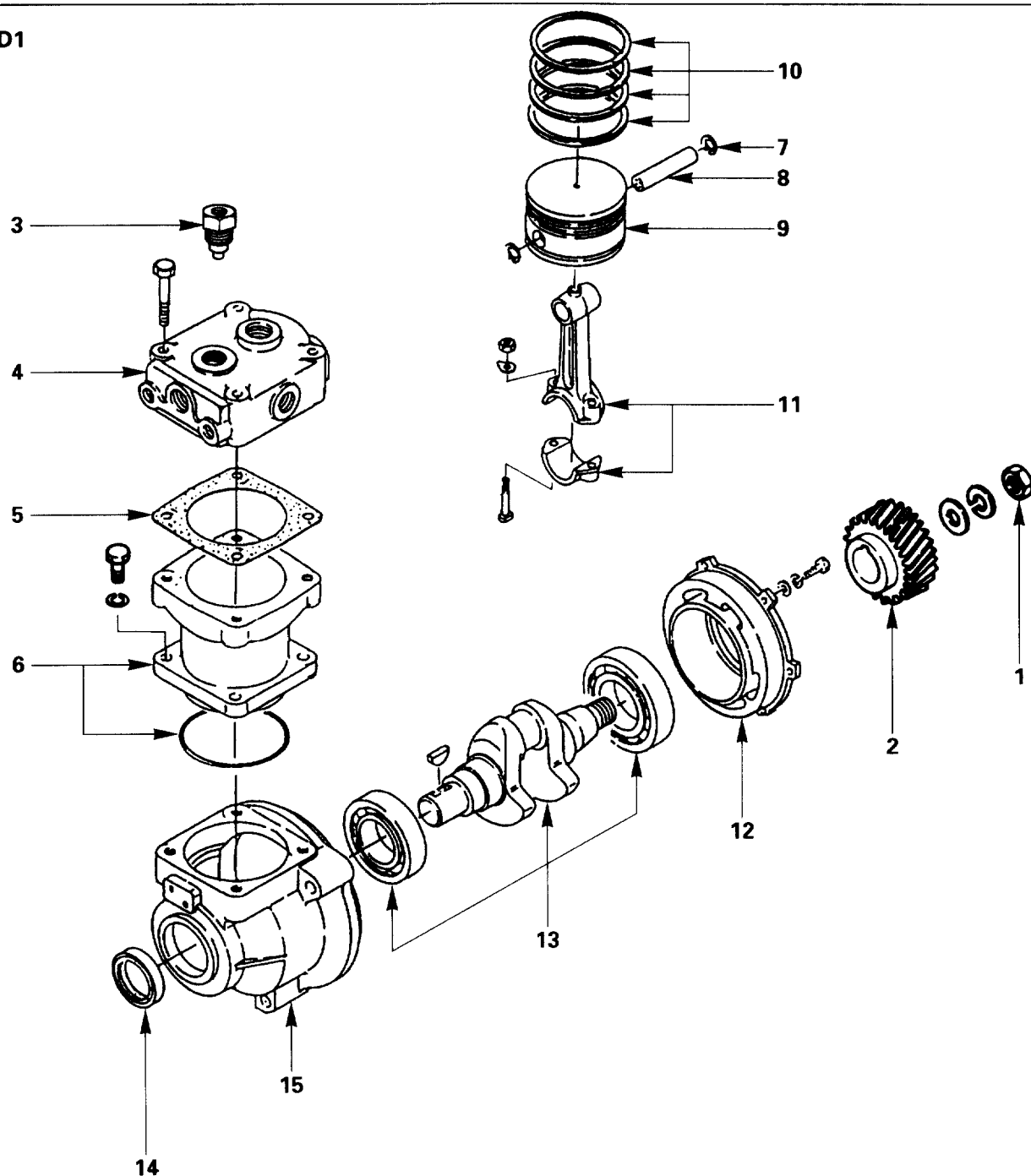
The compressor unloader is also regulated by the governor.

The system acts to maintain constant air pressure resulting in improved fuel economy.



DISASSEMBLY

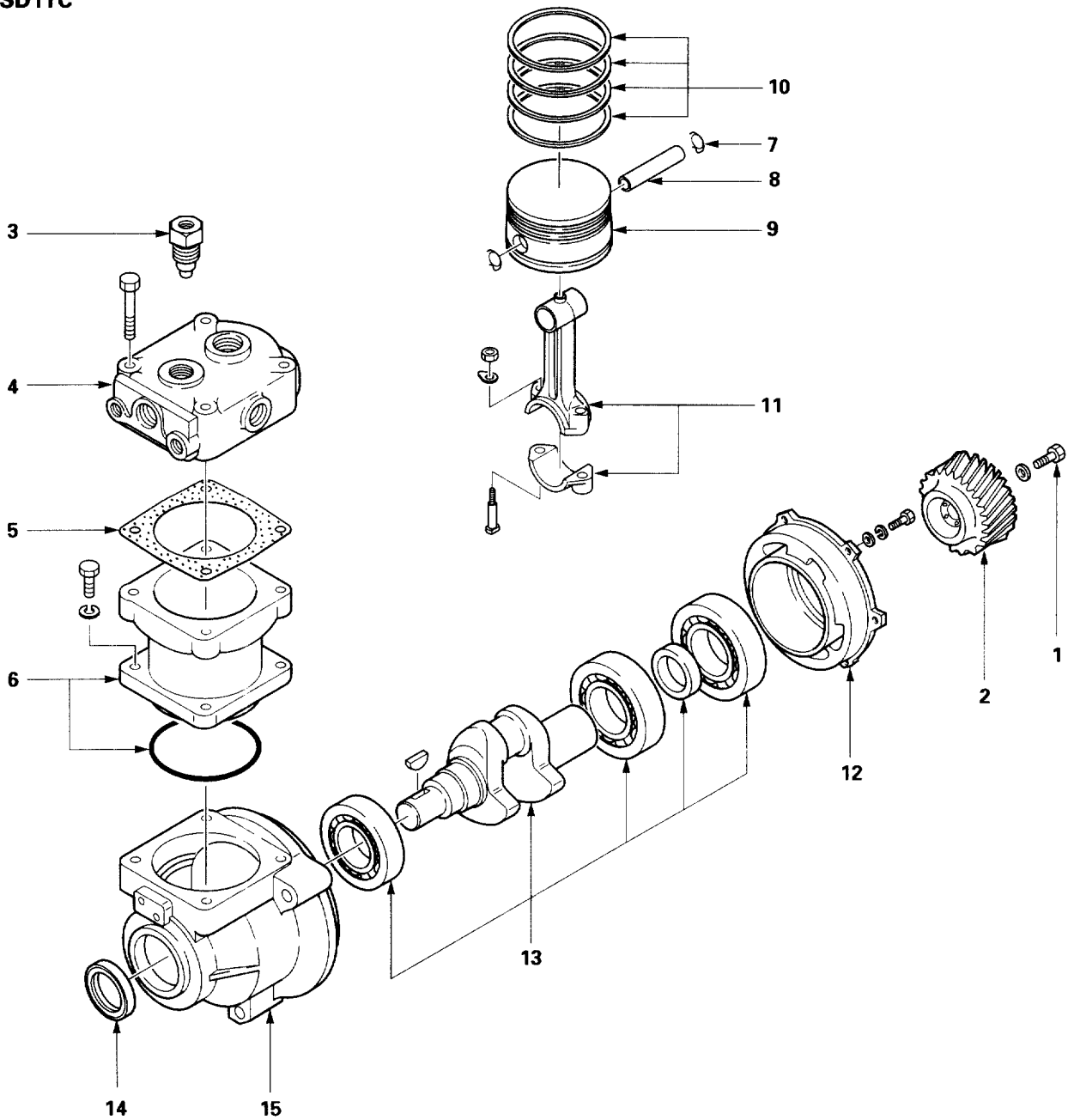
6SD1



Disassembly Steps

- | | |
|---------------------------------|----------------------------------|
| ▲ 1. Nut | 9. Piston |
| ▲ 2. Injection pump timing gear | ▲ 10. Piston ring |
| 3. Unloader | ▲ 11. Connecting rod and bearing |
| 4. Cylinder head | ▲ 12. Bearing cover |
| 5. Gasket | ▲ 13. Crankshaft and bearing |
| 6. Cylinder and O-ring | 14. Oil seal |
| ▲ 7. Snap ring | ▲ 15. Crankcase |
| 8. Piston pin | |

6SD1TC

**Disassembly Steps**

- | | |
|---------------------------------|---|
| ▲ 1. Bolt | 9. Piston |
| ▲ 2. Injection pump timing gear | ▲ 10. Piston ring |
| 3. Unloader | ▲ 11. Connecting rod and bearing |
| 4. Cylinder head | ▲ 12. Bearing cover |
| 5. Gasket | ▲ 13. Crankshaft and bearings with spacer |
| 6. Cylinder and O-ring | 14. Oil seal |
| ▲ 7. Snap ring | ▲ 15. Crankcase |
| 8. Piston pin | |



Important Operations

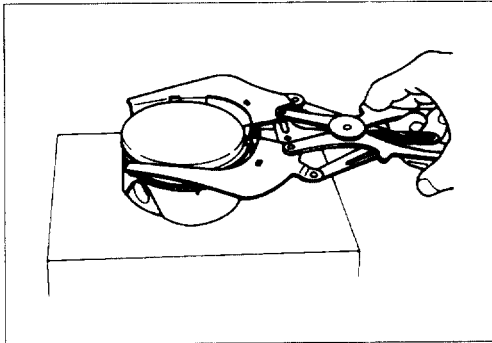
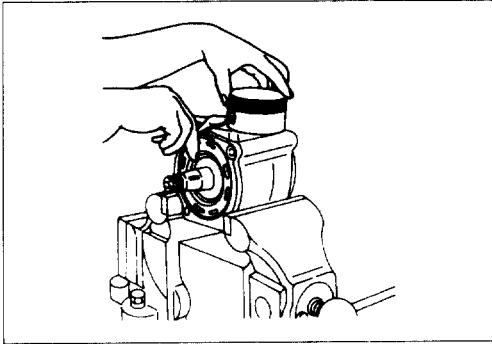
1. Nut

2. Injection Pump Timing Gear

- 1) Clamp the injection pump timing gear in a vise. Take care not to damage the timing gear.
- 2) Loosen the nut.
- 3) Use a remover to remove the injection pump timing gear.

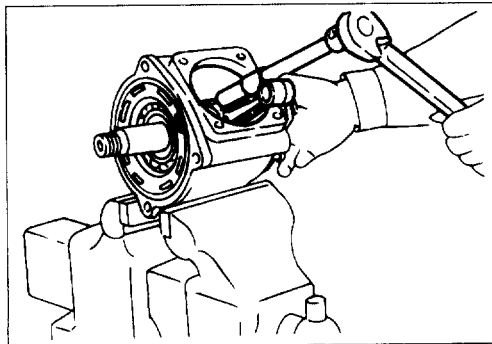
7. Snap Ring

Use snap ring pliers to remove the snap ring.



10. Piston Ring

Use a piston ring replacer to remove the piston ring.



11. Connecting Rod and Bearing

- 1) Straighten the connecting rod nut lock plate tang.
- 2) Loosen the connecting rod nuts.
- 3) Remove the connecting rod.

Note:

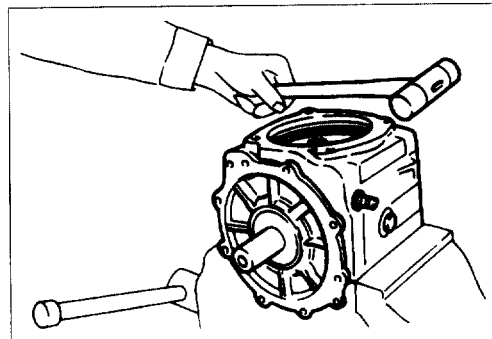
Do not attempt to remove the connecting rod cap bolts.

12. Bearing Cover

13. Crankshaft and Bearing

15. Crankcase

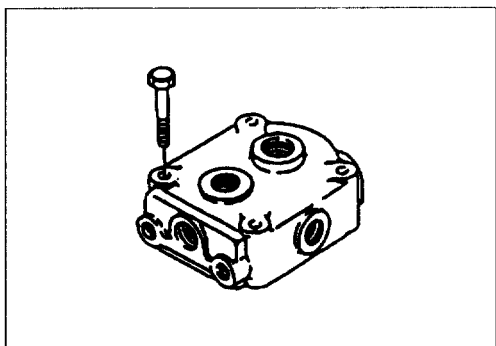
- 1) Use a mallet to drive out the crankshaft end. Take care not to damage the crankshaft.
- 2) Remove the crankshaft with the bearing cover from the crankcase.
- 3) Remove the bearing cover from the crankshaft.





INSPECTION AND REPAIR

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



CYLINDER HEAD

Cylinder Head

Check the cylinder head for cracking.

If the cylinder head is cracked, it must be replaced.

Inlet Valve (In The Cylinder Head)

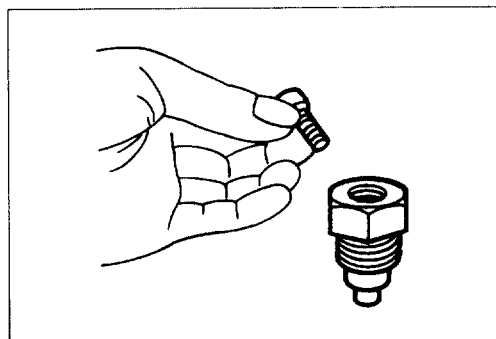
Check the valve spring and the valve seat for excessive wear or damage.

If the inlet valve is excessively worn or damaged, the entire cylinder head must be replaced.

Delivery Valve (In The Cylinder Head)

Check the valve for excessive wear or damage.

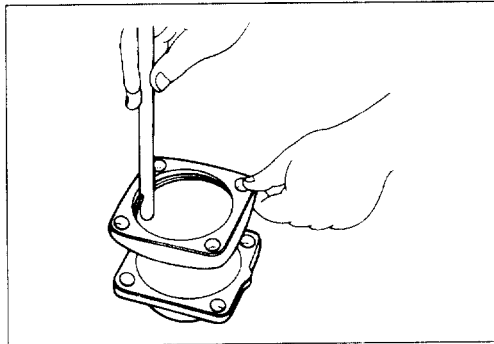
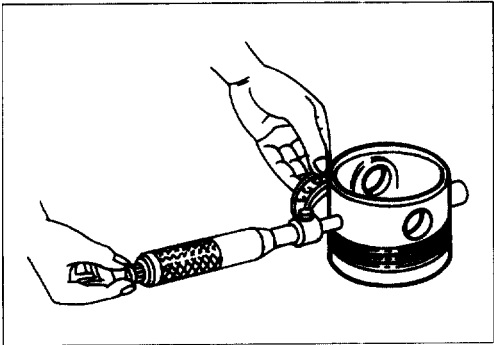
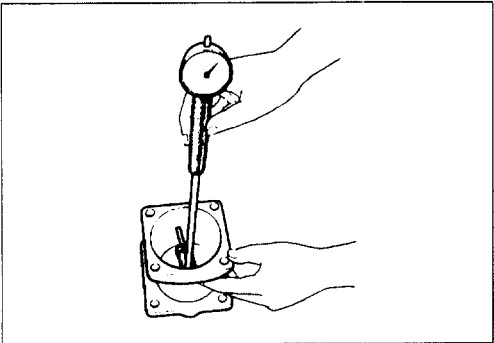
If the valve is excessively worn or damaged, the entire cylinder head must be replaced.



Unloader

1. Remove the snap ring from the inside of the unloader body.
2. Remove the unloader valve and spring from the body.
3. Check the unloader valve for excessive wear or damage.

If the unloader valve is excessively worn or damaged, it must be replaced.



CYLINDER

Cylinder Bore and Piston Clearance

Cylinder Bore Uneven Wear

1. Use a cylinder indicator to measure the cylinder bore.
If the uneven wear exceeds the specified limit, the cylinder must be replaced.

Cylinder Bore Uneven Wear	mm(in)
Limit	
0.1 (0.004)	

Cylinder Bore (Reference)	mm(in)
Standard	
85.00 - 85.03 (3.346 - 3.348)	

2. Use a micrometer to measure the piston outside diameter.

Piston Outside Diameter (Reference)	mm(in)
Standard	
84.91 - 84.93 (3.343 - 3.344)	

3. Calculate the cylinder bore and piston clearance.

Cylinder Bore and Piston Clearance	mm(in)
Standard	Limit
0.07 - 0.12 (0.0028 - 0.0047)	0.2 (0.008)

If the clearance exceeds the specified limit, the cylinder and/or the piston must be replaced.



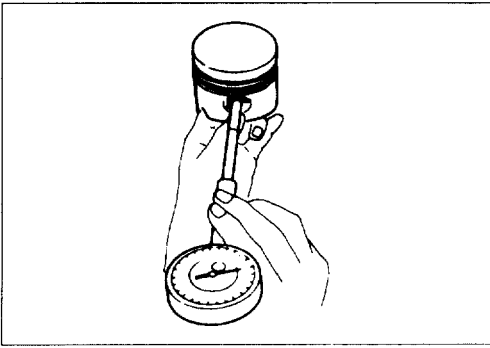
PISTON

Piston Ring Gap

Use a feeler gauge to measure the piston ring gap.
Do not allow the piston ring to slant to one side or the other. It must be perfectly horizontal.

Piston Ring Gap		mm(in)
	Standard	Limit
Compression Ring	0.15 - 0.30 (0.006 - 0.012)	1.0 (0.039)
Oil Ring	0.15 - 0.35 (0.006 - 0.014)	

If the measured value exceeds the specified limit, the piston ring must be replaced.



Piston and Piston Pin Clearance

1. Use a cylinder indicator to measure the piston pin bore.

Piston Pin Bore (Reference)	mm(in)
Standard	
16.006 - 16.017 (0.630 - 0.631)	

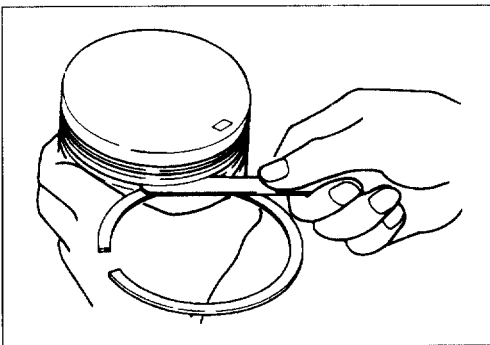
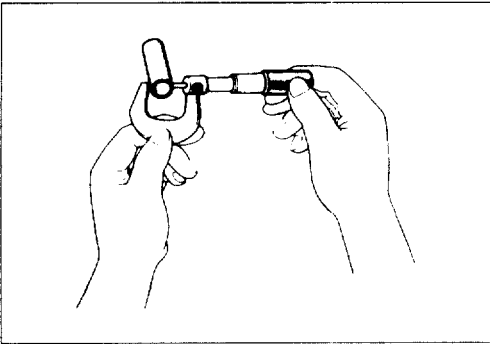
2. Use a micrometer to measure the piston pin diameter.

Piston Pin Diameter (Reference)	mm(in)
Standard	
15.991 - 16.000 (0.6296 - 0.6299)	

3. Calculate the piston and piston pin clearance.

Piston and Piston Pin Clearance	mm(in)
Standard	Limit
0.006 - 0.026 (0.0002 - 0.0010)	0.1 (0.004)

If the clearance exceeds the specified limit, the piston and/or the piston pin must be replaced.

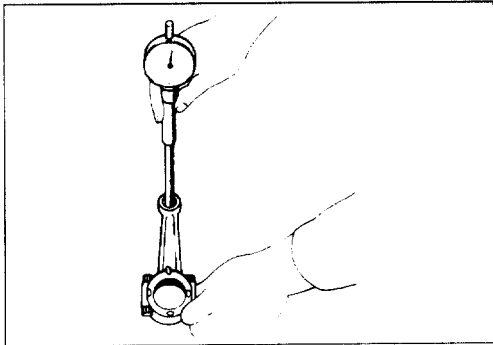


Piston Ring and Piston Ring Groove Clearance

Use a feeler gauge to measure the clearance between the piston ring and the piston ring groove at several points around the piston.

Piston Ring and Piston Ring Groove Clearance		mm(in)
	Standard	Limit
Compression Ring	0.02 - 0.05 (0.0008 - 0.0020)	0.15 (0.0060)
Oil Ring	0.03 - 0.07 (0.0012 - 0.0028)	

If the clearance exceeds the specified limit, the piston ring must be replaced.



CONNECTING ROD

Connecting Rod Small End and Piston Pin Clearance

1. Use a cylinder indicator to measure the connecting rod small end inside diameter.

Connecting Rod Small End Inside Diameter (Reference)	mm(in)
Standard	
16.006 - 16.017 (0.6300 - 0.6305)	

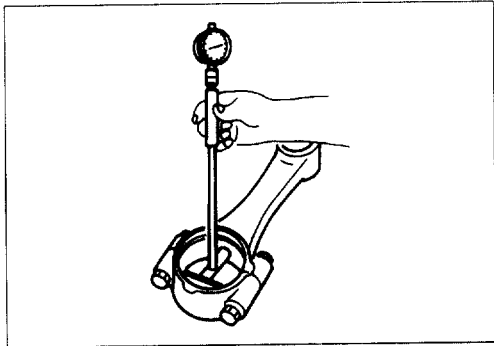
2. Use a micrometer to measure the piston pin diameter.

Piston Pin Diameter (Reference)	mm(in)
Standard	
15.991 - 16.000 (0.6296 - 0.6299)	

3. Calculate the connecting rod small end and piston pin clearance.

Connecting Rod Small End and Piston Pin Clearance		mm(in)
Standard	Limit	
0.006 - 0.026 (0.0002 - 0.0010)	0.1 (0.004)	

If the clearance exceeds the specified limit, the connecting rod and/or the piston pin must be replaced.



Connecting Rod Big End Bearing and Crankpin Clearance

1. Use a cylinder indicator to measure the connecting rod big end inside diameter.

Connecting Rod Big End Inside Diameter (Reference)	mm(in)
Standard	
35.009 - 35.034 (1.3783 - 1.3793)	

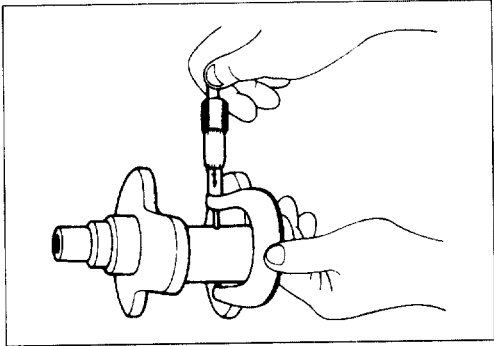
2. Use a micrometer to measure the crankpin diameter.

Crankpin Diameter (Reference)	mm(in)
Standard	
34.959 - 34.975 (1.3763 - 1.3770)	

3. Calculate the clearance between the connecting rod big end and the crankpin.

Connecting Rod Big End Bearing and Crankpin Clearance		mm(in)
Standard	Limit	
0.034 - 0.075 (0.0013 - 0.0030)	0.15 (0.006)	

If the clearance exceeds the specified limit, the connecting rod and/or the crankshaft must be replaced.



CRANKSHAFT

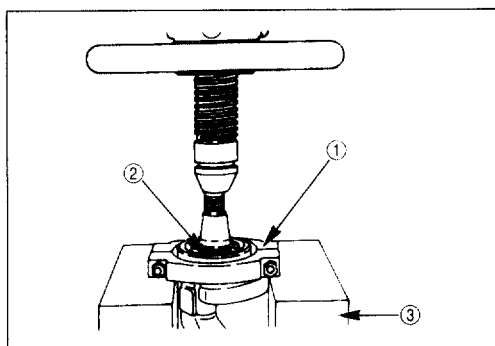
Crankshaft and Ball Bearing

1. Check the oil seal fitting faces for excessive wear and damage.

If the fitting faces are excessively worn or damaged, they must be replaced.

2. Listen for excessive bearing operating noise.
Excessive bearing operating noise indicates severe bearing wear.

The bearings must be replaced.

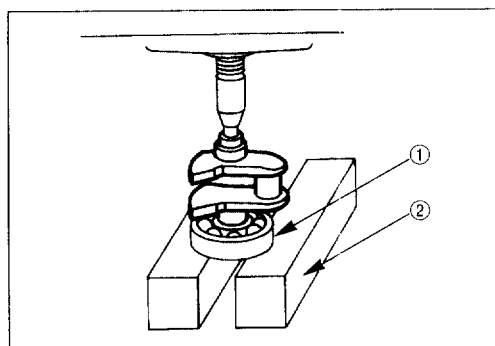


Ball Bearing Replacement

Ball Bearing Removal

1. Set a bearing remover ① to the ball bearing.
2. Place the crankshaft ② with the bearings installed between the base plates ③ of the bench press.
3. Use the bench press to gradually apply pressure to the water pump shaft to remove the ball bearings from the crankshaft.

Take care not to damage the crankshaft.



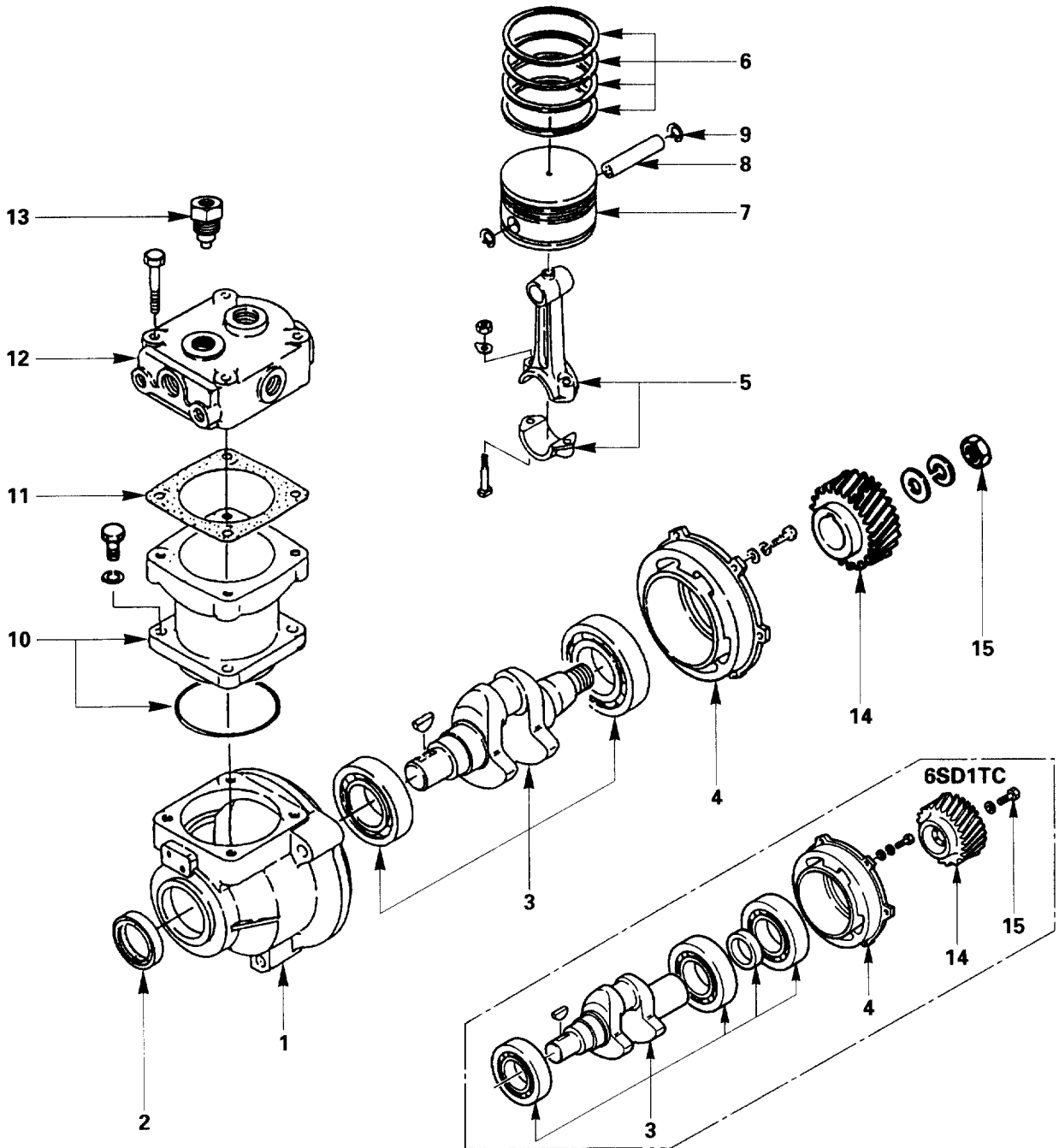
Ball Bearing Installation

1. Place the ball bearing ① on the base plates ②.
2. Apply engine oil to the crankshaft.
3. Set the crankshaft to the ball bearings.
4. Use the bench press to gradually press the crankshaft down until the ball bearing is correctly positioned.

Be absolutely sure that the bearing inner race is supported by the base plates.



REASSEMBLY



Reassembly Steps

- ▲ 1. Crankcase
- ▲ 2. Oil seal
- ▲ 3. Crankshaft and bearing
- ▲ 4. Bearing cover
- ▲ 5. Connecting rod and bearing
- ▲ 6. Piston ring
- ▲ 7. Piston
- ▲ 8. Piston pin
- ▲ 9. Snap ring
- ▲ 10. Cylinder and O-ring
- ▲ 11. Gasket
- ▲ 12. Cylinder head
- ▲ 13. Unloader
- ▲ 14. Injection pump timing gear
- ▲ 15. Nut / Bolt (6SD1TC)

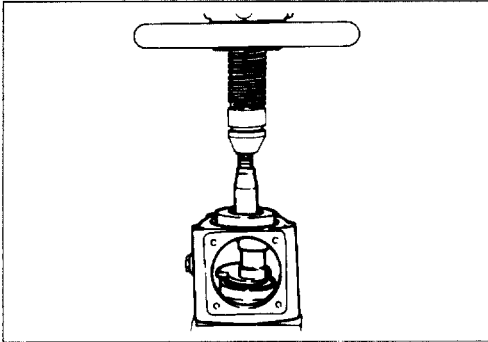


Important Operations

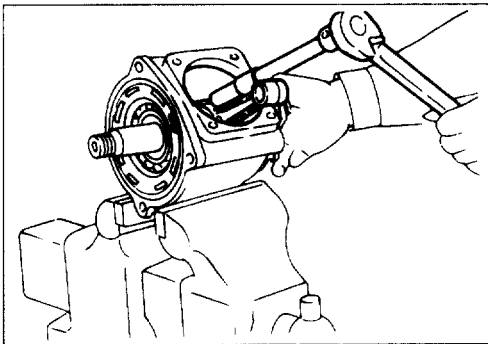


1. **Crankcase**
2. **Oil Seal**
3. **Crankshaft and Bearing**

- 1) Install the oil seal to the crankcase.
The oil seal lip must be facing the bearing.



- 2) Apply engine oil to the oil seal lip.
- 3) Set the crankshaft and bearing to the crankcase.
- 4) Use the bench press to gradually insert the crankshaft until the crankshaft bearing makes contact with the crankcase.



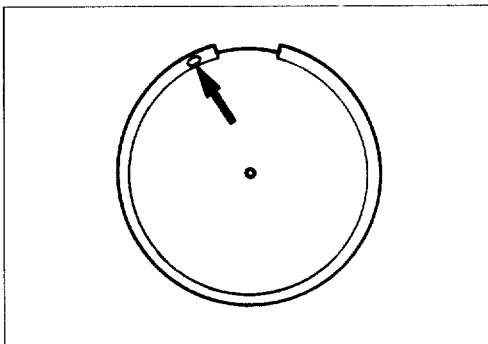
5. Connecting Rod and Bearing

- 1) Apply engine oil to the connecting rod bearings.
- 2) Install the connecting rod to the crankshaft.
- 3) Tighten the connecting rod bolt to the specified torque.



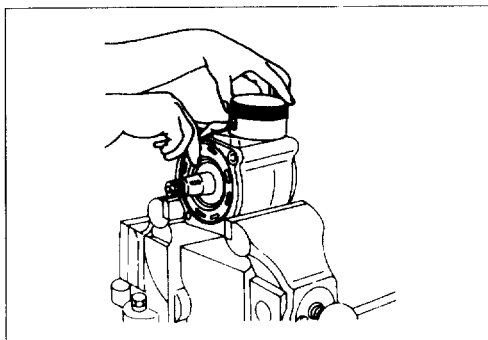
Connecting Rod Bolt Torque	N·m(kg·m/lb.ft)
24.5 (2.5 / 18.1)	

- 4) Bend back the connecting rod lock plate tangs.

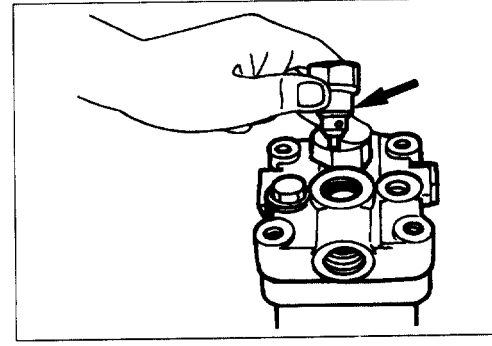
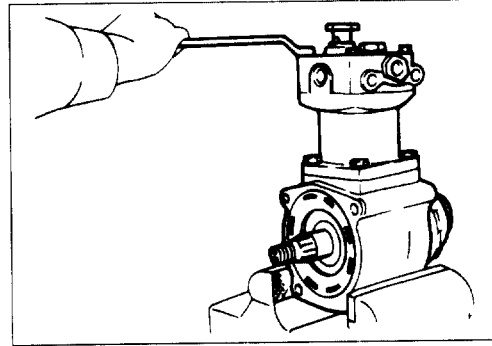
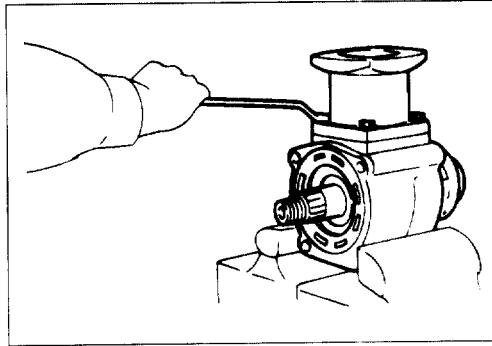
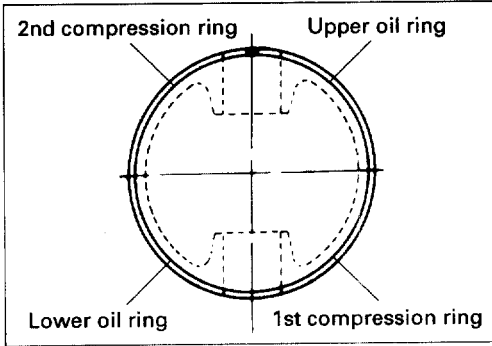
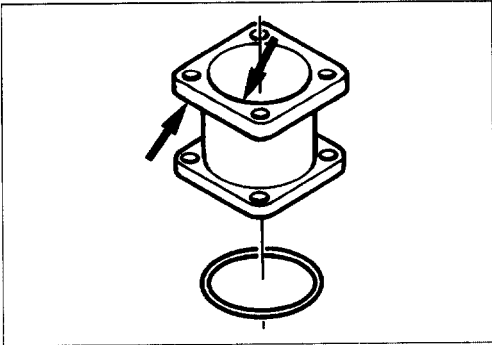


6. **Piston Ring**
7. **Piston**
8. **Piston Pin**
9. **Snap Ring**

- 1) Use a piston ring replacer to install the piston rings to the piston ring grooves.
The piston ring punched mark must be facing the cylinder head.



- 2) Set the piston to the connecting rod small end.
- 3) Insert the piston pin to the piston and the connecting rod.
- 4) Use snap ring pliers to install the snap rings to the piston.



10. Cylinder and O-Ring

- 1) Apply engine oil to the O-ring circumference.
- 2) Apply engine oil to the cylinder bore and the piston.



- 3) Position the piston ring gaps as shown in the illustration.



- 4) Install the cylinder to the piston and the crankcase.
- 5) Tighten the cylinder bolts to the specified torque.

Cylinder Bolt Torque	N·m(kg·m/lb.ft)
29.4 (3.0 / 21.7)	



12. Cylinder Head

- 1) Install the cylinder head to the cylinder.
The air inlet port must be facing the injection pump.
- 2) Tighten the cylinder head bolts to the specified torque.

Cylinder Head Bolt Torque	N·m(kg·m/lb.ft)
49.0 (5.0 / 36.2)	



13. Unloader

- 1) Apply ThreeBond 1360 (or the equivalent) to the unloader threads.
- 2) Tighten the unloader to the specified torque.

Unloader Torque	N·m(kg·m/lb.ft)
49.0 (5.0 / 36.2)	

**14. Injection Pump Timing Gear****15. Nut (6SD1)**

- 1) Install the injection pump timing gear to the crankshaft.
- 2) Clamp the injection pump timing gear assembly in a vise to prevent the crankshaft from turning.
Take care not to damage the crankshaft.
- 3) Tighten the injection pump timing gear nut to the specified torque.

Injection Pump Timing Gear Nut Torque	N·m(kg·m/lb.ft)
	255.0 (26.0 / 188.1)

15. Bolt (6SD1TC)

- 1) Install the injection pump timing gear to the crankshaft.
- 3) Tighten the bolt to the specified torque.

Injection Pump Timing Gear Bolt Torque		N·m(kg·m/lb.ft)
1st	2nd	
29.4 (3.0 / 21.7)	60° – 90°	
Apply molybdenum disulfide grease		

SECTION 6P

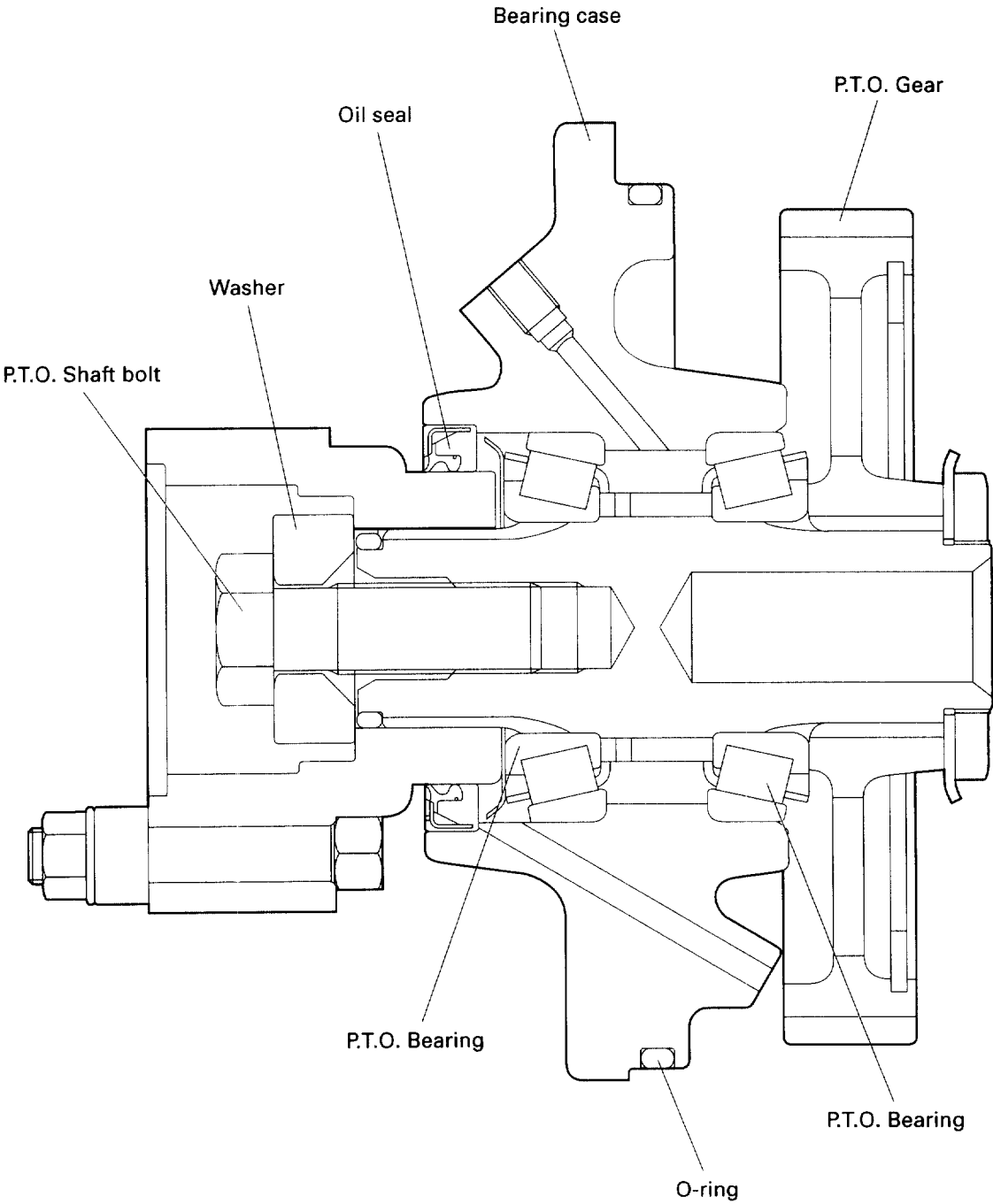
FLYWHEEL POWER TAKE OFF

CONTENTS

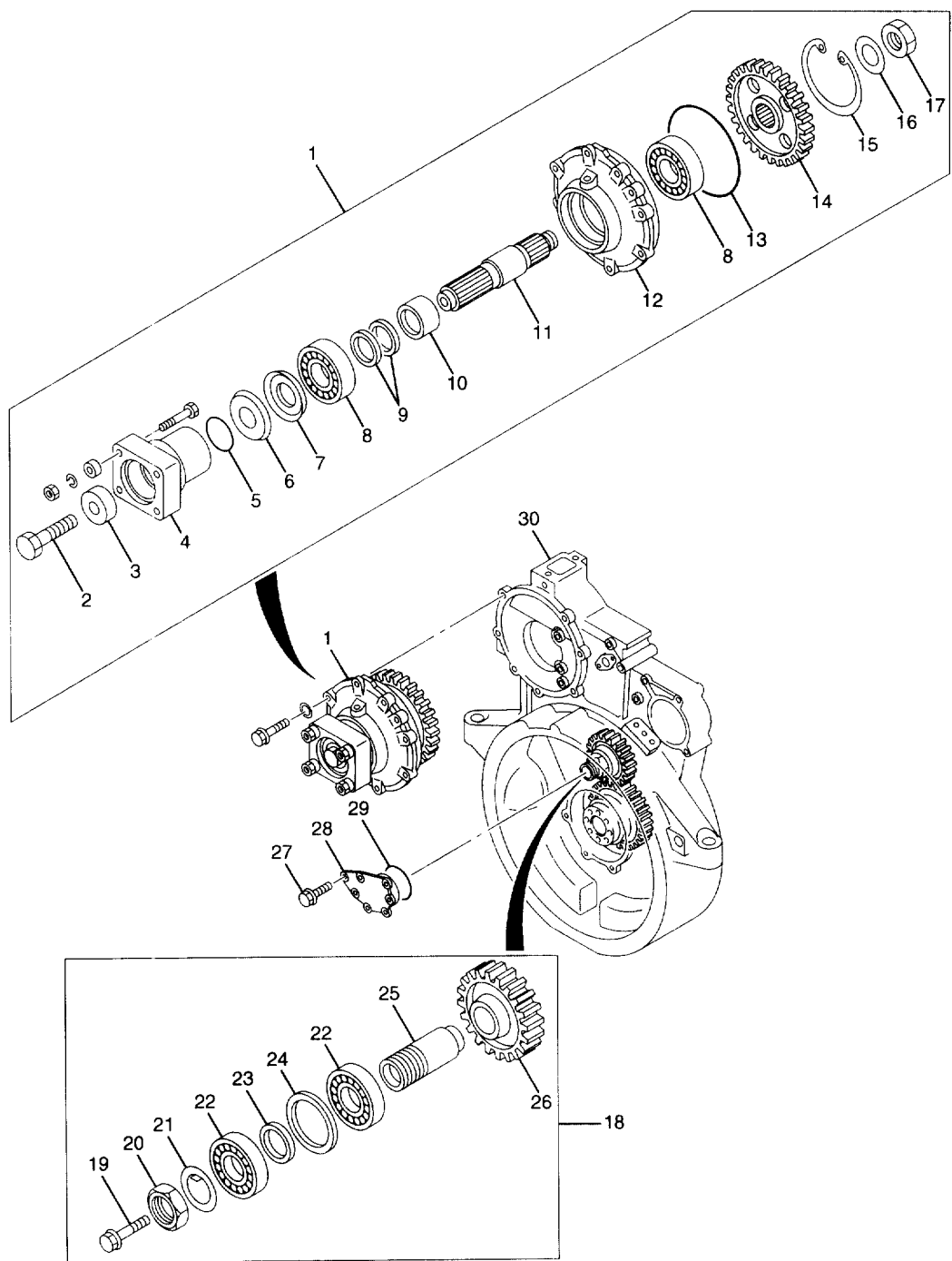
	PAGE
Flywheel Power Take Off	6P – 2
Flywheel P.T.O. Construction	6P – 2
Disassembly Steps	6P – 3
Disassembly	6P – 4
Inspection and Repair	6P – 5
Reassembly	6P – 6

FLYWHEEL POWER TAKE OFF

FLYWHEEL P.T.O. CONSTRUCTION



FLYWHEEL P.T.O.



Disassembly steps

- | | | |
|----------------------|------------------------|-----------------------|
| 1. P.T.O. assembly | 11. Shaft | 21. Lock washer |
| 2. P.T.O. shaft bolt | 12. Bearing case | 22. Idle gear bearing |
| 3. Washer | 13. O-Ring | 23. Inner spacer |
| 4. Flange | 14. P.T.O. gear | 24. Outer spacer |
| 5. O-Ring | 15. Ring | 25. Idle gear spindle |
| 6. Oil thrower | 16. Shaft nut washer | 26. Idle gear |
| 7. Oil seal | 17. Shaft nut | 27. Cover bolt |
| 8. Bearing | 18. Idle gear assembly | 28. Cover |
| 9. Shim | 19. Spindle bolt | 29. O-Ring |
| 10. Spacer | 20. Idle gear nut | 30. Flywheel housing |



DISASSEMBLY

1. P.T.O. Assembly

- 1) Loosen the fixing bolts to remove the P.T.O. assembly if necessary.
- 2) Remove the P.T.O. oil pipe with gasket.

2. P.T.O. Shaft Bolt

3. Washer

4. Flange

Remove the P.T.O. shaft bolt to disassemble the washer and flange.

5. O-Ring

6. Oil Thrower

7. Oil Seal

8. Bearing

9. Shim

10. Spacer

11. Shaft

12. Bearing Case

13. O-Ring

14. P.T.O. Gear

15. Ring

16. Shaft Nut Washer

17. Shaft Nut

18. Idle Gear Assembly

19. Spindle bolt

20. Idle Gear Nut

21. Lock Washer

22. Idle Gear Bearing

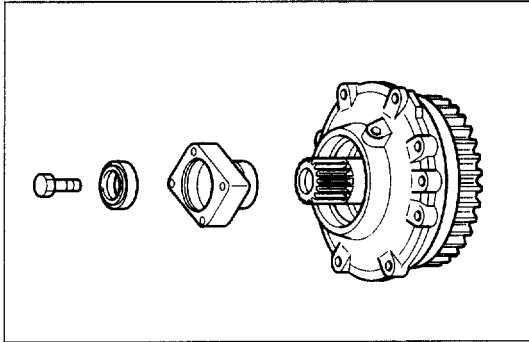
23. Inner Spacer

24. Outer Spacer

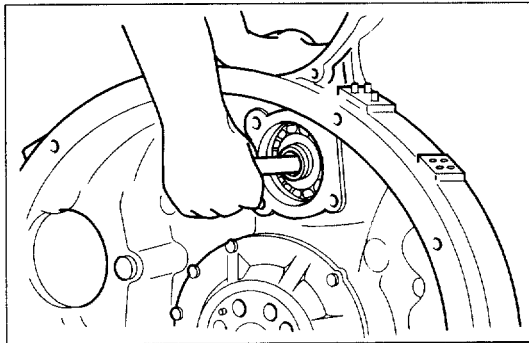
25. Idle Gear Spindle

26. Idle Gear

- 1) Use suitable brass bar to remove the idle gear spindle.
- 2) Same time remove the idle gear together with Idle gear bearing, inner and outer spacer.



020HW017



020HT005

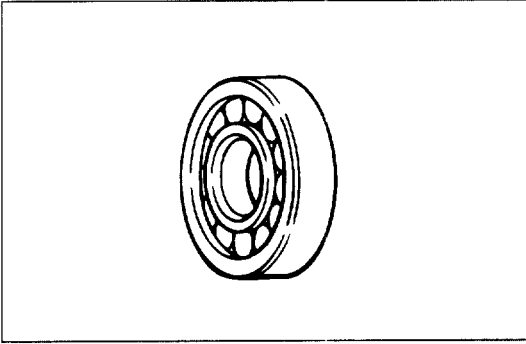


INSPECTION AND REPAIR

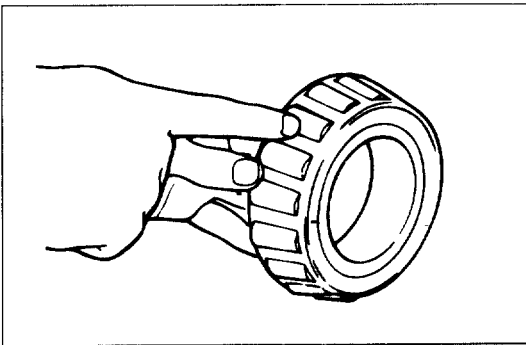
Make the necessary adjustments, repair and part replacements if excessive wear or damage is discovered during inspection.

P.T.O. Bearings

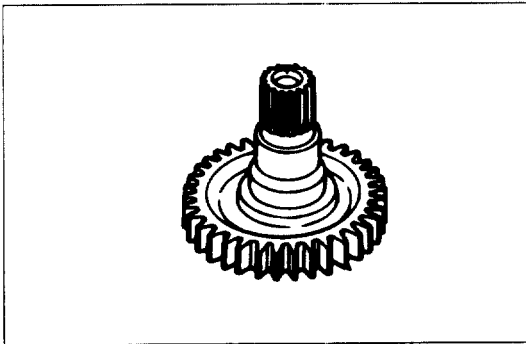
- 1) Visually check separation and/or any damage on the bearing race.
- 2) Inspect the bearing assembly for any wear.
- 3) Rotate the bearing for inspect abnormal noise.



090HY00001



090HY00002



090HY00003

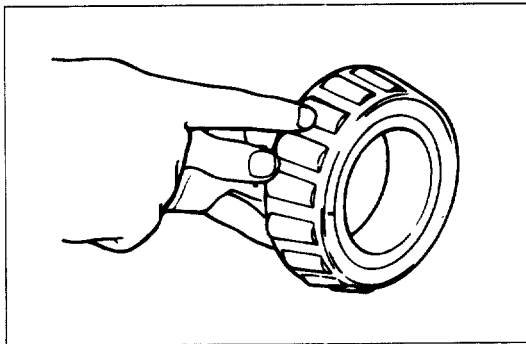
P.T.O. Gear

Inspect the P.T.O. gear for wear and/or damage.

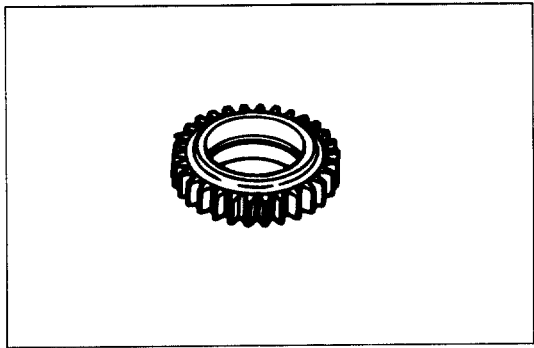
Same time check any wear or damage on the spline of the P.T.O. gear.

Idle Gear Bearings

- 1) Visually check separation and/or any damage on the bearing race.
- 2) Inspect the bearing assembly for any wear.
- 3) Rotate the bearing for inspect abnormal noise and abnormal rotating feeling.



090HY00002



090HY00004

Idle Gear

Inspect any wear and/or damage on the idle gear.

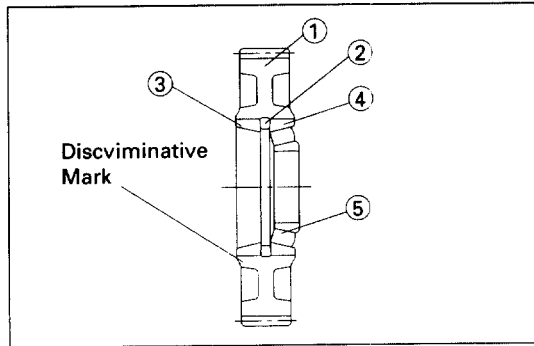


REASSEMBLY

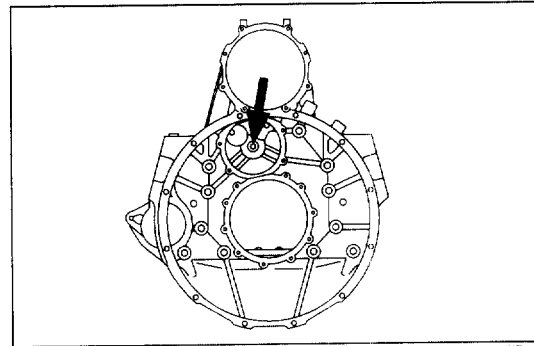
This section mentioned important items only.

Idle Gear Bearing

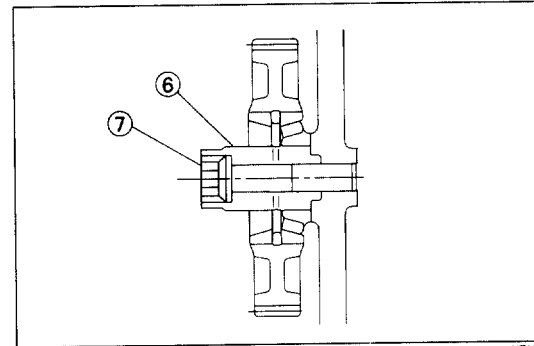
- 1) Install the idle gear bearing outer spacer ② to idle gear ①.
- 2) Press the idle gear bearing outer race ③, ④ to idle gear.
- 3) Initially install the bearing inner race ⑤ from front side of the idle gear.
- 4) The discriminative mark of idle gear turns on this side and it inserts into the P.T.O. hole.



020HT003



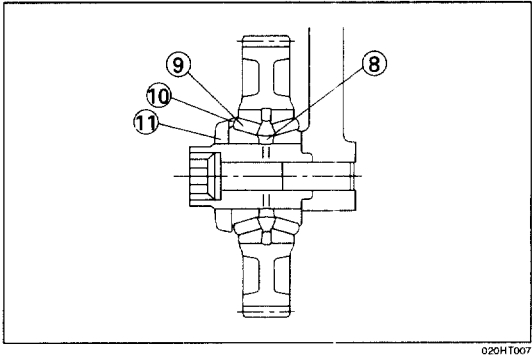
020HT006



020HT006

- 5) Install the idle gear spindle ⑥ to the idle gear.
- 6) Tighten the idle gear bolt ⑦ to the specified torque.

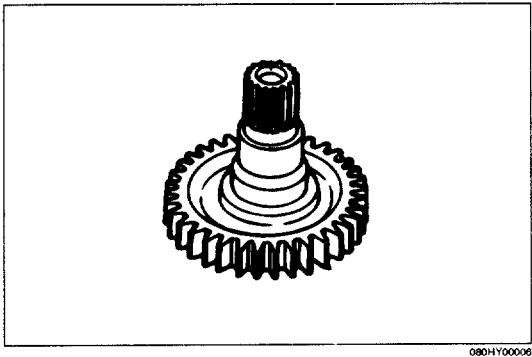
Idle Gear Bolt Torque	N·m (kg·m / lb·ft)
167.0 (17.0 / 123.0)	



- 7) Install the bearing inner space ⑧ and the bearing inner race ⑨.
- 6) Tighten the idle gear nut ⑪ with lock washer ⑩ to the specified torque.

Idle Gear Nut Torque	N·m (kg·m / lb·ft)
147.0 (15.0 / 108.0)	

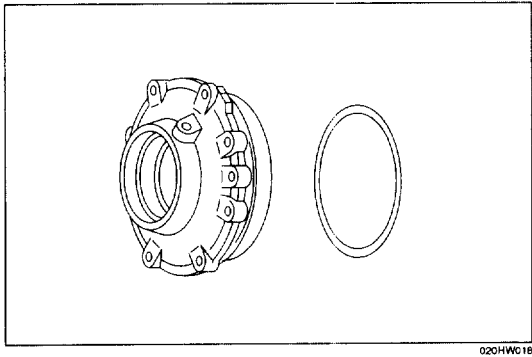
- 9) Twist the hook of the lock washer.



P.T.O. Gear

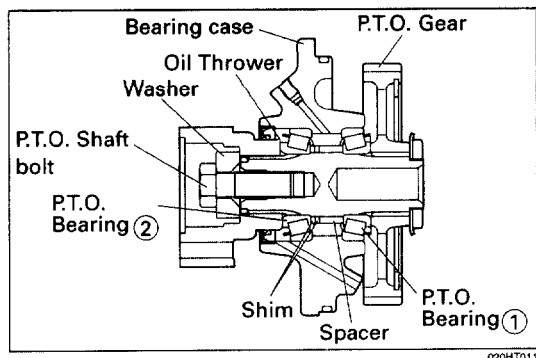
- 1) Fit P.T.O. gear on to shaft.
- 2) Tighten with lock washer and nut to the specified tightening torque.

P.T.O. Gear Nut Torque	N·m (kg·m / lb·ft)
147.0 (15.0 / 108)	



O-Ring

Apply engine oil to O-ring and install in bearing case.



P.T.O. Bearing

- 1) Press bearing ① on to shaft and install in bearing case.
- 2) Put spacer and shim on shaft.

NOTE:

Choose spacer and sh to make axial clearance 0.01 – 0.07 mm (0.0004 – 0.0027 in) in an assembled status.

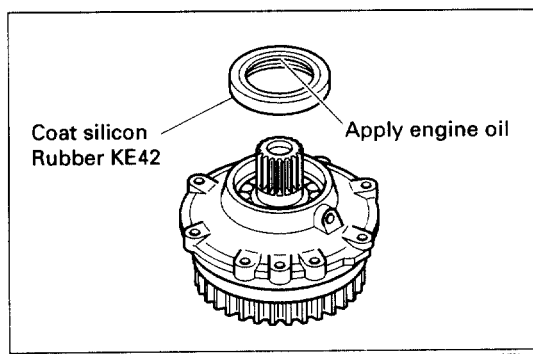
- 3) Install in bearing ②, oil thrower, and flange
- 4) Tighten washer and bolt to the specified tightening torque.

P.T.O. Shaft Bolt Torque	N·m (kg·m / lb·ft)
343.0 (35.0 / 253.2)	

NOTE:

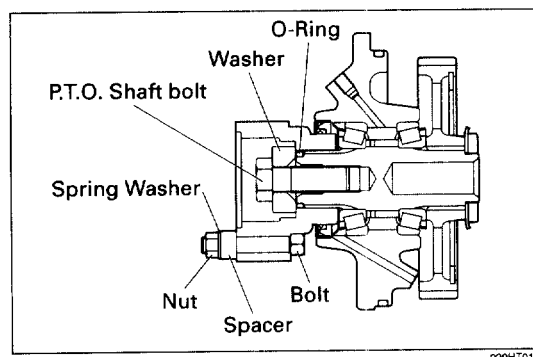
After tightening, make sure the assembly's axial clearance is 0.01 – 0.07 mm (0.0004 – 0.0027 in).

- 5) Loosen bolt and take out flange.



Oil Seal

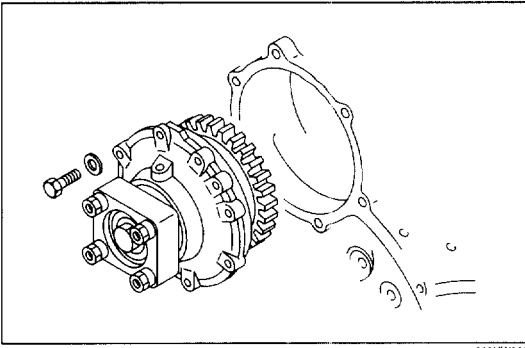
- 1) Apply engine oil to the oil seal lip.
- 2) Coat silicone rubber KE42 or equivalent to outside oil seal.
- 3) Install the oil seal until coming same surface with the bearing case.



Flange

- 1) Attach bolt, nut, spacer and spring washer to flange.
- 2) Install flange and O-ring.
- 3) Tighten with washer and bolt to the specified tightening torque.

P.T.O. Shaft Bolt Torque	N·m (kg·m / lb·ft)
343.0 (35.0 / 253.2)	



P.T.O. Assembly

- 1) Install the P.T.O. assembly to the flywheel housing.
- 2) Tighten the fixing bolts to the specified torque.

Fixing Bolt Torque	N·m (kg·m / lb·ft)
	53 (5.4/39)

NOTE :

Do not damage to the O-ring on the bearing case.

- 3) Install the P.T.O. oil pipe with gasket.

MG6SD-WE-9601

You are requested to order this manual using the manual number that is shown above.

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