Hino H06C H06CT ENGINE WORKSHOP MANUAL

CONTENTS

Continued on next page.

CONTENTS (continued)

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GROUP 1
GENERAL INTRODUCTION

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GENERAL PRECAUTIONS

Some recommended and standard maintenance services for your engine are mentioned in this section.
When performing maintenance on your engine be careful not to get injured by improper work.
Improper or incomplete work can cause a malfunction of the engine which may result in personal injury and/or property damage. If you have any question about performing maintenance, please consult your dealer.

WARNING

When working on your engine, observe the following general precautions to prevent personal injury and/or property damage in addition to the particular NOTES or WARNINGS.
Most threaded fasteners are metric.
Be careful not to mix with threaded fasteners using the inch system.

- Always wear safety glasses or goggles to protect your eyes.
- Remove rings, watches, ties, loose hanging jewelry and loose clothing before starting work on the engine.
- Bind long hair securely behind the head.
- To avoid serious burns, keep yourself away from hot metal parts such as the engine, exhaust manifold, radiator, muffler, exhaust pipe and tail pipe.
- Keep yourself, your clothing and your tools away from moving parts such as the cooling fan and V-belts when the engine is running.
- Always stop the engine by pulling out the engine stop knob. Leave the knob pulled out as long as the engine is stopped. And turn off the starter switch, unless the operation requires the engine running. Removing the key from the switch is recommended.
- Run the engine only in a well-ventilated area to avoid inhaling of carbon monoxide.
- Do not smoke while working on the truck since fuel and gages from the battery are flammable.
- Take utmost care when working on the battery. It contains corrosive sulfuric acid.
- Large electric current flows through the battery cable and starter cable. Be careful not to cause a short which can result in personal injury and/or property damage.
- Be careful not to leave any tool in the engine compartment. The tool may be hit by moving parts and can cause personal injury.
- Read carefully and observe the instructions placed on the jack when using it.
- Be careful not to damage lines and hoses by stepping or holding your feet on them.

IDENTIFICATION INFORMATION

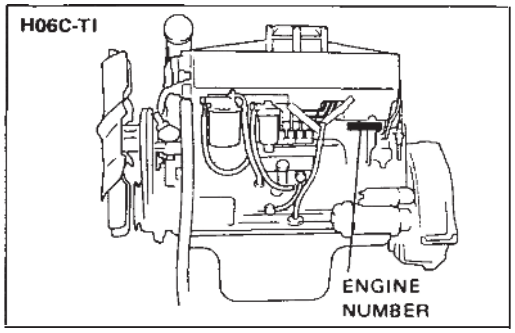

Fig. 1-1 SM1-078

ENGINE NUMBER

The Engine Number, as shown in Fig. 1-1 on the left-rear side of the engine block.

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GROUP 2

2

ENGINE
(MODEL H06C-TI)

TROUBLESHOOTING

Symptom	Possible cause	Remedy/Prevention
Engine overheating	**Coolant**	
	• Insufficient coolant	Add coolant.
	• Defective thermostat	Replace the thermostat.
	• Overflow of coolant due to leakage of exhaust into cooling system	Repair.
	• Damaged rubber hose	Replace rubber hose.
	• Coolant leakage due to deteriorated rubber hose	Replace rubber hose.
	• Coolant leakage from coolant pump	Replace the coolant pump.
	• Coolant leakage from rubber hose connection	Retighten or replace clamp.
	• Coolant leakage from cylinder head gasket	Replace gasket.
	Coolant pump	
	• Bearing seizure	Replace bearing.
	• Damaged (corroded) vane	Replace vane.
	Radiator	
	• Clogged with rust and scale	Clean radiator.
	• Clogged with iron oxide due to leakage of exhaust into cooling system	Clean coolant passage and correct exhaust leakage.
	• Coolant leakage	Repair or replace radiator.
	• Damaged cooling fan	Replace cooling fan.
	• Clogged radiator core due to mud or other debris	Clean radiator.
	• Defective radiator cap pressure valve	Replace radiator cap.
	Abnormal combustion	
	• Incorrect injection timing	Adjust injection timing.
	• Reduced injection pressure	Adjust injection pressure.
	• Poor fuel	Used good quality fuel.
	• Poor nozzle spray	Adjust or replace nozzle.
	• Unsatisfactory automatic timer advance angle	Repair or replace timer.

ENGINE

Symptom	Possible cause	Remedy/Prevention
Engine overheating	**Other problems**	
	• Defective or deteriorated engine oil	Change engine oil.
	• Unsatisfactory operation of oil pump	Replaced or repair.
	• Insufficient oil	Add oil.
	• Brake drag	Adjust.
	Severe operating conditions	
	• Lugging the engine	Operate engine properly
Excessive oil consumption	**Pistons, cylinder liners, and piston rings**	
	• Wear of piston ring and cylinder liner	Replace piston rings and cylinder liner.
	• Worn, sticking or broken piston rings	Replace piston rings and cylinder liner.
	• Insufficient tension on piston rings	Replace piston rings and cylinder liner.
	• Unsatisfactory break-in of piston rings	Replace piston rings and cylinder liner.
	• Unsuitable oil (viscosity too low)	Change oil as required and replace piston rings and cylinder liners.
	• Incorrectly fitted piston rings (upside down)	Replace piston rings.
	• Gaps of piston rings in line with each other	Reassemble piston rings.
	Valves and valve guides	
	• Worn valve stem	Replace valve and valve guide.
	• Worn valve guide	Replace valve guide.
	• Incorrectly fitted valve stem seal	Replace the stem seal.
	• Excessive lubricant on rocker arm	Check clearance of rocker arm and shaft.
	Excess oil feed	
	• Defective oil level gauge	Replace oil level gauge.
	• Oil level too high	Drain excess oil.

ENGINE

Symptom	Possible cause	Remedy/Prevention
Excessive oil consumption	**Oil leakage from miscellaneous parts**	
	• Oil leakage from oil seal	Replace oil seal.
	• Cracks or blowhole in cylinder block	Replace cylinder block.
	• Oil leakage from connections of oil lines	Tighten connections of oil lines.
	• Oil leakage from oil cooler	Replace oil cooler.
	• Oil leakage from oil pan gasket	Replace oil pan gasket.
	• Oil leakage from O-ring	Replace O-ring.
	Other problems	
	• Overcooled engine (low temperature wear)	Warm up engine before moving vehicle. Check cooling system.

NOTE: If oil consumption is excessive, the above problems will occur. Often, complaints from the customer are related to such problems.

1. **White smoke is emitted continuously when the engine is run at high speed.**
2. **White smoke is emitted only immediately after the engine speed is abruptly raised when idling.**
3. **The tail pipe is blackened with oil.**
4. **Oil leaks from the flanges of the exhaust manifold.**
5. **Lack of power.**
6. **Excessive blow-by gas.**

Piston seizure	**Pistons, cylinder liners, and piston rings**	
	• Incorrect clearance between piston and cylinder liner	Replace piston, piston rings and cylinder liner.
	• Unsatisfactory installation of piston pin	Replace piston, piston rings, cylinder liner and piston pin as required.
	• Broken piston ring	Replace piston, piston rings and cylinder liner.
	• Difference in expansion due to use of wrong piston	Replace piston, piston rings and cylinder liner.

Symptom	Possible cause	Remedy/Prevention
Piston seizure	**Coolant**	
	• Reduction in capacity of coolant pump (due to vane corrosion)	Replace the coolant pump.
	• Leakage of coolant	Repair.
	• Insufficient coolant	Add coolant.
	• Dirty coolant	Clean and replace coolant.
	• Defective radiator (coolant leakage, clogging)	Repair or replace the radiator.
	• Defective rubber hose (leakage)	Replace rubber hose.
	• Defective thermostat	Replace the thermostat.
	• Leakage of exhaust into cooling system	Repair.
	Operation	
	• Abrupt stoppage of engine after running at highspeed.	Operate engine properly.
	• Hill climbing using unsuitable gear	Select suitable gear.
	Oil	
	• Insufficient oil	Add oil.
	• Dirty oil	Change oil.
	• Poor quality oil	Replace with proper engine oils.
	• High oil temperature	Repair.
	• Low oil pressure	Repair.
	• Defective oil pump	Repair oil pump.
	• Reduced performance due to worn oil pump	Replace oil pump.
	• Suction strainer sucking air	Add oil and/or repair strainer.
	Abnormal combustion	
	• Use of defective fuel	Change fuel.
	• Incorrect injection timing	Adjust injection timing.
	• Engine overheating	See Symptom: "Engine overheating."

NOTE: If piston seizure occurs, the above problems will occur. Often, complaints from the customer are related to these problems.

1. **White smoke is emitted.**
2. **Lack of power**
3. **Excessive blow-by gas**

Symptom	Possible cause	Remedy/Prevention
Lack of power	Injection pump	Refer to "INJECTION PUMP"
	Intake	
	• Clogged air cleaner	Clean element or replace element.
	• Clogged inter cooler core due to mud or other debris	Clean inter cooler core or replace inter cooler
	• Clogged coolant of inter coolder	Clean inter cooler tube or replace inter cooler
	Overheating	See Symptom: "Engine overheating".
	Fuel and nozzle	
	• Poor nozzle spray	Adjust or replace injection nozzle.
	• Clogged nozzle with carbon	Clean nozzle.
	• Wear or seizure of nozzle	Replace nozzle.
	• Air in fuel system	Repair and bleed air from fuel system.
	• Clogged fuel filter	Replace element.
	• Use of poor fuel	Use good quality fuel.
	Pistons, cylinder liners, and piston rings	
	• Seized or wear of piston	Replace the piston, piston rings and liner.
	• Worn or broken piston rings, piston and cylinder liner	Replace piston rings, piston and liner.

Symptom	Possible cause	Remedy/Prevention
Lack of power	Other problems	
	• Connecting rod bent	Replace or repair connecting rod.
	• Exhaust pipe or muffler crushed (increased back-pressure)	Replace exhaust pipe or muffler.
	• Breakage of turbine or blower	Replace the turbine or blower or turbocharger
Leakage of exhaust	Head gasket	
	• Fatigued gasket (aging)	Replace gasket.
	• Damage	Replace gasket.
	• Improper installation	Replace gasket.
	Head bolts	
	• Loose bolts	Tighten bolt.
	• Elongated bolts	Replace bolt.
	• Improper tightening torque or tightening sequence	Tighten properly.
	Cylinder block	
	• Cracking	Replace cylinder block.
	• Surface distortion	Repair or replace.
	• Fretting of cylinder liner insertion portion (insufficient projection of cylinder liner)	Replace cylinder block.
	Cylinder head	
	• Cracking	Replace cylinder head.
	• Surface distortion	Repair or replace.
	Cylinder liners	
	• Cracking	Replace cylinder liner.
	• Corrosion	Replace cylinder liner.
	• Insufficient projection of cylinder liner	Replace cylinder liner.

Symptom	Possible cause	Remedy/Prevention
Leakage of exhaust	Other problems	
	• Incorrect injection timing	Adjust injection timing.

NOTE: If leakage of the exhaust occurs, the above prcblems will occur. Often, complaints from the customer are related to these problems.

1. **Lack of power.**
2. **The engine overheats.**
3. **The coolant is discolored.**

Difficulty starting engine	Electrical system	
	• Discharged battery	Charge battery.
	• Defective wiring in starter circuit	Repair wiring of starter.
	• Loose or open-circuit battery cable	Tighten battery terminal connections or replace battery cable.
	• Breakdown of starter	Replace starter.
	• Break of glow plug	Replace
	Injection pump	Refer to "INJECTION PUMP."
	Air cleaner	
	• Clogged element	Clean the element or replace the element.
	Fuel system	
	• No fuel in tank	Supply fuel.
	• Clogged fuel line	Clean fuel line.
	• Air sucked into fuel system through fuel line connections	Tighten fuel line connections.
	• Clogged fuel filter	Replace element.
	• Loose connection in high-pressure line	Tighten sleeve nut of high pressure line.
	• Water in fuel	Drain and clean fuel system.

Symptom	Possible cause	Remedy/Prevention
Difficulty starting engine	**Nozzles**	
	• Seized nozzle	Replace nozzle.
	• Broken or fatigued nozzle spring	Replace spring.
	Oil system	
	• Oil viscosity too high	Use proper viscosity oil, or install an oil immersion heater and warm up oil.
	Other problems	
	• Seized piston	Replace piston, piston rings, and liner.
	• Seized bearing	Replace bearing and crankshaft.
	• Reduced compression pressure	Overhaul engine.
	• Ring gear damaged or worn	Replace the ring gear and/or starter pinion.
	• Improperly adjusted or broken accelerator cable	Adjust or replace the accelerator cable.
Rough idling	**Injection pump**	Refer to "INJECTION PUMP."
	Nozzles	
	• Uneven injection pressure	Adjust.
	• Poor nozzle spray	Adjust or replace nozzle.
	• Carbon deposit on nozzle tip	Remove carbon.
	• Seized needle valve	Replace nozzle.
	Engine proper	
	• Improper valve clearance	Adjust valve clearance.
	• Improper contact of valve seat	Replace or repair valve and valve seat.
	• Idling speed too low	Adjust idling speed.
	• Coolant temperature too low	Warm up engine.
	• Compression pressure of cylinders markedly different from one another	Overhaul engine.

ENGINE

Symptom	Possible cause	Remedy/Prevention
Rough idling	**Other problems**	
	• Clogged high pressure injection line	Replace line.
	• Leakage due to improper tightening of high pressure injection line	Tighten sleeve nut.
	• Improperly adjusted or broken accelerator cable	Adjust or replace accelerator
	• Engine seizure	Replace pistons, piston rings and liners.
	• Incorrect valve timing	Replace camshaft.
Diesel knock	**Injection pump**	Refer to "INJECTION PUMP."
	Nozzles	
	• Incorrect injection pressure	Adjust.
	• Poor nozzle spray	Adjust or replace nozzle.
	• Sticking of nozzle	Check and/or replace.
	• Fatigued or broken nozzle spring	Replace spring.
	Fuel system	
	• Use of poor fuel	Use good quality fuel.
	• Fuel leakage into combustion chamber (e.g. during starting)	Adjust nozzles.
	Other problems	
	• Excessively cooled or heated engine	Warm up or cool engine.
	• Insufficient air intake	Correct.
	• Insufficient compression pressure	Repair.
	• Compression pressure leaks at cylinder head gasket	Replace head gasket.
	• Improper valve clearance or valve sticking	Adjust or repair.
	• Tappet sticking	Replace tappet and camshaft.

Symptom	Possible cause	Remedy/Prevention
Unusual engine noise	**Piston**	
	• Wear of piston pin boss or piston pin	Replace piston and/or piston pin.
	• Seized, damaged, or worn piston pin bushing	Replace piston pin bushing.
	• Worn pistons or cylinder liners	Replace piston or cylinder liner.
	• Damaged or seized piston	Replace piston and cylinder liner.
	• Foreign matter on top surface of the piston	Remove foreign matter and repair or replace piston, cylinder liner, and/or cylinder head.
	Valve mechanism	
	• Incorrect valve clearance	Adjust valve clearance.
	• Valve cotter out of place	Replace valve cotter.
	• Seized valve stem	Replace valve and valve guide.
	• Broken valve	Replace valve.
	• Damaged rocker arm support	Replace rocker arm support.
	• Broken or bent push rod	Replace push rod.
	• Damaged or worn tappet	Replace tappet and camshaft.
	• Broken valve spring	Replace valve spring.
	Bearings seizure	
	• Insufficient lubricating oil	Add oil.
	• Excessive or insufficient tightening of bearing housings	Retighten to specified torque.
	• Pits and scratches on bearing surface	Replace bearing and crankshaft.
	• Oil film formed on back of bearing	Replace bearing.
	• Improper installation of bearing	Replace bearing.
	• Reduction of spread dimension of bearing	Replace bearing.
	• Distorted bearing housing	Replace or correct bearing housing.
	• Excessive oil clearance	Replace bearing.

Symptom	Possible cause	Remedy/Prevention
Unusual engine noise	**Other various parts**	
	• Exhaust gas leakage from exhaust pipe joints	Retighten joints.
	• Loosen or missing intake manifold flange gasket	Retighten or replace
	• Intake valve seating is not concentric	Replace or correct the valve and valve seat
	• Intake gas leakage	Retighten
	Other problems	
	• Loose cooling fan mounting bolts or fan pulley nut	Tighten the fan and crankshaft pulley
	• Lack of lubricating oil (coolant pump, valves, etc.)	Lubricate
	• Worn timing gear	Replace the timing gear
	• Breakage of turbine or blower	Replace the turbine or blower and/or turbocharger

NOTE: The items on this page concern unusual engine noise which is due to causes other than, these given for diesel knock.

TROUBLE SHOOTING
(INJECTION PUMP)

Symptom	Possible cause	Remedy/Prevention
Engine does not start	**Fuel not reaching injection pump**	
	• Fuel lines clogged or damaged	Clean or replace fuel lines.
	• Fuel filter clogged	Clean or replace the filter element.
	• Air in fuel caused by improper connections of fuel line between fuel tank and feed pump	Repair connections.
	• Filter incorporated in inlet side of feed pump clogged	Remove foreign material.
	• Faulty feed pump check valve	Repair or replace it.
	• Feed pump piston spring broken	Replace it.
	• Feed pump push rod or tappet sticking	Repair or replace it.
	Fuel reaching injection pump	
	• Faulty connection of accelerator wire to pump adjusting lever.	Repair connection.
	• Control rack faulty or sticking	Repair it.
	• Damaged camshaft bearing	Repair it.
	• Plunger worn or sticking	Correct or replace it.
	• Faulty connection of engine stop wire to pump stop lever.	Repair it.
	Nozzle faulty	
	• Fuel leakage caused by loosened nozzle holder.	Inspect and tighten it.
	• Low opening pressure of nozzle	Adjust it.
	• Nozzle pressure spring broken	Replace it.
	• Nozzle needle sticking to nozzle body	Correct or replace it.
	Pump out of timing	
	• Improperly retarded injection timing	Correct injection timing.
	• Incorrect timing caused by improper installation of pump	Check engine timing and correct it.
	• Woodruff key for pump camshaft cut off.	Replace it.
	• Improper pre-stroke adjustment	Correct it to obtain specified injection timing.

Symptom	Possible cause	Remedy/Prevention
Engine has low power	Pump out of timing	
	• Excessive advanced timing resulting in loud knocking.	Check and correct it.
	• Excessively retarded timing resulting in black smoke.	Check and correct it.
	• Defective injection pump overflow valve.	Repair or replace it.
	• Feed pressure too low	Repair the feed pump.
	• Improper accelerator cable adjustment	Adjust it.
	Nozzle faulty	
	• Fuel leakage from nozzle holder	Check and repair nozzle holder.
	• Bad nozzle spray characteristic	Repair or replace it.
	• Loosened adjusting screw in nozzle holder, resulting in low opening pressure.	Adjust it.
	• Nozzle pressure spring broken	Replace it.
	Pump faulty	
	• Fuel leakage from delivery valve holder.	Retighten the delivery valve holder if it is loosened or replace O-ring if the O-ring is defective.
	• Defective seat of delivery valve assembly.	Repair or replace it.
	• Delivery valve spring broken	Replace the spring.
	• Plunger worn	Replace it.
	• Large spread in fuel delivery	Adjust it.
	• Wear of tappet roller	Replace the roller.
	• Camshaft bearing worn or broken	Replace it.
	• Improper adjustment of governor fuel load stopper screw.	Adjust it.
Loud knocking	Improper injection timing	Correct it.
	Bad fuel nozzle spray pattern after-dribble.	Check and correct it.
	High nozzle opening pressure	Adjust the opening pressure.
	Incorrect fuel deliveries to some nozzles.	Readjust the fuel deliveries.

Symptom	Possible cause	Remedy/Prevention
Excessive smoke	**Black smoke**	
	• Excessive fuel delivery caused by incorrect adjustment of fuel load stopper screw.	Adjust fuel delivery on test stand.
	• Excessively advanced injection timing.	Correct it.
	• Large spread in fuel delivery	Adjust it.
	• Bad nozzle fuel spray characteristics	Check and correct them.
	White smoke	
	• Improperly retarded injection timing.	Advance injection timing.
	• Water in fuel	Check and clean fuel lines.
Low idle speed irregular	Improper adjustment of idle button	Correct it.
	Bad fuel spray characteristic of nozzles.	Check and repair them.
	Incorrect injection timing	Correct it.
	Incorrect initial tension setting of idling spring or the spring broken.	Adjust or replace it.
	Control rack not smoothly move	Disassemble pump and repair it.
	Large spread in fuel delivery	Adjust it.
	Plunger worn	Replace it.
	Governor linkage not smoothly move.	Correct it.
	Defective feed pump	Disassembled and repair it.
Engine always runs at high speed	Accelerator cable sticking	Check and correct it.
	Governor linkage sticking	Disassemble and repair the governor.
	Control rack sticking	Check and correct it.
Engine starts and stops	Fuel lines clogged	Clean or replace fuel lines.
	Air in fuel caused by damaged fuel lines or improper connection of fuel lines.	Repair fuel lines or replace fuel lines and gaskets.

SPECIAL TOOL

Prior to starting an engine overhaul, it is necessary to have the following.

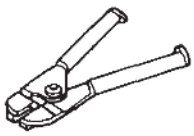
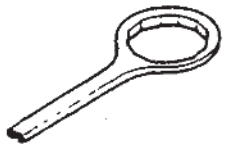
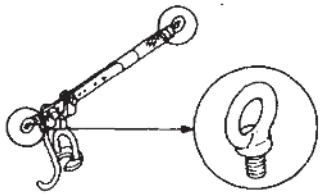
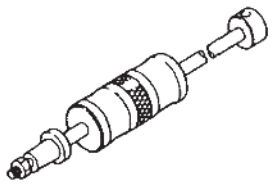
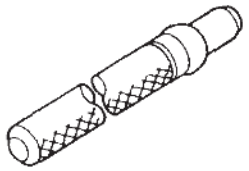
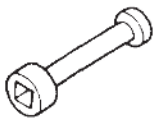
Illustration	Tool No.	Tool name	Usage
	09442-1061	PISTON RING EXPANDER	For removing and install the piston rings
	09553-1010	WRENCH	For removing and install the fuel filter
	09470-1022	VALVE SPRING PRESS	For installing or removing valve springs
	09420-1442	SLIDING HAMMER	For removing the nozzle holder (Used with nozzle holder puller 09462-1130)
	09482-1320	PUSH ROD GUIDE PIPE CAULKING TOOL	For caulking the push rod guide pipe
	09411-1070	WRENCH	To tighten the cylinder head bolt

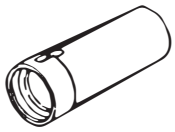
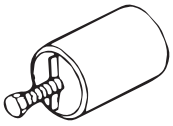
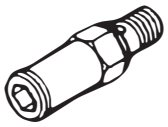
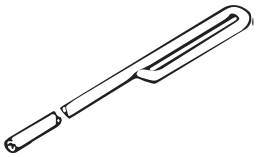
Illustration	Tool No.	Tool name	Usage
	09482-1550	PRESS	For the injection pump drive shaft sleeve (Used with 9851-36104)
	9851-36104	O-RING	For injection pump drive shaft sleeve press (Used with 09482-1550)
	09420-1490	PULLER	For the injection pump drive shaft sleeve
	09444-1290	TARGET PLATE	For inspection of the piston cooling jet
	9001-24262	BOLT	For inspection of the piston cooling jet
	09472-1620	ADJUSTER	To adjust the piston cooling jet nozzle

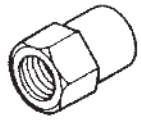
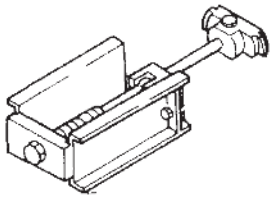
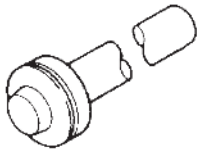
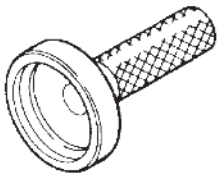
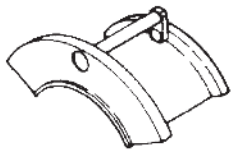
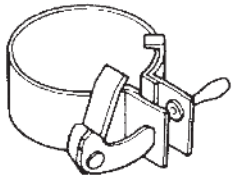
Illustration	Tool No.	Tool name	Usage
	09552-1030	PRESSURE GAUGE ADAPTER	For the compression gauge
	09420-1240	CYLINDER LINER PULLER	For removing the cylinder liner and measuring the protrusion of the cylinder liner
	09402-1340	DUST SLINGER PRESS	For pressing the dust slinger to crankshaft pulley
	09402-1210	PRESS	**To install the crankshaft front oil seal sleeve**
	09480-1040	CYLINDER LINER GUIDE	To install the cylinder liner
	09441-1101	PISTON RING HOLDER	For piston installation

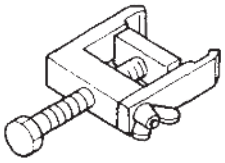
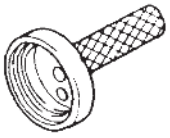
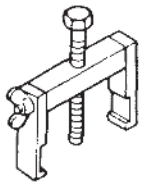
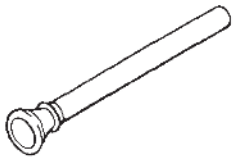
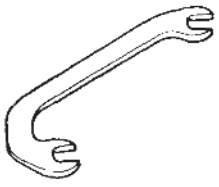
Illustration	Tool No.	Tool name	Usage
	09482-1090	PRESS	For front oil seal to timing gear cover
	09420-1071	PULLER	**To remove crankshaft front oil seal sleeve**
	09482-1400	PRESS	**To install crankshaft rear oil seal sleeve**
	09420-1420	PULLER	**To remove crankshaft rear oil seal sleeve**
	09431-1010	VALVE LAPPING TOOL	For valve lapping
	09819-3003	WRENCH	Tightening or retightening injection pump coupling

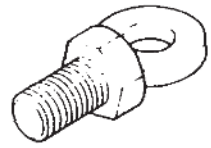
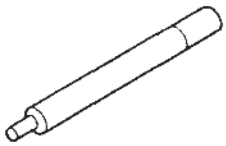
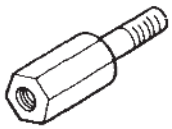
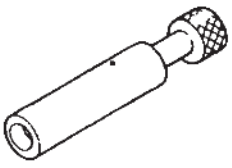
Illustration	Tool No.	Tool name	Usage
	09433-1061	EYE-BOLT	For hanging the cylinder head
	09472-1210	NOZZLE SLEEVE BAR	For installing the nozzle sleeve (Used with 9800-06100)
	9800-06100	STEEL BALL	For expanding the nozzle sleeve (Used with 09472-1210)
	09408-1010	COMPRESSION ADAPTER	For measuring engine compression pressure (Bolt size PF 3/8)
	09462-1130	ADAPTER	For with drawing the nozzle holder (Used with 09420-1442)
	09472-1781	STEM SEAL PRESS	To install the valve stem seal

Illustration	Tool No.	Tool name	Usage
	09444-1210	V-BELT TENSION GAUGE	For V-belt tension
	09503-1080	WRENCH	For removing and install the oil filter

ENGINE

GENERAL

WARNING

The following items should be observed to prevent injury to yourself and others when servicing the engine or vehicle;

- **O Stop the engine and keep the engine off during checks and adjustments.**
- **O Place the starter key in the "OFF" position.**
- **O Leave the engine stop knob pulled out fully.**

ENGINE OVERHAUL CRITERIA

FACTORS WHICH DETERMINE WHEN AN ENGINE OVERHAUL IS NEEDED.

1. Lowered compression pressure

a. Before the measurement

a) Correct the valve clearance.

Intake: 0.30 mm (0.0118 in)
Exhaust: 0.45 mm (0.0177 in)
when engine is cold.

b) Warm up engine [Bring the coolant temperature to about 80°C (176°F)].

c) Charge the battery fully.

d) Remove the air cleaner.

b. Measurement

a) Remove the six nozzle holders.

b) Install the gauge adapter in the nozzle holder hole.

Special Tool: Compression Gauge Adapter (09408-1010)
Compression Gauge Adapter (09552-1030)

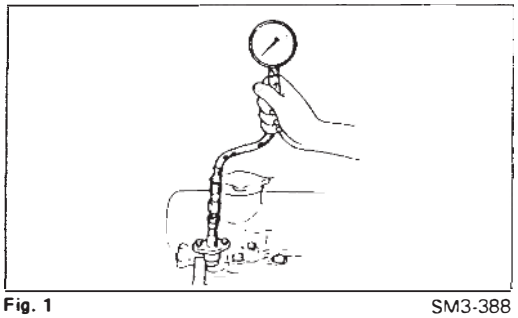


Fig. 1 SM3-388

c) Connect a compression gauge to the gauge adapter.

d) Drive the engine with the starter and read the compression pressure.

e) Measure the compression pressure for each cylinder. If the compression pressure is low, be sure to repeat the measuring.

NOTE: Be sure not to leak through sealing face.

Unit: kg/cm² (lb/sq.in)

	Assembly standard	Service limit	Difference between each cylinder	Engine speed (rpm)
Model H06C-TI engine	33–36 (469–511)	28 (398)	Less than 3 (43)	270–310

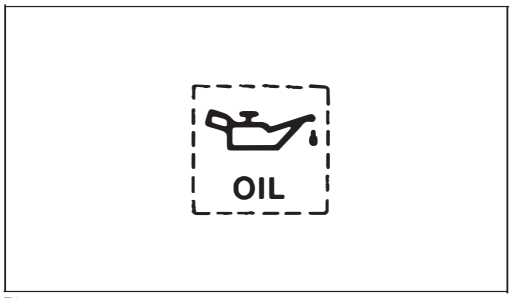


Fig. 2 SM3-349

2. Decreased oil pressure
Check the oil pressure warning lamp when the oil and coolant temperature is hot [about 80°C (176°F)].

a. If the warning lamp is light, check the oil level.

b. Check oil deterioration.
If oil quality is poor, replace with a suitable grade oil.

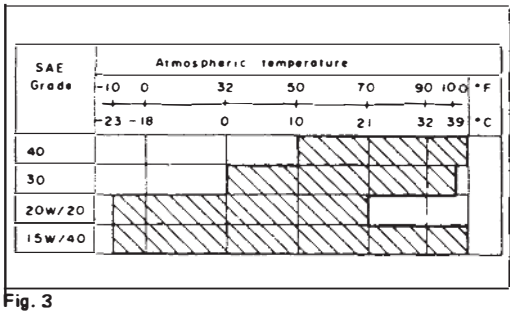


Fig. 3

c. Remove the oil pressure switch and install the oil pressure gauge.

d. Measure the oil pressure at coolant temperature 80°C (176°F) or more.

Service Limit: 0.5 kg/cm² (7.11 lb/sq.in)

3. Other factors

a. The blow-by gas increases.
b. The engine does not start easily.
c. Engine output decreases.
d. Fuel consumption increases.
e. Engine makes greater noise.
f. Excessive oil consumption.

DISMOUNTING THE ENGINE ASSEMBLY

1. **BLOCK THE WHEELS.**
   1. Park the vehicle on level ground.

2. **DISCONNECT THE BATTERY CABLES.**

> **WARNING**
> **Always disconnect the battery cables when servicing the engine.**

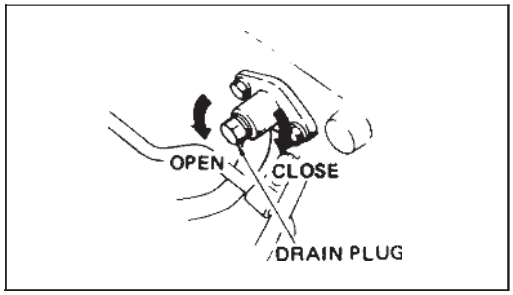


Fig. 4 E057

3. **DRAIN THE COOLANT AND ENGINE OIL.**

> **WARNING**
> **To avoid the danger of burns do not drain the engine oil and coolant while the engine and radiator are still hot.**

   1. Drain the coolant from the radiator.

NOTE: **The coolant can be drained more easily by removing the filler cap and breather plug of the inter cooler.**

   2. Drain the coolant from the cylinder block.
   3. Drain the engine oil through the drain plug.
   4. Disconnect the cable of oil level sensor.

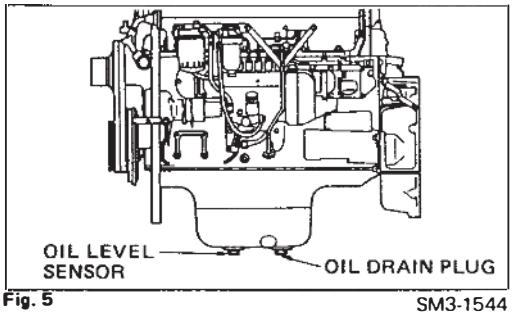


Fig. 5 SM3-1544

4. **BY-PASS OIL FILTER (OPTION).**
   1. Unscrew the breather plug, then unscrew the drain plug and drain the oil through the drain hole.
   2. Disconnect the oil lines.

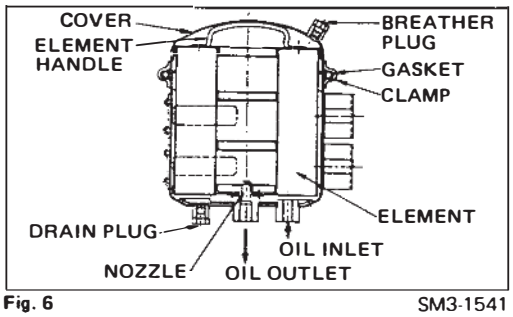


Fig. 6 SM3-1541

REMOVAL OF THE ENGINE COMPONENT PARTS

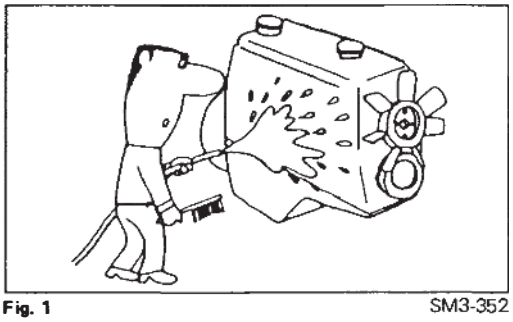


Fig. 1 SM3-352

1. CLEANING

1. Cover all openings with waterproof tape before steam cleaning.
2. Clean all disassembled parts using a steam cleaner.

NOTE: Do not spray steam on electrical parts (generator, starter, etc.).

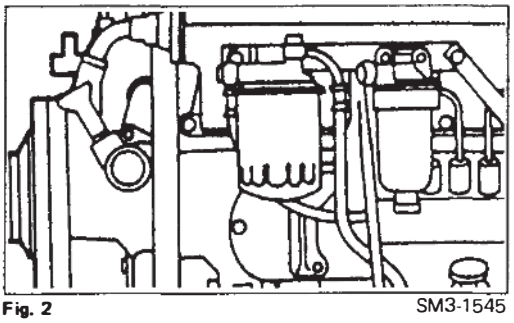


Fig. 2 SM3-1545

2. REMOVE THE FUEL FILTER WATER SEPARATOR AND FUEL LINES.

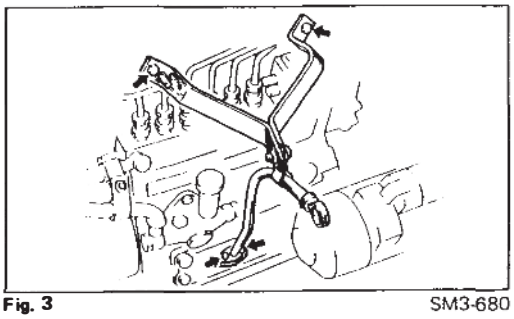


Fig. 3 SM3-680

3. REMOVE THE OIL LEVEL GAUGE.

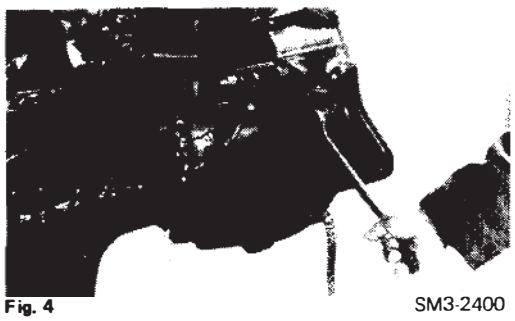


Fig. 4 SM3-2400

4. REMOVE THE STARTER.


Fig. 5 SM3-2401

5. REMOVE THE INJECTION PUMP.

1. Remove the fuel lines, oil lines and fuel leakage lines.

NOTE: Cover the open ends of the pipes to prevent entry of dirt.

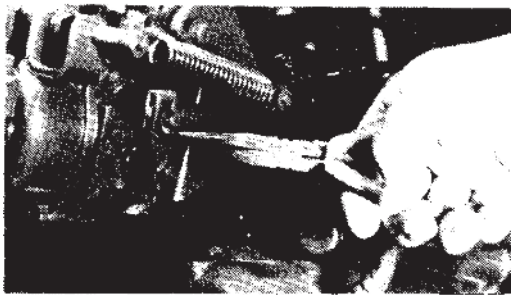


Fig. 6 SM3-2402

2. Disconnect the engine stop cable.

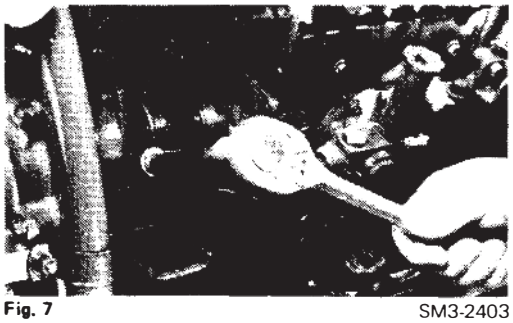


Fig. 7 SM3-2403

3. Loosen the through bolts.


Fig. 8 SM3-2404

4. Remove the coupling bolts and nuts.

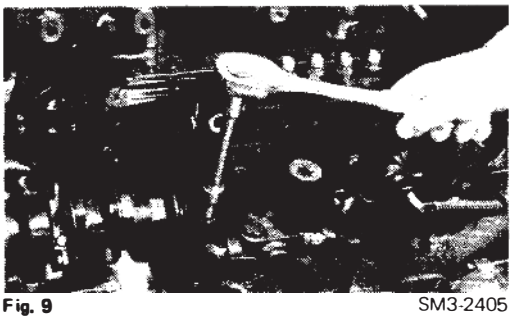


Fig. 9 SM3-2405

5. Remove the four setting bolts and remove the injection pump assembly.

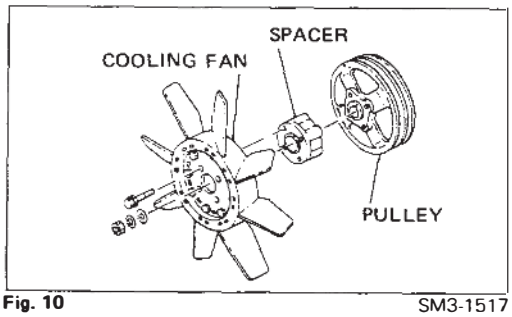


Fig. 10 SM3-1517

6. REMOVE THE COOLING FAN AND SPACER.

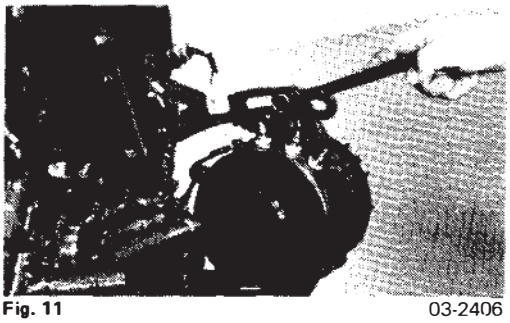


Fig. 11 03-2406

7. REMOVE THE BELTS AND GENERATOR.

1. Loosen the belt tension adjusting bolt.
2. Loosen the through bolt.
3. Remove the belts and generator.

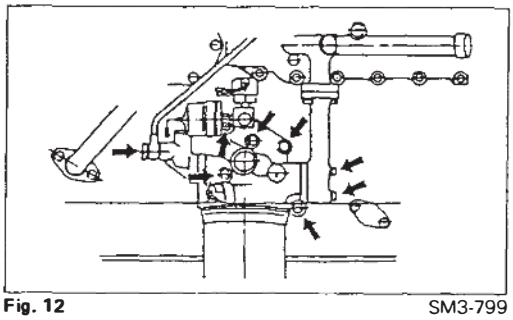


Fig. 12 SM3-799

8. REMOVE THE OIL FILTER.

1. Remove the oil lines.
2. Remove the oil filter.

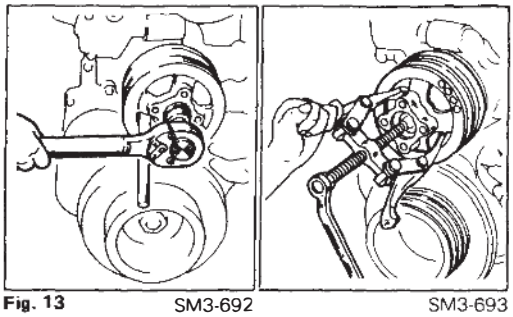


Fig. 13 SM3-692 SM3-693

9. REMOVE THE COOLANT PUMP AND THERMOSTAT CASE.

1. Remove the nut and pulley.
2. Remove the coolant line, thermostat case and coolant pump.

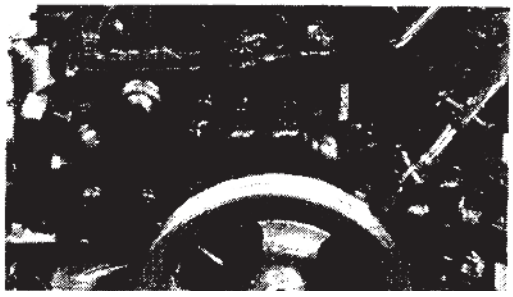


Fig. 14 SM3-2408

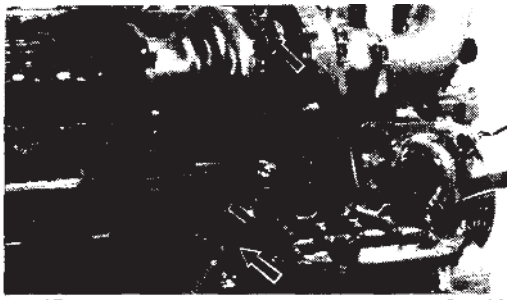


Fig. 15 03-2409

10. REMOVE THE TURBOCHARGER

1. Remove the oil pipes.

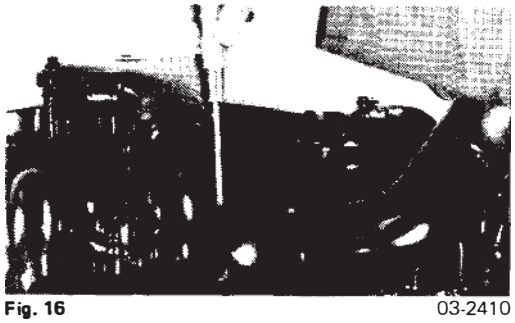


Fig. 16 03-2410

2. Remove the intake pipe.


Fig. 17 03-2411

3. Remove the exhaust pipe.

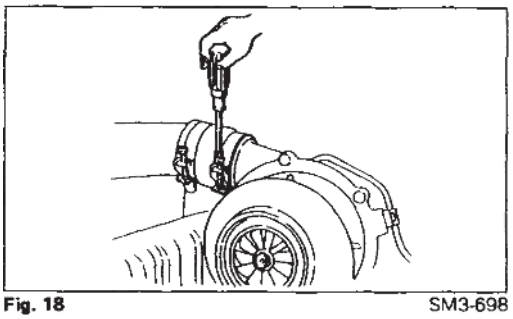


Fig. 18 SM3-698

4. Loosen the clip band.

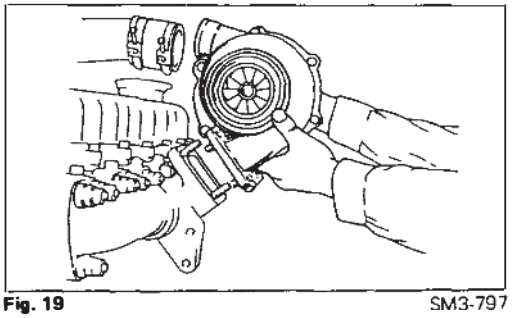


Fig. 19 SM3-797

5. Remove the turbocharger.

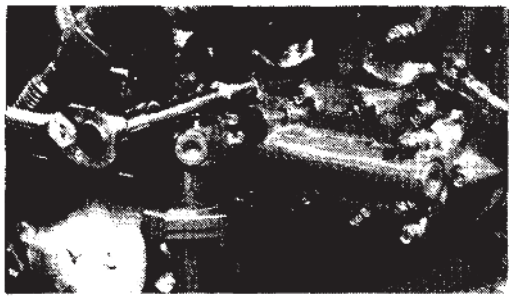


Fig. 20 03-2413

11. REMOVE THE OIL COOLER.


Fig. 21 03-2414

12. REMOVE THE ENGINE STOP MOTOR ASSEMBLY.

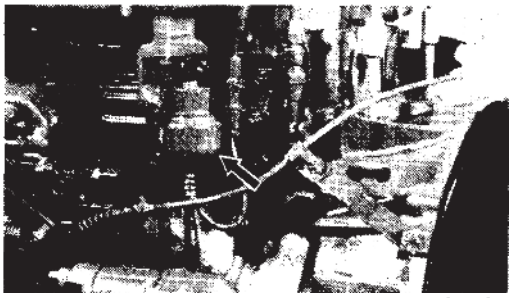
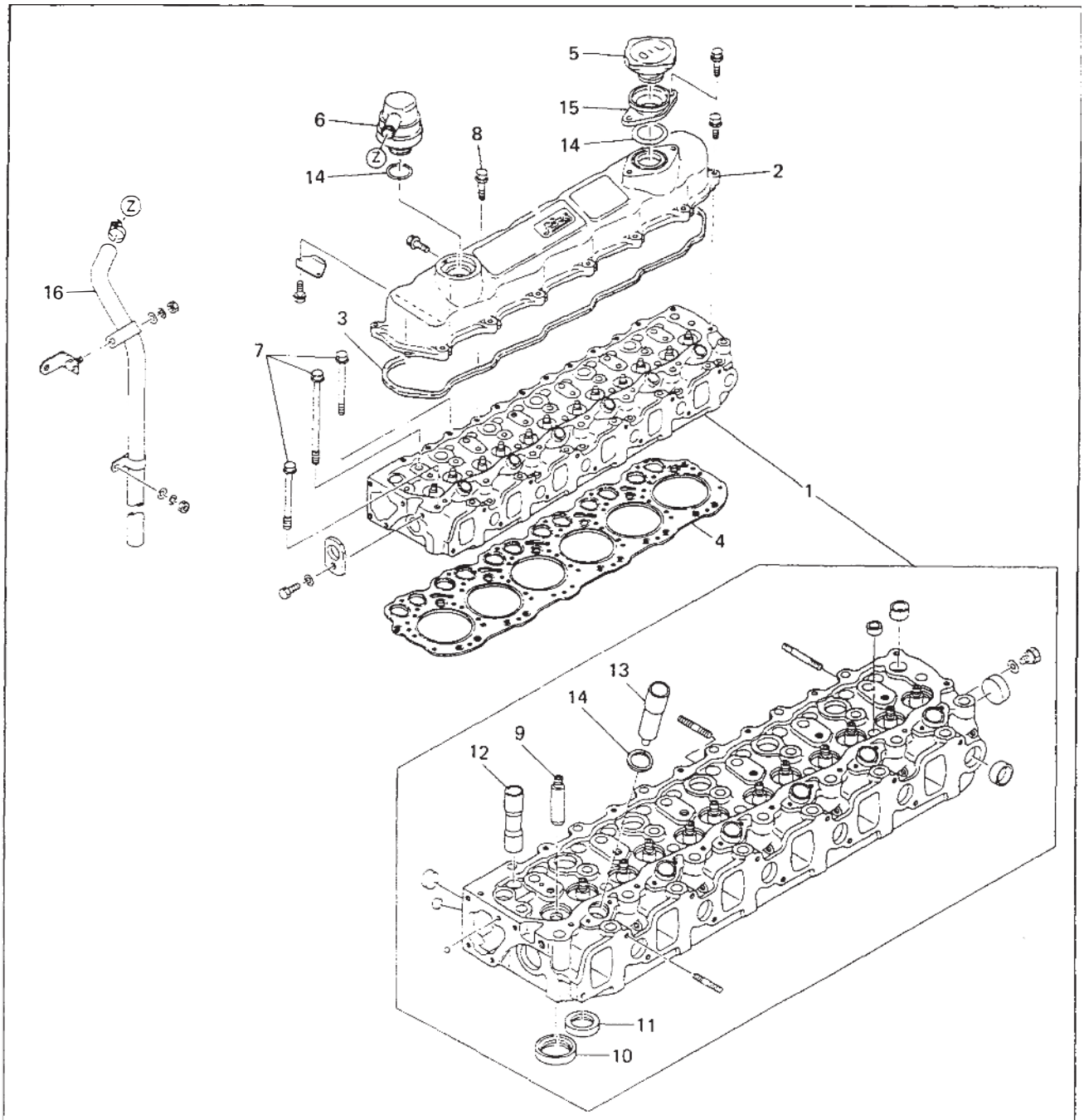


Fig. 22 03-2434

13. REMOVE THE INTAKE AIR HEATER RELAY ASSEMBLY.

CYLINDER HEAD

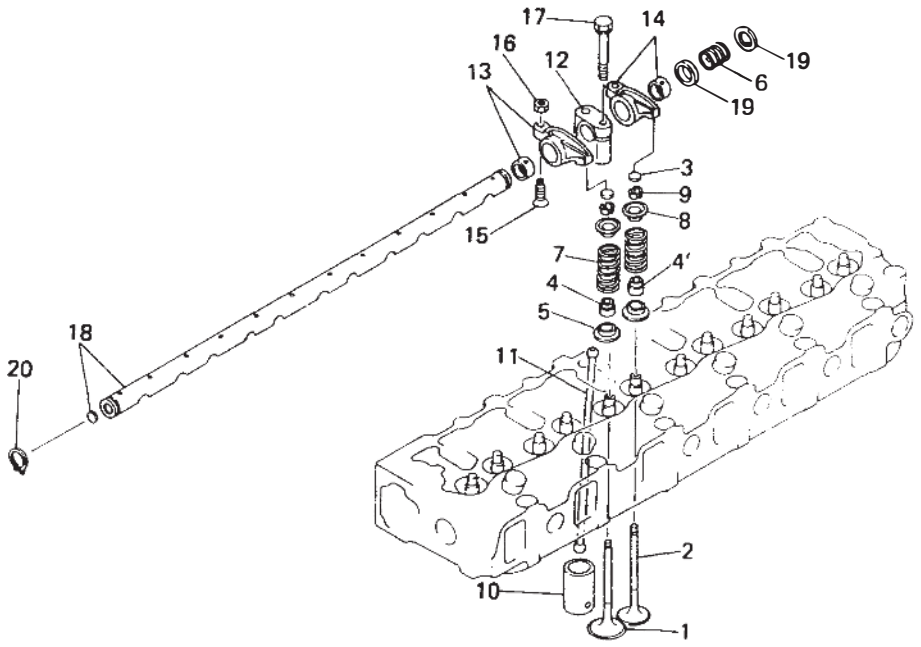


CYLINDER HEAD AND RELATED PARTS

1. Cylinder head
2. Cylinder head cover
3. Cylinder head cover gasket
4. Cylinder head gasket
5. Oil filler cap
6. Ventilator
7. Cylinder head bolt
8. Cylinder head cover bolt
9. Valve guide
10. Intake valve seat
11. Exhaust valve seat
12. Push rod guide pipe
13. Nozzle sleeve (copper sleeve)
14. O-ring
15. Oil filler
16. Vent hose

Fig. 1

SM3-1518

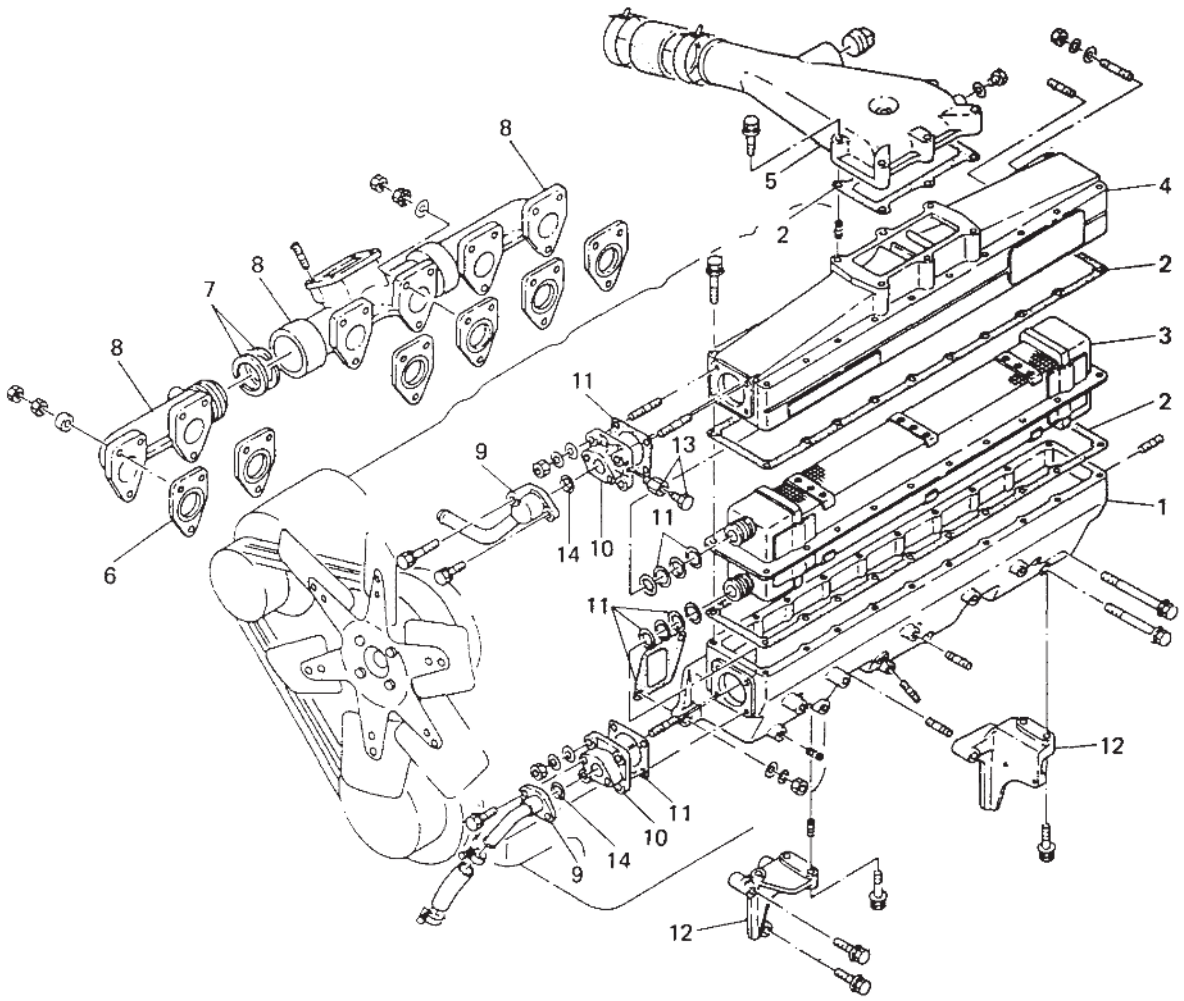


VALVE MECHANISM AND RELATED PARTS

1. Intake valve
2. Exhaust valve
3. Valve stem cap
4. Stem seal (Inlet)
4'. Stem seal (Exhaust)
5. Valve spring seat
6. Compression spring
7. Valve spring, outer
8. Valve spring upper seat
9. Valve stem key
10. Tappet
11. Push rod
12. Rocker arm support
13. Intake rocker arm
14. Exhaust rocker arm
15. Adjusting screw
16. Adjusting screw nut
17. Support bolt
18. Rocker arm shaft
19. Plain washer
20. Snap ring

Fig. 2 SM3-1519

HE11–068–00X01 (1320)



INTAKE AND EXHAUST MANIFOLD

1. Intake manifold
2. Gasket
3. Inter cooler assembly
4. Inter coolver cover
5. Intake pipe
6. Exhaust manifold gasket
7. Seal ring
8. Exhaust manifold
9. Pipe
10. Flange
11. Gasket
12. Bracket
13. Air breather plug
14. O-ring

Fig. 3 SM3-1520

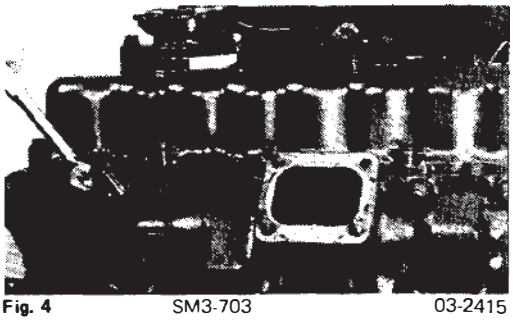


Fig. 4 SM3-703 03-2415

REMOVAL OF CYLINDER HEAD

1. REMOVE THE EXHAUST MANIFOLD.

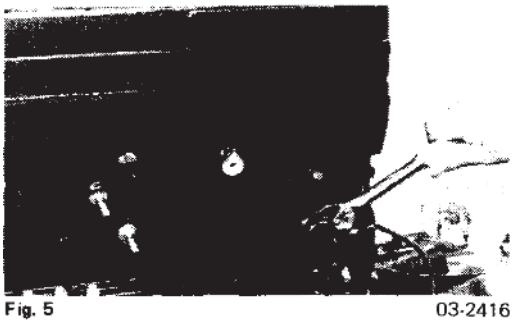


Fig. 5 03-2416

2. REMOVE THE GLOW PLUGS CONNECTOR, INTAKE PIPE AND MANIFOLD.
   1. Remove the intake manifold brackets.
   2. Remove the glow plugs connector.

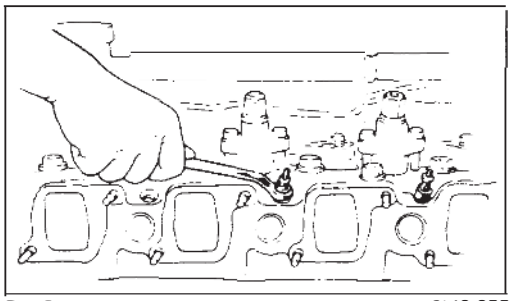


Fig. 6 SM3-355

3. REMOVE THE GLOW PLUGS

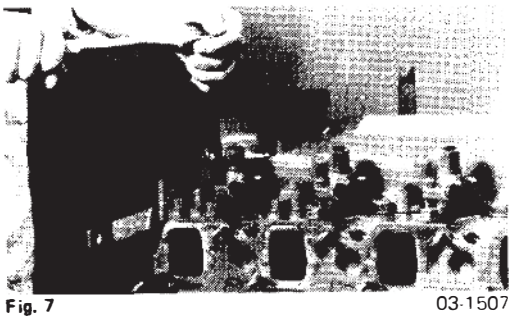


Fig. 7 03-1507

4. REMOVE THE INJECTION NOZZLES.

NOTE: When removing the nozzle holder, if foreign matter is allowed to enter the combustion chamber, engine trouble may result. Be sure to clean off the surrounding area thoroughly before removing the nozzle holder.

1. Remove the nozzle holder fitting bolts.

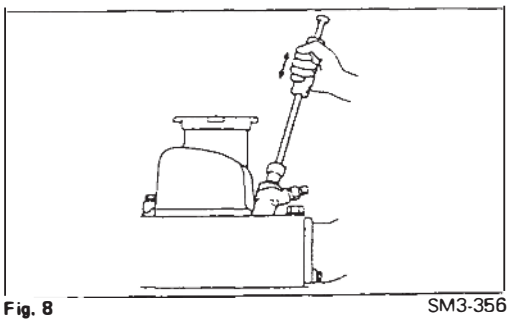


Fig. 8 SM3-356

2. After removal of the nozzle holder, cover the nozzle holder with cloth. Also cover the cylinder head with a cloth to prevent dust from getting in.

Special Tool: Sliding Hammer (09420-1442)
Adapter (09462-1130)

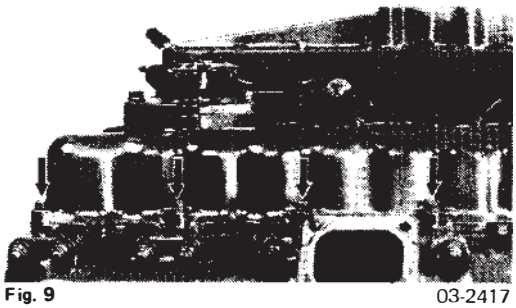


Fig. 9 03-2417

5. REMOVE THE CYLINDER HEAD COVER.

NOTE: Clean all dust from around the cylinder head cover before removing it to prevent dust from getting in.

1. Remove the vent hose.
2. Remove the cylinder head cover.

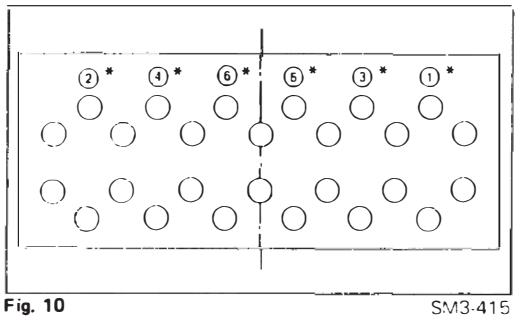


Fig. 10 SM3-415

6. REMOVE THE CYLINDER HEAD ADDITIONAL BOLT.

Loosen the cylinder head additional bolts in the numerical order shown.

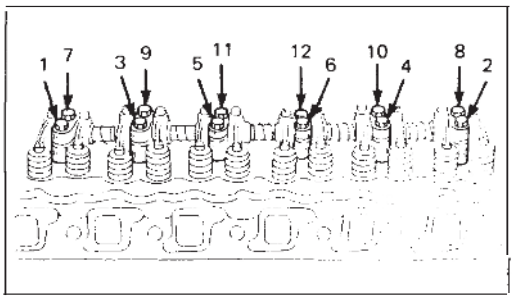


Fig. 11 SM3-704

7. REMOVE THE ROCKER ARM ASSEMBLY.

Loosen the rocker arm support bolts and cylinder head bolts in the numerical order shown.

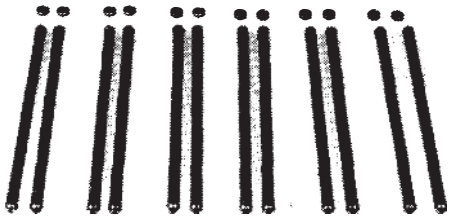


Fig. 12 03-2032

8. REMOVE THE PUSH RODS AND VALVE STEM CAPS.

NOTE: ○ Remove the valve stem caps. Pay special attension not to drop the stem cap into the interior of the engine.

○ Arrange the push rods and valve stem caps in correct order.

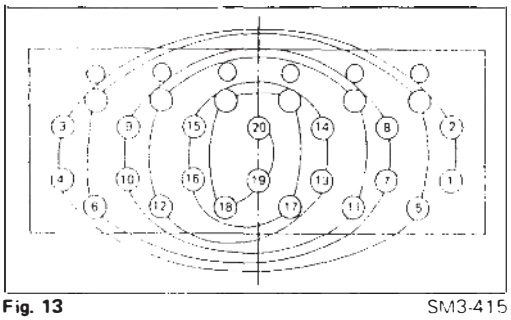


Fig. 13 SM3-415

9. LOOSEN THE CYLINDER HEAD BOLTS AND REMOVE THEM.

Loosen the cylinder head bolts in the numerical order shown.

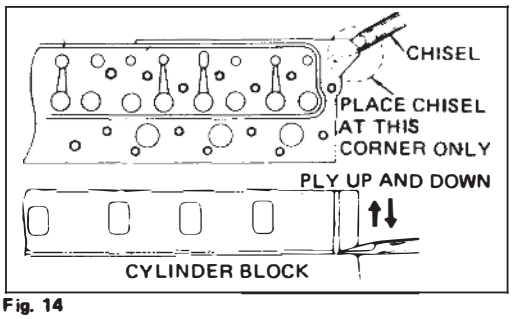


Fig. 14

10. LIFT THE CYLINDER HEAD FROM THE DOWELS ON THE CYLINDER BLOCK.

1. If the cylinder head is difficult to lift off, pry with a chisel between the cylinder head and block.

NOTE: Do not damage the machined surface of the head or block when removing the cylinder head.

Special Tool: Eye Bolt (09433-1061)

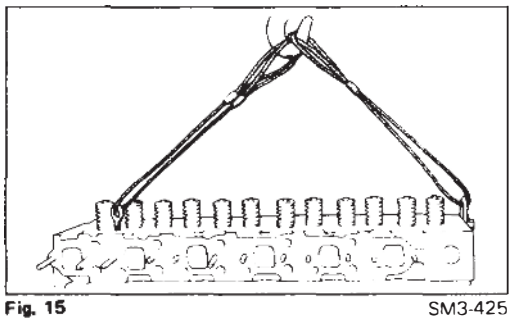


Fig. 15 SM3-425

2. Place the head on wooden blocks on a bench.

NOTE: ○ When placing the cylinder head with nozzle holders on the work bench, do not interference between the nozzle holder tip and wooden blocks.

○ Check the cylinder head gasket thoroughly for sign of leaks of oil, coolant, or gas, as well as for overheating.

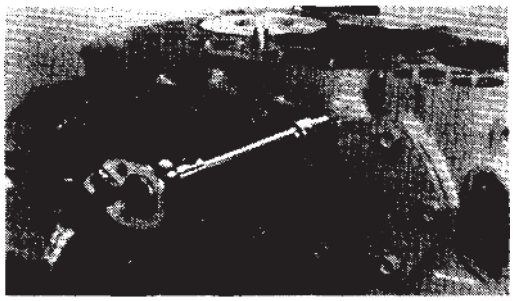


Fig. 16 03-1516

11. REMOVE THE TAPPET CHAMBER COVER.

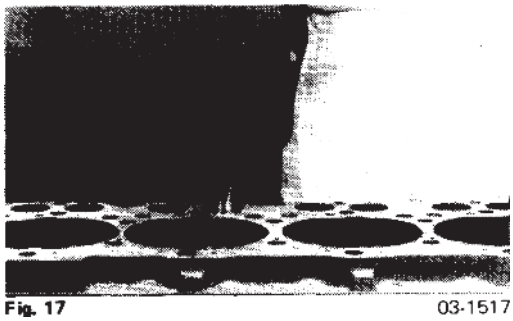


Fig. 17 03-1517

12. REMOVE THE TAPPETS FROM THE CYLINDER BLOCK.

Hook the oil hole of each tappets with a hooked wire and lift the tappets up.

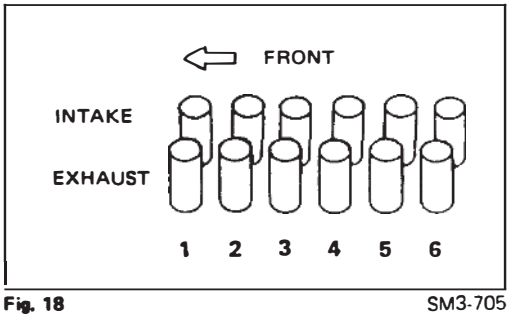


Fig. 18 SM3-705

NOTE: Arrange the tappets in correct order.

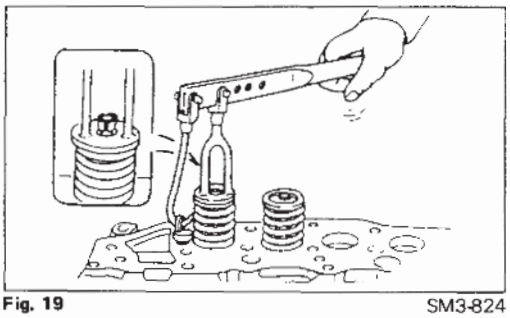


Fig. 19 SM3-824

DISASSEMBLY OF CYLINDER HEAD

1. REMOVE THE VALVE SPRINGS.

1. Remove the valve stem cotters, upper valve seats, and valve springs with a special tool.

Special Tool: Valve spring press (09470-1022)

2. Remove the intake and exhaust valves.

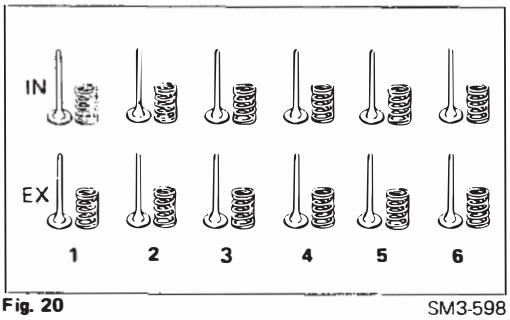


Fig. 20 SM3-598

2. KEEP THE VALVE SPRINGS ARRANGED IN THE SEQUENCE OF THE CYLINDERS.

1. Tag valves to identify their cylinder numbers and to eliminate valve lapping.
2. Do not remove valve guides and valve seats unless they need to be replaced.

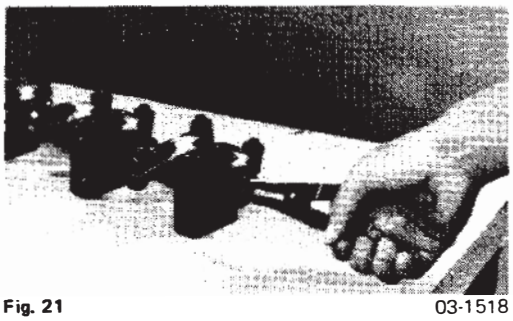


Fig. 21 03-1518

3. DISASSEMBLE THE ROCKER ARM ASSEMBLY.

Keep rocker arms in order so they can be re-installed in the same positions.

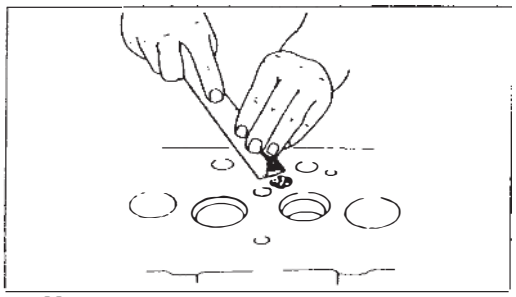


Fig. 22 SM3-825

INSPECTION AND REPAIR

1. **CLEAN THE CYLINDER HEAD THOROUGHLY WITH A SUITABLE SOLVENT.**

   NOTE: Be careful not to damage the cylinder head surface.

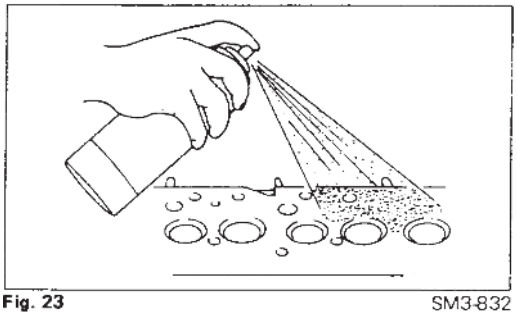


Fig. 23 SM3-832

2. **INSPECT THE CYLINDER HEAD FOR CRACKS.**

   Check the head surface and intake and exhaust valve seat, for cracks, using a dye penetrant.
   If cracks are found, replace the cylinder head.

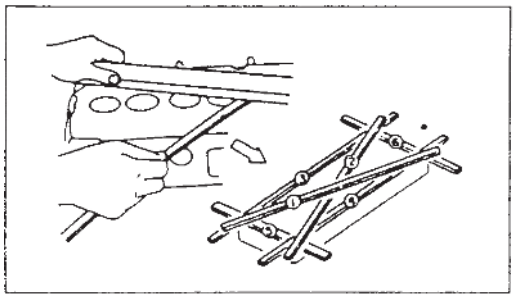


Fig. 24 SM3-831

3. **CHECK THE CYLINDER HEAD SURFACE FOR FLATNESS.**

   1. Check the cylinder head surface for flatness with a straight edge and a thickness gauge. Follow the checking pattern as show. If the measurements exceed specified limits, correct by surfacing or replace the head.

   Cylinder Head Surface Flatness:
   Assembly Standard: 0—0.05 mm (0—0.0019 in)
   Repair Limit: 0.10 mm (0.0039 in)

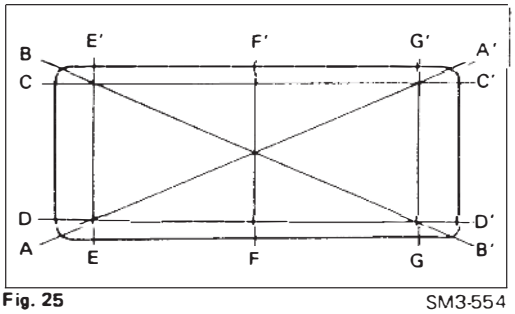


Fig. 25 SM3-554

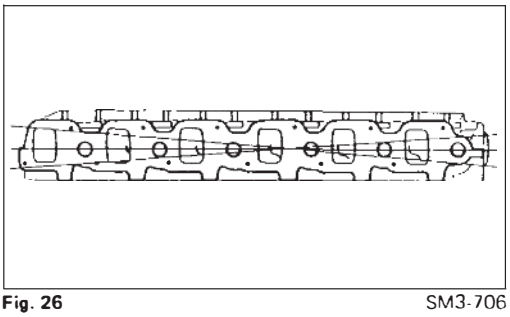


Fig. 26 SM3-706

   2. Check the flatness of the intake and exhaust manifolds mounting surface.

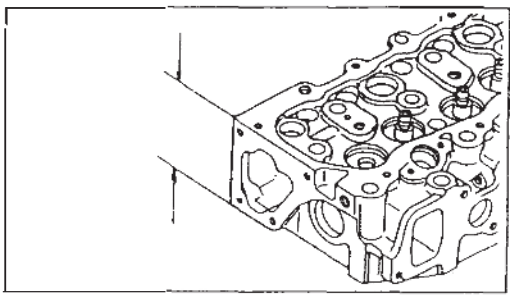


Fig. 27 SM3-783

4. CHECK THE CYLINDER HEAD HEIGHT (REGRINDING LIMIT).

Cylinder Head Height:
Nominal Dimension: 95 mm (3.74 in)
Service Limit : 94.70 mm (3.7283 in)

NOTE: ○ After the heads resurfaced, grind the valve seats so that the valve recession meet specifications.
○ When the height of a resurfaced head is less than the service limit, replace the head.

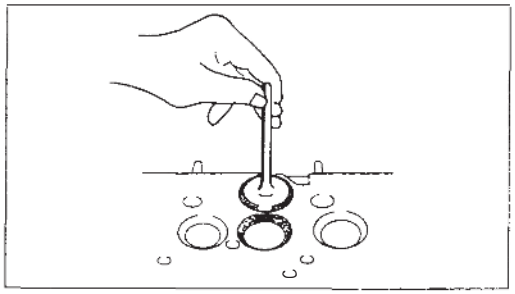


Fig. 28 SM3-833

5. INSPECT THE VALVE CONTACT SURFACES FOR PROPER CONTACT.

1. Visually check valves for excessive wear, burn mark, carbon accumulation, warpage, or cracks in valve heads, valve stems, and valve stem grooves.
Replace valves which are excessively worn, burnt, warped or cracked.

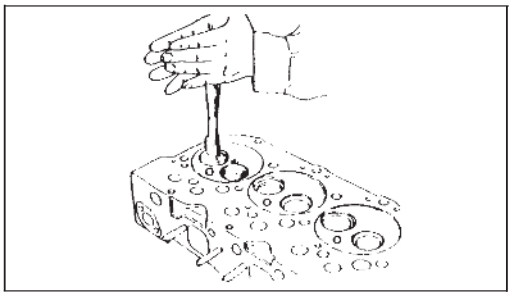


Fig. 29 SM3-364

2. Check the valve seating condition.
Lightly apply red lead marking compound to the valve face.
Install the valve with a special tool, tap and rotate the valve against the seat. Check the valve face and valve seat for seating.
When the red lead mark is not concentric or even all around the valve face or seat, correct the valve face or the valve seat.

Special Tool: Valve Lapping Tool (09431-1010)

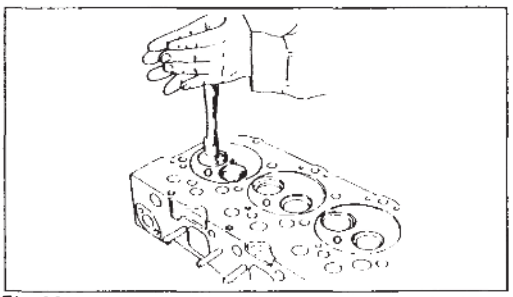


Fig. 30 SM3-364

6. HAND-LAP THE VALVE AND VALVE SEAT.

Lightly apply lapping compound to the valve face. Install the valve with a special tool, tap and rotate the valve against the seat.

NOTE: ○ Following completion of hand-lapping, clean off any lapping compound which has adhered to the valves and valve seats.
○ Following hand-lapping, always recheck the seating condition.

Special Tool: Valve Lapping Tool (09431-1010)

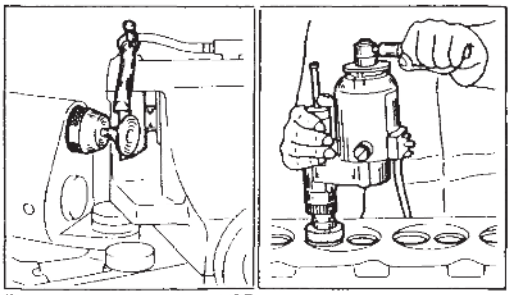


Fig. 31 SM3-707 SM3-708

7. GRIND THE VALVES AND VALVE SEATS.

NOTE: ○ Grinding of valves and valve seats should only be performed when hand-lapping does not result in proper seating.
○ When repairing or replacing valves and valve seats, always recheck their seating condition after assembly.
○ After grinding, always recheck the valve sink.

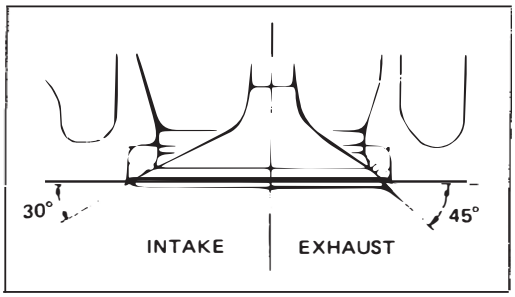


Fig. 32 SM3-899

Assembly Standard:

Valve Seat (Intake)	:	30° – 30°15′
Valve Face (Intake)	:	29°45′ – 30°
Valve Seat (Exhaust)	:	45° – 45°15′
Valve Face (Exhaust)	:	44°45′– 45°

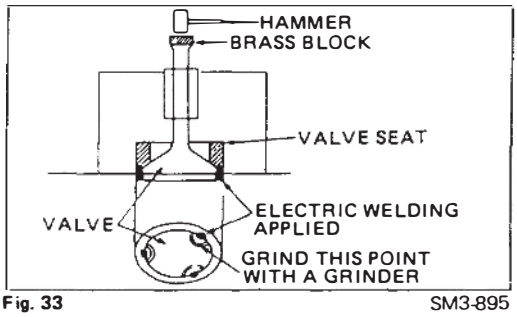


Fig. 33 SM3-895

8. IF NECESSARY, REPLACE THE VALVE SEAT.

1. Cut the circumference of a valve head at three places with a grinder and, install it into the seat as shown and weld the valve to the seat. Then drive the valve and the seat out with a hammer and a brass bar.

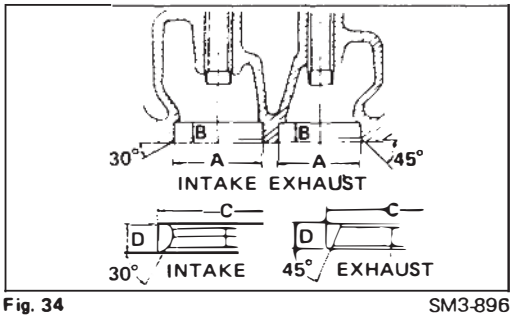


Fig. 34 SM3-896

2. Valve seat section machining specifications.

Unit: mm (in)

	Cylinder head dimension		Valve seat dimension	
	A	B	C	D
Intake	52.000 – 52.019 (2,0472 – 2.0479)	9.5 – 9.7 (0.374 – 0.381)	52.085 – 52.100 (2.0506 – 2.0511)	7.5 – 7.7 (0.296 – 0.303)
Exhaust	45.500 – 45.516 (1.7914 – 1.7919)	9.5 – 9.7 (0.374 – 0.381)	45.63 – 45.645 (1.7965 – 1.7970)	8.0 – 8.2 (0.315 – 0.322)

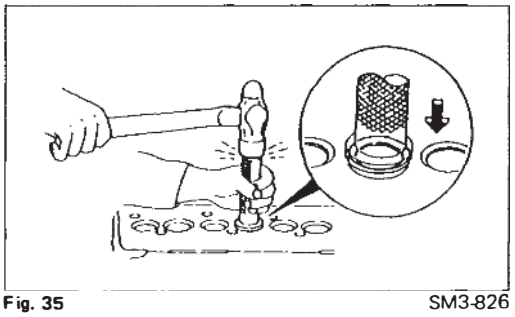


Fig. 35 SM3-826

3. Valve seat installation
Heat the cylinder head to about 80° – 100°C (176–212°F) with hot water. On the other hand, cool the valve seat with dry ice or liquid freon for about 30 minutes. Hold the seat with pincers and place it into the heated cylinder head.
The valve seat can be easily made to fit by lightly hitting it.

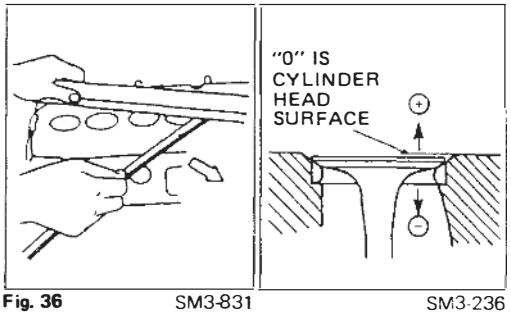


Fig. 36 SM3-831 SM3-236

9. MEASURE THE VALVE SINK.

Assembly Standard:

Intake –0.05 – 0.25 mm (–0.0019 – 0.0098 in)
Exhaust 0.25 – 0.55 mm (0.0098 – 0.0216 in)

Service Limit:

Intake	0.5 mm (0.020 in)
Exhaust	0.8 mm (0.031 in)

NOTE: If the valve heads are protruding from cylinder head surface, the valve heads may hit against the pistons while the engine is running.

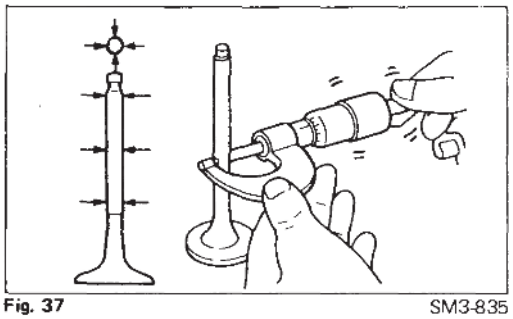


Fig. 37 SM3-835

10. MEASURE THE CLEARANCE BETWEEN VALVE STEM AND VALVE GUIDE.

1. Measure the outside diameter of the valve stem with a micrometer.

Normal Dimension:
Intake and Exhaust: 9 mm (0.35 in)

Service Limit:
Intake and Exhaust: 8.89 mm (0.3500 in)

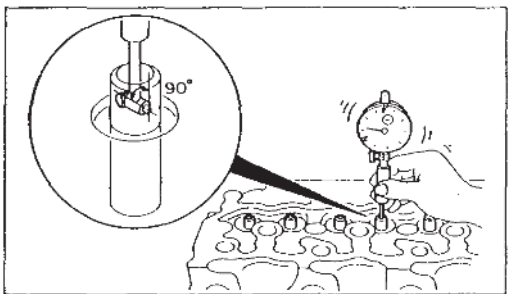


Fig. 38 SM3-834

2. Measure the inside diameter of the valve guide with a cylinder gauge.
3. Find the difference between the inside diameter of the valve guide and outside diameter of the valve stem. When the clearance exceeds specification, replace the valve guide or the valve.

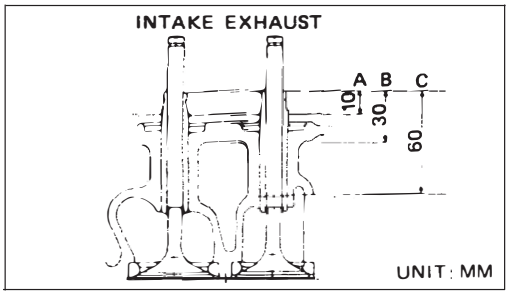


Fig. 39 SM3-1269

Clearance between valve stem and guide:

		Intake	Exhaust
Nominal dimension		0.055–0.088 mm (0.0022–0.0035 in)	0.070–0.103 mm (0.0028–0.0041 in)
Repair Limit	A	0.10 mm (0.0040 in)	0.12 mm (0.0047 in)
	B	0.10 mm (0.0040 in)	0.12 mm (0.0047 in)
	C	0.18 mm (0.0071 in)	0.20 mm (0.0079 in)

11. IF NECESSARY, REPLACE THE VALVE GUIDE.

1. Remove the valve stem seal.
2. Remove the valve guide.


Fig. 40 03-674

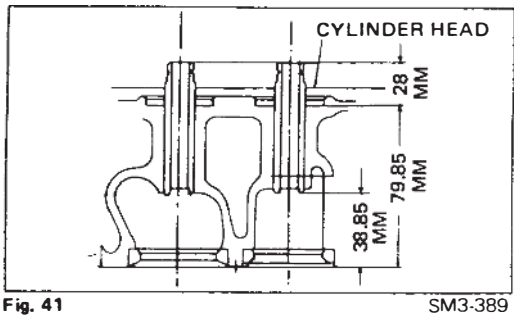


Fig. 41 SM3-389

3. Install the valve guide.
When installing a new valve guide, drive the guide straight into the head allowing it to protrude as shown.

NOTE: **Apply engine oil lightly to the valve guide outer circumference before installation.**

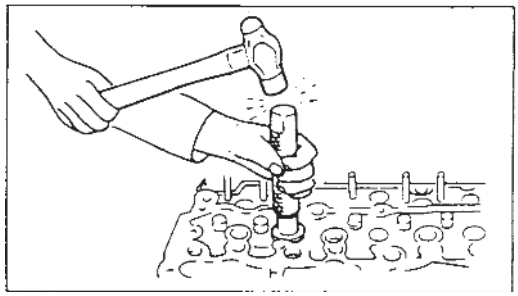


Fig. 42 SM3-984

4. Install the valve stem seal.
Replace the valve stem seal when the valve guide is replaced or seal clearance is excessive or the stem seal has been damaged.
First, install the lower spring seat and valve (For guide of special tool), then apply engine oil to the lip of the stem seal and drive the guide with a special tool.

Special Tool: **Stem Seal Press (09472–1781)**

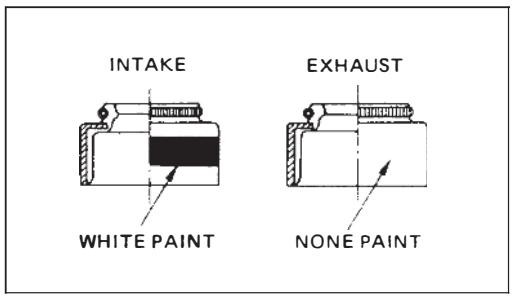


Fig. 43 SM3-709

NOTE: **Dinstinguish stem seal as shown in the left-hand figure since the same seal is not used for both intake and exhaust. Coat interior surface with oil.**

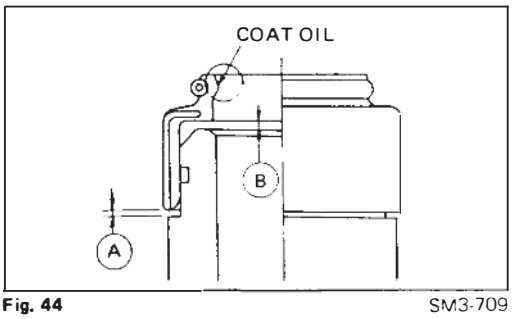


Fig. 44 SM3-709

NOTE: **After installing stem seal, make sure there is a gap A and B in the left-hand figure. Do not use the special tool if its tip (surface contacting lower spring seat) is worn or deformed.**

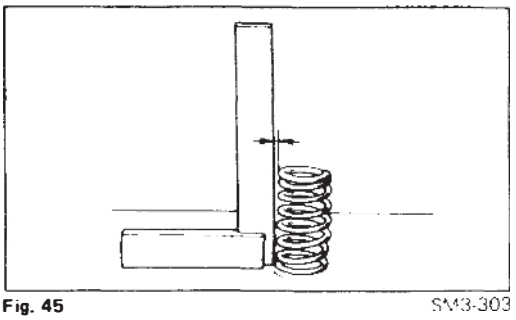


Fig. 45 SM3-303

12. INSPECT THE VALVE SPRINGS.

1. Check the valve springs for squareness using a square and a thickness gauge. If a spring is out of square beyond the service limit, replace it.

Service Limit: **2.5 mm (0.098 in)**

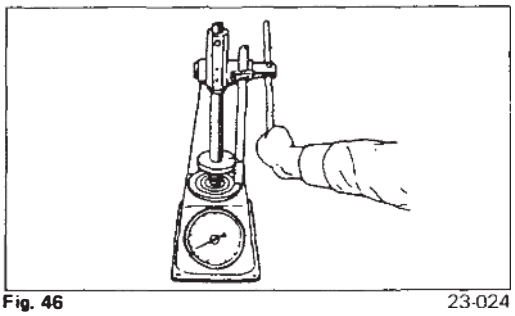


Fig. 46 23-024

2. Measure the valve spring force at a specified length with the valve spring tester. If the spring force is lower than service limit, replace it.

Free length mm (in)	Setting height mm (in)	Setting load kg (lb)	
		Nominal dimension	Service limit
68.6 (2.701)	47.5 (1.870)	31.0 (68.3)	27.5 (60.6)

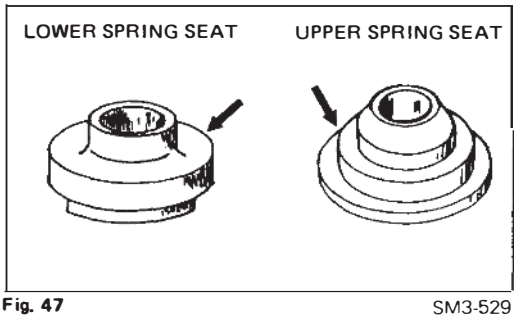


Fig. 47 SM3-529

3. Check the contact surface of the upper spring seats and the lower spring seats. Replacement is necessary if damages such as wear and scratches is excessive.

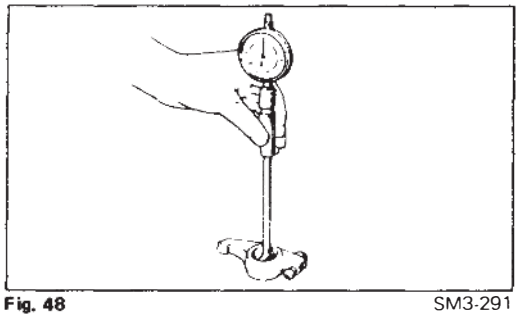


Fig. 48 SM3-291

13. INSPECT THE ROCKER ARMS AND ROCKER ARM SHAFT.

1. Measure the inside diameter of the rocker arm bushing using a cylinder gauge.
   If wear exceeds the service limit, replace it.

Nominal Dimension: 24.2 mm (0.953 in)
Service Limit: 24.28 mm (0.9559 in)

NOTE: **When installing a bushing into the rocker arm, align the oil holes of the bushing and the rocker arm.**

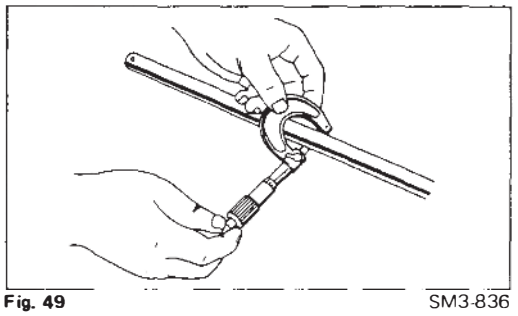


Fig. 49 SM3-836

2. Measure the outside diameter of the rocker arm shaft with a micrometer.
   If wear exceeds the service limit, replace it.

Nominal Dimension: 24.2 mm (0.953 in)
Service Limit: 24.12 mm (0.9496 in)

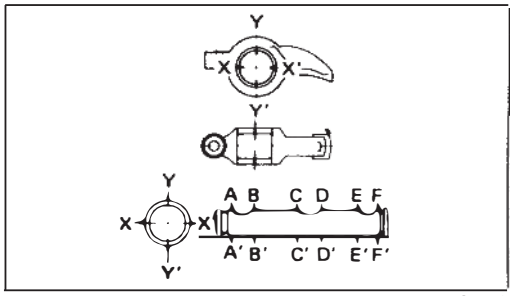


Fig. 50 SM3-558

3. Find the difference between the rocker arm bushing inside diameter and the shaft outside diameter.
If the clearance is greather than the specified limit, replace the shaft and/or the bushing.

Assembly Standard: 0.030–0.101 mm (0.0012–0.0039 in)
Repair Limit: 0.15 mm (0.0059 in)

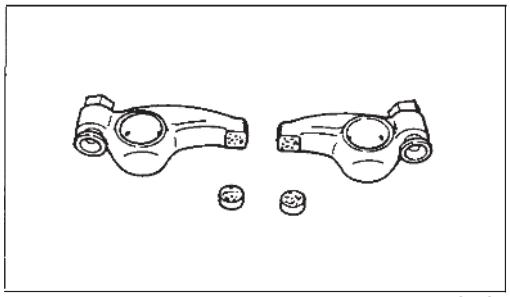


Fig. 51 SM3-930

4. Check the rocker arm and the valve stem cap.
Check the contact between the rocker arm and the valve stem cap. Replace the rocker arm and the stem cap if damages such as wear and scratches are excessive. If there is only a minimal amount of wear, the surface can be refaced with a valve refacer.

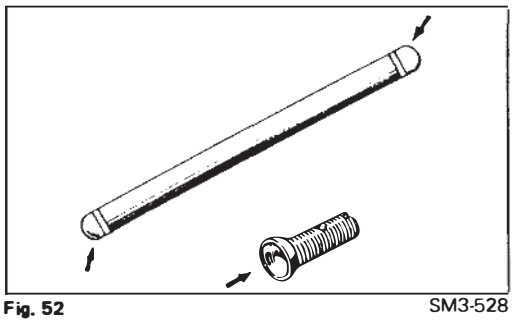


Fig. 52 SM3-528

14. CHECK THE ADJUSTING SCREWS AND PUSH RODS.

Check the adjusting screws for wear, or damage to the threads. If damaged or excessively worn, replace them. Check the push rods for wear. If excessive worn, replace them.

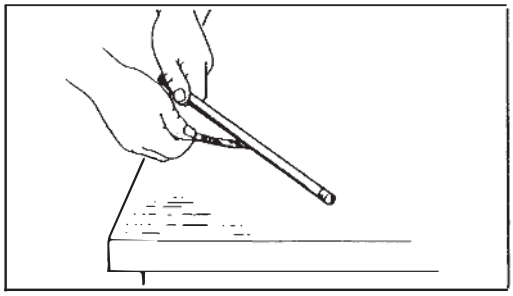


Fig. 53 SM3-292

15. INSPECT THE PUSH RODS FOR BENDING.

Place the push rod on a surface plate and insert a thickness gauge to measure the bend of the push rod. If the measurement is beyond limit, replace the push rod. Also replace the adjusting screw and the tappet if the wear of their contact surfaces is excessive.

Repair Limit: 0.5 mm (0.020 in)

Fig. 54 03-686

16. MEASURE THE TAPPETS.

1. Check the tappet face for wear. If excessively worn, replace it.

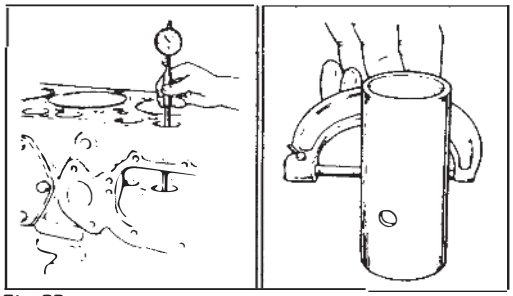


Fig. 55 SM3-420 SM3-293

2. Measure the outside diameter of a tappet with a micrometer and inside diameter of the tappet guide with a cylinder gauge.
Find the clearance by calculating the difference of diameters. If the clearance exceeds the specified limit, replace the tappet and/or cylinder block.

Assembly Standard:		**0.025 – 0.075 mm (0.0010 – 0.0029 in)**
Repair Limit	:	**0.1 mm (0.004 in)**

17. INSPECT THE CYLINDER HEAD COOLANT GALLERY FOR LEAKS.

Close all coolant holes and apply air pressure of about 2.5 kg/cm² (35 sq.in) from one of coolant hole.
Immerse the cylinder head into the water, then check the air leakage. If any leakage is found, replace the cylinder head.

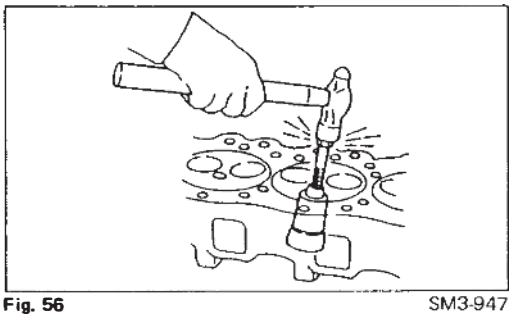


Fig. 56 SM3-947

18. IF NECESSARY, REPLACE THE NOZZLE SLEEVE.

1. Remove the nozzle sleeve
Place a brass rod with a diameter of 12 mm (0.47 in) at the nozzle hole at the bottom of the cylinder head and remove the cylinder head by hitting the nozzle sleeve.

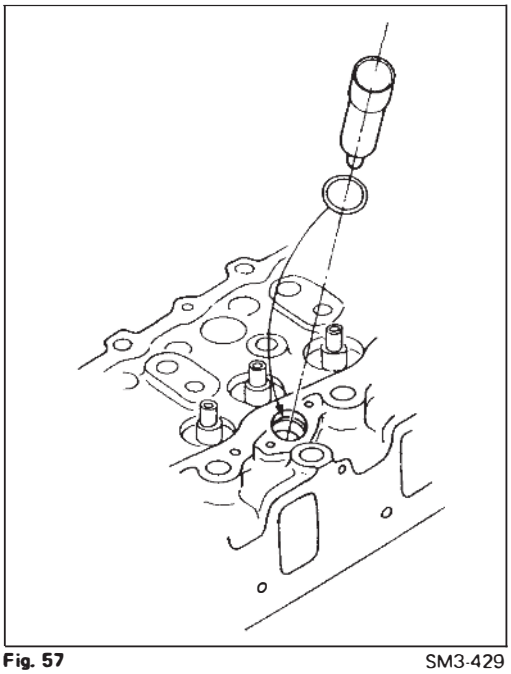


Fig. 57 SM3-429

2. Install the nozzle sleeve
Set the O-ring into the cylinder head
Apply adhesive (Super Three Bond No. 1210 or equivalent) to the lower part of the new copper nozzle sleeve and carefully insert the nozzle sleeve into the cylinder head.

NOTE: **A damaged O-ring may cause leaks and lead to overheating or cracked heads.**

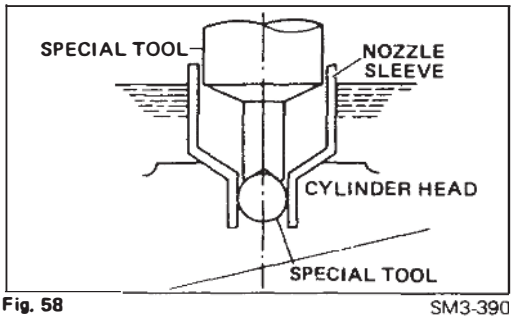


Fig. 58 SM3-390

3. Stick the nozzle sleeve fast to the cylinder head by pressing with the special tool.
Insert the seat press (Special tool) into the nozzle sleeve. Push the ball through the hole with the special tool.
So that the end of the nozzle sleeve with stick fast to the cylinder head.

Special Tool: Sleeve Bar (09472-1210)
Steel Ball (9800-06100)

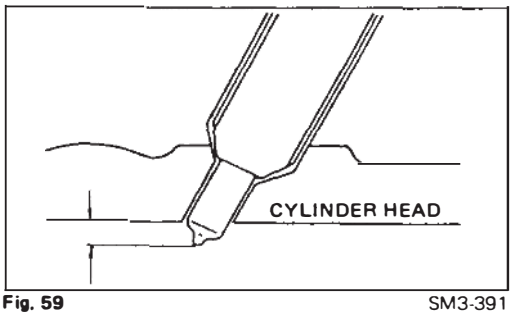


Fig. 59 SM3-391

4. Measure the protrusion of the nozzle from the cylinder head surface with a vernier caliper after the nozzle holder installation.

Assembly Standard: 3.40–3.90 mm (0.1339–0.1535 in)

Tightening Torque: 130–190 kg·cm (10–13 lb.ft)

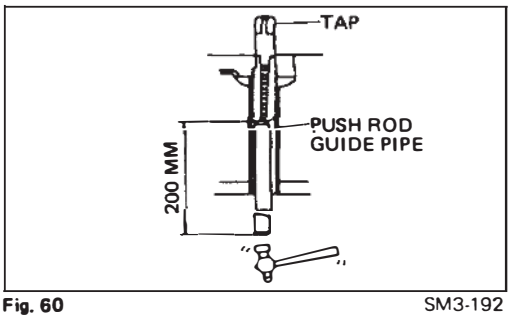


Fig. 60 SM3-192

19. IF NECESSARY, REPLACE THE PUSH ROD GUIDE PIPE.

1. Remove the push rod guide pipe.
a. Screw a tap (TG-1/2 or PT 1/2) into the guide pipe.
b. Drive the guide pipe out of the cylinder head using a hammer and a soft iron bar [Diameter of 15 mm (0.591 in)] as shown.
c. Hold the guide pipe with a pipe wrench and unscrew the tap from the guide pipe.

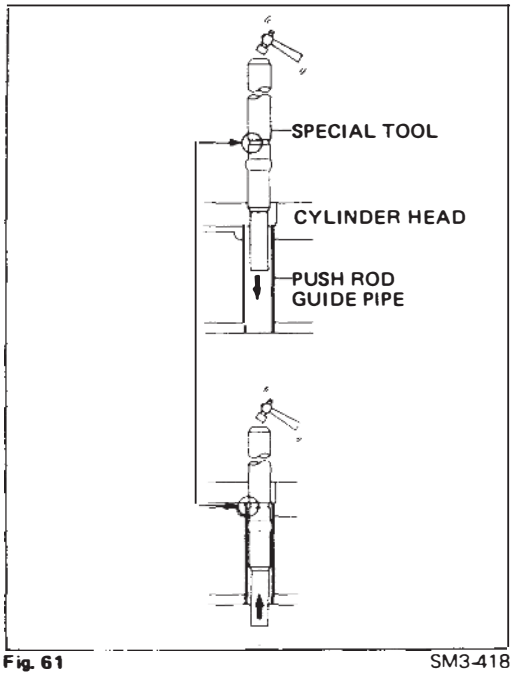


Fig. 61 SM3-418

2. Installation of push rod guide pipes.
a. Apply adhesive (Three Bond No.1215 or equivalent) to the holes of the cylinder head.
b. Place the cylinder head on a surface plate with the cylinder head gasket surface down. Insert a new clean guide pipe into the cylinder head until it contacts the surface plate.
c. Caulk the guide pipe by driving the push rod guide pipe caulking tool (Special tool) into the guide pipe until the groove on the tool has just entered the pipe, but no farther. Then repeat this procedure with the other end of the pipe.

Special Tool: Push Rod Guide Pipe Cauling Tool (09482–1320)

d. Remove the caulking tool from the pipe, then check the cylinder head for water tightness.

Water pressure or air pressure:
About 2.5 kg/cm² (36 psi)

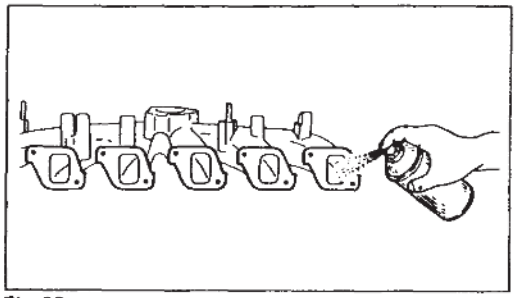


Fig. 62 SM3-710

20. INSPECT THE INTAKE AND EXHAUST MANIFOLDS.

1. Clean the manifold with a brush, etc.
2. Using a dye penetrant, check for cracks of the flange surface.
   If cracks are found, replace the manifold.

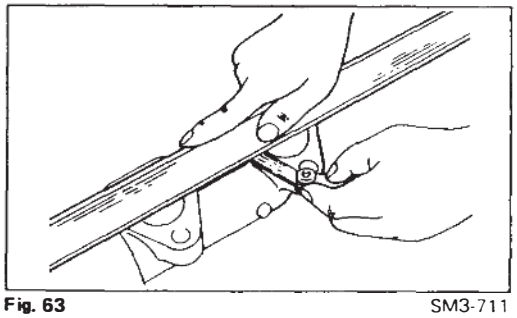


Fig. 63 SM3-711

3. Measure the intake manifold flange surface for flatness with a straight edge and a thickness gauge.
   If the value exceeds the service limit, correct the flange by cutting it to become within 0.1 mm (0.004 in).

Repair Limit: Within 0.5 mm (0.020 in)

4. Measure the exhaust manifold flange surface for flatness with a straight edge and a thickness gauge.
   If the value exceeds the service limit, correct the flange by cutting it to become within 0.3 mm (0.012 in) per 3 flanges or 0.1mm (0.004 in) per flange.

Repair Limit: Within 0.5 mm (0.020 in)

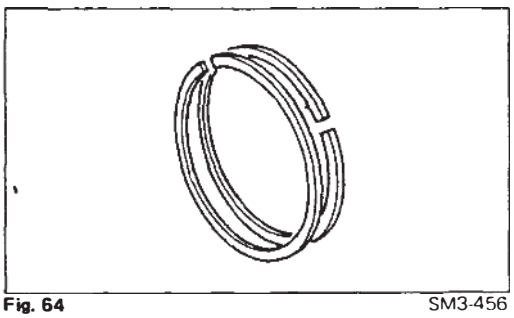


Fig. 64 SM3-456

5. Inspect the seal ring of the exhaust manifold.
   If it is significantly flattened, replace it with a new one.

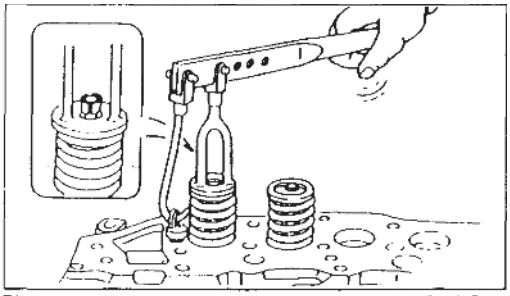


Fig. 65 SM3-824

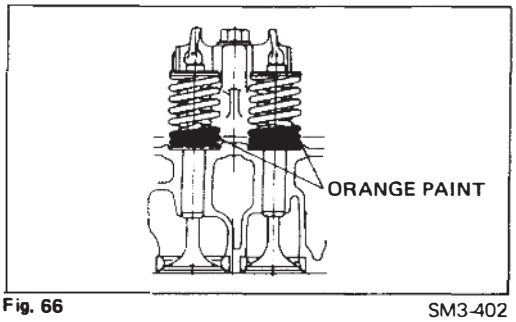


Fig. 66 SM3-402

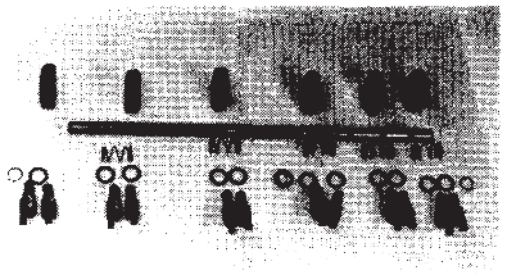


Fig. 67 03-1519

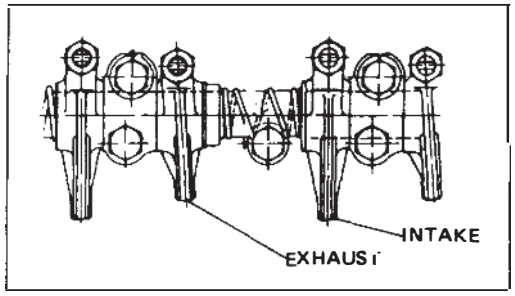


Fig. 68 SM3-401

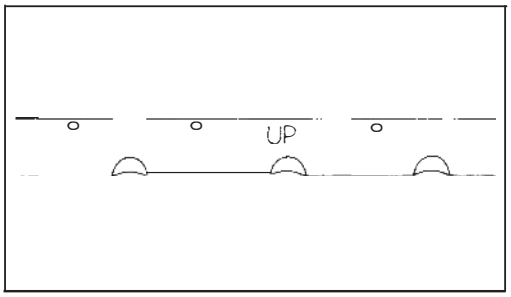


Fig. 69 SM3-357

ASSEMBLY OF THE CYLINDER HEAD

1. INSTALL THE VALVE SPRINGS.

1. Apply engine oil to the valve stems and insert the intake and exhaust valves in the cylinder head valve guides.

NOTE: Make sure that the valves are installed in the correct cylinders.

2. Install the inner and outer valve springs and upper springs seats.

NOTE: Install the valve springs with their painted side down, since they have variable pitches.

3. Using the special tool, press upper spring seats and install the valve stem keys securely in the upper spring seats.

NOTE: When pressing with the valve spring press, be careful not to damage the stem seals by contacting the upper seats.

Special Tool: Valve Spring Press (09470-1022)

2. ASSEMBLE THE ROCKER ARM.

1. Assemble the rocker arm.

2. Make sure that the rocker arm shaft is installed with the "UP" mark of the shaft upward.
Incorrect assembly results in seizure of the valve system. The intake rocker arm is different in length from the exhaust rocker arm. Be sure to install the rocker arm in the correct order.

INSTALLATION OF THE CYLINDER HEAD

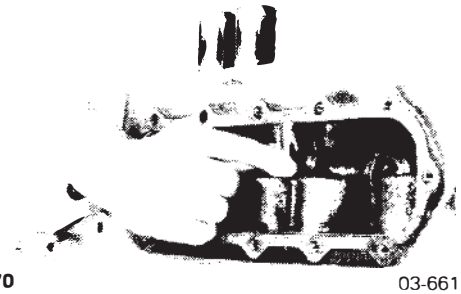


Fig. 70 03-661

1. INSTALL THE TAPPETS IN THE CYLINDER BLOCK IN CORRECT ORDER.

   NOTE: **Apply engine oil to the tappet faces and tappet guide when installing them in the cylinder block.**

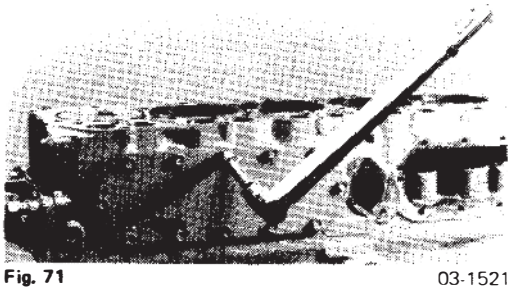


Fig. 71 03-1521

2. INSTALL THE TAPPET CHAMBER COVER USING A NEW GASKET.

   Tightening Torque: 190 – 260 kg.cm (14 – 18 lb.ft)

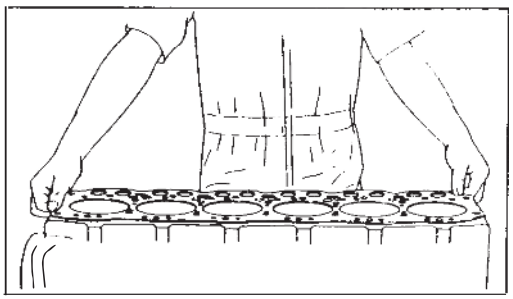


Fig. 72 SM3-531

3. INSTALL THE CYLINDER HEAD GASKET.

   With the part numbers side upward, place a new cylinder head gasket over dowels on the block.

   NOTE: **Always use new cylinder head gasket after cleaning the surfaces of the cylinder head, cylinder block and head gasket free of all dirt, water and grease.**

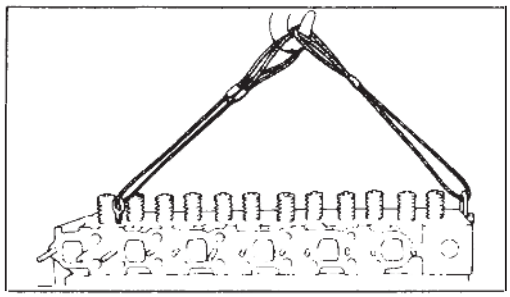


Fig. 73 SM3-425

4. INSTALL THE CYLINDER HEAD OVER THE DOWELS ON THE CYLINDER BLOCK.

Fig. 74 03-1524

5. APPLY ENGINE OIL TO THE THREADS AND HEADS OF THE CYLINDER HEAD BOLTS AND INSTALL THE BOLTS.

   Tighten the bolts provisionally and lightly (exclude the extension bolts for rocker arm support).

   NOTE: **Since the cylinder head bolts are unique to this engine, do not substitute ordinary bolts.**

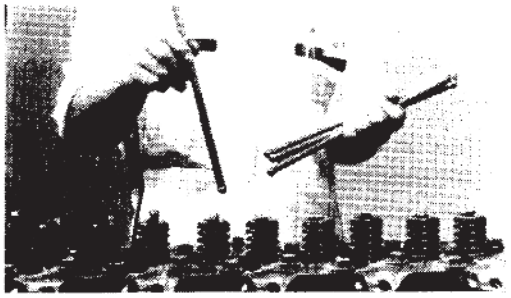


Fig. 75 03-1512

6. INSERT THE PUSH RODS IN CORRECT ORDER, AFTER APPLYING ENGINE OIL TO BOTH ENDS.

NOTE: **Insert the push rod carefully until they make contact with the tappets. Do not drop them in.**

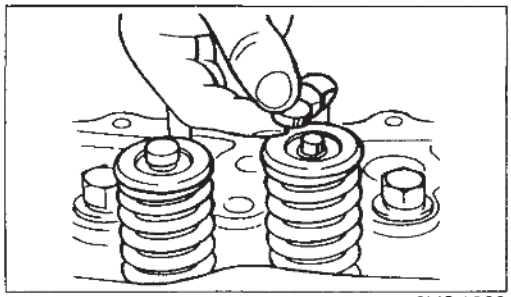


Fig. 76 SM3-1266

7. INSTALL THE STEM CAPS

Make sure that both the end of the valve stem and the inside of the valve stem cap are free from dust. Apply engine oil to the valve stem ends and put the stem caps on the valve stem ends. Be careful not to drop the caps into the engine.

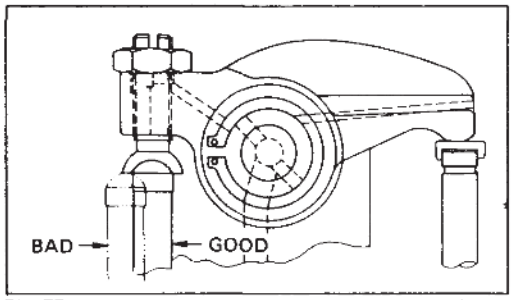


Fig. 77 SM3-712

8. TIGHTEN THE CYLINDER HEAD AND ROCKER ARM ASSEMBLY.

1. Make sure that the cylinder head top surface and the rocker arm support bottom are free of dust, chips, or other foreign matter.
2. Apply engine oil to the rocker arm end and adjusting screw.
3. Mount the rocker arm assembly on the cylinder head, make sure that the push rods interlock with the adjusting screws.

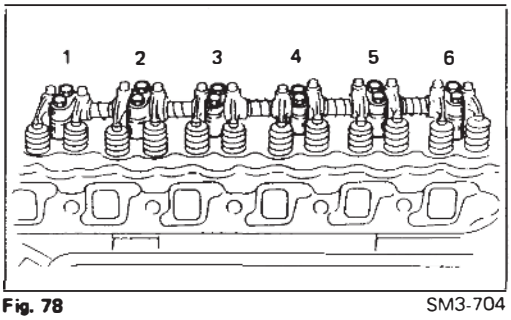


Fig. 78 SM3-704

WARNING

Always loosen the lock nut and raise the adjusting screws fully to the top. If the adjusting screws are too low, the piston and valves may strike each other during valve clearance adjustment.

4. Tighten the cylinder head bolts and rocker arm support bolts provisionally.

Tightening order: 3–4–2–5–1–6

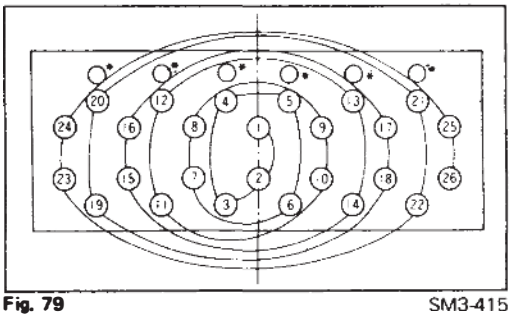


Fig. 79 SM3-415

5. Tighten the cylinder head bolts in three stages following the tightening order.
Tighten the bolts to the specified torque at each stage.

First Stage	:	**900 – 950 kg.cm (66 – 68 lb.ft)**
Second Stage	:	**1,350–1,400 kg.cm (98–101 lb.ft)**
Third Stage	:	**1,800–1,900 kg.cm (131–137 lb.ft)**
Special Tool	:	**Wrench (09411-1070)**

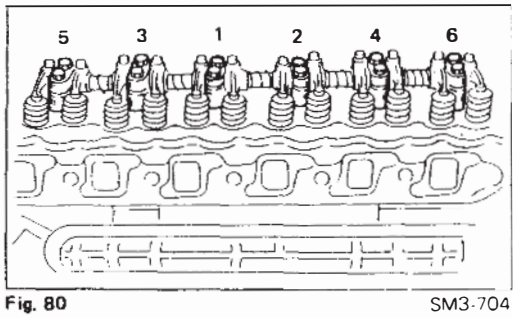


Fig. 80 SM3-704

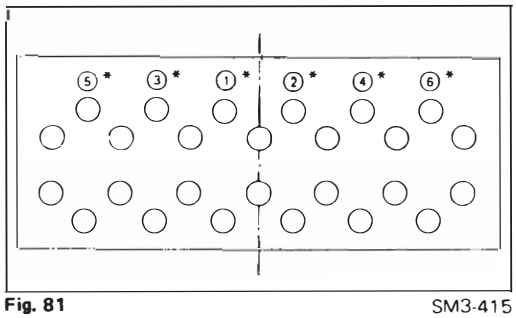


Fig. 81 SM3-415

6. Tighten the rocker arm support bolts in three stages following the tightening order.
   Tighten the bolts to the specified torque at each stage.

First Stage	:	350 – 400 kg.cm (26 – 28 lb.ft)
Second Stage	:	500 – 600 kg.cm (37 – 43 lb.ft)
Third Stage	:	700 – 800 kg.cm (51 – 57 lb.ft)

NOTE: The cylinder head extension bolts and the rocker arm support bolts have the same head size, so be sure to tighten them with their respectively correct tightening torques.

7. Tighten the cylinder head additional bolt in the numerical order as shown. (* mark)

Tightening torque: 650–750 kg·cm (47–54 lb.ft)

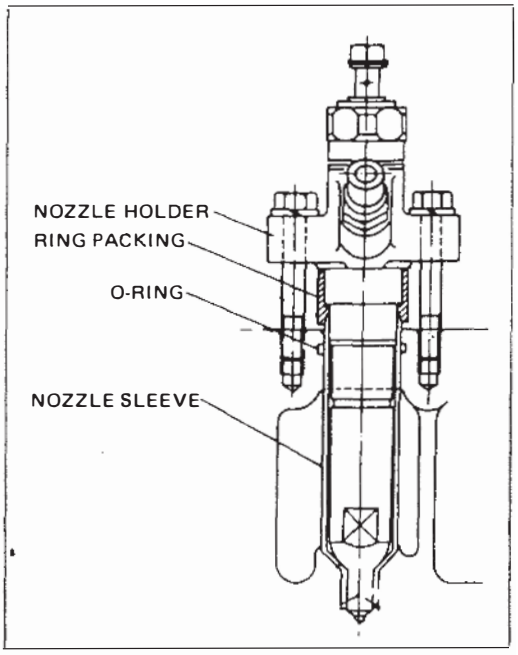


Fig. 82 SM3-400

9. INSTALL THE INJECTION NOZZLE

1. Insert the nozzle and holder assemblies into the nozzle sleeves with their inlet connectors toward the injection pump.

NOTE: Be careful not to let dust fall into the nozzle holder fits carefully over the top end of the sleeve.
Be careful not to damage the ring packing when installing the nozzle holder. If damaged, the entry of oil, water and dust makes removing the nozzle difficult.

2. Tighten the nozzle holder mounting bolts gradually and alternately.
   Then tighten the bolts at their specified torque.

Tightening Torque: **130 – 190 kg.cm (10 – 13 lb.ft)**

NOTE: Insufficient tightening torque causes gas leaks and could result in nozzle seizure.

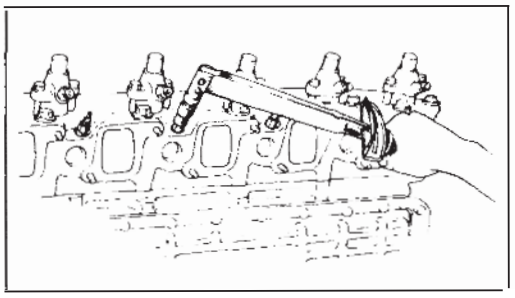


Fig. 83 SM3-369

10. INSTALL THE GLOW PLUGS.

Install glow plugs and glow plug connectors.
Install screw grommets on the threads of the glow plugs.

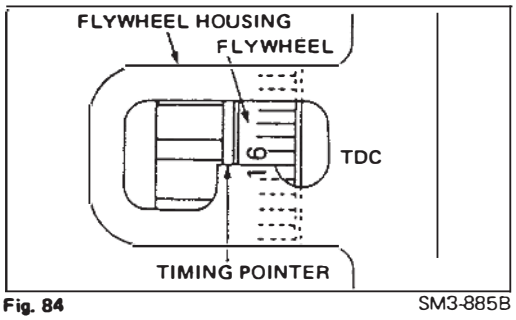


Fig. 84 SM3-885B

11. ADJUSTING THE VALVE CLEARANCE

1. Turning the crankshaft, align the mark "1–6" on the flywheel with the pointer on the flywheel housing. In this position either the No.1 or No.6 piston is at the top dead center end of the compression stroke.

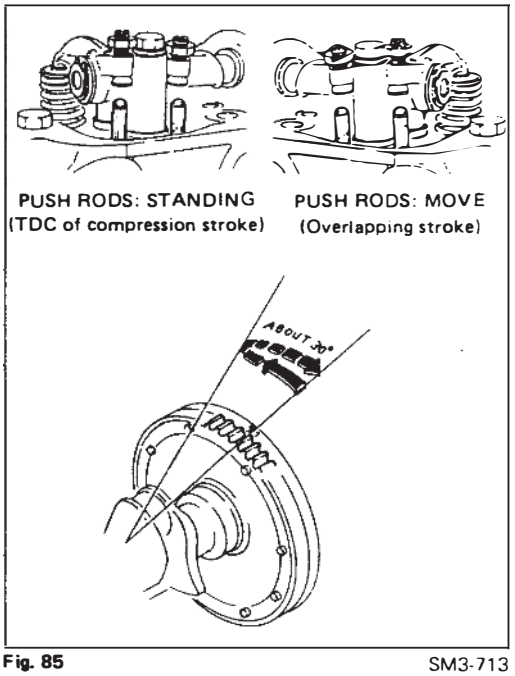


Fig. 85 SM3-713

2. Method for determining if the No. 1 or No.6 piston is at the top dead center of the compression stroke.

a. While looking at the push rod of No. 1 and No. 6 pistons. Turn the flywheel unticlockwise and clockwise about 30° to 40° (see left figure).
If the piston whose exhaust and inlet push rod do not move during the interval, it is at the top dead center of the compression stroke.
If the piston whose push rods have moved, it is at the completion of the exhaust and begun of the intake stroke (overlapping stroke).

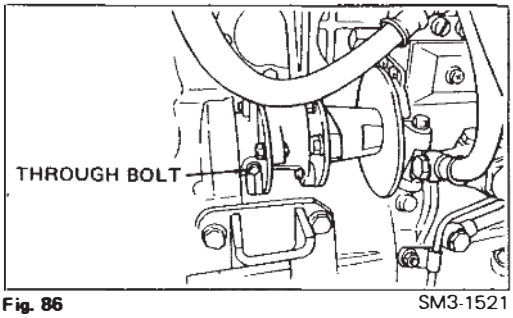


Fig. 86 SM3-1521

b. Piston No. 1 is at the top dead center end of the compression stroke when the head of the through bolt of the injection pump drive shaft coupling becomes visible to you as the pointer of the flywheel housing aligns with the "1–6" markings on the flywheel circumference.

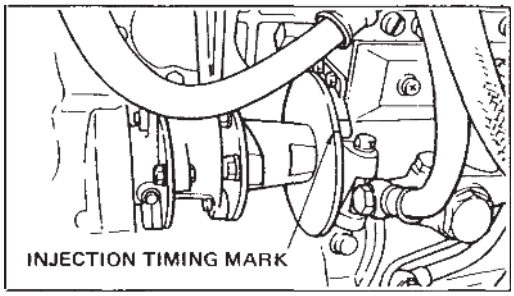


Fig. 87 SM3-1522

c. If the injection timing mark is nearly aligned with the pointer, the No.1 piston is at top dead center end of the compression stroke.

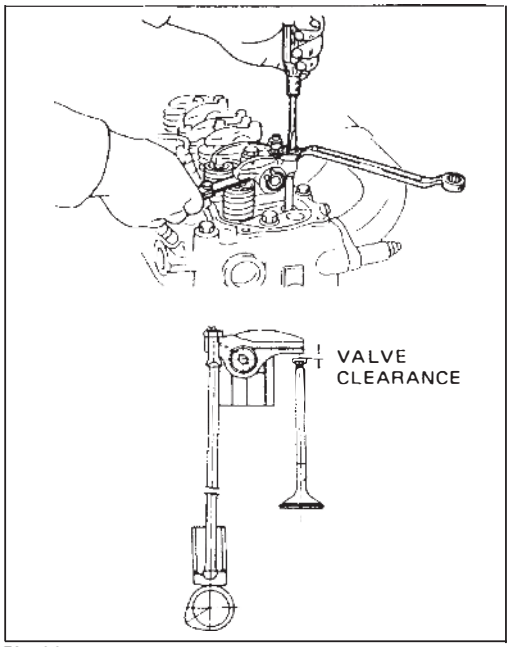


Fig. 88 SM3-715

2. With the No. 1 piston positioned at top dead center end of the compression stroke, adjust the No. 1 valve clearance using a thickness gauge.
   Insert a thickness gauge between the rocker arm and the valve stem cap to measure clearance. Loosen the lock nut and turn the adjusting screw to set the clearance. While holding the adjusting screw, tighten the lock nut as per specified torque.
   Check again and confirm the clearance.
   The thickness gauge should move with a very slight pull.
3. Turn the crankshaft clockwise 120° viewing from timing gear cover side. Adjust the valve clearance for each cylinder in the firing order (1–4–2–6–3–5).

Valve Clearance:
Intake : 0.30 mm (0.0118 in)
Exhaust : 0.45 mm (0.0177 in)

Tightening Torque:
Adjusting Screw Lock Nut: 400–450 kg·cm (29–32 lb.ft)

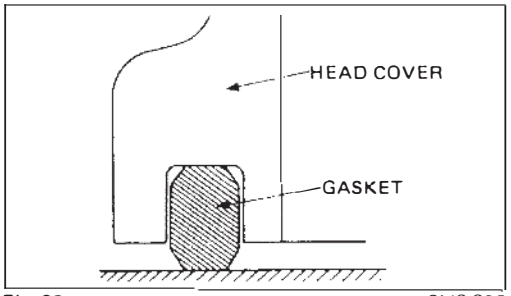


Fig. 89 SM3-398

12. INSTALL THE CYLINDER HEAD COVER.

Make sure that the cylinder head surface is free of dust oil or dust, and be sure that the gasket is fitted correctly into the groove of the cylinder head cover.

NOTE: **If a cylinder head cover with the gasket fitted incorrectly is installed, the gasket will be damaged and oil leaks will result.**

Tightening Torque: 130–180 kg·cm (10–13 lb.ft)

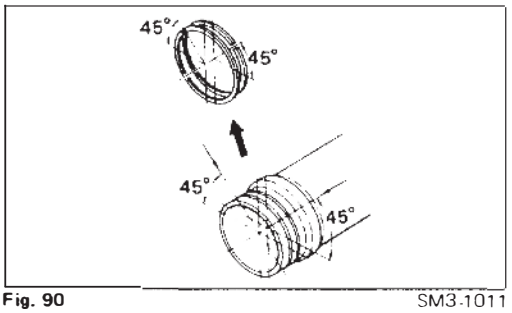


Fig. 90 SM3-1011

13. INSTALL THE EXHAUST MANIFOLD.

1. When installing seal rings on the exhaust manifold, fit new seal rings in such a way that the gaps are equally spaced, as shown, to prevent gas and oil leakage.

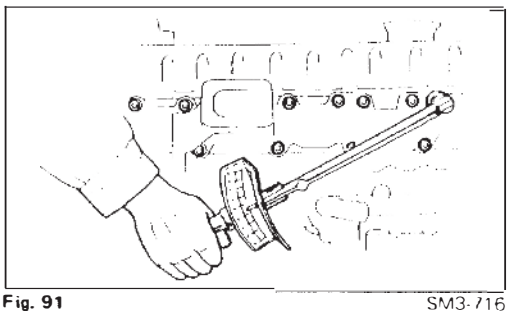


Fig. 91 SM3-716

2. Install the exhaust manifold.

NOTE: Use a new gasket.

Tightening Torque: 450–500 kg·cm (33–36 lb.ft)

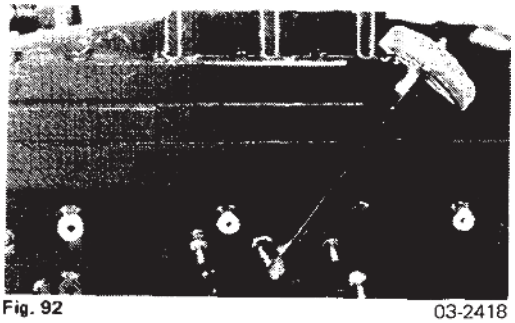


Fig. 92 03-2418

14. INSTALL THE INTAKE MANIFOLD.

NOTE: Use a new gasket.
Tightening Torque: 190—260 kg·cm (14—18 lb.ft)

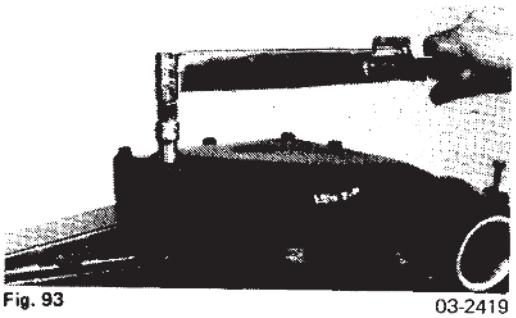


Fig. 93 03-2419

15. INSTALL THE INTAKE PIPE.
NOTE: Use a new gasket.
Tightening Torque: 190—260 kg·cm (14—18 lb.ft)

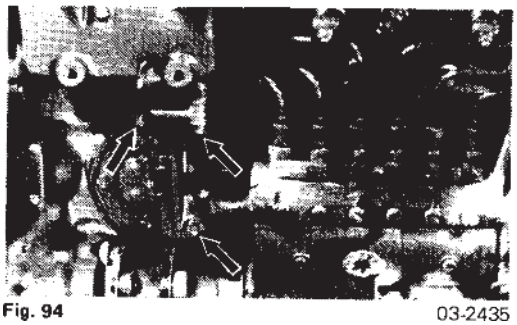
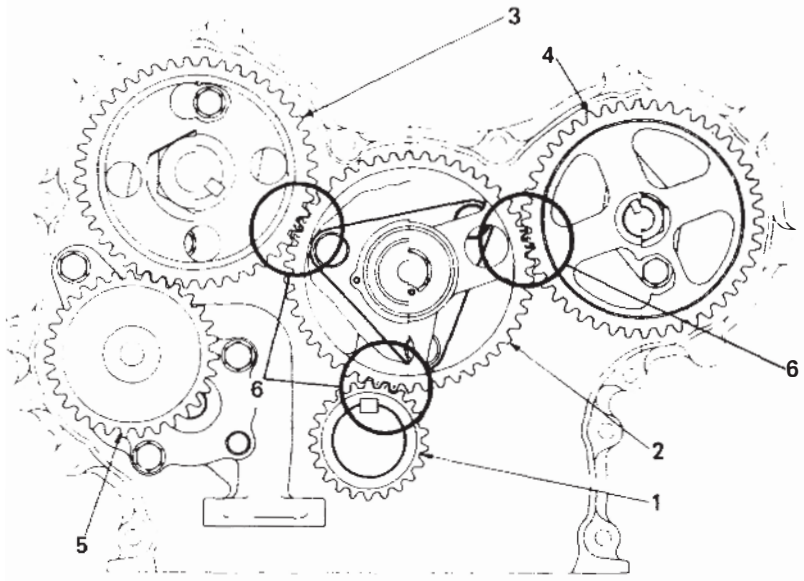


Fig. 94 03-2435

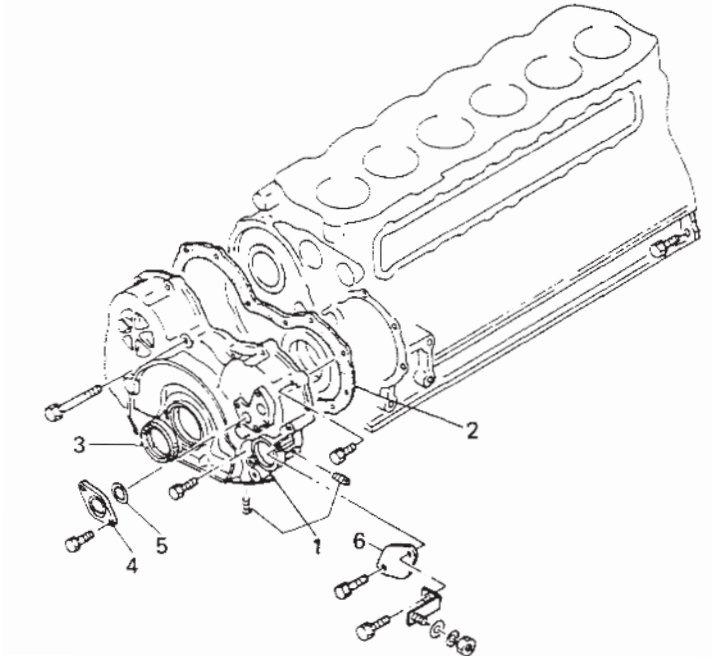
16. INSTALL THE INTAKE MANIFOLD BRACKETS.
Tightening Torque: 350—500 kg·cm (26—36 lb.ft)

TIMING GEAR AND CAMSHAFT



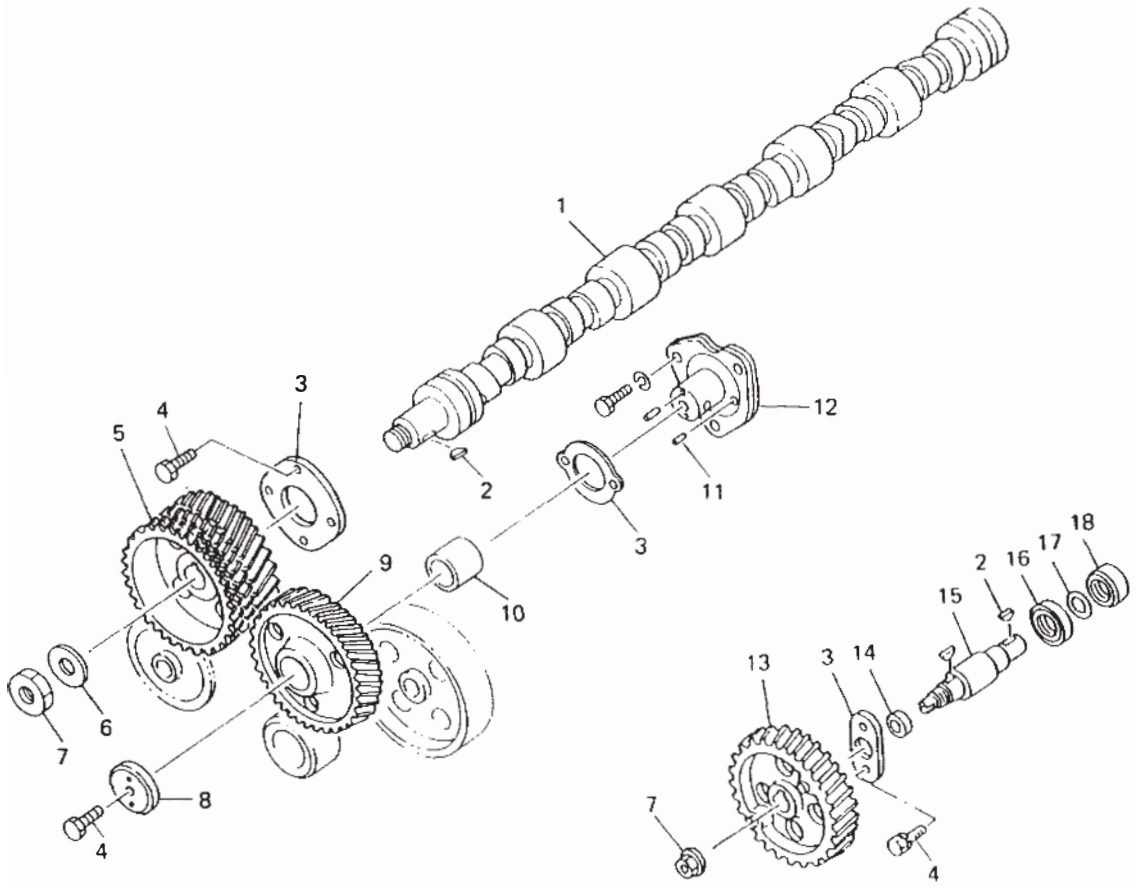
TIMING GEAR
1. Crankshaft gear
2. Ider gear
3. Camshaft gear
4. Injection pump drive gear
5. Oil pump drive gear
6. Timing match mark

Fig. 1 SM3-1523



TIMING GEAR COVER AND RELATED PARTS
1. Timing gear cover
2. Gasket
3. Oil seal
4. Flange
5. O-Ring
6. Blind plate

Fig. 2 SM3-1524



TIMING GEAR AND RELATED PARTS

1. Camshaft
2. Woodruff key
3. Thrust bearing
4. Bolt
5. Camshaft gear
6. Plain washer
7. Nut
8. Thrust plate
9. Idler gear
10. Bushing
11. Straight pin
12. Idler gear shaft
13. Injection pump drive gear
14. Collar
15. Injection pump drive shaft
16. Oil seal
17. O-ring
18. Sleeve

Fig. 3 SM3-1525


Fig. 4 03-698

DISASSEMBLY

1. REMOVE THE OIL PAN.

Remove the old gasket from the cylinder block and/or oil pan.

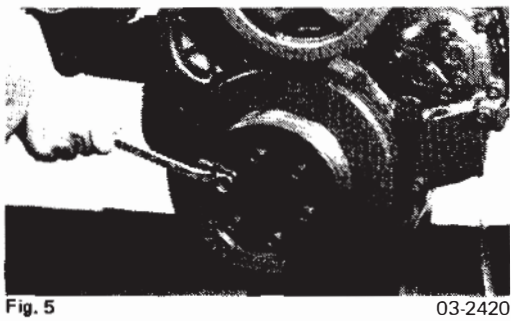


Fig. 5 03-2420

2. REMOVE THE CRANKSHAFT PULLEY.

1. Remove the crankshaft pulley.


Fig. 6 03-2421

2. Remove the crankshaft nut.

NOTE: ○ Use a puller if necessary.
○ Do not remove the dust slinger.

3. Remove the crankshaft damper.


Fig. 7 03-1528

3. REMOVE THE TIMING GEAR COVER.

Remove the old gasket from the cylinder block and/or timing gear cover.

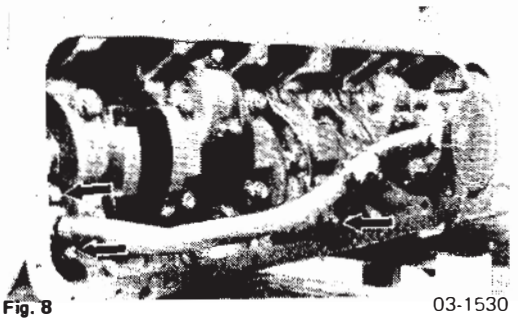


Fig. 8 03-1530

4. REMOVE THE OIL STRAINER.

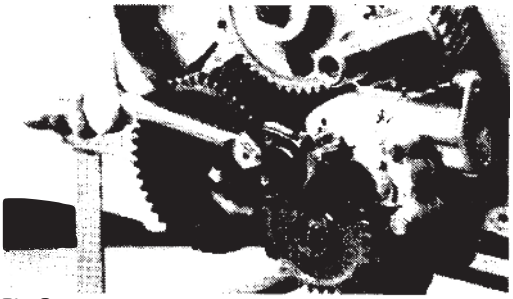


Fig. 9 03-1529

5. REMOVE THE OIL PUMP.

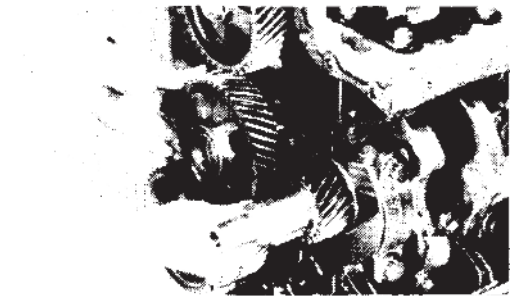


Fig. 10 03-702

6. REMOVE THE IDLER GEAR.

Remove the idler gear by removing the mounting bolts.

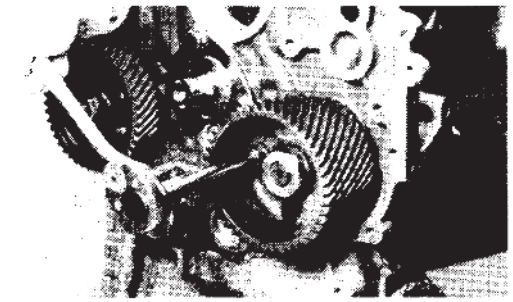


Fig. 11 03-1531

7. REMOVE THE CAMSHAFT.

Remove the camshaft assembly by removing the thrust bearing mounting bolts.

NOTE: ○ **Hold the tappets above the camshaft.**

○ **Pull out the camshaft, slowly turning it so as not damage the bearings.**

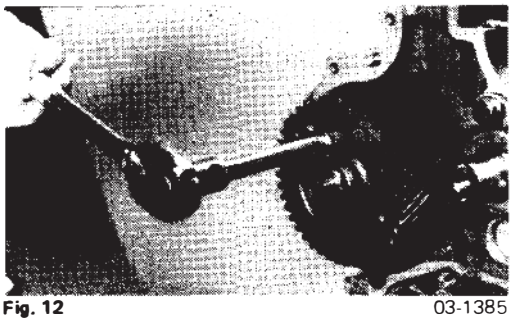


Fig. 12 03-1385

8. REMOVE THE INJECTION PUMP DRIVE SHAFT.

1. Remove through bolt.
2. Remove the injection pump coupling.
3. Remove the injection pump drive gear and shaft by removing the thrust bearing mounting bolts.

Fig. 13 03-1532

9. REMOVE THE IDLER GEAR SHAFT.

1. Remove the mounting bolts.
2. Using a special tool, remove the idler gear shaft.

Special Tool: **Sliding Hammer (09420-1442)**

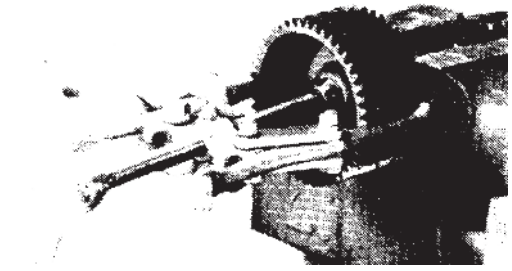


Fig. 14 03-706

10. REMOVE THE CAMSHAFT GEAR.

When the camshaft gear is worn or damaged, or the thrust bearing needs to be replaced, remove the camshaft gear from the camshaft. Hold the camshaft assembly with a vice through wooden plates.

Remove the nut, then using a gear puller, remove the gear.

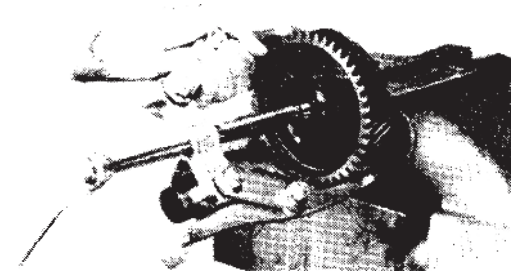


Fig. 15 03-707

11. REMOVE THE INJECTION PUMP DRIVE GEAR.

When the injection pump drive gear is worn or damaged, or the thrust bearing needs to be replaced, remove the gear in the same manner as above.

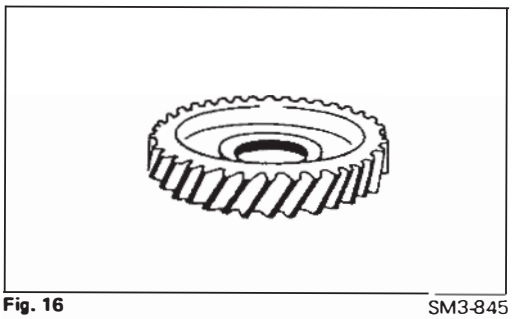


Fig. 16 SM3-845

INSPECTION AND REPAIR

1. INSPECT THE GEAR TEETH FOR PITTING OR WEAR.

If a gear is damaged, replace the gear.

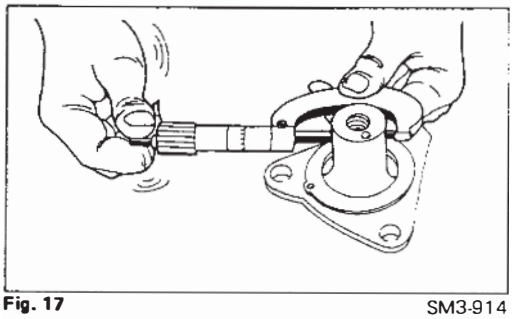


Fig. 17 SM3-914

2. MEASURE THE CLEARANCE BETWEEN THE IDLER GEAR BUSHING AND SHAFT.

1. Using a micrometer, measure the outside diameter of the shaft.

Nominal Dimension	34.0 mm (1.339 in)
Service Limit	33.85 mm (1.333 in)

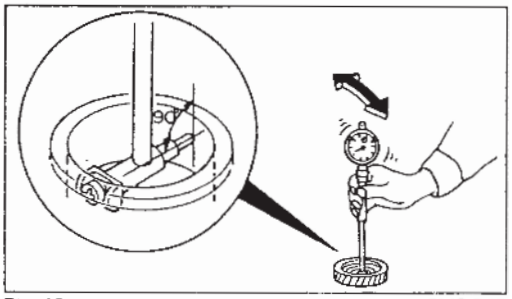


Fig. 18 SM3-847

2. Using a cylinder gauge, measure the inside diameter of the bushing.
3. Calculate the clearance from the above measurement.

Clearance;
Assembly Standard: 0.025 – 0.075 mm (0.0010–0.0029 in)
Repair Limit : 0.20 mm (0.0078 in)

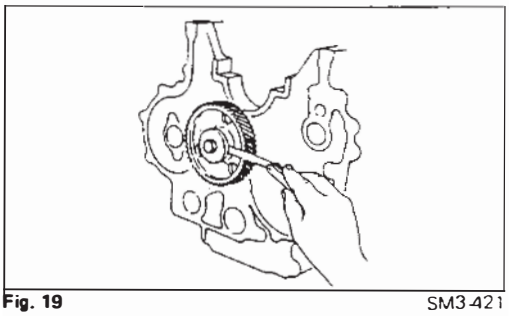


Fig. 19 SM3-421

3. MEASURE THE IDLER GEAR END PLAY.

Using a feeler gauge, measure the clearance between the idler gear and the thrust bearing.
If the measurement is greater than the limit, replace the thrust bearing.

Clearance;
Assembly Standard: 0.04 – 0.13 mm (0.0016 – 0.0051 in)
Repair Limit : 0.30 mm (0.0118 in)

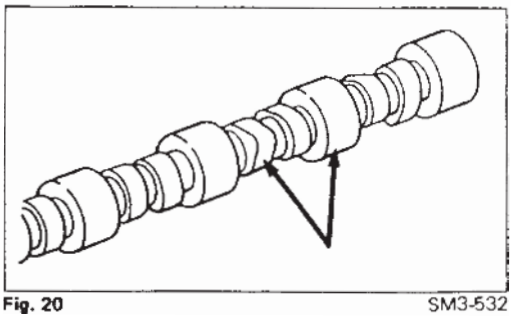


Fig. 20 SM3-532

4. INSPECT THE CAMSHAFT.

1. Visually check the camshaft lobes and journals for damage or wear.

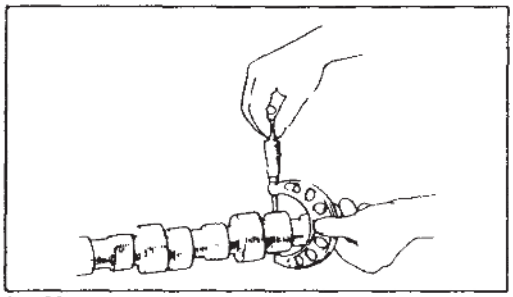


Fig. 21 SM3-374

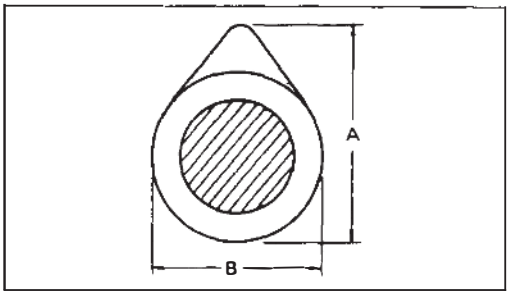


Fig. 22 SM3-404

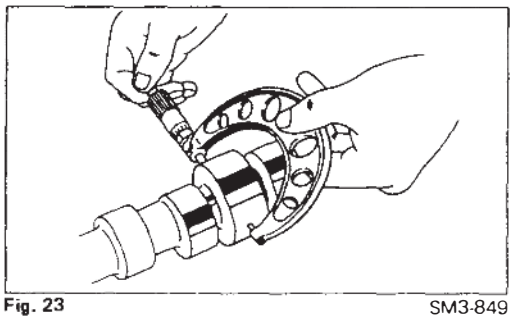


Fig. 23 SM3-849

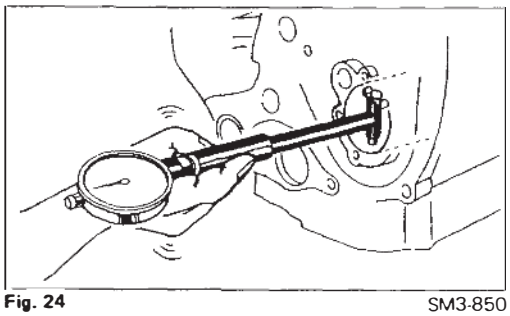


Fig. 24 SM3-850

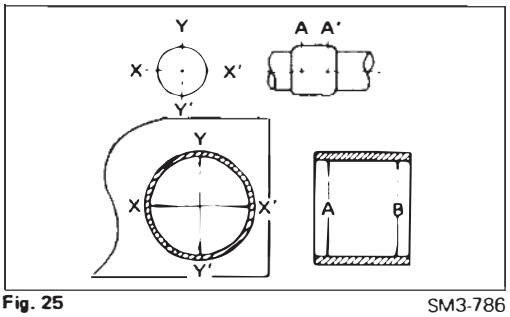


Fig. 25 SM3-786

2. Measure the cam lift.
Using a micrometer, measure the cam lift. Take a reading of A and B at the two axial points.
If the cam lift is below the limit, replace the camshaft.

Cam Lift = A – B

Cam Lift;

	Assembly Standard
Intake	7.18 mm (0.2827 in)
Exhaust	8.17 mm (0.3217 in)

	Assembly Limit
Intake	6.38 mm (0.2512 in)
Exhaust	7.37 mm (0.2902 in)

3. Measure the camshaft journal and bearing.
Measure the outside diameter of the camshaft journals with a micrometer and the inside diameter of the camshaft bearings in the cylinder block with a cylinder gauge.
Calculate the clearance from the above measurement.
If the clearance is greater than the limit, replace the bearings.

Unit: mm (in)

Number of Journal	Outside Diameter		Inside Diameter	
	Assembly Standard	Service Limit	Assembly Standard	Service Limit
No. 1	61.5 (2.421)	–0.10 (–0.0039)	61.5 (2.421)	+0.10 (+0.0039)
No. 2	61.3 (2.413)		61.3 (2.413)	
No. 3	61.1 (2.406)		61.1 (2.406)	
No. 4	60.9 (2.398)		60.9 (2.398)	
No. 5	60.7 (2.390)		60.7 (2.390)	
No. 6	60.5 (2.382)		60.5 (2.382)	
No. 7	58.3 (2.295)		58.3 (2.295)	

	Assembly Standard	Repair Limit
Clearance	0.03–0.08 (0.0012–0.0031)	0.15 (0.0059)

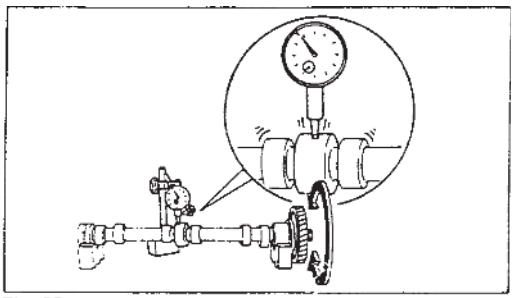


Fig. 26 SM3-858

4. Measure the camshaft run out.
Support the camshaft with V-blocks and measure the run out at the center journal with a dial gauge.
If the run out exceeds the limit, correct with a press or replace.

Repair Limit: 0.10 mm (0.0039 in)

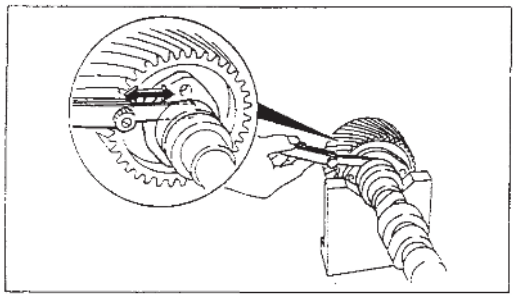


Fig. 27 SM3-848

5. Measure the camshaft end play.
Measure the clearance between the camshaft gear and the thrust bearing with a feeler gauge. If the clearance is greater than the limit, replace the thrust bearing.

Assembly Standard: 0.100 – 0.178 mm (0.0040 – 0.0070 in)
Repair Limit : 0.3 mm (0.012 in)

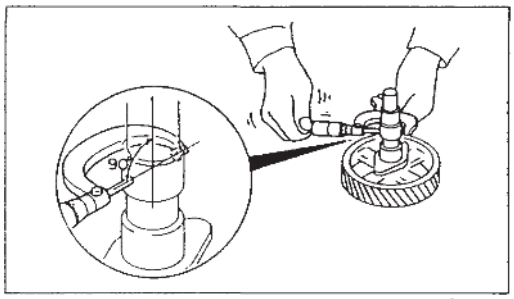


Fig. 28 SM3-1005

5. MEASURE THE INJECTION PUMP DRIVE SHAFT AND BUSHING.

1. Using a micrometer, measure the outside diameter of the injection pump drive shaft.

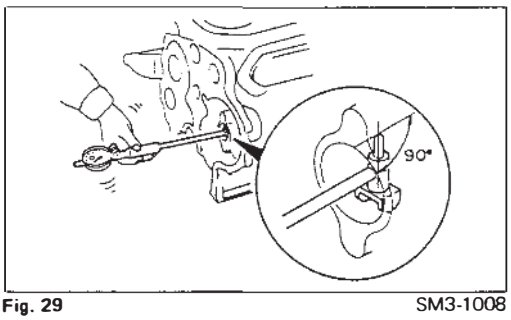


Fig. 29 SM3-1008

2. Using a cylinder gauge, measure the inside diameter of the bushing.
3. Calculate the clearance from the above measurements.

Assembly Standard: 0.030 – 0.072 mm (0.0012 – 0.0028 in)
Repair Limit : 0.30 mm (0.012 in)

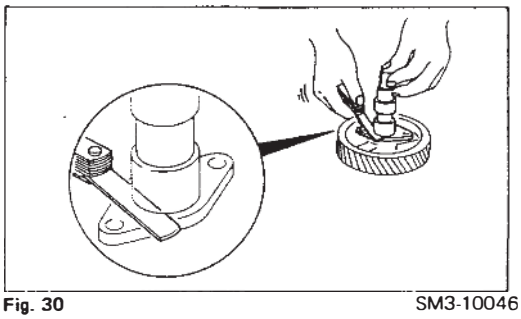


Fig. 30 SM3-10046

6. MEASURE THE INJECTION PUMP DRIVE GEAR END PLAY.

Measure the clearance between the injection pump drive gear and the thrust bearing with a feeler gauge.
If the clearance is greater than the limit, replace the thrust bearing.

Assembly Standard: 0.100–0.200mm (0.0039–0.0078 in)
Repair Limit : 0.3 mm (0.012 in)

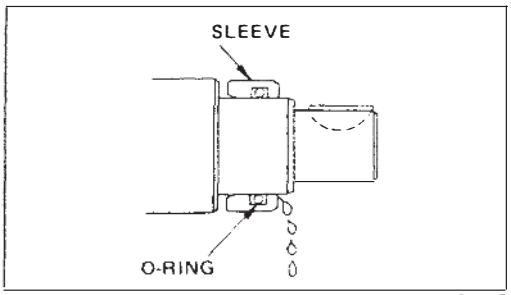


Fig. 31 SM3-717

7. INSPECT THE INJECTION PUMP DRIVE GEAR SHAFT SLEEVE.

NOTE: If there is oil leakage from the O-ring area or if the contact surface with the oil seal is worn, replace the O-ring or the sleeve.

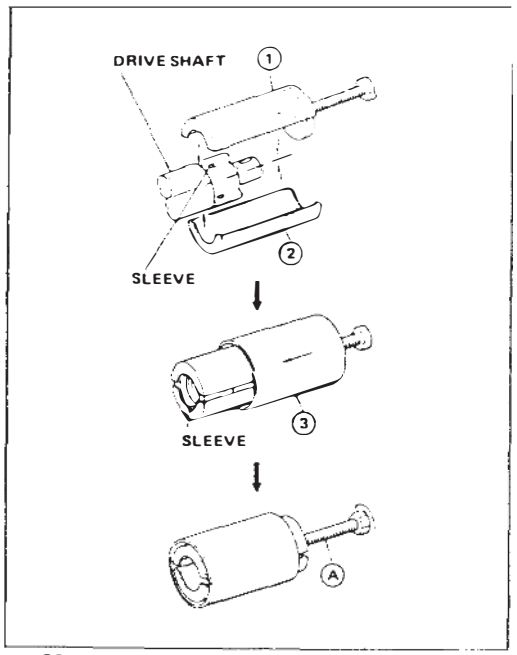


Fig. 32 03-812

8. IF NECESSARY, REPLACE THE INJECTION PUMP DRIVE SHAFT SLEEVE.

1. Using a special tool, remove the sleeve.

a. Put the puller [①, ②] onto the sleeve.

b. Insert the hook portion of the puller between shaft and sleeve.

c. Insert the puller [③].

d. After inserting the puller, screw in the center bolt [A], then remove the sleeve.

Special Tool: Puller (09420-1490)

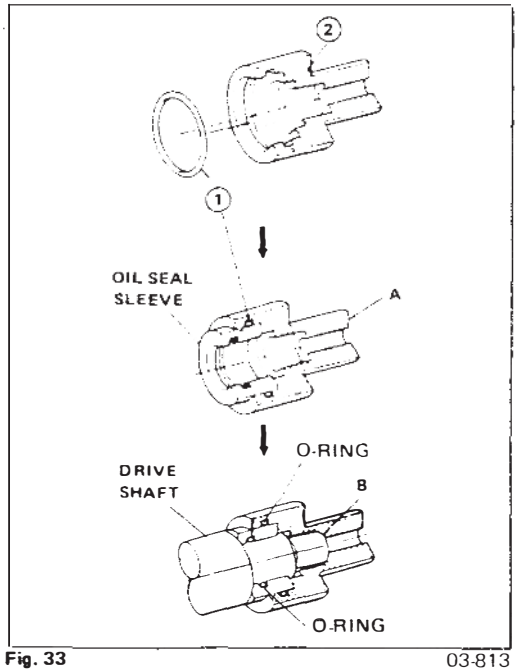


Fig. 33 03-813

2. Using a special tool, install the shaft sleeve with a new O-ring.

a. Put the O-ring 1 into the press 2 .

b. Insert the new oil seal sleeve with new O-ring into the press and then insert them into the drive shaft.

c. Hitting the "A" lightly by hammer, contact the press end and the shaft end "B", with this determine the oil seal sleeve position.

NOTE: ○ Be sure to fit an O-ring on the sleeve and also apply a liberal coating of oil to the shaft.

○ When driving on the shaft sleeve, taking care that the O-ring does not get cut or torn.

○ Once a sleeve has been removed, it cannot be reused.

Special Tool: Press (09482-1550)
O-ring (9851-36104)

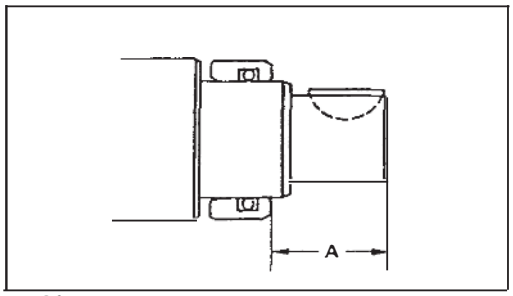


Fig. 34 SM3-717

Distance from the shaft end to the sleeve end (A):
27.1–27.7 mm (1.067–1.0905 in)

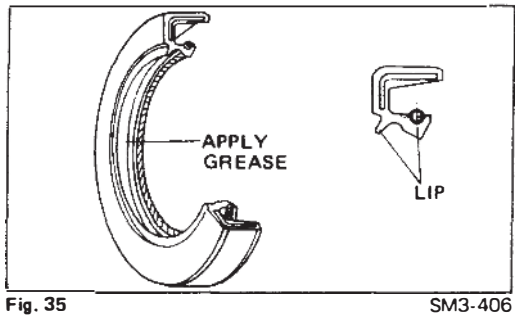


Fig. 35 SM3-406

9. INSPECT THE OIL SEAL.

Inspect the lip of the oil seal and if it is damaged, replace the oil seal. Check the oil seal in respect of the following items;

- **Wear of the lip.**
- **Cracking.**
- **Adhesion of foreign matter.**

NOTE:
- **In order to prevent oil leakage from the oil seals due to lip wear, apply grease between the main lip and sub lip.**
- **Grease used: Lithium-based grease.**
- **Greasing points:**
  Crankshaft oil seals (front and rear)
  Oil seal of injection pump drive shaft

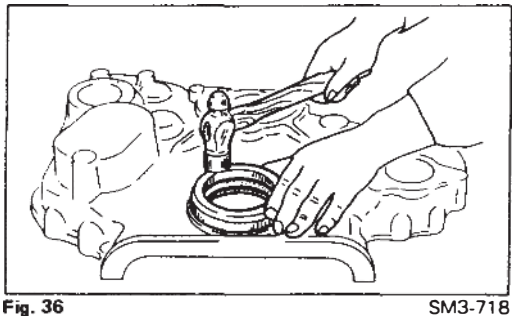


Fig. 36 SM3-718

10. IF NECESSARY, REPLACE THE TIMING GEAR CASE COVER OIL SEAL.

1. Using a screwdriver, remove the oil seal.
2. Using a special tool, install the new oil seal.

Special Tool: Press (09482-1090)

ASSEMBLY

1. INSTALL THE IDLER GEAR SHAFT

Tightening Torque: 500 – 650 kg.cm (37 – 47 lb.ft)

Fig. 37 03-1543

2. INSTALL THE INJECTION PUMP DRIVE GEAR TO THE SHAFT.

Install the gear 1 heated to about 180°C (356°F) on the shaft.
Make sure that the gear 1 is closely fitted against the shoulder of the shaft 4 through the collar 3 and the thrust bearing 2 .

Tightening Torque: 1,600–1,800 kg.cm (115–130 lb.ft)

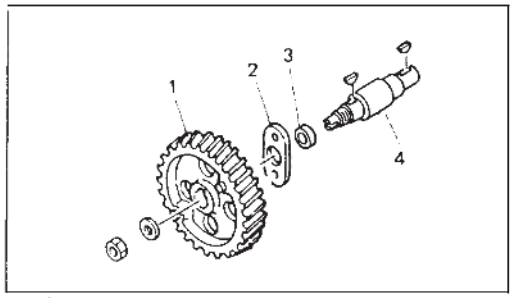


Fig. 38

3. INSTALL THE INJECTION PUMP DRIVE SHAFT.

Apply engine oil to the bearing surface of the shaft and the sleeve.
Then insert the shaft assembly into the cylinder block. Be careful not to damage the bushing and the oil seal.

Tightening Torque: 190 – 260 kg.cm (14 – 18 lb.ft)

Fig. 39 03-1544

4. INSTALL THE CAMSHAFT

1. Install the camshaft gear with thrust bearing.

NOTE: **When installing the gear to the camshaft:**
- **Before installation of the gear to the camshaft, heat the gear in hot water [Approx. 100°C (212°F)], then install the gear to the camshaft by using a press.**
- **When tightening the bolts, apply engine oil to the threads and bearing surface of the bolt.**

Tightening Torque: 2,500–3,000 kg.cm (181–216 lb.ft)

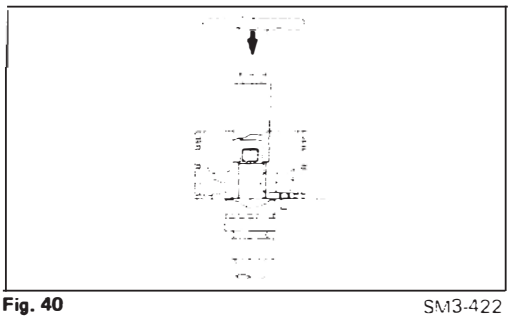


Fig. 40 SM3-422

Fig. 41 03-1545

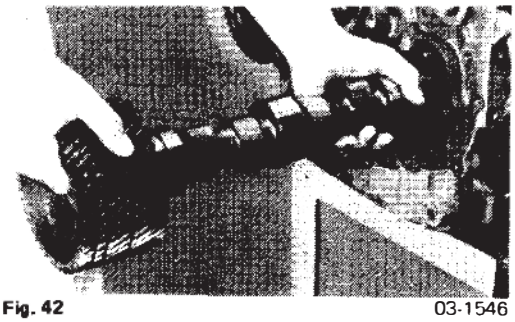


Fig. 42 03-1546

2. Lubricate all journals of the camshaft and insert the camshaft assembly into the cylinder block.
Tighten the bolts at the specified torque to fix the thrust bearing to the cylinder block.

NOTE: **Insert the camshaft, slowly turning while inserting so that the bearing will not be damaged.**

Tightening Torque: 190–260 kg·cm (14–18 lb.ft)

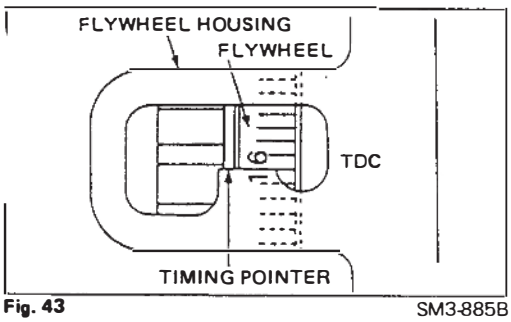


Fig. 43 SM3-885B

5. SET THE No. 1 PISTON TO TOP DEAD CENTER OF THE COMPRESSION STROKE.

Refer to page 3-3-22.

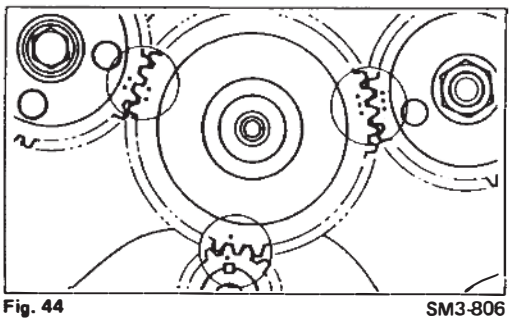


Fig. 44 SM3-806

6. INSTALL THE IDLER GEAR

When installing the idler gear, be sure that the matching marks of the crankshaft gear, camshaft gear, injection pump drive gear, and idler gear aligned correctly.
Incorrect installation can results in engine damage or lowering of engine performance by causing improper injection timing.

Tightening Torque: 1,100 – 1,300 kg.cm (80 - 94 lb.ft)

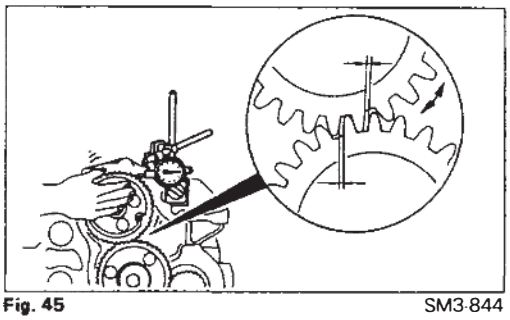


Fig. 45 SM3-844

7. MEASURE THE GEAR BACKLASH

Measure the backlash of each gear using a dial indicator.
Replace the gear if necessary.

Unit: mm (in)

Gears \ Backlash	Assembly standard	Service limit
Crankshaft gear and idler gear	0.05–0.11 (0.0020–0.0043)	0.30 (0.0118)
Injection pump drive gear and idler gear		
Camshaft drive gear and idler gear		
Oil pump drive gear and camshaft drive gear	0.07–0.22 (0.0028–0.0086)	0.35 (0.0138)


Fig. 46 03-1548

8. INSTALL THE OIL PUMP AND STRAINER

1. Before installation, visually check the oil pump gear teeth for damage or wear.
2. Make sure that the O-ring is in place in the oil hole in the cylinder block. If the O-ring is not installed, it causes a lowering of oil pressure.
   Always use new O-rings.
3. Install the oil pump.

Tightening Torque: **380–500 kg·cm (28–36 lb.ft)**

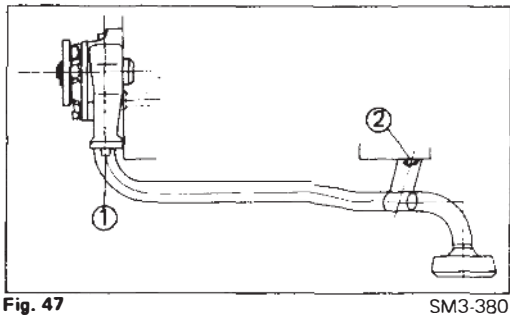


Fig. 47 SM3-380

4. The oil strainer is fixed to the end of the suction pipe.
   Install the suction pipe according to the following procedure in order to minimize the setting stress of the bracket.

a. Be sure to install a new O-ring the pipe flange. If the O-rings are not installed it may result in engine seizure by causing a lowering of oil pressure.

b. First, finger tighten the bolts **1** to mount the pipe flange on the oil pump. Then check that the bracket is positioned properly and the clearance between the bracket and the block is less than 0.5 mm (0.0196 in).

c. Finger tighten the bolts 2 to mount the bracket on the block.

d. Tighten the bolts 1 holding the pipe in place, and then the bolts 2 .

Tightening Torque: **180–230 kg·cm (14–16 lb.ft)**


Fig. 48 03-1530

9. INSTALL THE TIMING GEAR COVER

Install the timing gear cover on the block. Cut the protrusion of the gasket from the oil pan mounting surface of the block and make the gasket flush.

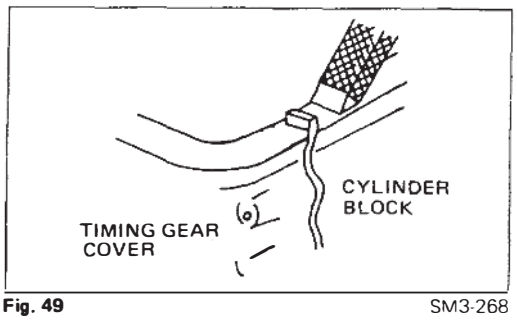


Fig. 49 SM3-268


Fig. 50 03-1528


Fig. 51 03-2421

10. INSTALL THE CRANKSHAFT DAMPER.

Install the crankshaft damper on the crankshaft. Tighten the nut with the spacer in place.

NOTE: **The nut for mounting the crankshaft damper is designed for this propose only. Never use an ordinary nut as a substitute.**

Tightening Torque: 5,500–7,000 kg·cm (398–506 lb.ft)

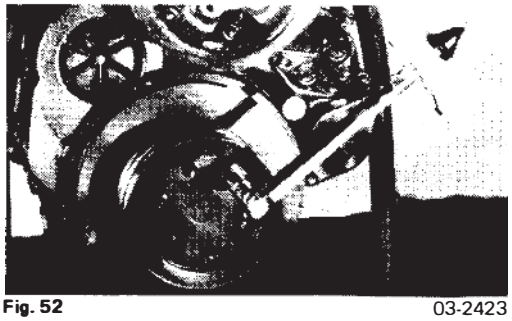


Fig. 52 03-2423

11. INSTALL THE CRANKSHAFT PULLEY.

Tightening Torque: 450–500 kg·cm (32–36 lb.ft)

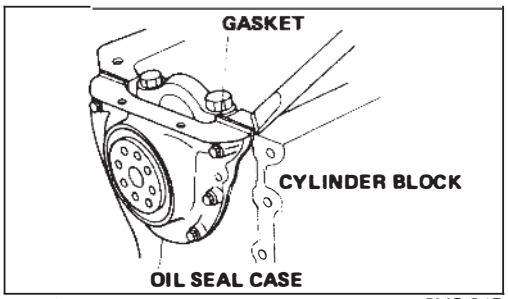


Fig. 53 SM3-245

12. INSTALL THE OIL PAN.

When the rear oil seal case have been removed, always use a new gasket when reinstalling. When the ends of the gasket protrude from the bottom surface of the block, make the gasket flush to the bottom surface by cutting the protruded ends.

Since a two-ply oil pan gasket is used, install the oil pan gasket with its attached sheet side faced to the oil pan.

Tightening Torque: 180–230 kg·cm (14–16 lb.ft)

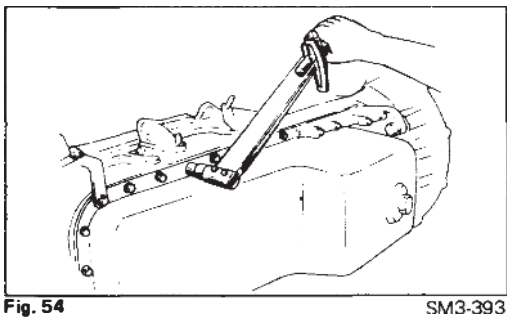
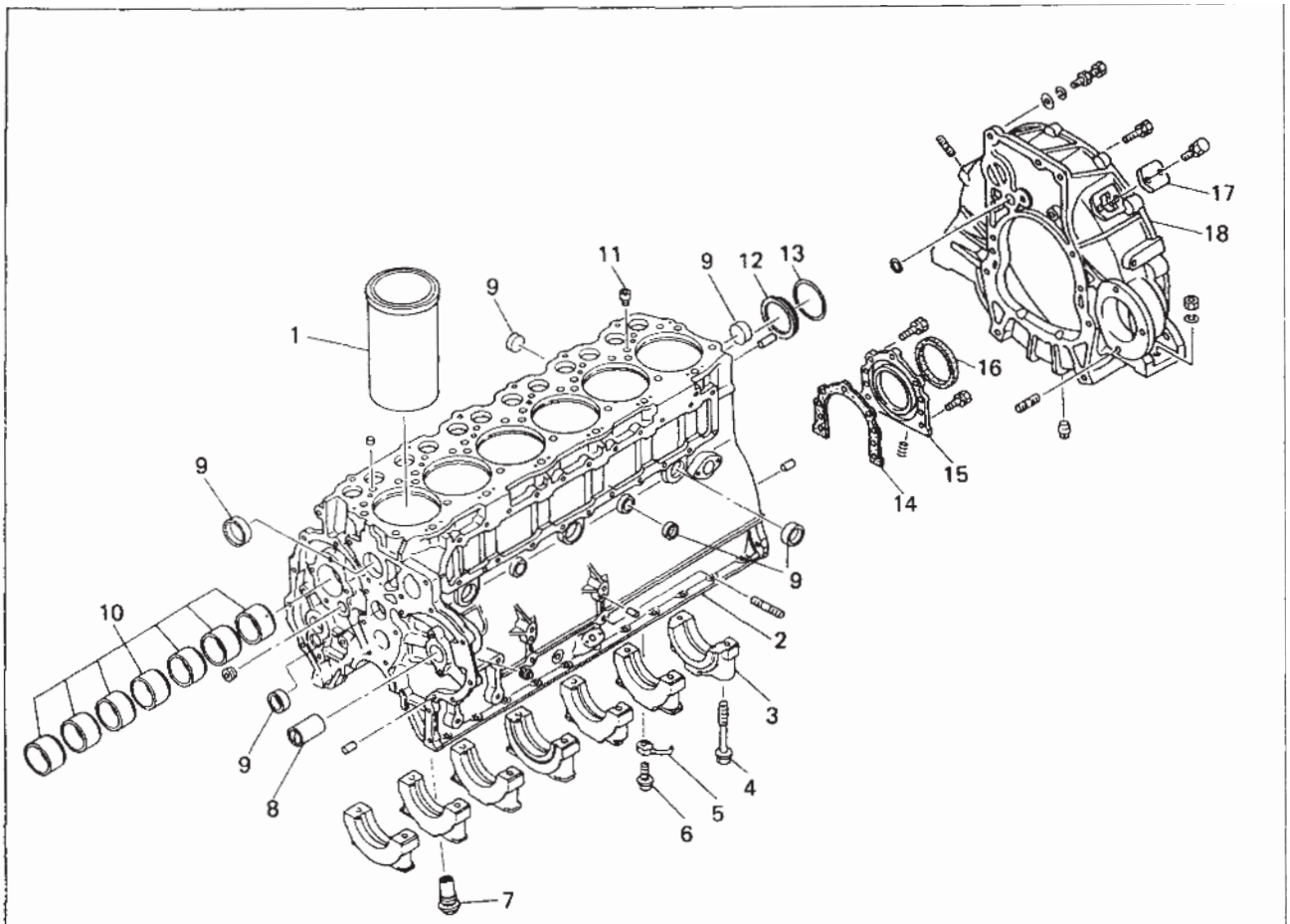


Fig. 54 SM3-393

CYLINDER BLOCK, FLYWHEEL HOUSING, PISTON AND CRANKSHAFT

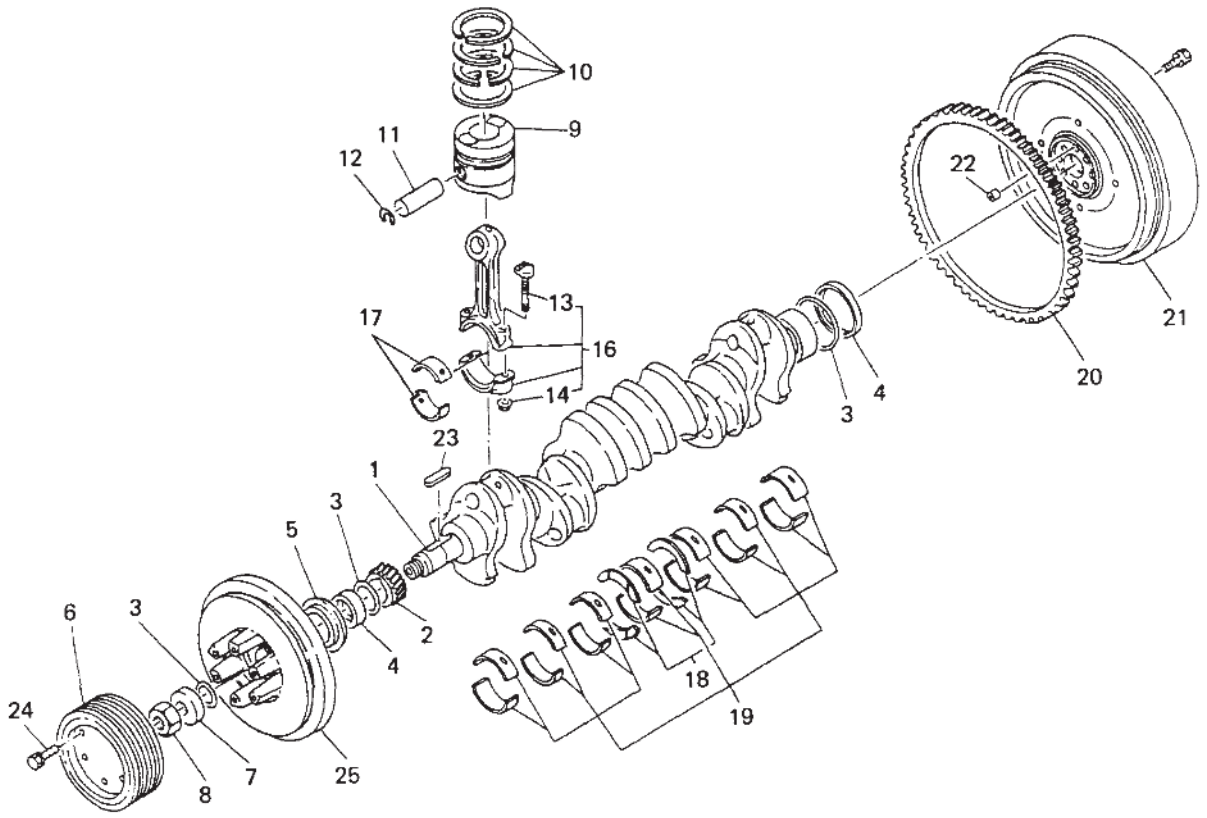


CYLINDER BLOCK AND RELATED PARTS

1. Cylinder liner
2. Cylinder block
3. Bearing cap
4. Bearing cap bolt
5. Oil jet pipe
6. Oil check valve
7. Oil pump safety valve
8. Injection pump drive shaft bushing
9. Plug
10. Camshaft bearing
11. Dowel
12. Seal plate
13. O-ring
14. Oil seal case gasket
15. Oil seal case
16. Oil seal
17. Flywheel housing dust cover
18. Flywheel housing

Fig. 1

SM3-1526



CRANKSHAFT, PISTON AND RELATED PARTS

1. Crankshaft
2. Crankshaft gear
3. O-ring
4. Crankshaft sleeve
5. Dust cover
6. Crankshaft pulley
7. Spacer
8. Nut
9. Piston
10. Piston ring set
11. Piston pin
12. Retainer ring
13. Connecting rod bolt
14. Connecting rod nut
15. Piston pin bushing
16. Connecting rod assembly
17. Connecting rod bearing
18. Thrust bearing set
19. Main bearing set
20. Ring gear
21. Flywheel
22. Collar
23. Key
24. Bolt
25. Crankshaft damper

Fig. 2 SM3-1527


Fig. 3 03-2424

DISASSEMBLY

1. REMOVE THE FLYWHEEL ASSEMBLY

1. Loosen the flywheel mounting bolts. Hold a metal rod through the starter hole against the flywheel and drive the rod lightly with a copper hammer to remove the flywheel from the crankshaft while rotating the crankshaft.

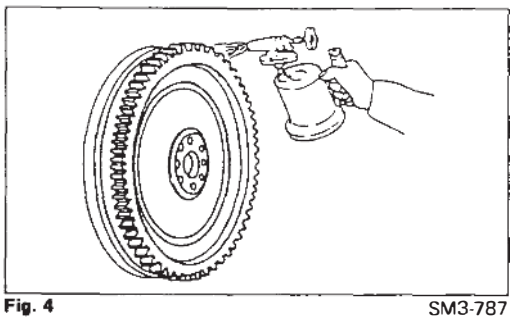


Fig. 4 SM3-787

2. Remove the ring gear.

a. Heat the ring gear with a blow torch in a uniform manner [Approx. 100°C (212°F)]

b. Using a metal rod as a pad and strike all around the ring gear in a uniform manner and remove the ring gear.

NOTE: Remove the ring gear only when replacement is necessary.

2. REMOVE THE FLYWHEEL HOUSING.

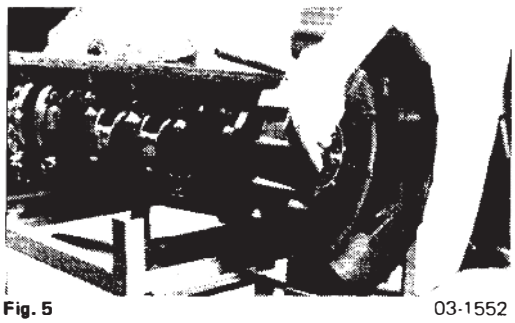


Fig. 5 03-1552

3. REMOVE THE OIL SEAL CASE.

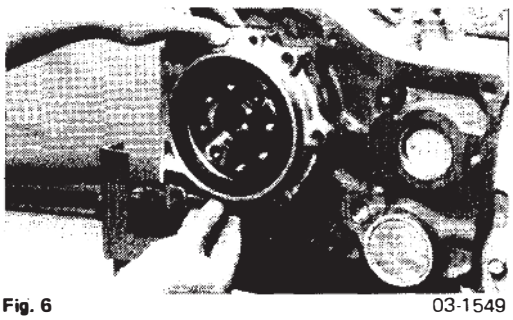


Fig. 6 03-1549

4. REMOVE THE PISTONS WITH CONNECTING RODS.

Loosen the connecting rod bolts to remove the connecting rod cap.
Extract the piston and connecting rod assembly out through the top of the cylinder.
The pistons can be removed two at a time; No. 1 and No. 6, No. 2 and No. 5, No. 3 and No. 4 are removed together.


Fig. 7 03-727 03-728

1. When removing the piston and connecting rod assembly, be careful not to damage the inside of the liner with the large end of the connecting rod.
2. When removing the pistons, be careful not to drop the large end bearing of the connecting rod or damage it.
3. During reassembly, the caps must be reassembled with the same connecting rod and in the same position. Likewise, the cap bearings and connecting rod bearings must maintain their original positions. Therefore, be careful to note these positions during removal and not to mismatch one part with another.
4. Before removing the pistons, remove carbon deposits from upper end of the liners with a scraper or emery paper (recommended: No. 150) in a circular direction.

NOTE: Remove the connecting rod in such a way that the connecting rod does not contact the cooling jet.
Adjust the cooling jet if by any chance the rod and the jet make contact.

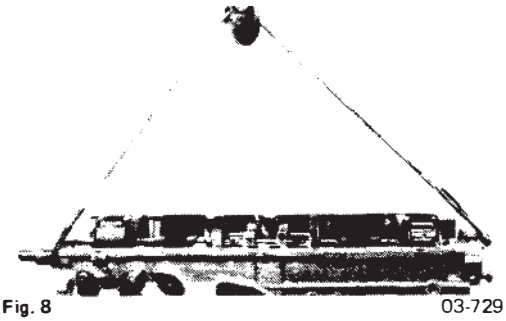


Fig. 8 03-729

5. REMOVE THE CRANKSHAFT.

Loosen the bearing cap bolts to remove the main bearing cap.
Remove the crankshaft.

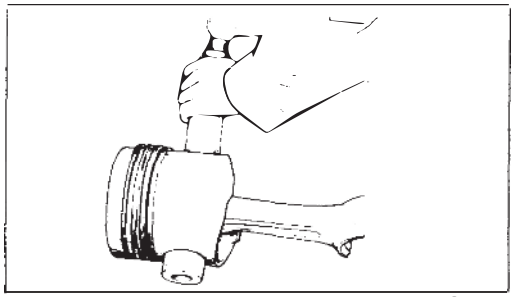


Fig. 9 SM3-294

6. REMOVE THE CONNECTING ROD.
   1. Remove the retainer ring installed on both ends of the piston pin, by means of retainer ring pliers.
   2. Apply a metal pad to the pin and strike out the pin with a hammer.

NOTE: Warm up the piston first in hot water 80 – 90°C (176–194° F) for about 5 minutes before removing the pin.

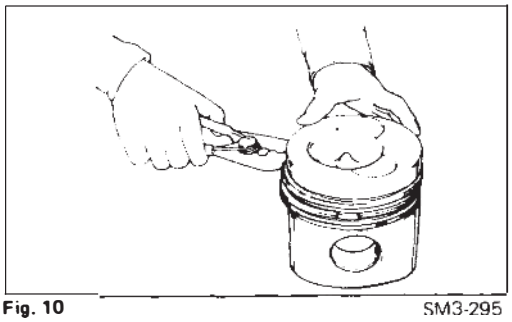


Fig. 10 SM3-295

7. REMOVE THE PISTON RINGS

Remove the piston rings using a special tool.

Special Tool: Piston Ring Expander (09442-1061)

NOTE: ○ Handle the piston rings carefully because they are made of a special casting which is easily broken.
○ Keep the rings for each cylinder separate.

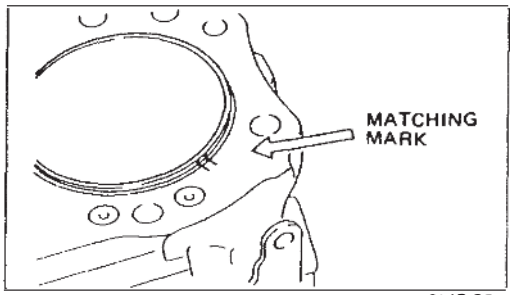


Fig. 11 SM3-851

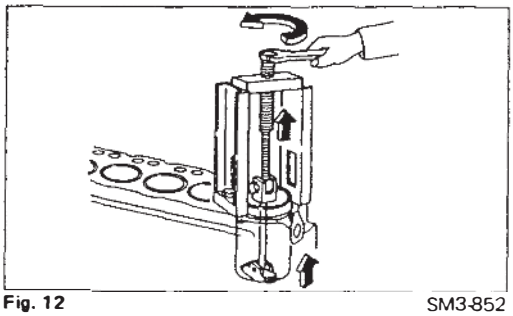


Fig. 12 SM3-852

8. REMOVE THE CYLINDER LINER.

1. It is possible to remove the cylinder liner by hand.
2. If, however, the liner is struck to the block, pull it towards the head, using a special tool.

Special Tool: Cylinder Liner Puller (09420-1240)

3. Successively remove the 6 cylinder liners through this procedure.
4. After removing the cylinder liners, put numbers on their periphery or arrange them in sequence.
5. Before removing the cylinder liners, be sure to put matching marks on the cylinder block and liner flange in order to ensure that the liners face their original directions when replacing. This is because the liners are thin and there is a rick of them being deformed by external force when reusing them. Do not make matching marks with a punch.
   Using a pen.

9. CLEAN THE CYLINDER BLOCK THROUGH THE FOLLOWING PROCEDURE.

1. Shake the block in a hot bath containing a commercially available alkali solution, in order to remove oil and grease.
2. Wash the block in hot water or steam to remove the alkali solution.
3. If the coolant jacket is particularly dirty, clean it through the following procedure.

a. Shake the block in commercially available pickling acid.

b. Stop shaking the block, then let it lie for about 30 minutes in the bath.

c. Raise the block, drain off the liquid, then immerse it for 10 minutes in the same liquid.

d. Repeat step c. until all scale has been removed from the block.

e. Rinse the block in warm water in order to remove all of the acid.

f. Neutralize any remaining acid by immersing the block in an alkali bath.

g. Wash the block with water or steam.

4. Dry the block with air and blow air through all the bolt holes.
5. Confirm that all water passages and oil galleries have been completely cleaned, then completely dry the block, and drive in new plugs, coated with sealing compounds.

INSPECTION AND REPAIR

1. CONNECTING ROD

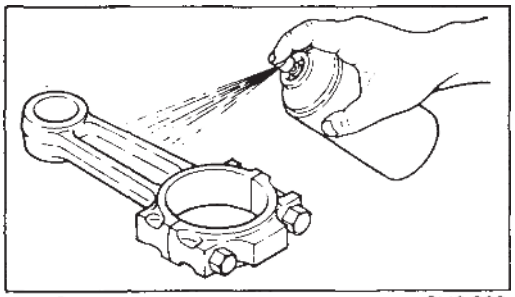


Fig. 13 SM3-363

1. Inspect with a dye penetrant or magnetic flaw detection test to see if there are any cracks or other defects on the connecting rod.

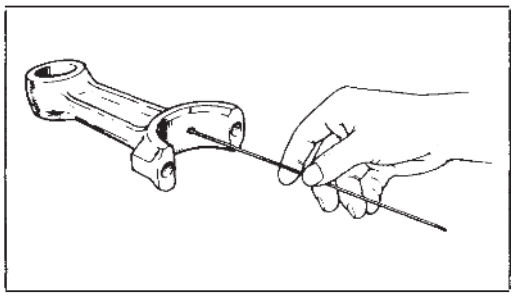


Fig. 14 SM3-424

2. An oil hole is provided in the connecting rod for lubricating the small end. Check to ensure that this hole is not clogged up, by blowing air through it or inserting a piece of wire into it.

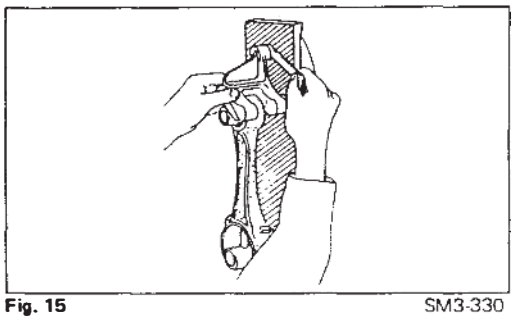


Fig. 15 SM3-330

3. Measure bending and twisting of the connecting rod. Measure the bending and twisting of the connecting rod using a connecting rod aligner. If the specified limits are exceeded, replace the connecting rod.

Service Limit;

Connecting Rod Straightness:
0.05 mm (0.0020 in) for each 100 mm (0.94 in)
Connecting Rod Twist:
0.05 mm (0.0020 in) for each 100 mm (3.94 in)

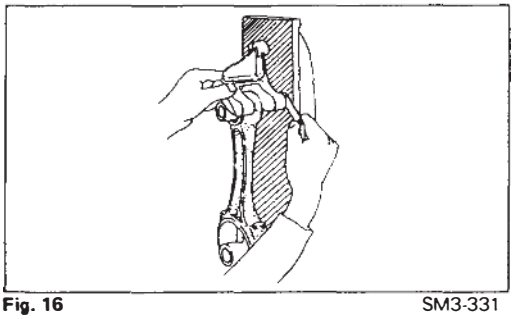


Fig. 16 SM3-331

2. MEASURE THE SMALL END BUSHING AND PISTON PIN.

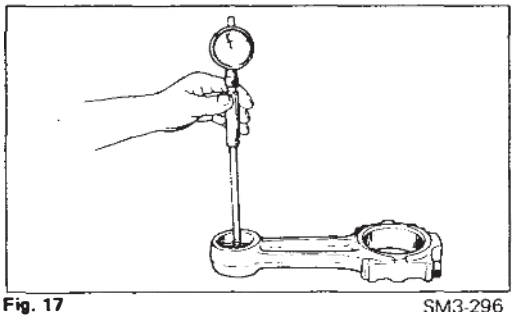


Fig. 17 SM3-296

1. Inspect the bushing of the connecting rod for scoring, seizure, or other damage, and replace it, if it is damaged.
2. Inspect the piston pin for signs of fretting and replace it, if it is damaged.
   The surface of the pin has been ground to a very fine finish. Do not, therefore, regrind it.

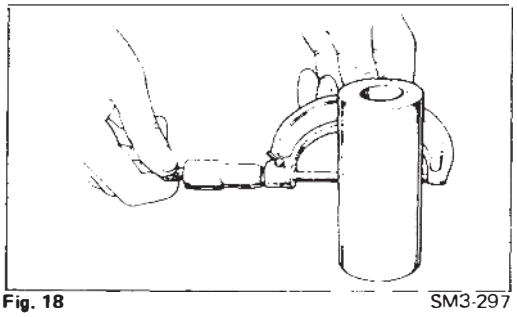


Fig. 18 SM3-297

3. Replace the piston pin if its outside diameter exceeds the specified limit.
4. Replace the piston pin or bushing if the clearance exceeds the specified limit.

Piston Pin Outside Diameter;
Nominal Dimension: 38.989 – 39.000 mm (1.5350 – 1.5354 in)
Service Limit : 38.95 mm (1.5334 in)
Clearance Between Piston Pin and Bushing;
Assembly Standard: 0.015 – 0.036 mm (0.0006 – 0.0014 in)
Repair Limit : 0.1 mm (0.004 in)

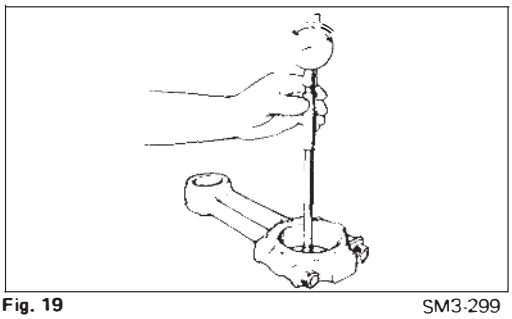


Fig. 19 SM3-299

3. MEASURE THE ROUNDNESS OF THE CONNECTING ROD.

Tightening Torque: 1,650–1,850 kg.cm (120–133 lb.ft)
Connecting Rod;
Nominal Dimension : 68.985–69.000 mm (2.7160–2.7165 in)
Roundness;
Service Limit : 0.06 mm (0.0024 in)

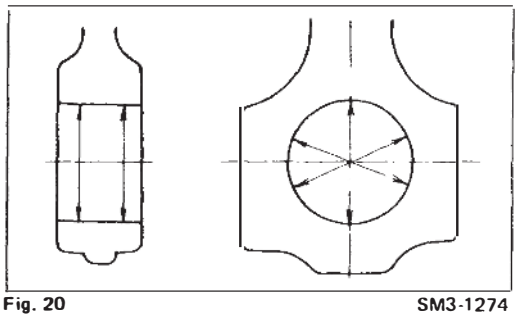


Fig. 20 SM3-1274

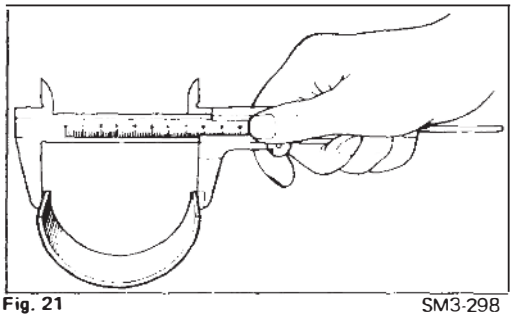


Fig. 21 SM3-298

4. MEASURE THE SPREAD DIMENSION OF THE CONNECTING ROD BEARING AND INSPECT THE CONNECTING ROD BEARING.

Inspect the connecting rod bearing.
If there is any scoring, pitching, flaking, corrosion, or seizure, replace both the top and bottom beraring as a set.

Nominal Dimension : 69.75 – 70.25 mm (2.7461 – 2.7657 in)
Service Limit : 69.2 mm (2.7244 in)

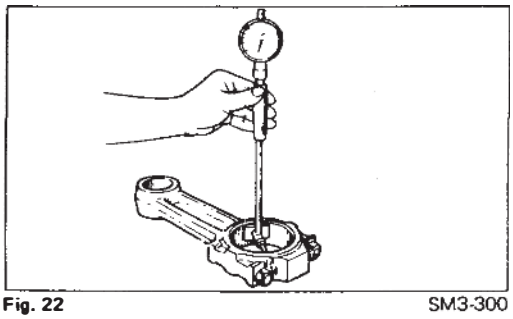


Fig. 22 SM3-300

5. MEASURE THE OIL CLEARANCE BETWEEN THE CONNECTING ROD AND CRANK PIN.

1. Measure the connecting rod inside diameter.

Tightening Torque: 1,650–1,850 kg.cm (120–133 lb.ft)

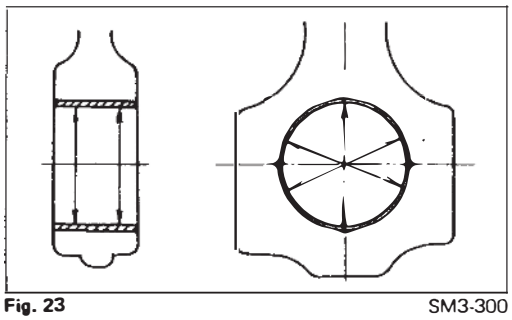


Fig. 23 SM3-300

2. Measure the crank pin diameter.
   If the clearance between the bearing and the crank pin exceeds the specified limit, replace the bearing. If the wear of the crank pin is great or uneven (see item on crankshaft), grind the crank pin to match an undersize bearing 4 types: 0.25 mm (0.0098 in), 0.50 mm (0.0197 in), 0.75 mm (0.0295 in), 1.00 mm (0.0394 in) and replace the bearing with an undersized one.

Assembly Standard: 0.031 – 0.082 mm (0.0012 – 0.0032 in)
Repair Limit : 0.15 mm (0.0059 in)

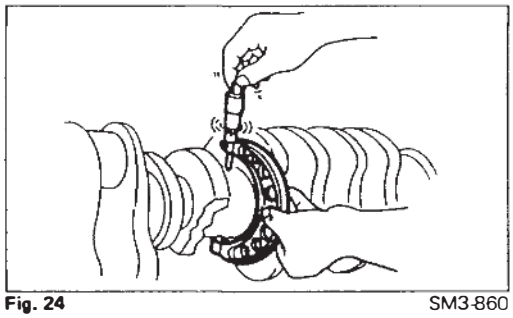


Fig. 24 SM3-860

NOTE: The connecting rod bearing consists of a top and bottom half. Be sure to replace both halves together.

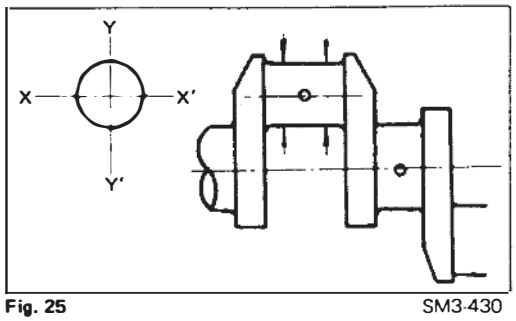


Fig. 25 SM3-430

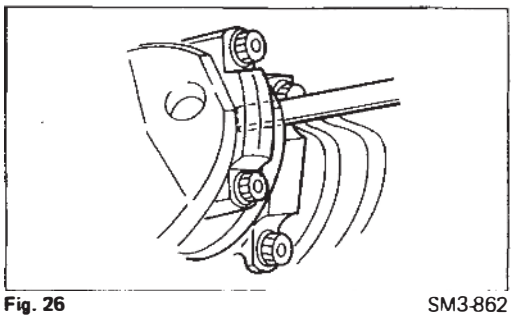


Fig. 26 SM3-862

6. MEASURE THE CONNECTING ROD END PLAY.

Assembly Standard: 0.2–0.5 mm (0.008–0.020 in)
Repair Limit : 0.6 mm (0.024 in)
Tightening Torque : 1,650–1,850 kg.cm (120–133 lb.ft)

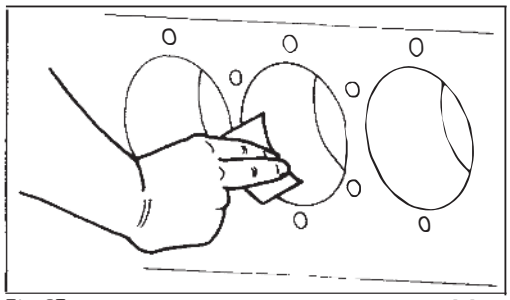


Fig. 27 SM3-359

7. INSPECT THE CYLINDER LINER

1. Before measuring the inside diameter of each cylinder liner, check to see that carbon has been removed from the inside of the liner and also if there are any scratch marks on the inside of the liner.

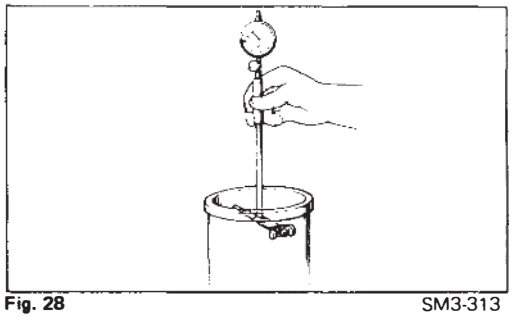


Fig. 28 SM3-313

2. Measure the inside diameter of the cylinder liner.

a. Using a cylinder gauge, measure the inside diameter of each liner at two points in the axial direction (X) and the perpendicular direction (Y), respectively. If the service limit is exceeded, replace the liner.

Nominal Dimention: **108 mm (4.25 in)**
Service Limit: **108.15** mm **(4.2579** in)

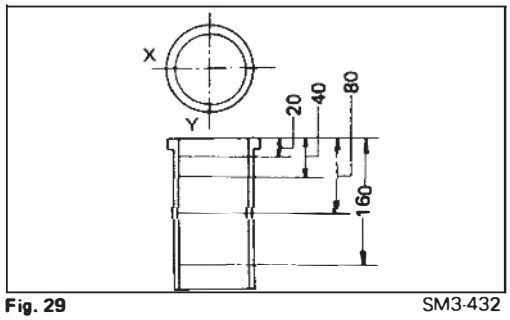


Fig. 29 SM3-432

b. If the wear of the cylinder liner is small and only the piston rings are to be replaced, correct the ridge at the top of the cylinder liner.

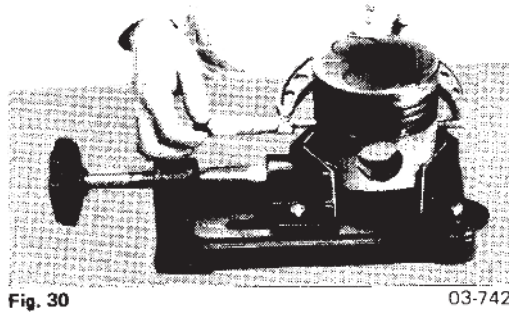


Fig. 30 03-742

8. MEASURE OF THE CLEARANCE BETWEEN CYLINDER LINER AND PISTON.

Measure the minimum inside diameter of the cylinder liner (bottom end of the liner) and the maximum outside diameter of the piston [64.2 mm (2.53 in) away from the bottom end of the piston and perpendicular to the pin] with a cylinder gauge and a micrometer, and calculate the clearance from the difference of the two. Replace both the piston and the liner if the standard value is exceeded.

Nominal Dimension of Liner: 108 mm (4.25 in)

Clearance Between Piston and Liner;
Assembly Standard: 0.192 – 0.224 mm
(0.0076 – 0.0088 in)

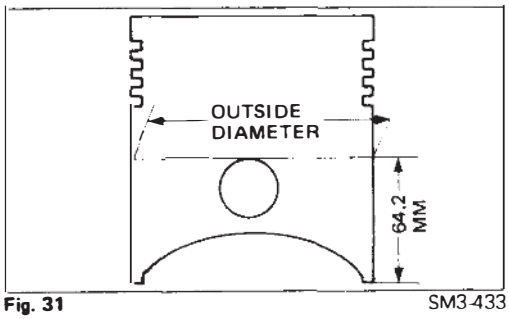


Fig. 31 SM3-433

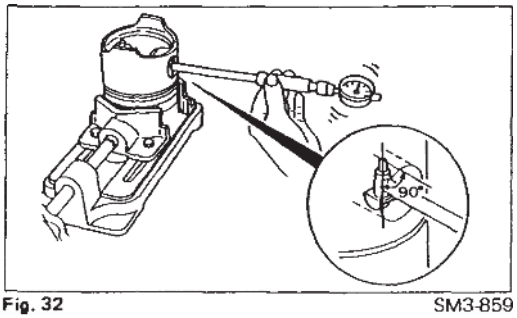


Fig. 32 SM3-859

9. MEASURE THE PISTON PIN HOLE AND PISTON PIN.

If the clearance exceeds the specified limit, replace the piston or piston pin.

Clearance Between Piston Pin Hole and Piston Pin:
0.013T – 0.014L mm (0.0005T – 0.0006L in)

Repair Limit: 0.1 mm (0.004 in)

NOTE: T = Tight, L = Loose

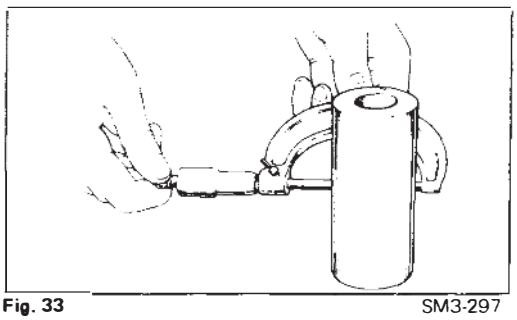


Fig. 33 SM3-297

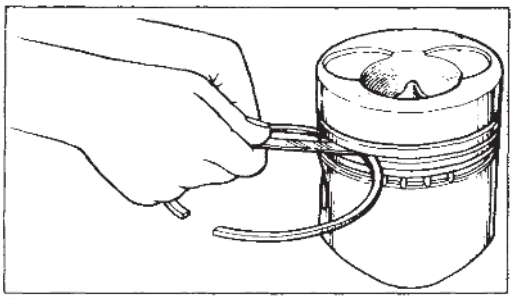


Fig. 34 SM3-301

10. MEASURE THE PISTON RING GROOVES AND RINGS

Insert the piston rings into the piston ring grooves, then measure the clearances between the ring grooves and the piston ring, using a thickness gauge. If the clearances exceed the specified limit, measure the thicknesses of the ring and also the width of the ring grooves. If these values also exceed the specified limits, replace the piston or piston rings.

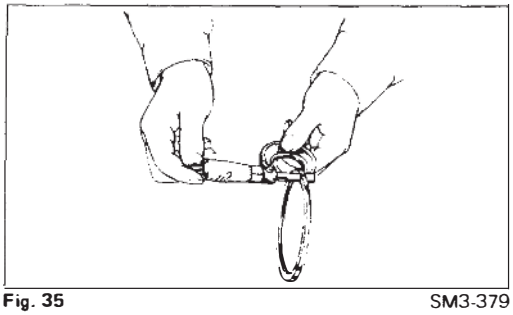


Fig. 35 SM3-379

Unit: mm (in)

	Clearance		Ring thickness		Groove width	
	Assembly standard	Repair limit	Dimension	Service limit	Dimension	Service limit
Top ring	Not easily measured.					
2nd ring	0.04–0.08 (0.0016–0.0031)	0.4 (0.016)	2.5 (0.098)	2.25 (0.0886)	2.5 (0.098)	2.75 (0.1083)
3rd ring	0.04–0.08 (0.0016–0.0031)	0.4 (0.016)	2.5 (0.098)	2.25 (0.0886)	2.5 (0.098)	2.75 (0.1083)
Oil ring	0.02–0.06 (0.0008–0.0023)	0.08 (0.0031)	5.0 (0.197)	4.95 (0.1949)	5.0 (0.197)	5.05 (0.1988)

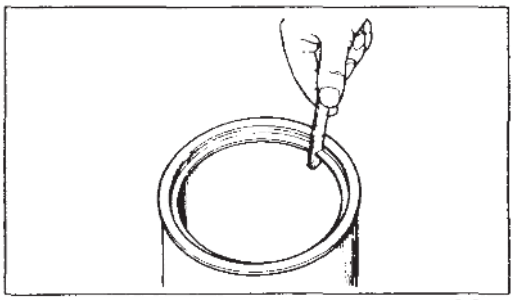


Fig. 36 SM3-302

11. MEASURE THE PISTON RING GAP

Insert the piston rings into the cylinder liner and measure the gap between the ends of each ring, using a thickness gauge.

During this above operation, insert the piston rings into the bottom portion where the wear of the liner is small, using the head of the piston and measure the gap after ensuring that each ring is perpendicular in the cylinder. If the gaps exceed the specified limits, replace the rings.

NOTE: If the liner is new, the piston rings may be installed in any part of the liner.

Piston Ring Gap; Unit: mm (in)

	Assembly standard	Service limit
Top ring	0.3 – 0.45 (0.012 – 0.017)	1.5 (0.059)
2nd ring	0.3 – 0.45 (0.012 – 0.017)	1.2 (0.047)
3rd ring	0.3 – 0.45 (0.012 – 0.017)	1.2 (0.047)
Oil ring	0.3 – 0.5 (0.012 – 0.019)	1.2 (0.047)

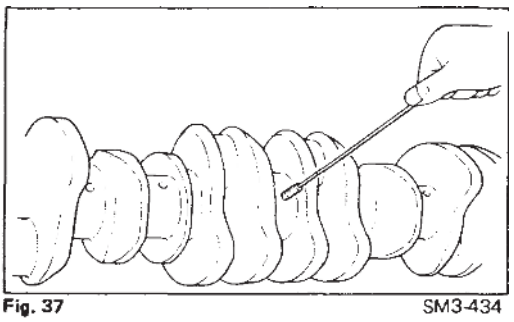


Fig. 37 SM3-434

12. INSPECT THE CRANKSHAFT

1. Completely clean the crankshaft with suitable cleaning solvent, and then blow air through the oil hole to see whether it is clogged.

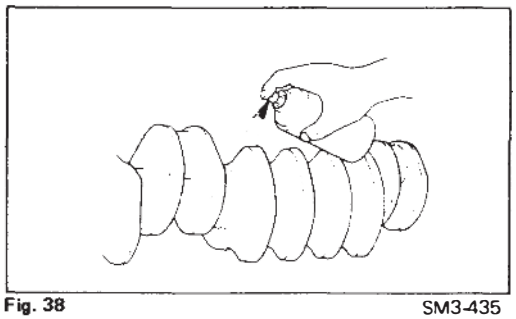


Fig. 38 SM3-435

2. It is necessary to carefully inspect the crankshaft, particularly the R portion and the oil holes of the journal and pin, for cracks, using a dye penetrant or magnetic flaw detector.
3. Check the surface of the crankshaft pin and journal for roughness and scratches, and grind or replace the crankshaft as necessary.

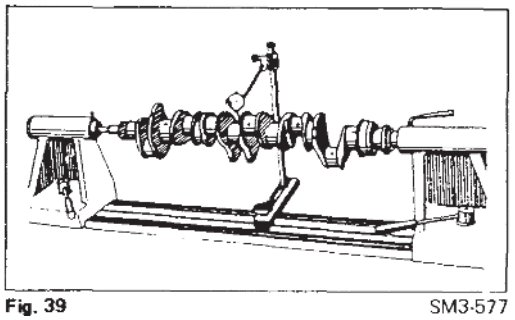


Fig. 39 SM3-577

4. Support the ends of the crankshaft on the V-block, then rotate the crankshaft and measure the amount of bending using a dial gauge.
   If the amount of bending exceeds the specified limit, replace the crankshaft.

Repair Limit: **0.18 mm (0.0071 in)**
(Indicator Reading)

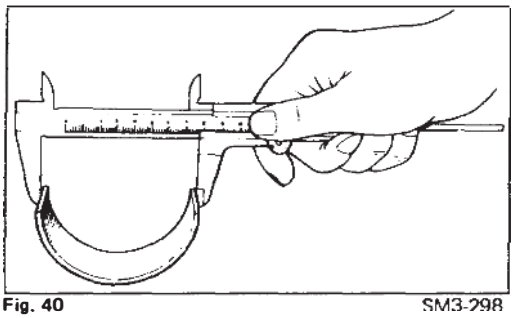


Fig. 40 SM3-298

13. MEASURE THE SPREAD DIMENSION OF THE MAIN BEARING AND INSPECT THE MAIN BEARING

1. If the spread dimension exceeds the standard dimension, replace the main bearing.
2. Inspect the main bearing for scoring, pitching, flaking, corrosion and seizure. In particular, check to see if there is any abnormality in the contact at the rear face of the bearing.
   If one of the above defects exists, replace the main bearing.

NOTE: If it is necessary to replace even one main bearing, replace all of the upper and lower bearings. Also, replace all of the bearings when the crankshaft is replaced with a new one.

Nominal Dimension: 85.75—86.75 mm (3.3760—3.4154 in)
Service Limit : 85.20 mm (3.3543 in)

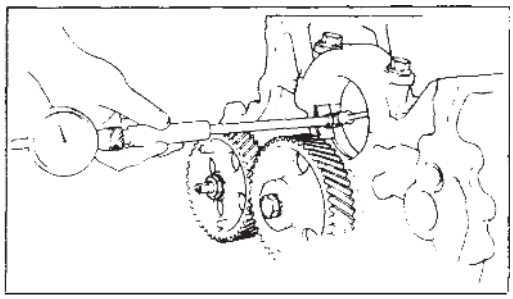


Fig. 41 SM3-436

14. MEASURE THE ROUNDNESS OF THE BEARING CAP

After tightening the main bearing cap of the crankshaft to the cylinder block, using the specified torque, slacken in and then tighten it to the specified torque again.
Then measure the roundness of the bearing cap using a cylinder gauge.
If, as a result of measurement, the specified limit is found to be exceeded, perform build-up welding and line boring or replace the cylinder block.

Tightening Torque: 1,600—1,800 kg·cm (115—130 lb.ft)
Repair Limit of Roundness: 0.06 mm (0.0024 in)

NOTE: The main bearing cap is machined together with the block.
Accordingly, during assembly, be sure to install each bearing cap in its original position.

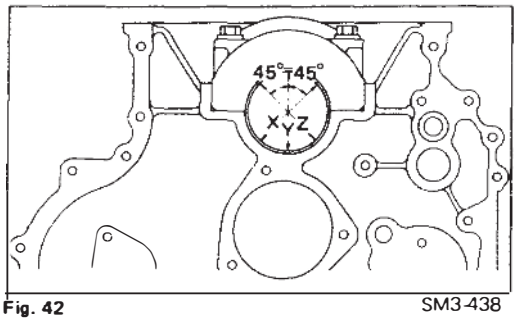


Fig. 42 SM3-438

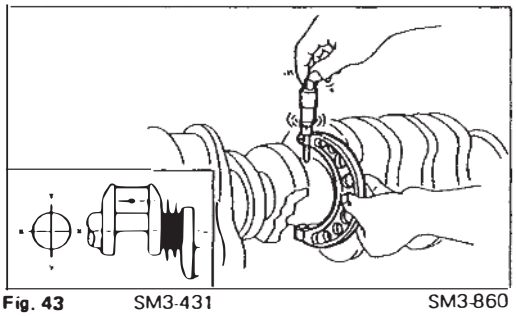


Fig. 43 SM3-431 SM3-860

15. MEASURE THE OIL CLEARANCE BETWEEN THE CRANKSHAFT JOURNAL AND MAIN BEARING

1. Crankshaft journal
   Measure the outside diameter of the journal of the crankshaft using a micrometer.

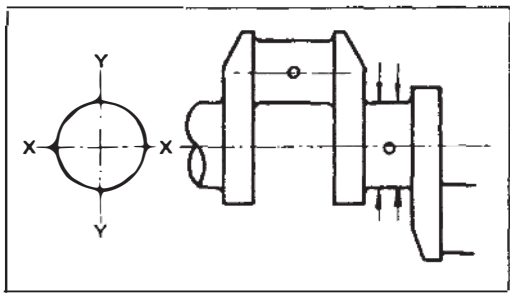


Fig. 44 SM3-431

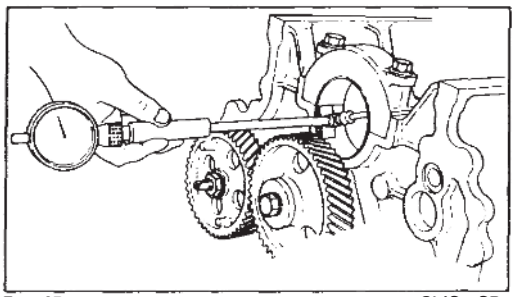


Fig. 45 SM3-437

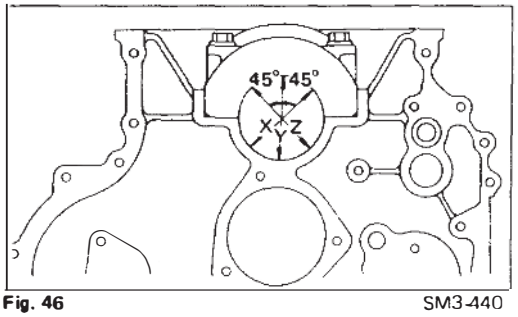


Fig. 46 SM3-440

Crankshaft maching;

Unit: mm (in)

Under size	Outside diameter	
	Crank pin	Journal
0.25	64.71–64.69 (2.5477–2.5468)	79.71–79.69 (3.1382–3.1374)
0.50	64.46–64.44 (2.5378–2.5370)	79.46–79.44 (3.1284–3.12750
0.75	64.21–64.19 (2.5280–2.5272)	79.21–79.19 (3.1185–3.1177)
1.00	63.96–63.94 (2.5182–2.5173)	78.96–78.94 (3.1087–3.1078)

Nominal Dimension : 80 mm (3.15 in)
Repair Limit : 79.9 mm (3.146 in)
Service Limit : 78.8 mm (3.102 in)

2. Bearing
Install the crankshaft main bearing on the cylinder block and cap, then tighten the cap bolts to the specified torque and measure the inside diameter with a cylinder gauge.

Tightening Torque: 1,600–1,800 kg·cm (115–130 lb.ft)
Assembly Standard Clearance: 0.051–0.102 mm (0.0020–0.004 in)
Repair Limit : 0.15 mm (0.0059 in)

NOTE:
- ○ If the clearance between the bearing and journal exceeds the specified limit, replace the bearing.
- ○ If the wear of the crankshaft journal matches an undersize bearing 4 types 0.25mm (0.00984 in), 0.50 mm (0.01968 in), 0.75mm (0.02952 in), 1.00 mm (0.03937 in), replace the bearing with an undersized one.
- ○ The main bearing is a set consisting of upper and lower halves. Consequently, be sure to replace the bearing as a set.

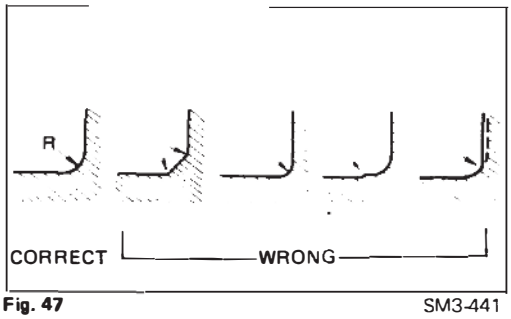


Fig. 47 SM3-441

Dimension of Fillet R:
Crank pin : 3.75–4.25 mm (0.1477–0.1673 in)
Journal : 3.00–3.50 mm (0.1182–0.1377 in)

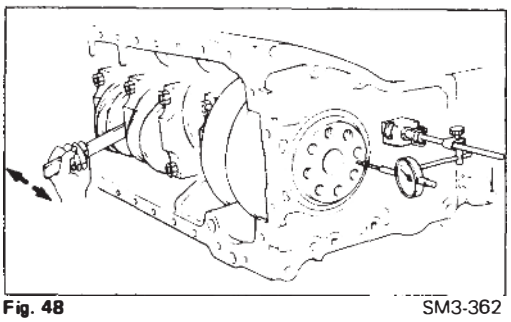


Fig. 48 SM3-362

16. MEASURE THE CRANKSHAFT END PLAY

Measure the end play of the crankshaft using a dial gauge. If the end play exceeds the specified limit, replace the thrust bearing with an oversize one 0.25 mm (0.0098 in).

Assembly Standard: 0.05 – 0.219 mm (0.0020 – 0.0086 in)
Repair Limit : 0.5 mm (0.020 in)

17. INSPECT THE CYLINDER BLOCK

1. Visually inspect each part of the cylinder block for cracking, and if necessary perform a dye penetrant. Clean out the various oil holes with compressed air.

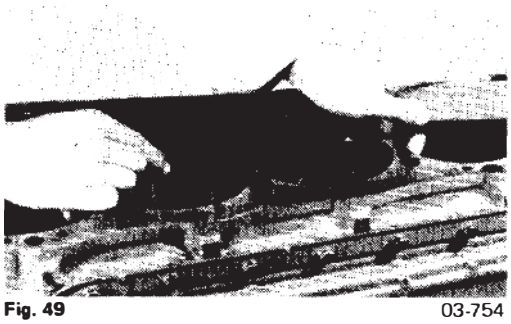


Fig. 49 03-754

2. Measure distortion at the top of the cylinder block.
Check the distortion at the top of the cylinder block, using a straight edge and a thickness gauge, employing the same procedure as that for the cylinder head.
If the specified limit is exceeded, replace the cylinder block.

Assembly Standard: 0 – 0.05 mm (0 – 0.0019 in)
Repair Limit : 0.1 mm (0.004 in)

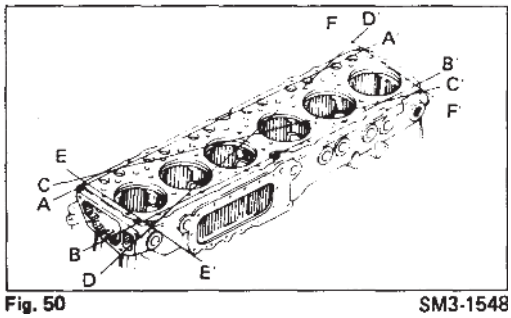


Fig. 50 SM3-1548

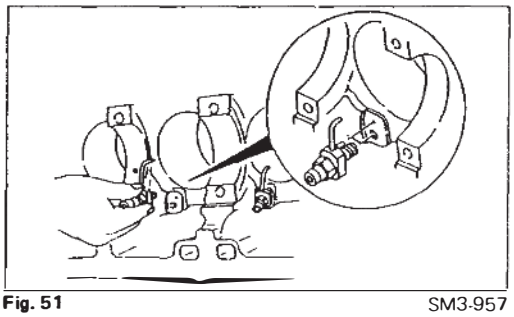


Fig. 51 SM3-957

18. INSPECT THE PISTON COOLING JET POSITIONING.

Inspection of the piston cooling jet positioning procedure are as follows.

1. Remove the piston cooling jet connector bolt and install a special tool.

Special Tool: Connector Bolt (9001-24262)

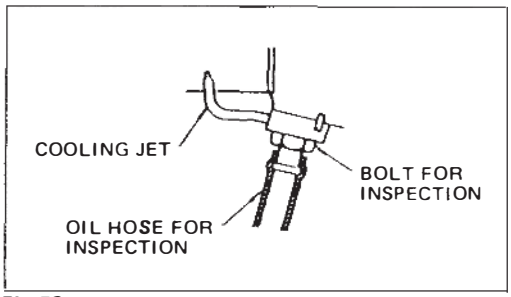


Fig. 52 SM3-579

2. Use a commercially available oil pump [pressure about 2 kg/cm², flow rate about 3ℓ/min (0.93 US.gal)].
3. Prepare new engine oil.
4. Connect the oil lines.
   Connect the oil pump outlet to a special tool (connector bolt).

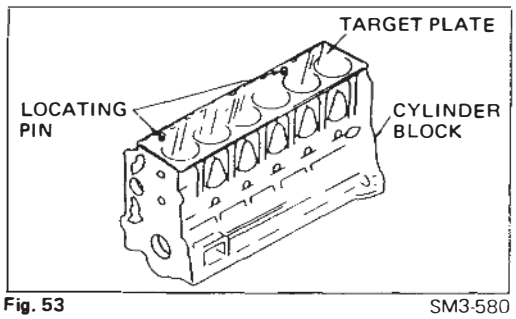


Fig. 53 SM3-580

5. Install a special tool on the cylinder block with locating pins.

Special Tool: Target Plate (09444-1290)

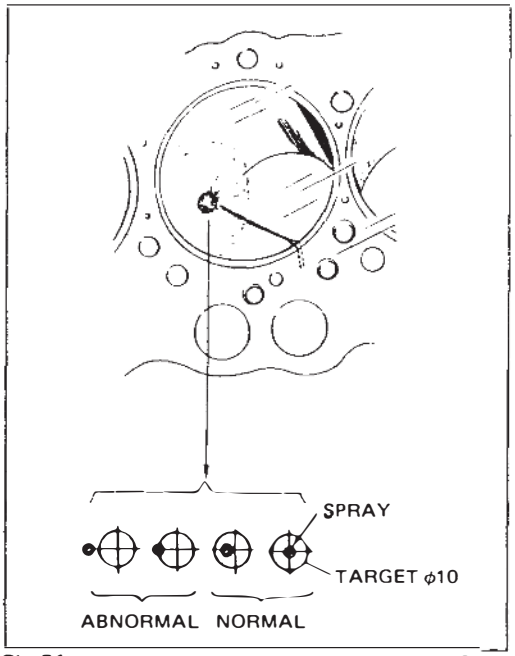


Fig. 54 SM3-581

6. Operate the oil pump, and with pressure at about 2 kg/cm² (28.44 lb/sq·in), pump new oil from the jet, and perform a spray test. Conditions are normal if the center of stream hits a target plate of ϕ10 mm (0.39 in).

WARNING

Diesel oil is flamable.
This spray test should be done in a well ventilated room and away from any open flames or electric sparks.

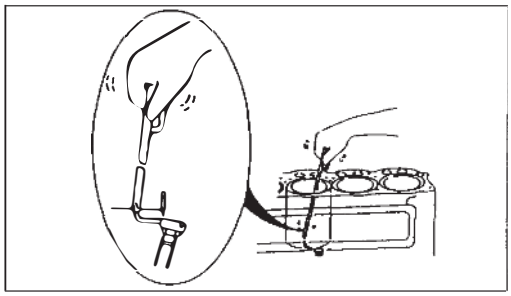


Fig. 55 SM3953

7. If the spray of the cooling jet messes the circle on the target plate, realign then nozzle using a special tool.

Special Tool: Adjuster bar (09472-1620)

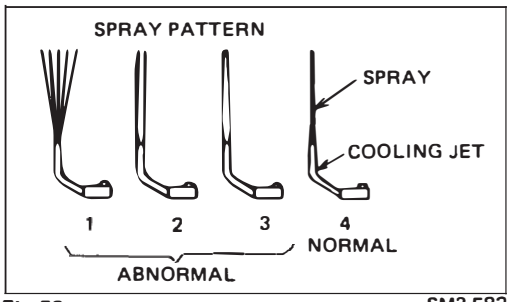


Fig. 56 SM3-582

8. Spray pattern.
When inspecting the piston cooling jet positioning, check that the spray is dispersed as shown in (4) and not as in (1), (2), or (3) in the illustration at left. Check that the spray is not a thin muddy color.

WARNING

If the tip of the jet is damaged so that the spray pattern is bad, replace the jet with a new one. When replacing the cooling jet, always inspect the new piston cooling jet's positioning.

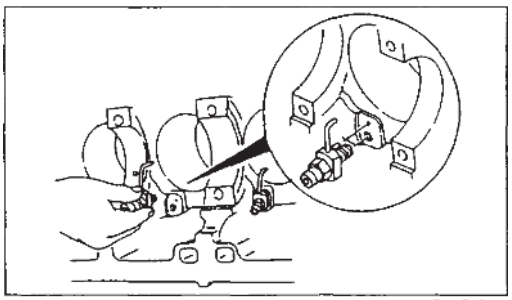


Fig. 57 SM3-957

9. After inspecting the piston cooling jet positioning. Remove the special tool (connector bolt), then install the cooling jet on the cylinder block using the correct mounting bolt.

Tightening Torque: 200–250 kg·cm (15–18 lb.ft)

10. After installing the piston, make sure that there is no interference between the cooling jet and the piston when the piston is at bottom dead center.

NOTE: ○ **Do not remove the cooling jet except when performing overhauls or when otherwise necessary.**
○ **In the event that the cooling jet is removed, be sure to replace it on the cylinder.**


Fig. 58 03-2425

19. INSPECT THE FLYWHEEL

1. Measure the runout of the friction face of the flywheel using a dial gauge. If the limit is exceeded, regrind the friction face.

Repair Limit: 0.3 mm (0.012 in)

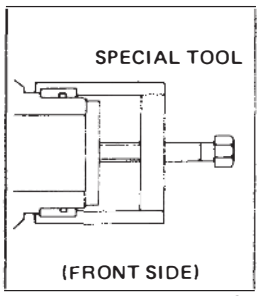
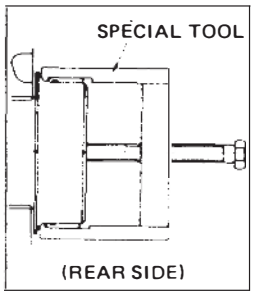


Fig. 59 SM3-565



SM3-566

20. REPLACEMENT OF THE CRANKSHAFT SLEEVE (FRONT AND REAR)

1. Remove the crankshaft sleeve using a special tool.

Special Tool: Puller (09401-1071)
Puller (09420-1420)

NOTE: Do not remove the crankshaft gear unless it is considered absolutely necessary.

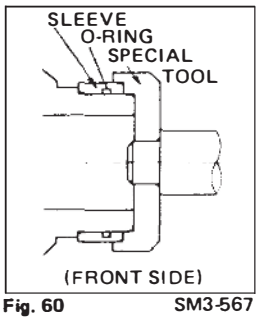
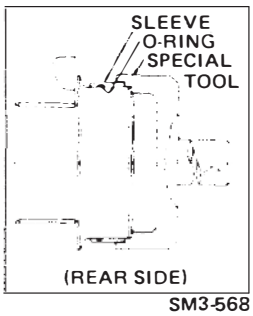


Fig. 60 SM3-567



SM3-568

2. Install a new sleeve
Be sure to fit an O-ring on the sleeve and also apply a liberal coating of oil to the pulley center side at the front, and the crankshaft side at the rear.
When driving on the crankshaft sleeve, use a crankshaft sleeve press, taking care that the O-ring does not get cut or torn.

Special Tool: Press (09402-1210)
Press (09482-1400)

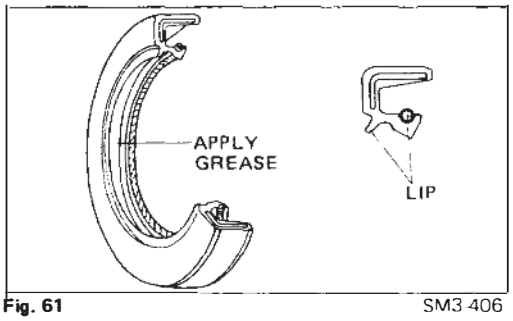


Fig. 61 SM3-406

21. INSPECT THE OIL SEAL

Inspect the lip of the crankshaft oil seal and if it is damaged, replace the oil seal. Check the oil seal in respect of the following items;

- **Wear of the lip.**
- **Cracking.**
- **Adhesion of foreign matter.**

NOTE:
- **In order to prevent oil leakage from the oil seals due to lip wear, apply grease between the main lip and sub lip.**
- **Grease used: Lithium-based grease.**
- **Greasing points:**
  Crankshaft oil seals (front and rear)
  Oil seal of injection pump drive shaft (installed on cylinder block).

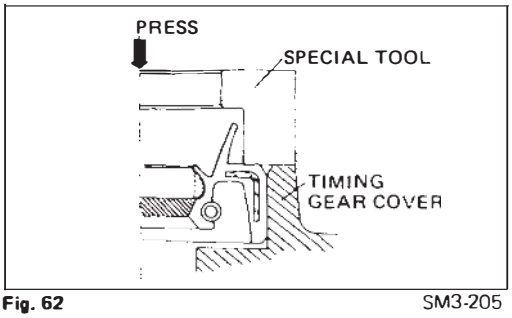


Fig. 62 SM3-205

22. METHOD OF INSTALLING OIL SEAL

1. Using a special tool, insert an oil seal to the timing gear cover, taking care that it does not project from the end of the timing gear cover.

Special Tool: Press (09482-1090)

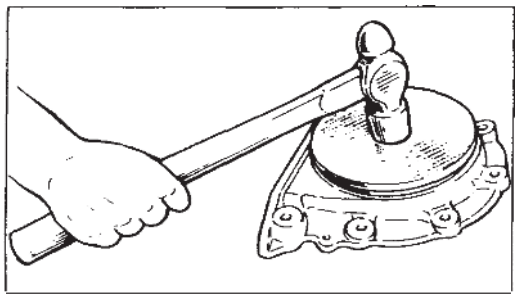


Fig. 63 SM3-373

2. Insert the oil seal to the seal case, ensuring that it is flush with the end of the seal case.

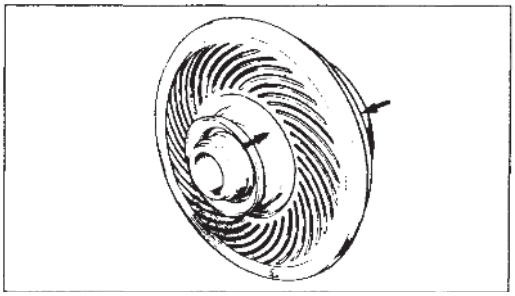


Fig. 64 SM3-372

23. INSPECT THE TORSIONAL DAMPER.

1. Clean the torsional damper with a suitable solvent cleaner.
2. Check if there are any cracks in the damper rubber section. If the cracks are excessive replacement is necessary.

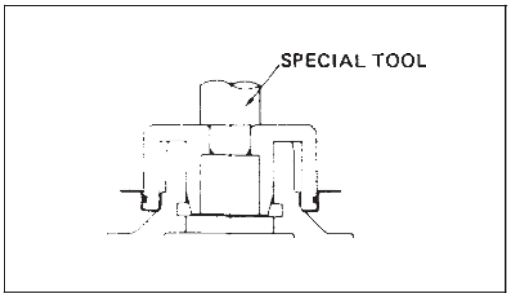


Fig. 65

24. INSTALL THE DUST SLINGER.

1. When driving in the dust slinger, use a special tool, and drive the dust slinger into the pulley center, ensuring that it is perpendicular to the pulley center.

Special Tool : Dust Slinger Press (09402-1340)

2. After driving in the front dust slinger, be sure that the straight portion of the pulley center is visible to ensure that the dust slinger does not drop out.

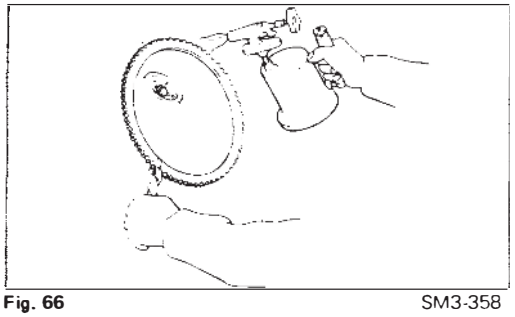


Fig. 66 SM3-358

25. INSTALL THE RING GEAR (WHEN REPLACING RING GEAR ONLY)

1. Heat the ring gear uniformly using a blow torch [approx. 100°C (212°F)].
2. Drive the ring gear with its chamfered gear teeth facing the block onto the flywheel using a metal rod.

NOTE: Be careful not to overheat the ring gear.

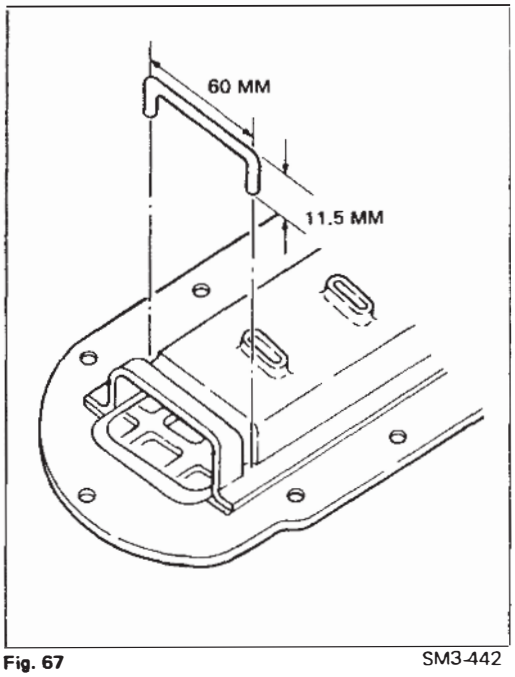


Fig. 67 SM3-442

26. REMOVE, INSPECT AND INSTALLING THE COOLANT GALLERY COVER.

1. Remove the coolant gallery cover.
2. Make sure that there are no holes or other defects in the coolant gallery cover. If there are any defects, replace the cover with a new one.
3. Using a new gasket, install the coolant gallery cover.

NOTE:
- **To ensure that the coolant passes through the inside of the cover, cut seal rubber to the dimension as shown, then insert it into the cover.**
- **Do not apply sealing compound to the gasket face.**

27. INSPECT THE CAMSHAFT END PLATE

1. Make sure that there is no oil leakage from the camshaft hole in the rear wall of the cylinder block.
   If there is oil leakage, replace the O-rings.

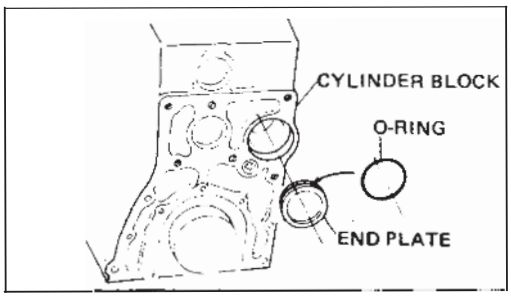


Fig. 68 SM3-360

2. Install the O-ring to the end plate.

NOTE: **Carefully observe the following points to ensure that oil does not leak from the end plate fitted over the camshaft hole.**
- **Do not twist the O-ring when installing it on the end plate.**
- **As a general rule, fit the end plate on the cylinder block by hand, taking care to avoid damaging (cutting, tearing or twisting) it. Also, coat the periophery of the O-ring with seal compound (Three Bond 1215).**
- **Do not re-use end plate after removing them.**

ASSEMBLY

1. INSERT THE CYLINDER LINER INTO THE CYLINDER BLOCK.

1. There are 4 different liner and cylinder block matches. The flange section of each liner has a marking either, W, X, Y, Z, or indicating the size of the outer diameter of the liner on which it is stamped. The markings W, X, Y and Z, indicating the inner diameter of the cylinder bore supporting the liner on the sides and top of the cylinder block (the boss section for attaching the coolant gallery cover), are inscribed on each cylinder.

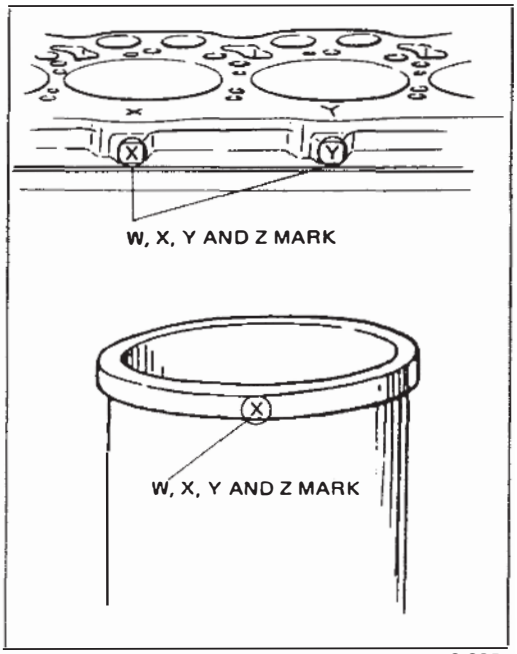


Fig. 69 SM3-387

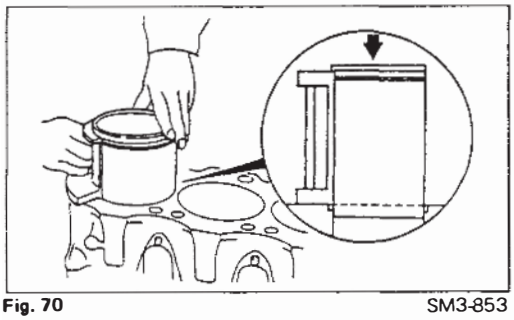


Fig. 70 SM3-853

2. New cylinder liners
When a new cylinder liner is used, make sure that the liner has the same mark as the mark on the cylinder block.

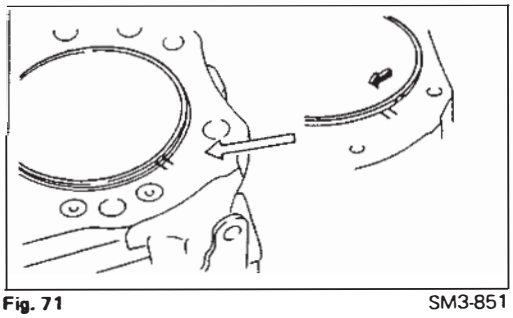


Fig. 71 SM3-851

3. When reusing a liner, insert the liner its original position aligning the marking marked before disassembly.
4. Apply a small amount of clean engine oil on the outer periphery of the liner, and apply pressure on the entire flange section of the liner. If insertion by hand is difficult, use a cylinder press, and the cylinder will easily be pushed in.

Special Tool: Cylinder Liner Press (09480-1040)

NOTE:
- **Do not use a liner that has been dropped.**
- **Take extra care when handling the liner since the liner is easily deformed.**

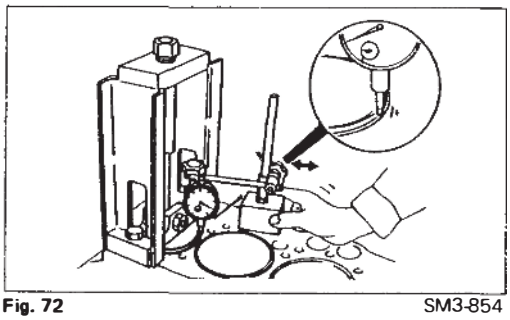


Fig. 72 SM3-854

2. MEASURE THE PROJECTION OF THE CYLINDER LINER.

Tighten a special tool with a tightening torque of 100 kg.cm (7.23 lb-ft) and measure the amount of projection of the top end of the liner from the cylinder block with a dial gauge or straight edge and a thickness gauge.

Special Tool : Cylinder Liner Puller (09420-1240)
Tightening Torque : 100 kg.cm (7.23 lb.ft)
Assembly Standard: 0.01–0.08 mm (0.0004–0.0031 in)

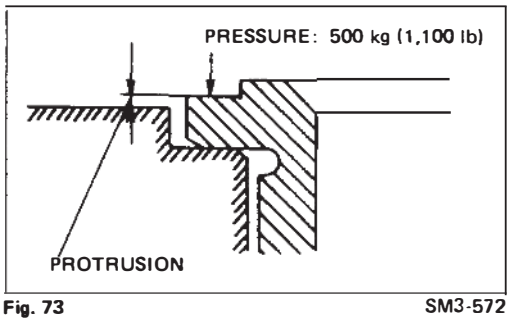


Fig. 73 SM3-572


Fig. 74 03-762

3. MOUNTING THE CRANKSHAFT.

1. Install the crankshaft bearings on the cylinder block.

NOTE: ○ **Apply new engine oil to each bearing surface.**
○ **The width of each bearing varies with its position. Accordingly, be sure that the bearings are installed in the correct order.**
○ **Install each bearing after aligning the projection on one end with the depression in the block and cap.**

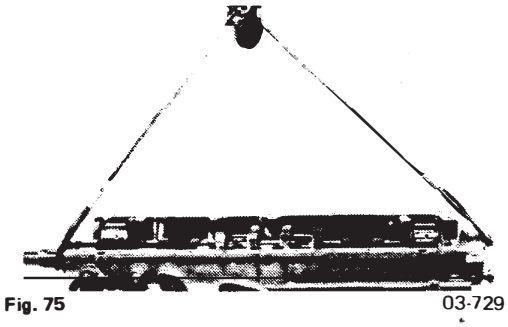


Fig. 75 03-729

2. Install the crankshaft on the cylinder block.

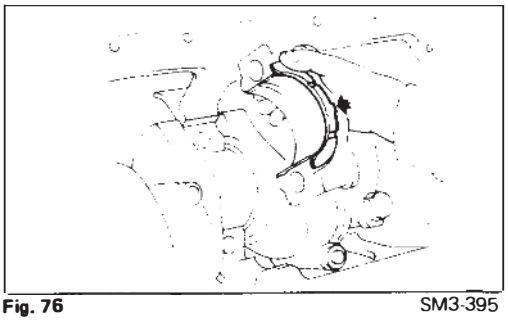


Fig. 76 SM3-395

3. Insert the crankshaft thrust bearings along the groove of the cylinder block.

4. Install the thrust bearings on the No.4 bearing cap sides. Install one bearing on each side of the No.4 cap and on each side of main bearing support that is, a total of 4, with the oil groove side on the thrust direction of the crankshaft.

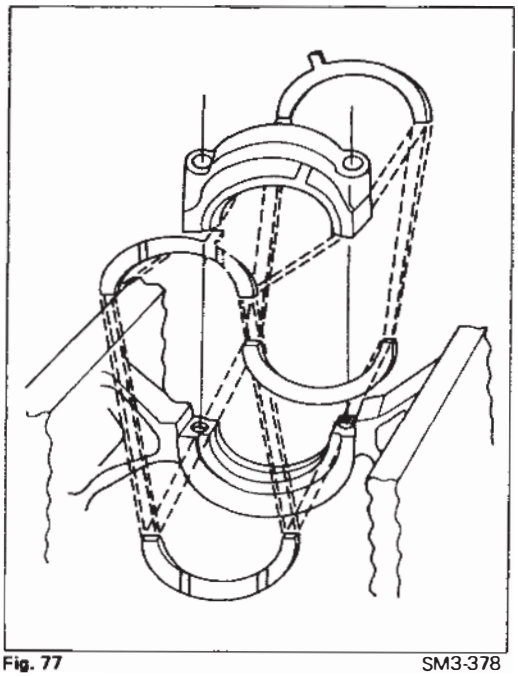


Fig. 77 SM3-378

NOTE:
- **Make sure which side is the front and which side is the back when installing the thrust bearings.**
  Install the bearings by facing the front side (the side with the groove) towards the crank arm and the back side (the side with the parts number in green) toward the main bearing support and cap and then apply grease or engine oil on both sides of the bearings before installing.
- **Install the thrust bearings after aligning the lug of the thrust bearing with the groove in the bearing cap.**

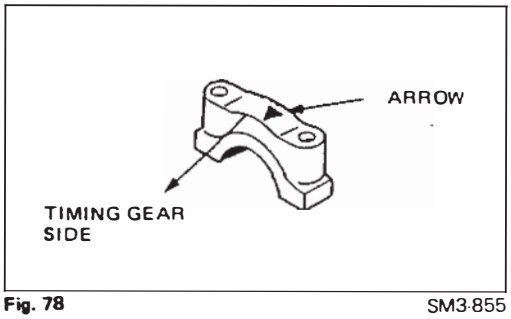


Fig. 78 SM3-855

5. Install the crankshaft bearing caps tighten them to the specified torque, then slacken and tighten it to the specified torque again.

Tighten Torque: 1,600–1,800 kg·cm (115–130 lb.ft)

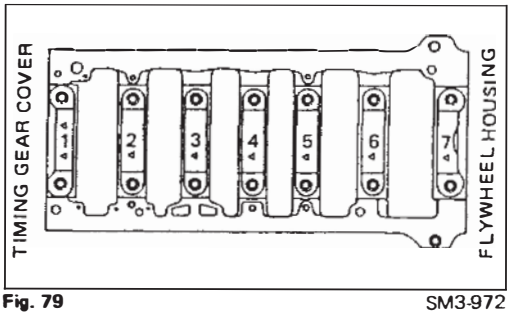


Fig. 79 SM3-972

a. Numbers 1 through 7 are marked on the rear of the caps. Install the caps in that sequence from the timing gear end.

b. An arrow is embossed on the rear of each cap. Install the caps so that the arrow points toward the timing gear.

c. Tighten the caps in the order No. 4, 3, 5, 2, 6, 1 and 7.

6. After tightening each cap, rotate the crankshaft and make sure that it turns smoothly.
Because the main bearing cap bolts have been specially designed for this purpose, do not under any circumstances use or dinary bolts.

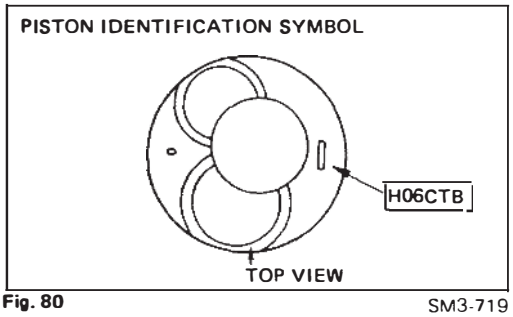


Fig. 80 SM3-719

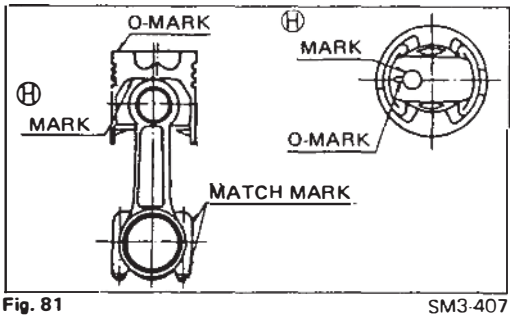


Fig. 81 SM3-407

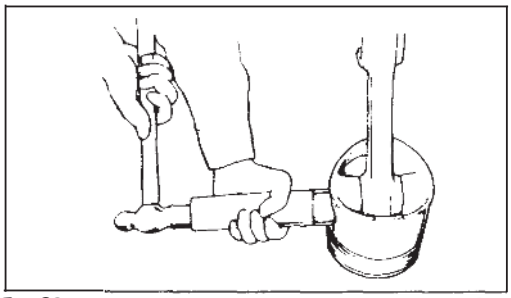


Fig. 82 SM3-304

4. ASSEMBLE THE PISTON

1. Matching engine model and piston

WARNING

When installing a new piston, be sure that it is matched with the engine model.

Correspondence between engine models and the identification symbol impressed on the piston top is as shown below.

* The engine models designation is impressed on the righthand side of the cylinder block as viewed from the fan side.

NOTE: Assemble the various parts after applying engine oil to the sliding portions.

2. Assemble the piston and connecting rod.

a. When assembling the piston and connecting rod, ensure that the O-mark at the top of the piston and the H-mark at the back of the piston are in the opposite direction of the matching mark on the connecting rod.

b. When inserting the piston pin into the piston, install one new retainer ring at the end of the piston, heat the piston to about 80–90°C (176–194°F) in hot water about 5 minutes. Apply oil to the piston pin. Fix the piston and connecting rod by inserting the pin, and fit the new retainer ring at the other end.

a) When fixing the piston, use a piece of cloth to protect it from damage.

b) When inserting the piston pin, be careful not to damage the groove of the retainer ring which has been firmly inserted.

PISTON RING		
No. 1	Top ring	
No. 2	2nd ring	
No. 3	3rd ring	
No. 4	Oil ring	

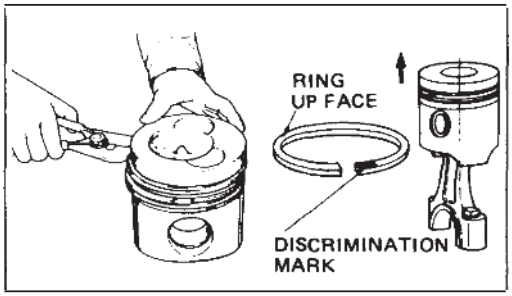


Fig. 83 SM3-295

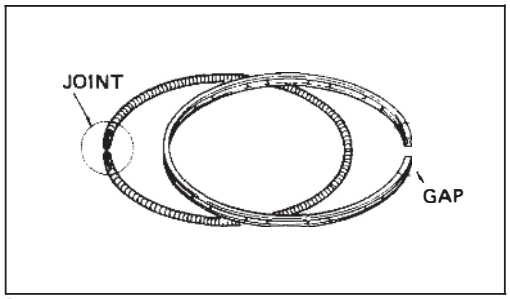


Fig. 84 SM3-443

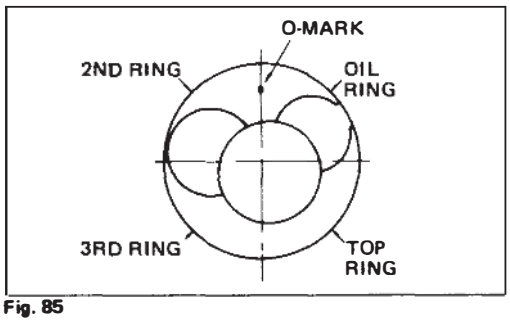


Fig. 85

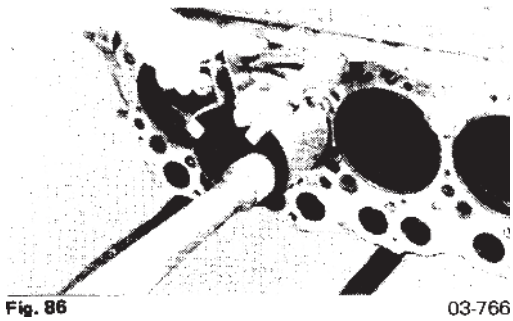


Fig. 86 03-766

3. Install the piston rings.

a. When installing the piston rings on the piston ensure that the piston skirt is at the bottom, and use a special tool.
Install the piston rings in the sequence 4, 3, 2, 1 with the identification mark at the top of the ring facing up.

Special Tool: Piston Ring Expander (09442-1061)

b. Install the oil ring after determining the orientation of the coil expander.

a) Connect the ends of the coil expander and then fit the coil inside the piston ring after ensuring that the gap of the piston ring is 180° away from the joint of the coil.

b) Because the oil ring forms a set with the coil, be careful not to replace it with a ring belonging to another set.

4. Install the connecting rod bearing.

a. Install the connecting rod bearing, which has one oil hole on the connecting rod side, and which has two oil holes on the cap side.

b. During this operation align the projecting portion at one end of the bearing with the recessed portion at the end of the connecting rod.

c. When reusing the bearings, reinstall them in their original positions.

5. INSTALL THE PISTON IN THE CYLINDER LINER.

1. Rotate the crankshaft to the bottom dead center position.

2. Arrange the piston rings so that their gaps are equally spaced.

3. Hold the piston rings using a special tool.

NOTE: Check the piston that the O-mark on the top is on the tappet chamber side.

Special Tool: Piston Ring Holder (09441-1101)

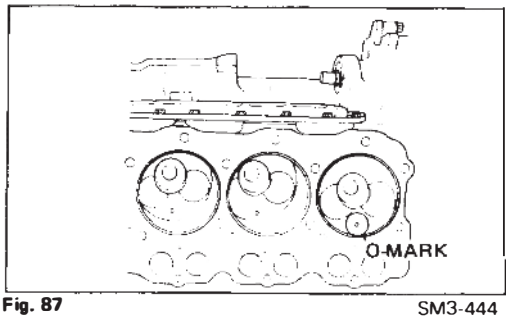


Fig. 87 SM3-444

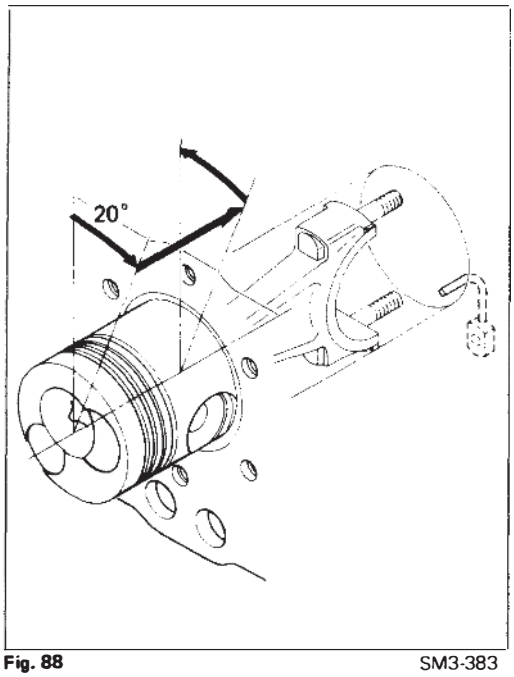


Fig. 88 SM3-383

4. Push the piston and connecting rod assembly using a wooden rod.

NOTE: **When installing the piston and connecting rod assembly, be careful that the cooling jet is not struck by the connecting rod. If the cooling jet is struck, adjust or replace**

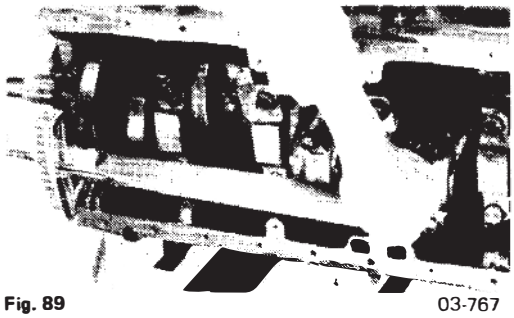


Fig. 89 03-767

6. INSTALL THE CONNECTING ROD

1. Install the connecting rod with bearing and cap with bearing on the pin of the crankshaft, being sure to align the match marks.

a. When installing the cap liberally coat the bearing surface with engine oil.

b. After coating the threaded portions and the bearing surface of the cap bolts with engine oil, tighten the bolts to the specified torque, loosen them, and retighten them to the specified torque.

Tightening Torque: 1,650–1,850 kg.cm (120–133 lb.ft)

7. INSTALL THE OIL PUMP, TIMING GEAR CASE, SUCTION STRAINER, OIL PAN ETC.

8. INSTALL THE CRANKSHAFT DAMPER ON THE CRANKSHAFT, INSERT THE SPACER AND THEN TIGHTEN UP THE FRONT NUT.

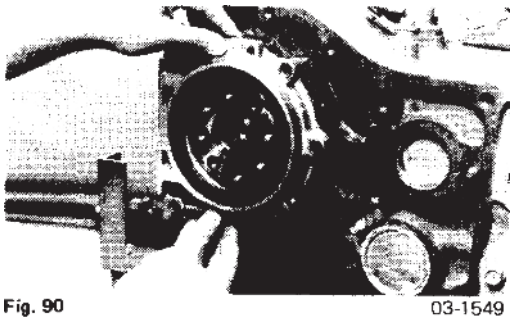


Fig. 90 03-1549

9. INSTALL THE OIL SEAL CASE.

Tightening Torque: 190–260 kg.cm (14–18 lb.ft)

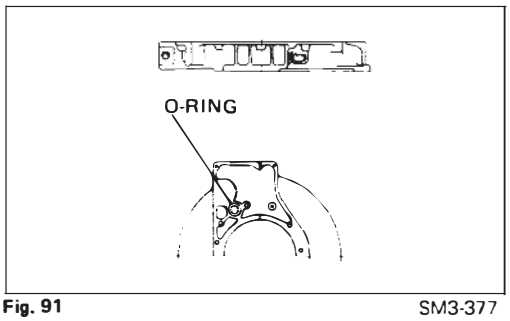


Fig. 91 SM3-377

10. INSTALL THE FLYWHEEL HOUSING.

NOTE: ○ When fitting an O-ring to the alignment face of the flywheel housing, apply adhesive to the housing to prevent to O-ring from dropping off.

○ Adhesive: Three Bond No. 1215

Tightening Torque;
Bolt Size:

10 mm Diameter (0.4 in) . . . . . 400 – 500 kg.cm (29 – 36 lb.ft)

12 mm Diameter (0.47 in) . . . . . 650 – 870 kg.cm (47 – 62 lb.ft)

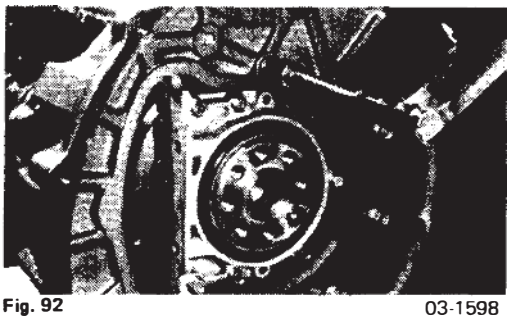


Fig. 92 03-1598

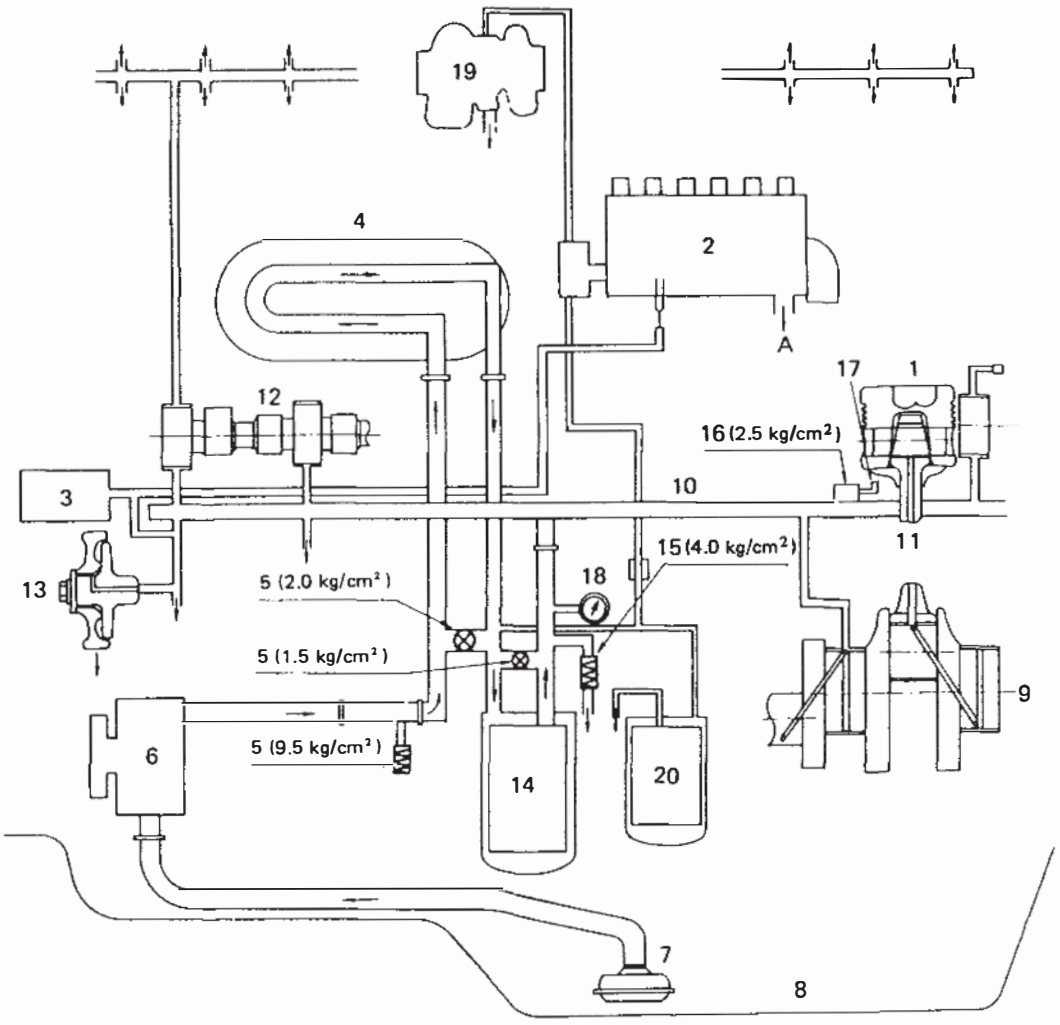
Fig. 93 032424

11. INSTALL THE FLYWHEEL.

NOTE: Align the "O" mark on the flywheel and crankshaft collar knock-in.

Tighting Torquq: 1,800–2,000 kg.cm (130–144 lb.ft)

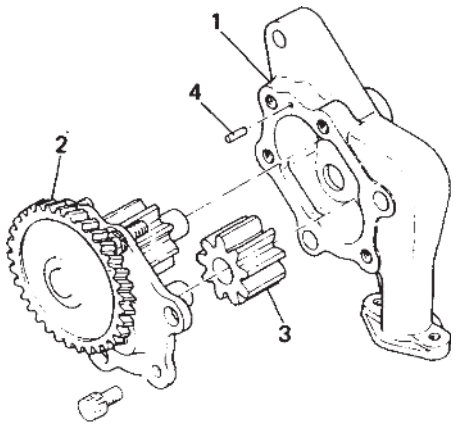
LUBRICATING SYSTEM



1. Piston
2. Fuel injection pump
3. Fuel injection pump drive gear
4. Oil cooler
5. Safety valve
6. Oil pump
7. Suction strainer
8. Oil pan
9. Crankshaft
10. Main hole
11. Connecting rod
12. Camshaft
13. Idler gear
14. Oil filter (Full-flow)
15. Regulator valve
16. Check valve
17. Piston cooling jet
18. Pressure gauge
19. Turbocharger
20. Oil filter (By-pass) (OPTION)

A: To oil pan

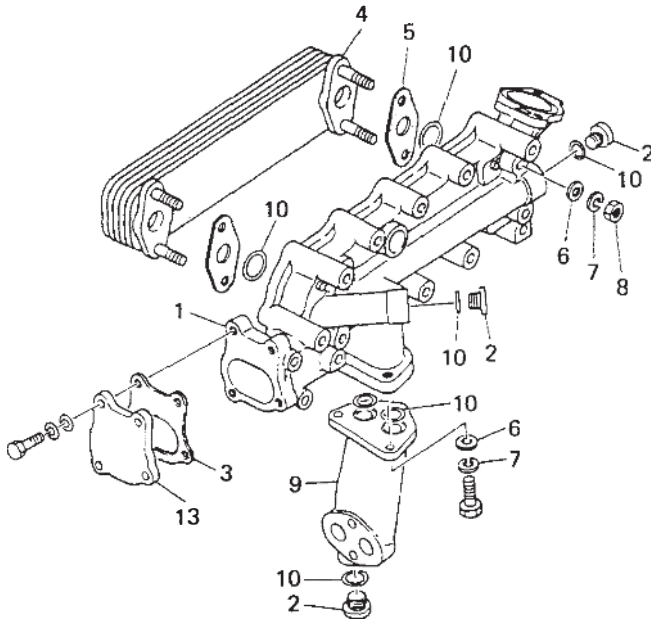
Fig. 1 SM3-721



OIL PUMP

1. Case
2. Oil pump cover sub assembly
3. Driven gear
4. Straight pin

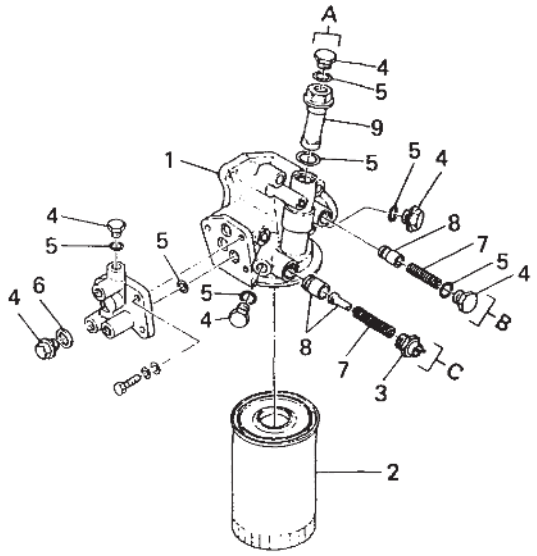
Fig. 2 SM3-1312



OIL COOLER

1. Case
2. Plug
3. Gasket
4. Oil cooler element
5. Element gasket
6. Plain washer
7. Lockwasher
8. nut
9. Oil cooler pipe
10. O-ring
11. Bolt
12. O-ring
13. Cover

Fig. 3 SM3-1529

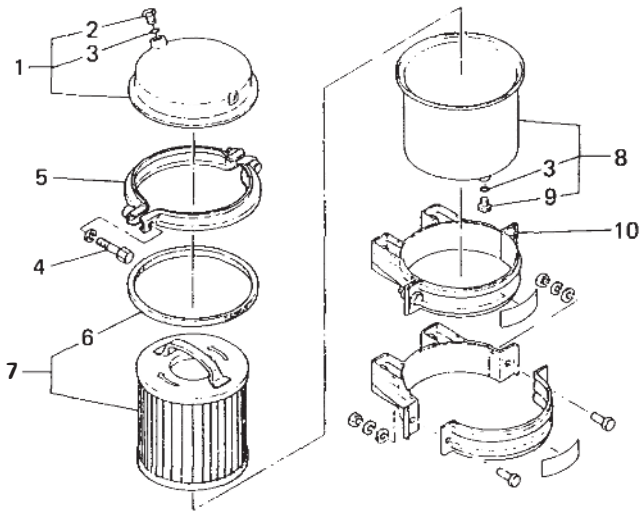


OIL FILTER PARTS

A. Regulator valve assembly
B. Oil cooler safety valve assembly
C. Oil filter safety valve

1. Oil filter assembly
2. Element set (Full-flow)
3. Plug assembly
4. Plug
5. O-ring
6. Gasket
7. Spring
8. Valve
9. Regulator valve
10. Insulator

Fig. 4 SM3-1530



BY-PASS OIL FILTER PARTS (OPTION)

1. Cover
2. Breather plug
3. O-ring
4. Bolt
5. Clamp
6. Gasket
7. Element
8. Case
9. Drain plug
10. Bracket

Fig. 5 SM3-1547

OIL PUMP

DISASSEMBLY

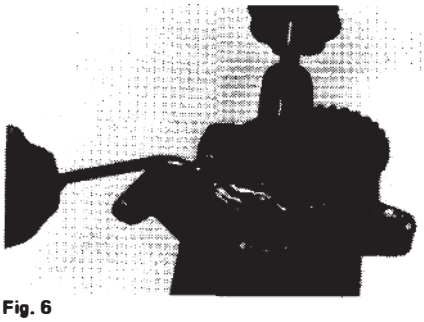


Fig. 6 03-1561

Loosen the bolts to remove the oil pump cover assembly. Remove the driven gear.

NOTE: **It is not possible to disassemble the oil pump drive gear since it is a press-fit type.**

INSPECTION AND REPAIR

1. Inspect the gear.

a. Clean the various parts with cleaning solvent, and then inspect them.

b. Inspect each gear, shaft, bushing, collar and cover for possible damage.
If there is any damage, replace them.

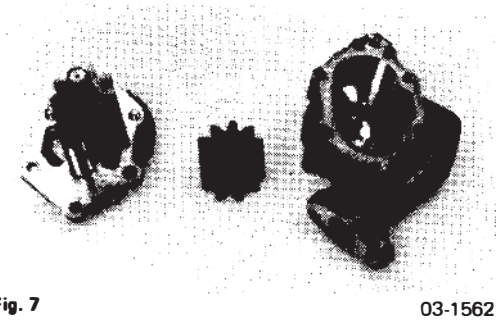


Fig. 7 03-1562

2. Measure the gear backlash.

Assembly Standard: 0.15–0.30 mm (0.0059–0.0118 in)
Repair Limit : 0.40 mm (0.0157 in)

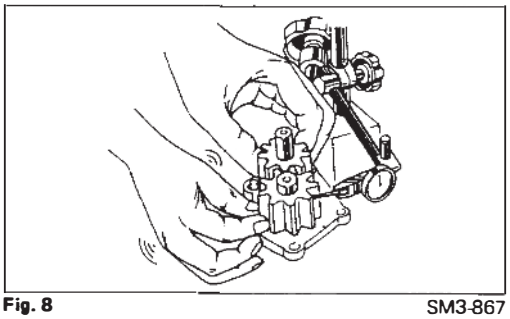


Fig. 8 SM3-867

3. Measuring the end play of gears.
Set the straight edge against the mounting face of the case cover, and measure the end play with a thickness gauge.
If it exceeds the specified limit, replace the oil pump assembly.

Assembly Standard: 0.030–0.095 mm (0.0012–0.0037 in)
Repair Limit : 0.15 mm (0.0059 in)

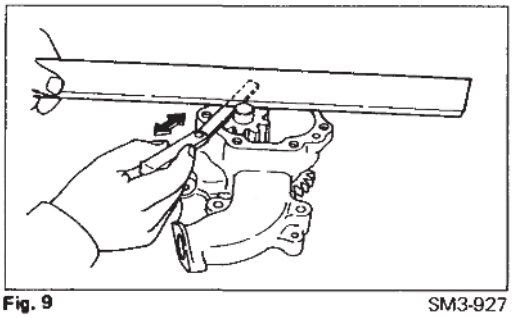


Fig. 9 SM3-927

4. Measure the outside diameter of the driven shaft and inside diameter of the driven gear.
Measure the outside diameter of the driven shaft and the inside diameter of the driven gear using a micrometer and cylinder gauge. If the specified limit is exceeded, replace the bushing and/or oil pump assembly.

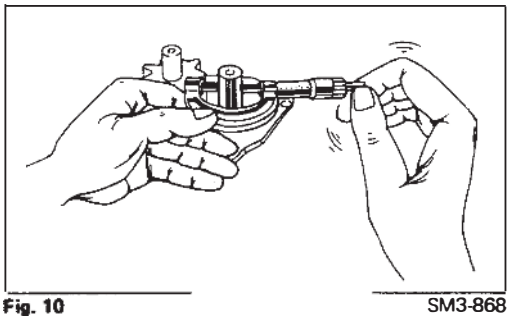


Fig. 10 SM3-868

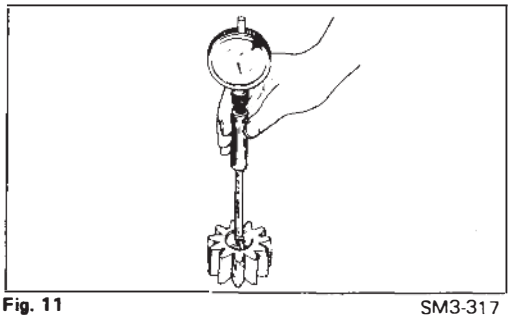


Fig. 11 SM3-317

Assembly Standard: 0.040 – 0.083 mm (0.0016 – 0.0032 in)
Repair Limit : 0.15 mm (0.0059 in)

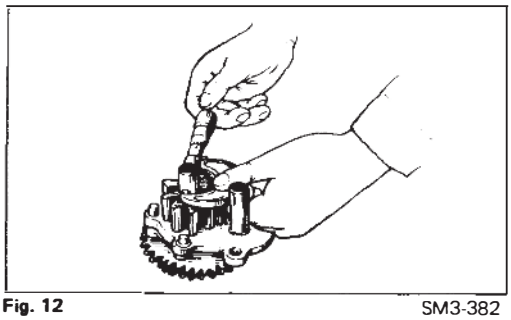


Fig. 12 SM3-382

5. Measuring the outside diameter of the drive shaft and the hole diameter of the case.
   Measure the outside diameter of the driveshaft and the hole diameter of the case using a micrometer and cylinder gauge. If the specified limit is exceeded, replace the oil pump assembly and/or case assembly.

Assembly Standard: **0.040 – 0.085 mm (0.0016 – 0.0033 in)**
Repair Limit : **0.15 mm (0.0059 in)**

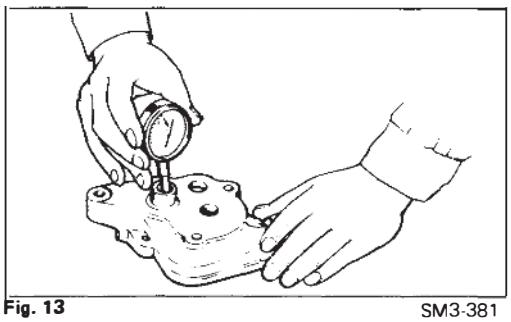


Fig. 13 SM3-381

ASSEMBLY

After installing the driven gear on the cover, install the cover assembly on the case using 4 bolts.

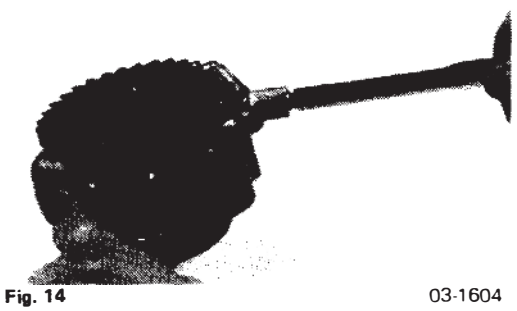


Fig. 14 03-1604

OIL PUMP SAFETY VALVE

DISASSEMBLY

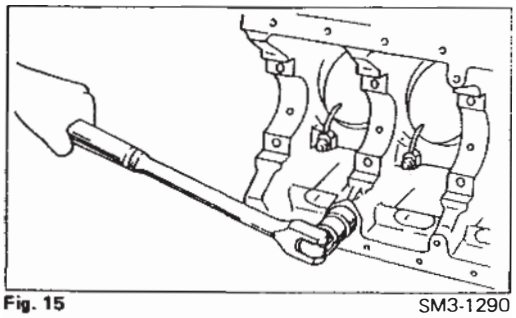


Fig. 15 SM3-1290

1. Remove the safety valve from the bottom of the block.
2. Remove the retainer ring, and then disassemble the safety valve.

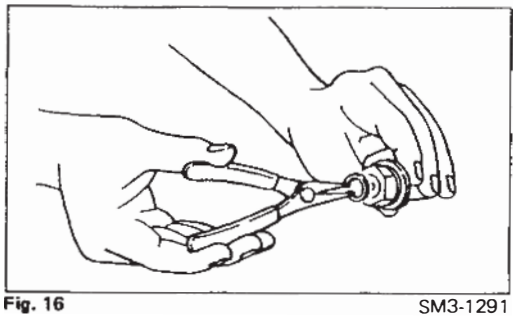


Fig. 16 SM3-1291

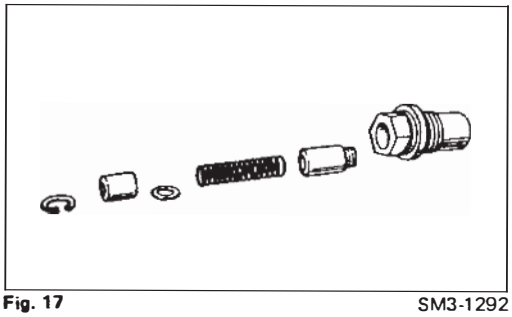


Fig. 17 SM3-1292

INSPECTION AND REPAIR

1. Remove the retainer ring, and inspect the valve inside.
   Inspect the sliding faces of the valve for possible damage, and also see if the valve moves smoothly. If there are any abnormalities, replace the valve assembly.
2. Inspect the spring, and replace it if it is damaged of flattened.

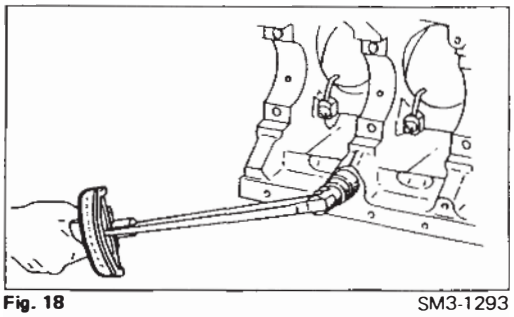


Fig. 18 SM3-1293

ASSEMBLY

1. Install the valve, spring, shim seat and retainer ring in that sequence.
2. Install the safety valve to the bottom of the block.

Tightening Torque: 800 – 900 kg.cm (58 – 65 lb.ft)

OIL COOLER

DISASSEMBLY

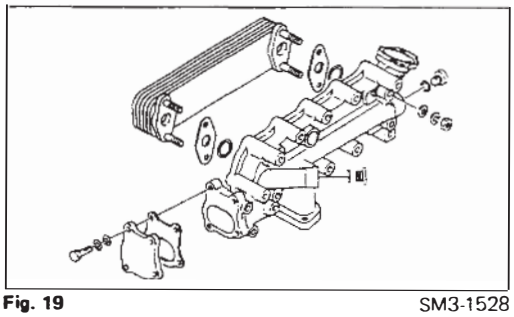


Fig. 19 SM3-1528

Loosen the nuts, and then remove the oil cooler element and plugs.

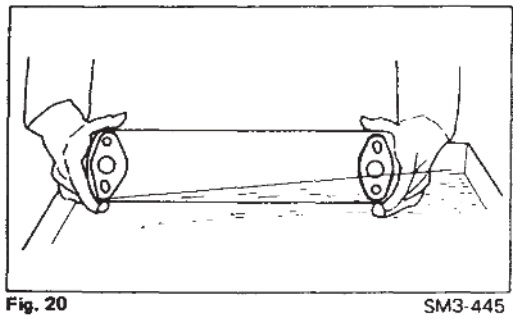


Fig. 20 SM3-445

INSPECTION AND REPAIR

1. Clean the oil passages of the oil cooler element with cleaning solvent.
2. In order to inspect the oil passages of the element, perform an air pressure test. If there is any damage or leakage, replace the element with a new one.

Pressure Test: 6 kg/cm² (85.3 lb/sq.in)

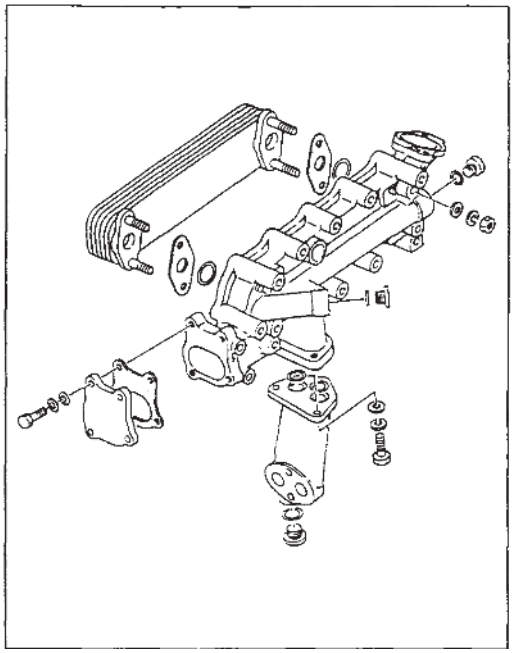


Fig. 21 SM3-1529

ASSEMBLY

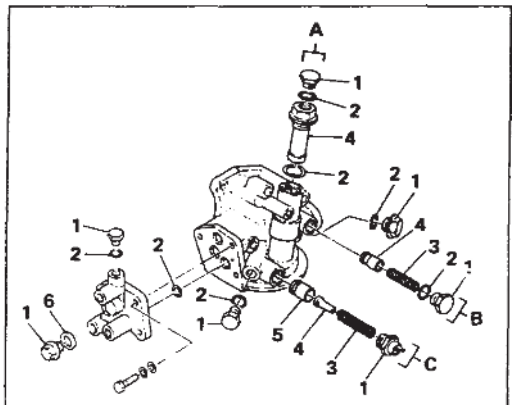
1. When assembling the oil cooler, be sure to replace the O-ring, gasket, with new ones (be careful to use O-rings of the correct diameter).
2. Fit the various plugs with O-rings onto the oil cooler case.

Tightening Torque: 190 – 260 kg.cm (14 – 18 lb.ft)

3. Install the element on the cooler case with a gasket, and tighten up the assembly using 4 nuts. Perform an air pressure test and confirm that there is no leakage of oil from the mounting portion of the case and element. Use a test pressure of 6 kg/cm² (85.3 lb/sq.in).

Tightening Torque: **100 – 150 kg.cm (8 – 10** lb.ft)

4. Install the oil pipe with O-rings and tighten the oil pipe fitting bolt provisionally.



A. REGULATOR VALVE ASSEMBLY
B. OIL COOLER SAFETY VALVE ASSEMBLY
C. OIL FILTER SAFETY VALVE ASSEMBLY
1. PLUG
2. O-RING
3. VALVE SPRING
4. VALVE
5. VALVE SEAT
6. GASKET

Fig. 22 SM3-1530

OIL FILTER

DISASSEMBLY

Remove the various valves and springs from the oil filter cover.

INSPECTION AND REPAIR

1. Wash metal portions with a volatile washing oil to remove oil and dirt.
2. Inspect the valves
   Inspect the sliding portions of the each valve for possible damage and to see if the valves operate smoothly. If there are any abnormalities, replace the valve assembly.
3. Inspect the valve springs
   Inspect the valve springs of the each valve.
   Replace the valves if they are damaged or flattened.

ASSEMBLY

1. INSTALL THE OIL FILTER COVER ASSEMBLY.

During assembly, be sure to replace the O-ring and gasket with new ones (be careful to fit O-ring of the correct diameter).

1. Attach an O-ring on the regulator valve case, and install the regulator valve case onto the oil filter cover. Then, insert first the regulator valve and then the valve spring. Next, attach the O-ring to the plug and tighten.

Tightening Torque:
Regulator valve case : 250–300 kg.cm (19–21 lb.ft)
Plug : 200–300 kg.cm (15–21 lb.ft)

2. Install the safety valves.
   After inserting each safety valve and valve spring on the oil filter cover, tighten the plug with a O-ring.

Tightening Torque: 250–300 kg.cm (19–21 lb.ft)

3. Install the oil filter cover assembly.

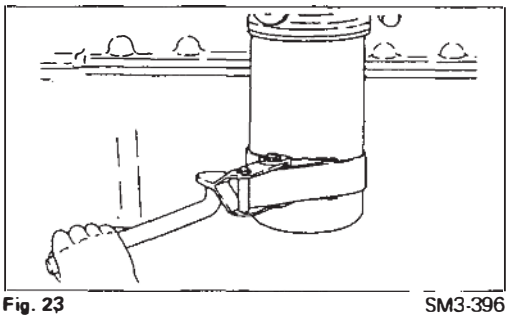


Fig. 23 SM3-396

2. INSTALL THE OIL FILTER ELEMENT SET.

1. Apply a slight amount of engine oil to the gasket of the new oil filter. Tighten the filter by hand until the gasket touches the filter cover.
2. Tighten the filter another 3/4 to 1 full turn with a filter wrench.

Special Tool: 09503-1080

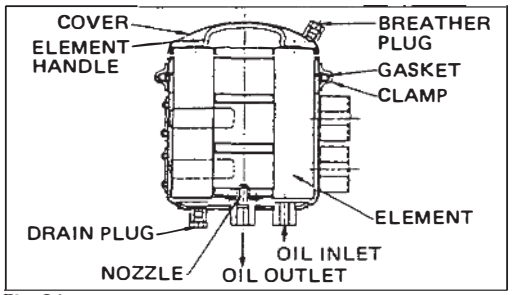


Fig. 24 SM3-1541

3. REPLACING THE BY-PASS OIL FILTER ELEMENT (OPTION).

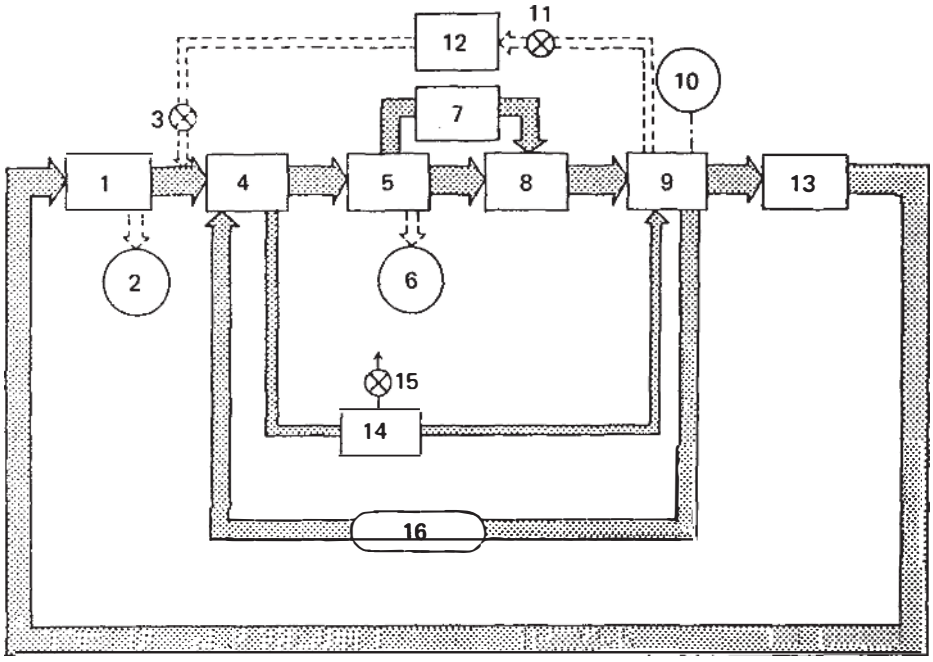
1. Unscrew the breather plug, then unscrew the drain plug and drain the oil through the drain hole.
2. Unscrew the clamp bolts and clamps, then remove the cover and gasket.
3. Remove the element by turning it counterclockwise.
4. Removed and clean the nozzle on the oil outlet.
5. Install a element in reverse sequence of removal. The tightening torque of each part is as shown below.

Element:
Turn fully by hand: 180–230 kg.cm (13–16 lb.ft)
Clamp mounting bolt: 150–210 kg.cm (11–15 lb.ft)
Drain plug and breather plug: 150–210 kg.cm (11–15 lb.ft)

6. After replacing the element, add approximately 4 liters of engine oil. Run the engine for several minutes, then stop it and check the oil level. If necessary, add engine oil.
7. Start the engine and check to see if there is any oil leakage.

NOTE:
- **Be sure to replace the gasket and O-ring in each plug with the new gasket and O-rings included in the element kit.**
- **When installing the element, take care not to twist or tear the gasket and O-rings.**

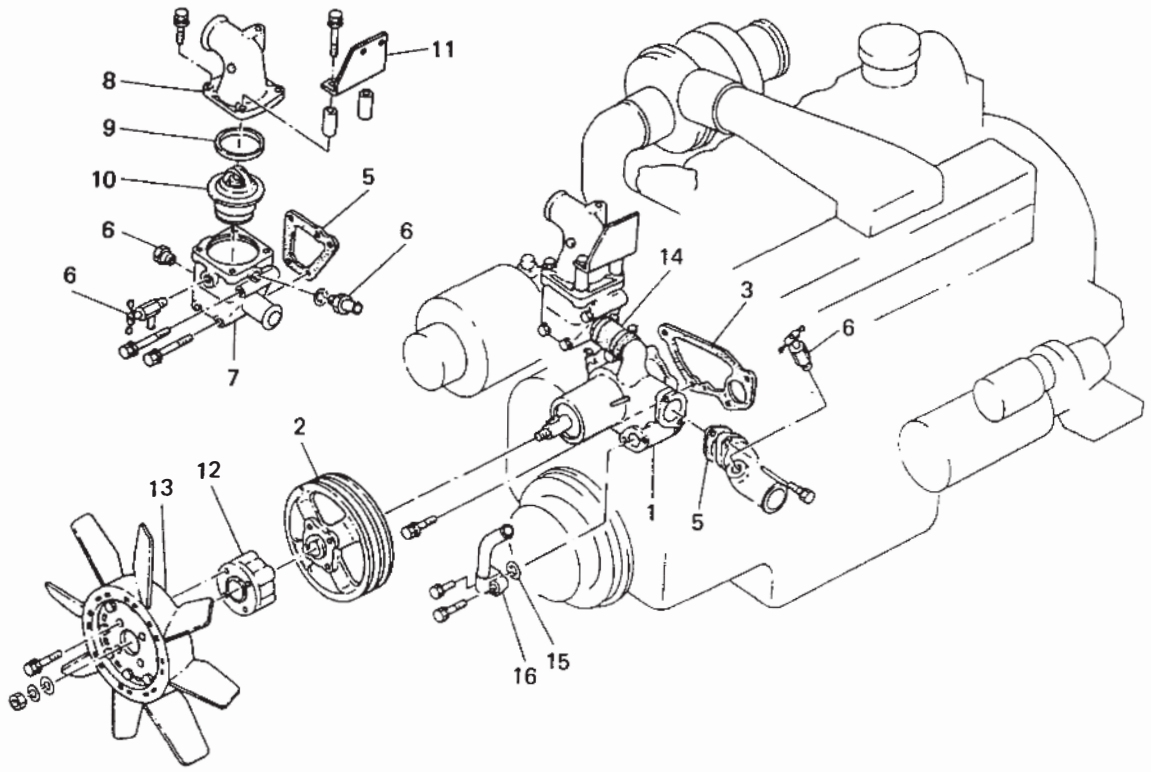
COOLING SYSTEM



COOLING SYSTEM

1. Radiator
2. Drain plug
3. Joint
4. Coolant pump
5. Cylinder block
6. Drain plug
7. Oil cooler
8. Cylinder head
9. Thermostat case
10. Temperature switch
11. Joint
12. Cab heater
13. Thermostat cover
14. Inter cooler
15. Air breather plug

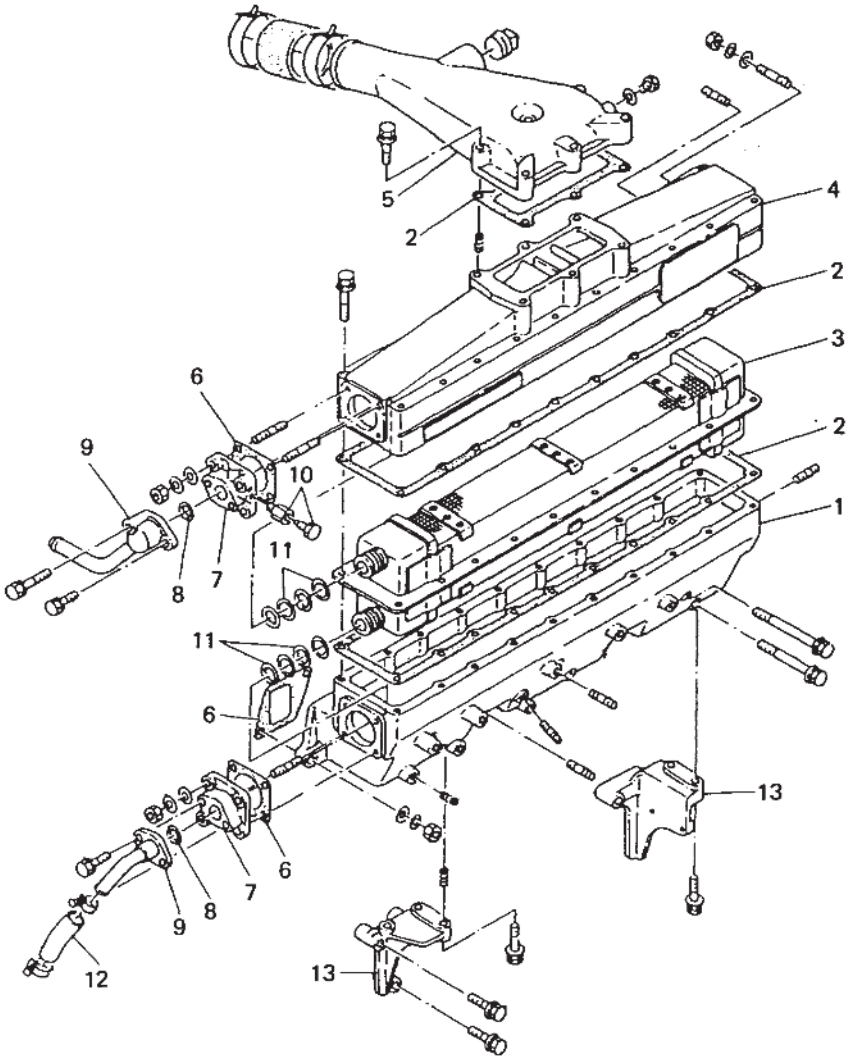
Fig. 1 SM3-1531



THERMOSTAT AND RELATED PARTS

1. Coolant pump assembly
2. Coolant pump pulley
3. Coolant pump gasket
4. Coolant intake pipe
5. Gasket
6. Joint
7. Thermostat case
8. Thermostat case cover
9. Gasket
10. Thermostat
11. Bracket
12. Spacer
13. Cooling fan
14. Coolant hose
15. O-ring
16. Pipe

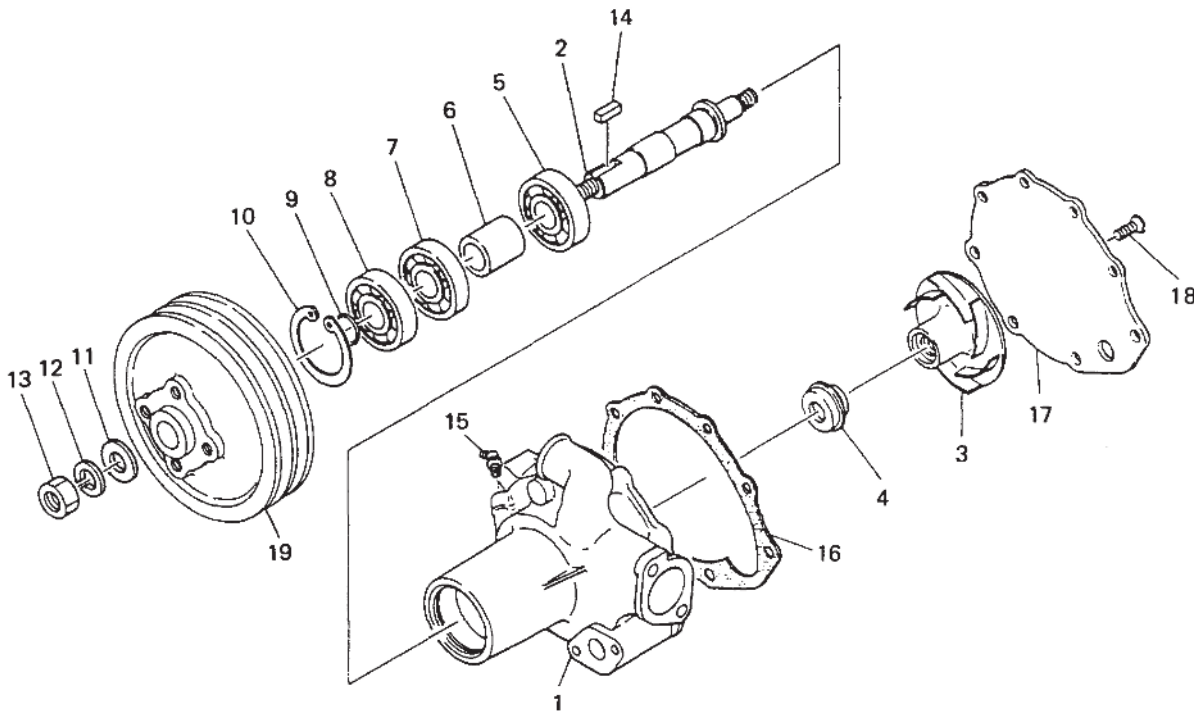
Fig. 2 SM3-1532



INTER COOLER AND RELATED PARTS

1. Intake manifold
2. Gasket
3. Inter cooler assembly
4. Inter cooler cover
5. Intake pipe
6. Gasket
7. Flange
8. O-ring
9. Pipe
10. Air breather plug
11. Gasket
12. Hose
13. Bracket

Fig. 3 SM3-1533



COOLANT PUMP

1. Case
2. Shaft
3. Vane
4. Coolant seal
5. Bearing
6. Bearing collar
7. Bearing
8. Bearing
9. Washer
10. Retainer ring
11. Plain washer
12. Lockwasher
13. Nut
14. Key
15. Lubrication fitting
16. Gasket
17. Cover
18. Screw
19. Pulley

Fig. 4 SM3-1534

INSPECT THE V-BELTS AND COOLING FAN

1. INSPECTING THE V-BELTS.

If a V-belt is damaged, replace it with a new one.

NOTE: **There are two generator drive V-belts. Be sure to replace them as a set and ensure that the difference in length between them is no more than 2 mm (0.078 in). Use belts having a length of 1,420 – 1,440 mm (55.9 – 56.7 in). If the belts are too long, the clearance between the generator and the frame will become too small when the engine is mounted on the vehicle, and when the engine is running, the resulting vibration could cause interference. Conversely, if the belts are too short, it will be difficult to fit them over the pulleys.**

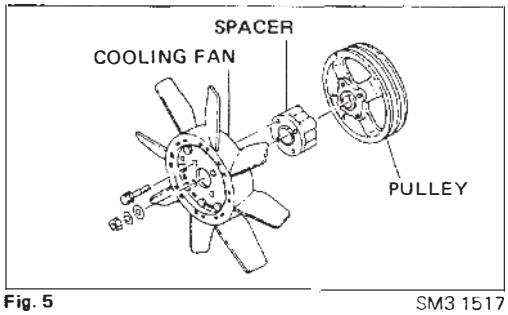


Fig. 5 SM3 1517

2. MAINTAINING AND INSPECTING THE FAN

1. Shock to the fan
   During maintenance and inspection, be careful not to drop or strike the fan itself. The resulting damage may lower the performance of the fan. Also, note that the fan is made of plastic and may become damaged or deformed if force is applied to it.

2. Replacing the fan
   Do not replace the fan unless it is faulty. When replacing the fan, replace it with the same type as the one which was removed. If the fan is replaced with one of a larger capacity becaused of overheating or, conversely is replaced with one of a smaller capacity due to overheating, the cooling performance may in fact reduced and durability may be jeopardized.

3. Other items
   Take care not to apply excessive force particular.
   Do not paint the fan.
   Do not place any paint or other reagents which are likely to dissolve plastic in contact with the fan.

COOLANT PUMP

DISASSEMBLY

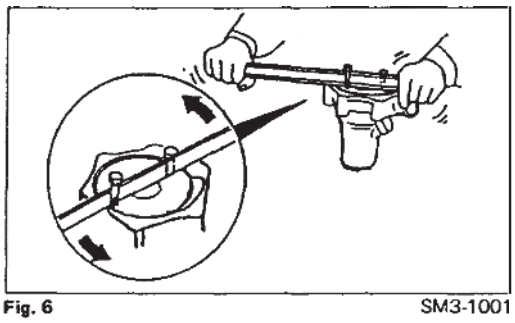


Fig. 6 SM3-1001

1. Remove the cover after slackening the bolts. The vane is a screw-in type, so it is removed by using the two projections at the back.

NOTE: **When removing the vane, the use of the special tool shown in the drawing is recommended.**

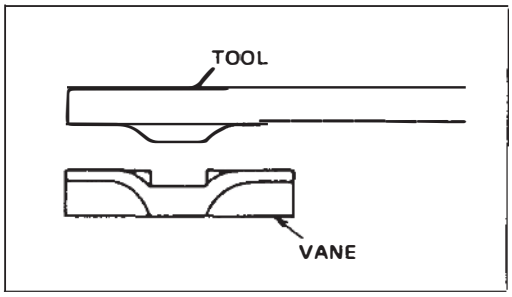


Fig. 7 SM3-411

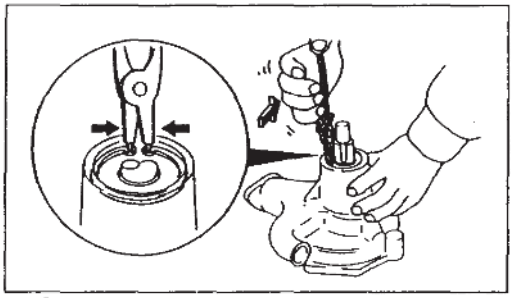


Fig. 8 SM3-996

2. Remove the retainer ring using retainer ring pliers.

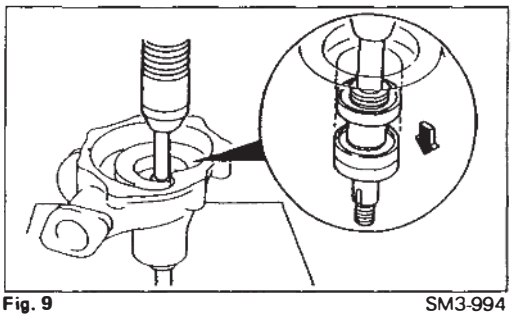


Fig. 9 SM3-994

3. Push the end of the shaft on the vane side using a press, and extract the bearings, collar and shaft.

NOTE: ○ **If the press is applied without removing the retainer ring, the pump case will be damaged.**
○ **Do not reuse bearings which have been removed. Replace them with new ones.**

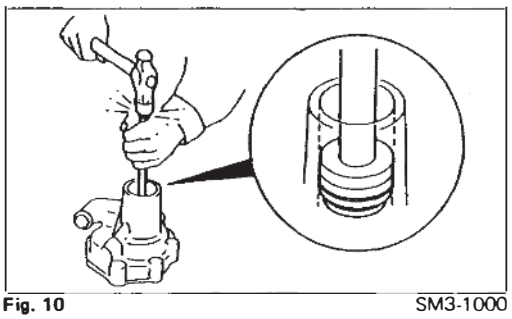


Fig. 10 SM3-1000

4. Strike the coolant seal from the coolant case with a hammer, using a copper rod, or the like.

NOTE: **It is not possible to reuse the seal after removing it from the case. Accordingly, be sure to replace it with a new one.**

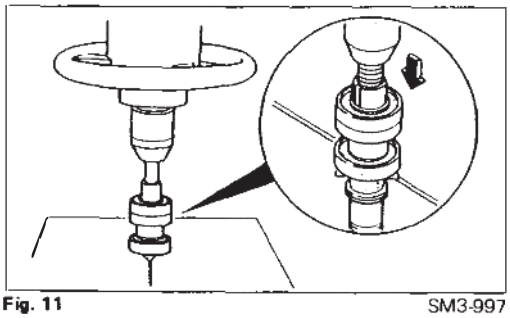


Fig. 11 SM3-997

5. Remove the bearings and collar using a press.

NOTE: **It is not possible to reuse the bearings after removing them from the coolant case. Accordingly, be sure to replace them with new ones.**

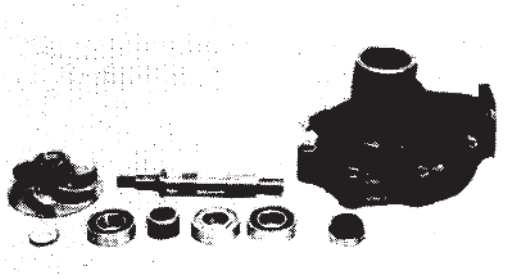


Fig. 12 03-783

INSPECTION AND REPAIR

1. Inspect the vane.
   Inspect the vane for rust, corrosion or damage.
   If defective, replace it. In particular, inspect the blades of the vane carefully.
2. Inspect the cover for corrosion, rust or damage.
   If defective, replace it.
3. Inspect the case.
   Inspect the portion of the case in which the seal is inserted and also the vane side of the portion in which the bearing is fitted. If there is any corrosion, wear or damage, replace the case.
4. Inspect the shaft.
   Replace the shaft if there is any damage to the threaded portion, or if the portion on which the inner race is inserted is worn or damaged.

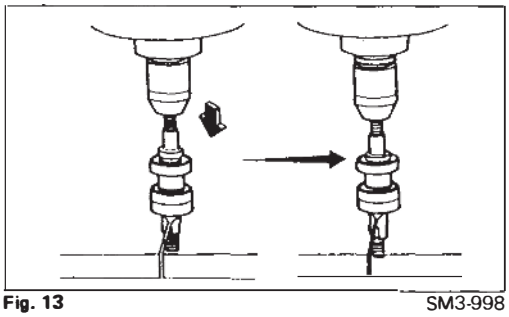


Fig. 13 SM3-998

ASSEMBLY

1. Install the bearing on the shaft.
   Install the ball bearings with collar on the shaft using a press.

NOTE: ○ **Install the bearings properly aligning the centers of the 3 bearings and the collar.**
○ **Do not install the bearings by striking the shaft with a hammer.**
○ **When installing individual bearings, use grease-packed bearings.**

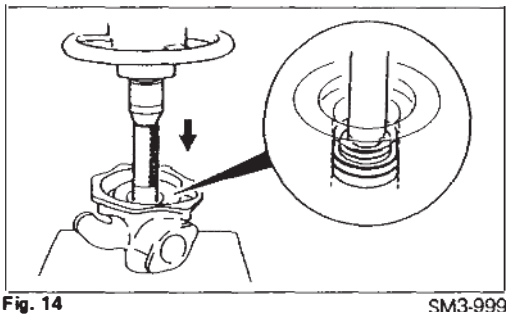


Fig. 14 SM3-999

2. Install the coolant seal.
   Before fitting the coolant seal into the case, apply liquid gasket (equivalent to Three Bond No. 1104) around the periphery of the coolant seal cage, and then fit the seal using a press.

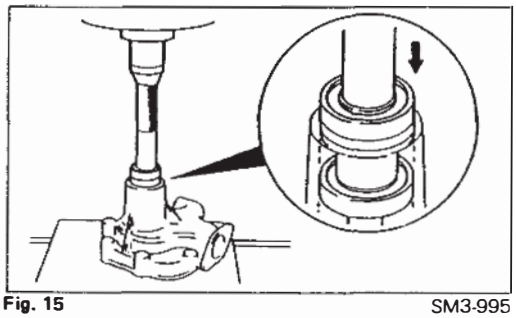


Fig. 15 SM3-995

3. Fit the shaft into the case using a press.

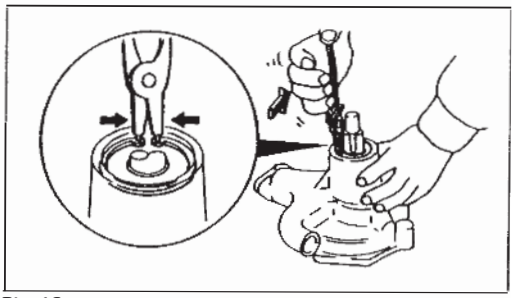


Fig. 16 SM3-996

4. Install the retainer ring
After fitting the shaft, install the plain washer, then install the retainer ring by means of an expander.

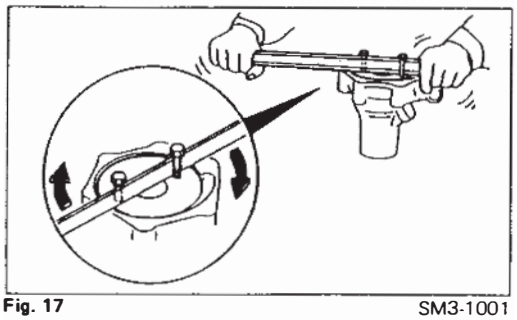


Fig. 17 SM3-1001

5. Install the vane

a. Install the vane onto the shaft.

Tightening Torque: 500 – 600 kg.cm (37 – 43 lb.ft)

After installing the vane, apply a few drops of locking adhesive to the threaded portion.

b. When tightening up the vane, the use of the special tool.

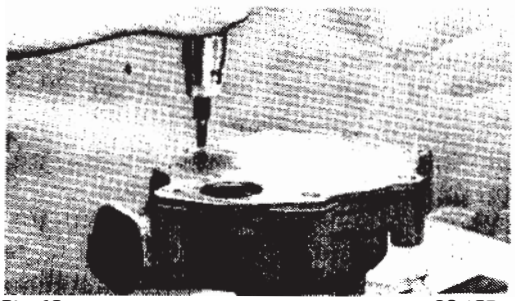


Fig. 18 03-1574

6. Install the cover with new gasket.

Tightening Torque: 180 – 230 kg.cm (14 – 16 lb.ft)

THERMOSTAT

DISASSEMBLY

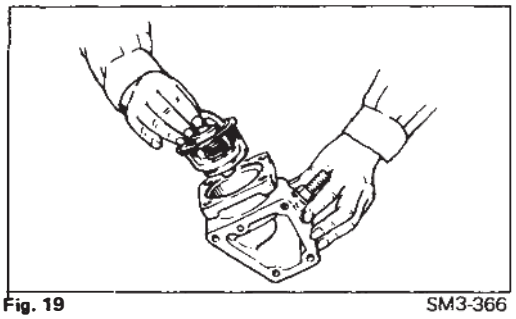


Fig. 19 SM3-366

Loosen the 4 bolts attaching the thermostat cover and case, then remove the thermostat from within the case.

INSPECTION

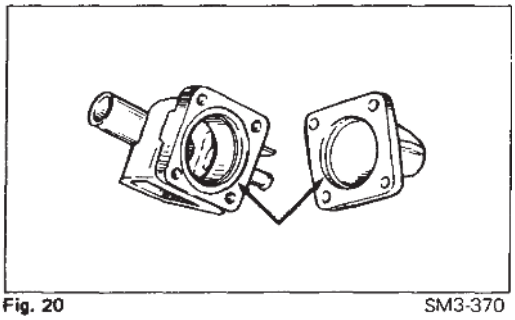


Fig. 20 SM3-370

1. Inspect the thermostat case.
   Check to see whether there is deterioration or damage to the thermostat attachment section. Replace any worn or damaged parts.

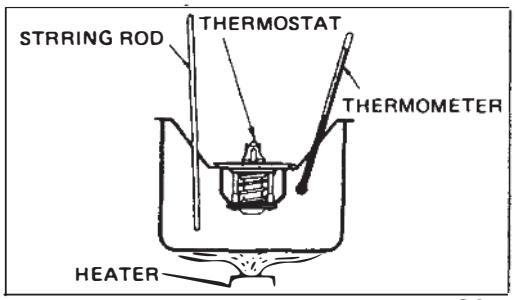


Fig. 21 SM3-888

2. Check the thermostat

a. Place the thermostat in hot water and check the opening temperature and the lift.

b. Using a thermometer, check to see the thermostat opens at the specified temperature:
   80 – 84°C (176 – 183°F).

c. Immerse the thermostat in water of a temperature of 95°C (203°F), and measure the lift of the pellet after a period of 5 minutes using vernier calipers. Measure the position of the bottom of the pellet before and after heating the thermostat.

Lift: **At least 10 mm (0.4 in) [95°C (203°F)]**

d. Immerse a heated thermostat in water of normal temperature.
   If it completely closes within 5 minutes it is satisfactory. If it remains even slightly open, it is defective and must be replaced.

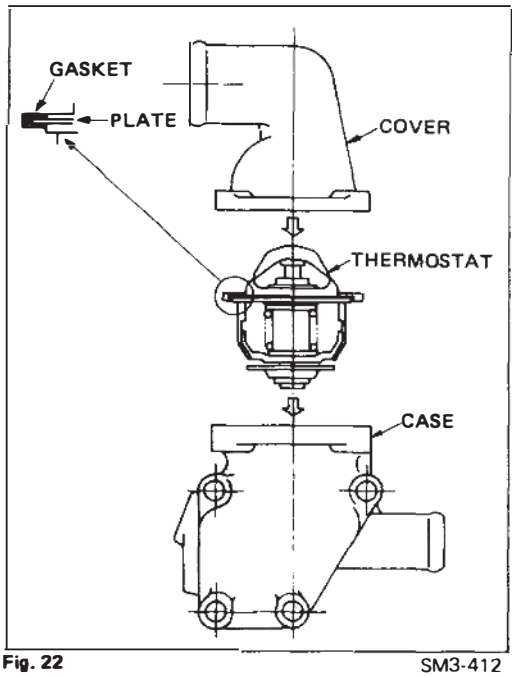


Fig. 22 SM3-412

ASSEMBLY

Install the thermostat in the reverse sequence of removal, paying attention to the following points.

1. Remove water and dirt adhering to the thermostat case.
2. Replace the gasket without fail if it is corroded, damaged or flattened.
3. Before installing the thermostat, apply sealing compound to the thermostat gasket and the hose installation portion of the thermostat case cover.
4. In order to prevent clogging of the radiator, do not use a large amount of sealing compound. In particular, do not apply a large amount of sealing compound to the hose side.

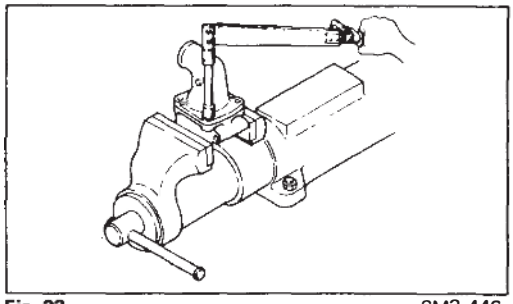


Fig. 23 SM3-446

5. Tighten up the clamp bolts of the case and thermostat cover.

Tightening Torque: 190 – 270 kg.cm (14 – 19 lb.ft)

Carefully observe the following points in order to prevent leakage of coolant from the thermostat case.

NOTE:
- **○ When installing the thermostat in the thermostat case, be sure to first insert the gasket in the thermostat plate portion, then fit the thermostat cover. (Be careful not to forget this gasket.)**
- **○ Install the thermostat cover, be careful of the direction of installation. If care is not taken, it may not be possible to connect the line.**

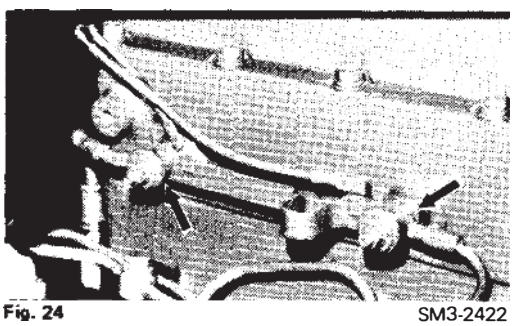


Fig. 24 SM3-2422

INTERCOOLER

DISASSEMBLY

1. Disconnect the cable of current sensor.

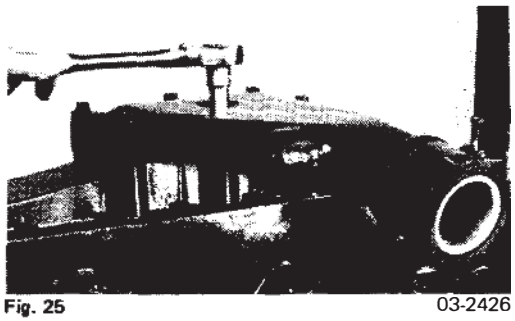


Fig. 25 03-2426

2. Remove the intake pipe.


Fig. 26 03-2408

3. Remove the coolant hoses, flanges and intercooler cover.

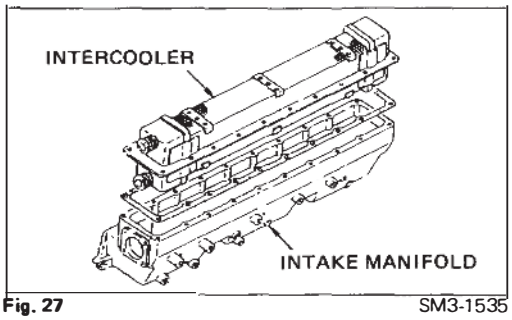


Fig. 27 SM3-1535

4. Remove the intercooler.

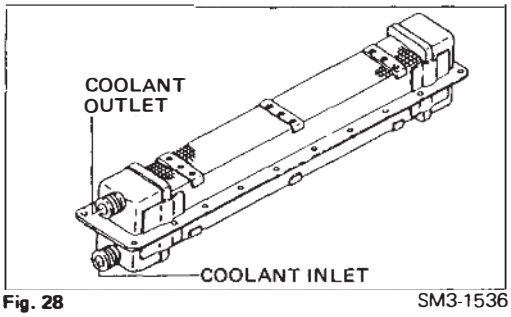


Fig. 28 SM3-1536

2. CHECK THE INTERCOOLER.

1. Clean the fins and coolant passages of the intercooler with cleaning solvent.
2. Check the intercooler for coolant leakage and clogging of the fins.

NOTE: When carrying out high pressure washing to remove fin clogging, avoid applying excessive pressure to the fins owing to the risk of deformation and consequent performance deterioration.

3. In order to inspect the coolant passages of the intercooler, perform an air pressure test. If there is any damage or leakage, replace the intercooler with a new one.

Pressure test: 2 kg/cm² (28.4 lb/sq.in)

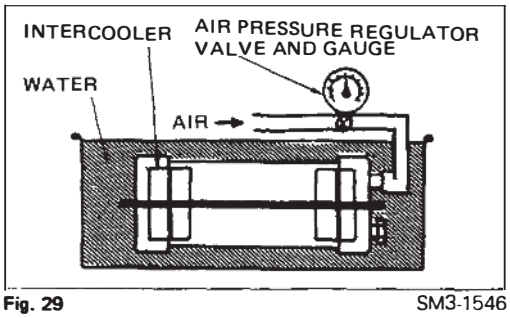


Fig. 29 SM3-1546

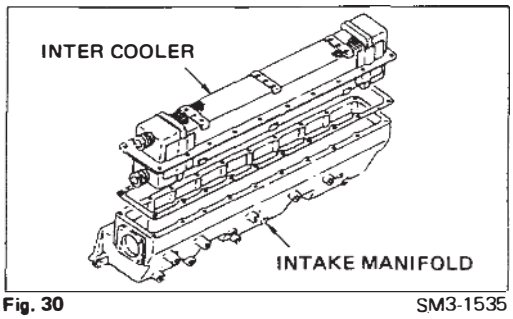


Fig. 30 SM3-1535

ASSEMBLY

1. Install the intercooler into the intake manifold.

NOTE: **During installation, be sure to first install the gasket.**

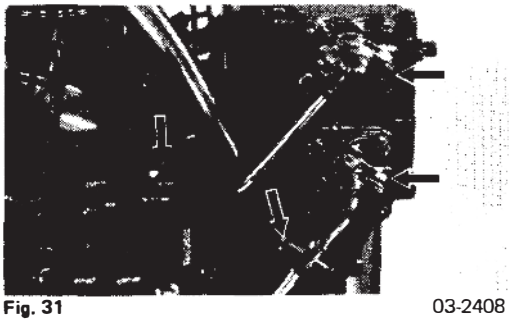


Fig. 31 03-2408

2. Install the intercooler cover on the intercooler, then the flanges and hoses on the cover.

NOTE: **During installation, be sure to first install the gasket.**

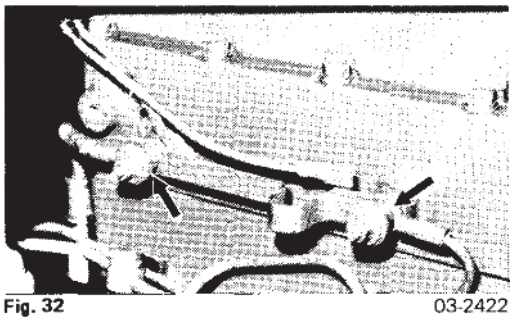


Fig. 32 03-2422

3. Connect the current sensor cables.

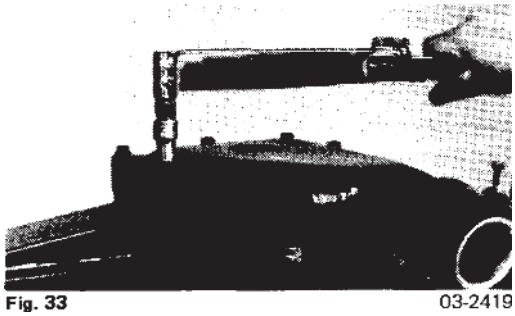
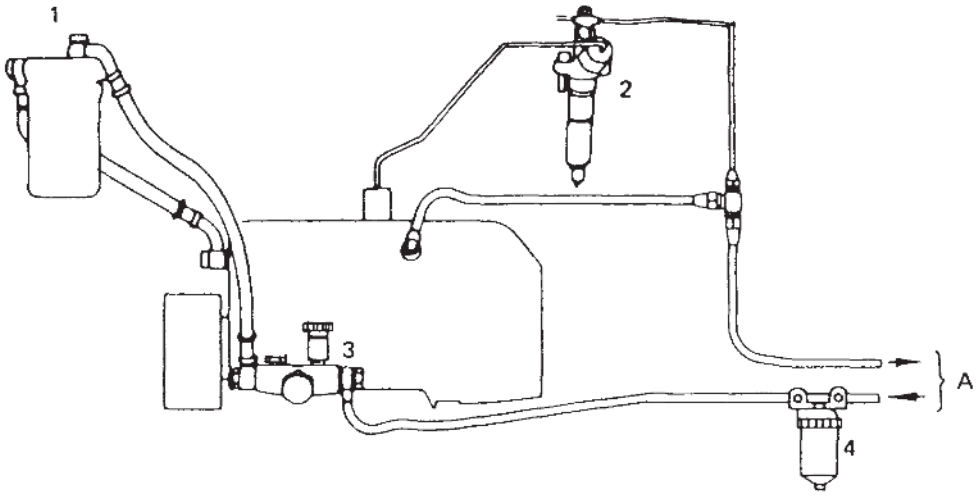


Fig. 33 03-2419

4. Install the intake pipe with gasket.

Tightening torque: 190–260 kg.cm (14–18 lb.ft)

FUEL SYSTEM

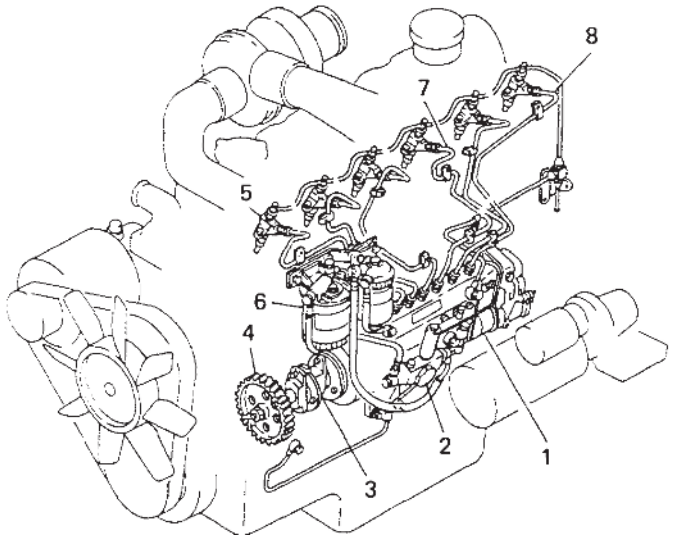


FUEL SYSTEM

1. Fuel filter
2. Nozzle holder
3. Feed pump
4. Water separator

A: Fuel tank

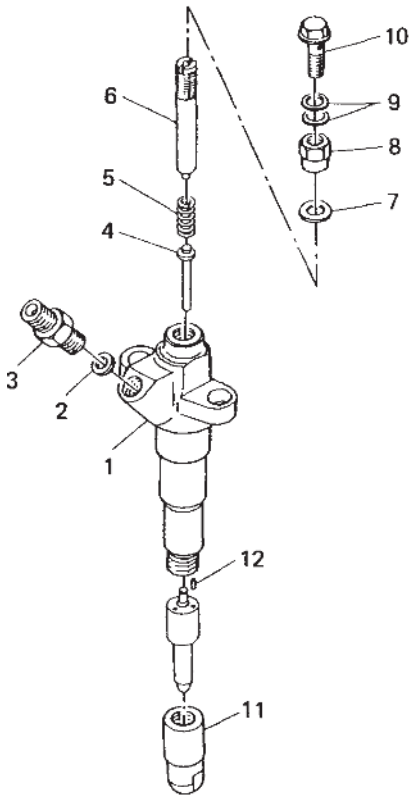
Fig. 1 SM3-723



RELATED PARTS OF FUEL SYSTEM

1. Fuel injection pump assembly
2. Fuel feed pump
3. Coupling
4. Fuel injection pump drive gear
5. Nozzle holder
6. Fuel filter
7. Injection line
8. Fuel (Return)

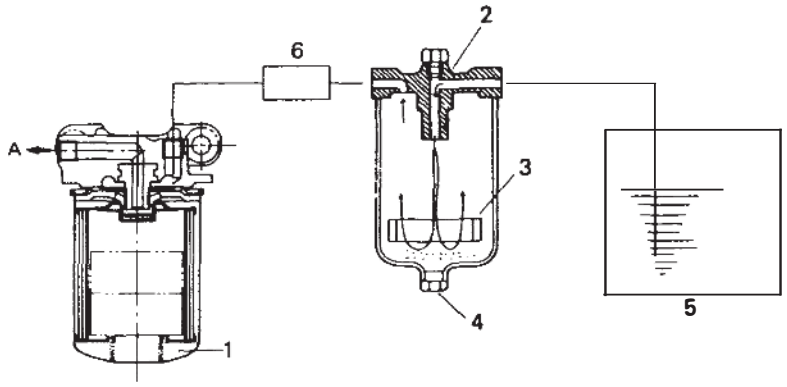
Fig. 2 SM3-1537



NOZZLE HOLDER

1. Nozzle holder assembly
2. Gasket
3. Inlet connector
4. Pressure pin
5. Pressure spring
6. Adjusting screw
7. Gasket
8. Lock nut
9. Gasket
10. Joint bolt
11. Retaining nut
12. Pin

Fig. 3 SM3-1538

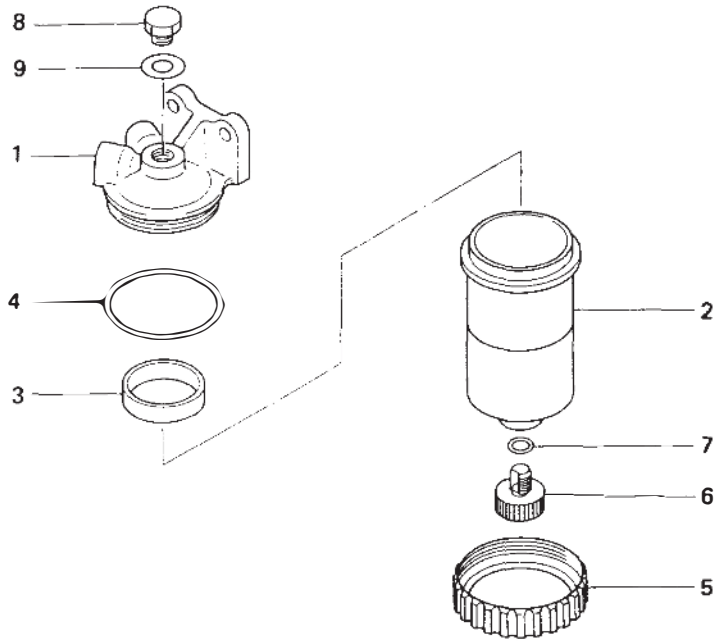


WATER SEPARATOR AND FUEL FILTER

1. Primary fuel filter
2. Water separator
3. Float
4. Drain plug
5. Fuel tank
6. Feed pump

A: To injection pump

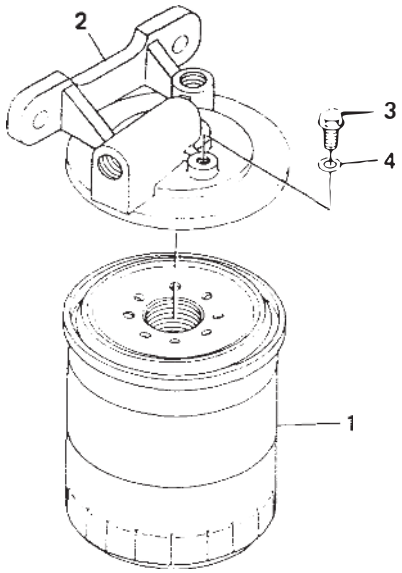
Fig. 4 SM3-449



WATER SEPARATOR

1. Cover
2. Body
3. Float
4. O-ring
5. Nut
6. Drain plug
7. O-ring
8. Bolt
9. Gasket

Fig. 5 SM3-1430



FUEL FILTER

1. Fuel filter element assembly
2. Fuel filter cover
3. Breather plug
4. Soft washer

Fig. 6

SM3-1539

DISASSEMBLY

1. DISASSEMBLE THE INJECTION NOZZLE

NOTE: **When disassembling and re-assembling the nozzle, be very careful of dust and dirt. The work place and all tools must be kept clean.**

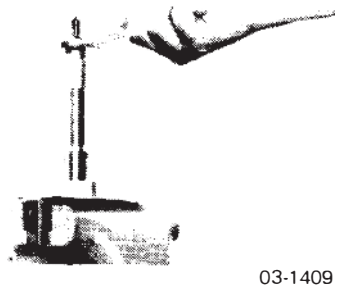


Fig. 7 03-1409

Loosen the adjusting screw, and remove the nozzle spring, nozzle holder, and press pin.
Insert the nozzle holder, place it in a vice, loosen the retaining nut, and then remove the retaining nut while taking care not to drop the needle valve of the nozzle.

NOTE: **When extracting the nozzle from the retaining nut, be careful not to damage the end of the nozzle.**

Fig. 8 03-786

INSPECTION AND REPAIR

1. INSPECT THE NOZZLE

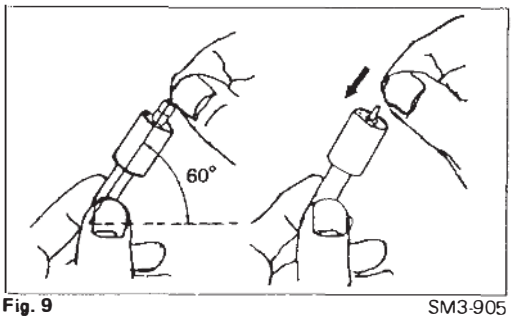


Fig. 9 SM3-905

Wash the nozzle proper with diesel fuel oil, them immerse it in diesel fuel oil.
Next slide the needle inside the nozzle proper and ensure that it move smoothly. The needle valve should fall under its own weight when withdrawn vertically about 1/3 and released. If its motion is sluggish, replace the nozzle with a new one.

2. INSPECT THE NOZZLE AND NEEDLE VALVE FOR DAMAGE.

Fig. 10 03-786

1. If the needle valve is deformed or worn, or the press pin is unevenly worn, replace the nozzle.
2. Inspect the contacting portions of the nozzle holder and nozzle proper for damage. If there is any damage replace the nozzle holder and nozzle proper.
3. Check the nozzle spring for damage, cracking, or flattening. If it is defective, replace it.
4. If the contacting faces of the spring of the spring pin and the needle valve are worn, replace these parts.

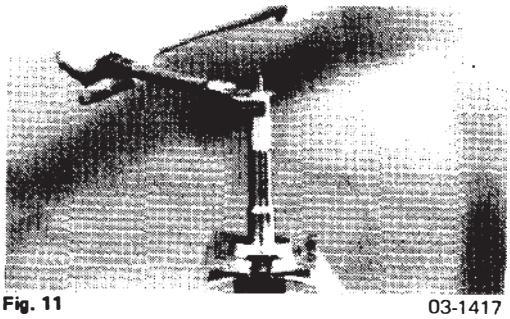


Fig. 11 03-1417

ASSEMBLY

1. ASSEMBLE THE NOZZLE

Assemble the nozzle assembly in the reverse sequence of disassembly.
When installing the nozzle, however, align the nozzle with the dowel pin of the nozzle holder, then gradually tighten the retaining nut until the specified torque is reached.

Tightening Torque: 600–800 kg·cm (44–57 lb.ft)

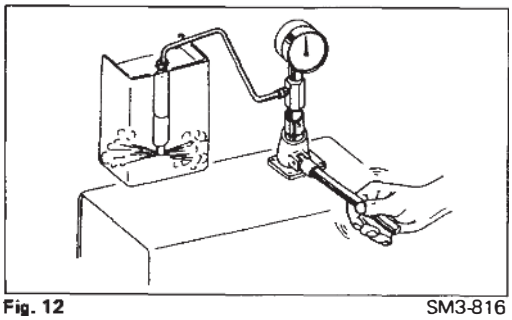


Fig. 12 SM3-816

2. ADJUST THE INJECTION NOZZLE

1. Wrap a piece of cloth around the nozzle holder, then place the nozzle holder in a vice, and loosen the retaining nut.
2. Connect the nozzle holder with a nozzle tester and move the lever at the rate of about 50 to 60 times per minute, rotate the adjusting screw until injection pressure is reached.

Injection **Pressure: 200 kg/cm^2 (2,844 lb/sq.in)**

3. When adjusting the injection pressure using the nozzle tester, check the nozzle for clogging improper spraying. If there are such defects replace the nozzle.
4. After tightening the retaining nut, re-check the injection pressure using the nozzle tester.
When tightening the retaining nut, insert a screwdriver into the joint hole to prevent the adjusting screw from turning.

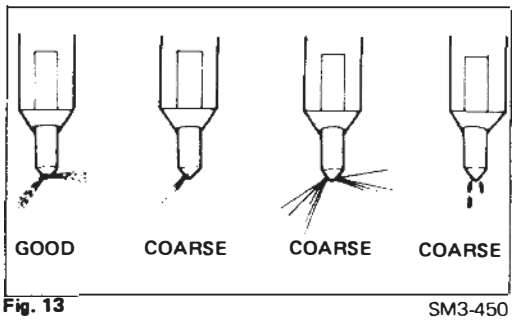


Fig. 13 SM3-450

5. Checking the spray profile
In the case of the new nozzle, operate the lever at the rate of 30 to 60 strokes per minute, and for a used nozzle, operate the lever at the rate of 15 to 60 strokes per minute.

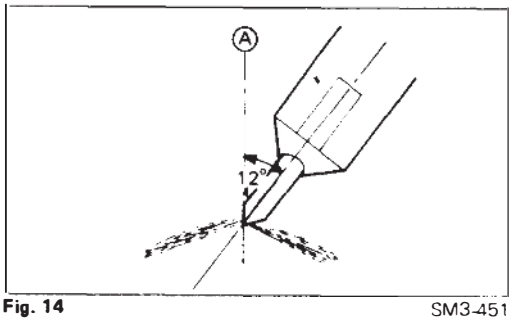


Fig. 14 SM3-451

6. Check that the spray profile is conical with respect to axis A of the figure.
In the spray profile is unsatisfactory, clean or replace the nozzle.
When checking for fuel leakage from the nozzle, apply a pressure of about 10 to 20 kg/cm² (284 lb/sq.in) lower than the correct injection pressure to the nozzle by means of the nozzle tester. If there is no fuel leakage, the nozzle is normal.

WARNING

- **Diesel fuel is flammable.**
  This nozzle adjusting should be done a well ventilated room and away from any open flames or electric spark.
- **The spray must always be covered. Keep your face and body away from the spray. This is because of the rick if fuel oil getting your eyes or passing into tour the body.**

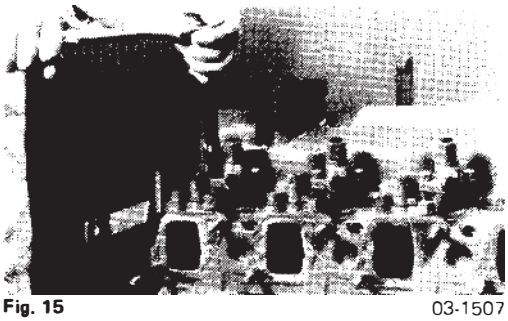


Fig. 15 03-1507

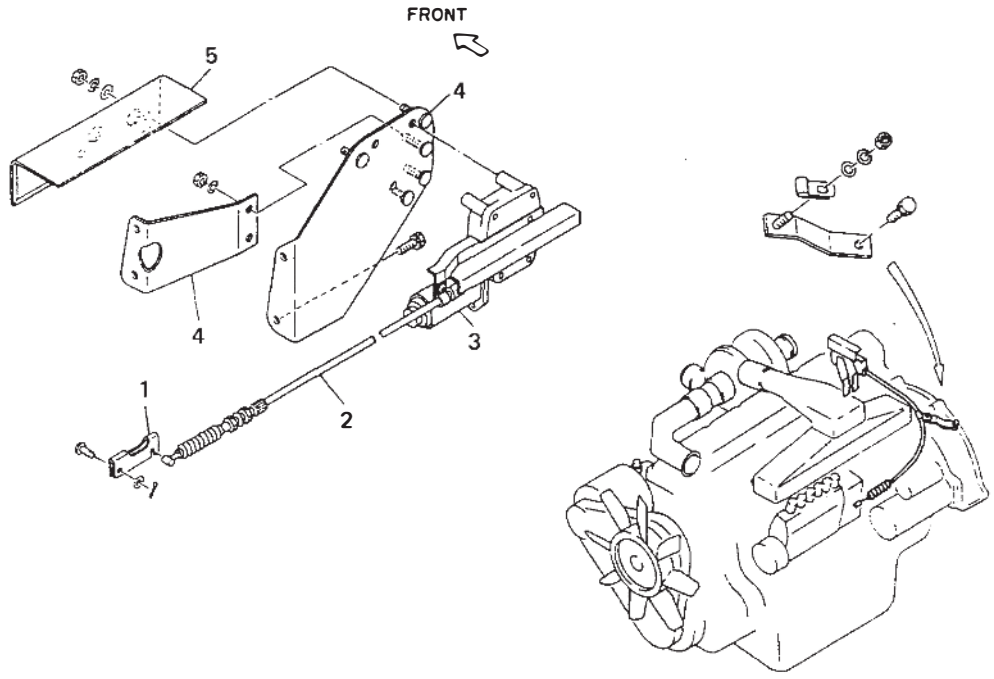
INSTALL

INSTALLMENT OF INJECTION NOZZLE HOLDER

1. Install the injection nozzle holder.

Tightening Torque: 130–190 kg·cm (10–13 lb.ft)

ENGINE STOP SYSTEM



ENGINE CONTROL LINKAGE

1. Connector
2. Cable, engine stop
3. Motor assembly, engine stop
4. Bracket
5. Cover

Fig. 1 SM3-1540

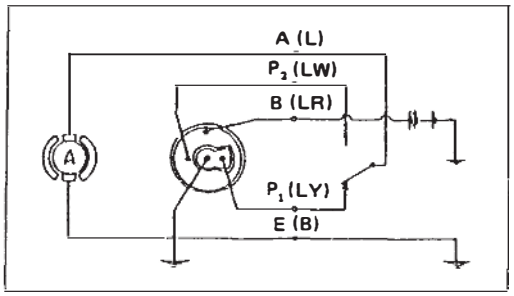


Fig. 2 SM3-1424

INSPECTION

1. CHECK THE OPERATION OF THE ENGINE STOP MOTOR AND MECHANICAL SWITCH.

1. Apply 24V D.C. across terminals A(L) and E(B).
2. Check the function of the engine stop motor.
   If the engine stop motor does not operate, replace it.

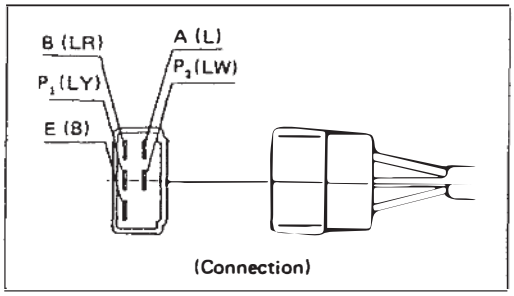


Fig. 3 SM3-1425

3. Using an ohmmeter, check that there is continuity between terminals and B(LR) and P_1 (LR), B(LR) and P_2 (LW).
   Make sure that the mechanical switch shifts "ON" and "OFF" with 180° rotation of the motor.

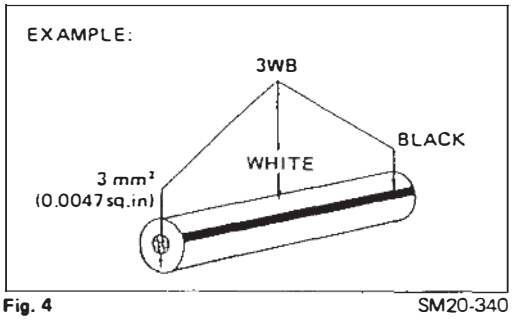


Fig. 4 SM20-340

NOTE: WIRING COLOR CODE

Symbols

B	— Black	G	— Green
W	— White	Y	— Yellow
L	— Blue	Br	— Brown
R	— Red	Lg	— Light green

Bymbols consisting of two letters
First letter — Ground color
Second letter — Color of stripe

Example
WB . . . . . Indicates a black stripe on a while ground.

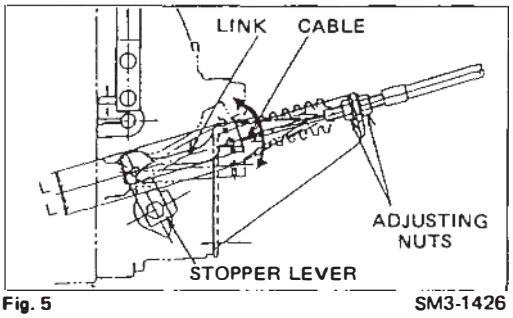


Fig. 5 SM3-1426

ADJUSTMENT

Adjust the cable with the adjusting cable so that the cable and the link can slide vertically and slightly under the condition that the stop lever is struck at the stopper.

Assembly standard (L): 10—15 mm (0.40—0.59 in)

NOTE: After the adjustment, confirm that the stroke of the cable is 35 mm (1.38 in).

INSTALLATION OF THE ENGINE COMPONENT PARTS

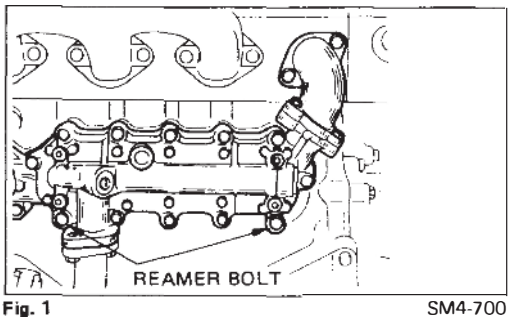


Fig. 1 SM4-700

1. INSTALL THE OIL COOLER AND COOLANT LINE BETWEEN THE CYLINDER HEAD.

1. Properly install new O-rings at the coolant inlet and oil inlet and outlet, then, using new gaskets, install the oil cooler assembly on the cylinder block.

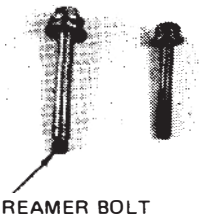


Fig. 2 03-1135

Tightening Torque: 190 – 260 kg.cm (14 – 18 lb.ft)

NOTE:
- **The length of each bolt is different.**
- **Ensure that the diameter of each O-ring matches the groove in which it is to be install.**
- **When installing the oil cooler case, make sure that it does not interfere with the tappet guide portion of the block.**
- **Reamer bolts (marked with arrows) are used to determine the mounting positions of the oil cooler and oil filter. Be sure to position these bolts in their specified positions. Note that if they are not position in their specified positions, improper tightening or thread damage may result.**

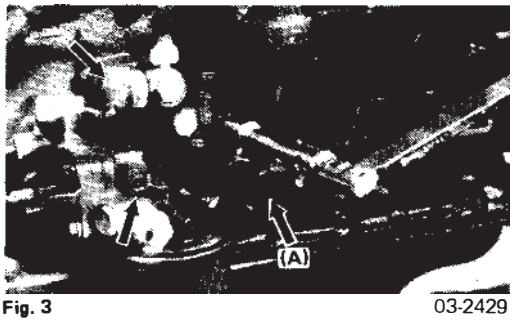


Fig. 3 03-2429

2. INSTALL THE OIL FILTER COVER.

a. Install the oil pipe with O-rings and tighten the oil pipe fitting bolt provisionally.

b. Align the oil pipe with the oil filter so that there are no gaps at the connection surface (A), then tighten all bolts.

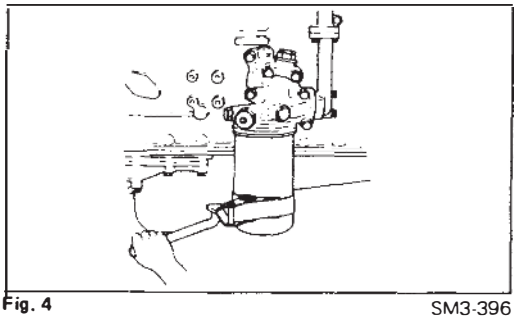


Fig. 4 SM3-396

3. INSTALL THE OIL FILTER.

1. Apply a slight amount of engine oil to the gasket of the new oil filter. Tighten the filter by hand until the gasket touches the filter cover.
2. Tighten the filter another 3/4 to 1 full turn with a filter wrench.

Tightening Torque: 300–350 kg·cm (22–26 lb.ft)

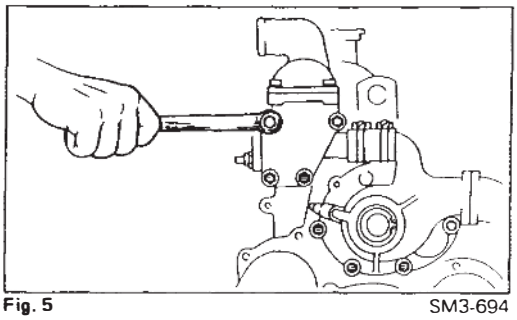


Fig. 5 SM3-694

4. INSTALL THE THERMOSTAT CASE ASSEMBLY AND THE COOLANT PUMP ASSEMBLY WITH A NEW GASKETS AND TIGHTEN THE BOLTS. THEN INSTALL THE COOLANT LINE.

Tightening Torque: 380–500 kg·cm (28–36 lb.ft)

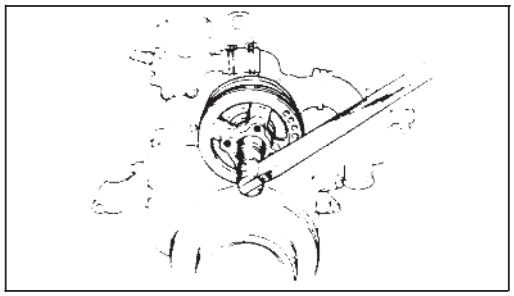


Fig. 6 SM3-473

5. INSTALL THE COOLANT PUMP PULLEY.

Using a copper hammer, or the like, gently drive the coolant pump pulley onto the shaft, then fit the plain washer and lock washer, and fix the pulley with a nut.

Tightening Torque: 1,800–2,400 kg·cm (131–173 lb.ft)

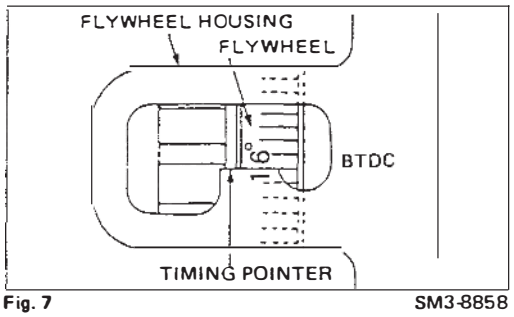


Fig. 7 SM3-8858

6. INSTALL THE INJECTION PUMP.

1. Adjusting the injection timing.

a. Rotate the crankshaft clockwise viewing from the front end to until 16° before top dead center of the compression stroke of the No. 1 cylinder meet of the timing pointer..

Engine model	Injection timing
H06C-TI	16°

NOTE: The engine models designation is impressed on the righthand side of the cylinder block as viewed from the fan side.

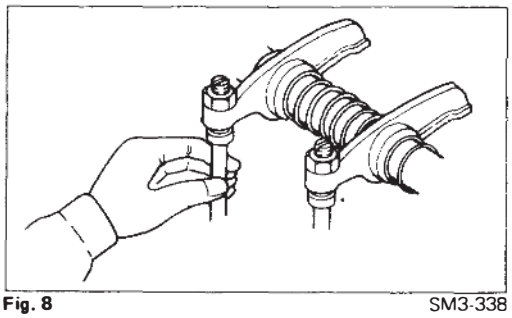


Fig. 8 SM3-338

2. Check the rocker arms on No.1 cylinder are loose and rockers on No.6 are tight.

NOTE: **If not, turn the crankshaft one complete revolution and align marks as above.**

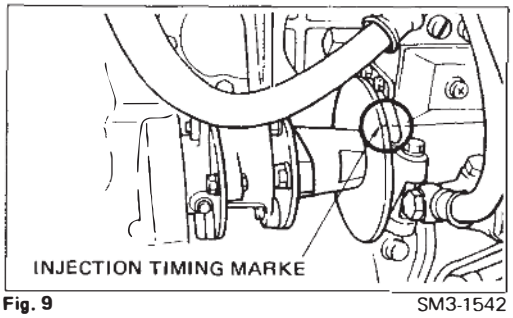


Fig. 9 SM3-1542

3. Align the injection timing mark on the coupling and the mark on the pump body.

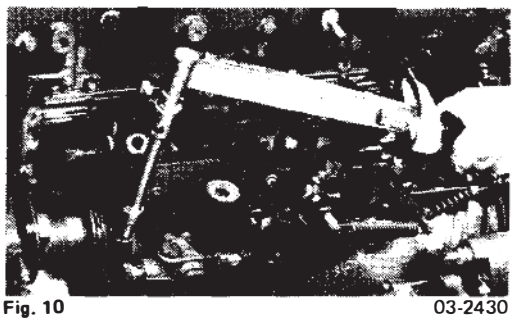


Fig. 10 03-2430

4. Position the pump assembly on the pump bracket, adjusting the position of the pump so that its mounting holes align with those of the bracket, and then tighten bolts.

Tightening Torque: **190–260** kg·cm **(14–18** lb.ft)

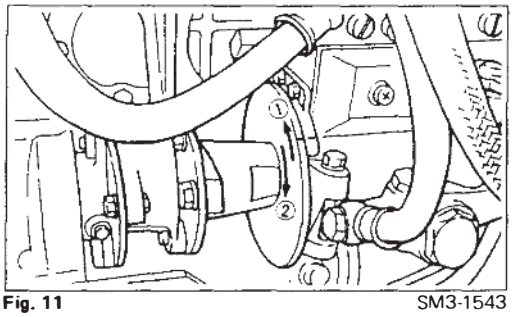


Fig. 11 SM3-1543

5. First, manually turn the coupling to counterclockwise (Arrow ①) (viewing from the driving side) to retard the timer, and then slowly turn the coupling to clockwise (Arrow ②) to align the timing mark.


Fig. 12 03-2404

e. Tighten the coupling bolt.

NOTE: There should not be any gap between the laminated plates or be any deformation of the flange due to pressure the laminated plates.

Tightening Torque: **300–350** kg·cm **(22–25** lb.ft)

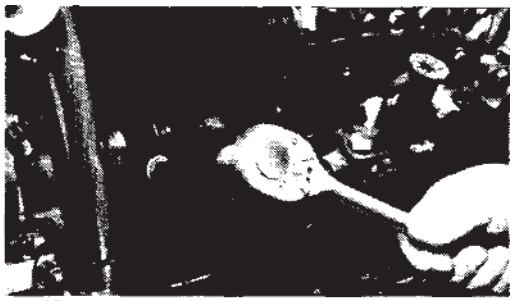


Fig. 13 03-2403

f. Tighten the through bolt of the flange.

NOTE: **Do not tighten the through bolt before tightening the coupling bolt.**

Tightening Torque: 300 – 350 kg.cm (22 – 25 lb.ft)

g. Install the fuel lines, oil lines and fuel leakage lines.

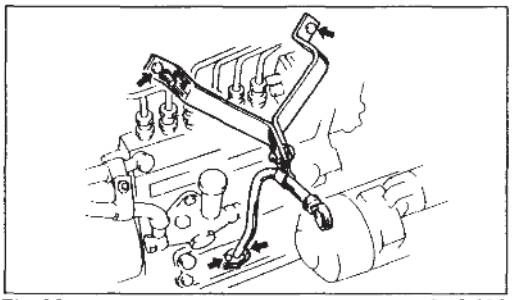


Fig. 14 SM3-680

7. INSTALL THE OIL LEVEL GAUGE.

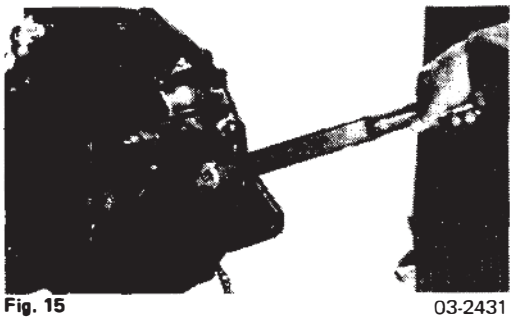


Fig. 15 03-2431

8. INSTALL THE STARTER

Tightening Torque : 650 – 870 kg.cm (47–63 lb.ft)

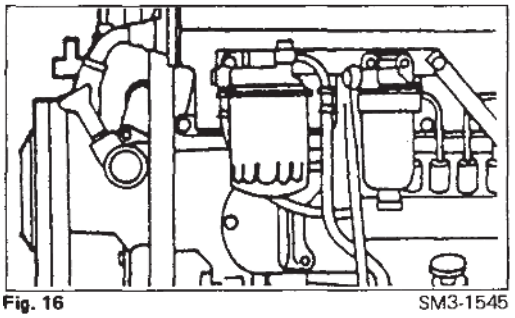


Fig. 16 SM3-1545

9. INSTALL THE FUEL FILTER AND FUEL LINES.


Fig. 17 03-2432

10. INSTALL THE GENERATOR.

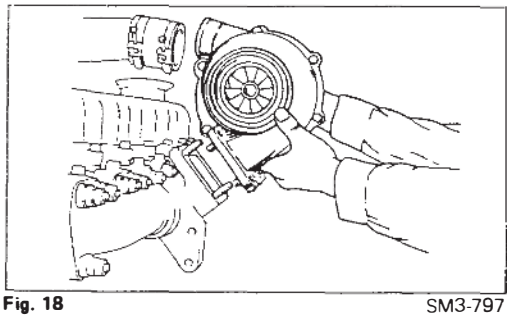


Fig. 18 SM3-797

11. INSTALL THE TURBOCHARGER.

1. Install the turbocharger.

Tightening Torque: 450–500 kg-cm (33–36 lb.ft)

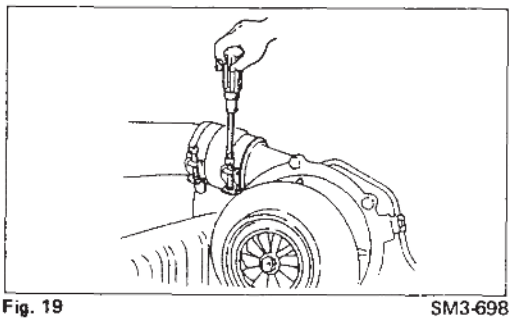


Fig. 19 SM3-698

2. Tighten the clip band.

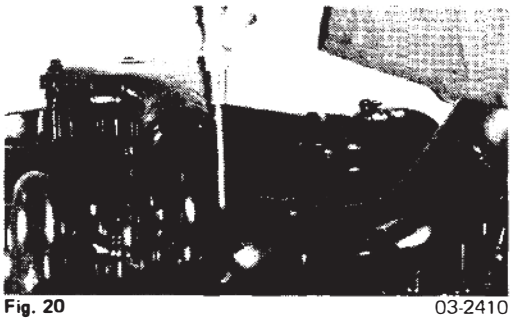


Fig. 20 03-2410

3. Install the intake pipes.

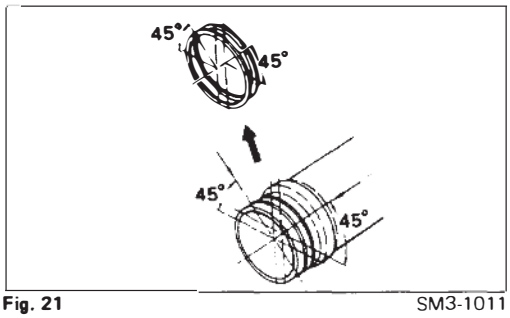


Fig. 21 SM3-1011

4. Install the seal rings.
When installing seal rings on the exhaust pipe connector, fit new seal rings in such a way that the gaps are equally spaced, as shown, to prevent gas and oil leakage.


Fig. 22 03-2433

5. Install the exhaust pipe connector.

Tightening torque: 450–500 kg.cm (32–36 lb.ft)

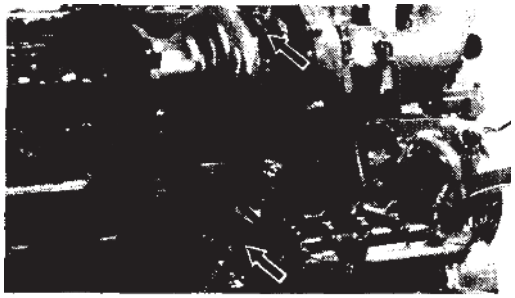


Fig. 23 03-2409

6. Install the oil pipes.


Fig. 24 03-2432

12. V-BELT ADJUSTMENT.

1. Install the V-belts, and adjust the belt tension.

a. Do not under any circumstances apply the lever directly against the generator body owing to the risk of damaging the generator.

b. When installing a new V-belt or adjusting the tension, be sure to repeat the adjustment two or three times, after running the engine for several minutes each time.

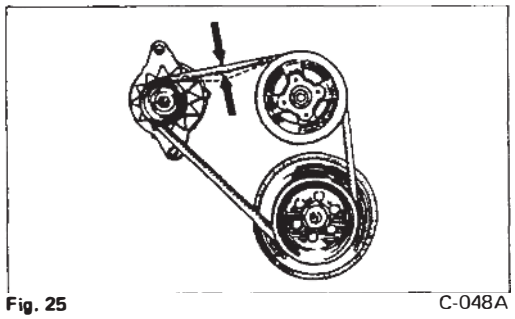


Fig. 25 C-048A

2. V-belt deflection
Apply a load of about 10 kg (22 lb) by pressing with your finger (or special tool).

Assembly Standard:
Two V-belts, Standard Vehicle:
10 – 15 mm (0.39–0.59 in)

Special Tool: **V-belt Tension Gauge (09444-1210)**

NOTE: **If the belt is excessively tensioned, there is a rick of damaging the bearings of the generator or coolant pump and also shortening the life of the V-belt.**
Conversely, if there is insufficient tension on the V-belt, the belt will slip, unusual noise will be emitted, the battery may run down and the engine may overheat.

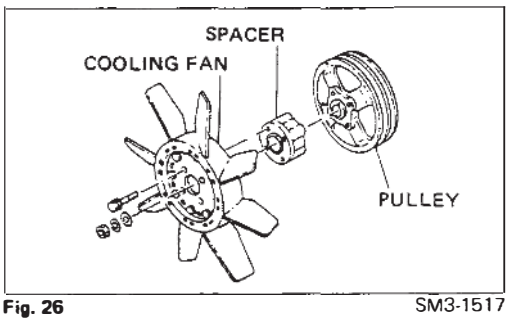


Fig. 26 SM3-1517

13. INSTALL THE COOLING FAN.

Install the pulley on the coolant pump shaft, and tighten the nut.
Install the fan on the spacer, then install both together on the coolant pulley.

Tightening torque:
Pulley nut: 1,800–2,400 kg.cm (131–173 lb.ft)
Bolt (Fan): 350–500 kg.cm (26–36 lb.ft)

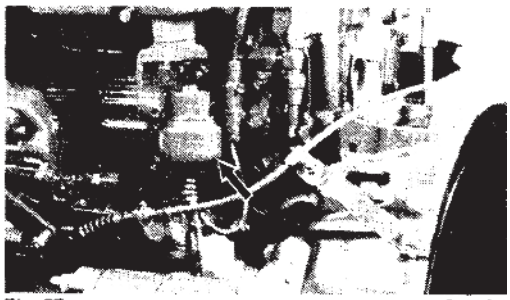


Fig. 27 03-2434

14. INSTALL THE INTAKE AIR HEATER RELAY ASSEMBLY.

ENGINE TUNE-UP

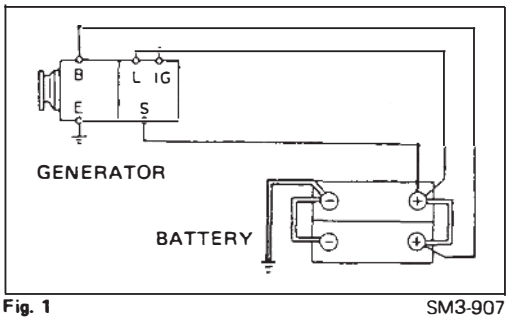


Fig. 1 SM3-907

NOTE: ○ Starting the engine when the generator is not connected to the battery may damage the generator. Always connect to the battery.

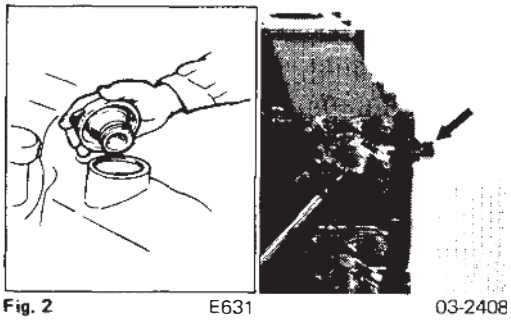


Fig. 2 E631 03-2408

1. SET THE ENGINE ASSEMBLY ON A TEST BENCH.

1. Add the proper amount of the specified engine oil through the oil filler cap on the cylinder head cover.
2. Add coolant.
   Bleed out air from inside the coolant gallery through the cylinder block drain plug and intercooler air breather plug.

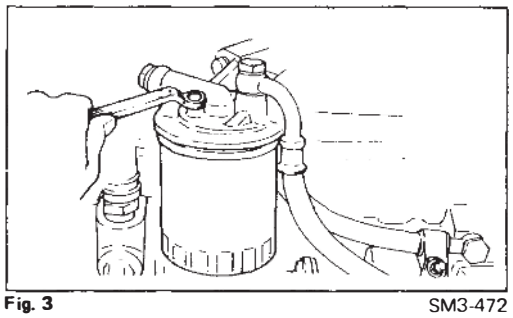


Fig. 3 SM3-472

2. BLEEDING THE AIR FROM THE FUEL FILTER

1. Loosen the bleether plug of the fuel filter.
2. Loosen the primping pump handle.
3. Operate the priming pump handle and bleed the air from the filter until no air comes out through the bleeding plug.
   Since fuel and air comes out together, cover the opening with a cloth, etc., so that fuel does not splash onto the surroundings.
4. Insert the priming pump handle, turn it to the right, and lock it.
5. Tighten the bleether plug.

Tightening Troque: 40–60 kg.cm (3 – 4 lb.ft)

NOTE: ○ Make sure that the priming pump handle is locked before tightening the bleether plug.
○ Remove traces of spilled fuel from around the plug.

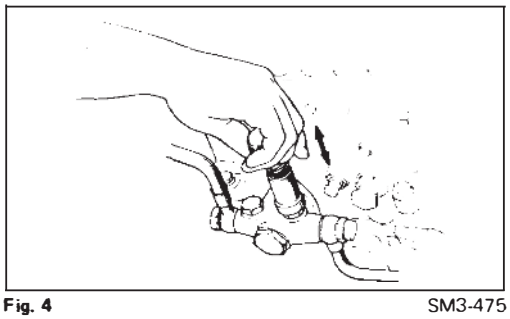


Fig. 4 SM3-475

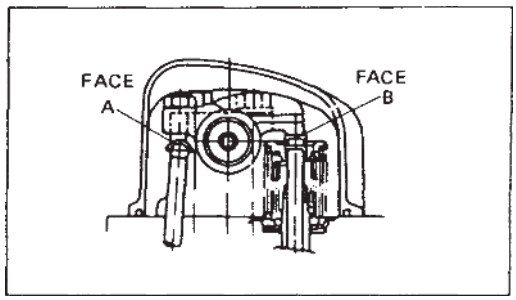


Fig. 5 SM3-399

3. START THE ENGINE.

NOTE: **Before starting the engine, make sure that the fuel cut lever of the fuel injection pump is operating normally.**

1. Check the oil feed to rocker arms.

a. Set the engine speed to 785–825 rpm.

b. Within one minute after starting the engine, oil should flow to the head (Face A) of all push rods and the head (Face B) of all valves. If the time required for the oil to flow to the rocker arms is long, various troubles such as seizing, abnormal wear and unusual noize may occur.

2. Check the contact of the rocker arm and valve stem caps.
After runing the engine, a contact of 7 to 11 mm (0.276 – 0.433 in) should be obtained at the cap contact face of the rocker arm.
If the contact face is one sided, the valve will tilt, resulting in valve seizure, breakage, damage, or wear of the rocker arm stem cap.

3. Operate the engine for 30 to 40 minutes so that the cylinder head gasket is warmed and stabilized in dimension.

NOTE: ○ **Coolant temperature should be 80°C (176° F).**
○ **Check the oil pressure, oil feed to the rocker arms, and check for water and gas leaks, and noise.**

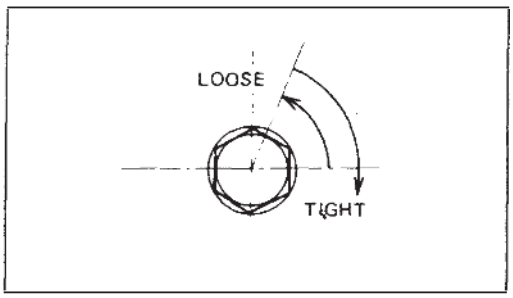


Fig. 6 SM3-457

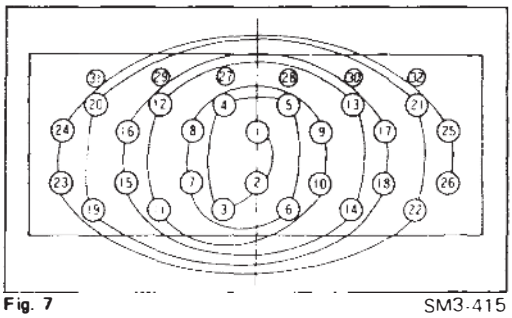


Fig. 7 SM3-415

4. RETIGHTEN THE CYLINDER HEAD BOLTS

Retighten the cylinder head bolts.
After the engine has warmed up, loosen the cylinder head bolts 1/8 to 1/4 of a turn, then tighten them to the specified torque.

NOTE: ○ **Perform the above step for a bolt at a time. Loosen and retighten each bolt in one operation, in the sequence as shown.**
○ **Retighten the six bolts Nos. 4 , 5 , 12 , 13 , 20 , and 21 using a special tool.**

Special Tool : Wrench (09839-1701)
(09411-1080)

Tightening Torque :
14 mm Diameter: 1,800–1,900 kg.cm (131–137 lb.ft)
10 mm Diameter: 650 – 750 kg.cm (47 – 54 lb.ft)

5. CHECK THE INJECTION TIMING

Adjust the injection timing, refer to Pages 3-10-2 and 3-10-3.

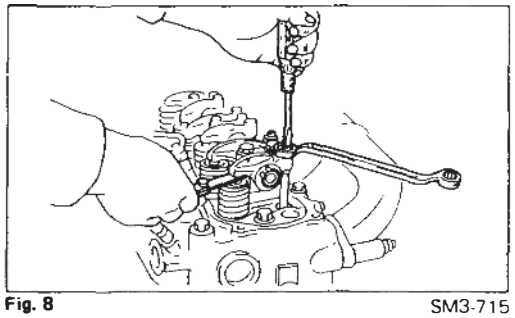


Fig. 8 SM3-715

6. ADJUST THE VALVE CLEARANCE

1. Set each piston in firing order at top dead center of the compression stroke and adjust the valve clearance.

Firing Order : 1–4–2–6–3–5
Valve clearance, when cold;
Inlet : 0.30 mm (0.0118 in)
Exhaust : 0.45 mm (0.0177 in)

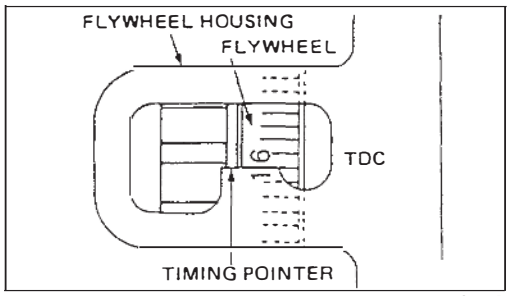


Fig. 9 SM3-885B

2. Set the No. 1 piston to top dead center of compression stroke and adjust the valve clearance of the valves indicated in the table below.
Then set the No. 6 piston to top dead center and adjust the remaining valves.

Cylinder	1		2		3		4		5		6	
Valve arrangement	I	E	I	E	I	E	I	E	I	E	I	E
	1	2	3	4	5	6	7	8	9	10	11	12
With No. 1 piston at T.D.C. on compression stroke	●	●		●	●			●	●			
With No. 6 piston at T.D.C. on compression stroke			○			○	○			○	○	○

GROUP 3

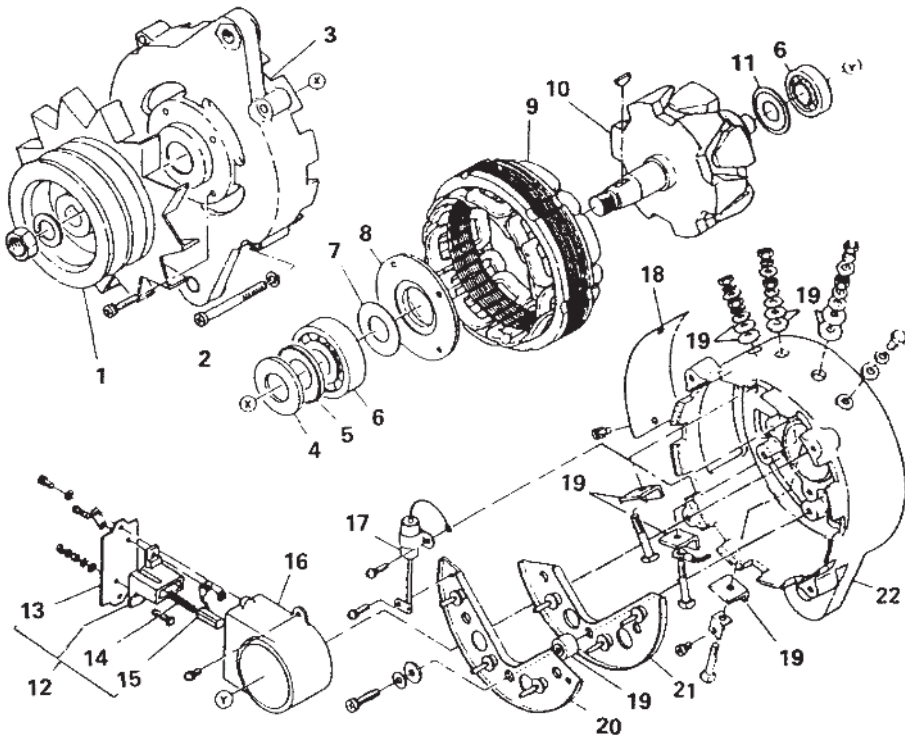
GENERATOR
Models H06C-TI, EL100 and EM100

3

TROUBLESHOOTING

Symptom	Possible cause	Remedy
Charge warning lamp does not light with starter switch ON and engine off	Fuse blown	Determine cause and replace fuse
	Lamp burned out	Replace lamp
	Wiring connection loose	Tighten loose connections
	IC regulator faulty	Replace IC regulator
Charge warning lamp does not go out with engine running (Battery requires frequent recharging)	Drive belt loose or worn	Adjust or replace drive belt
	Battery cables loose, corroded or worn	Repair or replace cables
	Fuse blown	Determine cause and replace fuse
	Charge lamp relay, IC regulator or generator faulty	Check charging system
	Wiring faulty	Repair wiring

GENERATOR



1. Pullry with fan
2. Through bolt
3. Drive end frame
4. Felt
5. Felt cover
6. Ball bearing
7. Retainer plate
8. Bearing retainer
9. Stator assembly
10. Rotor assembly
11. Plate
12. Brush holder assembly
13. Plate
14. Brush spring
15. Brush
16. Brush spring housing
17. Condenser
18. Cover
19. Insulator
20. Rectifier (Positive)
21. Rectifier (Negative)
22. Rear end frame

Fig. 21-1

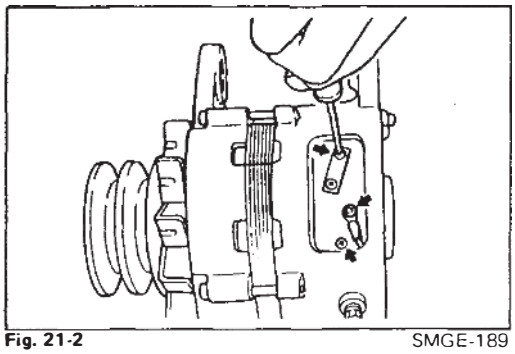


Fig. 21-2 SMGE-189

DISASSEMBLY

1. REMOVE THE BRUSH HOLDER ASSEMBLY

1. Remove the holder cover.
2. Remove the brush holder set screws.
3. Remove the lead wire.
4. Pull out the brush holder assembly.

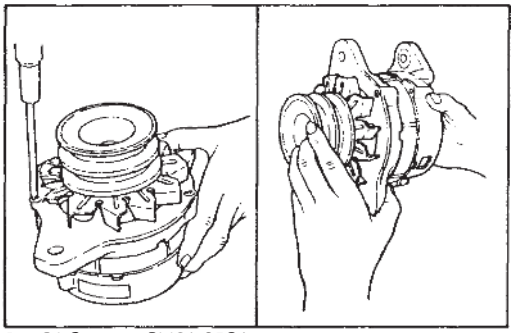


Fig. 21-3 SM21-076A SM21-077

2. SEPARATE THE REAR END FRAME FROM THE DRIVE END FRAME.

1. Remove the through bolts.
2. Pull out the rear end frame from the drive end frame.

NOTE: **Tap the rear end frame lightly with a plastic faced hammer if necessary.**

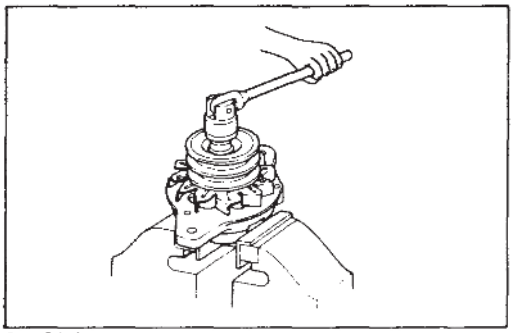


Fig. 21-4 SM21 079

3. REMOVE THE PULLEY WITH FAN

1. Clamp the rotor in a soft jawed vise.
2. Remove the pulley nut, spring washer, and pulley with fan.

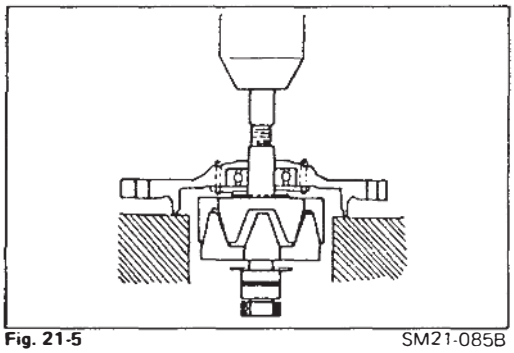


Fig. 21-5 SM21-085B

4. REMOVE THE ROTOR SHAFT FROM THE DRIVE END FRAME.

Using a press, remove the rotor shaft.

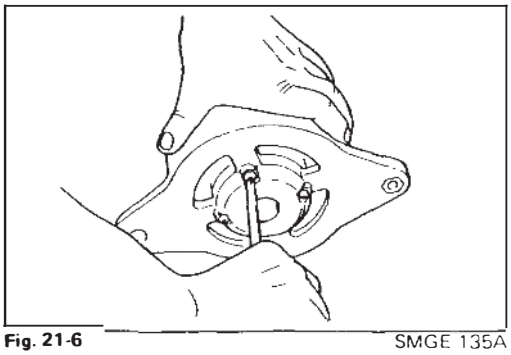


Fig. 21-6 SMGE 135A

5. REMOVE THE BEARING RETAINER SCREWS, BALL BEARING, COVER AND FELT FROM THE DRIVE END FRAME.

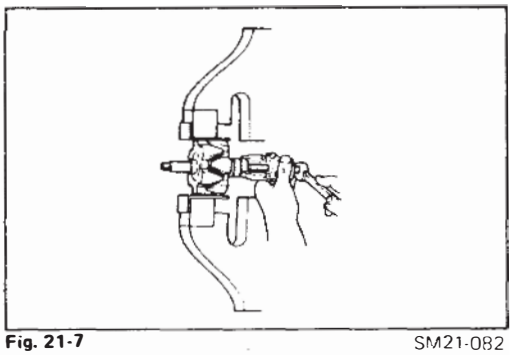


Fig. 21-7 SM21-082

6. **REMOVE THE BEARING FROM THE ROTOR SHAFT.**
   1. Clamp the rotor in a soft-jawed vise.
   2. Remove the bearing from the rotor shaft with a bearing remover.

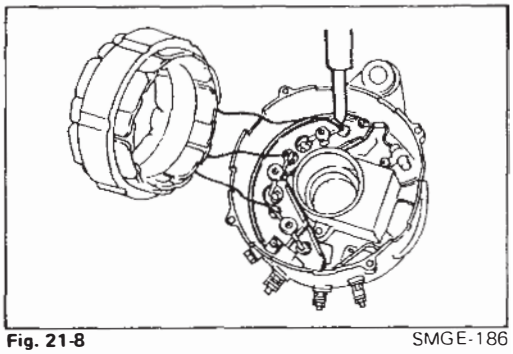


Fig. 21-8 SMGE-186

7. **UNSOLDER THE STATOR COIL FROM THE RECTIFIER HOLDER.**

   While holding the stator coil with long nose pliers, unsolder the leads from the rectifier holder.

   NOTE: The long nose pliers are used as a heat sink to help protect the rectifier from the heat.

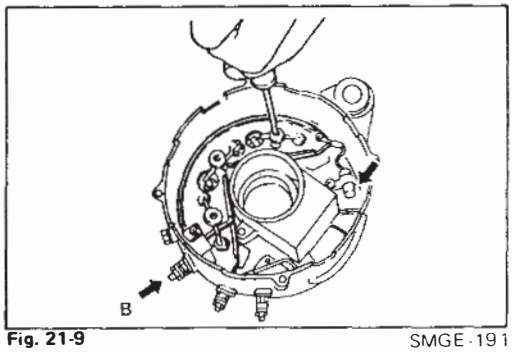


Fig. 21-9 SMGE-191

8. **REMOVE THE "B" TERMINAL, CONDENSER AND RECTIFIER ASSEMBLY FROM THE REAR END FRAME.**

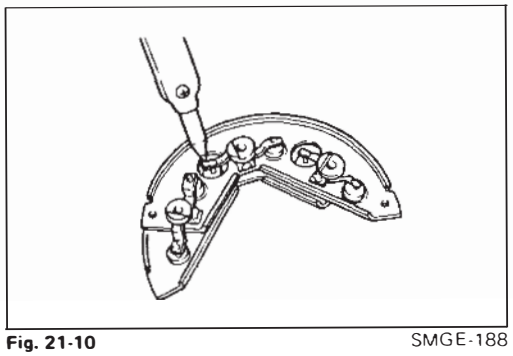


Fig. 21-10 SMGE-188

9. **UNSOLDER AND SEPARATE THE RECTIFIER.**

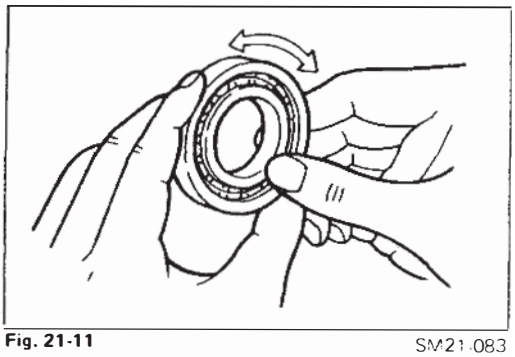


Fig. 21-11 SM21-083

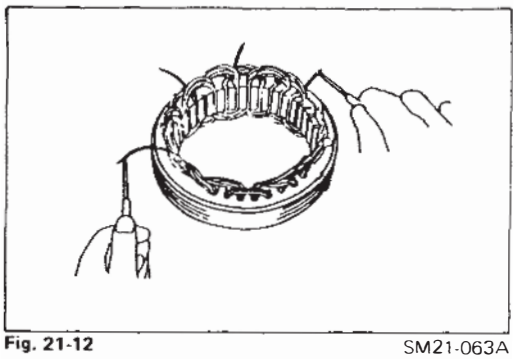


Fig. 21-12 SM21-063A

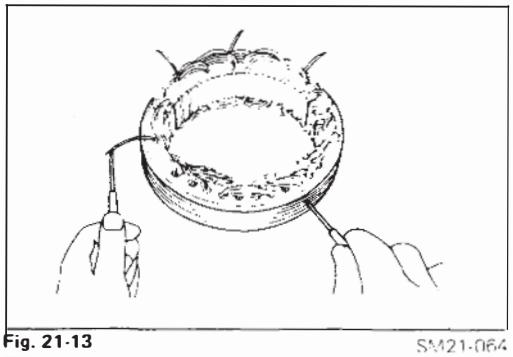


Fig. 21-13 SM21-064

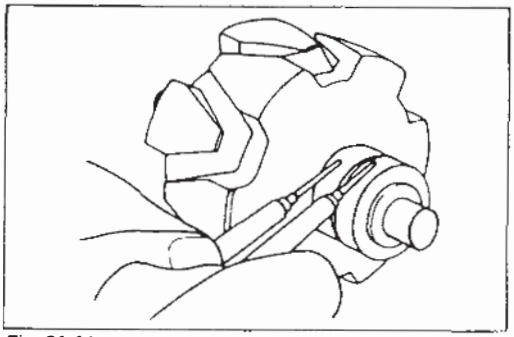


Fig. 21-14 SM21-086

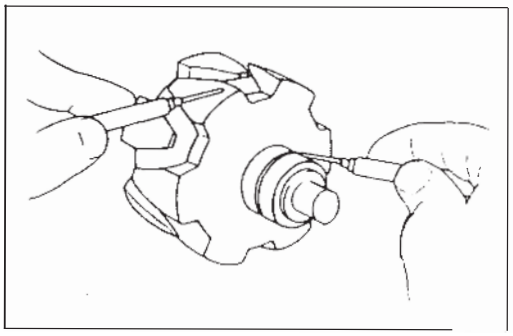


Fig. 21-15 SM21-087

INSPECTION AND REPAIR

1. INSPECT THE BEARING.

   Check that the bearing is not rough or worn. Replace if necessary.

2. INSPECT THE STATOR FOR OPEN CIRCUIT.

   Using an ohmmeter, check all coil leads for continuity.
   If there is no continuity, replace the stator.

   NOTE: At this time, the meeting wires should be connected with solder.

3. INSPECT THAT THE STATOR IS NOT GROUNDED.

   Using an ohmmeter, check that there is no continuity between the coil leads and stator core.
   If there is continuity, replace the stator.

4. INSPECT THE ROTOR FOR OPEN CIRCUIT.

   Using an ohmmeter, check for continuity between the slip rings.

   If there is no continuity, replace the rotor.

   Standard Resistance: 17.5Ω

5. INSPECT THAT THE ROTOR IS NOT GROUNDED.

   Using an ohmmeter, check that there is no continuity between the slip rings and rotor.
   If there is continuity, replace the rotor.

6. INSPECT THE SLIP RINGS.

   Check that the slip rings are not rough or scored.
   If rough or scored, replace the rotor.

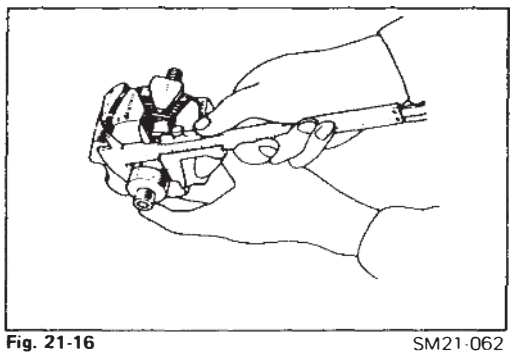


Fig. 21-16 SM21-062

7. MEASURE THE SLIP RING OUTER DIAMETER.

Assembly Standard: 37.5 mm (1.476 in)
Service Limit: 35.5 mm (1.397 in)

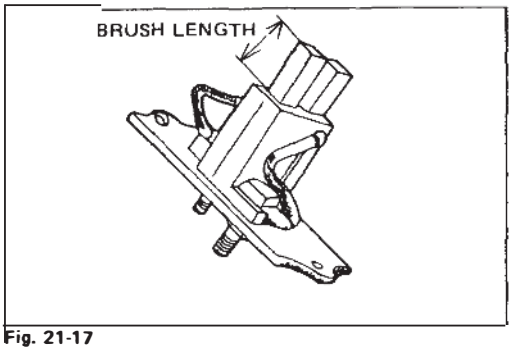


Fig. 21-17

8. MEASURE THE BRUSH LENGTH.

If the brush length is less than 4.5 mm (0.177 in), replace the brush.

Assembly Standard: 12.5 mm (0.492 in)
Service Limit: 4.5 mm (0.177 in)

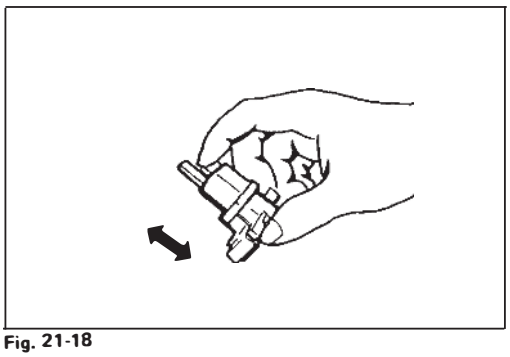


Fig. 21-18

9. INSPECT THE BRUSH HOLDER.

Inspect the brush holder moves smoothly. Replace if necessary.

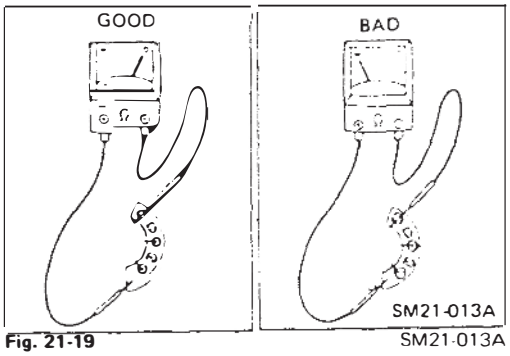


Fig. 21-19 SM21-013A

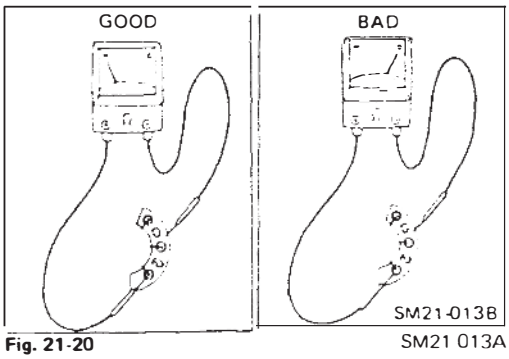


Fig. 21-20 SM21 013A

10. INSPECT THE RECTIFIER.

1. Rectifier holder positive side
   Connect an ohmmeter (+) lead to rectifier holder, and (−) lead of meter to rectifier terminal. If there is no continuity, rectifier assembly must be replaced.

   Reverse polarity of test leads and check again. If there is continuity, rectifier assembly must be replaced.

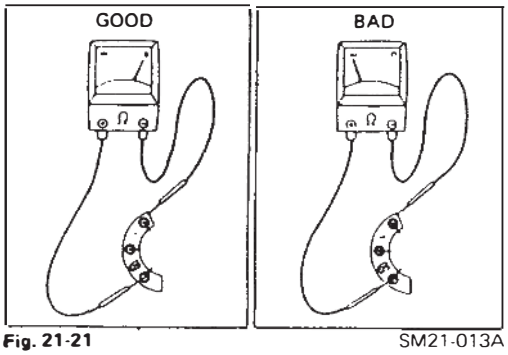


Fig. 21-21 SM21-013A

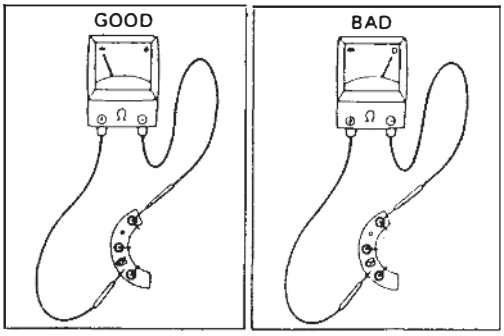


Fig. 21-22 SM21-013A

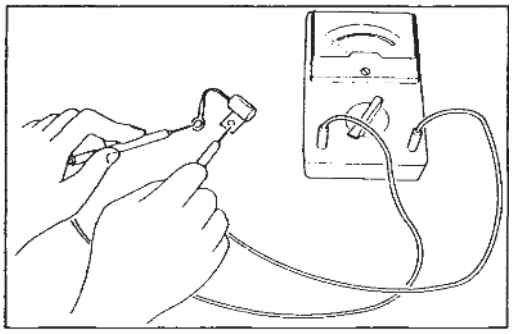


Fig. 21-23

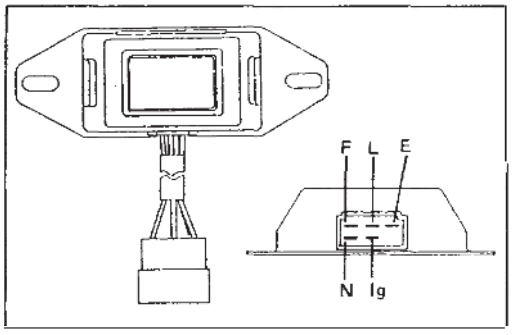


Fig. 21-24

2. Rectifier holder negative side
Connect an ohmmeter (+) lead to rectifier terminal, and (—) lead of meter to rectifier holder. If there is no continuity, rectifier assembly must be replaced.

Reverse polarity of test leads and check again. If there is continuity, rectifier assembly must be replaced.

11. MEASURE THE CONDENSER CAPACITY

Using a condenser tester, measure the condenser capacity.
If it exceeds the capacity, replace it with new one.

Condenser Capacity: 5 μF

12. INSPECT THE IC REGULATOR.

Using an ohmmeter, measure the resistance between each terminals.

Tester		Resistance (Ω)	Tester		Resistance (Ω)
+ Lead	— Lead	Range: X1	+ Lead	— Lead	Range: X1
Ig	L	∞	L	Ig	400
F	L	∞	L	F	∞
N	L	∞	L	N	∞
E	L	∞	L	E	150
F	Ig	500	Ig	F	∞
N	Ig	∞	Ig	N	∞
E	Ig	500	Ig	E	1K
N	F	∞	F	N	∞
E	F	∞	F	E	9
E	N	∞	N	E	∞

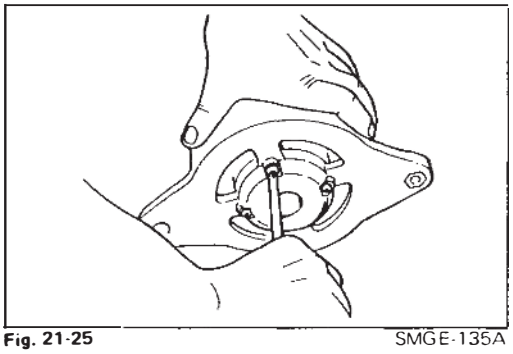


Fig. 21-25 SMGE-135A

ASSEMBLY

1. INSTALL THE BEARING IN THE DRIVE END FRAME.

1. Install the felt, cover ball bearing, plate and bearing retainer into the drive end frame.
2. Tighten the bearing retainer screws.

Tightening Torque: 60 – 80 kg·cm (4.4 – 5.7 lb.ft)

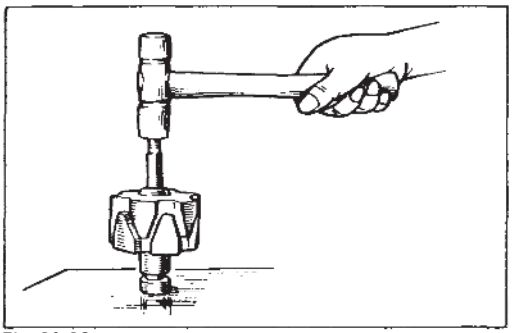


Fig. 21-26 SM21-100

2. INSTALL THE BEARING ON THE ROTOR SHAFT.

Tap the rotor shaft on with a plastic hammer.

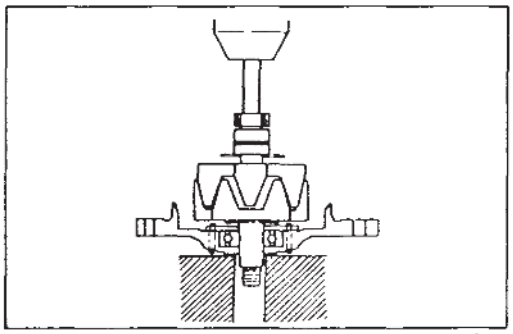


Fig. 21-27 SM21-095B

3. INSTALL THE ROTOR SHAFT.

Using a press, install the rotor shaft in the drive end frame.

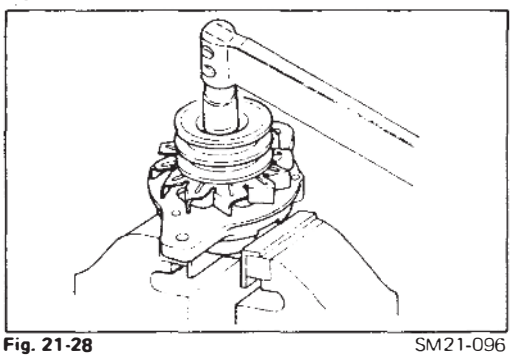


Fig. 21-28 SM21-096

4. INSTALL THE PULLEY WITH FAN.

1. Hold the rotor shaft in a soft-jawed vise.
2. Install the fan with pulley and spring washer on the rotor shaft.
3. Tighten the pulley nut.

Tightening Torque: 980 – 1,300 kg·cm (71 – 94 lb.ft)

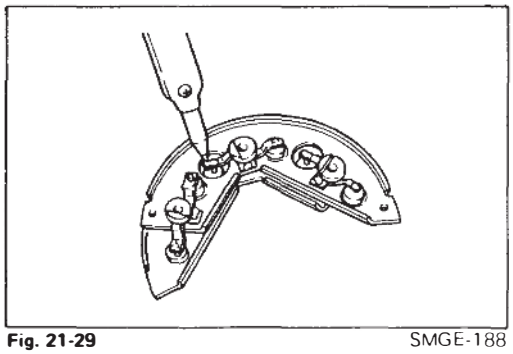


Fig. 21-29 SMGE-188

5. INSTALL THE RECTIFIER ASSEMBLY.

1. Solder and connect the rectifier.

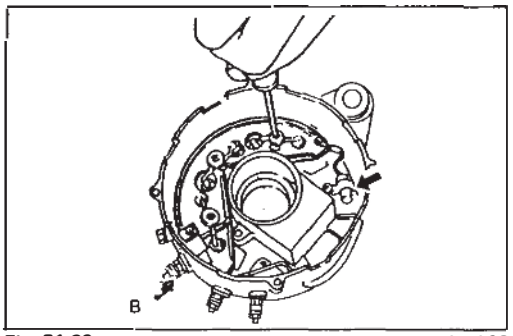


Fig. 21-30 21-283

2. Install the rectifier assembly, condenser and "B" terminal into the rear end frame.

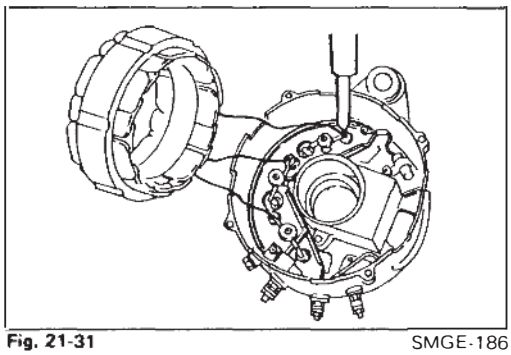


Fig. 21-31 SMGE-186

6. SOLDER THE STATOR COIL TO THE RECTIFIER HOLDER.

While holding the stator coil with long nose pliers, solder the lead to the rectifier holder.

NOTE: The long nose pliers are used as a heat sink to help protect the rectifier from the heat.

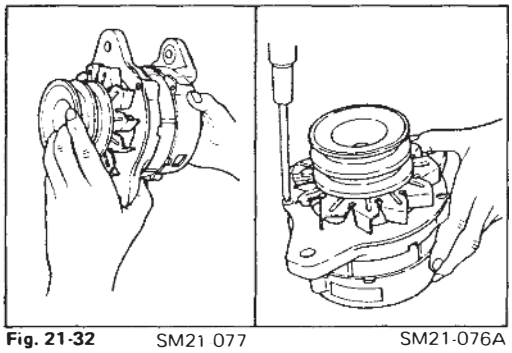
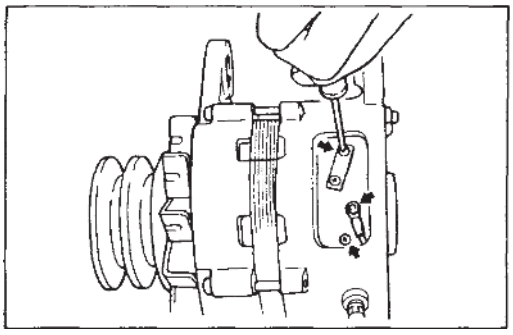


Fig. 21-32 SM21 077 SM21-076A

7. CONNECT THE DRIVE END FRAME AND THE REAR END FRAME.

1. Connect the drive end frame to the rear end frame.
2. Install the through bolts and tighten to the specified torque.

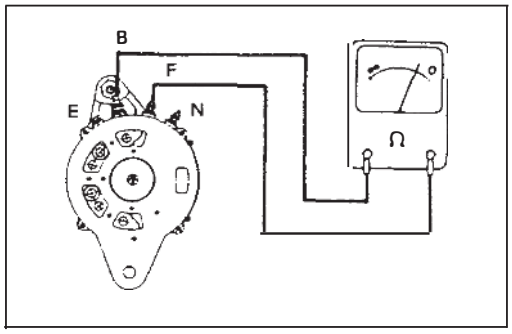
Tightening Torque: 37 – 50 kg·cm (2.7 – 3.6 lb.ft)



SMGE-189

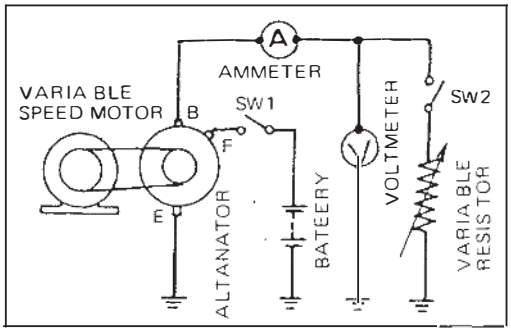
8. INSTALL THE BRUSH HOLDER ASSEMBLY.

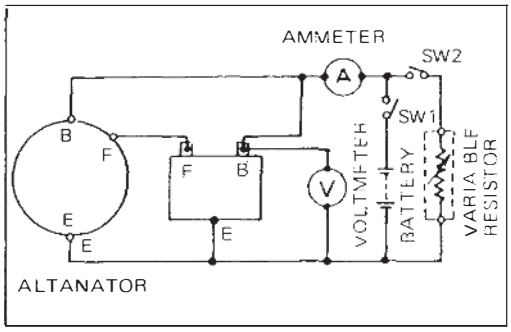
1. Install the brush holder assembly into the brush holder housing.
2. Install the brush holder cover.



9. AFTER ASSEMBLING THE GENERATOR, MEASURE THE RESISTANCE BETWEEN EACH TERMINALS OF THE GENERATOR.

Tester		Resistance	Tester		Resistance
+ Lead	– Lead	(Ω)	+ Lead	– Lead	(Ω)
B	E	About 40	F	B	∞
F	E	About 20	N	B	∞
N	E	About 8	B	F	About 100
E	B	∞	B	N	About 8
E	F	About 20	N	F	About 40
E	N	∞	F	N	∞





PERFORMANCE TESTS

1. GENERATOR PERFORMANCE TEST

1. Connect the leads, voltmeter, and ammeter as shown in the left diagram.
2. Close SW1 on and increase the generator speed until voltmeter reading reaches approx. 28V.
3. Close SW2. Regulating the load resistance, increase the generator speed, keeping the voltage at 28V until the ammeter reading reaches 25A.

Generator Speed: Less than 5,000 rpm at 28V, 25A

2. VOLTAGE REGULATION TEST

1. Connect the leads, voltmeter and ammeter as shown in the left diagram.
2. Close SW1 on and increase the generator speed until voltmeter reading reaches approx. 28V.
3. Close SW2. Increase the generator speed to 5,000 rpm, keeping the ammeter reading at 5A.
4. Check the voltmeter reading.

Generated Voltage: 28.5 – 29.5V

GROUP 4

STARTER
Model H06C-TI

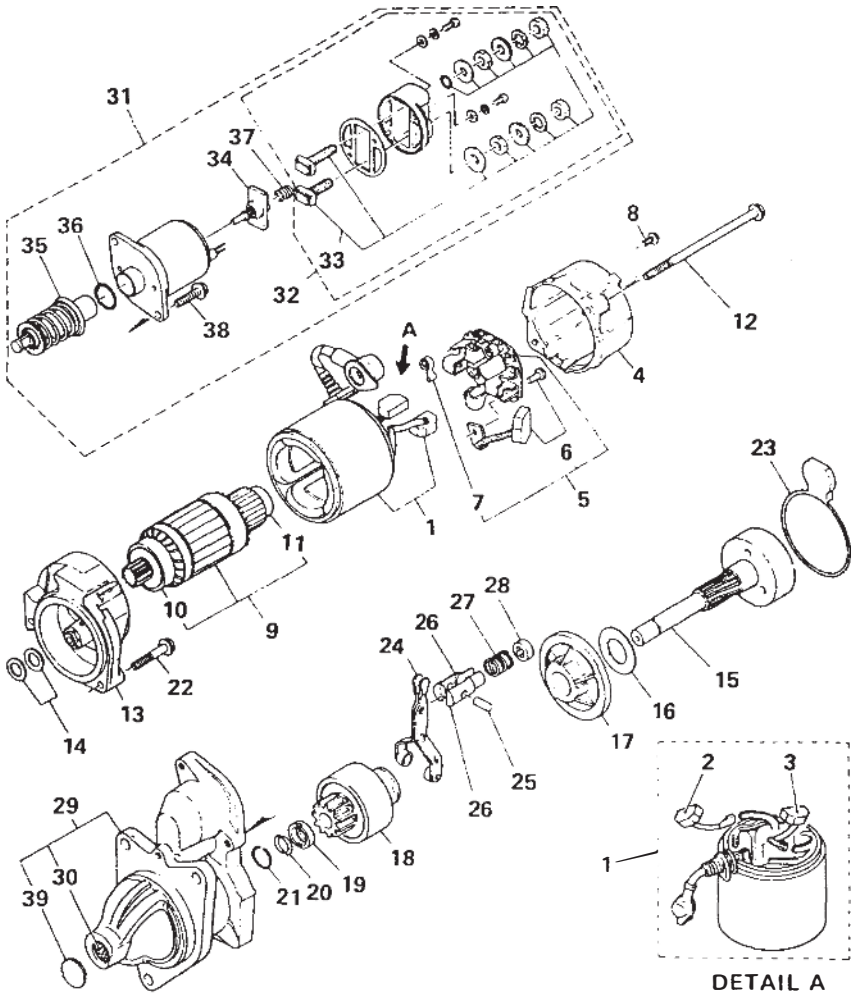
TROUBLESHOOTING

Symptom	Possible cause	Remedy
Engine does not crank, or cranks slowly.	**Key switch**	
	•Poor contact	Polish or replace contacts
	Battery	
	•Discharged battery	Charge
	•Short circuited between electrodes	Replace battery
	•Poor contact at battery terminal	Polish or retighten
	Engine oil	
	•Improper viscosity oil	Change oil
	Magnetic switch	
	•Poor contact caused by burnt contact plate	Polish or replace contact plate
	•Contact plate worn out	Repair
	•Hold-in coil disconnected (Overrunning clutch moves back and forth)	Replace field coil
	•Pull-in coil disconnected or short circuited	Replace
	Starter relay	
	•Defective or poor contact	Repair or replace
	Starter	
	•Brush worn out	Replace
	•Commutator burnt out	Correct on lathe
	•Commutator worn out	Correct by undercutting
	•Field winding shorted or grounded	Rewind or replace
	•Armature winding shorted or grounded	Replace armature
	•Insufficient brush spring tension	Replace brush spring
	•Poor contact between magnetic switch and field windings	Repair
	•Armature contacts pole core because of worn bearing or bent armature shaft	Replace bearing or armature
	•Overrunning clutch mulfunction	Replace

STARTER

Symptom	Possible cause	Remedy
Engine does not crank while starter is running in good condition.	**Overrunning clutch**	
	·Overrunning clutch mulfunction	Replace
	·Pinion teeth worn out	Replace
	·Poor sliding of spline teeth	Remove foreign materials, dirt, or replace
Starter does not stop running.	**Key switch**	
	·Contacts keep closing	Replace
	·Key switch sticks	Replace
	·Overrunning clutch sticks to armature	Repair or replace overrunning clutch or armature
	Starter relay	
	·Contacts keep closing	Repair or replace

STARTER



1. Yoke assembly
2. Brush
3. Brush
4. Commutator end frame
5. Brush holder assembly
6. Brush
7. Brush spring
8. Set bolt
9. Armature assembly
10. Ball bearing
11. Ball bearing
12. Set bolt
13. Gear housing
14. Shim
15. Drive shaft assembly
16. Shim
17. Bearing housing
18. Clutch and pinion assembly
19. Pinion stopper
20. Hook
21. Clip
22. Set bolt
23. Gasket
24. Drive pinion lever
25. Lever pinion
26. Lever holder
27. Holder spring
28. Insert
29. Drive housing assembly
30. Bushing
31. Magnetic switch assembly
32. Contactor with terminal cover assembly
33. Terminal assembly
34. Contactor assembly
35. Moving core assembly
36. O-ring
37. Contactor spring
38. Bolt
39. Plug

Fig. 22-1

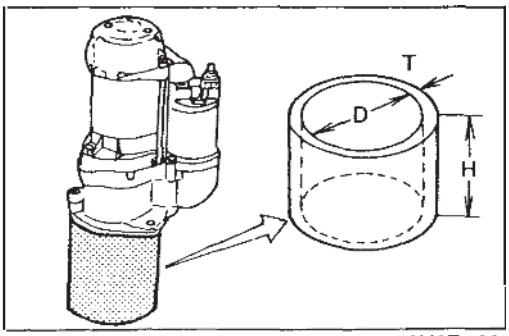


Fig. 22-2 SMST-130

DISASSEMBLY

When disassembling the starter, prepare a work stand as shown in the figure.

D: Diameter = 130 mm (5.118 in)
T: Thickness = 10 mm (0.394 in)
H: Hight = 120 mm (4.724 in)

1. REMOVAL OF THE MAGNETIC SWITCH

1. Remove the "M" terminal lead.

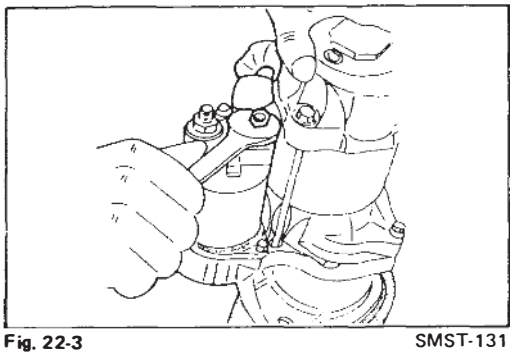


Fig. 22-3 SMST-131

2. Remove the magnetic switch set bolts, then remove the magnetic switch assembly.

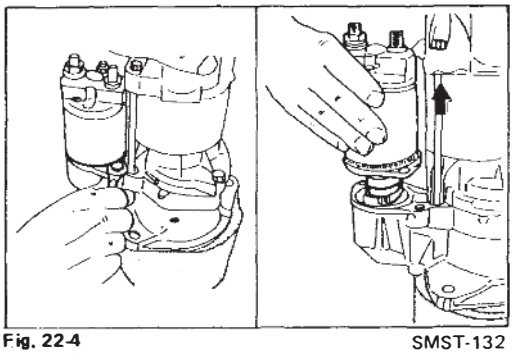


Fig. 22-4 SMST-132

3. Remove the moving core in the direction of the marked arrow in the order ① and ②.

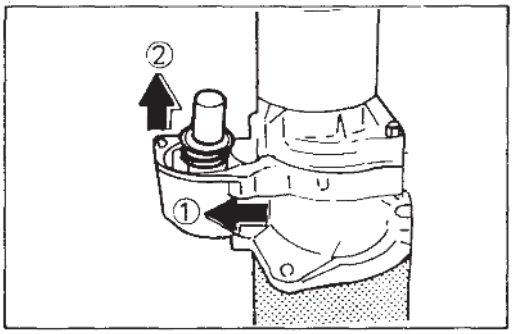


Fig. 22-5 SMST-133

2. REMOVAL OF THE FIELD COIL ASSEMBLY AND GEAR HOUSING FROM THE DRIVE HOUSING.

1. Remove the gear housing set bolt and commutator and frame set bolt.

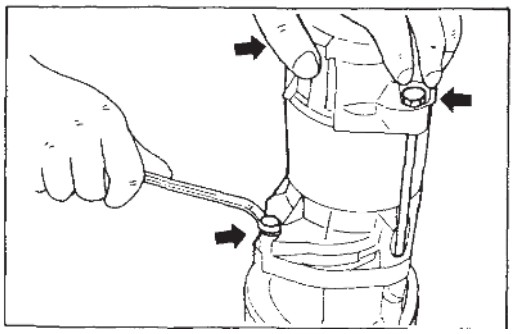


Fig. 22-6 SMST-134

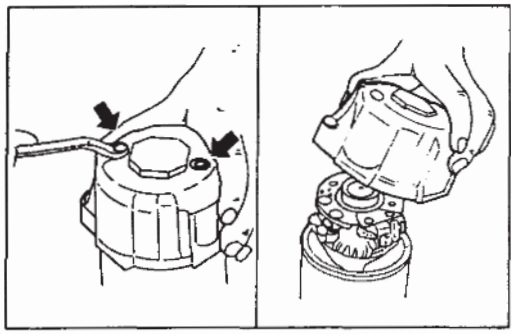


Fig. 22-7 SMST-135

2. Remove the commutator end frame set bolts, then remove the end frame.

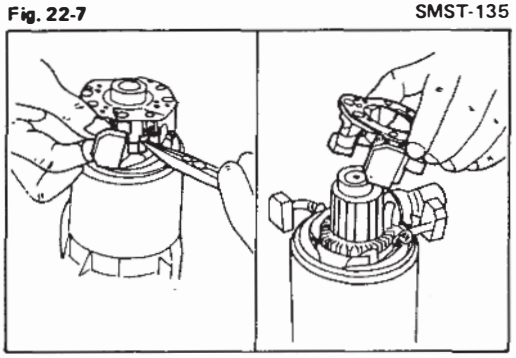


Fig. 22-8 SMST-136

3. Using long-nose pliers, remove the brushes from the brush holder.
4. Remove the brush holder.

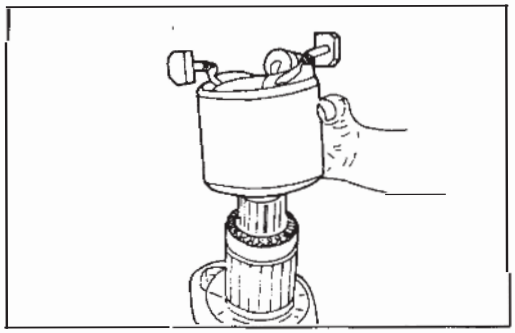


Fig. 22-9 SMST-137

5. Remove the field coil assembly.

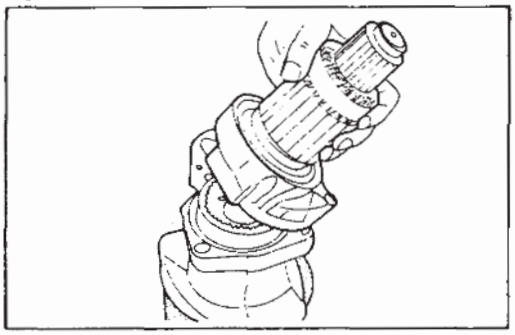


Fig. 22-10 SMST-138

6. Remove the armature assembly from the drive housing.

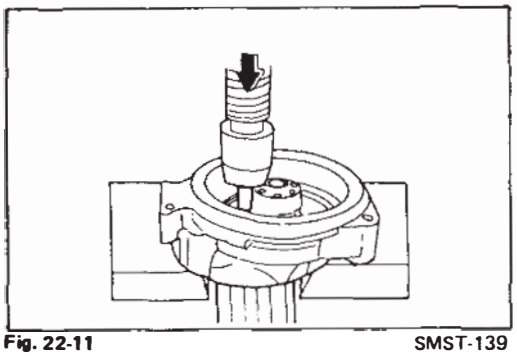


Fig. 22-11 SMST-139

7. Using a press, remove the armature from the gear housing.

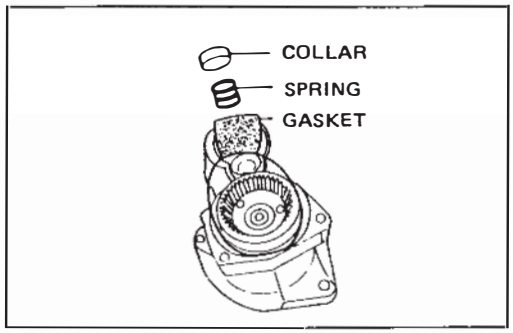


Fig. 22-12 SMST-139

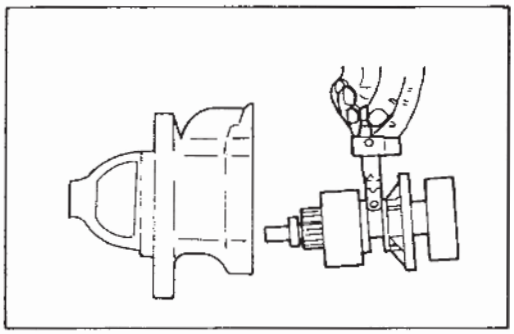


Fig. 22-13 SMST-140

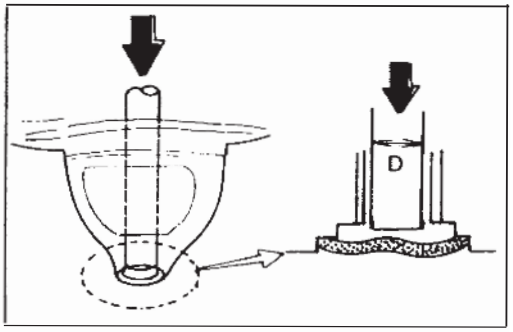


Fig. 22-14 SMST-141

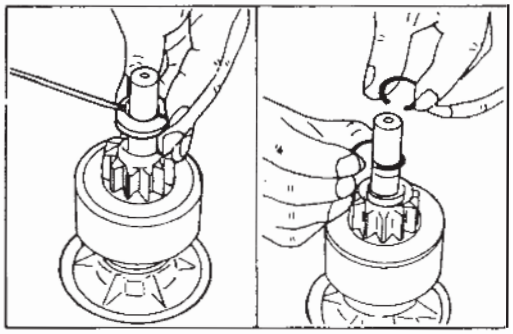


Fig. 22-15 SMST-142 SMST-143

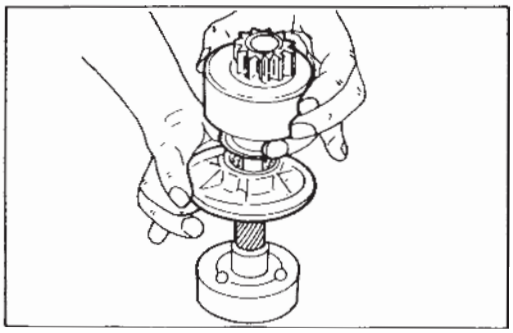


Fig. 22-16 SMST-144

3. REMOVAL OF THE DRIVE HOUSING.

1. Remove the gasket, collar, and spring.

2. Remove the clutch and pinion assembly from the drive housing.

3. Using a press, remove the drive housing plug.
   D: Diameter = 16 mm (0.620 in)

4. DISASSEMBLY OF THE CLUTCH AND PINION ASSEMBLY.

1. Remove the clip.
2. Remove the hooks and stopper.

3. Disconnect the clutch and pinion assembly, the bearing housing, and the drive shaft.

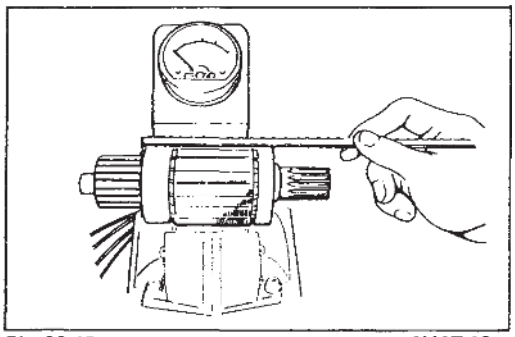


Fig. 22-17 SMST-091

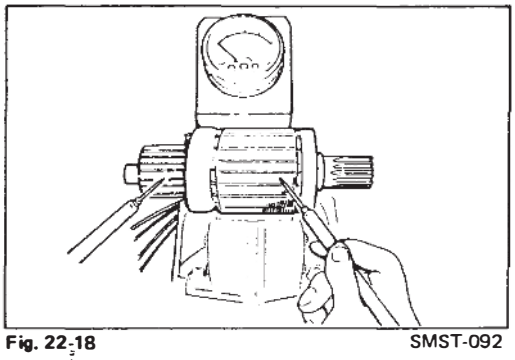


Fig. 22-18 SMST-092

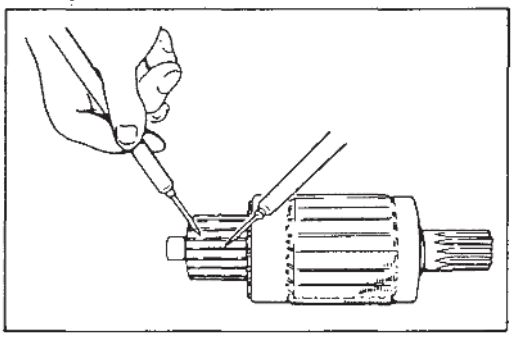


Fig. 22-19 SMST-125

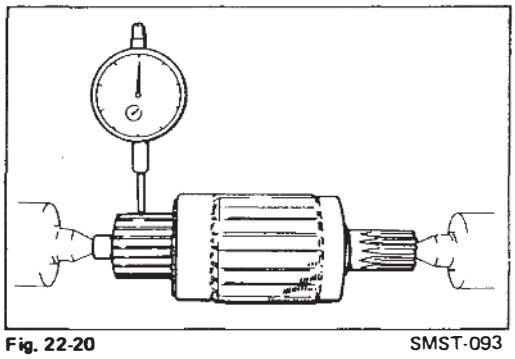


Fig. 22-20 SMST-093

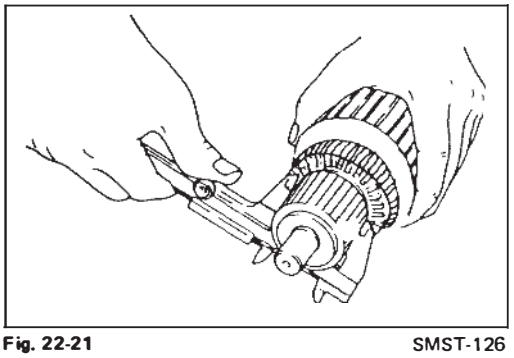


Fig. 22-21 SMST-126

INSPECTION AND REPAIR

Armature

1. ARMATURE SHORT-CIRCUIT TEST

Place the armature on a growler tester and hold a hack saw blade against the armature core while slowly rotating the armature.
A short circuited armature causes the blade to vibrate and to be attracted to the core.
An armature which is short-circuited must be replaced or repaired.

2. ARMATURE WINDING GROUND TEST

Using a circuit tester, touch one probe to a commutator segment and the other to the armature core. There should be no continuity. If there is continuity, the armature is grounded.
Replace the armature if grounded.

3. ARMATURE WINDING CONTINUITY TEST.

Using a circuit tester, touch probes to two segments. There should be continuity at any point. If there is no continuity, the winding is open-circuited.
Replace the armature if open-circuited.

4. COMMUTATOR RUN-OUT TEST.

Check the commutator run-out as shown.
If it exceeds the limit, repair or replace.

Standard: 0.05 mm (0.0020 in)
Service Limit: 0.1 mm (0.0039 in)

5. MEASUREMENT OF COMMUTATOR OUTER DIAMETER.

Measure the commutator outer diameter.
If it is worn, replace the armature.

Standard: 40 mm (1.575 in)
Service Limit: 38 mm (1.496 in)

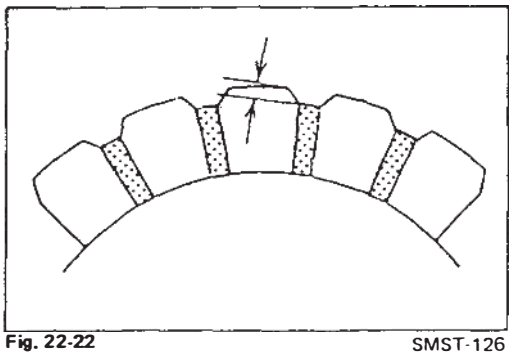


Fig. 22-22 SMST-126

6. MEASUREMENT OF SEGMENT MICA DEPTH.

Check the depth of the segment mica.
Undercut the segment mica if necessary.

Standard: **0.5 – 0.8 mm (0.0197 – 0.0314 in)**
Repair Limit: **0.2 mm (0.008 in)**

Yoke

1. VISUAL CHECK

Check the field windings for wear or damage.
Check all connections for clean and tight solder joints.

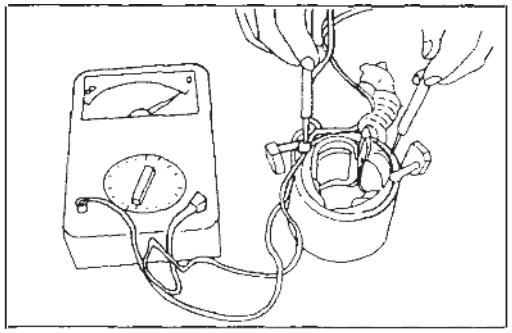


Fig. 22-23 SMST-145

2. FIELD WINDINGS GROUND TEST AND FIELD WINDINGS CONTINUITY TEST.

1. Field windings grounding test.
Using a circuit tester, touch one probe to the brushes and the other to the yoke body.
There should be no continuity. If there is continuity, the field windings are grounded. Repair or replace if necessary.

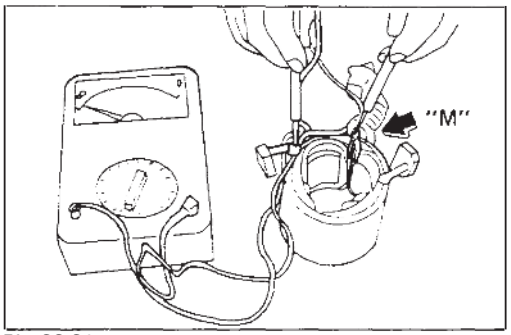


Fig. 22-24 SMST-146

2. Field windings continuity test.
Using a circuit tester, touch one probe to the "M" terminal and the other to the brushes.
There should be continuity. If there is no continuity, the field windings are open-circuited. Repair or replace if necessary.

Drive shaft

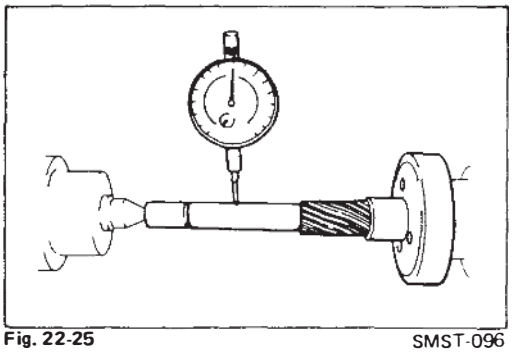


Fig. 22-25 SMST-096

1. DRIVE SHAFT RUN-OUT TEST.

Check the drive shaft run-out as shown.
If it exceeds the limit, repair or replace.

Standard: **0.05 mm (0.0020 in)**
Service Limit: **0.1 mm (0.0039 in)**

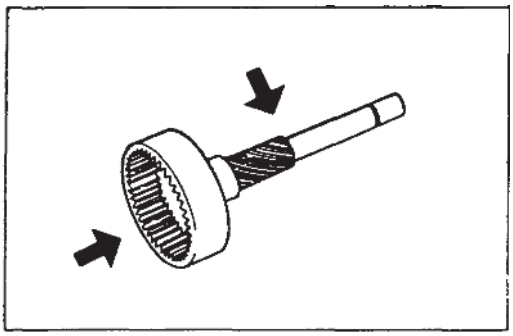


Fig. 22-26 SMST-097

2. INSPECTION OF DRIVE SHAFT.

Check the drive shaft spline and gear for wear or damage. Replace if necessary.

Bushing

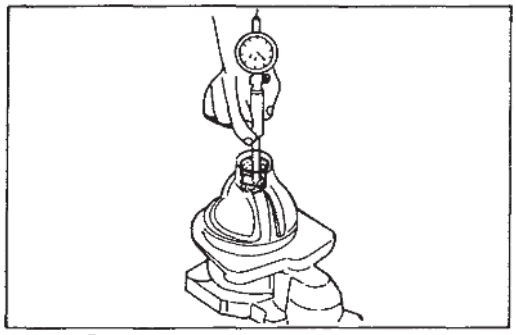


Fig. 22-27 SMST-147

1. MEASURE THE DRIVE HOUSING BUSHING.

Measure the inside diameter of the bushing.
If it exceeds the limit, replace the bushing.

Standard: 17.0 mm (0.669 in)
Service Limit: 17.2 mm (0.677 in)

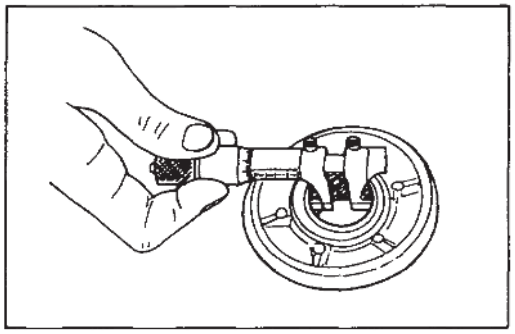


Fig. 22-28 SMST-148

2. MEASURE THE BEARING HOUSING BUSHING.

Measure the inside diameter of the bearing housing bushing.
If it exceeds the limit, replace the bearing bushing.

Standard: 28.0 mm (1.102 in)
Service Limit: 28.2 mm (1.110 in)

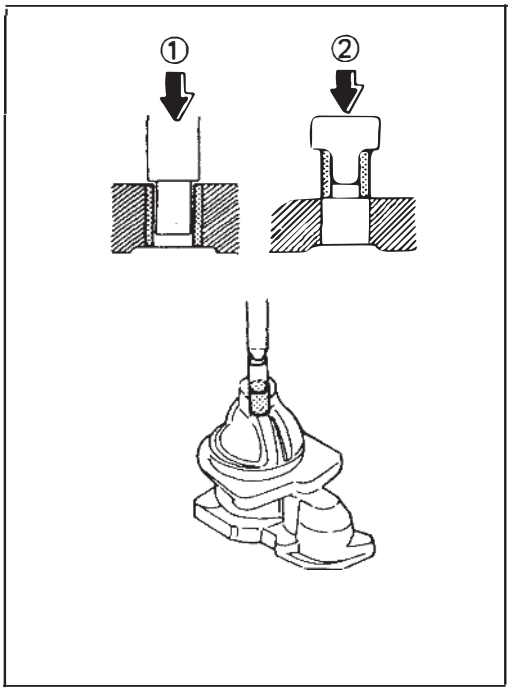


Fig. 22-29 SMST-149

3. REPLACEMENT OF BUSHING

① Remove the bushing as shown.

② Replace the bushing with a new one as shown.

NOTE: In the case of the bearing housing bushing, also replace the bearing housing bushing.

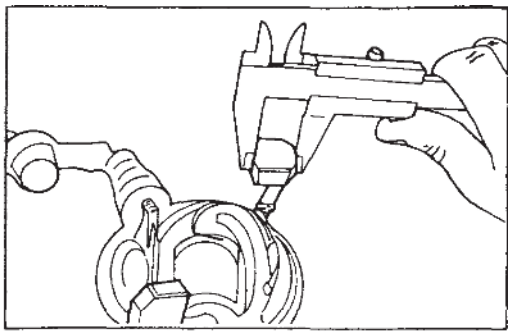


Fig. 22-30 SMST-150

Brush and brush holder

1. MEASUREMENT OF BRUSH LENGTH

Check the brush length for wear.
If it exceeds the limit, replace the yoke assembly or Brush holder assembly.

Standard: **20.0 mm (0.787 in)**
Service Limit: **13.0 mm (0.512 in)**

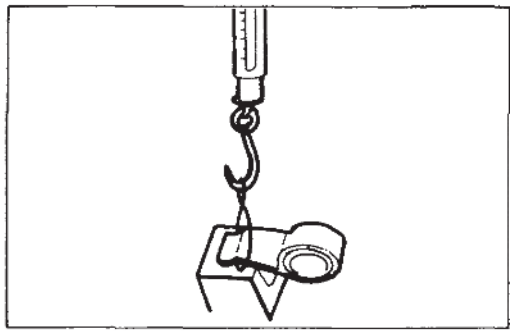


Fig. 22-31 SMST-117

2. MEASURE THE BRUSH SPRING.

Check the tension of the brush spring.
If it exceeds the limit, replace it with a new one.

Standard: **3.0 kg (6.6 lb)**
Service Limit: **2.0 kg (4.4 lb)**

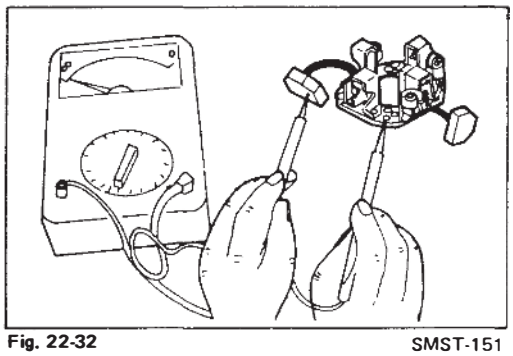


Fig. 22-32 SMST-151

3. BRUSH HOLDER INSULATION TEST.

Using a circuit tester, touch one probe to the brush and the other to the holder plate. There should be no continuity.
If there is continuity, replace.

Magnetic switch

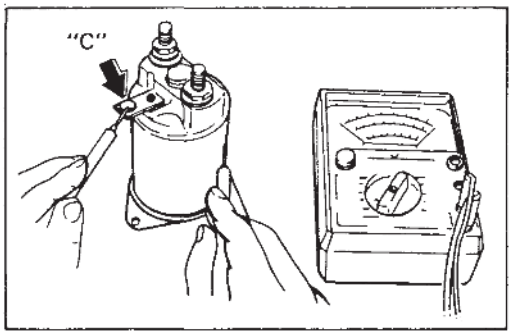


Fig. 22-33 SMST-152

1. MAGNETIC SWITCH WINDING CONTINUITY TEST BETWEEN "C" TERMINAL AND THE BODY.

Using a circuit tester, touch one probe to the "C" terminal and other to the body. There should be continuity, the magnetic switch windings are open-circuited. Repair or replace, if necessary.

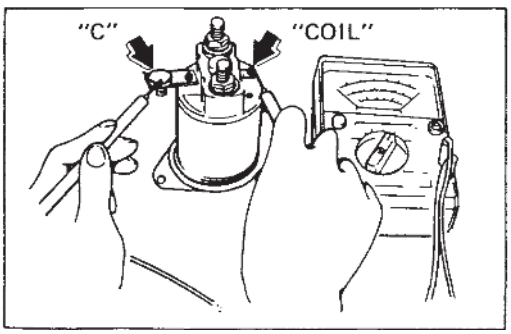


Fig. 22-34 SMST-153

2. MAGNETIC SWITCH WINDING CONTINUITY TEST BETWEEN "C" TERMINAL AND THE "COIL" TERMINAL.

Using a circuit tester, touch one probe to the "C" terminal and other to the "COIL" terminal. There should be continuity the magnetic switch windings are open-circuited. Repair or replace, if necessary.

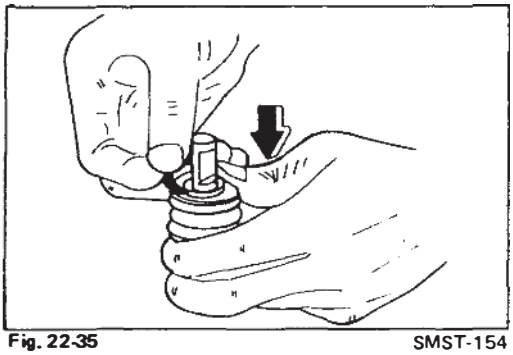


Fig. 22-35 SMST-154

REPLACEMENT OF THE MAGNETIC SWITCH.

1. Remove the clip, and disconnect the return spring from the moving core.

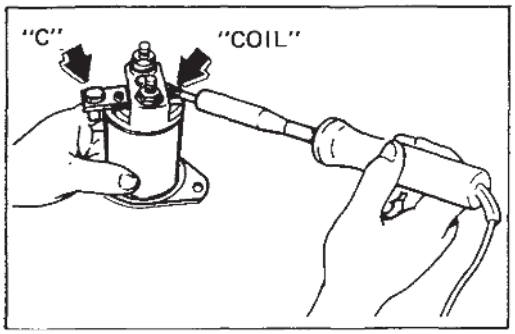


Fig. 22-36 SMST-155

2. Unsolder the "COIL" terminal and "C" terminal.

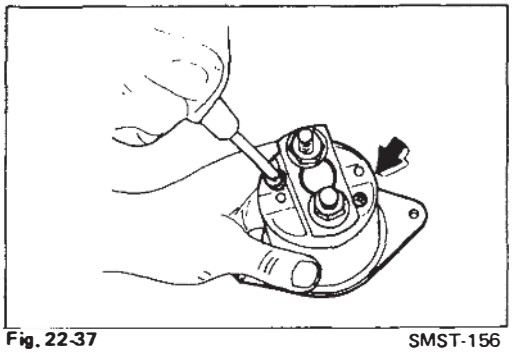


Fig. 22-37 SMST-156

3. Remove the contact housing screw.

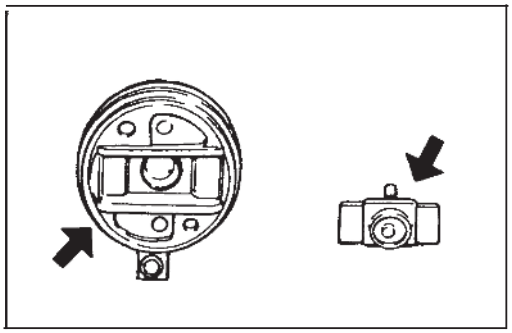


Fig. 22-38 SMST-104

4. Check the contact point for wear or damage. Replace if necessary.

Clutch and pinion

1. INSPECTION OF SPLINE TEETH

Inspect the spline teeth on the shaft and be sure that the clutch moves smoothly on it. Replace if necessary.

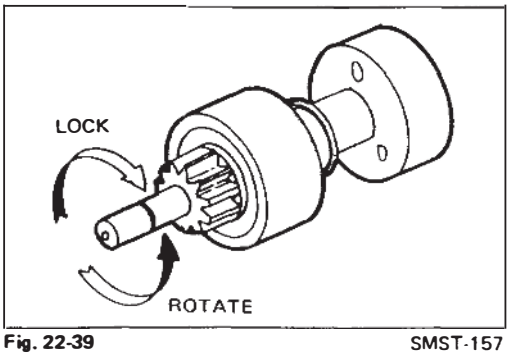


Fig. 22-39 SMST-157

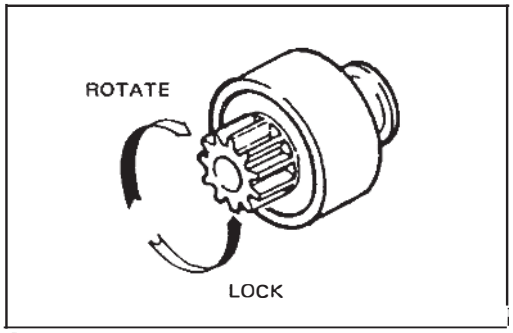


Fig. 22-40 SMST-158

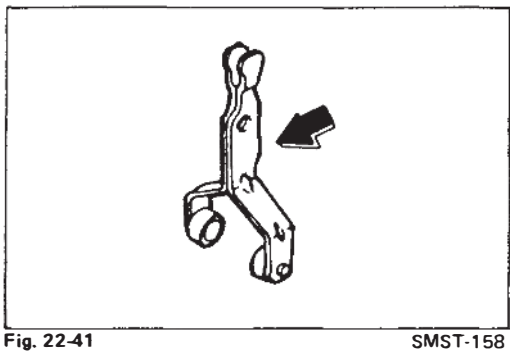


Fig. 22-41 SMST-158

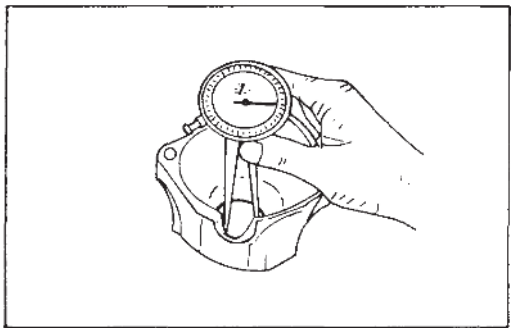


Fig. 22-42 SMST-159

2. INSPECTION OF CLUTCH.

Inspect the pinion to insure that it can be rotated freely in the direction of starter rotation and that it is looked in the opposite direction of rotation.
Replace if necessary.

Others

1. INSPECTION OF THE DRIVE PINION LEVER.

Check the drive pinion lever for wear and damage.
Replace if necessary.

2. MEASUREMENT OF COMMUTATOR END FRAME INSIDE DIAMETER.

Measure the end frame inside diameter.
If it is worn, replace the end frame.

Standard: **32.0 mm (1.260 in)**
Service Limit: **32.1** mm **(1.263 in)**

3. INSPECTION OF THE INSULATION PAPER.

Inspect the insulation paper applied at two locations inside for peeling or damage.
Replace, if necessary.

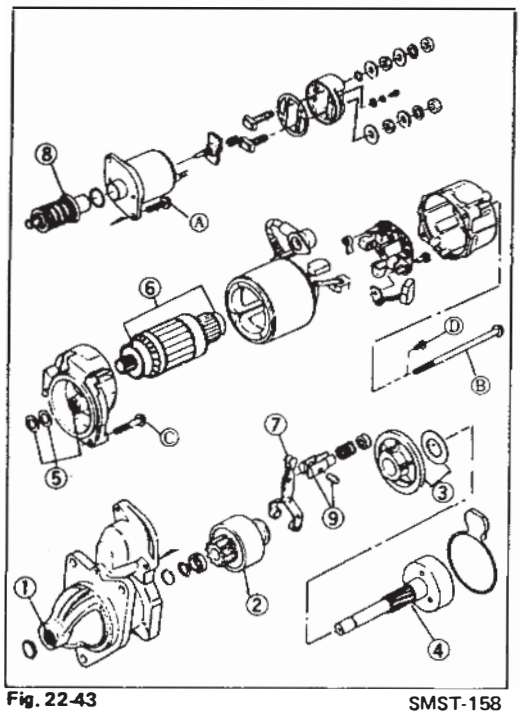


Fig. 22-43 SMST-158

ASSEMBLY

1. LUBRICATION AND TIGHTENING TORQUE

Before reassembling, apply the recommended grease as follows and when assembling, tighten the nuts and bolts to the specified torque value.

LUBRICATION POINTS:

① Bushing
② Clutch and pinion assembly
③ Bushing and shim
④ Drive shaft
⑤ Gear housing and shim
⑥ Bearing
⑦ Drive pinion lever
⑧ Moving core
⑨ Lever holder and pin

TIGHTENING TORQUE:

Ⓐ Magnetic switch set bolt
140 – 160 kg-cm (10.2 – 11.5 lb.ft)
Ⓑ Commutator end frame set bolt
140 – 160 kg-cm (10.2 – 11.5 lb.ft)
Ⓒ Gear housing set bolt
140 – 160 kg-cm (10.2 – 11.5 lb.ft)
Ⓓ Brush holder set bolt
37 – 50 kg-cm (2.7 – 3.6 lb.ft)

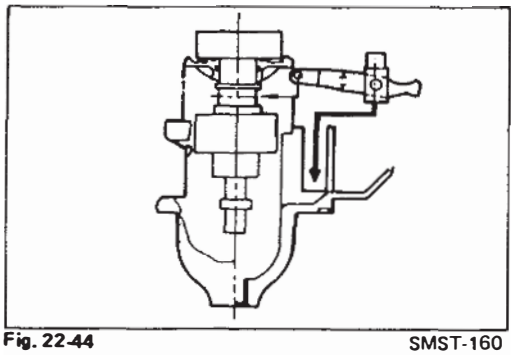


Fig. 22-44 SMST-160

2. TO REASSEMBLE, FOLLOW THE DISASSEMBLY PROCEDURE IN REVERSE ORDER.

NOTE: When assembling the starter, pay attention to the following points.

1. When installing the drive pinion lever on the shaft, pay attention to the direction in which the lever is installed.

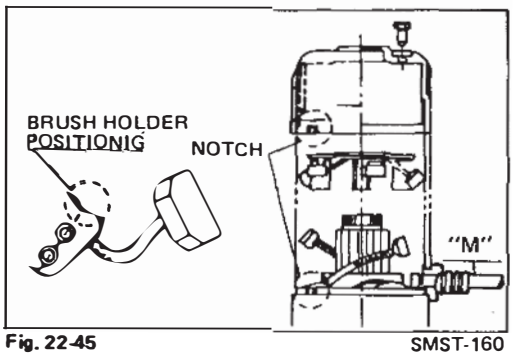


Fig. 22-45 SMST-160

2. Match the positioning of the brush holder with the "M" lead.
3. Match the end frame positioning guide with the notch of the brush holder positioning guide.

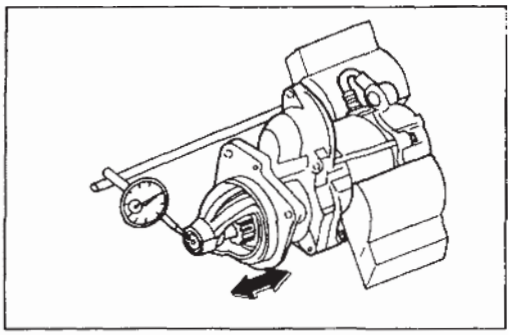


Fig. 22-46 SMST-161

3. MEASURE THE THRUST GAP.

After assembling the starter (without the magnetic switch), use a dial gauge to measure the thrust gap as you move the drive shaft in and out by hand.

Standard: **0.1 — 0.5 mm (0.004 — 0.0196 in)**

If the thrust gap exceeds the standard, adjust by decreasing or increasing the shim.

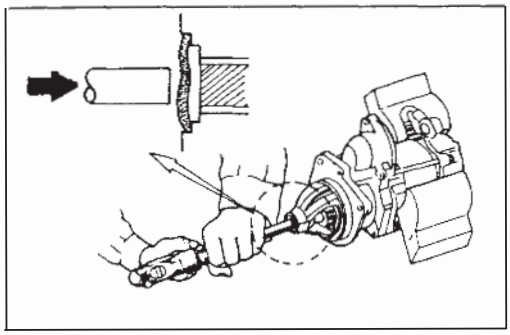


Fig. 22-47 SMST-162

AFTER MEASUREING THE GAP, INSTALL THE DRIVE HOUSING PLUG AND MAGNETIC SWITCH.

NOTE: **Use a new plug.**

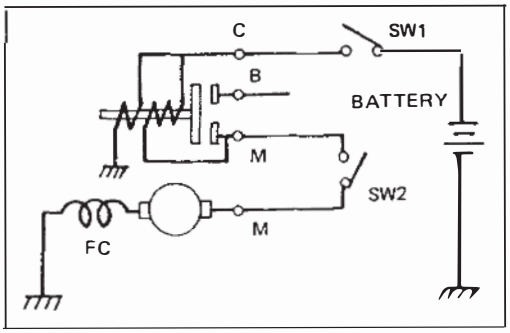


Fig. 22-48

4. AFTER ASSEMBLING THE STARTER, MEASURE THE TIMING GAP.

Arrange the circuit.
Close switches SW1 and SW2.
Open SW2 alone when the pinion pops out.
In the above condition, push the pinion back to measure the gap.

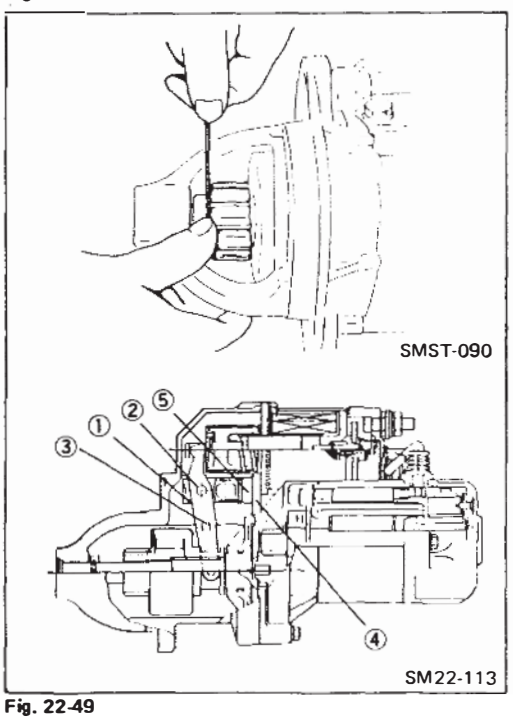


Fig. 22-49

Standard: **0.5 — 3.0 mm (0.020 — 0.118 in)**

If the gap exceeds the standard, check the following parts and, if necessary, replace them.

① Lever holder
② Lever pin
③ Drive pinion lever
④ Gasket
⑤ Insert

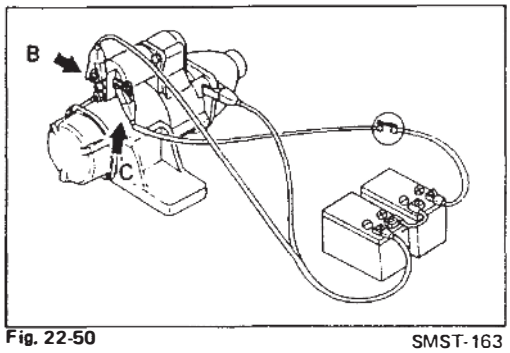


Fig. 22-50 SMST-163

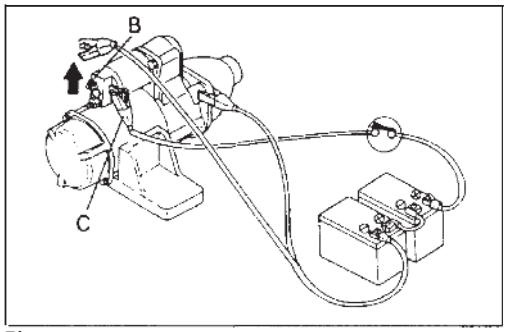


Fig. 22-51 SMST-163

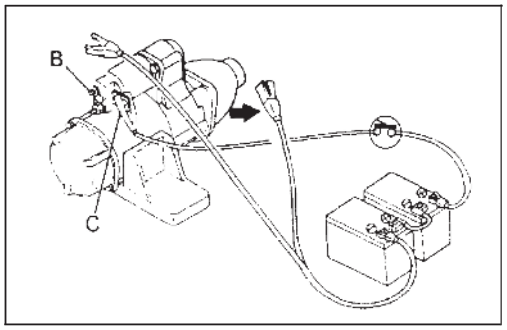


Fig. 22-52 SMST-163

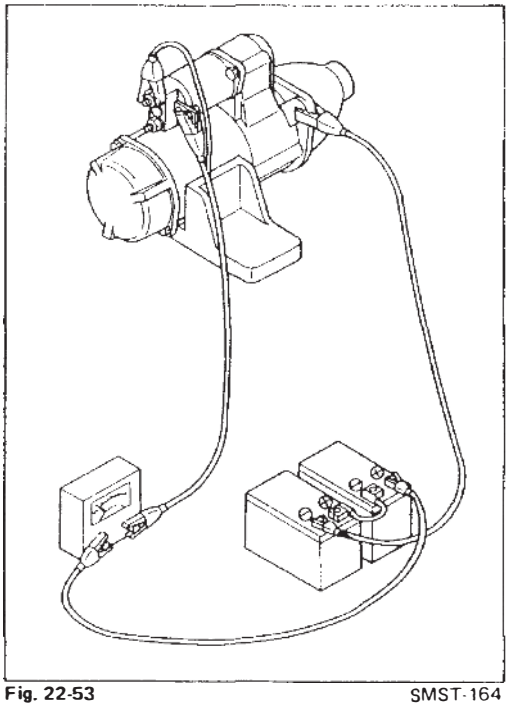


Fig. 22-53 SMST-164

TEST

1. MAGNETIC SWITCH TEST.

The following test should be performed with the starter assembled without the "M" terminal lead with specified voltage applied.

NOTE: Each test should be performed a short time (3 to 5 sec.) to prevent the magnetic switch winding from burning.

1. Pull-in test
   Connect the test leads as shown. When the switch is closed, the pinion should jump out.
2. Hold-in test
   With the same procedure as the pull-in test, disconnect the "B" terminal.
   The pinion should remain in the "jumped out" position.
3. Return-test
   With the same procedure as in the hold-in test, disconnect the "EARTH" jumper wire.
   The pinion should return immediately.

2. PERFORMANCE TEST

The following test should be carried out after re-assembling the starter. If suitable equipment is not available, at least the no-load test should be carried out.

No-load test
With the starter securely clamped in a vice, and using a battery and suitable ammeter, connect the positive lead of the battery, and the ammeter to the terminal. Connect the negative lead to the starter body.
The starter should show smooth and steady rotation immediately after jumping out of the pinion and should draw less than the specified current.

Specified Current: Less than 100A at more than 4,000 rom.

(KY)

GROUP 5

INJECTION PUMP CALIBRATION

CALIBRATION

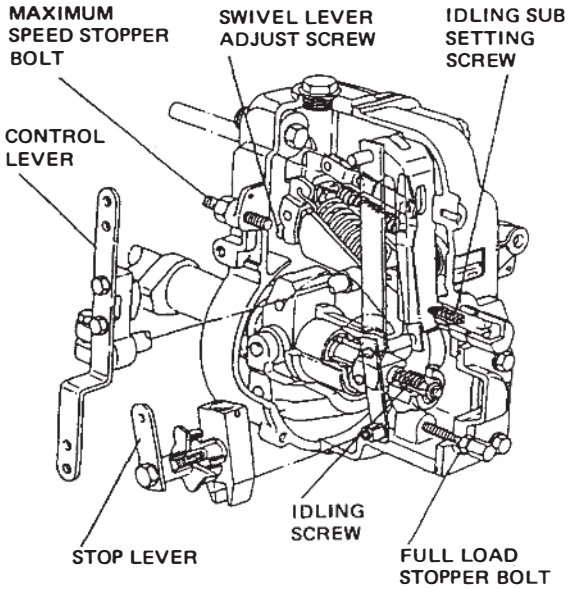
INJECTION PUMP SPECIFICATION	Engine model		H06C-TI
	Injection pump part number		22020–3001
	Injection pump type		NP–PE6AD105B320R
	Governor type		RSV
	Timer type		Not equipped
	Feed pump type		NP–FP/KE
TEST CONDITION	Test nozzle type		105780-8140
	Test nozzle opening pressure		175 kg/cm^2 (2,489 psi)
	Injection pipe	Outer diameter	6.0 mm (0.236 in)
		Inner diameter	2.0 mm (0.079 in)
		Length	600 mm (23.6 in)
	Calibration oil	Type	SAE J967C
		Oil temperature	40 – 45°C (104 – 113°F)
	Fuel feed pressure		1.6 kg/cm^2 (22.8 psi)
OVERFLOW VALVE	Opening pressure		1.5 – 1.8 kg/cm^2 (21.33 – 25.59 psi)
INJECTION TIMING	Rotation		Clockwise viewed from drive side
	Injection order		1–4–2–6–3–5
	Injection interval		60° ± 30′
	Pre-stroke		4.8 mm (0.189 in)

INJECTION VOLUME

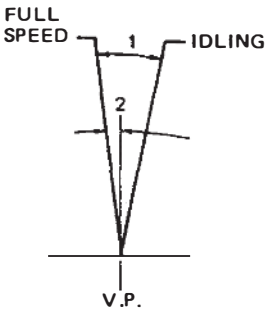
	Rack position mm (in)	Pump speed (rpm)	Measuring strokes	Injection volume cc (cu.in)	Max. variation limit cc (cu.in)
A	9.1 (0.358)	1,050	500	50.1–50.6 (3.057–3.086)	1.74 (0.212) – Base –
B	About 5.2 (0.205)	410	500	4.5–5.5 (0.275–0.335)	0.5 (0.031)
C	–	100	500	66.5–71.5 (4.057–4.361)	– – Rack limit–

GOVERNOR ADJUSTMENT

ADJUSTING POSITION



CONTROL LEVER ANGLE



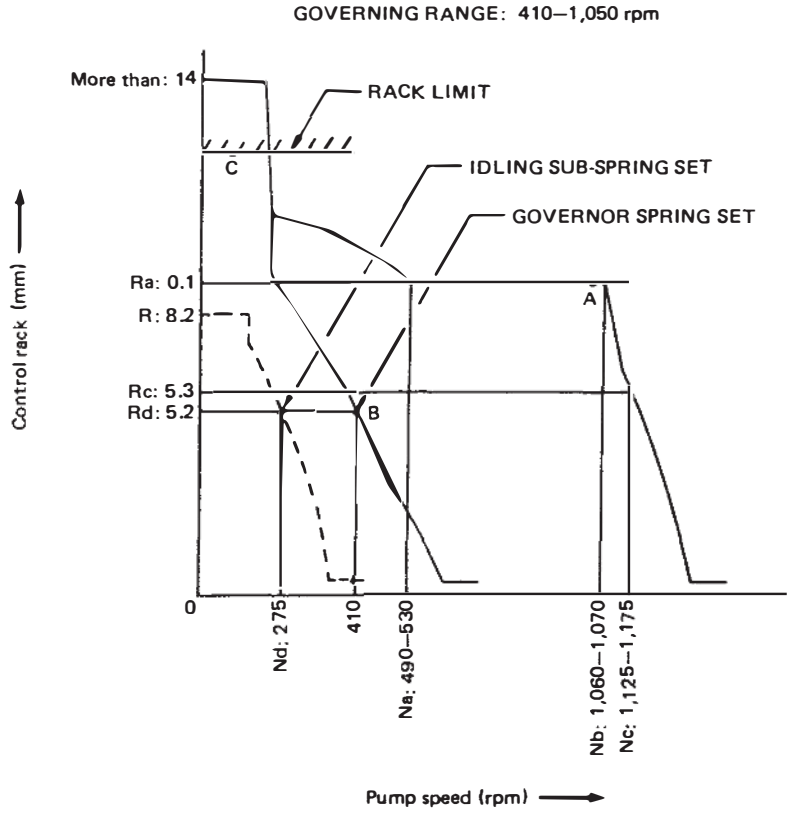
NOTE:
- ANGLE: 1 . . . 18° ± 5°
  2 . . . 3° ± 5°

- Lever angle "V.P." means. Vertical position

	Adjusting item	Adjusting lever position	Pump speed (rpm)	Control rack position mm (in)	Adjusting position
GOVERNOR ADJUSTMENT	Maximum speed	Full load	Na: 490–530	Ra: 9.1 (0.358 in)	Full load stopper bolt
			Nb: About 1,050	Rb: Should be start to pulled control rack	Maximum speed stopper bolt
			Nc: 1,125–1,175	Rc: 5.3 mm (0.209 in)	*Swivel lever adjusting screw
	Idling speed	Idle	N : 0 Nd: 275	R : 8.2 mm (0.323 in) Rd: 5.2 mm (0.205 in)	Idling sub-spring set

*NOTE: Recommend setting of swivel adjusting screw: 10 clinks from buttom end.

GOVERNOR CHARACTERISTIC DIAPHRAGM



GROUP 6
TURBOCHARGER

6

TROUBLESHOOTING

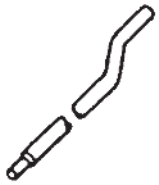
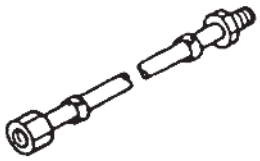
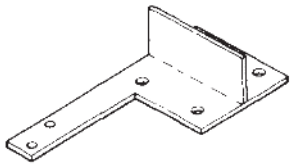
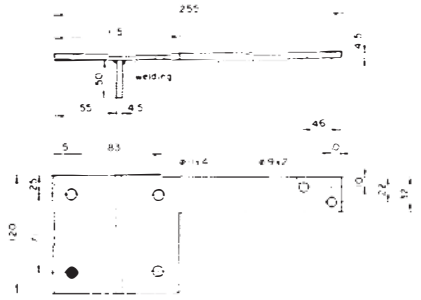
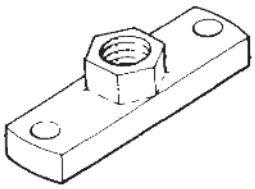
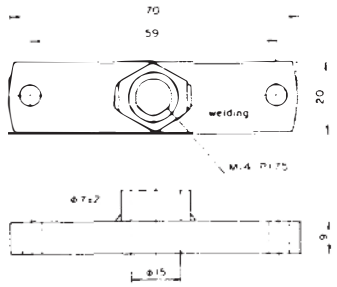
Symptom	Possible cause	Remedy/prevention
Dense black smoke	**Insufficient air intake**	
	• Air cleaner is choked with dust, causing greater intake air resistance.	Disassemble and clean or replace the air cleaner element.
	• Air inlet is choked	Repair.
	• Air is leaking from intake menifold.	Repair.
	Turbocharger does not rotate smoothly.	
	• Engine oil impurities deposited on rotor, resulting in heavy rotation or sticking.	Overhaul and clean turbocharger and/or change engine oil.
	Bearing sticking	
	• Insuffficient lubrication or blockalge of lubricating oil lines.	Check lubricating oil system, and/or repair.
	• Abnormal wear or damage of seal ring caused by wear of journal bearing, due to insufficient lubrication.	Repair.
	• Temperature of lubricating oil too high	Check cooling system.
	• Unbalanced rotating parts	Change rotating parts.
	• Incomplete warming-up, failure to idle before stopping engine, or jack rabbit starts.	Operate vehicle properly.
	Loose or damaged turbine wheel or compressor wheel.	
	• Over-rotation	Check and adjust the engine.
	• Temperature of exhaust gas too high	Check and adjust the engine.
	• Foreign matter present	Remove foreign material. Inspect the air cleaner and air intake manifold. Repair if necessary.
	• Worn thrust bearing	Overhaul and repair.
	• Incomplete assembly	Reassembly.
High volume exhaust like noise	Exhaust gas leaking before turbocharger, therefore insufficient revolution.	Check and repair connections.
	Deformed or blocked exhaust gas lines therefore insufficient revolution.	Repair.
White smoke	Choking defects, or deformation of oil return lines so that oil leaks around compressor or turbine sides.	Repair and replace the lines.
	Seal ring may be broken or worn due to abnormal wear of thrust washer.	Replace the thrust washer.

TURBO CHARGER

Symptom	Possible cause	Remedy/prevention
Loss of power	Gas leakage from exhaust system	Repair.
	Air leakage from air manifold	Repair.
	Clogged air cleaner element	Clean or replace.
	Turbocharger dirty or damaged	Repair or replace.
Poor response of turbocharger	Carbon accumulation on the turbine side seal ring and heavy rotation.	Change engine oil, clean turbocharger.
	Poor combustion	Check fuel system and improve combustion.
High pitched noise and vibration	Noise	
	• So called "surging" Surging sometimes occurs when the gas passage at the nozzle of the turbine housing is choked or when compressed air does not flow in proper responses to acceleration.	Overhaul and clean tubocharger.
	• Loose rotating parts	Replace.
	Vibration	
	• Joints loose between turbocharger and intake, exhaust manifold or oil lines.	Check the mounting and repair.
	• Damaged bearing, loose rotating parts, imbalanced rotating parts, etc.	Repair.

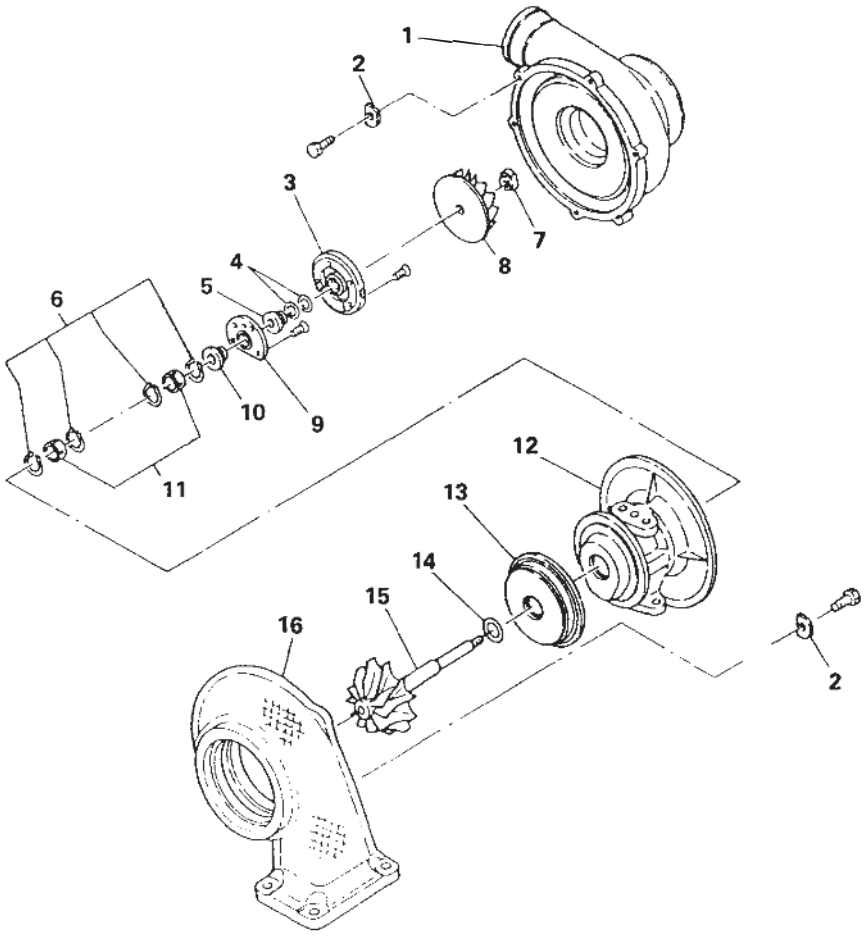
SPECIAL TOOLS

Before beginning a turbocharger overhaul, it is necessary to have the following special tools.

Illustration	Tool No.	Tool name	Use
	09444-1230	ATTACHMENT	For measuring the turbine shaft play with a dial gauge.
	09444-1250	PRESSURE GAUGE (Full scale 1 kg/cm^2)	For measuring boost pressure.
	17108-1040	HOSE	
	Tool name: *Mounting base 		For assembly, disassembly or inspecting of the turbo-charger.
	Tool name: *Attachmnet 		For removing the back plate.

*These special tools are not supplied by Hino motors and must be procured or manufactured by the maintenance shop.

OVERHAUL



1. Blower case
2. Plate
3. Back plate
4. Seal ring
5. Oil thrower
6. Retainer ring
7. Lock nut
8. Blower impeller
9. Thrust bearing
10. Thrust spacer
11. Bearing
12. Bearing case
13. Heat protector
14. Seal ring
15. Turbine rotor
16. Turbine case

Fig. 51-1

OVERHAUL FACTOR

CONDITIONS WHICH DETERMINE WHEN A TURBO-CHARGER OVERHAUL MAY BE NEEDED.

1. **THE ENGINE LACKS POWER OR ENGINE EXHAUST EMITS BLACK SMOKE.**

2. **BOOST PRESSURE IS BELOW THE NORMAL VALUE.**

   Inspect the turbocharger boost pressure according to the following procedures.

   NOTE: Before measurement
   - **Coolant temperature should approximately 80°C.**
   - **Air cleaner element should be clean.**

> **WARNING**
>
> **When making a pressure test, be sure that personnel are adequately protected against any stream of pressurized air that might be released by a leak or the rupture of a hose.**

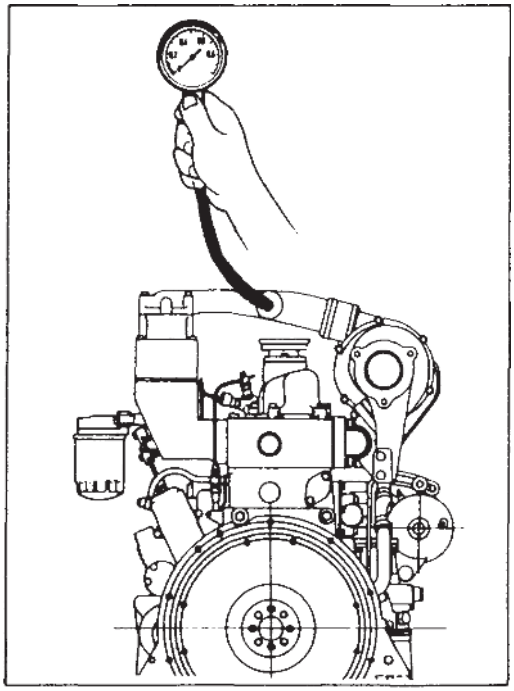


Fig. 51-2 SM51-069

1. Remove the blind plug on the intake pipe and install the hose and pressure gauge (special tools).

   Special Tools: Pressure gauge (09444-1250)
   Hose (17108-1040)

2. Run the engine at maximum rpm.

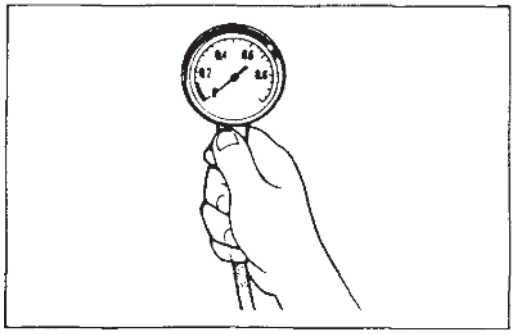


Fig. 51-3 SM51-041

3. Read the boost pressure.

   It the boost pressure is below the normal value, turbocharger overhaul is needed.

   Boost Pressure: 0.6 – 0.8 kg/cm^2

3. OTHER FACTORS

1. Noisy of excessive vibration of the turbocharger.
2. Excessive engine oil consumption.
3. Gas leakage at the turbine end or blower end.
4. Oil leakage from the turbocharger.

REMOVAL

WARNING

Do not work on the turbocharger while it is still hot. This can result in personal injury.

Dismount and mount, refer to the "CHAPTER 3".

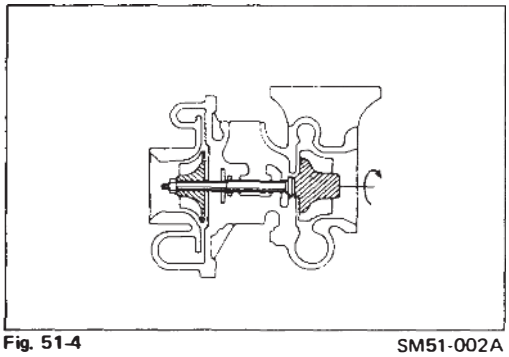


Fig. 51-4 SM51-002A

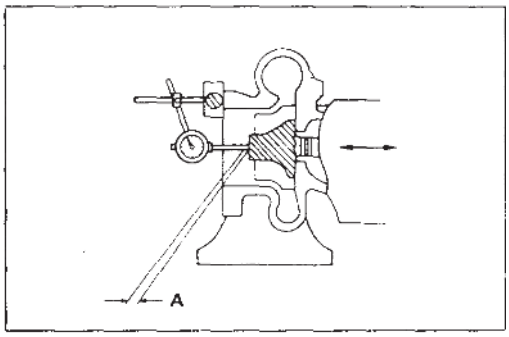


Fig. 51-5 SM51-002

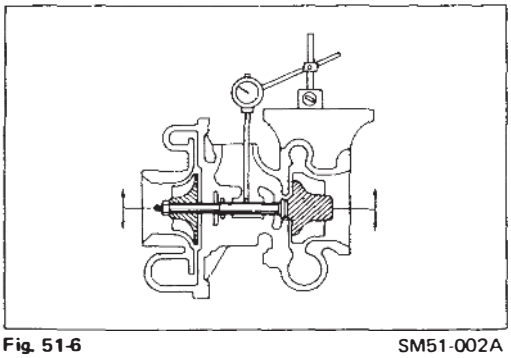


Fig. 51-6 SM51-002A

DISASSEMBLY

1. INSPECTION BEFORE DISASSEMBLY.

1. Rotate the blower impeller by hand to see if it turns smoothly.

   If it does not turn smoothly, clean and inspect the bearings and turbine rotor.

2. Check the turbine rotor for axial play (A).

   If the axial play is greater than the service limit, replace the thrust bearing and/or thrust spacer.

Axial Play: **0.06 – 0.09 mm (0.0023 – 0.0035 in)**
Service Limit: **0.11 mm (0.0043 in)**

3. Check the turbine rotor for radial play using a special tool.

   If the radial play is greater than the service limit, replace the bearings and/or turbine rotor.

Special Tool: **09444-1230**

Radial Play: **0.11 – 0.18 mm (0.004 – 0.007 in)**
Service Limit: **0.215 mm (0.0085 in)**

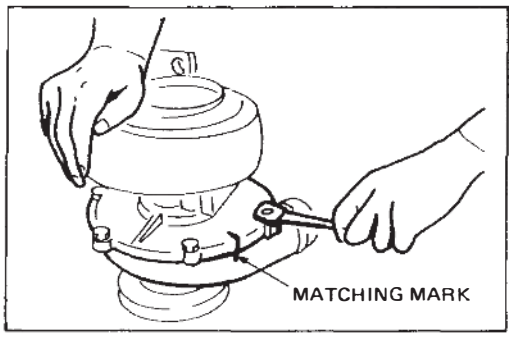


Fig. 51-7 SM51-017

2. DISASSEMBLE THE TURBINE CASE.

NOTE: **Make mate marks on the turbine case, bearing, housing, and blower case to aid alignment during reassembly.**

1. Unlock the lock plate and remove the turbine case fitting bolts.


Fig. 51-8 51-005A

2. Remove the turbine case.

NOTE: **Be careful not to damage the turbine blades.**

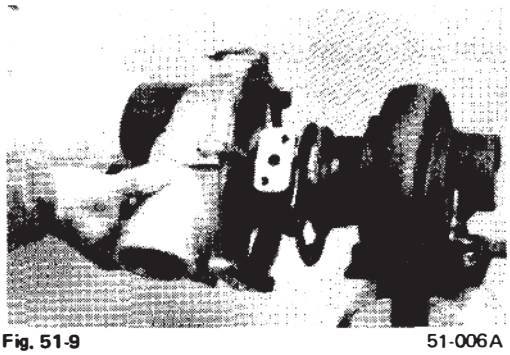


Fig. 51-9 51-006A

3. DISASSEMBLE THE BLOWER CASE.

1. Reposition the mounting base.
2. Mount the blower case on the mounting base.
3. Remove the blower case fitting bolt.

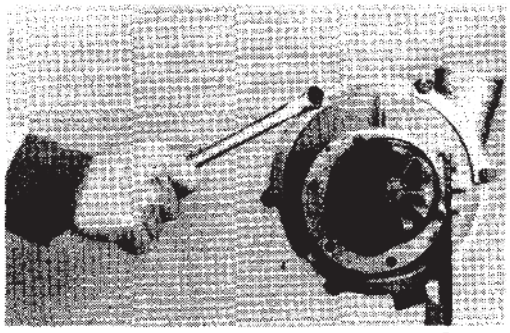


Fig. 51-10 51-007

4. Remove the blower case.

NOTE: **Lightly strike the blower case using a plastic hammer.**
Be careful not to damage the blower impeller.

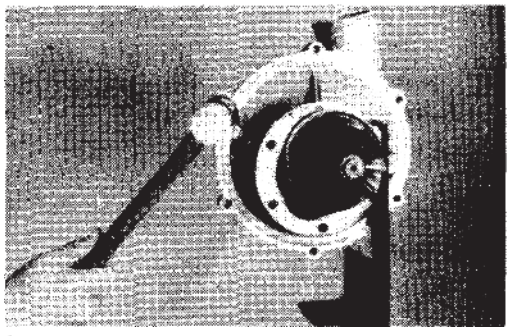


Fig. 51-11 51-008

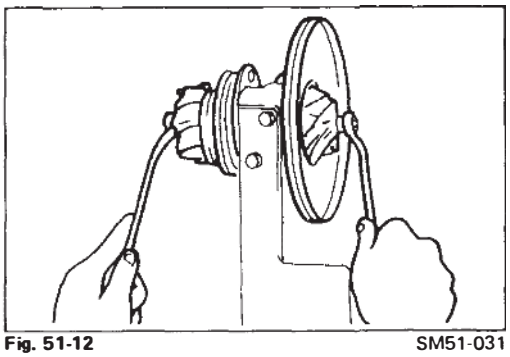


Fig. 51-12 SM51-031

4. REMOVE THE TURBINE ROTOR.
   1. Remove the blower impeller fitting nut.

   NOTE: **Turn the lock nut clockwise to loosen the nut (left-hand threads).**

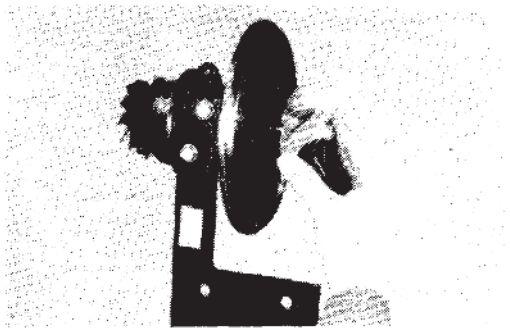


Fig. 51-13 51-010

   2. Remove the blower impeller by hand.


Fig. 51-14 51-011

   3. Remove the turbine rotor with heat protector.

5. REMOVE THE BEARINGS.
   1. Remove the holding plate.

   NOTE: **Mark one side of the holding plate so that it can be replaced in the proper direction during assembly.**

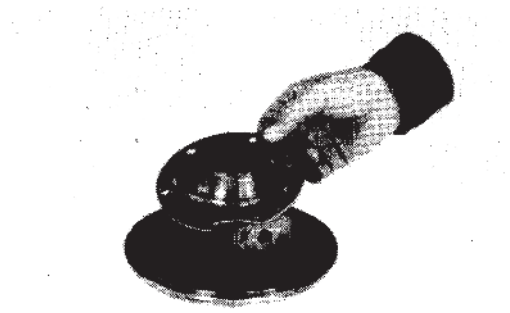


Fig. 51-15 51-012

   2. Remove the back plate.
   Pull out the back plate using the attachment and a sliding hammer.

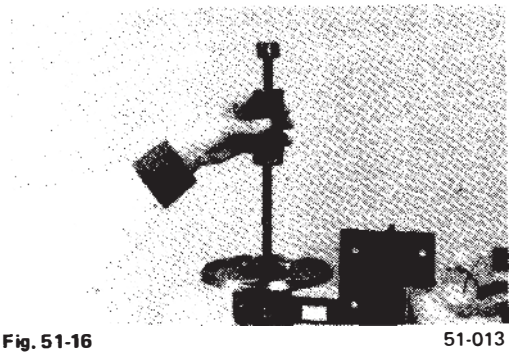


Fig. 51-16 51-013

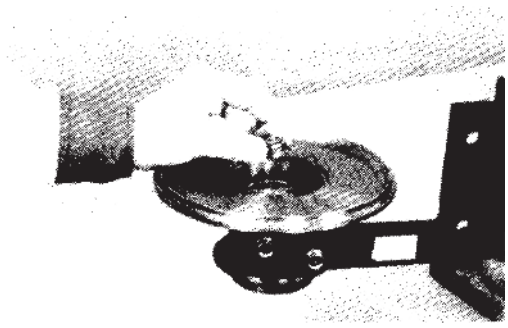


Fig. 51-17 51-014

3. Remove the oil thrower.

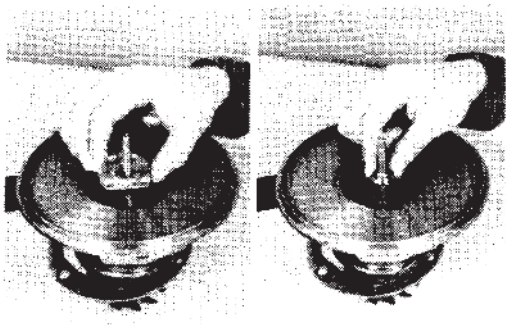


Fig. 51-18 51-015 51-016

4. Remove the thrust bearing and thrust bushing.

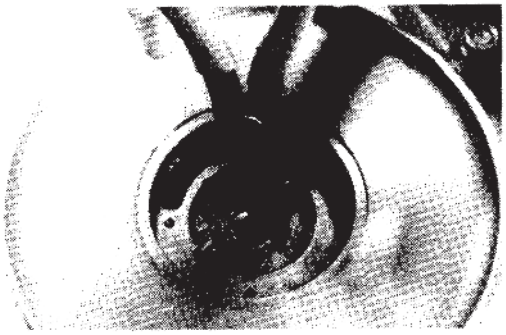


Fig. 51-19 51-017

5. Remove the retainer rings of each bearing.

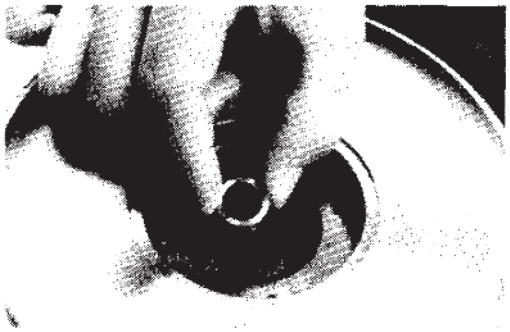


Fig. 51-20 51-018

6. Remove the bearings.

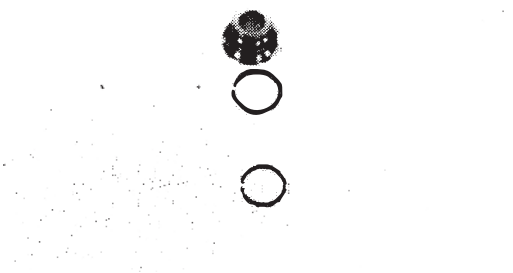


Fig. 51-21 51-019

7. Remove the seal rings from the oil thrower.

INSPECTION

1. INSPECTION

Before cleaning, the disassembled parts should be visually inspected to check for burning, abrasion, carbon deposits, gas and oil leakage.

2. CLEANING

Thoroughly clean all the parts with diesel fuel, using a soft brush, and dry with compressed air.

NOTE: ○ Never use a caustic cleaning solution, as it may attack aluminum.
○ Never use a wire brush.

WARNING

This cleaning should be done in a well ventilated room and away from any open flames or electric sparks.

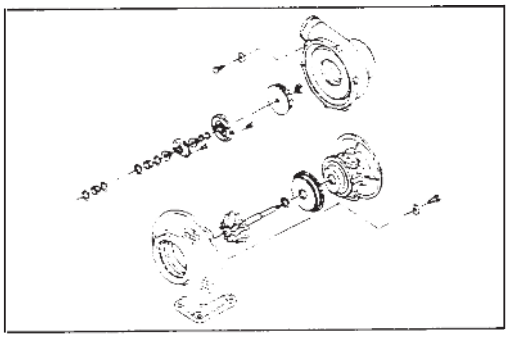


Fig. 51-22

3. INSPECT ALL THE DISASSEMBLED PARTS FOR ANY ABNORMAL WEAR, CRACKS, DEFORMATION, OR DISCOLORATION.

Replace any faulty part.

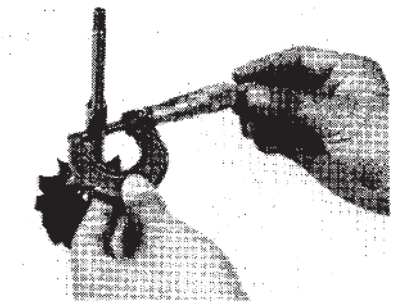


Fig. 51-23 51-021

4. MEASURE THE OUTSIDE DIAMETER OF THE TURBINE SHAFT.

If the turbine shaft is smaller than the service limit, replace the turbine rotor.

Service Limit: 12.28 mm (0.4835 in)

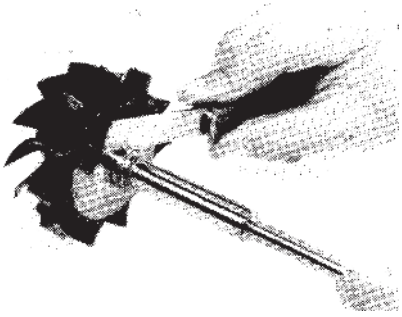


Fig. 51-24 51-022

5. MEASURE THE RING GROOVE WIDTH.

If the ring groove width is greater than the service limit, replace the turbine rotor.

Service Limit: 1.63 mm (0.0642 in)

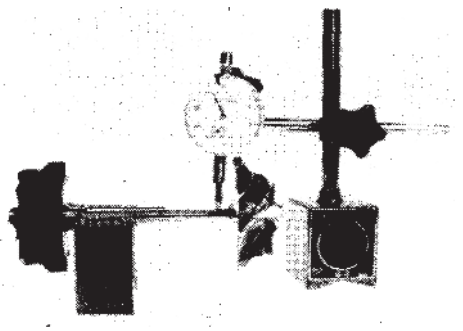


Fig. 51-25 51-023

6. MEASURE THE BEND OF THE TURBINE SHAFT.

If shaft runout is greater than the service limit, replace the turbine rotor.

NOTE: **Do not repair the turbine rotor.**

Service Limit: 0.011 mm (0.0004 in)

Fig. 51-26 51-024

7. MEASURE THE INSIDE AND OUTSIDE DIAMETERS OF THE BEARING.

If the inside diameter is greater than the service limit, replace the bearing.
If the outside diameter is less than the service limit, replace the bearing.

Service Limit:
Outside Diameter: 16.98 mm (0.6685 in)
Inside Diameter: 12.36 mm (0.4866 in)

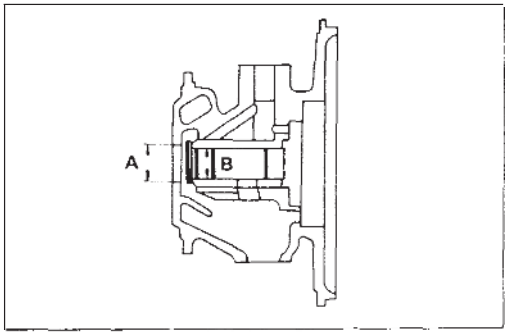


Fig. 51-27 SM51-006

8. MEASURE THE INNER DIAMETER OF THE BEARING HOUSING.

If the inner diameter is greater than the service limit, replace the bearing case.

Service Limit:
A: **18.55 mm (0.7303 in)**
B: **17.11 mm (0.6736 in)**

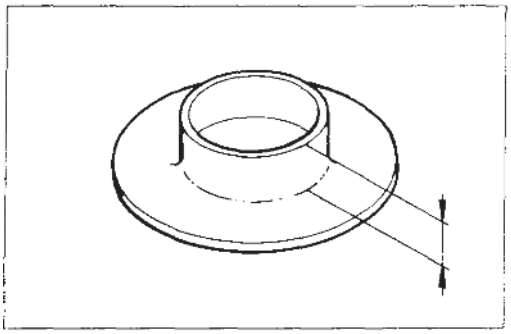


Fig. 51-28 SM51-007

9. MEASURE THE HEIGHT OF THE THRUST SPACER.

If the height is greater than the service limit, replace the thrust spacer.

Service Limit: **4.6 mm (0.1811 in)**

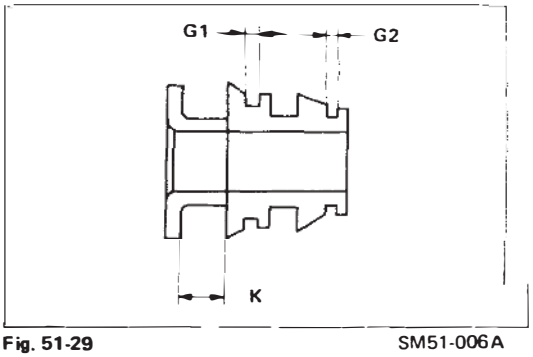


Fig. 51-29 SM51-006A

10. MEASURE THE SEAL RING GROOVE WIDTH OF THE OIL THROWER.

If the groove width is greater than the service limit, replace the oil thrower.

Service Limit:
G1: **1.75 mm (0.0689 in)**
G2: **1.52 mm (0.0598 in)**
K: **4.60 mm (0.1811 in)**

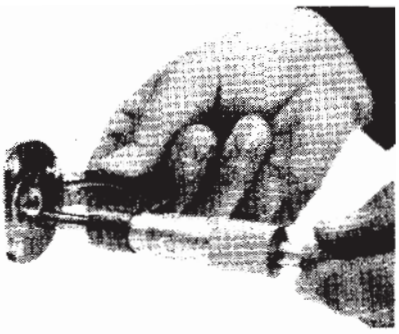


Fig. 51-30 51-025

11. MEASURE THE THICKNESS OF THE THRUST BEARING.

If the thickness is less than the service limit, replace the thrust bearing.

Service Limit: 4.44 mm (0.1748 in)

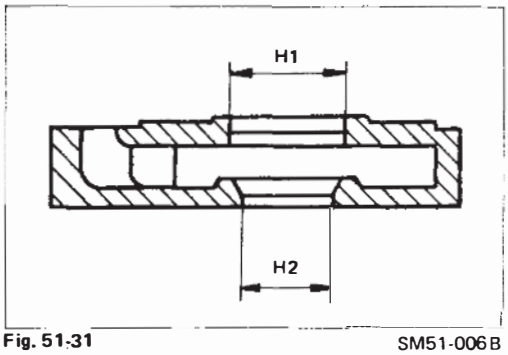


Fig. 51-31 SM51-006B

12. MEASURE THE SEALING BORE OF THE SEAL PLATE.

If the sealing bore is greater than the service limit, replace the seal plate.

Service Limit:
H1: 16.05 mm (0.6319 in)
H2: 14.05 mm (0.5531 in)

ASSEMBLY

1. ASSEMBLE THE JOURNAL BEARINGS.

1. Install the first retainer ring in the bearing casing. The position of the retainer ring should be seen in Fig. 51-32.

NOTE: **Make sure that the retainer ring is securely fitted in the groove.**

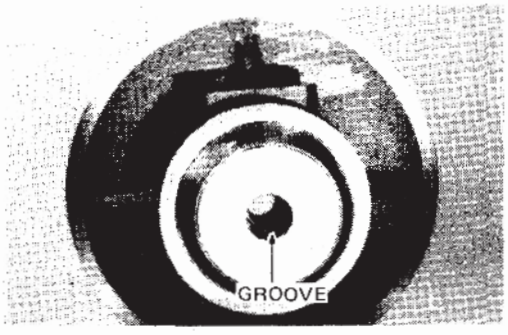


Fig. 51-32 51-026

NOTE: **The beveles edge of the retainer ring should be positioned toward the bearing case.**

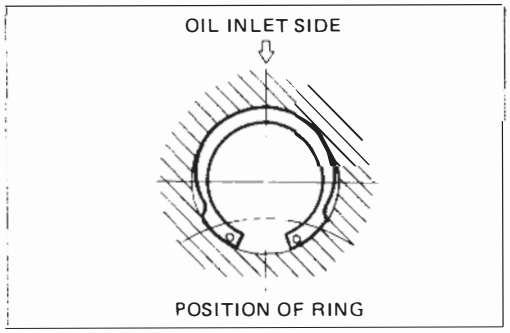


Fig. 51-33 SM51-003A

2. Install the bearing in the bearing case.

NOTE: Apply clean engine oil.

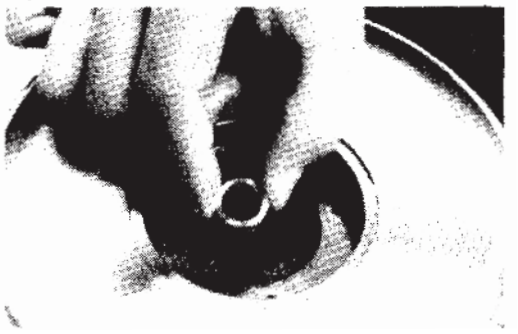


Fig. 51-34 51-018

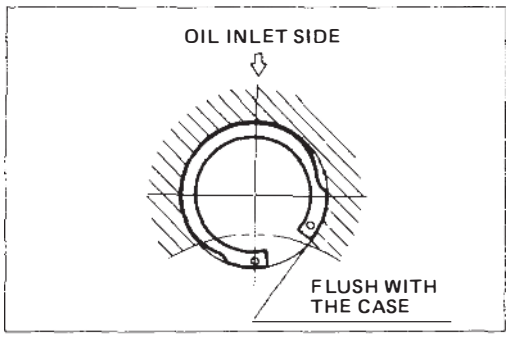


Fig. 51-35 SM51-003B

3. Install the other retainer ring.

NOTE: **The only nearest turbine side of the retainer ring should be installed according to the figure on the left.**

4. Repeat step 1) through 4) to install the second bearing.

2. ASSEMBLE THE TURBINE ROTOR.

1. Install a new seal ring in the seal ring groove of the turbine shaft.

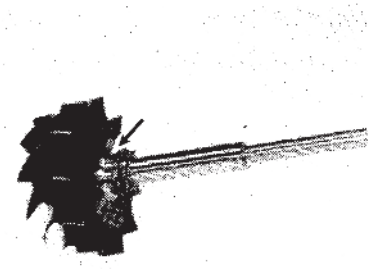


Fig. 51-36 51-027

2. Replace the holding plate.

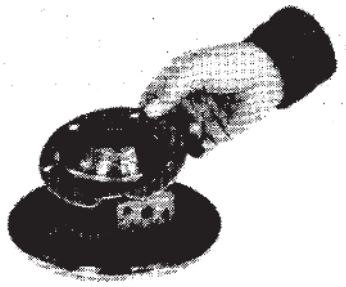


Fig. 51-37 51-012

3. Position the heat protector on the bearing case.

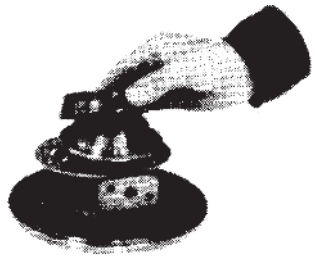


Fig. 51-38 51-028

4. Coat the journals of the turbine rotor with clean engine oil and install the turbine rotor in the bearing case.

Fig. 51-39 51-011

Fig. 51-40 51-016

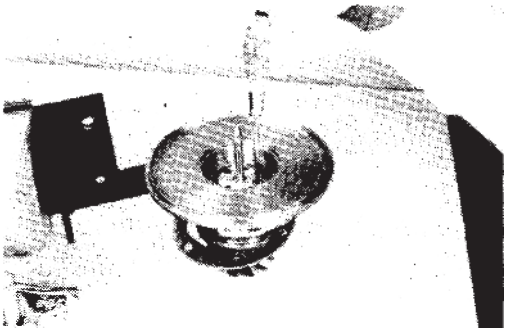


Fig. 51-41 51-029

3. ASSEMBLE THE THRUST BEARING.

1. Install the thrust spacer on the turbine shaft.

2. Coat the thrust bearing with clean engine oil and install the bearing case.

NOTE: Always use new screws and lock washers.

Tightening Torque: 12 – 14 kg·cm (0.87 – 1.01 lb.ft)

4. ASSEMBLE THE BACK PLATE.

1. Insert two new seal rings on the oil thrower.

Fig. 51-42 51-019

2. Install the oil thrower in the back plate.

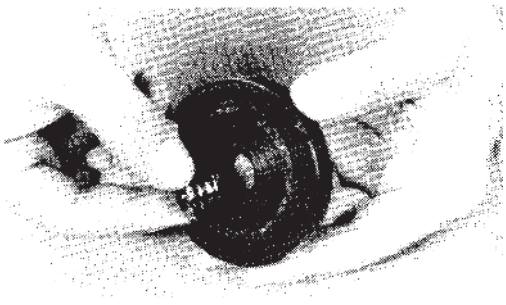


Fig. 51-43 51-030

NOTE: The openings of seal rings should be positioned as seen in Fig. 51-44.

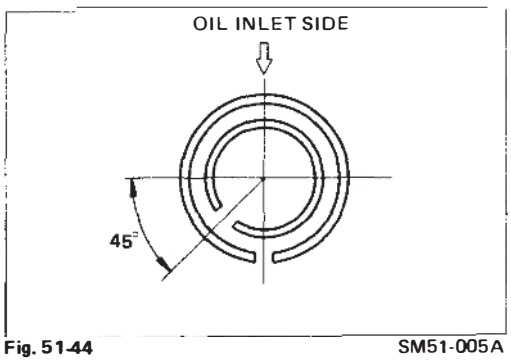


Fig. 51-44 SM51-005A

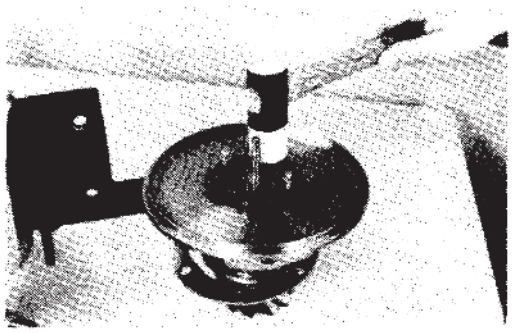


Fig. 51-45 51-031

3. Install the back plate in the bearing case.

NOTE: The oil return hole should face the oil outlet side.
Apply silicone R.T.V. sealer to the flanged surface of the back plate.

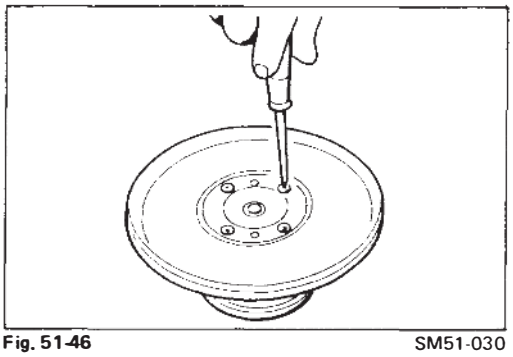


Fig. 51-46 SM51-030

4. Tighten the four screws with lock washers.

NOTE: Always use new screws and washers.

Tightening Torque: 25 – 35 kg·cm
(1.81 – 2.53 lb.ft)

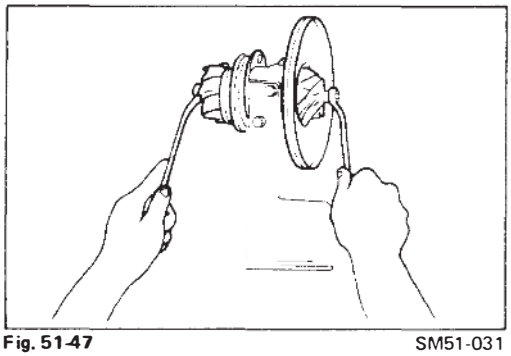


Fig. 51-47 SM51-031

5. FIT THE BLOWER IMPELLER ON THE TURBINE ROTOR AND TIGHTEN THE LOCK NUT.

NOTE: Remember that this nut has left-hand threads.

Tightening Torque: 75 – 85 kg·cm
(5.42 – 6.14 lb.ft)

Fig. 51-48 51-033A

6. INSTALL THE TURBINE CASE TO THE BEARING CASE, BEING SURE TO ALIGN THE MATE MARKS.

Tightening Torque: 280 – 290 kg·cm
(20.25 – 20.96 lb.ft)

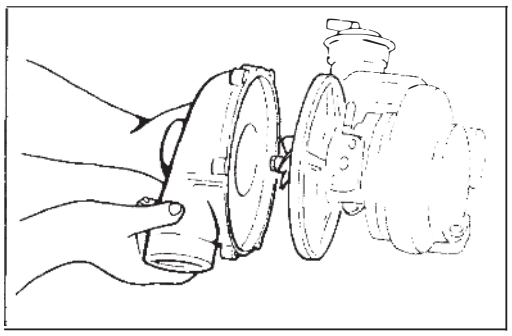


Fig. 51-49 SM51-032

7. ASSEMBLE THE BLOWER CASE.

1. Install the blower casing to the bearing case, referring to the mate marks.

NOTE: Coat the flange face of the blower case with silicone R.T.V. sealant.

Tightening Torque: 195 – 205 kg·cm
(14.10 – 14.82 lb.ft)

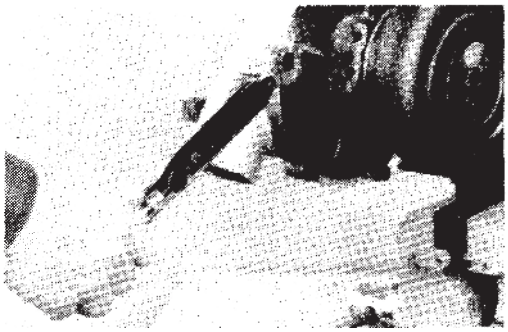


Fig. 51-50 51-035A

2. Tighten the six fitting bolts.

GROUP 7
SERVICE SPECIFICATIONS

7

SERVICE SPECIFICATIONS

SPECIFICATIONS

DIESEL ENGINE FOR HYDRALIC EXCAVATOR

HINO H06C-TI

6.485 liters, 4-cycle, 6-cyl., water-cooled

Ambient conditions:	JIS D1005
Intake air temperature	20°C
Barometric pressure	760 mmHg
Water vapour pressure	11.4 mmHg

○ ENGINE DESCRIPTION

1.	Type	Diesel, 4-cyc., 6-cyl., in-line, overhead valve, water-cooled, inter-cooled, turbo-charged
2.	Combustion system	Direct injection type
3.	Cylinder Bore x Stroke	108 x 118 mm (4.25 x 4.65 in)
4.	Piston displacement	6.485 liters (395.7 cu.in)
5.	Compression ratio	17.7
6.	Direction of rotation	Counter-clockwise viewed from flywheel
7.	Dimensions (L x W x H)	Approx. 1,221 x 775 x 1,065 mm (48.1 x 30.5 x 41.9 in)
8.	Dryweight	Approx. 615 kg (1,356 lb)

○ FEATURES

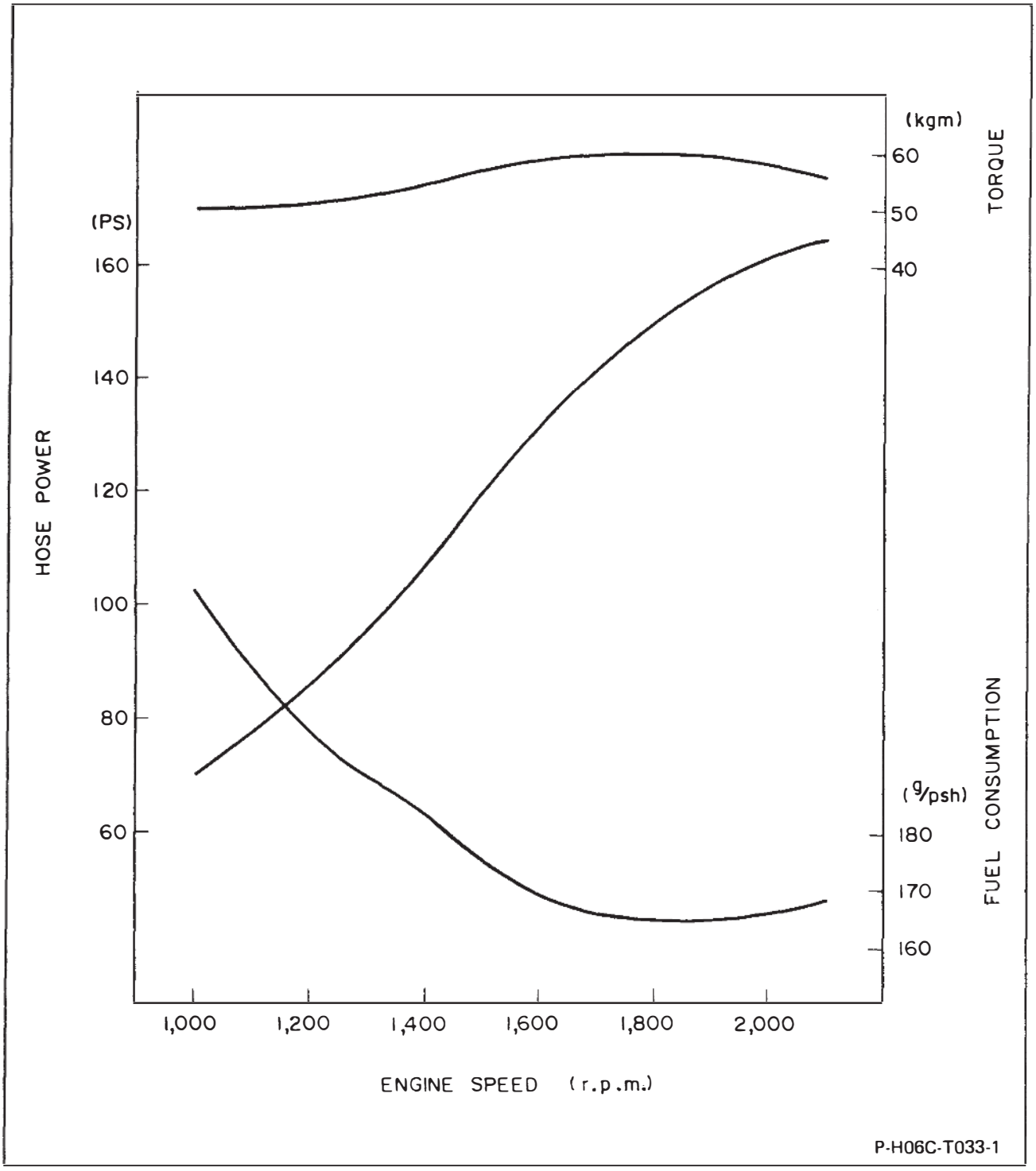
1.	Cylinder block	Mono block cast iron with replaceable dry type liners
2.	Cylinder head	Special cast iron
3.	Crankshaft	Induction-hardened die forged special steel with counter weights
4.	Piston and rings	Heat-resistance aluminum alloy Three compression rings, chrome plated One oil ring, chrome plated with coil expander
5.	Camshaft	Induction hardened carbon steel
6.	Valves	Heat resistance steel

SERVICE SPECIFICATIONS

○ EQUIPMENT

1.	Flywheel housing	HINO own (SAE No. 2 type)
2.	Flywheel	HINO own
3.	Fuel injection pump	DIESEL KIKI "AD" type
4.	Governor	Centrifugal, all speed control type
5.	Fuel injection nozzle	BOSCH hole type
6.	Fuel filter	Paper element type
7.	Cooling system	Forced-circulation by volute pump
8.	Lubricating system	Full-forced pressure feed by gear pump
9.	Oil filter	Peper element type (Full flow), by-pass flow (O.P.T)
10.	Intake manifold	With inter-cooler
11.	Exhaust manifold	With water-cooler
12.	Generator	24V, 25A
13.	Starter	24V, 6KW

ENGINE PERFORMANCE CURVE



REPAIR SPECIFICATIONS
ENGINE
H06C-TI

SERVICE STANDARD

Unit: mm (inch)

Item				Nominal dimensions	Assembly standard or clearance	Repair limit	Service limit	Corrective method
Cylinder head	Flatness			–	0 – 0.05 (0 – 0.0019)	0.10 (0.0039)	–	Regrind or replace
	Regrinding limit			95 (3.74)	–	–	94.70 (3.7283)	
	Protrusion of nozzle			–	3.40 – 3.90 (0.1339 – 0.1535)	–	–	Replace gasket or nozzle
Valve mechanism	Intake valve seat	Valve seat angle		30° – 30°15′	–	–	–	Regrind with 30° or 45° cutter and finish by lapping
		Valve face angle		29°45′ – 30°	–	–	–	
	Exhaust valve seat	Valve seat angle		45° – 45°15′	–	–	–	
		Valve face angle		44°45′ – 45°	–	–	–	
	Valve sink	Intake valve		–	–0.05 – 0.25 (–0.0019 – 0.0098)	–	0.5 (0.020)	Replace valve and valve seat
		Exhaust valve		–	0.25 – 0.55 (0.0098 – 0.0216)	–	0.8 (0.031)	
	Rocker arm	Rocker arm shaft outside diameter		24.2 (0.953)	–	–	24.12 (0.9496)	Replace shaft
		Bushing inside diameter		24.2 (0.953)	–	–	24.28 (0.9559)	Replace bushing
		Clearance		–	0.030 – 0.101 (0.0012 – 0.0039)	0.15 (0.0059)	–	Replace shaft and/or bushing
	Pushrod bend			–	–	0.5 (0.020)	–	Repair by pressing or replace
	Valve and valve guide	Intake valve	Valve stem outside diameter	9.0 (0.354)	–	–	8.89 (0.3500)	Replace valve
			Clearance	–	0.055 – 0.088 (0.0022 – 0.0035)	–	–	Replace valve guide and/or valve
		Exhaust valve	Valve stem outside diameter	9.0 (0.354)	–	–	8.89 (0.3500)	Replace valve
			Clearance	–	0.070 – 0.103 (0.0028 – 0.0041)	–	–	Replace valve guide and/or valve
	Valve spring	Free length		68.6 (2.701)	–	–	–	
		Setting height		47.5 (1.870)	–	–	–	Replace spring seat
		Setting load		31.0 kg (68.3 lb)	–	–	27.5 kg (60.6 lb)	Replace spring
		Squareness		–	–	–	2.5 (0.098)	

SERVICE SPECIFICATIONS

SERVICE STANDARD (Cont'd)

Unit: mm (inch)

Item				Nominal dimensions	Assembly standard or clearance	Repair limit	Service limit	Corrective method
Valve mechanism	Clearance between tappet and tappet guide			–	0.025 – 0.075 (0.0010 – 0.0029)	0.1 (0.004)	–	Replace tappet
	Valve clearance	Intake		–	0.30 (0.0118)	–	–	Adjust at cold engine
		Exhaust		–	0.45 (0.0177)	–	–	
Piston, piston ring and piston pin	Ring gap	Top ring		–	0.3 – 0.45 (0.012 – 0.0177)	–	1.5 (0.059)	Replace piston ring
		2nd ring 3rd ring		–	0.3 – 0.45 (0.012 – 0.0177)	–	1.2 (0.047)	
		Oil ring		–	0.3 – 0.5 (0.012 – 0.019)	–	1.2 (0.047)	
	Piston and piston ring	2nd ring, 3rd ring	Ring thickness	2.5 (0.098)	–	–	2.25 (0.0886)	Replace piston and/or piston ring
			Ring groove width	2.5 (0.098)	–	–	2.75 (0.1083)	
			Clearance	–	0.04 – 0.08 (0.0016 – 0.0031)	0.4 (0.016)	–	
		Oil ring	Ring thickness	5.0 (0.197)	–	–	4.95 (0.1949)	Replace piston and/or piston ring
			Ring groove width	5.0 (0.197)	–	–	5.05 (0.1988)	
			Clearance	–	0.02 – 0.06 (0.0008 – 0.0023)	0.08 (0.0031)	–	
	Piston pin	Piston pin hole inside diameter		38.987 – 39.003 (1.5350 – 1.5355)	–	–	–	Replace piston and piston pin
		Piston pin outside diameter		38.989 – 39.000 (1.5350 – 1.5354)	–	–	38.95 (1.5334)	
		Clearance between piston pin hole and pin		–	0.013T – 0.014L (0.0005T – 0.0006L)	0.1 (0.004)	–	
		Connecting rod bushing inside diameter		39.015 – 39.025 (1.5361 – 1.5364)	–	–	–	Replace connecting rod
		Clearance between piston pin and bushing		–	0.015 – 0.036 (0.0006 – 0.0014)	0.1 (0.004)	–	
	Connecting rod end play			–	0.2 – 0.5 (0.008 – 0.020)	0.6 (0.024)	–	Replace connecting rod

SERVICE SPECIFICATIONS

SERVICE STANDARD (Cont'd)

Unit: mm (inch)

Item			Nominal dimensions	Assembly standard or clearance	Repair limit	Service limit	Corrective method
Crankshaft and connecting rod	Connecting rod	Straightness	–	–	–	0.05 (0.0020) for each 100 (3.94)	Replace
		Twist	–	–	–		
		Connecting rod big end inner diameter	68.985 – 69.000 (2.7160 – 2.7165)	–	–	–	
		Crank pin outside diameter	65.0 (2.559)	–	–0.10 (–0.0039)	–1.10 (–0.0433)	Regrind undersize or replace
		Clearance	–	0.031 – 0.082 (0.0012 – 0.0032)	0.15 (0.0059)	–	
		Connecting rod bearing spread	69.75 – 70.25 (2.7461 – 2.7657)	–	–	69.2 (2.7244)	
	Journal	Journal outside diameter	80 (3.15)	–	79.9 (3.146)	78.8 (3.102)	Regrind undersize or replace
		Clearance	–	0.051 – 0.102 (0.0020 – 0.0040)	0.15 (0.0059)	–	
		Main bearing spread	85.75 – 86.75 (3.3760 – 3.4154)	–	–	85.20 (3.3543)	Replace bearing
	End play		–	0.050 – 0.219 (0.0020 – 0.0086)	0.5 (0.020)	–	Replace oversize bearing
	Crankshaft runout		–	–	0.18 (0.0071)	–	Regrind or replace
Fly wheel	Face alignment		–	–	0.3 (0.012)	–	Replace or regrind
Cylinder block	Distortion at the top of the cylinder		–	0 – 0.05 (0 – 0.0019)	0.1 (0.004)	–	Regrind
Cylinder liner	Liner, inside diameter		108 (4.25)	–	–	108.15 (4.2579)	Replace cylinder liner
	Piston clearance		–	0.192 – 0.224 (0.0076 – 0.0088)	–	–	
	Height projection		–	0.01 – 0.08 (0.0004 – 0.0031)	–	–	
Camshaft	Bearing inside diameter	No. 1	61.5 (2.421)	–	–	+0.10 (+0.0039)	Replace camshaft and/or bearing
		No. 2	61.3 (2.413)				
		No. 3	61.1 (2.406)				
		No. 4	60.9 (2.398)				
		No. 5	60.7 (2.390)				
		No. 6	60.5 (2.382)				
		No. 7	58.3 (2.295)				

SERVICE SPECIFICATIONS

SERVICE STANDARD (Cont'd)

Unit: mm (inch)

Item			Nominal dimensions	Assembly standard or clearance	Repair limit	Service limit	Corrective method
Camshaft	Camshaft outside diameter	No. 1	61.5 (2.421)	–	–	–0.10 (–0.0039)	Replace camshaft and/or bearing
		No. 2	61.3 (2.413)				
		No. 3	61.1 (2.406)				
		No. 4	60.9 (2.398)				
		No. 5	60.7 (2.390)				
		No. 6	60.5 (2.382)				
		No. 7	58.3 (2.295)				
	Clearance		–	0.03 – 0.08 (0.0012 – 0.0031)	0.15 (0.0059)	–	
	Camshaft end play		–	0.100 – 0.178 (0.0040 – 0.0070)	0.3 (0.012)	–	Replace cam thrust bearing
	Cam lift	Intake	–	7.18 (0.2827)	–	6.38 (0.2512)	Replace camshaft
		Exhaust	–	8.17 (0.3217)	–	7.37 (0.2902)	
	Runout		–	–	0.10 (0.0039)	–	Repair or replace
Timing gear	Backlash	Crankshaft gear and idler gear	–	0.05 – 0.11 (0.0020 – 0.0043)	–	0.30 (0.0118)	
		Injection pump drive gear and idler gear					
		Camshaft drive gear and idler gear					
		Oil pump drive gear and camshaft drive gear	–	0.07 – 0.22 (0.0028 – 0.0086)	–	0.35 (0.0138)	
	Idler gear	Idler gear shaft	34.0 (1.339)	–	–	33.85 (1.333)	Replace shaft
		Clearance	–	0.025 – 0.075 (0.0010 – 0.0029)	0.20 (0.0078)	–	Replace bushing and/or shaft
		Gear end play	–	0.04 – 0.13 (0.0016 – 0.0051)	0.30 (0.0118)	–	Replace thrust bearing

SERVICE SPECIFICATIONS

SERVICE STANDARD (Cont'd)

Unit: mm (inch)

Item			Nominal dimensions	Assembly standard or clearance	Repair limit	Service limit	Corrective method
Timing gear	Injection pump drive gear	Clearance	–	0.030 – 0.072 (0.0012 – 0.0028)	0.3 (0.012)	–	Replace gear and/or shaft
		End play	–	0.100 – 0.200 (0.0039 – 0.0078)	0.3 (0.012)	–	Replace thrust bearing
Oil pump	End play		–	0.030 – 0.095 (0.0012 – 0.0037)	0.15 (0.0059)	–	Replace gear
	Gear backlash		–	0.15 – 0.30 (0.0059 – 0.0118)	0.40 (0.0157)	–	Replace gear
	Clearance between drive shaft and case		–	0.040 – 0.085 (0.0016 – 0.0033)	0.15 (0.0059)	–	Replace bushing and/or drive gear assembly
	Clearance between driven gear and shaft		–	0.040 – 0.083 (0.0016 – 0.0032)	0.15 (0.0059)	–	Replace bushing and/or driven gear assembly
V-belt	Two-belt standard vehicle		–	10 – 15 (0.39 – 0.59)	–	–	Adjust
Compression pressure	Compression pressure		–	33 – 36 kg/cm^2 (469 – 511 lb/sq.in) at 270 – 310 rpm	–	28 kg/cm^2 (398 lb/sq.in) at 270 – 310 rpm	Engine overhaul
	Differences between cylinders		–	Less than 3 kg/cm^2 (43 lb/sq.in)	–	–	
Oil pressure			1.8 kg/cm^2 (25.6 lb/sq.in) at 700 – 750 rpm ≀ 4.0 kg/cm^2 (56.9 lb/sq.in) at 2,000 rpm	—	—	0.5 kg/cm^2 (7.11 lb/sq.in)	Inspect and/or overhaul
Injection pressure			200 kg/cm^2 (2,845 lb/sq.in)	–	–	–	Adjust
Intake manifold flatness			–	–	–	Within 0.5 (0.020)	Replace
Exhaust manifold flatness			–	–	–	Within 0.5 (0.020)	Replace

SERVICE SPECIFICATIONS

TIGHTENING TORQUE

Tightening position		kg·cm	lb.ft
Nozzle holder		130 – 190	10 – 13
Tappet chamber cover		190 – 260	14 – 18
Oil cooler fitting bolt		190 – 260	14 – 18
Cylinder head bolt	14 mm diameter	1,800 – 1,900	131 – 137
	10 mm diameter	650 – 750	47 – 54
Rocker arm support bolt		700 – 800	51 – 57
Intake manifold		190 – 260	14 – 18
Exhaust manifold		450 – 500	33 – 36
Rocker arm adjust screw nut		400 – 450	29 – 32
Cylinder head cover		130 – 180	10 – 13
Injection pump drive gear fitting nut		1,600 – 1,800	115 – 130
Injection pump drive shaft assembly fitting bolt		190 – 260	14 – 18
Camshaft drive gear fitting nut		2,500 – 3,000	181 – 216
Camshaft fitting bolt		190 – 260	14 – 18
Idler gear fitting bolt		1,100 – 1,300	80 – 94
Oil strainer fitting bolt		180 – 230	14 – 16
Crankshaft damper fitting nut		5,500 – 7,000	398 – 506
Oil pan fitting bolt		180 – 230	14 – 16
Main bearing cap bolt		1,600 – 1,800	115 – 130
Cooling jet fitting bolt		200 – 250	15 – 18
Connecting rod cap bolt		1,650 – 1,850	120 – 133
Flywheel housing fitting bolt	10 mm diameter	400 – 500	29 – 36
	12 mm diameter	650 – 870	48 – 62
Flywheel fitting bolt		1,800 – 2,000	131 – 144
Oil pump safety valve		800 – 900	56 – 65
Oil cooler various plug		190 – 260	14 – 18
Oil cooler element fitting nut		100 – 150	8 – 10
Oil filter regulator valve		250 – 300	19 – 21
Oil filter plug		200 – 300	15 – 21
Oil filter safety valve		250 – 300	19 – 21
Coolant pump vane		500 – 600	37 – 43
Coolant pump cover		180 – 230	14 – 16
Thermostat case cover		190 – 270	14 – 19
Injection nozzle retaining nut		600 – 800	44 – 57
Injection pump mounting bolt		190 – 260	14 – 18
Injection pump through bolt		300 – 350	22 – 25
Idle gear shaft fitting bolt		500 – 650	37 – 47

SERVICE SPECIFICATIONS

TIGHTENING TORQUE (Cont'd)

Tightening position	kg·cm	lb.ft
Oil pump fitting bolt	380 – 500	28 – 36
Coolant pump fitting bolt	380 – 500	28 – 36
Coolant pump pulley nut	1,800 – 2,400	131 – 173
Oil filter	300 – 350	22 – 26
Starter	650 – 870	47 – 63
Turbocharger fitting nut	450 – 500	32 – 36
Intake pipe and intercooler cover fitting bolt	190 – 260	14 – 18
Cooling fan fitting bolt	350 – 500	26 – 36
Glow plug fitting	100 – 150	8 – 10
Oil pump fitting bolt	380 – 500	28 –36
Fuel filter bleeder plug	40 – 60	3 – 4
Crankshaft pulley fitting bolt	450 – 500	32 – 36
Engine mounting bracket bolt	1,000 – 1,200	72 – 86
Thermostat case fitting bolt	380 – 500	28 – 36
Intake manifold bracket fitting bolt	350 – 500	26 – 36
Oil seal case fitting bolt	190 –260	14 –18

GENERATOR
H06C-TI, EL100 and EM100

SERVICE STANDARD

Unit: mm (inch)

Item		Assembly standard	Repair limit	Service limit	Correct measure
Brush	Length	12.5 (0.492)	–	4.5 (0.177)	Replace
Slip ring	Outer diameter	37.5 (1.476)	–	35.5 (1.397)	Replace
Rotor coil	Resistance	17.5Ω	–	–	Replace

TIGHTENING TORQUE

Tightening position	kg·cm	lb.ft
Pulley nut	980 – 1,300	71 – 94
Through bolt	37 – 50	2.7 – 3.6
Bearing plate	60 – 80	4.4 – 5.7

SERVICE SPECIFICATIONS

STARTER
H06C-TI

SERVICE STANDARD

Unit: mm (inch)

Item		Assembly standard	Repair limit	Service limit	Correct measures
Brush length		20.0 (0.787)	–	13.0 (0.512)	Replace
Brush spring tension		3.0 kg (6.6 lb)	–	2.0 kg (4.4 lb)	Replace
Commutator	Outer diameter	40.0 (1.575)	–	38.0 (1.496)	Replace
	Mica depth	0.5 – 0.8 (0.0197 – 0.0314)	0.2 (0.008)		Repair
	Run-out	0.05 (0.0020)	–	0.1 (0.0039)	Repair or replace
Drive shaft run-out		0.05 (0.0020)	–	0.1 (0.0039)	Repair or replace
Drive housing bushing inside diameter		17.0 (0.669)	–	17.2 (0.667)	Replace
Bearing housing bushing inside diameter		28.0 (1.102)	–	28.2 (1.110)	Replace
Commutator end frame inside diameter		32.0 (1.260)	–	32.1 (1.263)	Replace

TIGHTENING TORQUE

Tightening position	kg-cm	lb.ft
Magnetic switch set bolt	140 – 160	10.2 – 11.5
Commutator end frame set bolt	140 – 160	10.2 – 11.5
Gear housing set bolt	140 – 160	10.2 – 11.5
Brush holder set bolt	35 – 50	2.7 – 3.6

SERVICE SPECIFICATIONS

TURBOCHARGER
H06C-TI

SERVICE STANDARD

Unit: mm (inch)

Item		Service limit	Corrective method
Turbine shaft	Shaft outside diameter	12.28 (0.4835)	Replacement of turbine shaft
	Groove width	1.63 (0.0642)	
	Groove width of oil thrower	1.75 (0.0689) 1.52 (0.0598)	Replacement of oil thrower
	Runout of turbine shaft	0.011 (0.00043)	Replacement of turbine shaft
Bearings	Bearing inside diameter	12.36 (0.4866)	Replacement of bearing
	Bearing outside diameter	16.98 (0.6685)	
	Bushing inside diameter	17.11 (0.6736)	Replacement of bearing housing
	Thrust bearing width	4.44 (0.1748)	Replacement of thrust bearing
	Thrust bush	4.60 (0.1811)	Replacement of thrust bush or oil thrower
Bearing case		18.55 (0.7303)	Replacement of bearing casing
Seal plate		16.05 (0.6319) 14.05 (0.5531)	Replacement of seal plate
Play in axial direction		0.11 (0.0043)	
Play in radial direction		0.215 (0.0085)	

TIGHTENING TORQUE

Tightening position	kg·cm	lb.ft
Thrust bearing	12 – 14	0.87 – 1.01
Bearing back plate	25 – 35	1.81 – 2.53
Blower impeller	75 – 85	5.43 – 6.14
Bearing case	280 – 290	20.25 – 20.96
Blower case	195 – 205	14.10 – 14.82
Turbocharger mounting nut	450 – 500	32.54 – 36.15

SERVICE SPECIFICATIONS

METRIC INFORMATION

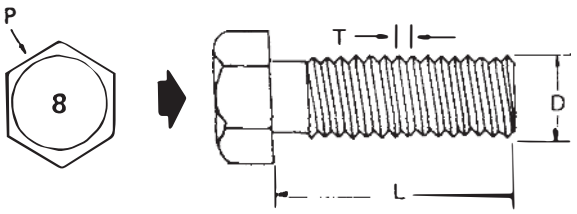
METRIC FASTENERS

1. Most threaded fasteners on the Hino Model H06C-TI sereis are metric.
   Be careful not mix them up with threaded fasteners using the inch system.
   Mismatched or incorrect bolts, nuts and screws can cause damage or malfunction, resulting in personal injury and/or property damage.
2. When bolts, nuts and screws are removed form the engine, they should be kept for re-use whenever possible.
   If they are not re-useble, parts that are equivalent to the original parts in dimensions, strength, and thread pitch must be selected.
3. Most original bolts are marked with identification numbers indicating the strength of the bolts. The markings are shown on the following page.
4. When replacing bolts, be careful to use bolts with the same markings as the original bolts.

NOMENCLATURE FOR BOLTS

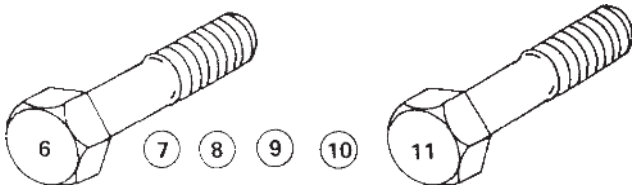
METRIC SYSTEM

BOLT M12-1.75 x 25
D T L



D- Nominal Diameter (millimeters)
L- Length (millimeters)
P- Property Class (bolt strength)
T- Thread Pitch (thread width crest to crest mm)

BOLT STRENGTH IDENTIFICATION



Metric Bolts – Identification class numbers correspond to bolt strength – Increasing numbers represent increasing strength.

SERVICE SPECIFICATIONS

DECIMAL AND METRIC EQUIVALENTS

Fractions	Decimal In.	Metric mm.	Fractions	Decimal In.	Metric mm.
1/64	0.015625	0.397	33/64	0.515625	13.097
1/32	0.03125	0.794	17/32	0.53125	13.494
3/64	0.046875	1.191	35/64	0.546875	13.891
1/16	0.0625	1.588	9/16	0.5625	14.288
5/64	0.078125	1.984	37/64	0.578125	14.684
3/32	0.09375	2.381	19/32	0.59375	15.081
7/64	0.109375	2.778	39/64	0.609375	15.478
1/8	0.125	3.175	5/8	0.625	15.875
9/64	0.140625	3.572	41/64	0.640625	16.272
5/32	0.15625	3.969	21/32	0.65625	16.669
11/64	0.171875	4.366	43/64	0.671875	17.066
3/16	0.1875	4.763	11/16	0.6875	17.463
13/64	0.203125	5.159	45/64	0.703125	17.859
7/32	0.21875	5.556	23/32	0.71875	18.256
15/64	0.234375	5.953	47/64	0.734375	18.653
1/4	0.250	6.35	3/4	0.750	19.05
17/64	0.265625	6.747	49/64	0.765625	19.447
9/32	0.28125	7.144	25/32	0.78125	19.844
19/64	0.296875	7.54	51/64	0.796875	20.241
5/16	0.3125	7.938	13/16	0.8125	20.638
21/64	0.328125	8.334	53/64	0.828125	21.034
11/32	0.34375	8.731	27/32	0.84375	21.431
23/64	0.359375	9.128	55/64	0.859375	21.828
3/8	0.375	9.525	7/8	0.875	22.225
25/64	0.390625	9.922	57/64	0.890625	22.622
13/32	0.40625	10.319	29/32	0.90625	23.019
27/64	0.421875	10.716	59/64	0.921875	23.416
7/16	0.4375	11.113	15/16	0.9375	23.813
29/64	0.453125	11.509	61/64	0.953125	24.209
15/32	0.46875	11.906	31/32	0.96875	24.606
31/64	0.484375	12.303	63/64	0.984375	25.003
1/2	0.500	12.7	1	1.00	25.4

STANDARD TIGHTENING TORQUE

Bolt tightening torque chart—for general purpose

Unit : kg·cm (lb·ft)

Bolt	Tightening conditions \ Bolt diameter (mm)	4	6	8	10	12	14	16	18	20	22	24
4	Even tightening area. Bolt nut, coating, naked bolt, lubricant, etc. Optimum conditions.	10 – 15 (0.8 – 1.0)	36 – 53 (2.7 – 3.8)	88 – 128 (7 – 9)	174 – 255 (13 – 18)	304 – 445 (22 – 32)	486 – 712 (36 – 51)	759 – 1,110 (55 – 80)	1,040 – 1,530 (76 – 110)	1,480 – 2,170 (108 – 156)	2,030 – 2,980 (147 – 215)	2,560 – 3,750 (186 – 271)
5	Cast iron or aluminium tightening surface. Washers. Medium conditions.	14 – 20 (1.1 – 1.4)	48 – 71 (3.5 – 5.1)	117 – 172 (9 – 12)	232 – 340 (17 – 24)	405 – 592 (30 – 42)	647 – 950 (47 – 68)	1,010 – 1,480 (74 – 107)	1,390 – 2,040 (101 – 147)	1,970 – 2,900 (143 – 209)	2,700 – 3,970 (196 – 287)	3,410 – 5,000 (247 – 361)
	Tightening area having black coarse surface. Rusty. Naked bolt or lubricant unavailable. Poor tightening conditions	17 – 25 (1.3 – 1.8)	60 – 88 (4.4 – 6.3)	146 – 214 (11 – 15)	290 – 425 (21 – 30)	506 – 742 (37 – 53)	**809** – 1,180 **(59** – 85)	1,260 – 1,850 (92 – 133)	1,740 – 2,540 (126 – 183)	2,460 – 3,620 (178 – 261)	3,380 – 4,950 (245 – 358)	4,260 – 6,250 (309 – 452)
6	Even tightening area. Bolt nut, coating, naked bolt, lubricant, etc. Optimum conditions.	16 – 24 (1.2 – 1.7)	58 – 83 (4.2 – 6.0)	138 – 201 (10 – 14)	273 – 400 (20 – 28)	477 – 700 (35 – 50)	**764** – 1,120 (56 – 81)	1,190 – 1,750 (87 – 126)	1,640 – 2,400 (119 – 173)	2,320 – 3,410 (168 – 246)	3,180 – 4,680 (231 – 338)	4,020 – 5,360 (291 – 387)
7	Cast iron or aluminium tightening surface. Washers. Medium conditions.	22 – 32 (1.6 – 2.3)	75 – 110 (5.5 – 7.9)	183 – 270 (14 – 19)	364 – 533 (27 – 38)	636 – 932 (47 – 67)	1,020 – 1,500 (74 – 108)	1,590 – 2,330 (116 – 168)	2,180 – 3,200 (158 – 231)	3,100 – 4,550 (225 – 329)	4,250 – 6,210 (308 – 449)	5,360 – 7,850 (388 – 567)
	Tightening area having black coarse surface. Rusty. Naked bolt or lubricant unavailable. Poor tightening conditions.	27 – 40 (2.0 – 2.8)	94 – 138 (6.8 – 9.9)	229 – 336 (17 – 24)	455 – 667 (33 – 48)	795 – 1,165 (58 – 84)	1,270 – 1,870 (92 – 135)	1,990 – 2,920 (144 – 211)	2,730 – 4,000 (198 – 289)	3,870 – 5,680 (280 – 410)	5,310 – 7,800 (385 – 564)	6,700 – 9,850 (485 – 712)
8	Even tightening area. Bolt nut, coating, naked bolt, lubricant, etc. Optimum conditions.	24 – 32 (1.8 – 2.3)	82 – 110 (6.0 – 7.9)	200 – 267 (15 – 19)	397 – 574 (29 – 41)	694 – 925 (51 – 66)	1,010 – 1,480 (74 – 107)	1,730 – 2,310 (125 – 167)	2,380 – 3,170 (173 – 229)	3,380 – 4,510 (244 – 326)	4,630 – 6,170 (335 – 446)	5,850 – 7,790 (424 – 563)
9	Cast iron or aluminium tightening surface. Washers. Medium conditions.	32 – 42 (2.4 – 3.0)	110 – 146 (8.0 – 10.5)	267 – 356 (19 – 25)	529 – 706 (39 – 51)	925 – 1,230 (67 – 88)	1,480 – 1,970 (108 – 142)	2,310 – 3,080 (167 – 222)	3,170 – 4,230 (230 – 305)	4,510 – 6,010 (327 – 434)	6,170 – 8,230 (447 – 595)	7,790 – 10,390 (564 – 751)
10												
11	Tightening area having black coarse surface. Rusty. Naked bolt or lubricant unavailable. Poor tightening conditions.	40 – 53 (2.9 – 3.8)	137 – 183 (10.0 – 13.2)	334 – 445 (25 – 32)	662 – 882 (48 – 63)	1,160 – 1,540 (84 – 111)	1,850 – 2,470 (134 – 178)	2,690 – 3,850 (195 – 278)	3,970 – 5,290 (288 – 382)	5,640 – 7,510 (408 – 543)	7,720 – 10,290 (559 – 744)	9,740 – 12,990 (705 – 939)

NOTE: The torque values given in this table should be applied where bolt torque is not specified.

SERVICE SPECIFICATIONS

RECOMMENDED LUBRICANTS

No.	LUBRICANTS	POSI-TIONS	S.A.E. No.	SHELL	MOBIL	EXXON	TEXACO	GULF
1	ENGINE OIL (A.P.I. CD) Previous Classification (A.P.I. DS) (MIL-L-2104C) (MIL-L-45199B)	Cylinder Block Injection Pump	15W-40	Rotella T 15W/40	Delvac Super 15W/40	XD-3 15W/40 XD-3 Extra 15W/40	Ursa Super Plus 15W/40 Ursa Premium Deo 15W/40	Gulf Super Motor Oil 15W/40
			40	Rotella T 40 Riumla 40	Delvac 1340	XD-3 40 XD-3 Extra 40	Ursa Super Plus 40	Gulf Super Duty Motor Oil 40
			30	Rotella T 30 Rimula 30	Delvac 1330	XD-3 30 XD-3 Extra 30	Ursa Super Plus 30	Gulf Super Duty Motor Oil 30
			20	Rotella T 20W/20 Rimula 20W/20	–	XD-3 20W/20 XD-3 Extra 20W/20	Ursa Super Plus 20W/20	Gulf Super Duty Motor Oil 20

No.	LUBRICANTS	POSITIONS
2	COOLANT PUMP BEARING GREASE (MIL-G-10924B)	Coolant Pump
3	STARTER GREASE	Pinion Shaft Lever & Reduction Gear
4	GENERATOR & STARTER BEARING GREASE	Generator Bearing Starter Bearing
5	ANTI FREEZE (MIL-H-5559A)	Engine, Radiator

Notes: