NISSAN

SERVICE MANUAL

H15/H20-II/H25 ENGINE

NISSAN FORKLIFT

H15/H20-II/H25 ENGINE

QUICK REFERENCE INDEX

FOREWORD

This service manual has been prepared primarily for the purpose of assisting service personnel in providing effective service and maintenance of the H15/H20-II/H25 Engine for NISSAN FORKLIFT.

This manual includes procedures for maintenance, adjustments, removal and installation, disassembly and assembly of components, and trouble-shooting.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. If your Engine differs from the specifications contained in this manual, consult your NISSAN dealer for information.

The right is reserved to make changes in specifications and methods at any time without notice.

ENGINE TUNE-UP
(ET)

—H15/H20-II/H25 ENGINE—

CONTENTS

SERVICE DATA AND SPECIFICATIONS

INSPECTION AND ADJUSTMENT

Item \ Engine model	H15	H20-II	H25
Valve clearance (Hot) mm (in) Intake	0.38 (0.015)		
Valve clearance (Hot) mm (in) Exhaust	0.38 (0.015)		
Fan belt deflection mm (in)	11 - 13 (0.43 - 0.51)		
Applied pushing force N (kg, lb)	98 (10, 22)		
Engine oil capacity ℓ (US qt, Imp qt) With oil filter	3.8 (4, 3-3/8)		
Without oil filter	3.5 (3-3/4, 3-1/8)		
Engine compression pressure kPa (bar, kg/cm², psi)/rpm Standard	1,275 (12.75, 13.0, 185)/300	1,226 (12.26, 12.5, 178)/300	1,275 (12.75, 13.0, 185)/300
Minimum	1,079 (10.79, 11.0, 156)/300	1,030 (10.30, 10.5, 149)/300	1,079 (10.79, 11.0, 156)/300
Spark plug Type	BP4ES, BPR4ES		
Gap mm (in)	0.8 - 0.9 (0.031 - 0.035)		
Distributor Air gap mm (in)	0.35 - 0.45 (0.0138 - 0.0177)		
High tension cable resistance Ω	Less than 30,000		
Ignition timing idle speed B.T.D.C. degree/rpm	6°/650	4°/650	
Max. engine speed under no load rpm	3,100 - 3,300		2,800 - 3,000
Max. engine speed under load rpm	2,500 - 2,900	2,600 - 3,000	2,300 - 2,600

TIGHTENING TORQUE

Unit: N·m (kg-m, ft-lb)

Cylinder head bolt	74 - 83 (7.5 - 8.5, 54 - 61)
Manifold nut	16 - 19 (1.6 - 1.9, 12 - 14)
Oil pan drain plug	20 - 39 (2.0 - 4.0, 14 - 29)
Spark plug	18 - 24 (1.8 - 2.4, 13 - 17)

TROUBLE DIAGNOSES AND CORRECTIONS

Condition	Probable cause	Corrective action
CANNOT CRANK ENGINE OR SLOW CRANKING	Improper grade oil.	Replace with proper grade oil.
	Discharged battery.	Charge battery.
	Faulty battery.	Replace.
	Loose fan belt.	Adjust.
	Trouble in charge system.	Inspect.
	Wiring connection trouble in starting circuit.	Correct.
	Faulty starter switch.	Repair or replace.
	Faulty starter motor.	Repair or replace.

(Trouble-shooting procedure on starting circuit)
Switch on the starting motor with light "ON."

When light goes off or dims considerably.

a. Check battery.
b. Check connection and cable.
c. Check starter motor.

When light stays bright.

a. Check wiring connection between battery and starter motor.
b. Check starter switch.
c. Check starter motor.

ENGINE WILL CRANK NORMALLY BUT WILL NOT START

In this case, the following trouble causes may exist, but in many cases ignition system or fuel system is in trouble.

Ignition system trouble
Fuel system trouble
Valve mechanism does not work properly
Low compression

(Trouble-shooting procedure)
Check spark plug first by following procedure.
Disconnect high tension cable from one spark plug and hold it about 10 mm (0.39 in) from the engine metal part and crank the engine.

If good spark occurs.

a. Check spark plug.
b. Check ignition timing.
c. Check fuel system.
d. Check cylinder compression.

If no spark occurs. — Check the current flow in primary circuit.

Very high current. — Inspect for shorted primary circuit.

Condition	Probable cause	Corrective action
Ignition trouble	Faulty condenser.	Replace.
	Leak at rotor cap and rotor.	Clean or replace.
	Faulty spark plug.	Clean, adjust plug gap or replace.
	Improper ignition timing.	Adjust.
	Faulty ignition coil.	Replace.
	Disconnection of high tension cable.	Replace.
	Loose connection or disconnection in primary circuit.	Repair or replace.
Fuel system trouble	Lack of fuel.	Supply.
	Dirty fuel strainer.	Replace.
	Dirty or clogged fuel pipe.	Clean.
	Fuel pump will not work properly.	Repair or replace.
	Carburetor choke will not work properly.	Check and adjust.
	Improper adjustment of float level.	Correct.
	Improper idling.	Adjust.
	Dirty or clogged carburetor.	Disassemble and clean.
	Clogged breather pipe of fuel tank.	Repair and clean.
Low compression	Incorrect spark plug tightening or damaged gasket.	Tighten to normal torque or replace gasket.
	Improper grade engine oil or low viscosity.	Replace with proper grade oil.
	Incorrect valve clearance.	Adjust.
	Compression leak from valve seat.	Remove cylinder head and lap valves.
	Sticky valve stem.	Correct or replace valve and cylinder head.
	Weak or defective valve springs.	Replace valve springs.
	Compression leak at cylinder head gasket.	Replace gasket.
	Sticking or worn piston ring.	Replace piston rings.
	Worn piston ring or cylinder.	Overhaul engine.
(Trouble shooting procedure) Pour engine oil into plug hole, and then measure cylinder compression.		
Compression increases.		Trouble in cylinder or piston ring.
Compression does not change.		Compression leaks from valve, cylinder head or head gasket.

Condition	Probable cause	Corrective action
IMPROPER ENGINE IDLING		
Fuel system trouble	Clogged or damaged carburetor jets.	Clean or replace.
	Incorrect idle adjustment.	Adjust.
	Clogged air cleaner.	Replace element.
	Damaged manifold gaskets or carburetor insulator.	Replace gasket or insulator.
	Improper float level adjustment.	Adjust.
Low compression		Previously mentioned.
Others	Incorrect valve clearance.	Adjust.
	Extremely low revolution.	Adjust.
ENGINE POWER NOT UP TO NORMAL		
Low compression		Previously mentioned.
Ignition system trouble	Incorrect ignition timing.	Adjust.
	Faulty spark plugs.	Clean, adjust or replace plugs.
Fuel system trouble	Malfunction of choke system.	Adjust.
	Clogged fuel pipe.	Clean.
	Dirty or clogged fuel strainer.	Replace.
	Fuel pump will not work properly.	Repair or replace.
	Clogged carburetor jets and/or needle valve.	Disassemble and clean.
	Throttle valve does not open fully.	Readjust.
	Fuel pump out of adjustment.	Readjust.
Air intake system trouble	Clogged air cleaner.	Replace element.
	Air inhaling from manifold gasket or carburetor gasket.	Replace gasket.
Overheating	Insufficient coolant.	Replenish.
	Loose fan belt.	Adjust fan belt.
	Worn or loose fan belt.	Replace.
	Faulty thermostat.	Replace.
	Faulty water pump.	Replace.
	Clogged or leaky radiator.	Flush, repair or replace.

Condition	Probable cause	Corrective action
	Faulty radiator filler cap.	Replace.
	Air in cooling system.	Retighten each part of cooling system.
	Improper engine oil grade.	Replace with proper grade oil.
	Incorrect ignition timing.	Adjust.
	Faulty carburetor (lean mixture).	Overhaul carburetor.
Overcooling	Damaged thermostat.	Replace.
Others	Improper octane fuel.	Replace with specified octane fuel.
	Improper tire pressure.	Inflate to specified pressure.
	Dragging brake.	Adjust.
	Clutch slipping.	Adjust.
NOISY ENGINE		
Knocking	Overloaded engine.	Use right gear in driving.
	Carbon knocking.	Disassemble cylinder head and remove carbon.
	Timing knocking.	Adjust ignition timing.
	Fuel knocking.	Use specified octane fuel.
	Preignition (misusing of spark plug).	Use specified spark plug.
Mechanical knocking		
Crankshaft bearing knocking.	This strong dull noise increases when engine is accelerated. To locate the place, cause a misfire on each cylinder. If the noise stops by the misfire, this cylinder generates the noise.	This is caused by worn or damaged bearings, or unevenly worn crankshaft. Renew bearings and adjust or change crankshaft. Check lubrication system.
Connecting rod bearing knocking.	This is a little higher-pitched noise than the crankshaft knocking, and also increases when engine is accelerated. Cause a misfire on each cylinder and if the noise diminishes almost completely, this crankshaft bearing generates the noise.	Same as the case of crankshaft bearings.
Piston and cylinder noise.	When you hear an overlapping metalic noise which increases its magnitude with the revolution of engine and which decreases as engine is warmed up, this noise is caused by piston and cylinder. To locate the place, cause a misfire on each cylinder.	This may cause an abnormal wearing of cylinder and lower compression which in turn will cause a lower out-put power and excessive consumption of oil. Overhaul engine.
Piston pin noise.	This noise is heard at each highest and lowest dead end of piston. To locate the place, cause a misfire on each cylinder.	This may cause a wear on piston pin, or piston pin hole. Renew piston and piston pin assembly.
Water pump noise.	This noise may be caused by worn or damaged bearings, or by the uneven surface of sliding parts.	Replace water pump with a new one.

Condition	Probable cause	Corrective action
Others.	An improper adjustment of valve clearance.	Adjust.
	Noise of timing chain.	Replace chain and tensioner sprocket.
	An excessive end-play on crankshaft.	Disassemble engine and renew main bearing.
	Note: This noise will be heard when clutch is disengaged.	
	Wear on clutch pilot bushing.	Renew bush and adjust drive shaft.
	Note: This noise will be heard when clutch is disengaged.	
ABNORMAL COMBUSTION (back fire, after fire run-on etc.)		
Improper ignition timing	Improper ignition timing.	Adjust ignition timing.
	Improper heat range of spark plugs.	Use specified spark plugs.
Fuel system trouble	Damaged carburetor or manifold gasket. (back fire, after fire).	Replace them with new parts.
	Faulty carburetor jet.	Disassemble carburetor and check it.
	Improper function of the float.	Adjust the level, and check needle valve.
	Uneven idling. (Run on)	Adjust.
Defective cylinder head, etc.	Improperly adjusted valve clearance.	Adjust.
	Excess carbon in combustion chamber.	Remove head and get rid of carbon.
	Damaged valve spring (back fire, after fire).	Replace it with a new one.
EXCESSIVE OIL CONSUMPTION		
Oil leakage	Loose oil drain plug.	Tighten it.
	Loose or damaged oil pan gasket.	Renew gasket or tighten it.
	Loose or damaged chain cover gasket.	Renew gasket or tighten it.
	Damaged oil seal in front and rear of crankshaft.	Renew oil seal.
	Loose or damaged locker cover gasket.	Renew gasket or tighten it (but not too much).
	Improper tightening of oil filter.	Renew gasket and tighten it with the proper torque.
	Loose or damaged oil pressure switch.	Renew oil pressure switch or tighten it.
Excessive oil consumption	Cylinder and piston wear.	Overhaul cylinder and renew piston.
	Improper location of piston ring gap or reversely assembled piston ring.	Remount piston rings.
	Damage piston rings.	Renew rings.
		Repair or renew piston and cylinder.

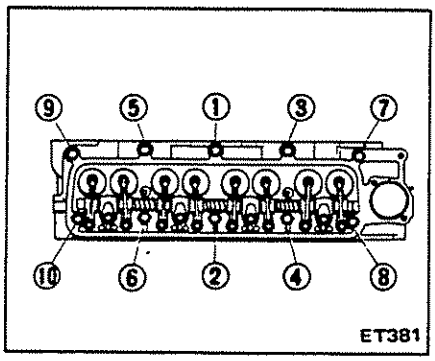
Condition	Probable cause	Corrective action
	Worn piston ring groove and ring.	Renew piston and piston ring.
	Fatigue of valve oil seal lip.	Replace seal lip with a new one.
	Worn valve stem.	Renew valve.
Others	Inadequate quality of engine oil.	Use the designated oil.
	Engine overheat.	Previously mentioned.
POOR FUEL ECONOMY		
See the explanation of the power decrease		
Others	Exceeding idling revolution.	Adjust it to the designated rpm.
	Faulty acceleration recovery.	Adjust it.
	Fuel leakage.	Repair or tighten the connection of fuel pipes.
TROUBLE IN OTHER FUNCTIONS		
Decreased oil pressure	Inadequate oil quality.	Use the designated oil.
	Overheat.	Previously mentioned.
	Faulty function of oil pump regulator valve.	Disassemble oil pump and repair or renew it.
	Functional deterioration of oil pump.	Repair or replace it with a new one.
	Blocked oil filter.	Renew it.
	Increased clearance in various sliding parts.	Disassemble and replace the worn parts with new ones.
	Blocked oil strainer.	Clean it.
	Troubles in oil gauge pressure switch.	Replace it with a new one.
Excessive wear on the sliding parts	Oil pressure decreases.	Previously mentioned.
	Faulty quality or contamination of oil.	Exchange the oil with proper one and change element.
	Unsufficient air cleaner.	Check element.
	Overheat or overcool.	Previously mentioned.
	Improper fuel mixture.	Check the fuel system.
Scuffing of sliding parts	Decrease in oil pressure.	Previously mentioned.
	Insufficient clearances.	Readjust to the designated clearances.
	Overheat.	Previously mentioned.
	Improper fuel mixture.	Check the fuel system.

ENGINE TUNE-UP

BASIC MECHANICAL SYSTEM

RETIGHTENING CYLINDER HEAD BOLTS

When the engine is cold, retightening should be made in the sequence shown.



Ⓣ : Cylinder head bolt
74 - 83 N·m
(7.5 - 8.5 kg-m,
54 - 61 ft-lb)

RETIGHTENING MANIFOLD NUTS

Intake and exhaust manifold nuts should be retightened to prevent air and/or exhaust gas leakage.

Ⓣ : Manifold nuts
16 - 19 N·m
(1.6 - 1.9 kg-m,
12 - 14 ft-lb)

ADJUSTING INTAKE AND EXHAUST VALVE CLEARANCE

Adjustment should be made while engine is warm but not running.

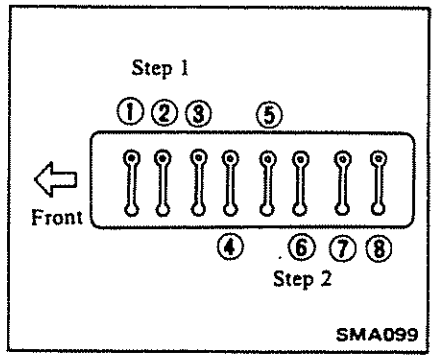
1. Start engine and warm it up sufficiently. Then turn off engine.
2. Remove valve rocker cover.
3. Rotate crankshaft.

(1) Set No. 1 cylinder in top dead center on its compression stroke, and adjust valve clearance.

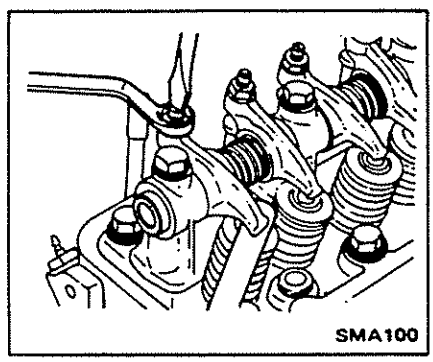
①, ②, ③ & ⑤

(2) Set No. 4 cylinder in top dead center on its compression stroke and adjust valve clearance.

④, ⑥, ⑦ & ⑧



Valve clearance (Hot):
Intake & exhaust:
0.38 mm (0.015 in)



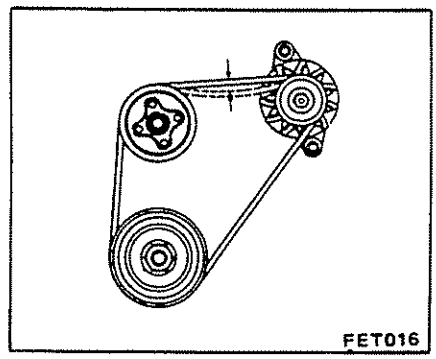
CHECKING AND ADJUSTING FAN BELT

1. Visually inspect for cracks, fraying, wear or oiliness.

The belt should not touch the bottom of the pulley groove.

2. Check belt deflection by pushing midway between pulleys.

Fan belt deflection:
11 - 13 mm
(0.43 - 0.51 in)
Pushing force:
98 N (10 kg, 22 lb)



CHANGING ENGINE OIL AND OIL FILTER

1. Start engine and warm up engine suficiently, then stop engine.
2. Remove oil filler cap and oil pan drain plug, and allow oil to drain.

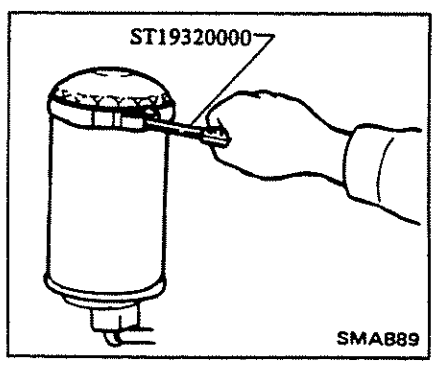
⚠ WARNING:
Be careful not to burn yourself, as the engine oil may be hot.

- **A milky oil indicates the presence of cooling water. Isolate the cause and take corrective measure.**
- **An oil with extremely low viscosity indicates dilution with gasoline.**

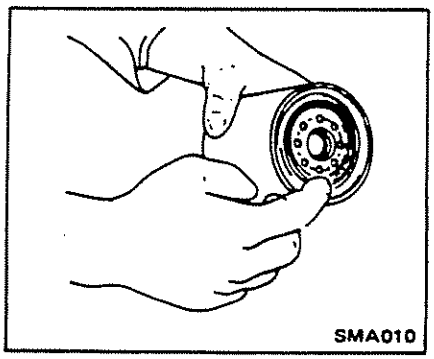
3. Clean and install oil pan drain plug with washer.

Ⓣ : Oil pan drain plug
20 - 39 N·m
(2.0 - 4.0 kg-m,
14 - 29 ft-lb)

4. Using Tool, remove oil filter.



5. Wipe oil filter mounting surface with a clean rag.
6. Smear a little engine oil on rubber gasket of new oil filter.

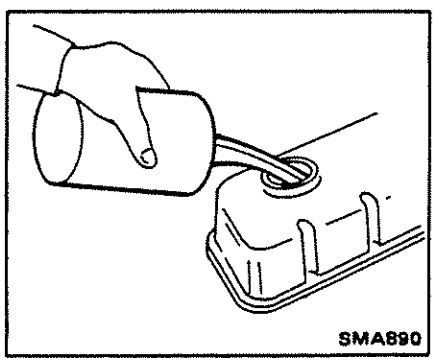


7. Install new oil filter. Hand-tighten ONLY. DO NOT use a wrench to tighten the filter.
8. Refill engine with new recommended engine oil, referring to Recommended Lubricants.
Check oil level with dipstick.

Oil capacity:

Unit: liter (US qt, Imp qt)

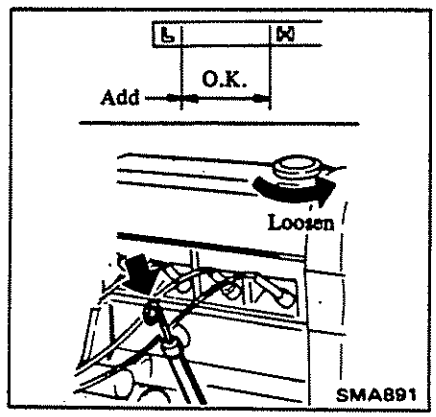
With oil filter	3.8 (4, 3-3/8)
Without oil filter	3.5 (3-3/4, 3-1/8)



9. Start engine. Check area around drain plug and oil filter for any sign of oil leakage.
If any leakage is evident, these parts have not been properly installed.

10. Warm up engine sufficiently. Then stop engine and wait a few minutes. Check oil level. If necessary, add engine oil.

When checking oil level, set engine at level.



CHANGING ENGINE COOLANT

WARNING:
To avoid the danger of being scalded, never attempt to change the coolant when the engine is hot.

When using anti-freeze coolant, mix the anti-freeze coolant with water, observing instructions attached to anti-freeze container.

CLEANING RADIATOR OUTSIDE

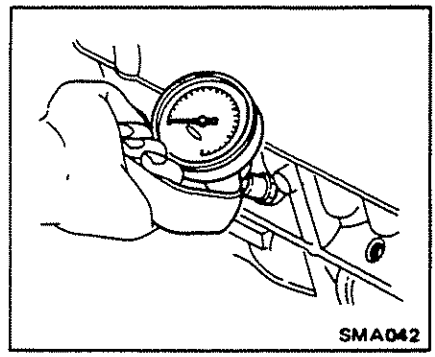
Clean outside of radiator with dry compressed air.

CHECKING COOLING SYSTEM, HOSES AND CONNECTIONS

Check hoses and fittings for loose connections or deterioration. Re-tighten or replace if necessary.

CHECKING ENGINE COMPRESSION PRESSURE

1. Warm up engine sufficiently, then stop engine.
2. Remove all spark plugs.
3. Properly attach a compression tester to spark plug hole in cylinder being tested.



4. Set carburetor throttle valve at fully-open position.
5. Crank engine and read gauge indication.
- Run engine at about 350 rpm.
- Engine compression measurement should be made as quickly as possible.

Compression pressure:

Standard

H15	1,275 kPa (12.75 bar, 13.0 kg/cm^2, 185 psi)/ 300 rpm
H20-II	1,226 kPa (12.26 bar, 12.5 kg/cm^2, 178 psi)/ 300 rpm
H25	1,275 kPa (12.75 bar, 13.0 kg/cm^2, 185 psi)/ 300 rpm

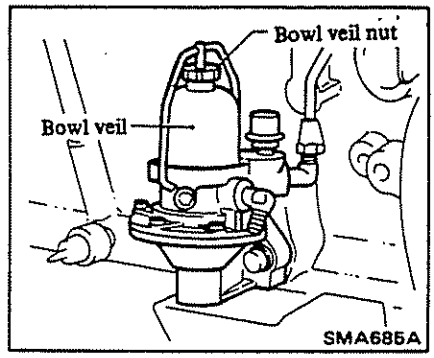
Minimum

H15	1,079 kPa (10.79 bar, 11.0 kg/cm^2, 156 psi)/ 300 rpm
H20-II	1,030 kPa (10.30 bar, 10.5 kg/cm^2, 149 psi)/ 300 rpm
H25	1,079 kPa (10.79 bar, 11.0 kg/cm^2, 156 psi)/ 300 rpm

6. Cylinder compression in cylinders should not be less than 80% of the highest reading.
If cylinder compression in one or more cylinders is low, pour a small quantity of engine oil into cylinders through the spark plug holes and retest compression.
- If adding oil helps the compression pressure, piston rings may be worn or damaged.
- If pressure stays low, valve may be sticking or seating improperly.

- If cylinder compression in any two adjacent cylinders is low, and if adding oil does not help the compression, there is leakage pass on the gasket surface.

Oil and water in combustion chambers can result from this problem.



CHECKING FUEL LINES
(Hoses, piping, connections, etc.)

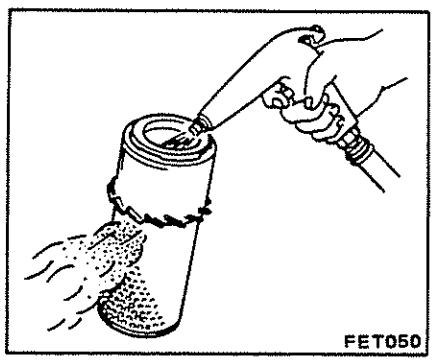
Check fuel lines for proper attachment, leaks, cracks, damage, loose connections, chaffing and deterioration. If necessary, replace any damaged or defective parts.

IGNITION AND FUEL SYSTEM

CLEANING OR REPLACING AIR CLEANING FILTER

Dry paper type

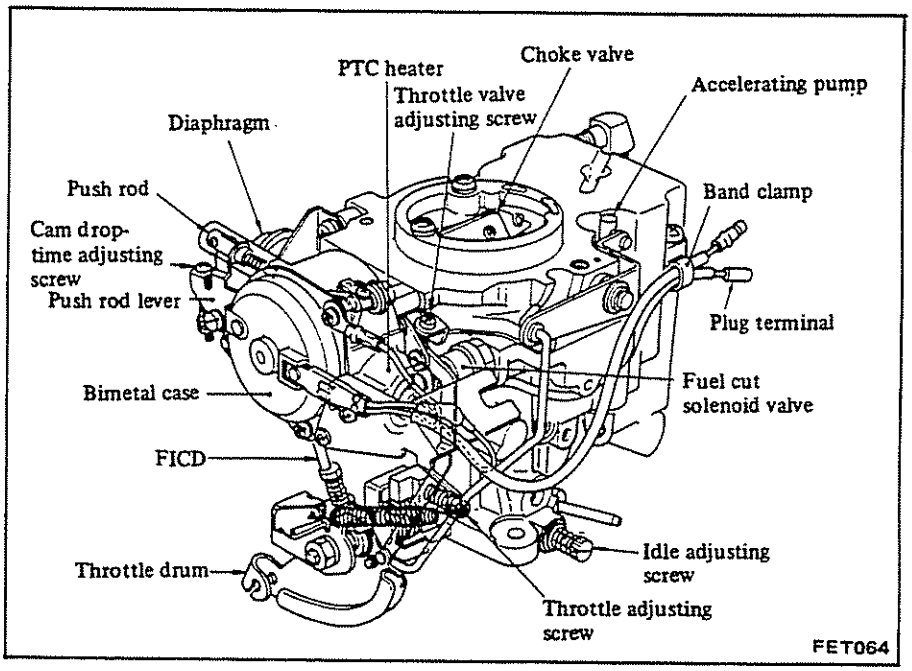
It is necessary to clean the element or replace it at the recommended interval, and more frequent maintenance should be carried out under dusty or other dirty operating conditions.



CLEANING OR REPLACING FUEL STRAINER ELEMENT

The fuel strainer element should be checked, cleaned or replaced periodically.

CHECKING CARBURETOR



CHECKING LINKAGE AND VALVE

- Remove air horn. Visually check carburetor interior for dirt and linkage for wear or damage.
- Check throttle valve shaft for wear by moving it by hand. It must not move (no free play).
- Check operation (opening and closing) of throttle valve and choke valve.

Maintenance

- If carburetor is excessively soiled, disassemble and clean.
- If linkage is excessively worn, bent or damaged, replace with new one.
- If throttle valve shaft is excessively bent, replace with new one.

CHECKING AUTO-CHOKE MECHANISM

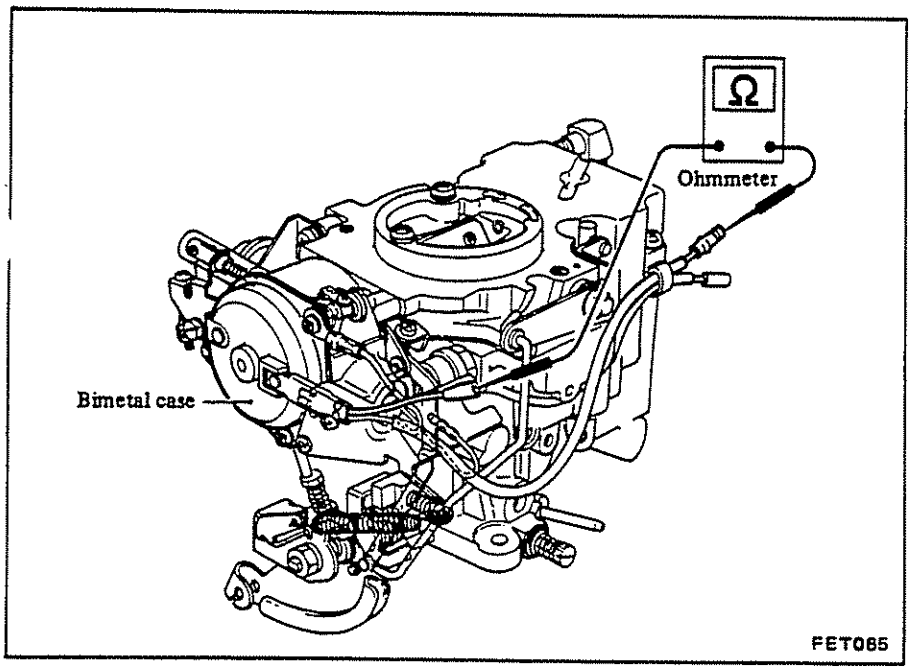
Functional check

- Visually check auto-choke mechanism for deformed linkage, etc.
- Before starting engine, depress accelerator pedal one time.
- After starting engine, ensure engine speed decreases to specified idle rpm.

	Choke valve	Throttle valve	Cam lever and fast idle cam
Ambient temperature below 20°C (68°F)	Fully closed	Fast idle position	Differs with ambient temperature. During engine starts: 1st or 2nd ratchet position After warm-up: 3rd or 4th rachet position
After warm-up	Fully open	Idle position	Clearance exists.

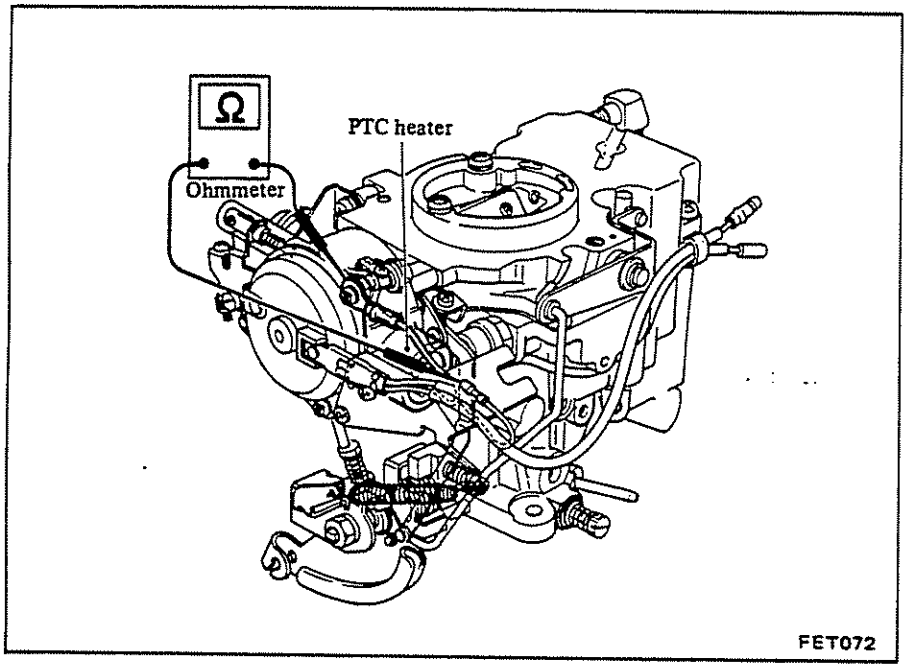
CHECKING BIMETAL

- Start engine. Touch bimetal case to ensure it is hot. See construction drawing for bimetal location. (Simple check method)
- Using circuit tester, check bimetal for continuity. Continuity must exist.



CHECKING THERMOWAX

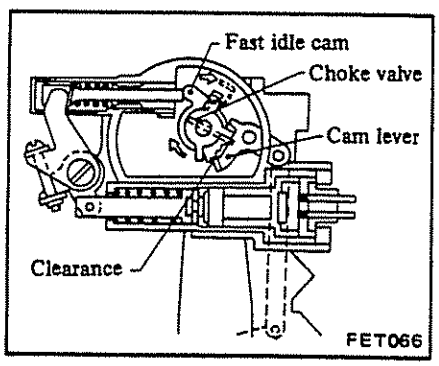
- Ensure PTC heater becomes hot when engine is started. (Simple check method)
- Using circuit tester, check PTC for continuity. Continuity must exist.



CHOKE VALVE

Inspection

Ensure clearance does not exist between fast idle cam and cam lever when choke valve is closed by hand.



Adjustment

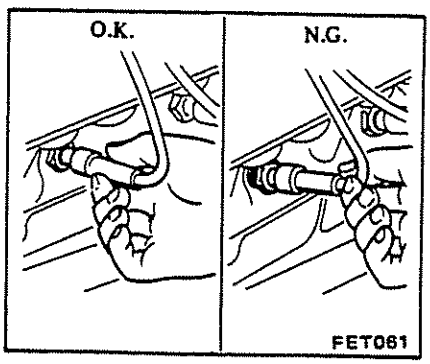
Adjust cam drop-time adjusting screw until choke valve is closed completely.

Cam drop-time adjusting screw is properly adjusted at the factory before delivery. Do not attempt to adjust it in the field unless necessary.

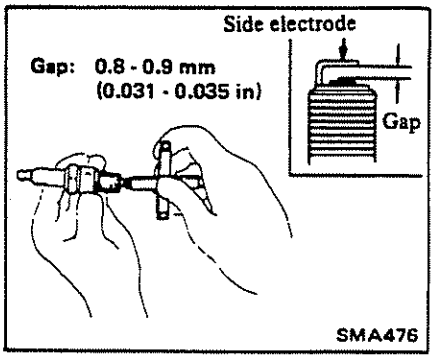
CHECKING AND REPLACING SPARK PLUGS

1. Disconnect spark plug wire at boot.

Do not pull on the wire.



2. Remove spark plugs with spark plug wrench.
3. Clean plugs in sand blast cleaner.
4. Inspect insulator for cracks or chips, gasket for damage or deterioration and electrode for wear or burning. If they are excessively worn, replace with new spark plug.
5. Check spark plug gap.



Spark plug type:
BP4ES, BPR4ES
Ⓣ: 18 - 24 N·m
(1.8 - 2.4 kg-m,
13 - 17 ft-lb)

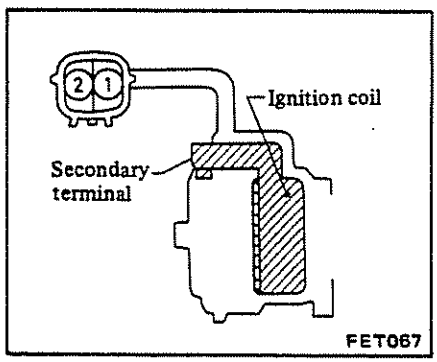
CHECKING DISTRIBUTOR

Inspection

Ignition coil

Using circuit tester, measure primary coil resistance between terminals (1) and (2) and secondary coil resistance between terminals (1) or (2) and secondary terminal.

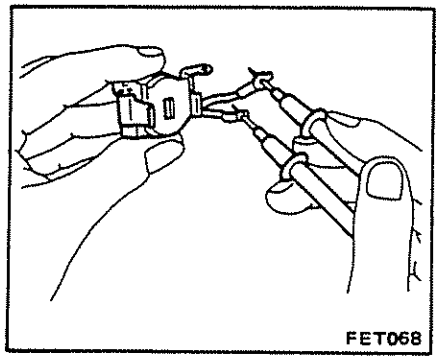
Primary coil resistance:
0.9 - 1.2Ω
Secondary coil resistance:
20 - 29 kΩ



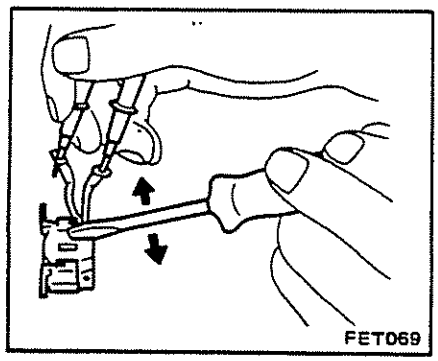
Pickup assembly

- Using circuit tester, measure pickup coil resistance.

Specifications:
420 - 540Ω



- Ensure tester pointer deflects when moving standard screwdriver's blade near pickup coil's iron core.



Carbon contacts

If spherical surfaces of all contacts are worn, replace with new cap assembly.

Cap rotor

Check for cracks or damage.

Signal rotor

Check for bends or damage.

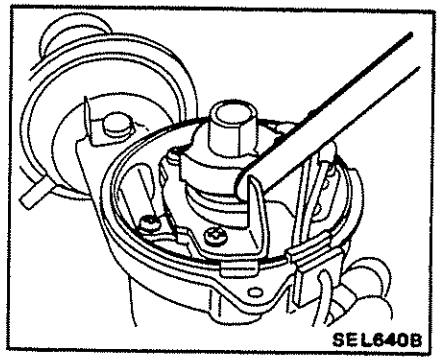
Vacuum control

Using vacuum pump, apply vacuum to diaphragm. Linkage must be attracted.

Inspection after reassembly

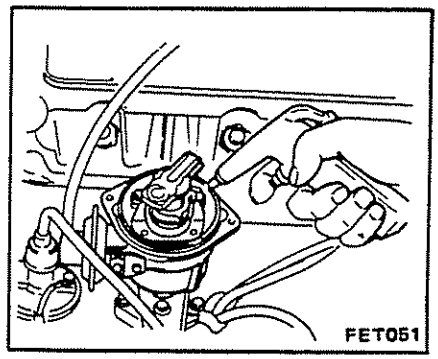
Measure air gap between signal rotor and pickup assembly.

Specifications:
0.35 - 0.45 mm
(0.0138 - 0.0177 in)



CLEANING DISTRIBUTOR INSIDE

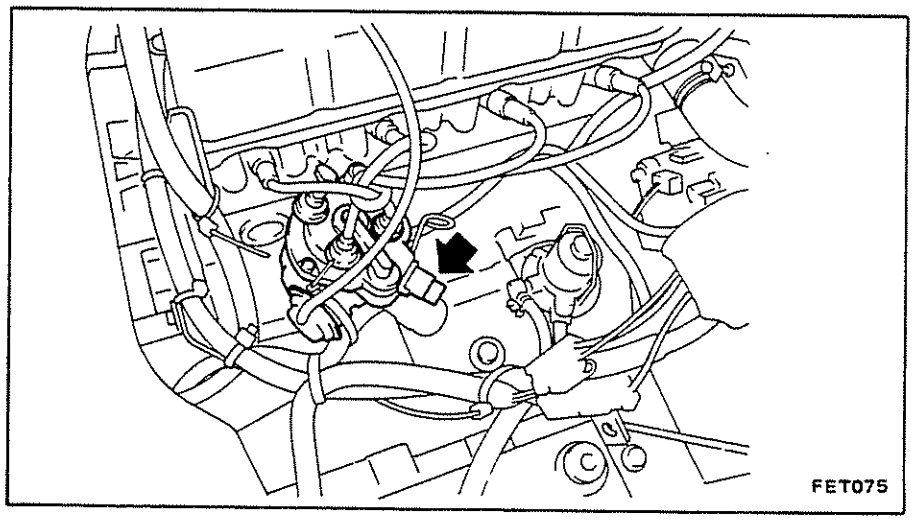
Blow dust off inside of distributor with dry compressed air.



ENGINE RPM MEASUREMENT

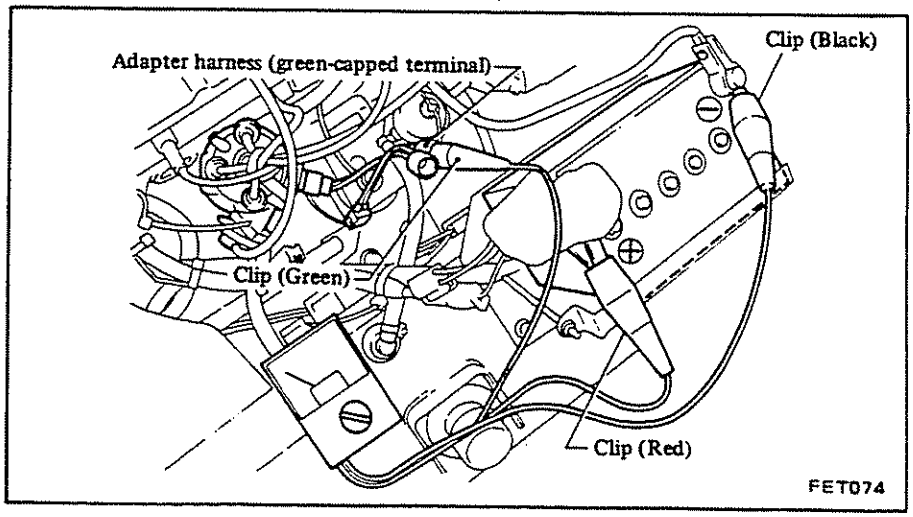
Since the ignition coil is built into the distributor on H-series engines for the J01 and J02 forklifts, an adapter harness is required to measure engine speed.

1. Disconnect distributor connector (shown by an arrow) from receptacle.



2. Connect adapter harness (EG11140000) between distributor connector and receptacle. Using clips, fasten tachometer power cables to battery positive and ground terminals. Connect tachometer's measuring lead to green-capped terminal (located in the middle of the adapter harness) to check engine rpm.

Note that the red-capped terminal cannot be used to measure engine speed.



CHECKING AND ADJUSTING IGNITION TIMING, IDLE-RPM AND MIXTURE RATIO

CAUTION:

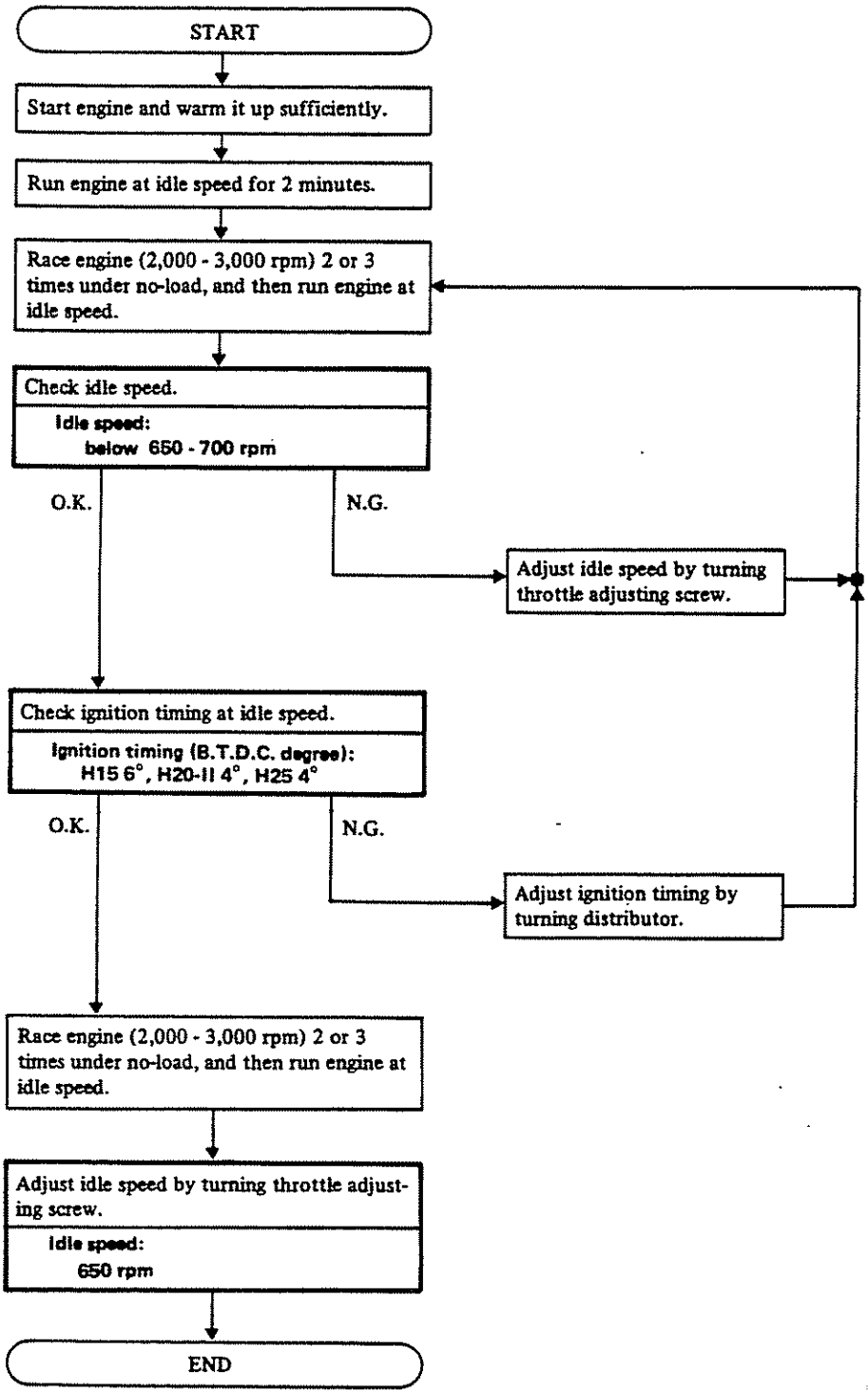
a. Idle mixture ratio is adjusted at factory and requires no further adjustment. If it becomes necessary to adjust it, proceed with the following steps.

b. Do not attempt to screw the idle adjusting screw down completely. Doing so could cause damage to tip, which in turn will tend to cause malfunctions.

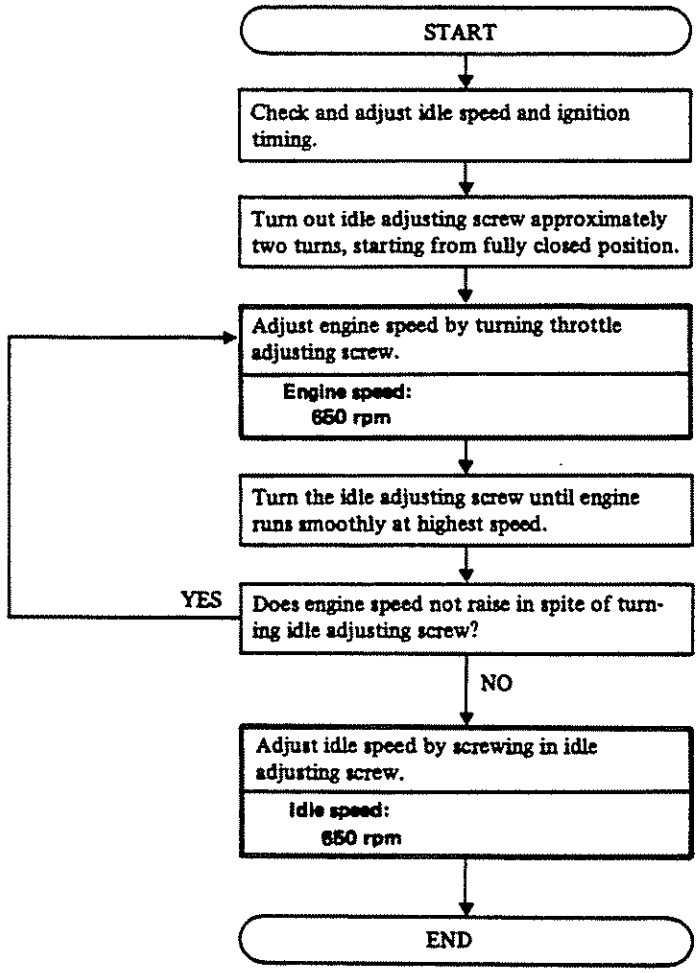
Preparation

1. Make sure that the following parts are in good order.
   - Ignition system
   - Engine oil and coolant levels
   - Valve clearance
   - Float level at idling speed
2. Set shift lever in "Neutral" position.

Checking and adjusting idle-rpm and ignition timing



Checking and adjusting mixture ratio



GOVERNOR SYSTEM

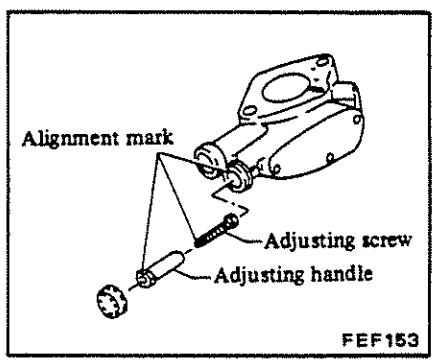
Governor is adjusted at factory and requires no further adjustment.

ADJUSTING MAXIMUM ENGINE SPEED UNDER NO-LOAD

1. Shift F-R control lever into neutral.
2. Run engine and set carburetor throttle valve at fully-open position. Check engine speed.

Maximum engine speed under no-load:
H15
3,100 - 3,300 rpm
H20-II
3,100 - 3,300 rpm
H25
2,800 - 3,000 rpm

3. If engine speed is not within the specified range, adjust it by turning governor adjusting handle.



ADJUSTING MAXIMUM ENGINE SPEED UNDER LOAD

1. Shift F-R control lever into neutral.
2. Run engine with mast assembly tilted fully backward with hydraulic control lever.
3. With carburetor throttle valve at fully open position, check engine rpm.

Maximum engine speed under load:
H15
2,500 - 2,900 rpm
H20-II
2,600 - 3,000 rpm
H25
2,300 - 2,600 rpm

4. If the engine speed is not within the specified range, adjust it by turning governor adjusting screw.
Also adjust maximum engine speed under no-load.

For details, refer to Adjustment of Governor in EF section.

FAST IDLE CONTROL DEVICE

ADJUSTMENT OF IDLE SPEED

1. Warm up engine sufficiently.
2. Make sure that push rod of F.I.C.D. does not touch adjusting screw on throttle lever of carburetor.
3. Adjust engine idle speed by throttle adjusting screw and idle adjusting screw on carburetor.

Idle speed:

650-700 rpm H20-II Gas, LP & H25 Gas
700-750 rpm H25 LP

4. Adjust ignition timing at idle speed.

Gas engine ignition timing:
B.T.D.C.

H15 engine	**6°**
H20-II engine	**4°**
H25 engine	**4°**

LP engine ignition timing:
B.T.D.C.

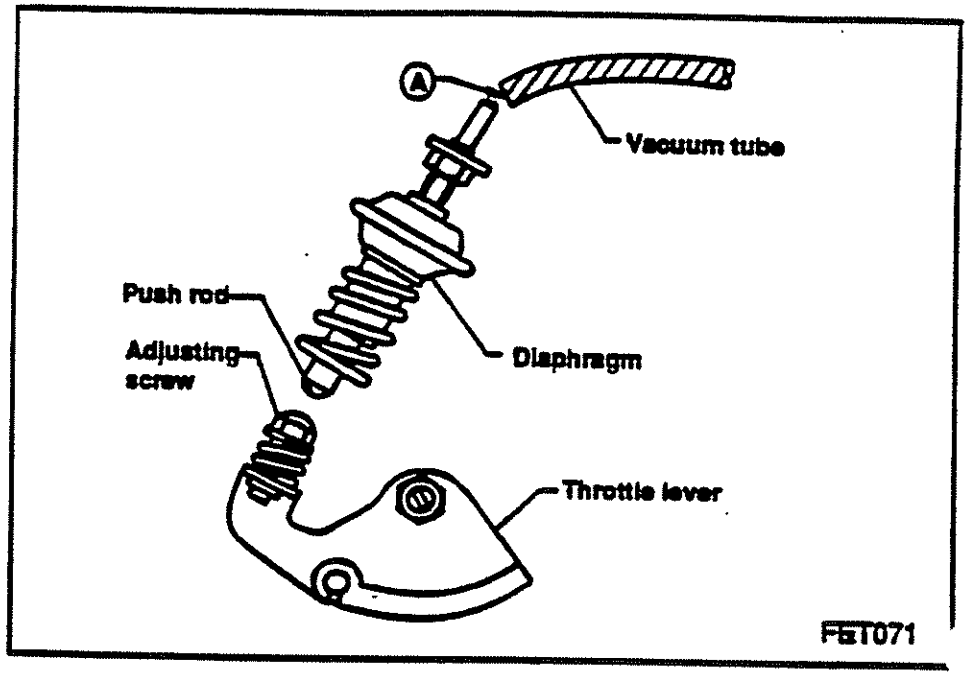
H15 engine	**10°**
H20-II engine	**12°**
H25 engine	8°

Note: Due to some difficulty in adjusting timing accurately with a standard timing light, it is recommended that service be performed using a dial-indicated timing light.

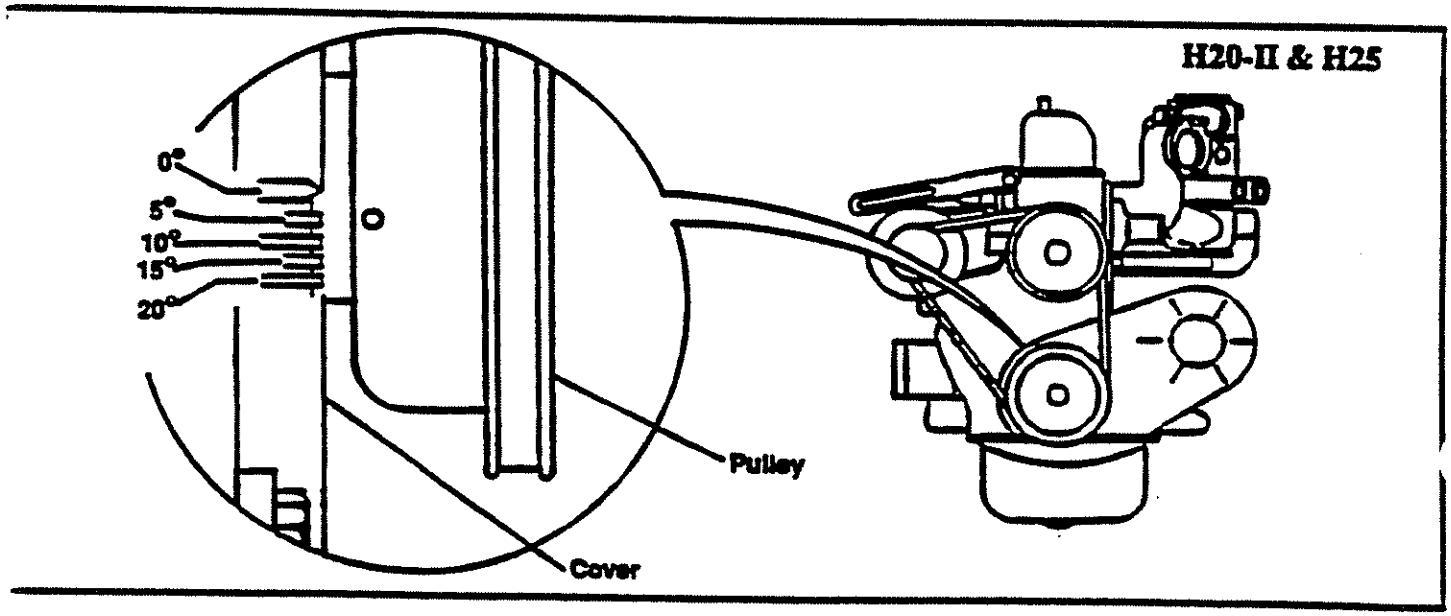
5. Disconnect vacuum tube from F.I.C.D. and then plug (A) port of vacuum tube to prevent air sucking.
6. With this condition, F.I.C.D. push rod pushes the carburetor throttle lever. Next, adjust engine speed as follows:

Gas engine 1200 - 1500 rpm
Use adjusting screw on throttle lever.

LPG engine 1000 - 1200 rpm
Adjust F.I.C.D. directly.



7. After adjustment, connect vacuum tube and make sure that engine is at correct idle speed. If not, adjust F.I.C.D. according to previous procedure in order to attain final correct idle speed.



ENGINE MECHANICAL
(EM)

—H15/H20-II/H25 ENGINE—

CONTENTS

SERVICE DATA AND SPECIFICATIONS

GENERAL SPECIFICATIONS

		H15	H20-II	H25
Engine model		H15	H20-II	H25
Cylinder arrangement		4, in-line	4, in-line	4, in-line
Displacement	cc (cu in)	1,486 (90.7)	1,982 (120.9)	2,472 (150.8)
Bore x stroke	mm (in)	75.5 x 83.0 (2.972 x 3.268)	87.2 x 83 (3.433 x 3.268)	92.0 x 93.0 (3.622 x 3.661)
Valve arrangement		O.H.V.	O.H.V.	O.H.V.
Firing order		1-3-4-2	1-3-4-2	1-3-4-2
Number of piston rings				
Compression		2	2	2
Oil		1	1	1
Number of piston rings		5	5	5
Compression ratio		9.0	8.7	8.7
Engine idle speed	rpm	650	650	650

INSPECTION AND ADJUSTMENT

Valve mechanism

Valve clearance (Hot)		
Intake	mm (in)	0.38 (0.015)
Exhaust	mm (in)	0.38 (0.015)
Valve head diameter		
Intake	mm (in)	35.0 to 35.2 (1.378 to 1.386)
Exhaust	mm (in)	30.0 to 30.2 (1.181 to 1.189)
Valve length		
Intake	mm (in)	108.55 to 108.85 (4.2736 to 4.2854)
Exhaust	mm (in)	108.05 to 108.35 (4.2539 to 4.2657)
Valve stem diameter		
Intake	mm (in)	6.97 to 6.985 (0.2744 to 0.2750)
Exhaust	mm (in)	6.945 to 6.960 (0.2734 to 0.2740)
Valve spring free length		
Intake and exhaust	mm (in)	44.9 (1.768)
Valve spring pressured length (Valve open)		
Intake and exhaust	mm/N (mm/kg, in/lb)	29.3/385.4 to 434.5 (29.3/39.3 to 44.3, 1.154/86.7 to 97.7)
Valve spring assembled height (Valve closed)		
Intake and exhaust	mm/N (mm/kg, in/lb)	37.7/177.5 to 201.0 (37.7/18.1 to 20.5, 1.484/39.9 to 45.2)

Valve spring out-of-square		
Intake and exhaust	mm (in)	1.5 (0.059)
Valve guide to stem clearance		
Intake	mm (in)	0.015 to 0.048 (0.0006 to 0.0019)
Exhaust	mm (in)	0.040 to 0.073 (0.0016 to 0.0029)
Valve seat width		
Intake	mm (in)	1.3 to 1.5 (0.051 to 0.059)
Exhaust	mm (in)	1.6 to 1.8 (0.063 to 0.071)
Valve seat angle		
Intake and exhaust	degree	45°
Valve face angle		
Intake and exhaust	degree	45°30′

Camshaft

Camshaft bend limit	mm (in)	0.05 (0.0020)
Camshaft end play	mm (in)	0.05 to 0.23 (0.0020 to 0.0091)
Camshaft bushing inner diameter standard	mm (in)	
#1	mm (in)	45.472 to 45.485 (1.7902 to 1.7907)
#2, #3	mm (in)	43.948 to 43.961 (1.7302 to 1.7307)
Camshaft journal to bearing clearance		
#1, #3	mm (in)	0.025 to 0.051 (0.0010 to 0.0020)
#2	mm (in)	0.038 to 0.062 (0.0015 to 0.0024)
Camshaft lobe lift		
Intake and exhaust	mm (in)	36.750 to 36.800 (1.4468 to 1.4488)

Crankshaft and main bearing

Journal diameter	mm (in)	62.942 to 62.955 (2.4780 to 2.4785)
Journal taper & out-of-roundness	mm (in)	0.01 (0.0004)
Wear limit	mm (in)	0.03 (0.0012)
Journal oil clearance	mm (in)	0.020 to 0.062 (0.0008 to 0.0024)
Wear limit	mm (in)	0.1 (0.0039)
Crank pin diameter	mm (in)	(H15, H20-II) 44.961 to 44.974 (1.7701 to 1.7706) (H25) 49.961 to 49.974 (1.9670 to 1.9675)
Crank pin taper out-of-roundness	mm (in)	0.01 (0.0004)
Wear limit	mm (in)	0.03 (0.0012)
Crankshaft free end play	mm (in)	0.05 to 0.18 (0.0020 to 0.0071)
Wear limit	mm (in)	0.2 (0.0079)
Crankshaft bend	mm (in)	Less than 0.02 (0.0008)

Flywheel runout at clutch disc contact face	mm (in)	.....	Less than 0.1 (0.0039)

Connecting rod

Center distance	mm (in)	.....	143.97 to 144.03 (5.6681 to 5.6705)
Big end play	mm (in)	.....	0.17 to 0.3 (0.0067 to 0.0118)
Wear limit	mm (in)	.....	0.4 (0.0157)
Connecting rod bearing clearance	mm (in)	.....	0.01 to 0.066 (0.0004 to 0.0026)
Wear limit	mm (in)	.....	0.03 (0.0012)
Connecting rod bend (per 100 mm or 3.937 in)	mm (in)	.....	Less than 0.025 (0.0010)

Piston

Piston diameter (Service standard)	mm (in)	.....	(H15) 75.465 to 75.515 (2.9711 to 2.9730) (H20-II) 87.165 to 87.215 (3.4317 to 3.4337) (H25) 91.965 to 92.015 (3.6207 to 3.6226)
(Service parts)			
0.50 (0.0197) Over size	mm (in)	.....	(H15) 75.965 to 76.015 (2.9907 to 2.9927) (H20-II) 87.655 to 87.715 (3.4510 to 3.4533) (H25) 92.465 to 92.515 (3.6403 to 3.6423)
1.0 (0.0394) Over size	mm (in)	.....	(H15) 76.465 to 76.515 (3.0104 to 3.0124) (H20-II) 88.165 to 88.215 (3.4711 to 3.4730) (H25) 92.965 to 93.015 (3.6600 to 3.6620)
Ring to groove clearance			
Top	mm (in)	.....	0.040 to 0.073 (0.0016 to 0.0029)
Second	mm (in)	.....	0.030 to 0.063 (0.0012 to 0.0025)
Piston ring end gap			
Top	mm (in)	.....	0.25 to 0.35 (0.0098 to 0.0138)
Second oil	mm (in)	.....	0.15 to 0.25 (0.0059 to 0.0098)
Oil	mm (in)	.....	0.3 to 0.9 (0.012 to 0.035)

Pin diameter	mm (in)	(H15, H20-II) 19.993 to 19.998 (0.7871 to 0.7873) (H25) 20.993 to 20.998 (0.8265 to 0.8267)
Piston to bore clearance	mm (in)	0.025 to 0.045 (0.0010 to 0.0018)

Cylinder block

Cylinder bore inner diamter	mm (in)	(H15) 75.50 to 75.55 (2.9724 to 2.9744) (H20-II) 87.20 to 87.25 (3.4331 to 3.4350) (H25) 92.00 to 92.05 (3.6220 to 3.6240)
Wear limit	mm (in)	0.2 (0.0079)
Cylinder bore taper and out-of roundness	mm (in)	0.02 (0.0008)
Surface flatness	mm (in)	Less than 0.05 (0.0020)

Cylinder head

Surface flatness	mm (in)	Less than 0.1 (0.0039)

TIGHTENING TORQUE

Unit	N·m	kg-m	ft-lb
Cylinder head bolts	74 - 83	7.5 - 8.5	54 - 61
Rocker cover nuts	1.8 - 2.7	0.18 - 0.28	1.3 - 2.0
Rocker shaft	49 - 59	5.0 - 6.0	36 - 43
Connecting rod cap bolts			
H15, H20-II	31 - 37	3.2 - 3.8	23 - 27
H25	38 - 44	3.9 - 4.5	28 - 33
Main bearing cap bolt	83 - 93	8.5 - 9.5	61 - 69
Flywheel housing fixing bolts	43 - 58	4.4 - 5.9	32 - 43
Flywheel fixing bolts or driving plate	132 - 142	13.5 - 14.5	98 - 105
Camshaft sprocket bolt	29 - 39	3.0 - 4.0	22 - 29
Oil pan bolts	6.4 - 7.5	0.65 - 0.76	4.7 - 5.5
Oil pan pump bolts	21 - 34	2.1 - 3.5	15 - 25
Oil pan drain plug	20 - 39	2.0 - 4.0	14 - 29
Carburetor nuts	14 - 18	1.4 - 1.8	10 - 13
Manifold nuts	16 - 19	1.6 - 1.9	12 - 14
Fuel pump nuts	14 - 18	1.4 - 1.8	10 - 13
Crank pulley bolt	142 - 152	14.5 - 15.5	105 - 112
Cover for hydraulic pump chain	3.7 - 5.0	0.38 - 0.51	2.7 - 3.7
Engine front cover bolts	16 - 19	1.6 - 1.9	12 - 14
Alternator bolts	44 - 59	4.5 - 6.0	33 - 43

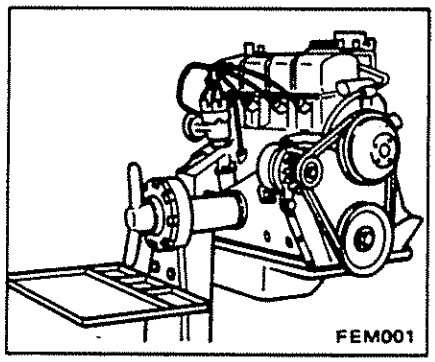
TROUBLE DIAGNOSES AND CORRECTIONS

Condition	Probable cause	Corrective action
I. Noisy engine		
Knocking of crankshaft and bearing.	Loose main bearing.	Replace.
	Seized bearing.	Replace.
	Bent crankshaft.	Repair or replace.
	Uneven wear of journal.	Correct.
	Excessive crankshaft end play.	Replace center bearing.
Piston and connecting rod knocking	Loose bearing.	Replace.
	Seized bearing.	Replace.
	Loose piston pin.	Replace pin or bushing.
	Loose piston in cylinder.	Recondition cylinder.
	Broken piston ring.	Replace.
	Improper connecting rod alignment.	Realign.
Camshaft knocking	Loose bearing.	Replace.
	Excessive axial play.	Replace bearing thrust plate.
	Rough gear teeth.	Repair.
	Broken cam gear.	Replace.
Timing chain noise	Improper chain tension.	Adjust.
	Worn and/or damaged chain.	Replace.
	Worn sprocket.	Replace.
	Worn and/or broken tension adjusting mechanism.	Replace.
	Excessive camshaft and bearing clearance.	Replace.
Camshaft and valve mechanism knocking	Improper valve clearance.	Adjust.
	Worn adjusting screw.	Replace.
	Worn rocker face.	Replace.
	Loose valve stem in guide.	Replace guide.
	Weakened valve spring.	Replace.
	Seized valve.	Repair or replace.
Water pump knocking	Improper shaft end play.	Replace.
	Broken impeller.	Replace.
II. Other mechanical troubles		
Sticking valve.	Improper valve clearance.	Adjust.
	Insufficient clearance between valve stem and guide.	Clean stem or ream guide.
	Weakened or broken valve spring.	Replace.
	Seized or damaged valve stem.	Replace or clean.
	Poor fuel quality.	Use better fuel.

Condition	Probable cause	Corrective action
Seized valve seat	Improper valve clearance.	Adjust.
	Weakened valve spring.	Replace.
	Thin valve head edge.	Replace valve.
	Narrow valve seat.	Reface.
	Overheating	Repair or replace.
	Over speeding.	Drive within proper speed.
	Stuck valve guide.	Repair.
Excessively worn cylinder and piston	Shortage of engine oil.	Add or replace oil.
	Dirty engine oil.	Clean crankcase, replace oil and oil filter element.
	Poor quality of oil.	Use right oil.
	Overheating.	Repair or replace.
	Wrong assembly of piston with connecting rod.	Repair or replace.
	Improper piston ring clearance.	Adjust.
	Broken piston ring.	Replace.
	Dirty air cleaner.	Clean.
	Mixture too rich.	Adjust.
	Engine over run.	Drive at proper speeds.
	Stuck choke valve.	Clean and adjust.
	Overchoking.	Start correctly.
Malfunctioning connecting rod	Shortage of engine oil.	Add oil.
	Low oil pressure.	Correct.
	Poor quality engine oil.	Use right oil.
	Rough surface of crankshaft.	Grind and replace bearing.
	Clogged oil passage.	Clean.
	Bearing wear or damage.	Replace.
	Improper bearing assembly.	Correct.
	Loose bearing.	Replace.
	Connecting rod alignment incorrect.	Repair or replace.
Malfunctioning crankshaft bearing	Shortage of engine oil.	Add or replace.
	Low oil pressure.	Correct.
	Poor quality engine oil.	Use right oil.
	Crankshaft journal worn or out-of-round.	Repair.
	Clogged oil passage in crankshaft.	Clean.
	Bearing wear or damage.	Replace.
	Improper bearing assembly.	Correct.
	Damaged crankshaft or bearing.	Replace.

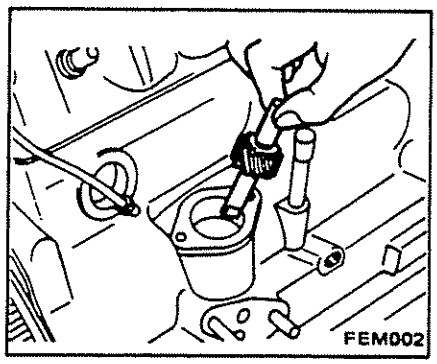
ENGINE DISASSEMBLY

1. Remove air cleaner assembly, and cover carburetor air horn with a clean cloth.
2. Fix engine on an engine stand. To do this, remove oil filter with bracket, oil pressure switch, fuel pump and right side engine mounting bracket, and then install attachment.



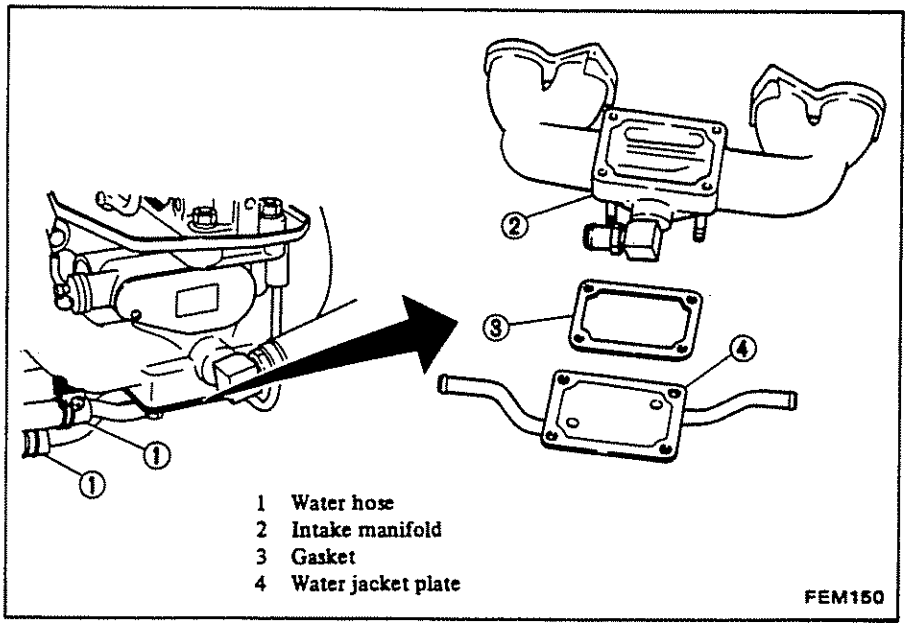
Engine on Stand

3. Remove oil pan drain plug and drain oil.
4. Remove oil level gauge, fuel line, and distributor (advance timer) connections. Remove distributor by unscrewing clamping bolts and pick up distributor driving spindle.



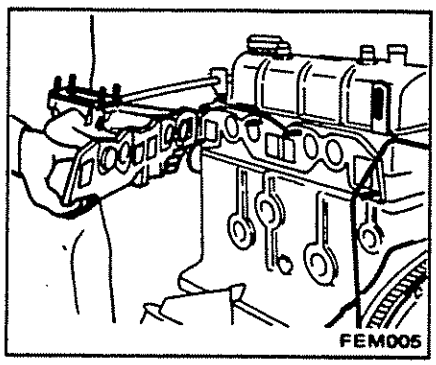
Removal of Distributor and Distributor Driving Spindle

5. Remove spark plugs. Keep washer together with spark plug.
6. Loosen fan belt. Remove cooling fans, pulley and spacers. Remove water outlet (elbow) and thermostat.
7. Remove water pump and alterna-.or fixing bar.
8. Remove alternator, bracket, left side mounting bracket and drain hose.
9. Remove carburetor.
10. Disconnect water hose from water jacket at intake manifold; remove water jacket plate together with gasket.



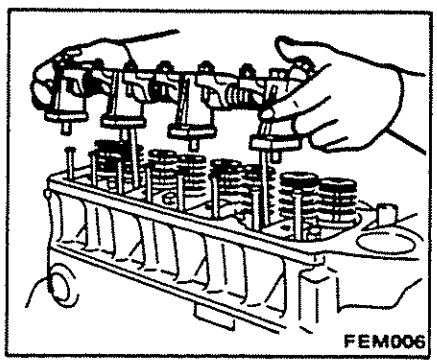
Removal of Water Jacket Plate

11. Remove intake and exhaust manifolds.



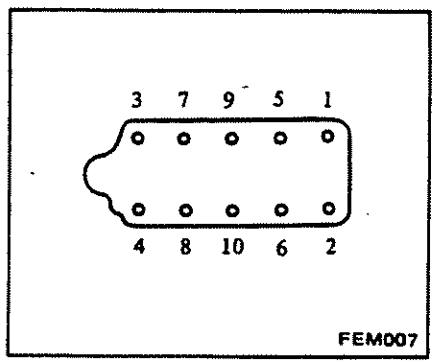
Removal of Manifold Assembly

12. Remove rocker cover and gasket.

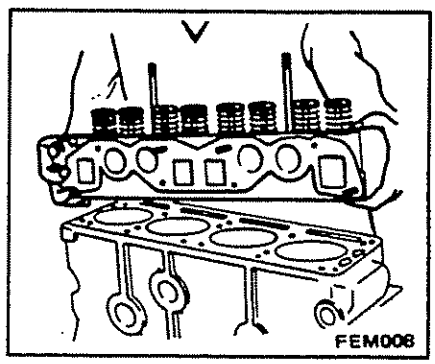


Removal of Rocker Shaft Assembly

13. Remove rocker shaft assembly. Bolts attaching rocker shaft brackets should be equally loosened in proper sequence. Withdraw push rods. Remove front slinger.



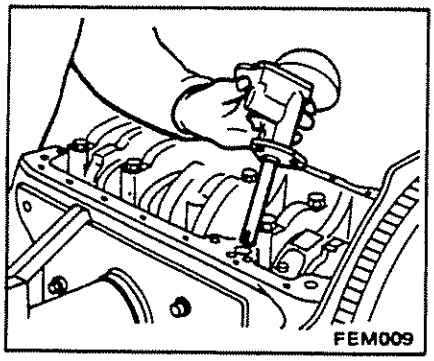
Cylinder Head Bolt Loosening Sequence



Removal of Cylinder Head

14. Remove cylinder head and gasket.

Loosen bolts beginning with those on outside so as not to warp head.



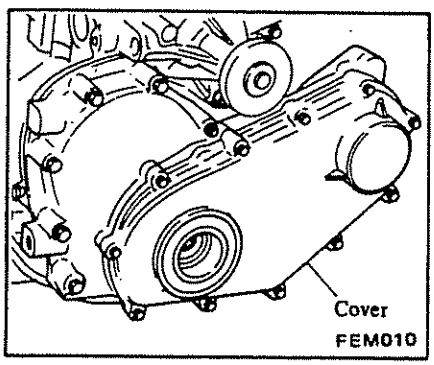
Removal of Oil Pump

15. Remove oil pan and oil pan gasket.
16. Remove oil pump.
17. Remove crankshaft pulley bolts.
18. Remove crankshaft pulley.
19. Remove sprocket bushing.
20. Remove hydraulic pump chain cover.

Note:

a. To remove cover, remove attaching bolts and then tap cover with a soft-faced hammer.

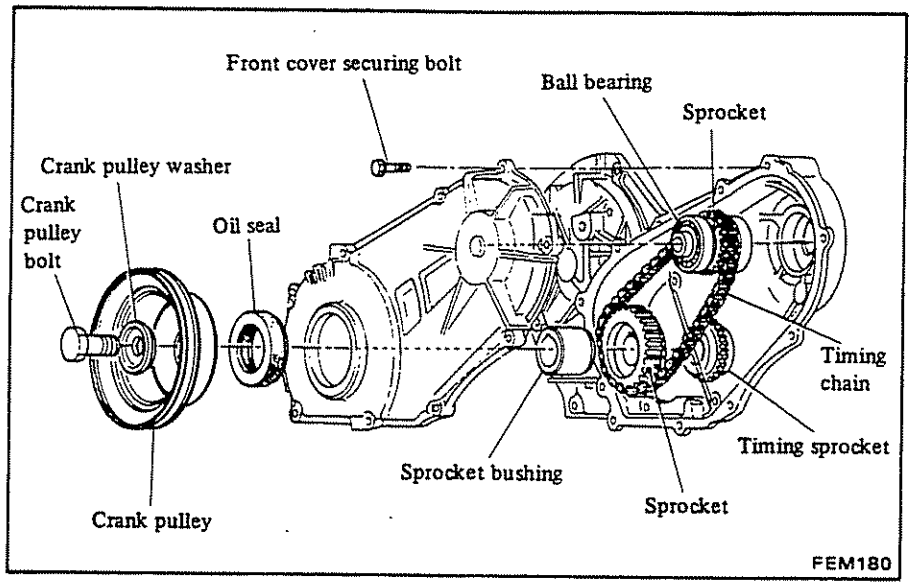
b. Always install a new gasket.

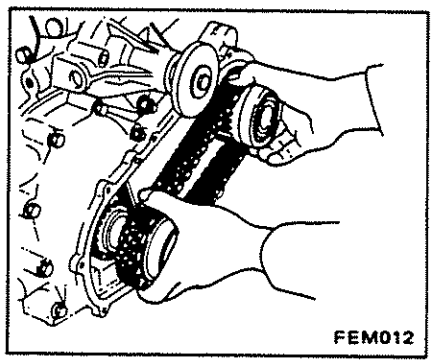


Cover of Hydraulic Pump Driving Chain

21. Remove crankshaft sprocket wheel, oil pump sprocket wheel and hydraulic pump chain as an assembly.

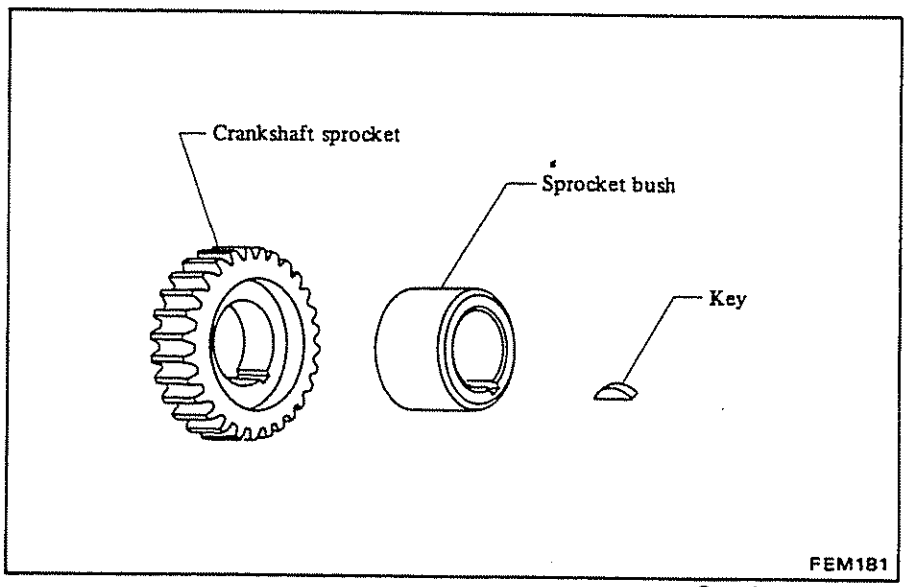
Note: Pull out crankshaft sprocket after removing attaching bolts; pull out hydraulic pump sprocket together with bearing by hand.





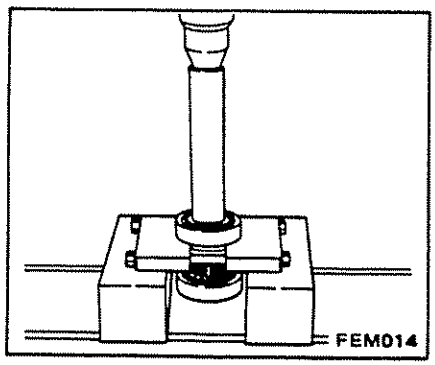
Crankshaft Sprocket

CAUTION:
Be careful not to damage chain.



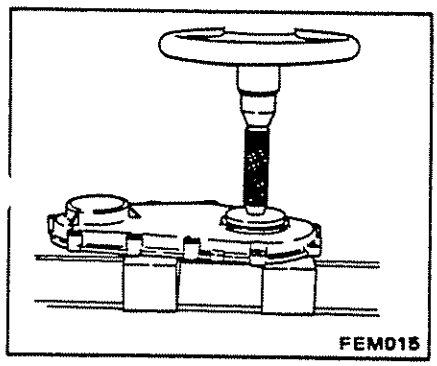
Camshaft Sprocket

22. Press out bearing from hydraulic pump sprocket with Bearing Puller ST3D031000 and Bearing Drift ST22360002.



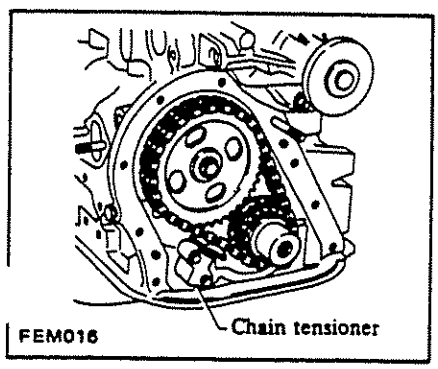
Removing bearing

23. Remove front oil seal.



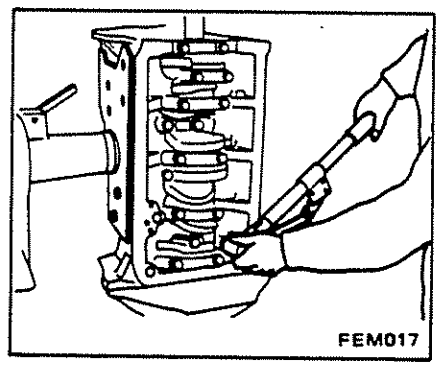
Removing Front Oil Seal

24. Remove front cover and gasket.
25. Remove chain tensioner.
26. Remove camshaft sprocket, crankshaft sprocket and timing chain simultaneously.



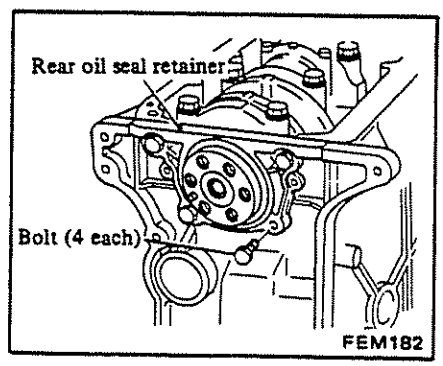
Removing Timing Chain

27. Remove crankshaft gear shim, if installed.
Shim can be removed by taking off a woodruf key.
28. Turn engine over.
29. Withdraw valve lifters. Lay out removed valve lifters in proper order (by cylinder).
30. Remove connecting rod caps.
Pre-set crankshaft pin to top or bottom dead center (TDC or BDC). Be careful that pistons do not drop. Lay out bearings according to applicable pistons.

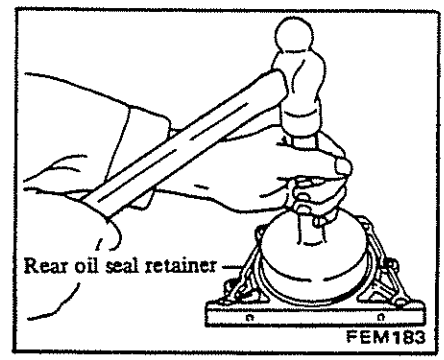


Removing Connecting Rod Cap

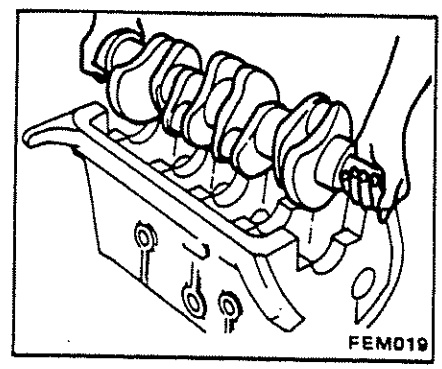
31. Remove flywheel. Straighten bent tongue of lock plate with a chisel or other appropriate tool.
32. Remove rear plate.
33. Remove rear oil seal retainer.
34. Remove rear main bearing cap bolts, then remove bearing cap while lightly tapping with mallet.



35. Using Oil Seal Drift KV10105500, remove oil seal from rear oil seal retainer.



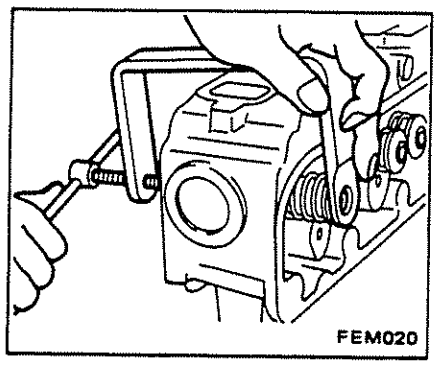
36. Remove (pull) pistons in direction of cylinder block fire deck (toward cylinder block). Temporarily secure cap and connecting rods so that they are not interchanged (mixed) and lay them out in proper order for each cylinder.
37. Remove two bolts attaching camshaft locating plate. Then remove camshaft, taking care not to damage metal surfaces.
38. Remove bearing caps from crankshaft. Remove seals from both sides of rear bearing cap together with crankshaft bearing cap.
39. Remove crankshaft and bearings.
After bearings are removed, lay them out with corresponding caps to side of block so that they are not interchanged (mixed).



Removing Crankshaft

40. Remove valves and valve springs.

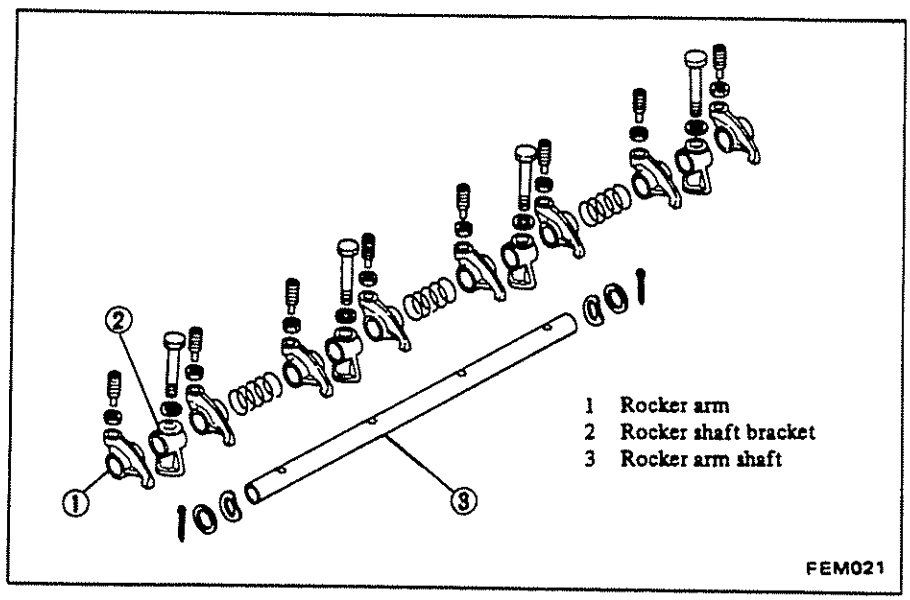
After valves and valve springs are removed, lay them out by individual cylinders. Be careful not to lose or damage rubber ring on end of intake valve stem when removing valves.



Removing Valve Spring

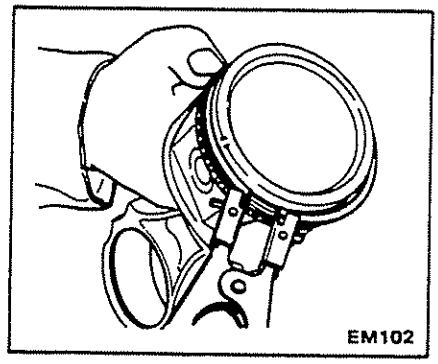
41. Remove bolts from rocker shaft bracket.

42. Remove cotter pin, washer, and outer spring and then remove rocker arm shaft and bracket in that order.



Disassembling Valve Rocker Parts

43. Remove lock nuts and adjusting nuts from rocker arm.



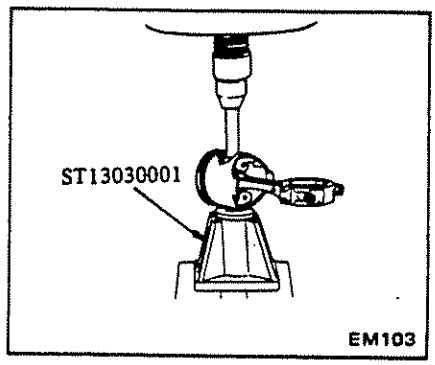
Removing Piston Rings

44. Remove piston rings beginning with top ring. (Ring expander)

45. Extract piston pin.

Piston pin and connecting rod are press fit. To remove piston pin, first remove snap rings and heat piston [80°C (176°F)] and press out pin.

Note: Keep piston, piston pin, piston rings and connecting rod for each cylinder together so that they are not interchanged (mixed) with parts for other cylinders.



Disassembling Piston and Connecting Rod

INSPECTION AND REPAIR

PREPARATIONS FOR INSPECTION

1. Prior to cleaning, check cylinder head and cylinder block for water leakage.
2. Thoroughly clean all components and completely remove all oil, grime, sealing, etc.
3. Blow compressed air through oil passages in main gallery, etc. to make sure that passages are not clogged.
4. Lay out components such as main bearing cap, connecting rod, etc. as individual assemblages or groups (for each cylinder) so that they are not interchanged (mixed).

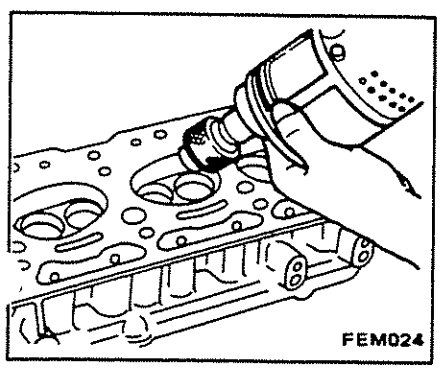
INTAKE MANIFOLD WATER JACKET

1. Check water jacket plate for leakage. If there is leakage, replace gasket.
2. Also check water hose for deterioration or damage, replacing if necessary. If water leaks at or around connection, retighten clamp.

CYLINDER HEAD

REMOVING CARBON

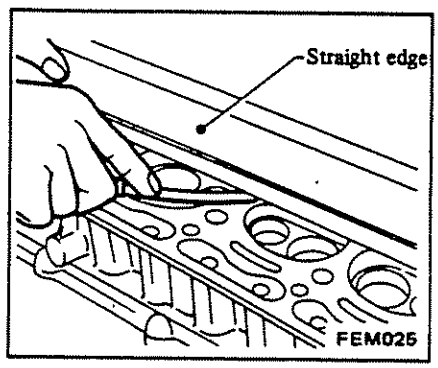
Remove carbon from the combustion chamber of the cylinder head and from the side surface on which the manifold is installed and check for scars or damage.



Cleaning Cylinder Head

MEASURING CYLINDER HEAD FOR WARPAGE

Measure the cylinder head surface for both longitudinal and transverse warpage. If uneven (warpage exceeds specified limit), correct the surfaces with a grinder.

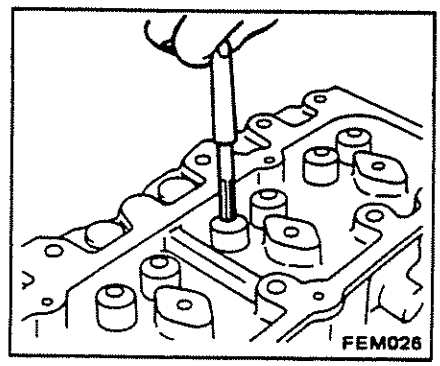


Measuring Cylinder Head for Warpage

Surface flatness mm (in)	Less than 0.1 (0.004)
Grinding limit mm (in)	0.2 (0.008)

REAMING VALVE GUIDES

Measure valve stem and valve guide clearance. If clearance exceeds prescribed limit, ream out the valve guide and install valves with oversized stems. Two types are provided (for intake and exhaust valves): 20 and 40 oversizes.



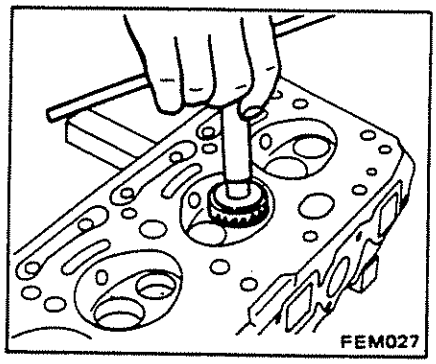
Reaming Valve Guide

		Standard clearance	Service limit
			Clearance
Valve stem/valve guide clearance mm (in)	(Intake)	0.015 to 0.048 (0.0006 to 0.0019)	0.10 (0.0039)
	(Exhaust)	0.040 to 0.073 (0.0016 to 0.0029)	0.10 (0.0039)

	Intake valve stem dia. mm (in)	Exhaust valve stem dia. mm (in)
STD	6.970 to 6.985 (0.2744 to 0.2750)	6.945 to 6.960 (0.2734 to 0.2740)
20	8.857 to 8.870 (0.3487 to 0.3492)	8.827 to 8.840 (0.3475 to 0.3480)
40	9.057 to 9.070 (0.3566 to 0.3571)	9.027 to 9.040 (0.3554 to 0.3559)

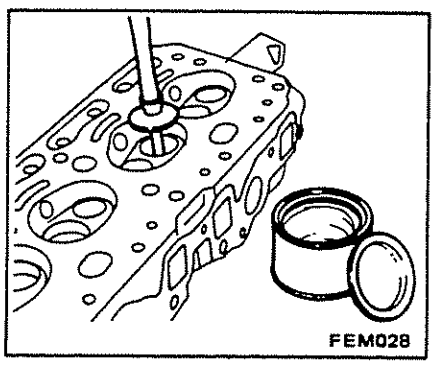
CORRECTING (Grinding) VALVE SEATS

Inspect the valve seat for burning or faulty contact. When correcting the valve seat, first check the valve guide for wear, and if excessively worn, replace the valve and then correct the valve seat.

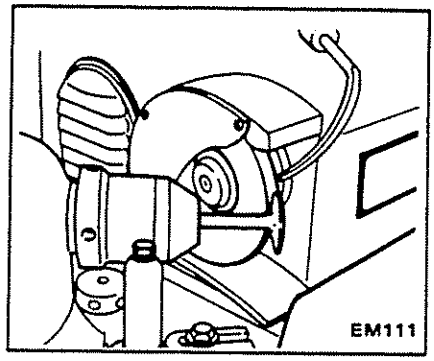


Grinding Valve Seats

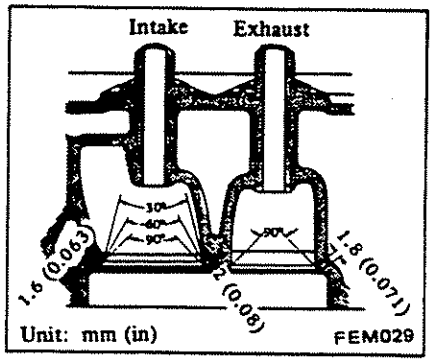
1. Correct valve seat with a seat cutter or seat grinder and finish for proper fit (proper contact) using grinding compound.
2. First cut to a 75° angle (around entire valve seat) and then bevel edge evenly to a 45° angle. For proper fitting, apply grinding compound (first course and then fine compound) and work valve and valve seat back and forward until a smooth fit is provided and apply oil for final fit.



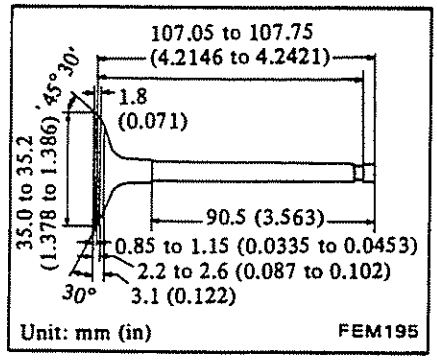
Fitting Valve



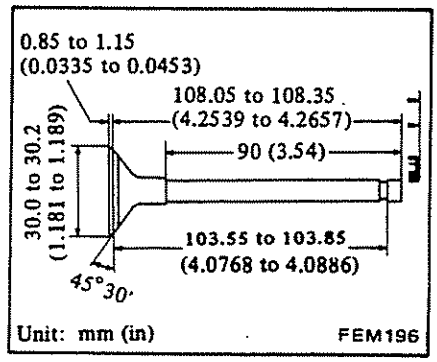
Grinding Valve



Dimensions of Valve Seats



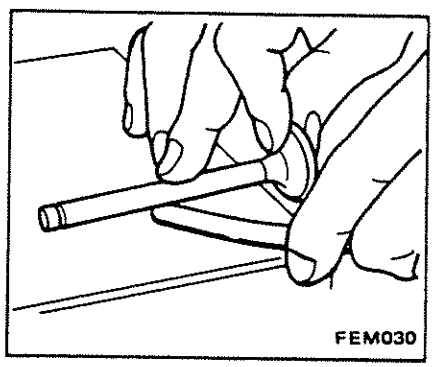
Dimensions of Intake Valve



Dimensions of Exhaust Valve

VALVE

1. Remove all carbon from valve stem and valve seat and inspect valve stem for wear, binding, etc. and check valve seat for wear, recession, etc. caused by stem head wear, and correct or replace as required.

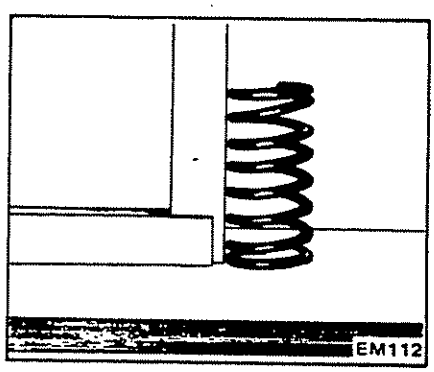


Checking Valve Stem for Bending

2. Correct valve seat and valve with a valve grinder. Replace valve if valve head thickness is less than 0.5 mm (0.020 in). Do not grind end of stem (valve) more than 0.5 mm (0.020 in) [keep within 0.5 mm (0.020 in)].

VALVE SPRINGS

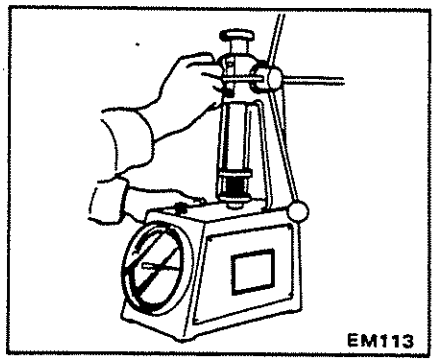
1. Inspect springs for cracks or damage, measure spring force, and replace if damaged or not within prescribed limits.
2. Measure inclination (right angle alignment) of each valve spring with a steel square and surface plate. Replace springs if inclined by more than limit.



Measuring Spring Inclination

Valve spring specification

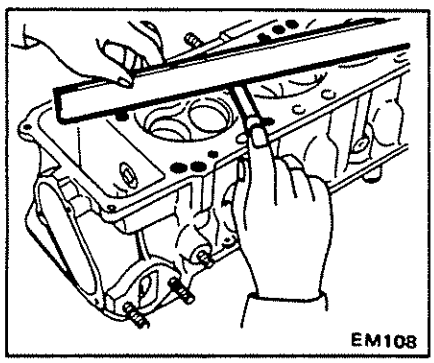
Item \ Model	H15, H20-II H25
Free length mm (in)	44.9 (1.768)
Installed (set) length mm (in)	29.3 (1.154)
Set load N (kg, lb)	409.9 (41.8, 92.2)
Inclination limits mm (in)	Less than 1.5 (0.059)



Measuring Spring Constant

CYLINDER BLOCK

Measuring longitudinal and transverse warp of cylinder block surface.

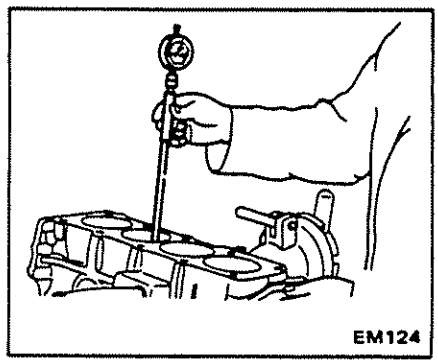


Measuring Warp of Cylinder Block

1. Remove carbon and other material adhering to cylinder block surface and inspect for cracks, scars, damage, etc. and then measure cylinder head (using a straight edge and feeler gauge) for both longitudinal and transverse warp, according to instructions in paragraph "2-2" above.

		Correct to within	Service limit
Cylinder block surface	Longitudinal direction mm (in)	0.05 (0.0020)	0.10 (0.0039)
	Transverse direction mm (in)	0.02 (0.0008)	0.04 (0.0016)

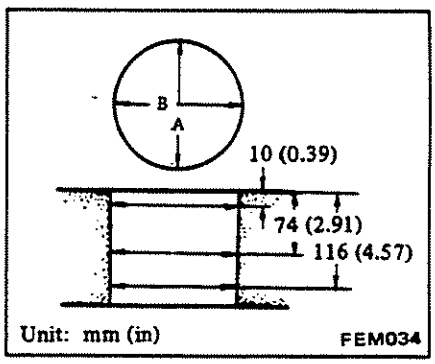
2. Perform a water leakage test using a hydraulic pressure of from 392 to 441 kPa (3.92 to 4.41 bar, 4 to 4.5 kg/cm^2, 57 to 64 psi).



Cylinder Bore Measurement

MEASURING CYLINDER BORE

Measure the cylinder bore and if excessively worn or tapered or if scarred, pitted or damaged, or if the piston rings (piston) bind, rebore the cylinder. If only slightly worn or tapered, merely correct the counterbore with a counterbore tool. Measure cylinder bore with a cylinder gauge, measuring in A and B directions at three places from top to bottom, as shown in the figure, and determine cylinder bore wear (difference between maximum and minimum measurement values).

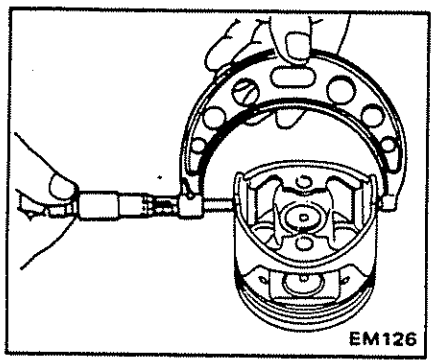


Measuring position of Cylinder Bore

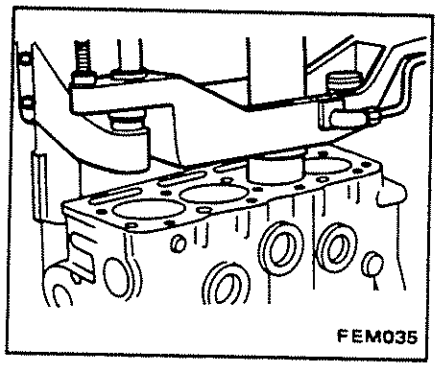
		Correct to within	Service (wear) limit
Cylinder bore	mm (in)	(H15) 75.50 to 75.55 (2.9724 to 2.9744) (H20-II) 87.20 to 87.25 (3.4331 to 3.4350) (H25) 92.00 to 92.05 (3.6220 to 3.6240)	0.2 (0.0079)
Cylinder bore out-of-round limit	mm (in)	0.02 (0.0008)	–
Cylinder bore taper	mm (in)	0.02 (0.0008)	–
Difference in cylinder bore measurements	mm (in)	0.05 (0.0020)	–

BORING AND HONING

1. Determine proper oversize according to extend of cylinder bore wear, measure outside diameter of piston (long span across skirt of piston) and rebore, leaving 0.02 mm (0.0008 in) for honing, so that piston to cylinder clearance is within 0.025 to 0.045 mm (0.0010 to 0.0018 in). Measure cylinder at normal temperature. If reboring of one cylinder is required, rebore all cylinders at same time.



Measuring Long Span of Piston Skirt



Honing of Cylinder Block

2. Calculating individual cylinder bore sizes:

Piston skirt outside diameter (measured value): A
Piston to cylinder clearance: B
B = 0.025 to 0.045 mm (0.0010 to 0.0018 in) [at 20°C (at 68°F)]
Honing allowance: C
C = 0.02 mm (0.0008 in)
Cylinder bore: D
D = A + B – C

3. Cylinder boring precautions

Cutting depth of cutting tool should be approximately 0.05 mm (0.0020 in). Do not cut quickly all at one time – cut gradually.

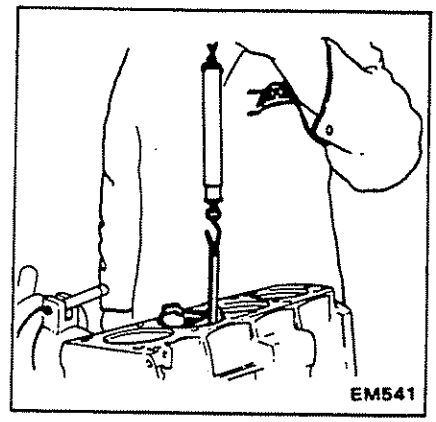
Measure cylinder bore carefully, since bore will change due to heat generated by cutting.

To avoid deviations or distortions due to cutting heat, bore cylinders in following sequence of 2-4-1-3.

Mark pistons according to applicable cylinder so that pistons are properly applied to correct cylinder and so that they are not interchanged (mixed).

4. Measure bore and check taper and trueness (out-of-round) condition after proper finishing by honing.

5. Measure piston to cylinder clearance.



Measuring Clearance between Piston and Cylinder

For this measurement, insert piston from reverse side (with piston pin removed) and insert a feeler gauge 0.04 mm (0.016 in) so that it projects on thrust side of piston. Then apply a spring scale to gauge and lift vertically. If spring scale reading is 4.9 to 14.7 N (0.5 to 1.5 kg, 1.1 to 3.3 lb), clearance is normal.

Oversized piston

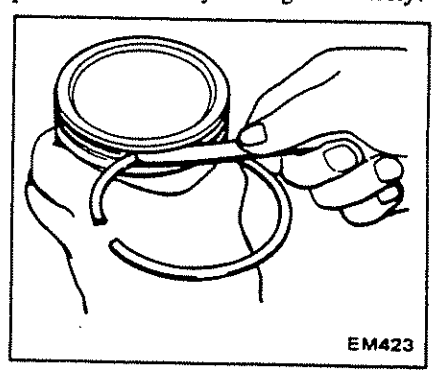
Piston size	Diameter mm (in)		
	H20-II	H15	H25
STD	87.165 to 87.215 (3.4317 to 3.4337)	75.465 to 75.515 (2.9711 to 2.9730)	91.965 to 92.015 (3.6207 to 3.6226)
0.50 O.S.	87.655 to 87.715 (3.4510 to 3.4533)	75.965 to 76.015 (2.9907 to 2.9927)	92.465 to 92.515 (3.6403 to 3.6423)
1.00 O.S.	88.165 to 88.215 (3.4711 to 3.4730)	76.465 to 76.515 (3.0104 to 3.0124)	92.965 to 93.015 (3.6600 to 3.6620)
1.50 O.S.	88.665 to 88.715 (3.4907 to 3.4927)	76.965 to 77.015 (3.0301 to 3.0321)	93.465 to 93.515 (3.6797 to 3.6817)

Prescribed clearance mm (in)	0.025 to 0.045 (0.0010 to 0.0018) [20°C (68°F)]
Feeler gauge pulling force N (kg, lb)	4.9 to 14.7 (0.5 to 1.5, 1.1 to 3.3)
Feeler gauge thickness mm (in)	0.04 (0.0016)

PISTON, PISTON PIN, AND PISTON RINGS

MEASURING PISTON WEAR

1. Inspect piston thrust surface for binding, scratches, or scars, and replace if excessively damaged or faulty.



Measuring Piston Ring End Gap

2. Measure piston ring to piston groove (land) clearance. For this measurement, install a new ring on piston and measure with a feeler (thickness) gauge. If clearance exceeds prescribed limits, replace rings (or piston) as required.

		Standard mm (in)	Limit mm (in)
Piston ring-to-groove (land) clearance	Top	0.040 to 0.073 (0.0016 to 0.0029)	0.1 (0.0039)
	Second	0.030 to 0.063 (0.0012 to 0.0025)	0.1 (0.0039)

3. Difference in weight between piston assemblies for individual cylinders should be within 2 grams (0.07 oz).

PISTON RINGS

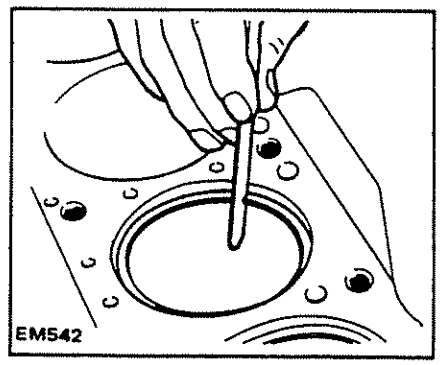
1. Piston ring end gap

To measure piston ring end gap, apply piston ring to part of piston skirt where cylinder wear is minimum, invert piston and, after assuring that piston and ring are positioned at right angles to cylinder, depress piston.

Measure piston ring end gap with a thickness gauge and replace piston ring with a new ring if end gap measurement exceeds 1 mm (0.04 in). If end gap is less than 0.15 mm (0.0059 in), either correct by applying an oil stone to grind down ends of ring, or replace ring with a new one.

2. Measuring piston ring contracting force

Measure contracting force with a ring tester. If load required to contract gap is below specified value, replace ring.



Checking Ring Grooves

Oversize piston rings

Oversize pistion ring mm (in)	0.5 (0.020)
	1.0 (0.039)

		Standard mm (in)	Limit mm (in)
Piston ring end gap	Top	0.25 to 0.35 (0.0098 to 0.0138)	1.0 (0.039)
	Second	0.15 to 0.25 (0.0059 to 0.0098)	1.0 (0.039)
	Oil	0.30 to 0.90 (0.0118 to 0.0354)	1.0 (0.039)

CAUTION:
When piston ring only is to be replaced, without cylinder bore being corrected, measure gap at bottom of cylinder where wear is minor.

Ring compression [Ring end gap 0.51 to 0.84 mm (0.0201 to 0.0331 in)]	Service limit
Top ring N (kg, lb)	13.34 to 16.08 (1.36 to 1.64, 3.00 to 3.62)
Second ring N (kg, lb)	10.30 to 13.24 (1.05 to 1.35, 2.32 to 2.98)
Oil ring N (kg, lb)	12.95 to 16.48 (1.32 to 1.68, 2.91 to 3.70)

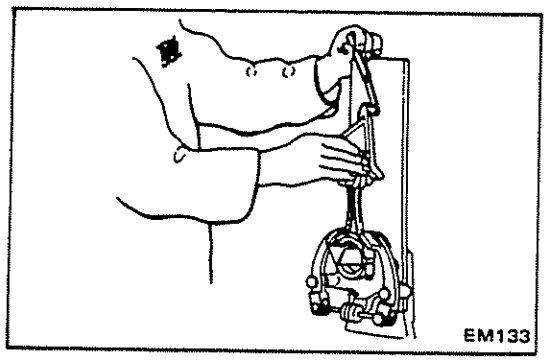
PISTON PIN

Check piston-to-piston pin fit for looseness. To check, warm piston pin in piston with a finger. If piston pin can be pushed in with some resistance, the fitting is normal. If loose fitting is detected, replace piston and piston pin as an assembled unit.

CONNECTING RODS

CORRECTION FOR BENDING OR TWISTING (Parallel alignment)

Inspect the thrust surfaces (both ends) and the inner portion of the large end (crankshaft end) for wear or damage, and correct or replace, as required. Check for bending or twisting (parallel alignment) using a connecting rod alignment tool. If bent or twisted (out of parallel alignment) beyond the service limit, but within repair limit, correct with a press. If bent or twisted beyond repair limit, replace with a new connecting rod.



Measuring Parallel Alignment (Bending and Twisting) of Connecting Rod

	Correct to within	Service (Bend/twist) limit
Bend/twist (Parallel alignment) [Per 100 mm (3.94 in)] mm (in)	0.025 (0.0010)	(B) 0.05 (0.002)
		(T) 0.05 (0.002)

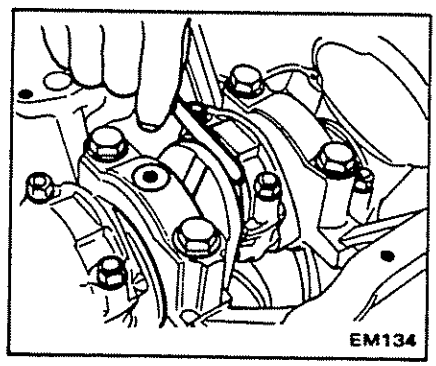
CONNECTING ROD WEIGHT

When replacing any or all of the connecting rods, carefully measure their weight to insure that the difference in weight between individual connecting rods does not exceed 5 gr (0.18 oz).

Difference in weight between individual connecting rods (including metal fasteners):
Within 5 gr (0.18 oz)

MEASURING CONNECTING ROD END PLAY

Apply the bushing to the connecting rods and install them on the crankshaft. By pushing the rod to one side, and using a feeler (thickness) gauge, measure rod clearance in the shaft (axial) direction against the crankpin.



Measuring Connecting Rod End Play

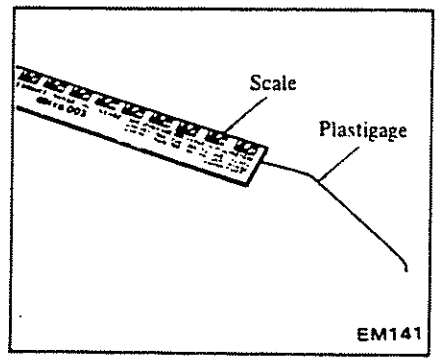
	Standard	Limit
End play mm (in)	0.17 to 0.3 (0.0067 to 0.0118)	0.4 (0.0157)

CONNECTING ROD BUSHINGS

1. Inspect bushings for binding, fusing, peeling, contact, etc., and replace if faulty.
2. Measure lubrication (oil) clearance with a width gauge (plastigage).

Measuring lubrication (oil) clearance

1. Thoroughly clean all oil and dirt from each component (especially re verse side of bushing) and install connecting rod bushings.

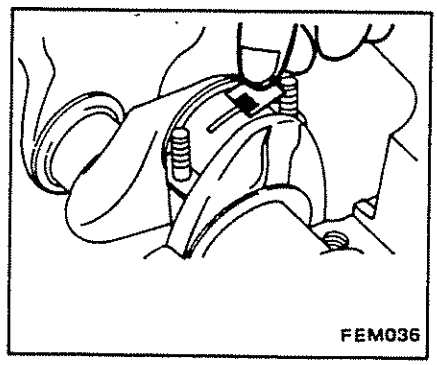


Plastigage

2. Cut a width gauge (plastigage) same width as bushing and provide oil clearance parallel to crank pin. After installing connecting rods, tighten to specified torque.

Ⓣ Tightening torque:
Connecting rod
49 to 59 N·m
(5.0 to 6.0 kg-m, 36 to 43 ft-lb)

CAUTION:
Do not turn crankshaft while plastigage is being inserted.



Measuring Lubrication (Oil) Clearance (II)

3. Remove cap, and measure width of gauge (using a scale for measurement) at widest point.

If difference between maximum and minimum width of pressed gauge exceeds 0.03 mm (0.0012 in), check journal for eccentric wear.

4. If lubrication (oil) clearance exceeds prescribed limit, replace parts as required from service parts. Under no circumstances should any attempt be made to adjust lubrication (oil) clearance by using emery cloth on portion to which cap is applied, by using shims, or by scraping or filing down bushing.

Connecting rod bushing specifications

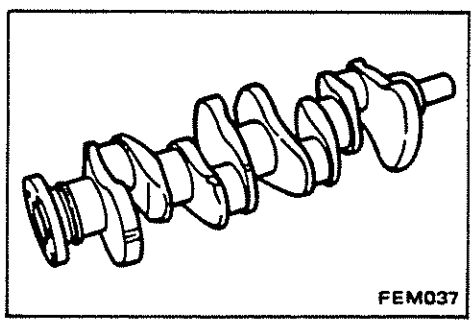
Under size mm (in)	Thickness at top of bushing mm (in)	Crank pin dia. mm (in)
0.25 (0.0098)	1.623 to 1.631 (0.0639 to 0.0642)	51.711 to 51.724 (2.0359 to 2.0364)
0.50 (0.0197)	1.748 to 1.756 (0.0688 to 0.0691)	51.461 to 51.474 (2.0260 to 2.0265)
0.75 (0.0295)	1.873 to 1.881 (0.0737 to 0.0741)	51.211 to 51.224 (2.0162 to 2.0167)
1.0 (0.0394)	1.998 to 2.006 (0.0787 to 0.0790)	50.961 to 50.974 (2.0063 to 2.0068)

	Correct to within	Service (clearance) limit
Connecting rod lubrication (oil) clearance mm (in)	0.01 to 0.066 (0.0004 to 0.0026)	0.1 (0.0039)

CRANKSHAFT

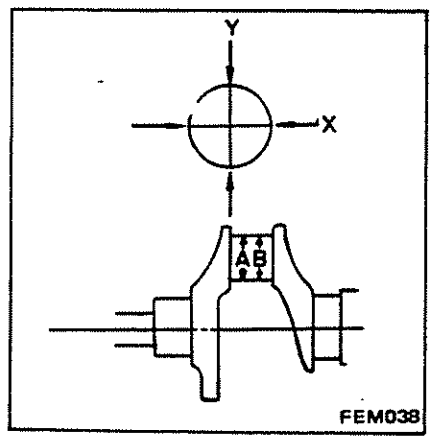
INSPECTION

Thoroughly clean the crankshaft and inspect the pin and journal counterweights (balance weights) for cracks or damage, make sure that the oil seal contact surface is satisfactory and that the pins and journals are not scarred or damaged.



Inspecting Crankshaft

beyond the normal service (wear) limit or if eccentrically worn, correct them to an appropriate undersize. (For finishing dimensions refer to paragraphs on main bearing and connecting rod bushings). Measure at a total of 8 positions: 2 positions in the center parts of the pins and journals in which there are no holes, 2 positions at both ends, and 2 positions at right angles to both ends. Eccentric wear is determined as being the difference between maximum and minimum measurement values.



Measuring Journal and Pin Diameter

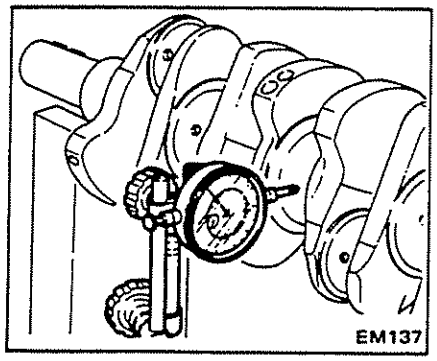
	Correct to within	Service (out-of round/taper) limit
Degree of out-of-round and taper mm (in)	0.01 (0.0004)	0.03 (0.0012)

OURNAL AND PIN DIAMETER MEASUREMENT

Measure journal and pin diameters for wear using a micrometer. If worn

MEASURING CRANKSHAFT FOR BENDING

Support both end journals in a V-block or other appropriate support, apply a dial gauge to the center of the journal bearing surface, turn the crankshaft and measure the bend of the crankshaft (1/2 of the maximum value shown on the gauge is the amount of bend). If bent beyond the prescribed service limit, correct (straighten) with a press, or replace the crankshaft, as required.



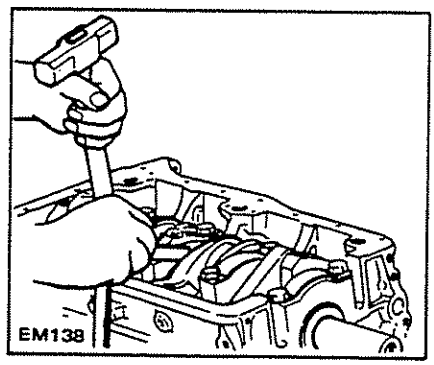
Measuring Crankshaft for Bending

Note: When measuring bend, use a dial gauge. Bend value is half of the reading obtained when crankshaft is turned one full revolution with a dial gauge attached to its center journal.

	Correct to within mm (in)	Service (bend) limit mm (in)
Crankshaft bend	0.02 (0.0008)	0.05 (0.0020)

MEASURING END PLAY

With the crankshaft installed in place and the bearing caps tightened, check end play at the center bearing. If the clearance exceeds the limit, replace the center bearing with a new one.



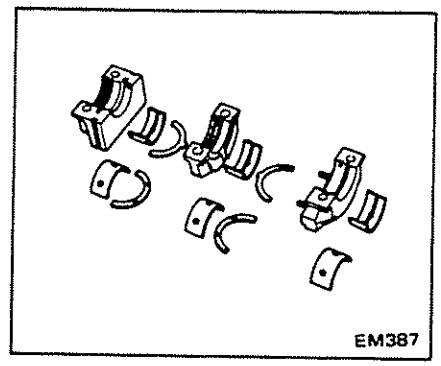
Checking End Play

		Standard	Limit
End play	mm (in)	0.05 to 0.18 (0.0020 to 0.0071)	0.2 (0.0079)

MAIN BEARING SHELLS

INSPECTING BEARING SURFACES

The upper and lower bearing are matched for the front, rear and center bearings and should not be interchanged (mixed). (The upper bearing shell for the rear bearing, for example, should not be used with the lower bearing shell for the front bearing). Make sure that the bearings are not scarred or scratched (due to entry of dirt or other abrasive matter) and that there is no sign of metal fatigue, peeling, or binding. Replace both upper and lower bearing shells as a set, if faulty.



Main Bearing Caps and Bearings

Measuring lubrication (oil) clearance

1. Measure lubrication (oil) clearance with a width gauge (plastigage). For applicable instructions, refer to paragraph on lubrication (oil) clearance measurement for connecting rod bushings.

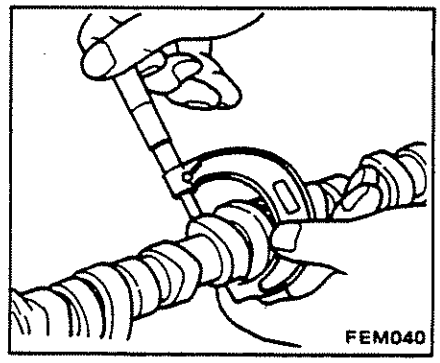
Ⓣ Tightening torque:
Bearing cap
83 to 93 N·m
(8.5 to 9.5 kg-m,
61 to 69 ft-lb)

2. If lubrication (oil) clearance exceeds prescribed limit, select an appropriate replacement part from service parts, checking crank-journal diameter.

	Correct to within	Service (clearance) limit
Main bearing lubrication (oil) clearance mm (in)	0.02 to 0.062 (0.0008 to 0.0024)	0.1 (0.0039)

Main bearing bushing specifications

Undersize mm (in)	Crank journal dia. mm (in)
0.25 (0.0098)	62.692 to 62.705 (2.4682 to 2.4687)
0.50 (0.0197)	62.422 to 62.455 (2.4576 to 2.4589)
0.75 (0.0295)	62.192 to 62.205 (2.4485 to 2.4490)
1.00 (0.0394)	61.942 to 61.955 (2.4387 to 2.4392)

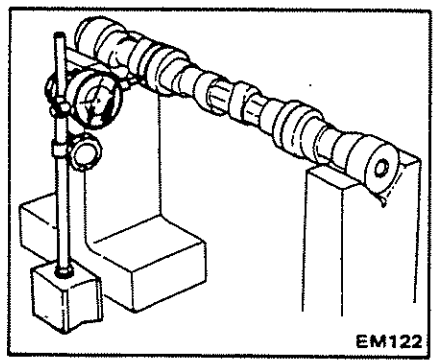


Inspecting Cam Surface

CAMSHAFT

CHECKING CAMSHAFT FOR BENDING

Measure the camshaft for bending and, if beyond prescribed bend limit, correct with a press or replace with a new camshaft. For measurement, support the camshaft on V-blocks at each end, as shown in Fig. EM-53 (1/2 of the maximum value shown on the dial gauge is the amount of bend).

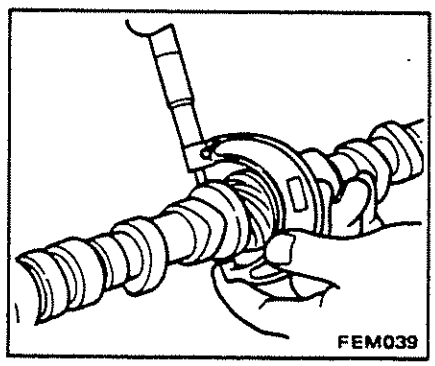


Measuring Camshaft Bending

	Correct to within	Service (bend) limit
Camshaft bending mm (in)	0.02 (0.0008)	0.05 (0.0020)

INSPECTING CAMSHAFT JOURNALS

Check the camshaft journals for damage, eccentric wear, etc. and correct or replace, as required. (Measure with a micrometer) If excessively worn beyond service limit, grind to prescribed undersize.



Inspecting Camshaft Journal

	Correct to within	Service (out-of-round/taper) limit
Degree of taper or out-of-round (eccentricity) of camshaft journals mm (in)	0.01 (0.0004)	0.03 (0.0012)
Journal wear mm (in)		0.05 (0.0020)

INSPECTING CAM SURFACES

Inspect the cam surfaces. If the cam surfaces are excessively damaged or if cam height has been reduced (worn) by 0.25 mm (0.0098 in) or more.

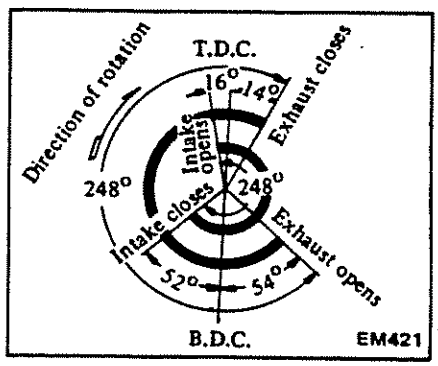
Camshaft lobe lift:
36.750 to 36.800 mm
(1.4468 to 1.4488 in)

INSPECTING DRIVE GEAR

Inspect the distributor and oil pump drive gear. If excessively worn or damaged, replace the gear or camshaft with a new one.

VALVE TIMING

This diagram applies to all cylinders. If any valve is found out of specifications, one possibility is that the cam lobe is worn or damaged. This calls for replacement of the camshaft.



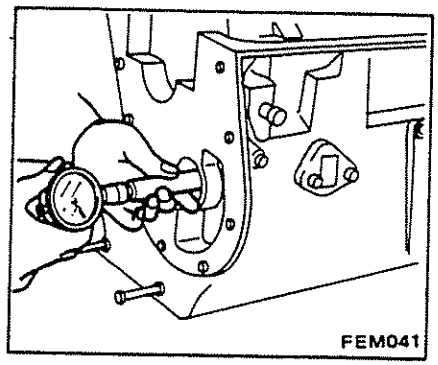
CAM BUSHING

Inspecting cam bushing

Inspect the cam bushing for binding, fusing, peeling, proper contact, etc., and if faulty, select a suitable replacement from the service parts and replace the bushing.

Measuring lubrication (oil) clearance

Measure the inside diameter of each bushing with a bore gauge. If lubrication (oil) clearance exceeds the prescribed limit, replace the bushing.



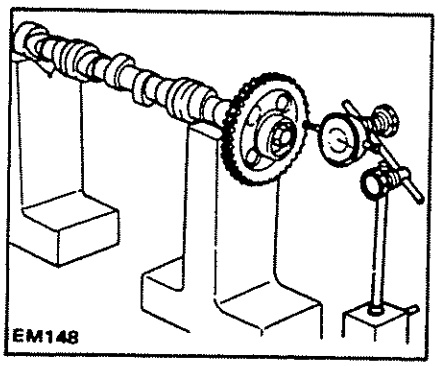
Measuring Bushing I.D.

		Correct to within	Service (clearance) limit
Lubrication (oil) clearance mm (in)	Front & rear	0.025 to 0.051 (0.0010 to 0.0020)	0.1 (0.0039)
	Center	0.038 to 0.062 (0.0015 to 0.0024)	0.15 (0.0059)

TIMING SPROCKET

Inspecting cam gear for runout

With the camshaft and camshaft sprocket placed on the V-block, measure camshaft sprocket runout, and correct or replace the cam gear if runout exceeds 0.1 mm (0.0039 in). Also, inspect the sprocket for broken or damaged teeth and for wear or damage on the boss surface. If excessively worn or damaged, replace with a new gear.



Checking Camshaft Sprocket Runout

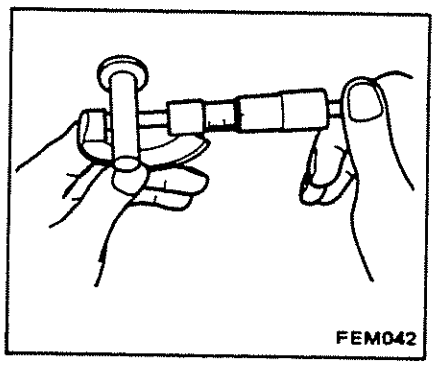
FRONT COVER AND HYDRAULIC PUMP CHAIN COVER

Inspect the installation (mating) surface and oil seal. If damaged or faulty, correct or replace as required.

VALVE ROCKER MECHANISM

VALVE LIFTERS

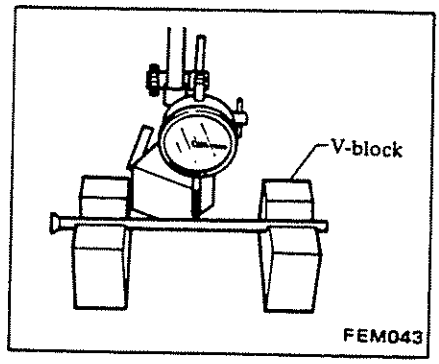
Inspect the periphery of the valve lifter and the cam contact surface. Replace the valve lifter if excessively worn, damaged or fused. Also check fit in the cylinder block and replace if fit is not proper. Fit should be such that the lifter, with oil applied, lowers slowly and naturally in the hole in the cylinder block.



Measuring Diameter of Valve Lifter

		Correct to within	Service limit
Fit (clearance) of valve lifter and cylinder block hole	mm (in)	0.016 to 0.052 (0.0006 to 0.0020)	0.1 (0.0039)

PUSH RODS



Measuring Push Rod Bending

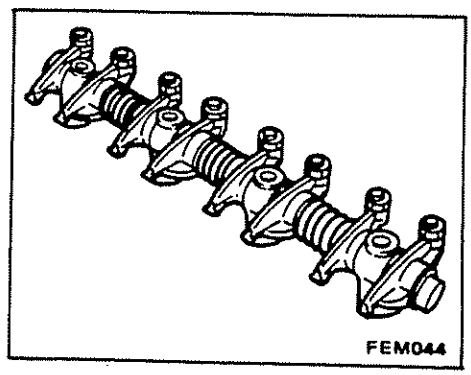
Inspect the push rods. If excessively worn, twisted, or damaged, replace with a new push rod. If bent by more than 0.05 mm (0.0020 in), correct or replace.

ROCKER SHAFT

Inspect the rocker shaft for wear, damage, bending, etc. Replace if worn by more than 0.05 mm (0.0020 in).

ROCKER ARM AND ADJUSTING BOLT

Inspect the portion of the rocker arm and adjusting bolt contacting the valve stem and check for fit with the rocker shaft. If excessively worn or scarred, or if rocker shaft clearance exceeds the prescribed limit, replace the rocker arm (and adjusting bolt) with a new one.



Valve Rocker Shaft Assembly

	Correct to within	Service limit
Rocker arm/shaft clearance mm (in)	0.020 to 0.054 (0.0008 to 0.0021)	0.1 (0.004)

DRIVING PLATE, RING GEAR AND FLYWHEEL

Inspect driving plate disc or flywheel contact surface and ring gear teeth. If excessively damaged or worn, repair or replace as required. On flywheel, if ring gear teeth are only slightly worn or damaged, ring gear can be reused by changing the installation setting to flywheel by 45°.

For replacement, heat the ring gear to 180°C (356°F) and install by shrinkage-fitting.

MEASURING RUNOUT

Measure runout with a dial gauge while turning crankshaft. If it exceeds specified limits, replace parts.

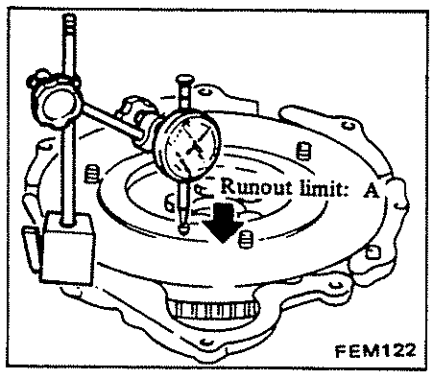
1. Flywheel

Runout limit:

A:

Less than 0.1 mm (0.004 in)

Runout limit A is max. allowable runout of flywheel, as measured perpendicularly with respect to clutch surface mating with flywheel.



Measuring Flywheel

2. Driving plate

Fig. FEM123 shows points at which runout limit for driving plate is to be measured.

Driving plate has concave and convex surfaces. When measured on concave surface, true runout cannot be obtained. To obtain correct runout, attach a dial gauge to a level surface or measure variations at most convex surface with a dial gauge while rotating driving plate. In other words, when determining ring gear roundness, measure variations at tooth tops.

Runout limit:

B: 0.5 mm (0.020 in)

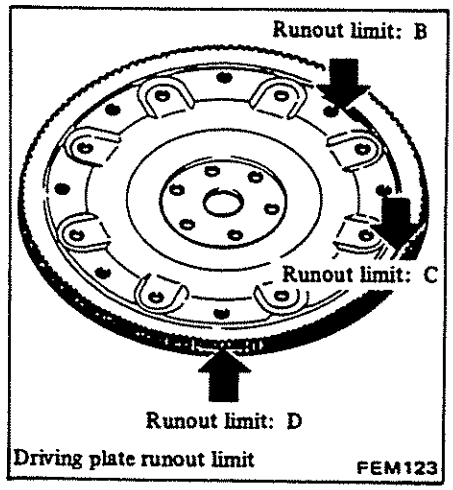
C: 0.3 mm (0.012 in)

D: 0.2 mm (0.008 in)

a. Runout limit B is max. allowable runout of driving plate, as measured in the same direction as for its shaft.

b. Runout limit C is max. allowable runout of ring gear when measured in the same direction as for driving plate.

c. Runout limit D is used to measure roundness of rotating ring gear.



ENGINE ASSEMBLY

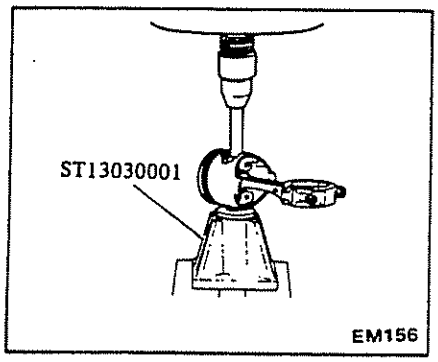
PRECAUTIONS

1. Thoroughly clean all components and make sure that all oil passages are clear to prevent clogging.
2. Properly lubricate all sliding or rotary parts such as bushings, etc. with engine oil.
3. As a general rule, new packing, oil seals, gaskets, etc. should be applied at time of reassembly.
4. Apply sealant to portions where there is leakage and/or sealant was used before disassembly to prevent water and oil from leaking.
5. Make sure that tools, work tables, etc. are clean and free from dirt, grime and oil.
6. Provide all parts and tools required for assembly and place them in close proximity to work area wherever possible.
7. Carefully observe prescribed tightening torques and tightening sequence where applicable.
8. Make sure that all components are properly matched by cylinder and are applied according to proper cylinder.

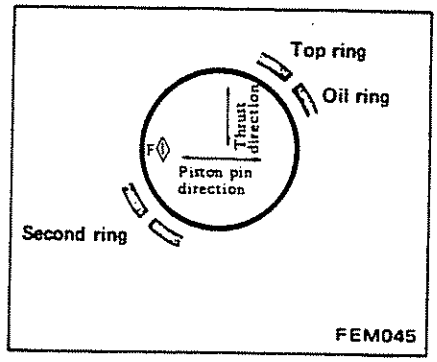
PISTON AND CONNECTING RODS

ASSEMBLY

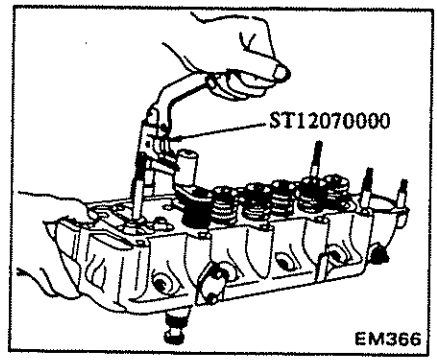
Assemble pistons, piston pins and connecting rods on the designated cylinder.



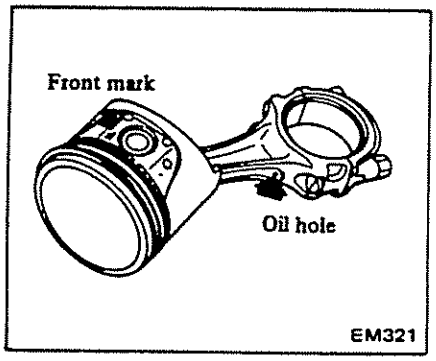
Installing Piston Pin



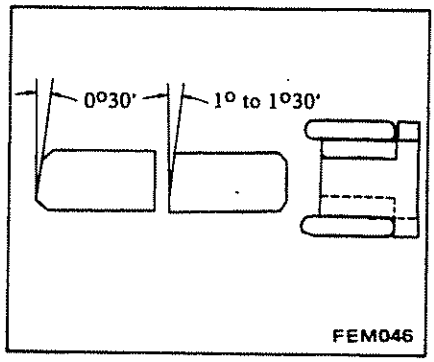
Correct Piston Ring Position on Piston



Installing Valve Springs



Assembling Piston and Connecting Rod



Section View of Piston Rings

Note:

a. **Piston is pressed into connecting rod, with fitting force of 0.5 to 1.5 tons (1,000 to 3,000 lb); aid of Piston Pin Press Stand ST13030001 is necessary.**
   When pressing piston pin into connecting rod, apply engine oil to pin and small end of connecting rod.
b. **Arrange so that oil jet of connecting rod big end is directed toward right side of cylinder block.**
c. **Be sure to install piston in cylinders with front mark of piston head toward front of engine.**
d. **Arrange connecting rods and caps so that cylinder numbers face in same direction.**

INSTALLING PISTON RINGS

1. Make sure that top, second, and oil rings are placed in proper positions and are not interchanged. Reassemble oil ring, second ring, and top ring in that order.
2. Install rings with piston ring notch facing up.

ASSEMBLING OF ENGINE

INSTALLING VALVES AND VALVE SPRINGS

Use Valve Lifter ST12070000, to install intake and exhaust valves, valve springs, valve spring retainers, valve collets and rubber rings to cylinder head in the order listed.

Note:

a. **Do not interchange valves between cylinders, for their sliding or seating surfaces have undergone wearing-in or have been lapped at assembly, forming specific contact with their mating parts.**
b. **Check to be sure that valves are properly seated on valve seats without foreign particles stuck in between.**

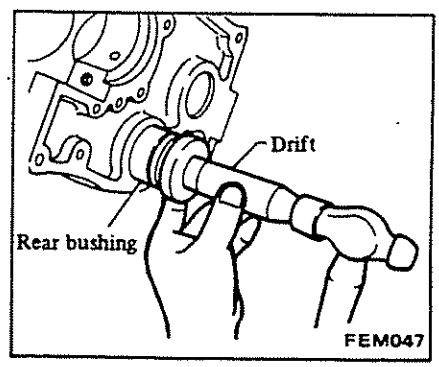
INSTALLING VALVE ROCKER SHAFT

Install the bracket and inner spring on the valve rocker shaft. The shaft has four installation bolt holes. Face the side with the larger hole (which also serves as a lubrication hole) to the front. Install the lock washer, spacer, and cotter pin in that sequence to both ends of the rocker arms.

INSTALLING CAM BUSHINGS

1. Installing center bushing

Face notch toward distributor drive side (downward) match block and jig caulking hole and tap on bushing.



Installing Rear Bushing

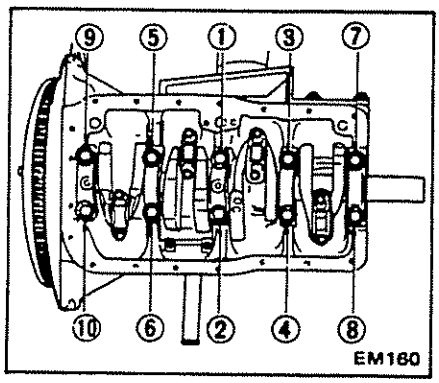
2. Installing rear bushing

Face arrow mark on end of bushing upward. Align oil hole with oil hole in cylinder block and tap rear bushing into position, as shown in figure. Diameter of bushing is slightly larger toward rear and bushing is press fit in block.

INSTALLING CRANKSHAFT

Install the crankshaft bearing caps with spring washers and bolts, and tighten the bolts.

1. Install seals to both sides of rear crankshaft bearing cap. Face wire backed (hard) side of seal toward cap.



Torque Sequence of Main Bearing Cap Bolts

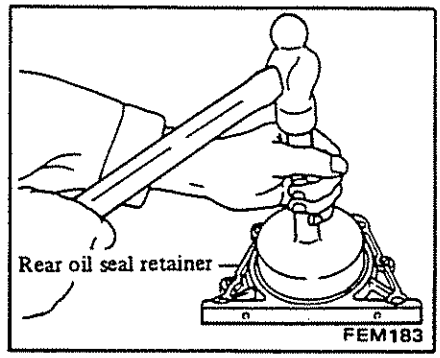
2. Install front and rear caps with their arrow marks to front.
3. Move crankshaft in an axial (shaft) direction so that center bearing cap is properly aligned and then tighten crankshaft bearing caps with prescribed tightening torque.
4. Do not tighten caps all at once. Tighten them in 3 or 4 stages beginning from inside to out (repeating tightening sequence 3 or 4 times until completely tightened to prescribed tightening torque).
5. After tightening caps, check crankshaft to make sure that it turns freely.

Cranking (crankshaft turning torque should be 15 N·m (1.5 kg-m, 11 ft-lb) or less.

Ⓣ Tightening torque:
Main bearing cap
83 to 93 N·m
(8.5 to 9.5 kg-m,
61 to 69 ft-lb)

INSTALLING REAR OIL SEAL RETAINER

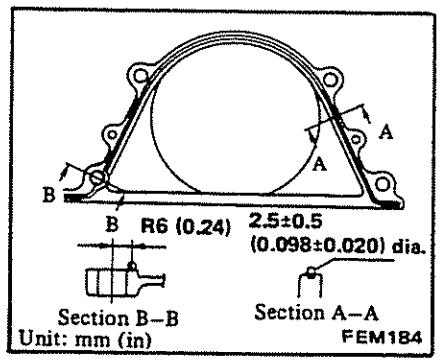
1. Using special tool (KV10105500), install oil seal into rear oil seal retainer.

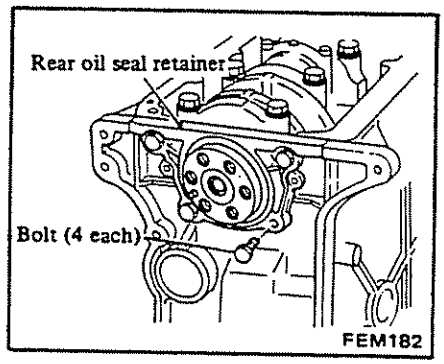


2. Install rear oil seal retainer on cylinder block using bolts.

Ⓣ Bolt tightening torque:
16 - 19 N·m
(1.6 - 1.9 kg-m, 12 - 14 ft-lb)

Apply a coat of liquid packing to retainer before installation.

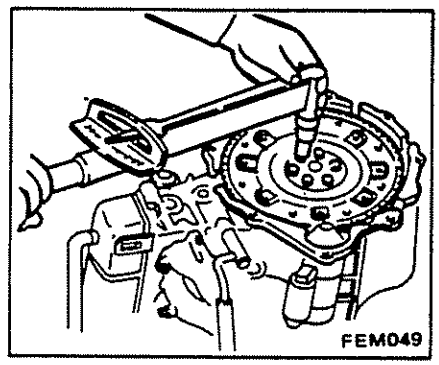




INSTALLING DRIVING PLATE AND FLYWHEEL

1. Install flywheel housing.
2. Install driving plate or flywheel with bolts and lock plates, and bend lock plates from outside for safety lock.

Ⓣ Tightening torque:
Flywheel housing
43 to 58 N·m
(4.4 to 5.9 kg-m,
32 to 43 ft-lb)



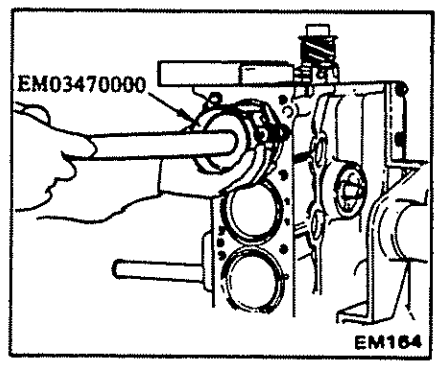
Installing Driving Plate

Tighten crank nuts.

Ⓣ Tightening torque:
Flywheel or driving plate
132 to 142 N·m
(13.5 to 14.5 kg-m,
98 to 105 ft-lb)

INSTALLING PISTONS

1. Install bushing in connecting rods.
2. Install piston and connecting rod assembly in cylinder corresponding to cylinder number marked on side of connecting rod.



Installing Piston and Connecting Rod Assembly

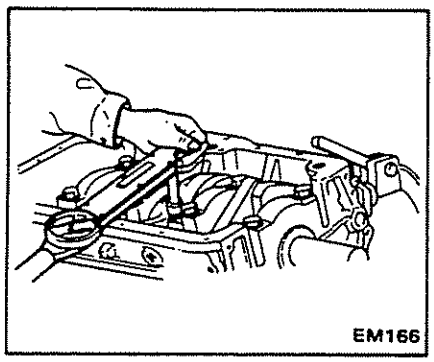
3. Install piston with "F" mark (on piston head) to front.
4. Set crankshaft pins to top and bottom dead center position.

5. Position piston rings so that end gaps are offset (alternately for adjacent rings) by 180° and so that none of end gaps is aligned in piston thrust direction.
6. Install piston and connecting rod assembly (without cap) from top.

INSTALLING CONNECTING ROD CAPS

Install the connecting rod cap so that the cap and connecting rod cylinder number markings are aligned (on the same side).

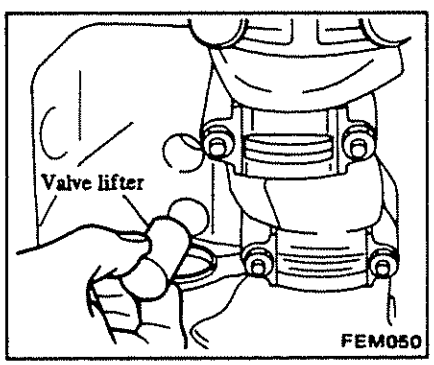
Ⓣ Tightening torque:
Connecting rod caps
31 to 37 N·m
(3.2 to 3.8 kg-m,
23 to 27 ft-lb)



Tightening Connecting Rod Bearing Caps

INSTALLING VALVE LIFTERS

Make sure that the valve lifters are installed in proper direction. Apply oil to the holes in the cylinder block and lightly press the valve lifters into the holes by hand. Apply Herme seal and install the front plate and packing.



Insert Valve Lifter

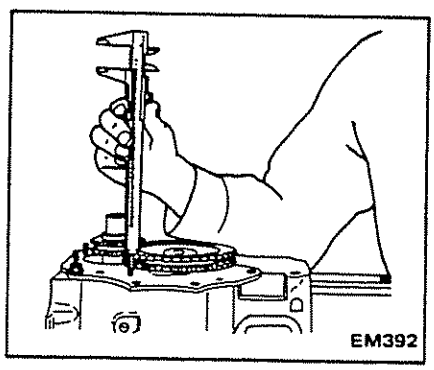
INSTALLING CAMSHAFT

1. Install the camshaft in place, taking care not to damage the bearing bushings.
2. Tighten the bolts attaching the camshaft locating plate to the cylinder block to the specified torque.

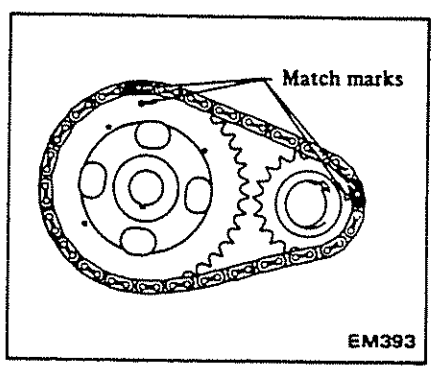
Ⓣ Tightening torque:
Camshaft locating plate to cylinder block bolts
6 to 8 N·m
(0.6 to 0.8 kg-m,
4.3 to 5.8 ft-lb)

Temporarily install the camshaft and crankshaft sprockets in place, and adjust the position of both gears, using washers, so that they are in line with an error of within 0.2 mm (0.008 in). Align the marks on the gears and timing chain, and install them to the engine and tighten the camshaft sprocket securing bolt.

Ⓣ Tightening torque:
Camshaft sprocket securing bolt
29 to 39 N·m
(3.0 to 4.0 kg-m,
22 to 29 ft-lb)



Checking Alignment of Gears

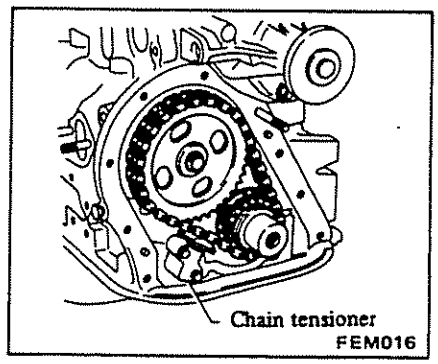


Installing Timing Gears and Chain

INSTALLING TIMING CHAIN TENSIONER

Install the chain tensioner, lock washers and tighten the bolts to the specified torque and bend the tongue of washers to lock the bolts.

Ⓣ Tightening torque:
Chain tensioner
6 to 8 N·m
(0.6 to 0.8 kg-m,
4.3 to 5.8 ft-lb)



Installing Chain Tensioner

INSTALLING FRONT COVER

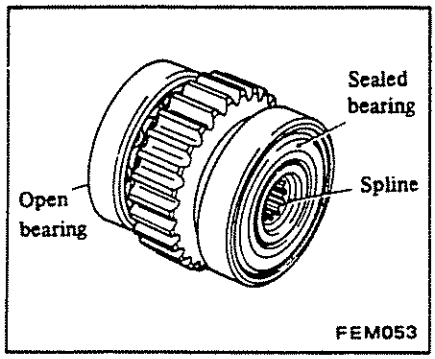
1. Install oil seal on front cover.
2. Using front oil seal drift (ST1524S000), drive oil seal into place.
3. Apply lithium grease to the lip of the oil seal.

INSTALLING COVER, SPROCKETS AND CHAIN FOR HYDRAULIC OIL PUMP

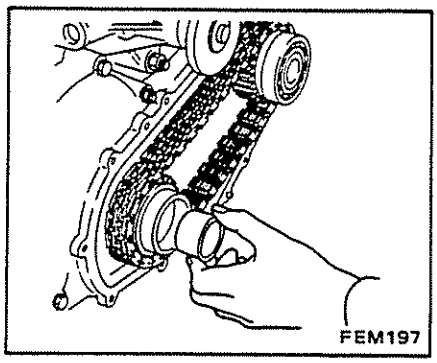
1. Press bearing into sprocket on pump side. Bearings come in two types, a one-side shielding type and an open type (not shielded on either side).

Make sure that shielding type bearing is installed in sprocket on pump side with shielding face toward sprocket splines.

CAUTION:
Note installation direction of bearing.

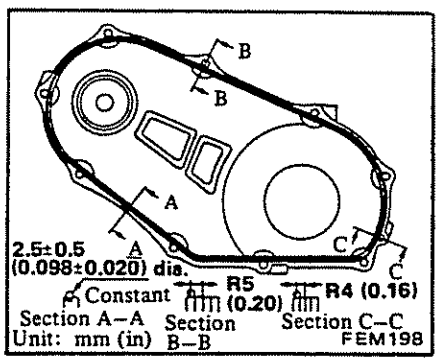


2. Install chain on sprocket, oil pump and crankshaft pulleys.
3. Attach key to crankshaft, and then drive a wedge into clearance between crankshaft and its sprocket. Temporarily tighten crankshaft bolt to secure wedge in place, and then remove bolts.



4. Install hydraulic oil pump chain cover with gasket in place.

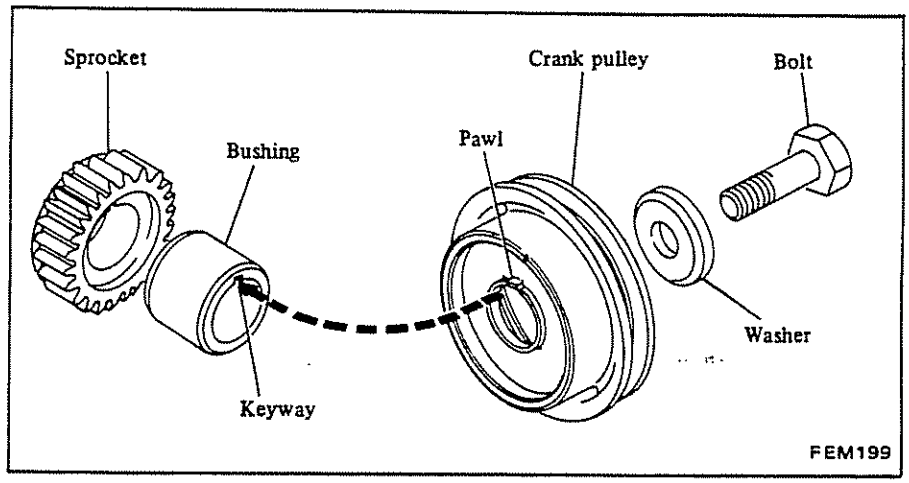
Apply liquid packing to front cover before installation.



INSTALLING CRANK PULLEY

Align the pulley key slot with the key on the crankshaft, fit the pulley, and secure the crank pulley bolt.

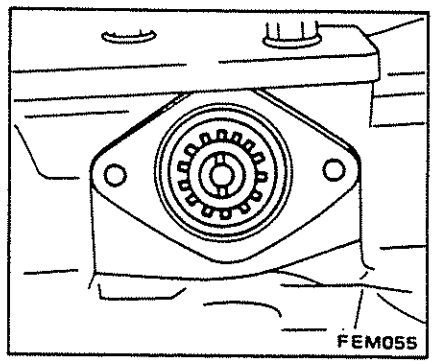
Ⓣ Tightening torque:
Crank pulley bolt
142 to 152 N·m
(14.5 to 15.5 kg-m,
105 to 112 ft-lb)



INSTALLING OIL PUMP

The distributor is driven by the oil pump through the oil pump pinion. Ignition timing is changed according to the installing direction of the gear.
1. Turn oil pump so that narrow portion on top of drive pinion gear faces to front when No. 1 cylinder is set to compression top dead center (TDC) position and align oil pump with set bolt position.

Install oil pan end first.



Drive Gear Position

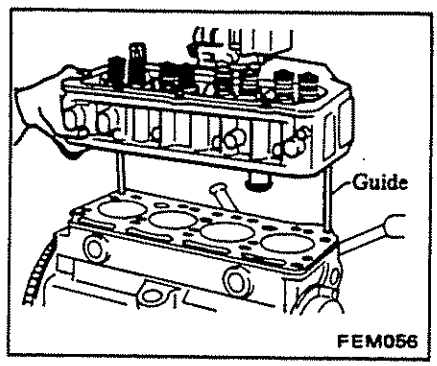
2. Apply Herme seal to set bolt and install it in hole in pump body and tighten bolt securely and lock with lock nut.
3. Install oil pan with oil pan gasket.

Ⓣ Tightening torque:
Oil pan
6.4 to 7.5 N·m
(0.65 to 0.76 kg-m,
4.7 to 5.5 ft-lb)

Drain plug
20 to 39 N·m
(2.0 to 4.0 kg-m,
14 to 29 ft-lb)

INSTALLING CYLINDER HEAD

1. Install guide bolts on both sides of cylinder block.
2. Install cylinder head new gasket.
3. Place cylinder head over guide bolts, and install cylinder head on cylinder block.

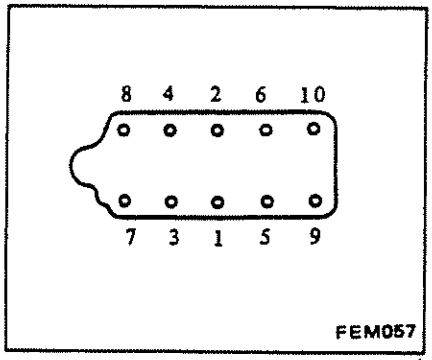


Installing Cylinder Head

4. Install cylinder head bolts, tighten them in sequence shown below (tighten alternately and evenly, gradually tightening in 3 or 4 stages) and finally tighten them to prescribed tightening torque.

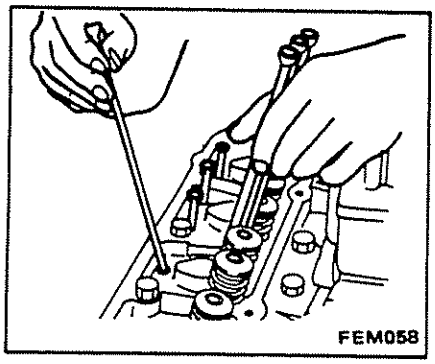
Ⓣ Temporary tightening torque:
Cylinder head bolts
64 N·m (6.5 kg-m, 47 ft-lb)

Ⓣ **Tightening torque:**
Cylinder head bolts
74 to 83 N·m
(7.5 to 8.5 kg-m,
54 to 61 ft-lb)



Tightening Sequence of Cylinder Head Bolts

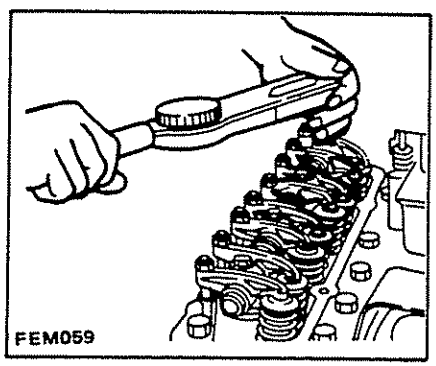
5. Install push rods.



Inserting Push Rods

INSTALLING ROCKER SHAFT ASSEMBLY

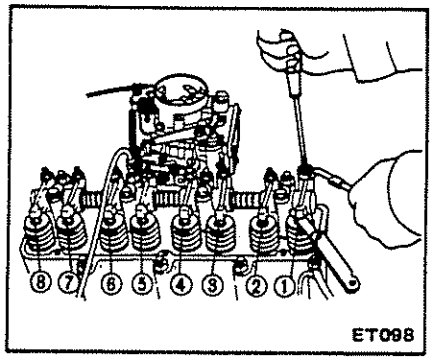
1. Tighten rocker shaft assembly in same manner as cylinder head (viz: gradually tightening alternately and evenly in 3 or 4 stages from center to outside).



Securing Rocker Shaft

Ⓣ **Tightening torque:**
Rocker shaft
49 to 59 N·m
(5.0 to 6.0 kg-m,
36 to 43 ft-lb)

2. Adjust valve clearance to standard value (at normal temperature - with engine cool).



Adjusting Valve-Tappet Clearance

	Model H15, H20-II, H25
Intake valve clearance (hot)	0.38 mm (0.015 in)
Exhaust valve clearance (hot)	0.38 mm (0.015 in)

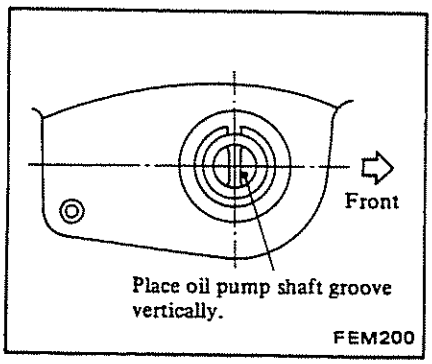
3. Install rocker cover.

INSTALLING ENGINE ACCESSORY

Install oil pressure switch.

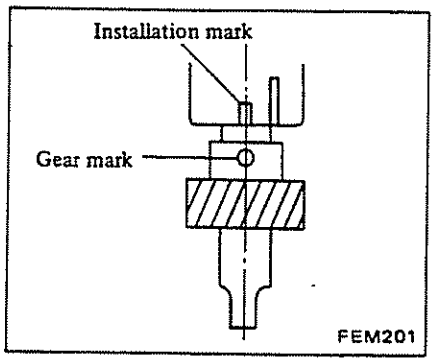
INSTALLING DISTRIBUTOR

1. Exercising care so as not to twist O-ring, match projected part of distributor drive shaft to recess in oil pump drive gear.



2. Align distributor gear mark with short mark on housing.

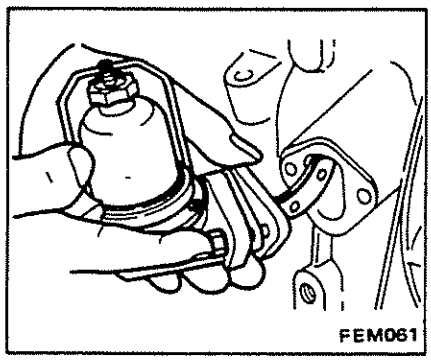
Do not align with long mark or gear mounting pin.



3. Match support and block holes and temporarily secure with bolts.

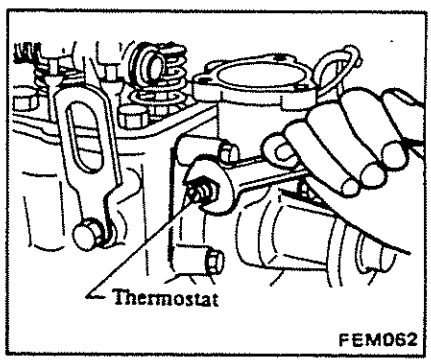
OTHER PARTS

1. Install fuel pump and fuel line.
2. Install oil filter assembly.



Installing Fuel Pump

3. Install oil level gauge.



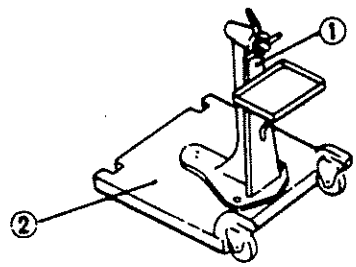
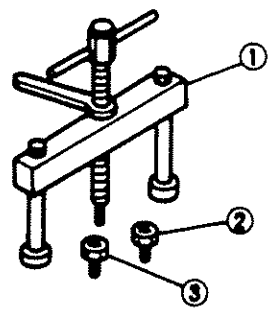
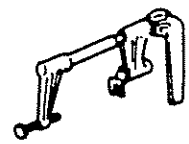
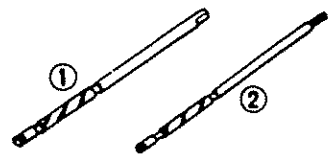
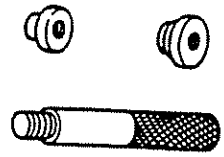
Installing Thermostat

4. Install thermostat.
5. Connect governor rod and spring to carburetor throttle lever.
6. Install spark plugs.

Ⓣ Tightening torque:
Spark plug
18 to 24 N·m
(1.8 to 2.4 kg-m,
13 to 17 ft-lb)

7. Install distributor control advance tube and high tension code.
8. Dismount engine from support (engine stand).
9. Install left engine mounting bracket and insulator.
10. Install right engine mounting bracket and insulator.
11. Install adjusting bar and alternator.
12. Install fan belt and fan blade.
13. Adjust governor and fan belts, and tighten adjusting bolts.
14. Install air cleaner.

SPECIAL SERVICE TOOLS

Tool number	Tool name
ST05240001	Engine attachment 
ST0501S000 ① ST05011000 ② ST05012000	Engine stand assembly Engine stand Base 
KV101041S0 ① KV10104110 ② ST16512001 ③ ST16701001	Crankshaft main bearing cap puller Crankshaft main bearing puller Adapter Adapter 
ST12070000	Valve lifter 
ST1102S000 ① ST11021000 ② ST11022000	Valve guide reamer set Valve guide reamer 8.90 mm (0.3504 in) Valve guide reamer 9.10 mm (0.3583 in) 
KV10102600	Valve seat cutter 
ST1524S000 KV10105500 ST15243000	Front oil seal drift Rear oil seal drift Drift rod 

ENGINE LUBRICATION & COOLING SYSTEMS (LC)

—H15/H20-II/H25 ENGINE—

CONTENTS

SERVICE DATA AND SPECIFICATIONS

ENGINE LUBRICATION SYSTEM

GENERAL SPECIFICATIONS

Lubrication method	Pressed feed flow
Oil pump	Spur gear type
Oil filter	Full flow and cartridge type

INSPECTION AND ADJUSTMENT

Oil pump

Unit: mm (in)

Pump gear to pump body clearance	Less than 0.40 (0.0157)
Pump gear backlash	Less than 0.50 (0.0197)
Pump gear vertical clearance	Less than 0.30 (0.0118)

TIGHTENING TORQUE

	N-m	kg-m	ft-lb
Oil pump mounting bolt	21 - 34	2.1 - 3.5	15 - 25
Oil pump cover bolt	7 - 9	0.7 - 0.9	5.1 - 6.5
Oil pan bolt	6.4 - 7.5	0.65 - 0.76	4.7 - 5.5
Oil pan drain plug	20 - 39	2.0 - 4.0	14 - 29

ENGINE COOLING SYSTEM

GENERAL SPECIFICATIONS

Cooling method	Water-cooled, forced circulation
Water pump	Centrifugal type
Thermostat	Wax-pellet type

INSPECTION AND ADJUSTMENT

Radiator

Unit: kPa (bar, kg/cm^2, psi)

Cap relief pressure	88 (0.88, 0.9, 13)
Leakage test pressure	157 (1.57, 1.6, 23)

Thermostat

	Frigid type	Standard type
Valve opening temperature °C (°F)	88 (190)	82 (180)
Max. valve lift mm/°C (in/°F)	8/100 (0.31/212)	8/95 (0.31/203)

Water pump

Fan belt deflection mm/N (kg), (in/lb)	11 - 13/98 (10), (0.43 - 0.51/22)

TIGHTENING TORQUE

	N-m	kg-m	ft-lb
Water pump bolt	20 - 25	2.0 - 2.5	14 - 18
Water outlet bolt	14 - 21	1.4 - 2.1	10 - 15

TROUBLE DIAGNOSES AND CORRECTIONS

ENGINE LUBRICATION SYSTEM

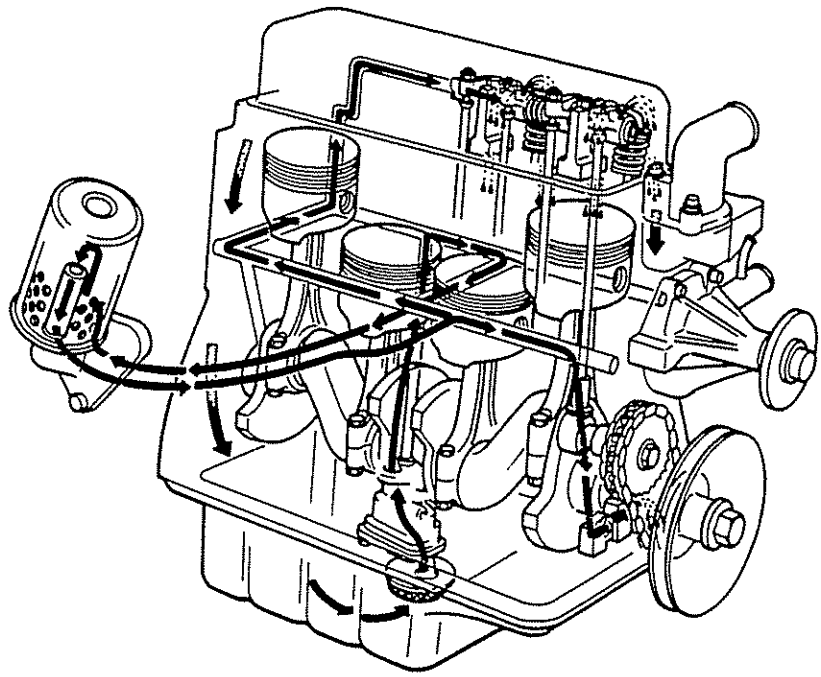
Condition	Probable cause	Corrective action
Oil leakage	Damaged or cracked pump body cover.	Replace.
	Oil leakage from gasket and oil seal.	Replace.
	Oil leakage from regulator valve.	Tighten or replace.
	Oil leakage from blind plug.	Replace.
Decreased oil pressure	Lack of oil in engine oil pan.	Correct.
	Dirty oil strainer.	Clean or replace.
	Damaged or worn pump rotors.	Replace.
	Malfunctioning regulator.	Replace.
	Use of poor quality engine oil.	Replace.
Warning light remains "on"- engine running	Decreased oil pressure.	Previously mentioned.
	Oil pressure switch unserviceable.	Replace.
	Electrical fault.	Check circuit.
Noise	Excessive backlash in pump rotors.	Replace.

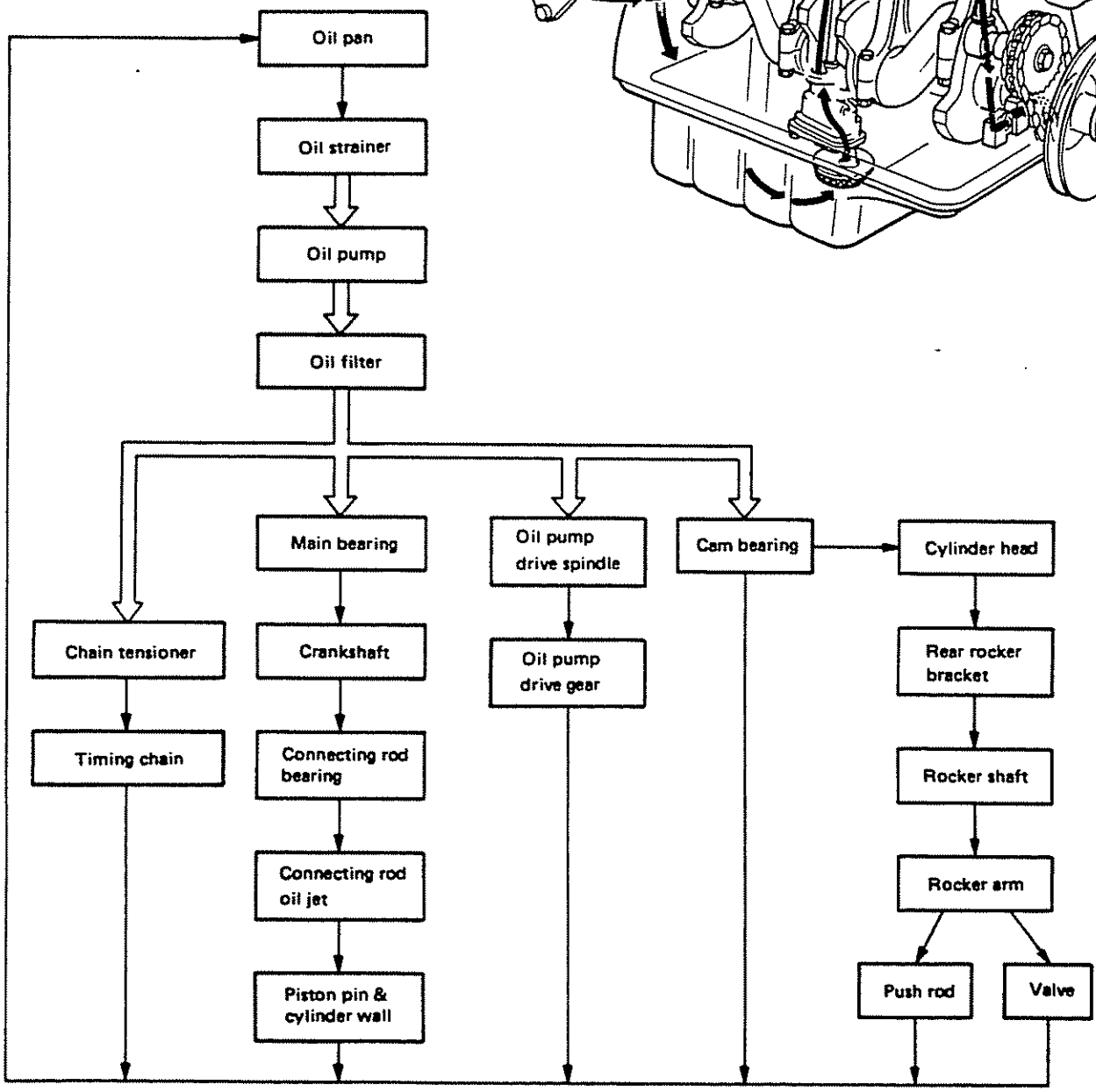
ENGINE COOLING SYSTEM

Condition	Probable cause	Corrective action
Water leakage	Damaged radiator seams.	Repair.
	Water leakage from water pump shaft seal.	Replace as pump assembly.
	Water leakage from water temperature gauge.	Tighten.
	Loose joints.	Tighten.
	Damaged cylinder head gasket.	Replace. Check engine oil for contamination.
	Cracked cylinder block.	Replace. Check engine oil in crankcase for mixing with water by pulling oil level gauge.
	Cracked cylinder head.	Replace.
	Loose cylinder head bolts.	Tighten.
Poor circulation	Restriction in system.	Check hoses for crimps, and clear the system of rust and sludge by flushing radiator.
	Insufficient coolant.	Replenish.
	Inoperative water pump.	Replace.
	Loose fan belt.	Adjust.
	Inoperative thermostat.	Replace.
Corrosion	Excessive impurity in water.	Use soft, clean water. (rain water is satisfactory).
	Infrequent flushing and draining of system.	Cooling system should be drained and flushed thoroughly. Refer to ET section.
Overheating	Faulty thermostat.	Replace.
	Radiator fin choked with mud, chaff, etc.	Clean out air passage thoroughly by using air compressed air.
	Incorrect ignition and valve timing.	Adjust.
	Dirty oil and sludge in engine.	Flush engine and refill oil.
	Inoperative water pump.	Replace.
	Loose fan belt.	Adjust.
	Restricted radiator.	Flush radiator.
	Inaccurate temperature gauge.	Replace.
	Impurity in water.	Use soft, clean water.
Overcooling	Faulty thermostat.	Replace.
	Inaccurate temperature gauge.	Replace.
Noise	Squeak at water pump mechanical seal.	Use suitable water pump seal lubricant.
	Damaged or worn water pump bearing.	Replace as pump assembly.

ENGINE LUBRICATION SYSTEM

LUBRICATION CIRCUIT





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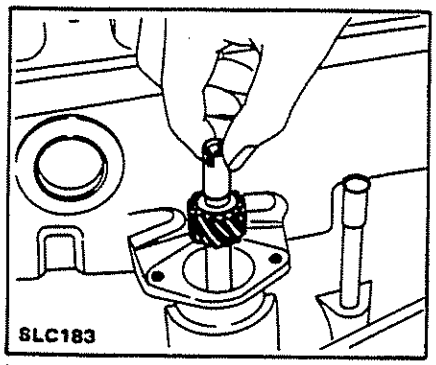
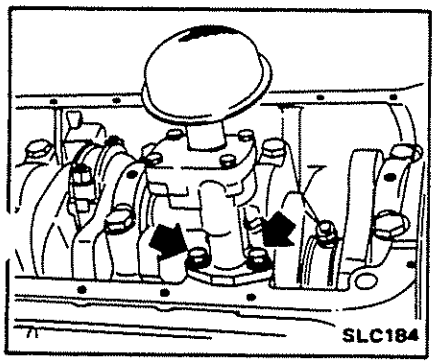
OIL PUMP

REMOVAL

1. Remove oil pan drain plug, and allow oil to drain.
2. Remove distributor and oil pump spindle.



3. Remove oil pan.
4. Remove oil pump body.

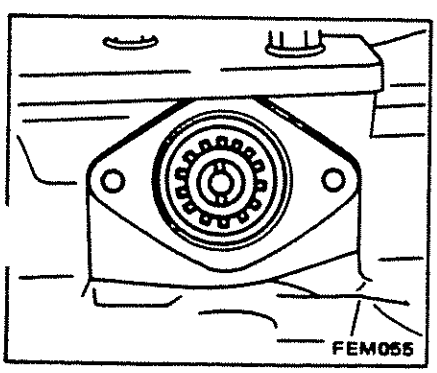


INSTALLATION

1. Before installing oil pump in engine, turn crankshaft so that No. 1 piston is at T.D.C.
2. Install oil pump on cylinder block.

Ⓣ : **Oil pump mounting bolts**
21 - 34 N·m
(2.1 - 3.5 kg-m,
15 - 25 ft-lb)

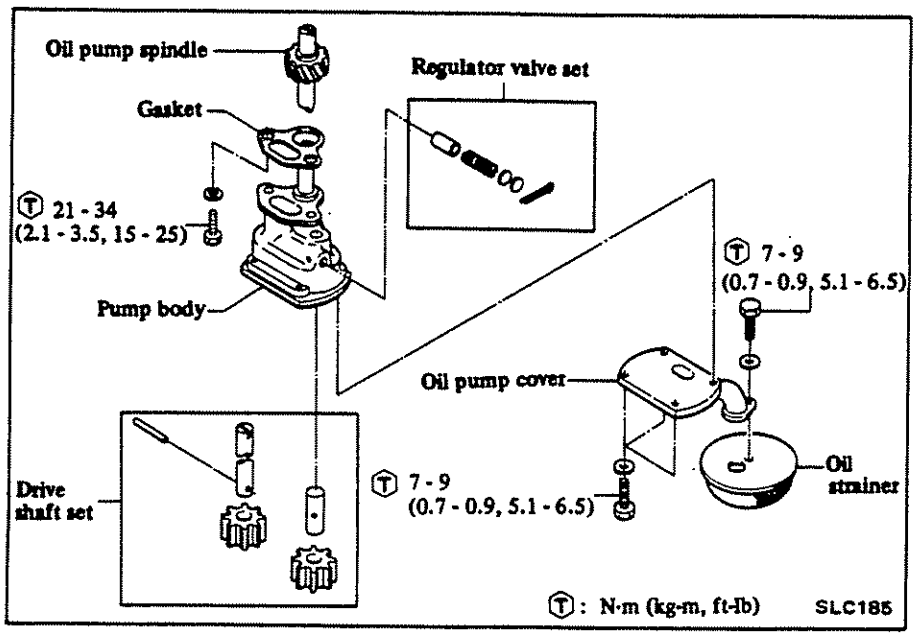
3. Install oil pump spindle as shown.



4. Install oil pan with oil pan gasket.

Ⓣ : **Oil pan bolt**
6.4 - 7.5 N·m
(0.65 - 0.76 kg-m,
4.7 - 5.5 ft-lb)

DISASSEMBLY AND ASSEMBLY



INSPECTION

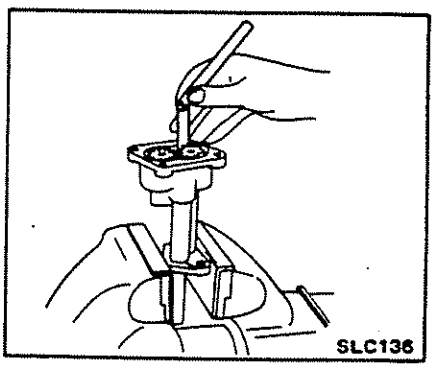
1. Inspect the following for wear or damage.
- Pump body and cover
- Pump gears
- Drive spindle

Pump gears and body are not serviced separately. If pump gears or body are damaged or worn, replace drive shaft set or entire oil pump assembly.

2. Using a feeler gauge, check the following clearance.

If it exceeds the limit, replace drive shaft set or entire oil pump assembly.

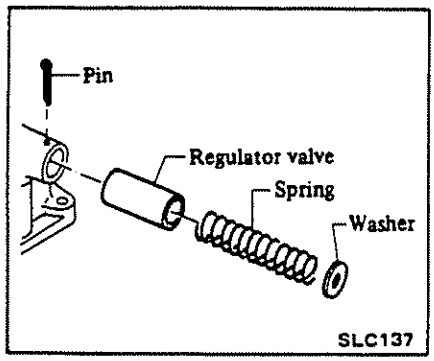
Pump gear to pump body:
Less than 0.40 mm (0.0157 in)



Pump gear backlash:
Less than 0.50 mm (0.0197 in)
Pump gear vertical clearance:
Less than 0.30 mm (0.0118 in)

3. Check oil pressure regulator valve spring.

If damaged, replace valve set or pump assembly.

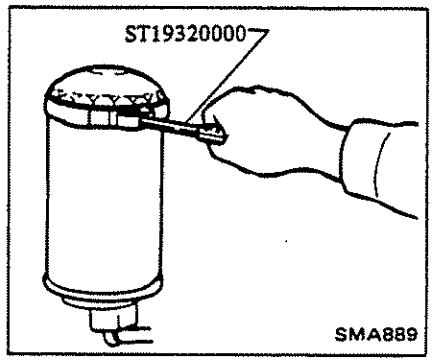


OIL FILTER

REPLACEMENT

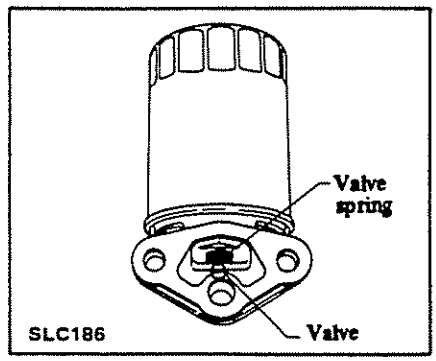
When removing oil filter, use Tool. When installing it, sparingly apply oil on oil seal and fasten it by hand.

Do not overtighten filter, or oil leakage may occur.



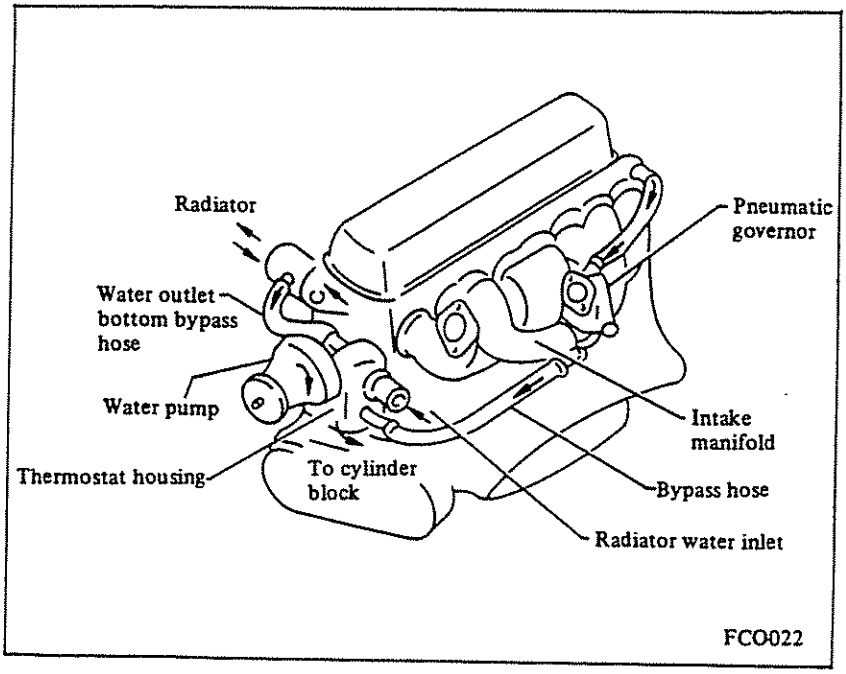
OIL PRESSURE RELIEF VALVE

With oil filter bracket removed, check valve for operation. Replace oil filter bracket assembly if necessary.



ENGINE COOLING SYSTEM

COOLING CIRCUIT



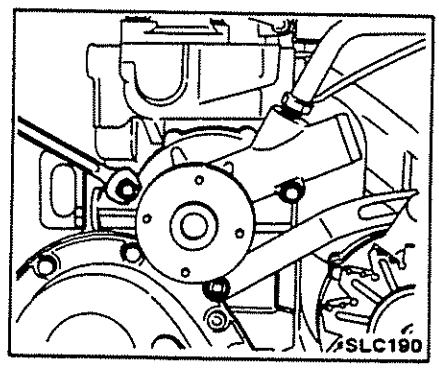
WATER PUMP

REMOVAL

1. Open radiator drain cock and allow coolant to drain into a suitable container.

⚠ WARNING:
To avoid the danger of being scalded, never attempt to drain the coolant when the engine is hot.

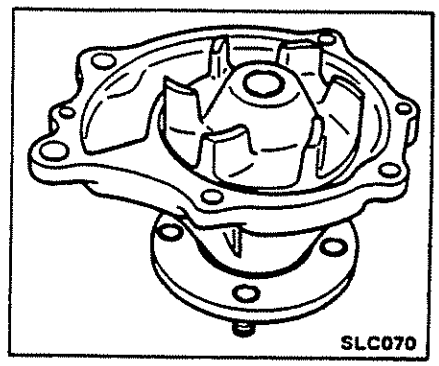
2. Remove radiator shroud.
3. Loosen fan belt.
(1) Loosen alternator securing bolts.
(2) Move alternator toward engine.
4. Remove fan, and fan pulley.
5. Remove water pump with gasket.



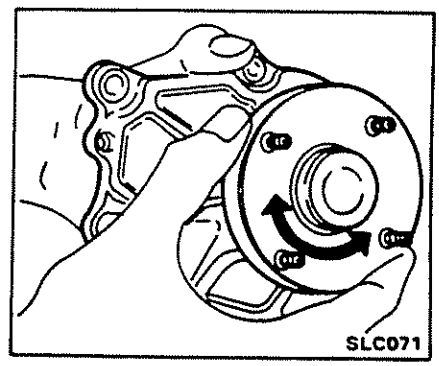
INSPECTION

The water pump cannot be disassembled and should be replaced as a unit for the best results.

1. Inspect water pump body and vane for rust or corrosion.



2. Check water pump bearing for excessive end play or rough operation.



INSTALLATION

1. Install water pump in the reverse order of removal.

Always use new gasket.

2. Adjust fan belt tension.

Fan belt deflection:
11 - 13 mm (0.43 - 0.51 in)
Pushing force:
98 N (10 kg, 22 lb)

3. Fill radiator with coolant.

For details, refer to Changing Engine Coolant in Section ET.

THERMOSTAT

REMOVAL

1. Drain a small amount of coolant partially and disconnect radiator upper hose at water outlet.

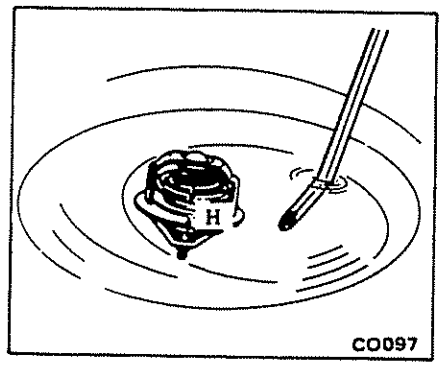
⚠ WARNING:
To avoid the danger of being scalded, never attempt to drain the coolant when the engine is hot.

2. Remove water outlet and then remove thermostat.

INSPECTION

Inspect thermostat for the following and replace if necessary.

1. Valve seating condition at ordinary temperature. It should seat tightly.
2. Valve opening temperature and maximum valve lift (Refer to S.D.S.).



3. Then check if valve closes at 5°C (9°F) below valve opening temperature.

It is necessary to check a new thermostat before installing it in engine.

INSTALLATION

Install thermostat in the reverse order of removal.

Always use new gasket.

RADIATOR

REMOVAL AND INSTALLATION

1. Drain coolant.

⚠ WARNING:
To avoid the danger of being scalded, never attempt to drain the coolant when the engine is hot.

2. Disconnect radiator upper and lower hoses.
3. Remove radiator shroud.
4. Remove radiator.
5. Install radiator in reverse sequence of removal and refill cooling system with coolant to specified level. (Refer to Section ET.)

INSPECTION

Inspect radiator cap relief pressure and water leakage using cap tester. (Refer to Section ET.)

ENGINE FUEL
(EF)

—H15/H20-II/H25 ENGINE—

CONTENTS

SERVICE DATA AND SPECIFICATIONS

FUEL PUMP

Fuel pump capacity mℓ (US fl oz, Imp fl oz)/minute at 1,000 rpm	More than 1,400 (47.3, 49.3)
Fuel pump pressure kPa (bar, kg/cm², psi)	16.7 - 23.5 (0.167 - 0.235, 0.17 - 0.24, 2.4 - 3.4)

CARBURETOR

Engine		H15	H20-II	H25
Carburetor model		210030-051	210030-061	210030-071
Choke type		Automatic	Automatic	Automatic
Inlet diameter	mm (in)	63 (2.48)	63 (2.48)	63 (2.48)
Outlet diameter	mm (in)	30 (1.18)	30 (1.18)	30 (1.18)
Venturi diameter	mm (in)			
Large		22 (0.87)	24 (0.94)	26 (1.02)
Small (inner dia. - outer dia.)		12 - 16.5 (0.472 - 0.650)	12 - 16.5 (0.472 - 0.650)	12 - 16.5 (0.472 - 0.650)
Main jet		#104	#114	#120
Main air bleed		#80	#60	#60
Slow jet		#44	#48	#54
Slow air bleed		#80/#150	#80/#140	#80/#150
Float level adjustment	mm (in)	5.6 (0.220)	5.6 (0.220)	5.6 (0.220)
Top float position "H1"		5.6 (0.220)	5.6 (0.220)	5.6 (0.220)
Bottom float position "H2"		42 (1.65)	42 (1.65)	42 (1.65)

GOVERNOR

Type	Pneumatic
Speed control system	By controlling mixture amount
Operation of control mechanism	By suction negative pressure
Max. engine speed under no load rpm	
H15	3,100 - 3,300
H20-II	3,100 - 3,300
H25	2,800 - 3,000
Max. engine speed under load rpm	
H15	2,500 - 2,900
H20-II	2,600 - 3,000
H25	2,300 - 2,600
No. of allowable hunting repetitions	3 times (Max.)

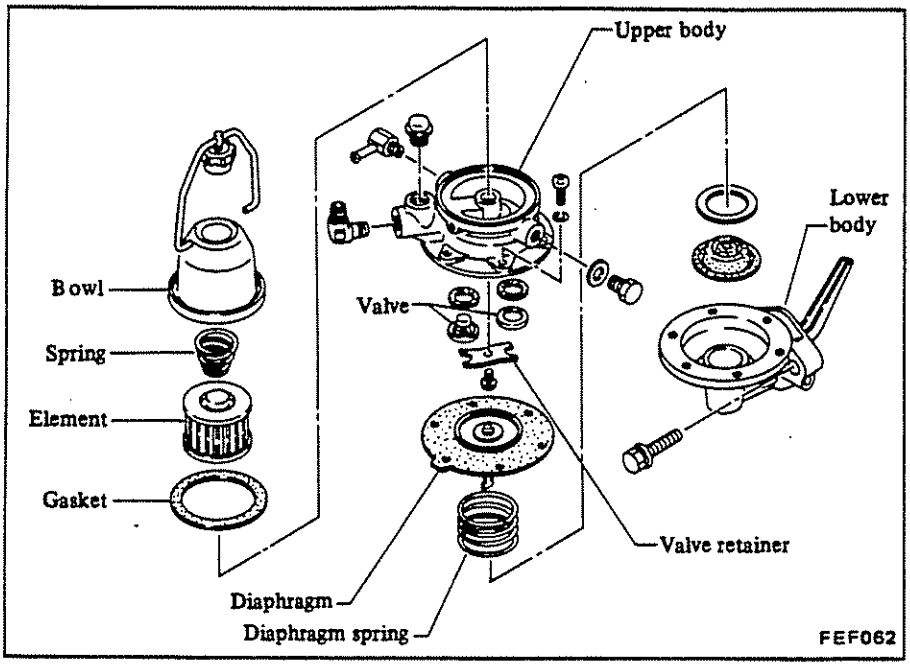
GOVERNOR

When an engine problem occurs, first determine whether or not it is due to faulty governor or engine using following information and Trouble Diagnoses and Corrections chart as a guide.

1. Track down problem, referring to descriptions listed in the chart.
2. Remove cam chamber's cover and check condition of cam band.
3. If cam band is in good order, start engine, open governor valve completely, then gradually open carburetor's throttle valve.
4. If engine speed gradually increases in response to movement of throttle valve, governor is malfunctioning.
5. If engine speed does not increase, engine itself is malfunctioning.

Condition	Probable cause	Corrective action
Insufficient engine performance	Broken cam rope. Broken or fatigued spring.	Replace.
Lift truck speed too slow (but lifting speed is good, or hunting is accompanied).	Improper adjustment of cam spring. Sticking of stabilizer piston.	Adjust. Replace governor assembly.
Lift truck speed too slow (Lifting speed too slow).	Incorrect adjustment of cam spring. Fatigued cam spring.	Adjust. Replace cam-rope kit.
Lifting speed too slow (lift truck speed is good).	Improper adjustment of cam spring.	Adjust.
Too high lift truck speed.	Incorrect adjustment of cam spring. Sticking of stabilizer piston. Sticking of governor valve shaft.	Adjust. Replace governor assembly. Replace governor assembly.
Excessive repetition of hunting (should be within three times, or within 9 seconds).	Improper adjustment of cam spring. Sticking of stabilizer piston. Sticking of governor valve shaft.	Adjust. Replace governor assembly. Replace governor assembly.

FUEL PUMP



⚠ WARNING:

a. Be sure to turn ignition switch "off".

b. Before starting to work on any part of fuel system, disconnect battery ground cable from battery.

c. Arcs, sparks, flames and lit cigarettes should be kept away from any part of fuel system.

When disconnecting fuel hoses, use a container to receive fuel remaining in fuel hoses.

OPERATING TEST

FUEL PRESSURE TEST

1. Disconnect fuel hose between carburetor and fuel pump.
2. Connect a rubber hose to each open end of a T-connector, and connect this connector-hose assembly between carburetor and fuel pump.

Locate this T-connector as close to carburetor as possible.

3. Connect a suitable pressure gauge to the opening of T-connector, and fasten the hose between carburetor and T-connector securely with a clip.
4. Start and run the engine at various speeds.
5. The pressure gauge indicates fuel pressure in the line. The gauge reading should be within the specified value.

Fuel pressure:
16.7 - 23.5 kPa
(0.167 - 0.235 bar,
0.17 - 0.24 kg/cm^2,
2.4 - 3.4 psi)

INSPECTION

1. Flush pump by immersing it in a fuel bath and operating rocker arm a number of times.
2. Drain fuel from fuel pump. Then block off the inlet port and operate rocker arm. If the rocker arm operates, the fuel pump seat is malfunctioning. Replace fuel pump.
3. Remove your finger from the inlet port and listen for a suction sound which will confirm that a sufficient suction was produced.
4. Block off outlet port and once again operate the rocker arm. After air pressure has been built up, confirm that the pressure remains for two or three more seconds.
5. Put a finger over the outlet port and again build up pressure in the pump. Then submerse the pump in a fuel bath and check for air leaks.

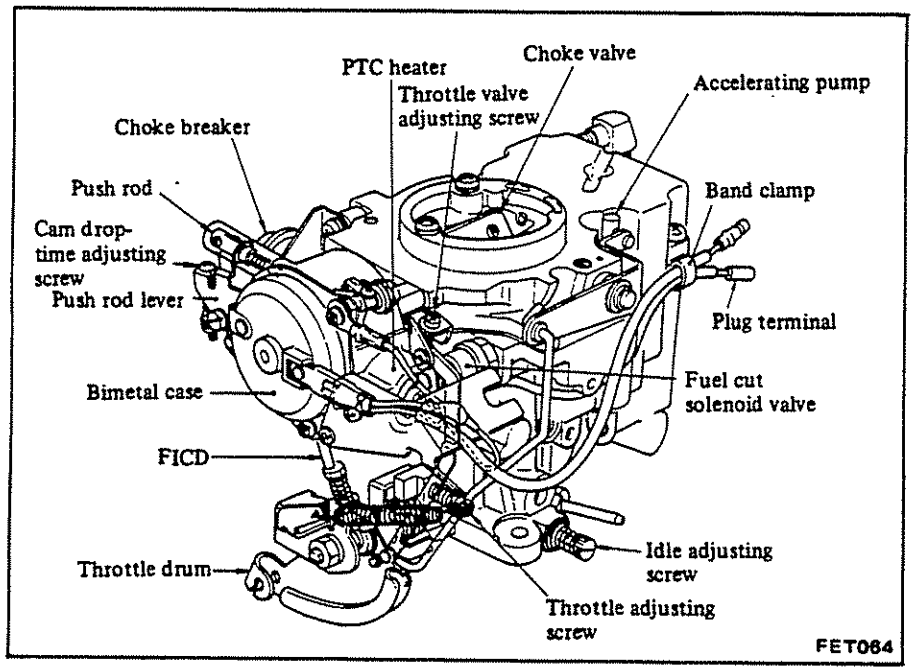
CARBURETOR

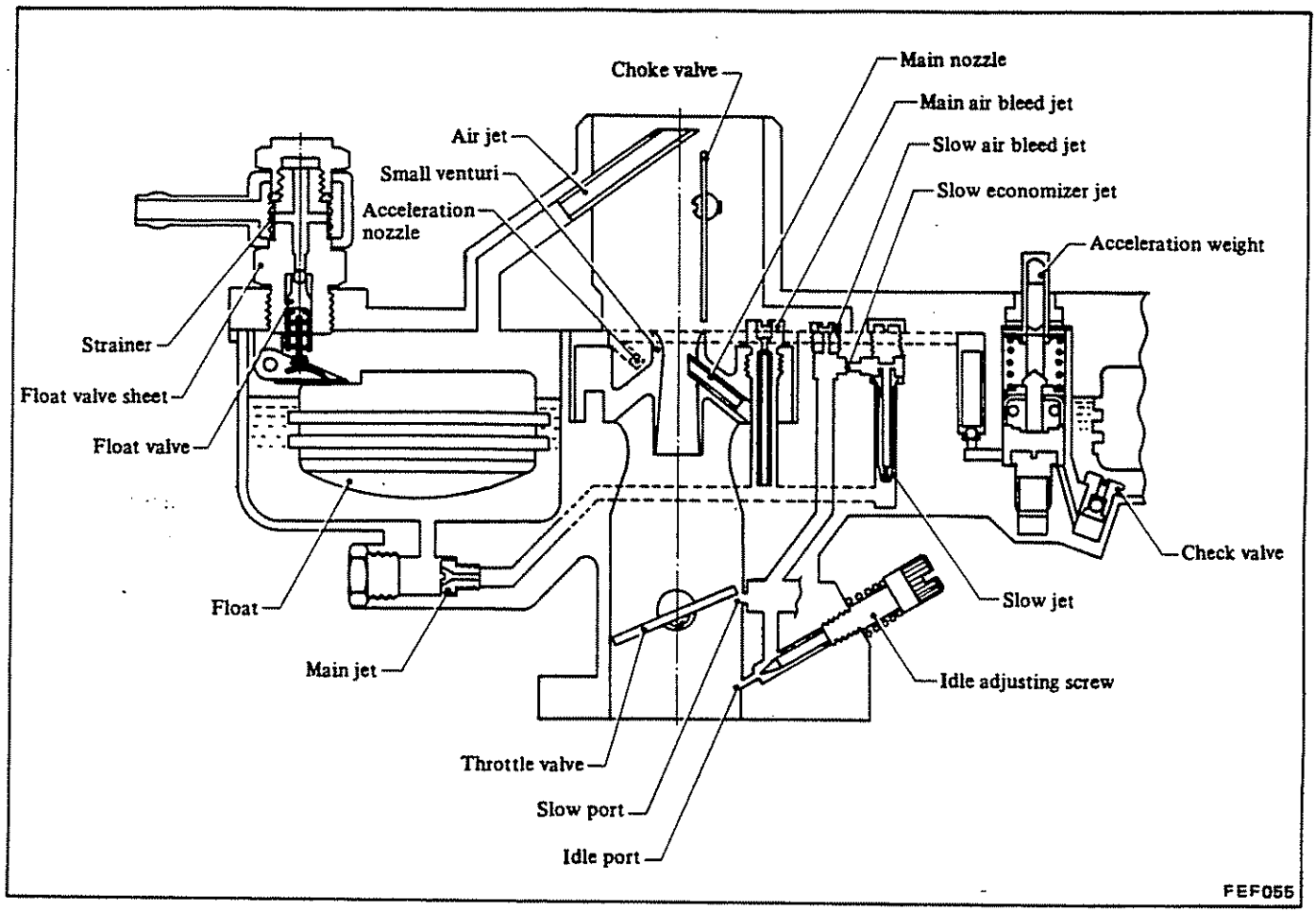
⚠ WARNING:

a. Be sure to turn ignition switch "off".

b. Before starting to work on any part of fuel system, disconnect battery ground cable from battery.

c. Arcs, sparks, flames and lit cigarettes should be kept away from any part of fuel system.





INSPECTION AND ADJUSTMENT

IDLE RPM AND MIXTURE RATIO

Refer to Checking and Adjusting of idle rpm and mixture ratio in section ET.

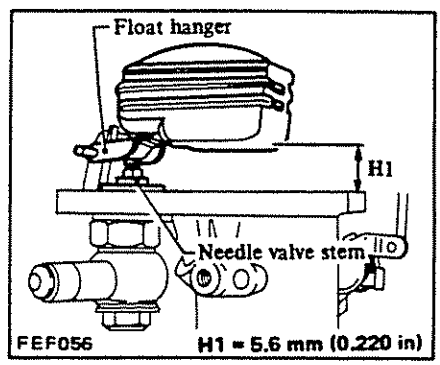
FUEL LEVEL

Fuel level is factory-adjusted and needs no adjustment.
Adjust only when overhauling or replacing inner parts.
Use the following procedure.

Top float position "H1"

Turn down float and check float position "H1".

Top float position "H1":
5.6 mm (0.220 in)

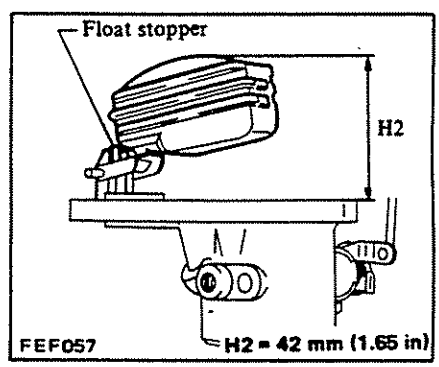


If out of specification, adjust it by bending float hanger.

Bottom float position "H2"

Check float position "H2" when float is fully raised.

Bottom float position "H2":
42 mm (1.65 in)



If out of specification, adjust it by bending float stopper.

JET AND AIR BLEED

CAUTION:

a. Be sure to use a screwdriver of proper size.

b. Be careful not to scratch or score jet and air bleed.

c. To clean jet and air bleed, use solvent and compressed air.

1. Remove choke chamber from center body and check jets and air bleeds for stamped number, looseness and clogging.
If any abnormality is found, correct.
2. Check power jet for looseness and clogging.
3. Remove main jet cap from lower portion of float chamber and check main jet.

ACCELERATOR PUMP

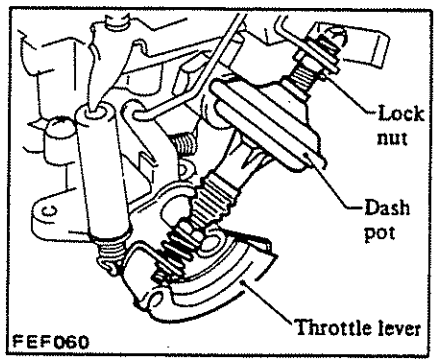
When accelerator pump is operated by opening throttle lever by hand with engine stopped, remove air horn and check pump injector located at primary port if it injects fuel smoothly without delay.

DASH POT

1. Idle speed of engine and mixture must be well tuned and engine sufficiently warm.
2. Turn throttle lever by hand, and read engine speed when dash pot just touches throttle lever.

Dash pot touch speed:
1,450 - 1,550 rpm

3. If out of specification, adjust it by turning dash pot adjusting screw after loosening lock nut.



4. Tighten lock nut and make sure that engine speed drops smoothly from 2,000 to 1,000 rpm in approximately three seconds.

FUEL CUT SOLENOID VALVE

If engine does not stop when ignition switch is turned off, this indicates that a striking (closed) solenoid valve is shutting off supply of fuel to engine. If harness is in good condition, replace solenoid valve as a unit.

Ⓣ Tightening torque:
18 - 22 N·m
(1.8 - 2.2 kg-m, 13 - 16 ft-lb)

After replacement, start engine and check to be sure that fuel is not leaking, and that fuel cut solenoid is in good condition.

AUTO-CHOKE MECHANISM

Functional check

- Visually check auto-choke mechanism for bent linkage, etc.
- Before starting engine, depress accelerator pedal one time.
- After starting engine, make sure engine speed automatically decreases to specified idle rpm.

	Choke valve	Throttle valve	Cam lever and fast idle cam
Ambient temperature below 20°C (68°F)	Fully closed	Fast idle position	Differs with ambient temperature: During engine starts (1st or 2nd ratchet position) During warm-up (3rd or 4th ratchet position)
After warm-up	Fully open	Idle position	Clearance exists.

THERMOSTATIC COIL

Removal

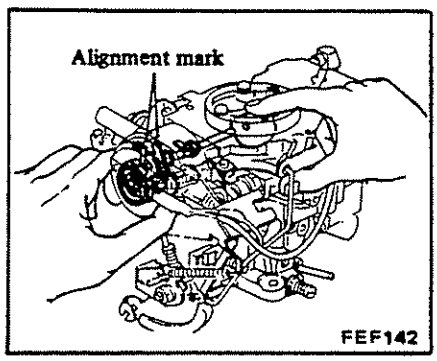
- Scribe alignment mark on thermostatic coil case if not clear.
- Remove three screws, then thermostatic coil case.

Inspection

- Start engine and touch thermostatic coil case. It should be hot. (simple check method)
- Using circuit tester, check thermostatic coil for continuity. Continuity must exist.

Installation

While aligning alignment mark, install thermostatic coil case.



THERMOWAX

- Ensure PTC heater becomes hot when engine starts. (simple check method)
- Using circuit tester, check PTC heater for continuity. Continuity must exist.

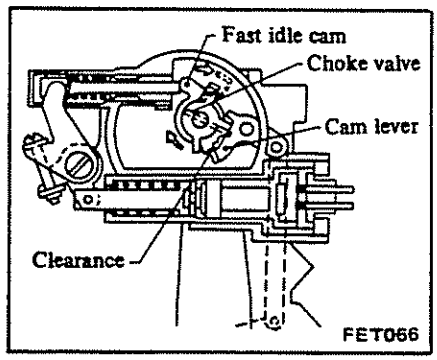
CAM LEVER

Inspection

Ensure clearance does not exist between fast idle cam and cam lever when choke valve is closed by hand.

Adjustment

Adjust cam drop time adjustment screw until choke valve is closed completely.



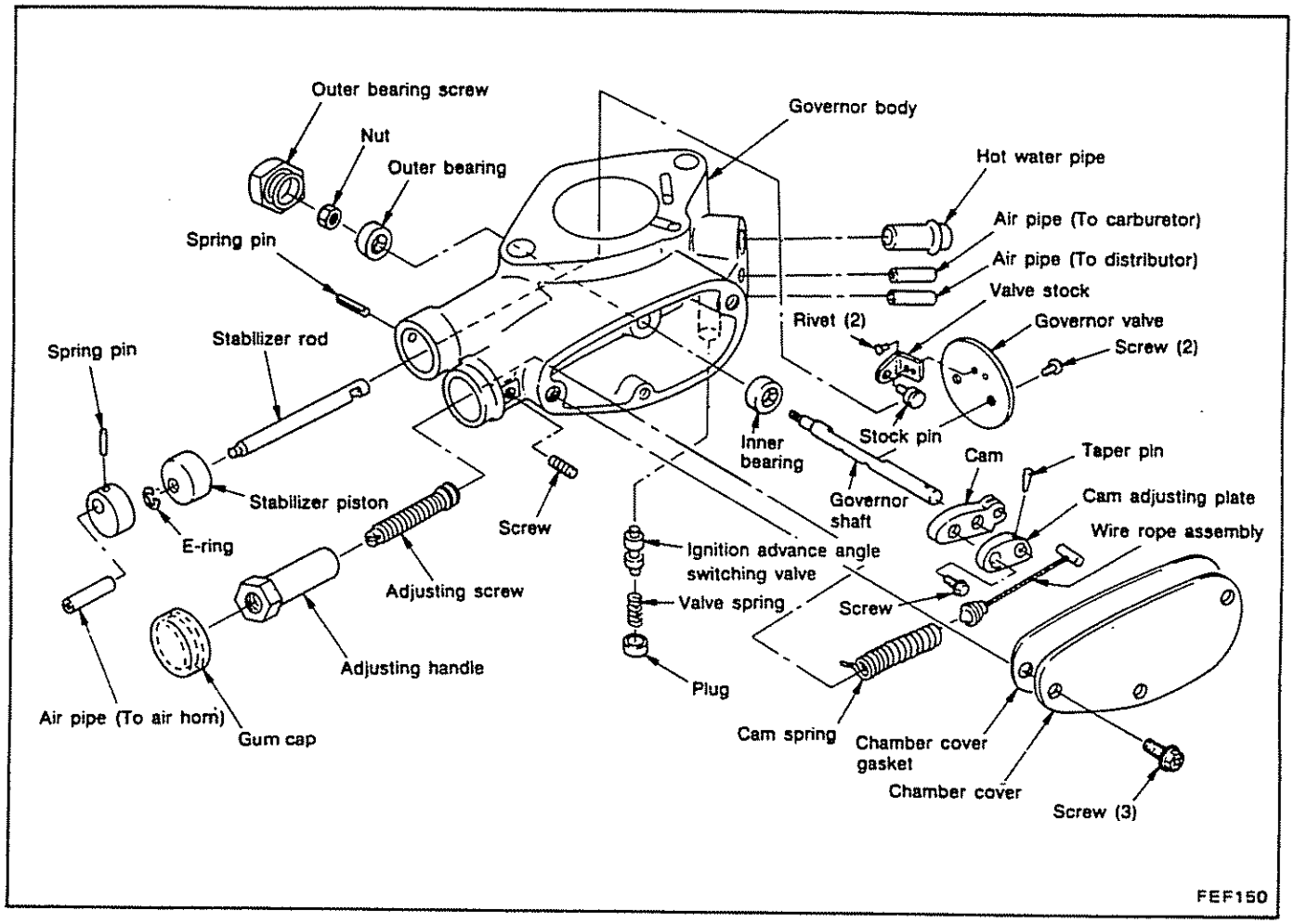
MAJOR SERVICE OPERATION

The perfectly adjusted carburetor delivers the proper fuel and air ratios at all speeds for the particular engine for which it was designed. The carburetor should be maintained in its original condition and will continue to deliver the proper ratios.

To maintain accurate carburetion of passages and discharge holes, extreme care must be taken in cleaning.

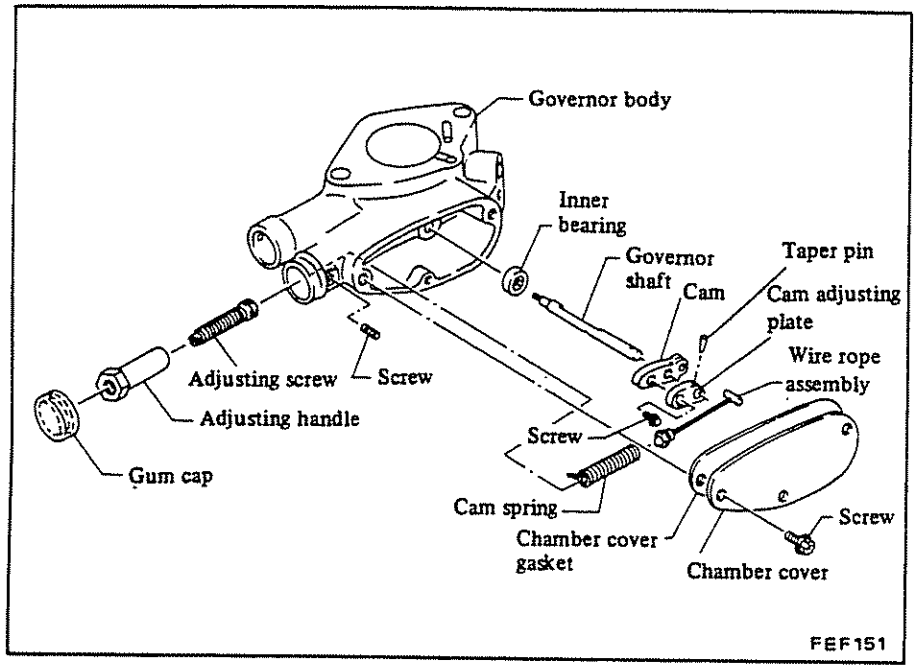
Use only carburetor solvent and compressed air to clean all passages and discharge holes. Never use wire or other pointed instrument to clean or carburetor calibration will be affected.

GOVERNOR

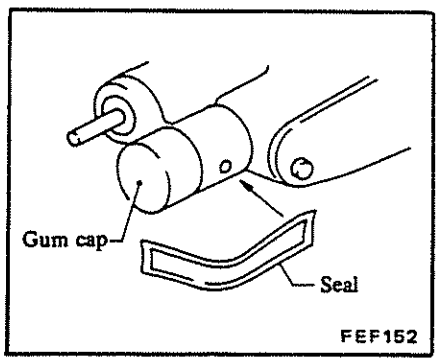

Outer bearing screw
Nut
Outer bearing
Governor body
Hot water pipe
Air pipe (To carburetor)
Air pipe (To distributor)
Valve stock
Rivet (2)
Governor valve
Screw (2)
Spring pin
Stabilizer rod
Spring pin
Inner bearing
Stock pin
Cam
Taper pin
Cam adjusting plate
Wire rope assembly
Governor shaft
Stabilizer piston
E-ring
Screw
Ignition advance angle switching valve
Valve spring
Adjusting screw
Screw
Adjusting handle
Plug
Air pipe (To air horn)
Gum cap
Cam spring
Chamber cover gasket
Chamber cover
Screw (3)
FEF150

DISASSEMBLY

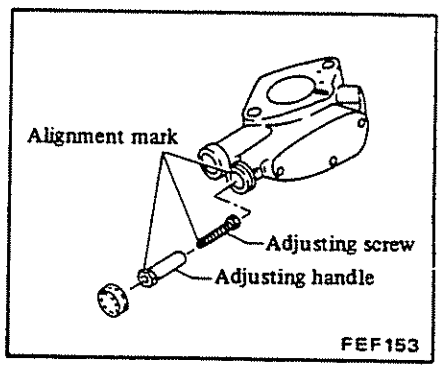
Do not attempt to disassemble governor unless necessary, especially cam assembly which requires precise adjustment of cam and cam plate.



1. Remove seal and gum cap.



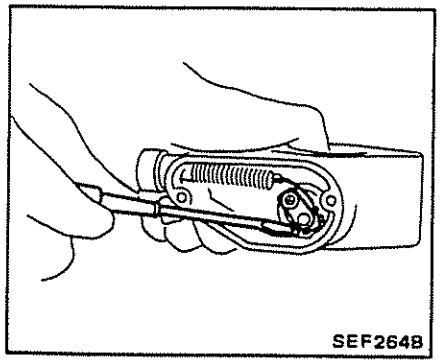
2. Paint alignment marks across adjusting handle, adjusting screw and body. Then, remove cover from cam chamber.



3. Remove stopper screw.
4. Remove adjusting handle.

To facilitate adjustments during re-installation, use alignment marks as a guide to record number of rotations required to remove adjusting handle.

5. Remove adjusting screw.
6. Drive tapered pin out of camshaft from the lower end; then remove tapered pin.



7. Remove cam, cam spring and wire rope assembly from camshaft as a unit. Be careful not to deform cam spring.

When it is necessary to further disassemble it, record number of spring's active turns, screwed-in state of spring ends.

8. Remove cam spring and wire rope assembly.

Do not attempt to disassemble cam and cam adjusting plate unless necessary, since it requires precise adjustment during re-installation.

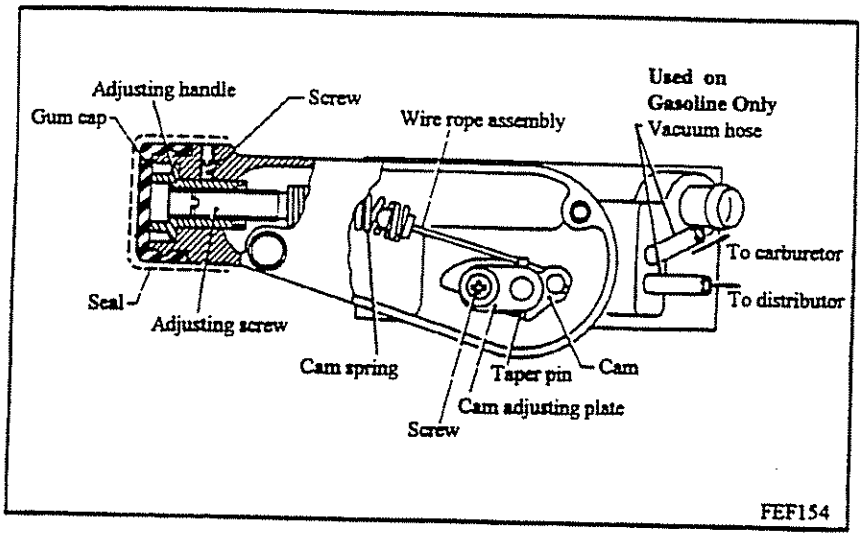
INSPECTION

Carefully check governor and other parts for signs of wear, cracks or sticking; if any part is found damaged, replace entire governor assembly – not only damaged parts.

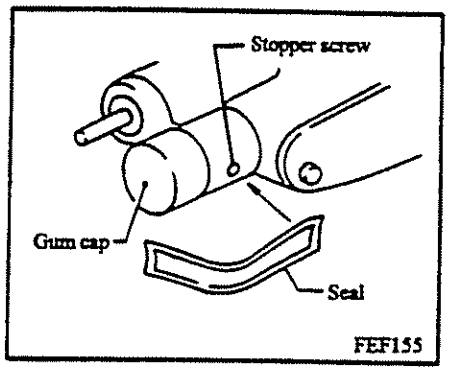
ASSEMBLY

To assemble, reverse disassembly procedure.

ADJUSTMENT



● Turn adjusting handle. This changes amount of spring tension. Because of this, maximum speed (rpm) under no-load can be adjusted without changing output characteristics of governor as often. Turn adjusting screw. This changes both cam spring's tension and rate accordingly. In other words, output characteristics change along with a change in maximum speed under no-load.



Before making any adjustments, loosen stopper screw by rotating it counter-clockwise approximately 1 to 2 turns.

After adjustments, tighten stopper screw by turning it clockwise until it just contacts the adjusting handle; then turn it clockwise an additional 1/4 to 1/2 turn.

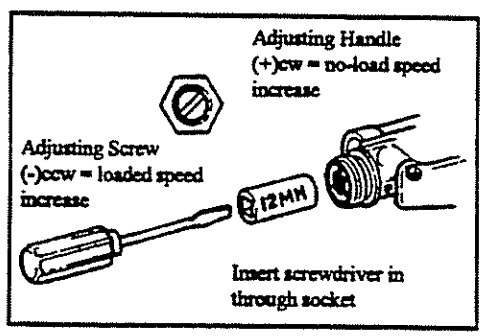
Affix seal to cover both stopper screw and gum cap.

● Output characteristics change considerably when relative postion of cam and cam adjusting plate is changed. (Do not attempt to adjust relative position unless necessary, because it greatly influences output characteristics.)

FINAL ADJUSTMENT

Before proceeding to final adjustment, completely adjust engine operation with respect to such points as valve clearance, advance angle of ignition, distributor air gap, revolution during idling, etc.

CAUTION:
While adjusting either maximum speed or speed under load, hold one adjustment constant. For example, when adjusting maximum speed, turn adjusting handle while holding adjusting screw in place. This can be done by utilizing a 12mm deep socket with a regular screw driver inserted through the socket drive. See figure.



1. Adjusting maximum engine speed under no-load.

(1) Shift transmission gears into neutral so that engine will bear no-load, then fully open throttle valve of carburetor.

(2) Under this condition, bring engine speed within allowable range **(H15 and H20-II: 3,100 to 3,300 rpm, H25: 2,800 to 3,000 rpm)** by turning adjusting handle.

Note: Hold adjusting screw constant.

Turn adjusting handle clockwise to increase, or counter-clockwise to decrease engine speed.

2. Adjusting maximum engine speed under load.

(1) Shift transmission gears into neutral. Fully open carburetor throttle valve while tilting mast assembly fully backward with hydraulic control lever.

(2) Adjust engine speed by adjusting screw so that engine speed is within allowable range **(H15: 2,500 to 2,700 rpm, H20-II: 2,600 to 2,800 rpm, H25: 2,300 to 2,600 rpm)**. Also re-adjust maximum engine speed under no-load.

Turn adjusting screw counter-clockwise to increase or clockwise to decrease loaded engine speed.

Note: Do not adjust more than 2 to 3 turns counter-clockwise, otherwise spring will detach from screw and require reassembly.

3. Check for hunting. Term "Hunting" means sudden fluctuation of engine speed attended with vibration. Be sure to check engine for hunting when maximum engine speed under no-load as well as rated output has been adjusted.

(1) Stop hydraulic mechanism, place gear in neutral, and idle engine.

(2) Suddenly toe in accelerator pedal under this condition, and make certain that hunting ceases after repeating three times or less, or within 9 seconds.

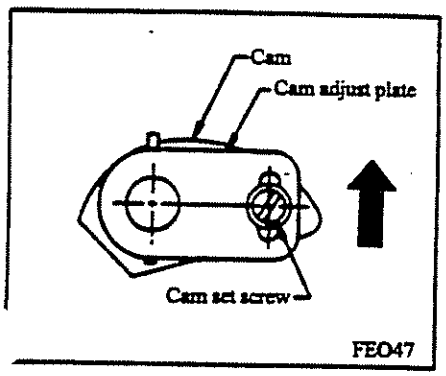
If hunting repeats more than three times, or within 9 seconds, proceed as follows:

ADJUSTMENT

(a) Turn adjusting screw 1/4 of a revolution clockwise, and every time begin with adjustment of maximum engine speed under no-load as described in paragraph "1" above.

(b) If hunting condition still remains, it may be eliminated by adjusting cam. This should be avoided as much as possible because it is very delicate and is liable to greatly affect engine performance.

(c) Shift cam set screw in direction of arrow mark shown in figure below and secure cam. By doing so, hunting may be remedied easily.



(d) After adjustment, begin once more with adjustment of maximum no-load speed as described above.

ENGINE ELECTRICAL SYSTEM
(EE)

—H15/H20-II/H25 ENGINE—

CONTENTS

SERVICE DATA AND SPECIFICATIONS

BATTERY

Type	48D26R	55D26R	55D26R
Applicable model	Except U.S.A. and Canada		U.S.A. and Canada
	Standard	Option	
Capacity V-AH	12 - 50	12 - 60	12 - 60
Full charge specific gravity at 20°C (68°F)	1.28	1.28	1.28

STARTER MOTOR

Type	M3T21882	M001T60381
	Reduction gear type	Planetary gear type
System voltage V	12	
No-load Terminal voltage V	11.5	11.0
Current A	Less than 60	Less than 90
Revolutions rpm	More than 6,800	More than 3,000
Outer diameter of commutator mm (in)	More than 37.7 (1.484)	More than 28.8 (1.134)
Wear limit length of brush mm (in)	11.5 (0.453)	5.5 (0.217)
Brush spring tension N (kg, lb)	16.7 - 21.6 (1.7 - 2.2, 3.7 - 4.9)	12.7 - 24.5 1.3 - 2.5, 2.9 - 5.5)
Movement "a" in height of pinion assembly mm (in)	0.5 - 2.0 (0.020 - 0.079)	

ALTERNATOR

Type	A7T03371
Nominal rating V-A	12 - 35
Ground polarity	Negative
Minimum revolutions at 14 volts under no-load rpm	Less than 1,300
Output current A/rpm	More than 27.5/2,500 More than 35/5,000
Regulated output voltage V	14.1 - 14.7
Brush wear limit mm (in)	More than 5 (0.20)
Brush spring pressure N (g, oz)	2.648 - 5.590 (270 - 570, 9.52 - 20.10)
Slip ring outer diameter mm (in)	More than 32.4 (1.276)

DISTRIBUTOR

Type	T006T87771 (H15 engine)	T006T87772 (H20-II engine)	T006T87773 (H25 engine)
	IC type		
Firing order	1-3-4-2		
Rotating direction	Counterclockwise		
Air gap mm (in)	0.35 - 0.45 (0.0138 - 0.0177)		
Cap insulation resistance MΩ	More than 50		
Rotor head insulation resistance MΩ	More than 50		
Cap carbon point length mm (in)	More than 10 (0.39)		
Vacuum advance [Distributor degree/distributor kPa (mbar, mmHg, inHg)]	0°/11.3 - 13.3 (113 - 133, 85 - 100, 3.35 - 3.94) 10.5° - 12.5°/60.0 (600, 450, 17.72)	0°/15.3 - 16.7 (153 - 167, 115 - 125, 4.53 - 4.92) 11° - 13°/66.7 (667, 500, 19.69)	0°/14.7 - 18.0 (147 - 180, 110 - 135, 4.33 - 5.31) 7.5° - 9.5°/66.7 (667, 500, 19.69)
Centrifugal advance [Distributor degree/distributor rpm]	0°/550 - 700 10.5° - 12.5°/1,600	0°/500 - 550 11° - 13°/1,600	0°/700 - 730 7.5° - 9.5°/1,200

SPARK PLUG

Type	BP4ES, BPR4ES
Size (Screw dia. x reach) mm (in)	14 x 19 (0.55 x 0.75)
Plug gap mm (in)	0.8 - 0.9 (0.031 - 0.035)

BATTERY

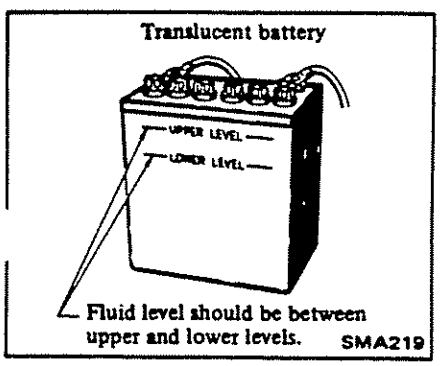
⚠ WARNING:

a. Before starting to work on any part of the electrical system, be sure to turn ignition switch "OFF" and then disconnect battery ground cable.
b. Remove rings and jewelry to prevent accidental short circuit.
c. Protect your eyes when checking the battery to prevent splashing of the acid solution.
d. Wash hands after checking the battery.
e. Never touch positive and negative terminals at the same time with bare hands. This could result in injury.
f. If it becomes necessary to start the engine with a booster battery and booster cables, the booster battery voltage must not exceed 12 volts.
   - Connecting sequence of booster cables:
   1. Connect booster cable from positive terminal of booster battery to positive terminal of discharged battery.
   2. Connect cable from negative terminal of booster battery to engine block of lifttruck with discharged battery. After starting, disconnect in reverse order.
g. If the battery cables are disconnected, they should be tightly clamped to the battery terminals to secure a good contact.

CHECKING ELECTROLYTE LEVEL

Check for electrolyte level in each cell.

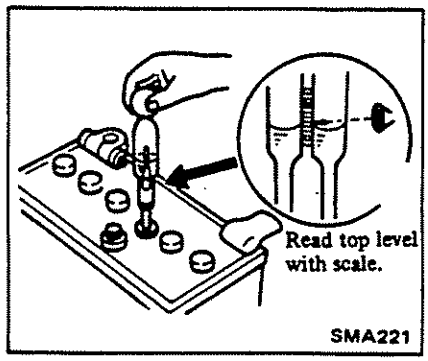
If necessary, add only distilled water. Do not overfill.



CHECKING SPECIFIC GRAVITY

1. Read hydrometer and thermal gauge indications at eye level.

Read top level with scale.

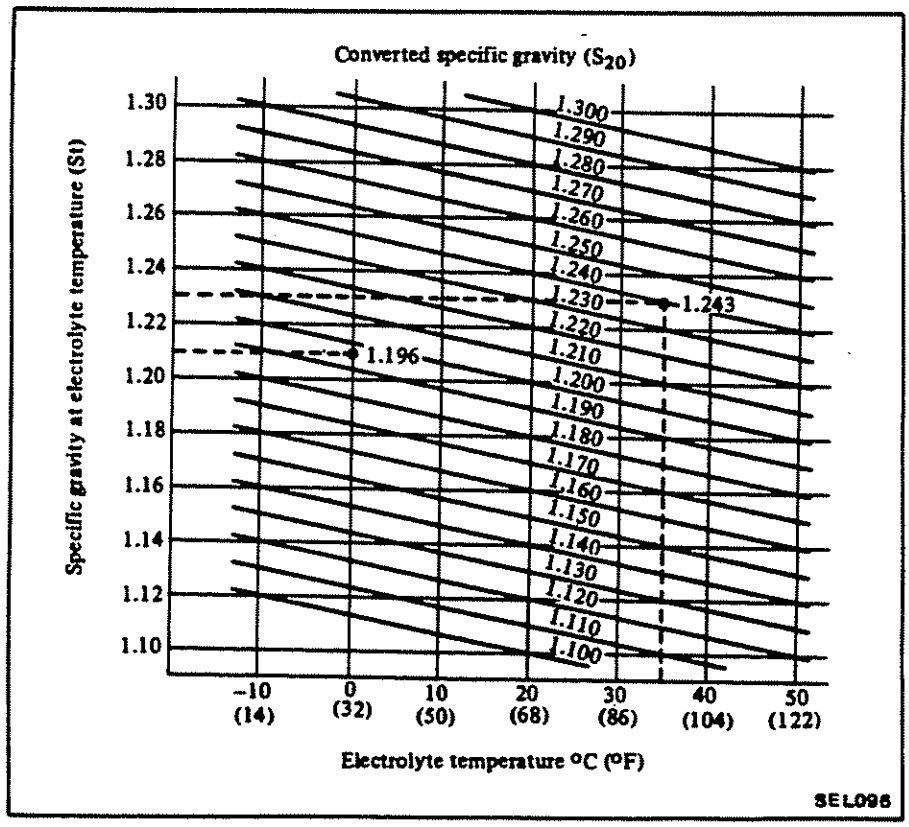


2. Correct specific gravity at 20°C (68°F).

$$S_{20} = St + 0.0007 (t - 20)$$

St: Specific gravity of electrolyte at t°C
S_{20}: Specific gravity of electrolyte corrected at 20°C (68°F)
t: Electrolyte temperature

Examples:
1. When electrolyte temperature is 35°C (95°F) and specific gravity of electrolyte is 1.230, specific gravity corrected at 20°C (68°F) is 1.243.
2. When electrolyte temperature is 0°C (32°F) and specific gravity of electrolyte is 1.210, specific gravity corrected at 20°C (68°F) is 1.196.

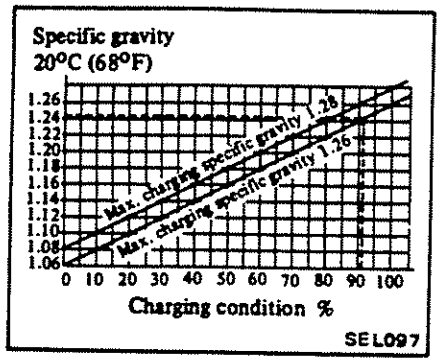


3. Determine charging state of battery.

Examples:

Charging state of battery whose max. charging specific gravity is 1.26, and whose specific gravity corrected at 20°C (68°F) is 1.243, is 92%.

For battery whose max. charging specific gravity is 1.28, charging state is 82% at a corrected specific gravity of 20°C (68°F).



4. Recharge battery if its rate drops below 70% of full charge.

CHARGING

CAUTION:

a. Carry out charging with negative cable removed.
b. Do not allow electrolyte temperature to go over 45°C (113°F).

Clean corroded terminal with a brush and common baking-soda solution.

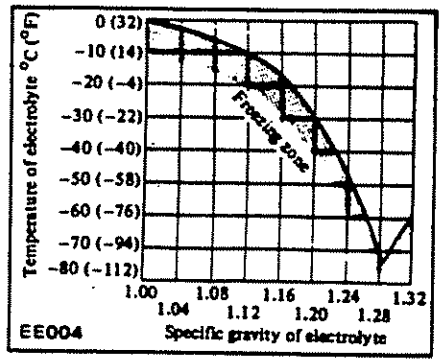
WARNING:

a. Keep battery away from open flames, arcs, sparks or lit cigarettes while it is being charged.
b. Have a well-ventilated working area.
c. When connecting charger, connect leads first, then turn on charger. Do not turn on charger first, as this may cause a spark.

BATTERY FREEZING

CAUTION:

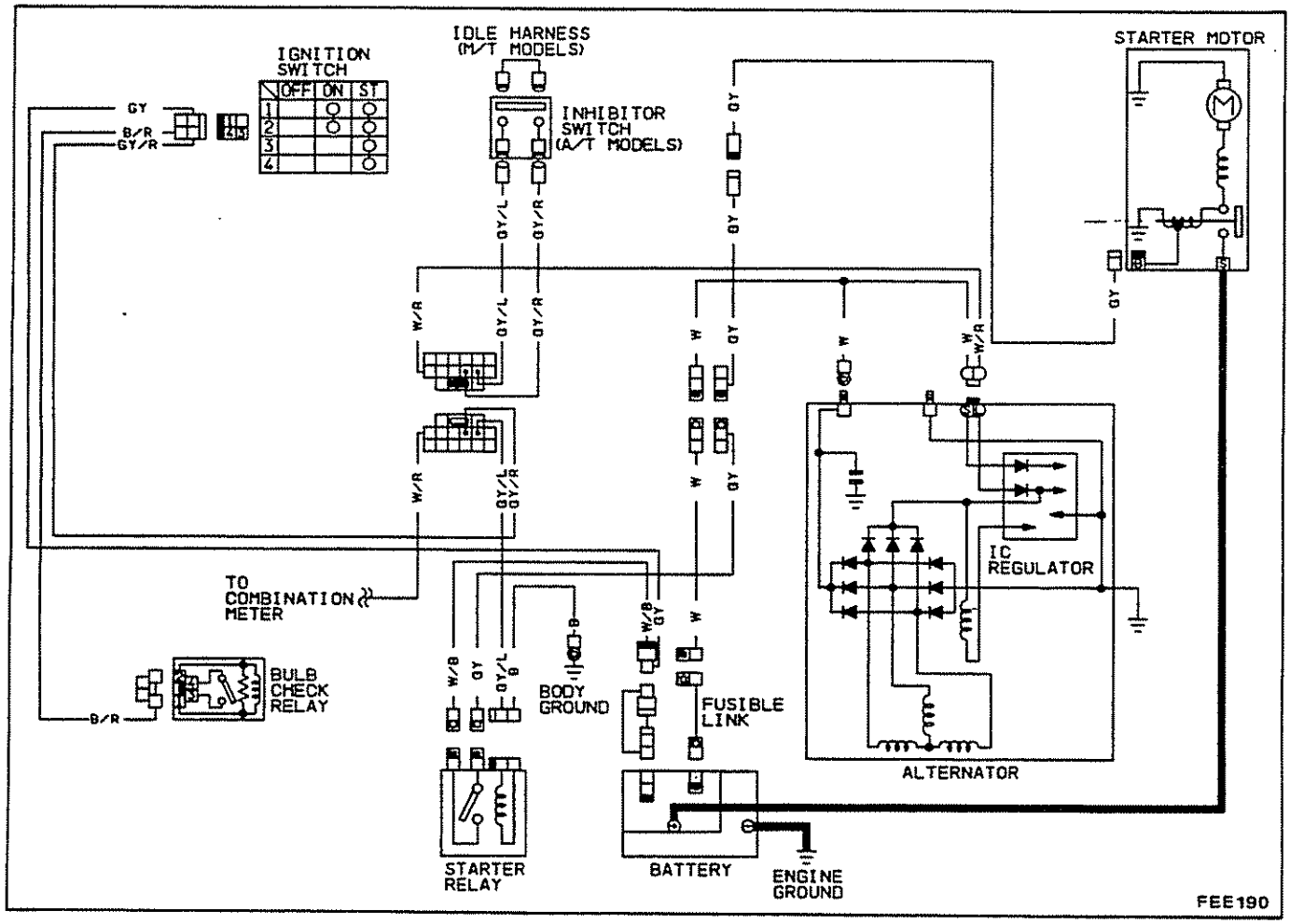
Use extreme caution to avoid freezing battery.



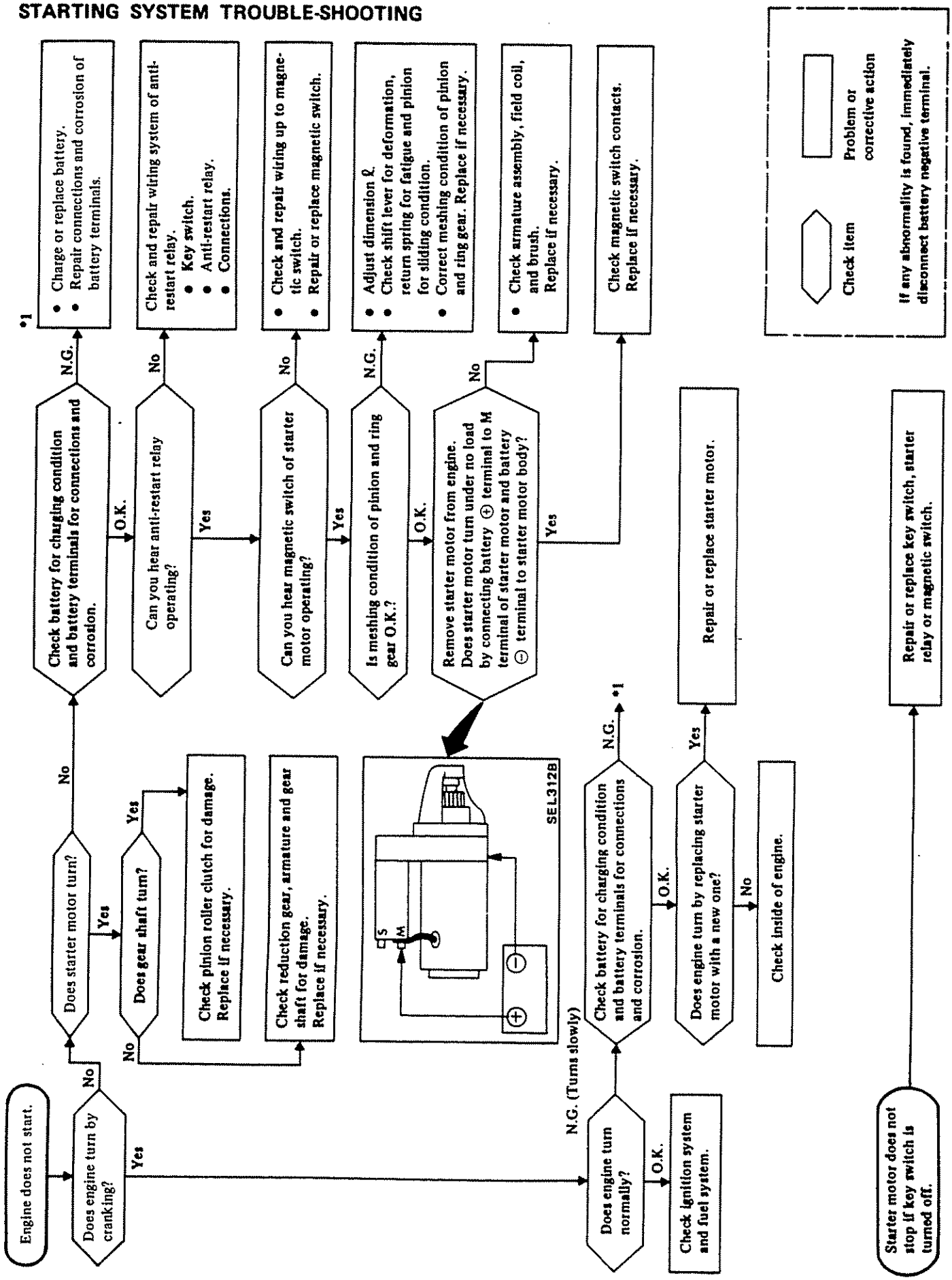
STARTING SYSTEM

WARNING:
Before starting to work on any part of electrical system, be sure to turn key switch "OFF" and then disconnect battery ground cable.

WIRING DIAGRAM

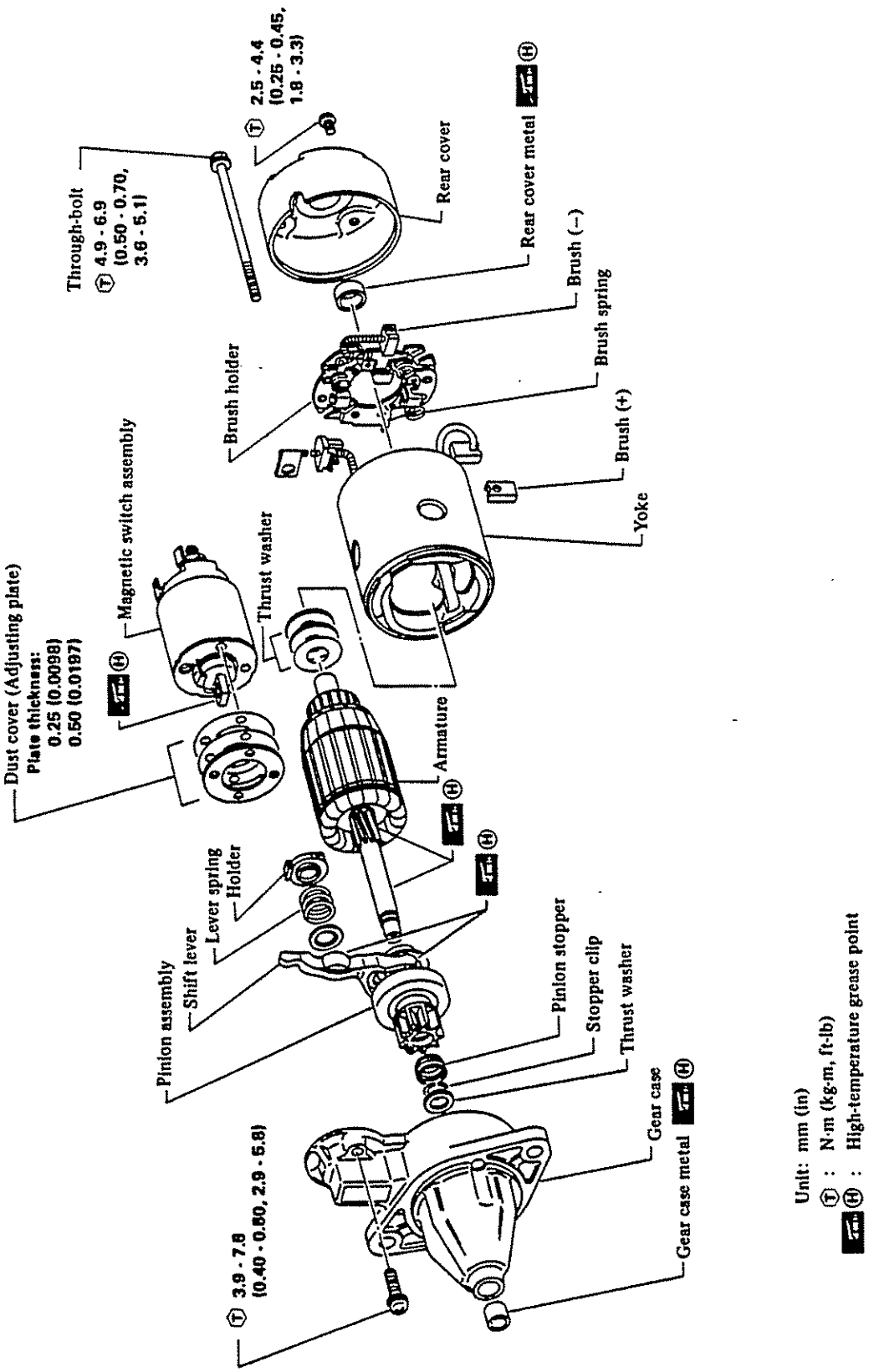


STARTING SYSTEM TROUBLE-SHOOTING



STARTER MOTOR

REDUCTION GEAR TYPE



Unit: mm (in)
Ⓣ : N·m (kg-m, ft-lb)
Ⓗ : High-temperature grease point

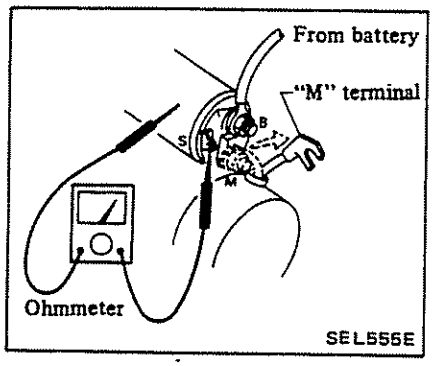
SEL044D

INSPECTION

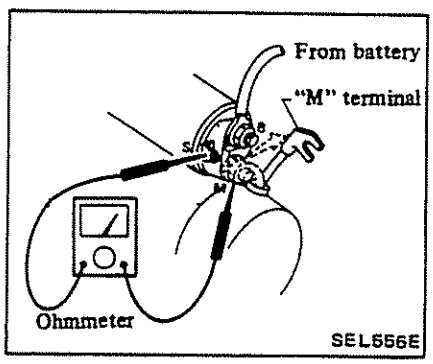
Magnetic switch

- Disconnect "M" terminal of starter motor.

1. Continuity test (between "S" terminal and switch body).
- No continuity ... Replace.

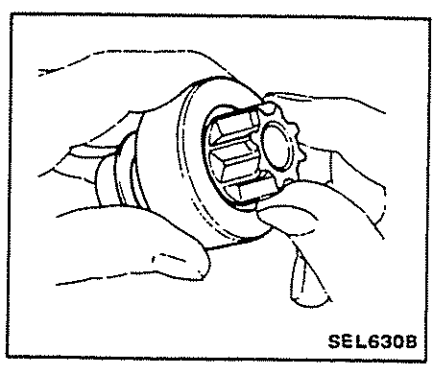


2. Continuity test (between "S" terminal and "M" terminal).
- No continuity ... Replace.



Pinion assembly

1. Check to see if pinion locks in one direction and rotates smoothly in the opposite direction.
- If it does not lock in either direction or unusual resistance is evident ... Replace.

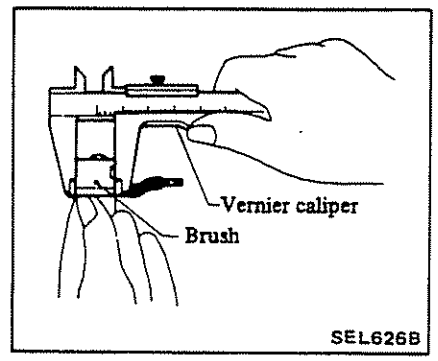


2. Inspect pinion teeth.
- Replace pinion if teeth are worn or damaged. (Also check condition of ring gear teeth.)

Brush

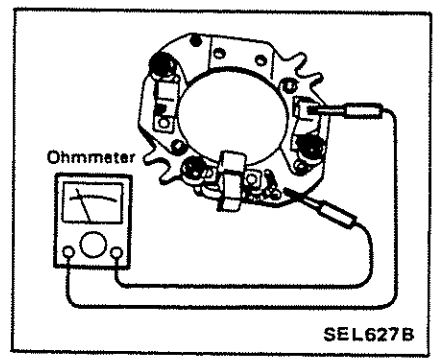
Check wear of brush.

Wear limit length:
11.5 mm (0.453 in)
- Excessive wear ... Replace.



Brush holder

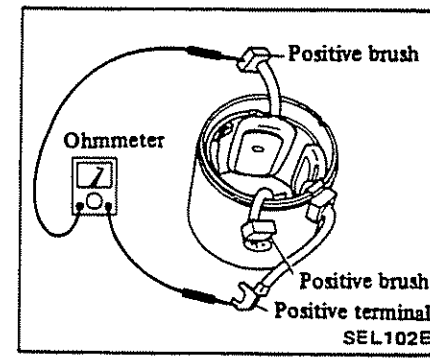
1. Perform insulation test between brush holder (positive side) and its base (negative side).
- Continuity exists ... Replace.



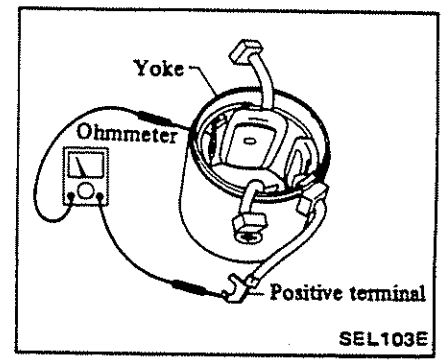
2. Check brush to see if it moves smoothly.
- If brush holder is bent, replace it; if sliding surface is dirty, clean it.

Field coil

1. Continuity test (between field coil positive terminal and positive brushes).
- No continuity ... Replace field coil.

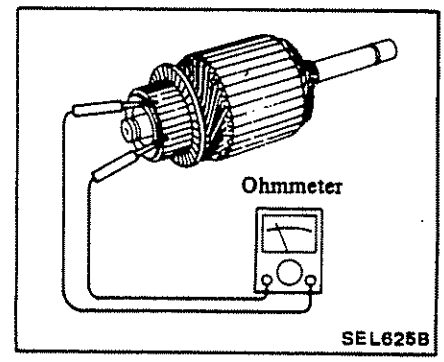


2. Insulation test (between field coil positive terminal and yoke).
- Continuity exists ... Replace field coil.

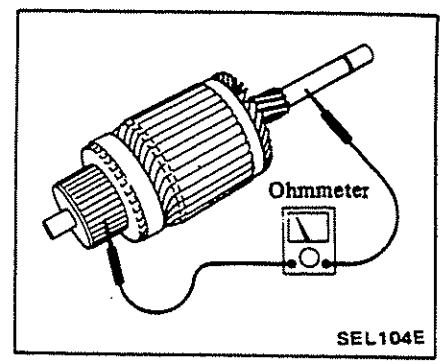


Armature

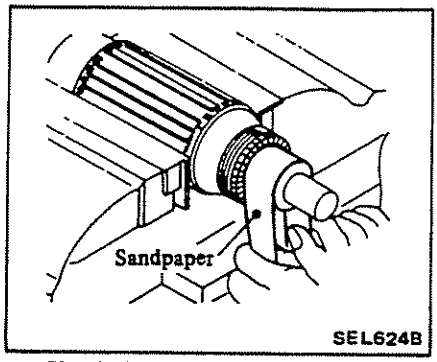
1. Continuity test (between two segments side by side).
- No continuity ... Replace.



2. Insulation test (between each commutator bar and shaft).
- Continuity exists ... Replace.



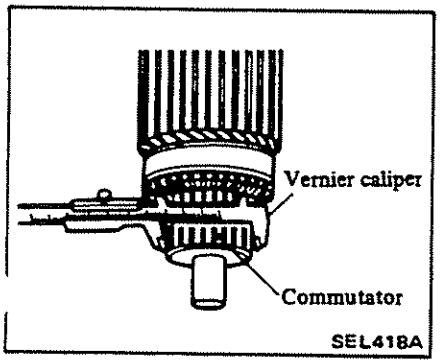
3. Check commutator surface.
- Rough ... Sand lightly with No. 500 - 600 sandpaper.



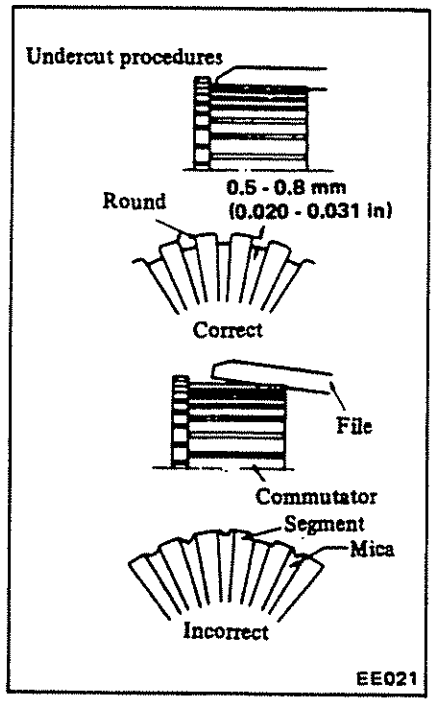
4. Check diameter of commutator.

Commutator minimum diameter:
31.4 mm (1.236 in)

- Less than specified diameter ... Replace..



5. Check depth of insulating mica from commutator surface.
- Less than 0.2 mm (0.008 in) ... Undercut to 0.5 - 0.8 mm (0.020 - 0 031 in)



ASSEMBLY

Carefully observe the following instructions.

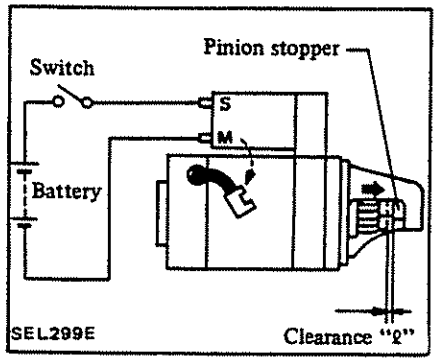
Grease point

- Rear cover metal
- Gear case metal
- Frictional surface of pinion
- Moving portion of shift lever
- Plunger of magnetic switch

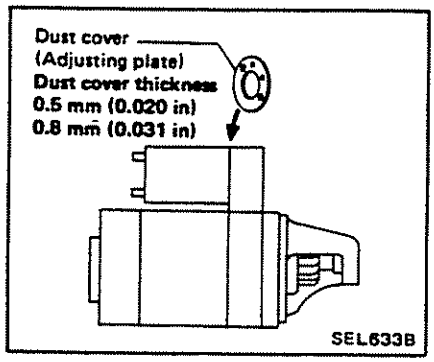
Pinion protrusion length adjustment

With pinion driven out by magnetic switch, push pinion back to remove slack and measure clearance "ℓ" between the front edge of the pinion and the pinion stopper.

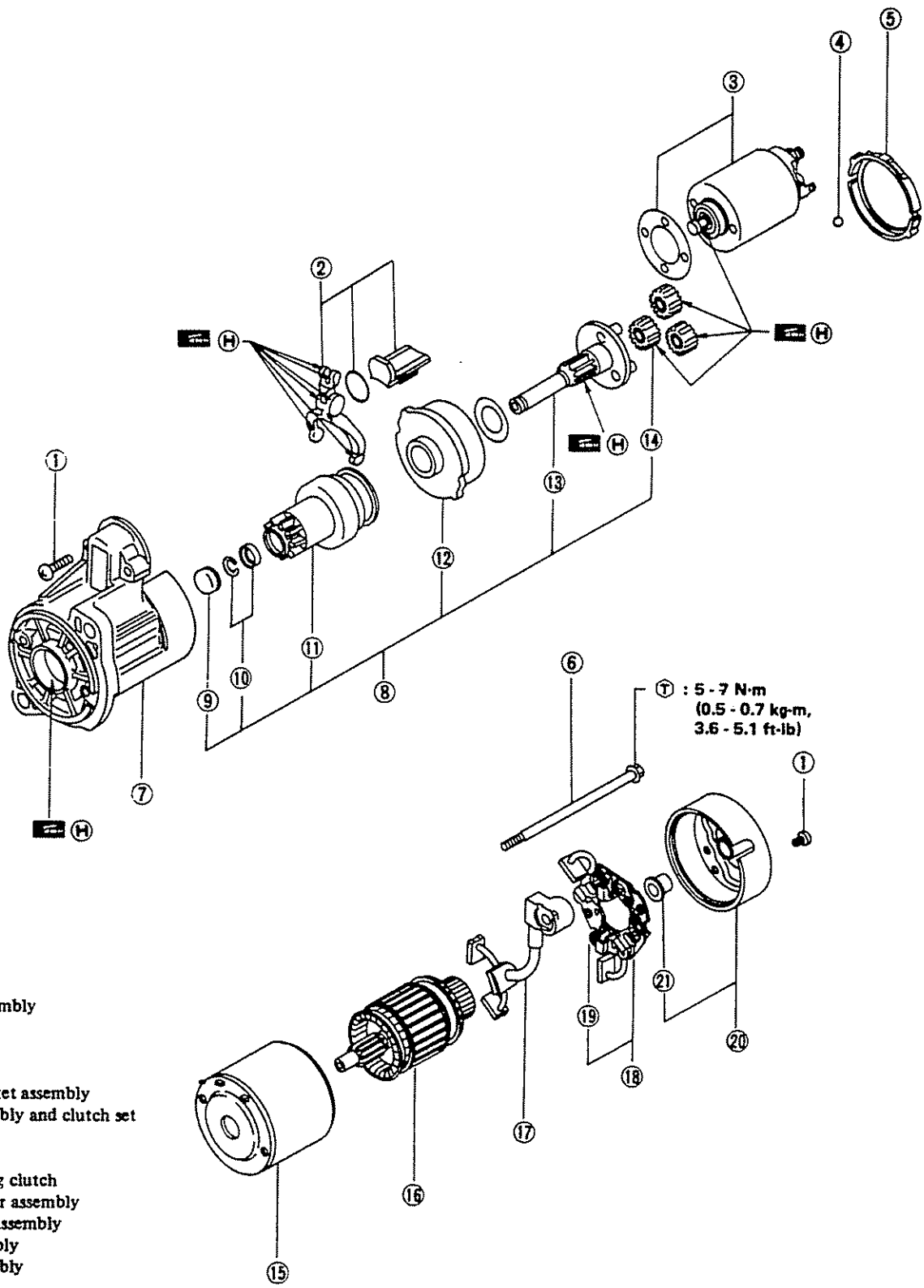
Clearance "ℓ":
0.5 - 2.0 mm
(0.020 - 0.079 in)



- Not in the specified value ... Adjust by dust cover (adjusting plate).



PLANETARY GEAR TYPE



① Screw set
② Lever set
③ Switch assembly
④ Ball
⑤ Packing
⑥ Hex. bolt
⑦ Front bracket assembly
⑧ Shaft assembly and clutch set
⑨ Cap
⑩ Stopper set
⑪ Overrunning clutch
⑫ Internal gear assembly
⑬ Gear shaft assembly
⑭ Gear assembly
⑮ Yoke assembly
⑯ Armature
⑰ Brush assembly
⑱ Brush holder assembly
⑲ Brush spring
⑳ Rear bracket assembly
㉑ Sleeve bearing (R)

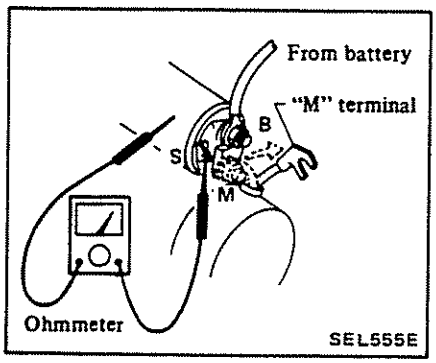
FEE138

INSPECTION

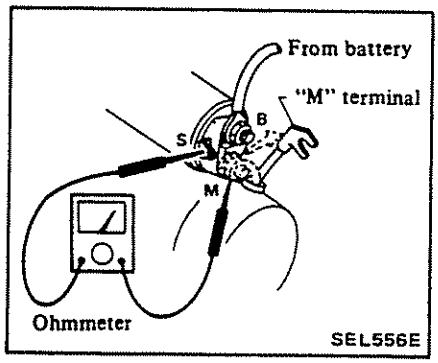
Magnetic switch check

- Before starting to check, disconnect battery ground cable.
- Disconnect "M" terminal of starter motor.

1. Continuity test (between "S" terminal and switch body).
- No continuity ... Replace.



2. Continuity test (between "S" terminal and "M" terminal).
- No continuity ... Replace.

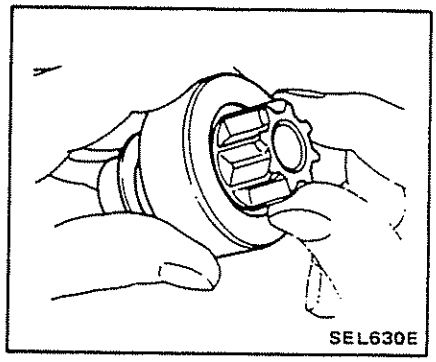


Pinion/clutch check

1. Inspect pinion teeth.
- Replace pinion if teeth are worn or damaged. (Also check condition of ring gear teeth.)

2. Check to see if pinion locks in one direction and rotates smoothly in the opposite direction.
- If it does not lock (or locks) in either direction or unusual resistance is evident ... Replace.

3. Inspect reduction gear teeth.
- Replace reduction gear if teeth are worn or damaged. (Also check condition of armature shaft gear teeth.)



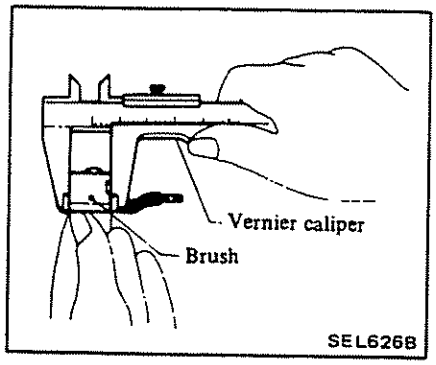
Brush check

Brush

Check brush for wear.

Wear limit length:
5.5 mm (0.217 in)

- Excessive wear ... Replace.

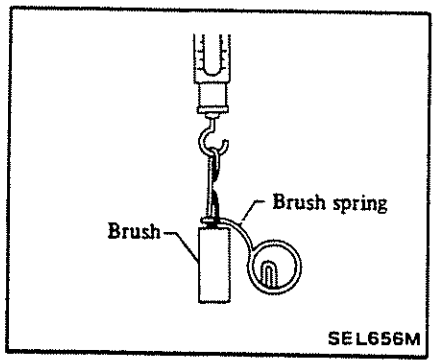


Brush spring pressure

Check brush spring pressure with brush spring detached from brush.

Spring pressure
(with new brush):
12.7 - 24.5 N
(1.3 - 2.5 kg,
2.9 - 5.5 lb)

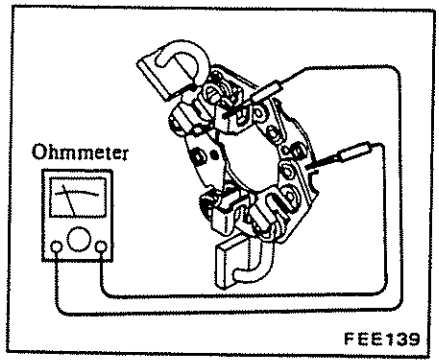
- Not within the specified values ... Replace.



Brush holder

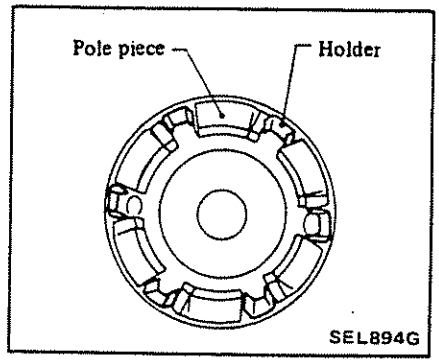
1. Perform insulation test between brush holder (positive side) and its base (negative side).
- Continuity exists. ... Replace.

2. Check brush to see if it moves smoothly.
- If brush holder is bent, replace it; if sliding surface is dirty, clean.



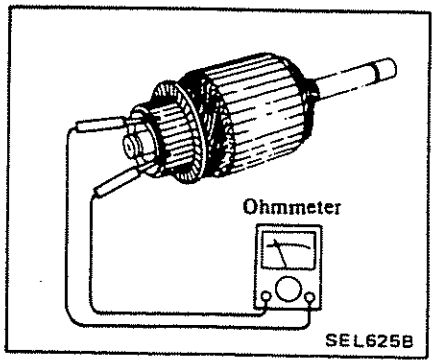
Pole piece check

Pole piece is secured to yoke by bonding agent. Check pole piece to see that it is secured to yoke and for any cracks. Replace malfunctioning parts as an assembly.
Holder may move slightly as it is only inserted and not bonded.

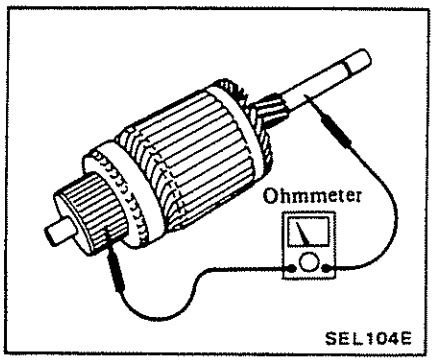


Armature check

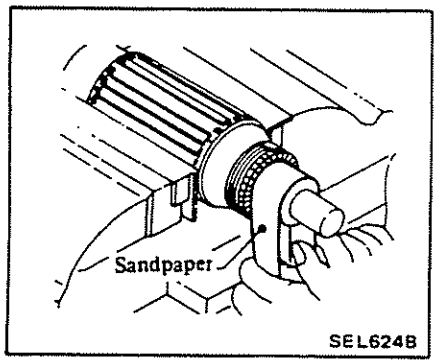
1. Continuity test (between two segments side by side).
- No continuity ... Replace.



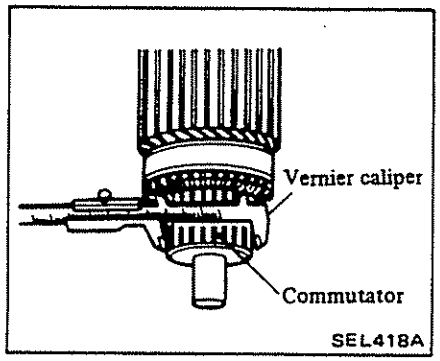
2. Insulation test (between each commutator bar and shaft).
● Continuity exists. ... Replace.



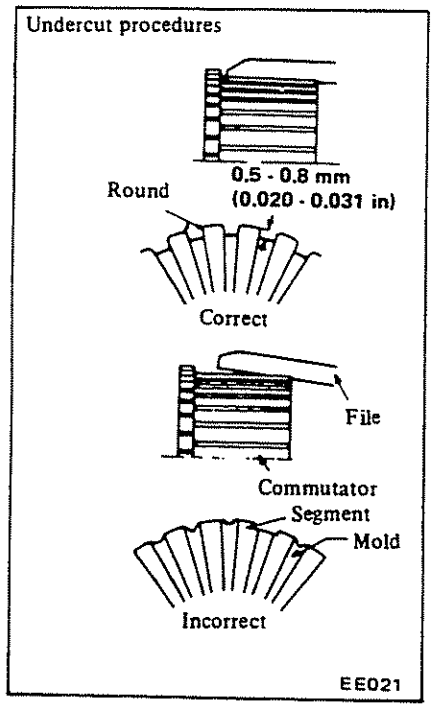
3. Check commutator surface.
● Rough ... Sand lightly with No. 500 - 600 sandpaper.



4. Check diameter of commutator.
Commutator minimum diameter:
28.8 mm (1.134 in)
● Less than specified value ... Replace.



5. Check depth of insulating mold from commutator surface.
● Less than 0.2 mm (0.008 in) ... Undercut to 0.5 to 0.8 mm (0.020 to 0.031 in)

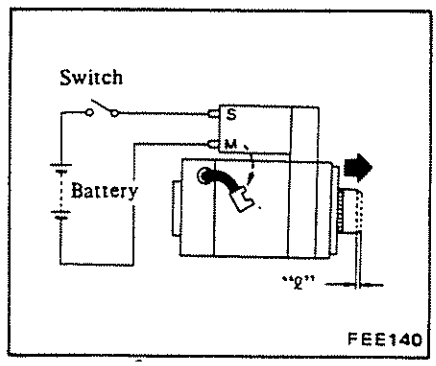


ASSEMBLY

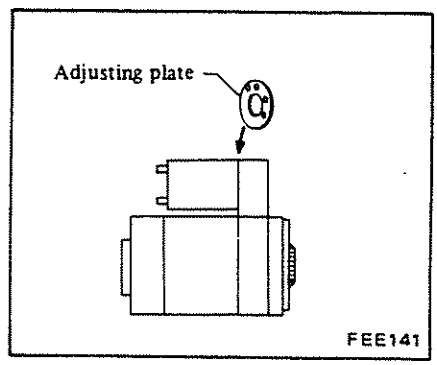
Apply high-temperature grease to lubricate the bearing, gears and frictional surface when assembling the starter.
Carefully observe the following instructions.

Pinion protrusion length adjustment

Compare movement " ℓ " in height of pinion when it is pushed out with magnetic switch energized and when it is pulled out by hand until it touches stopper.
Movement " ℓ ":
0.5 - 2.0 mm
(0.020 - 0.079 in)



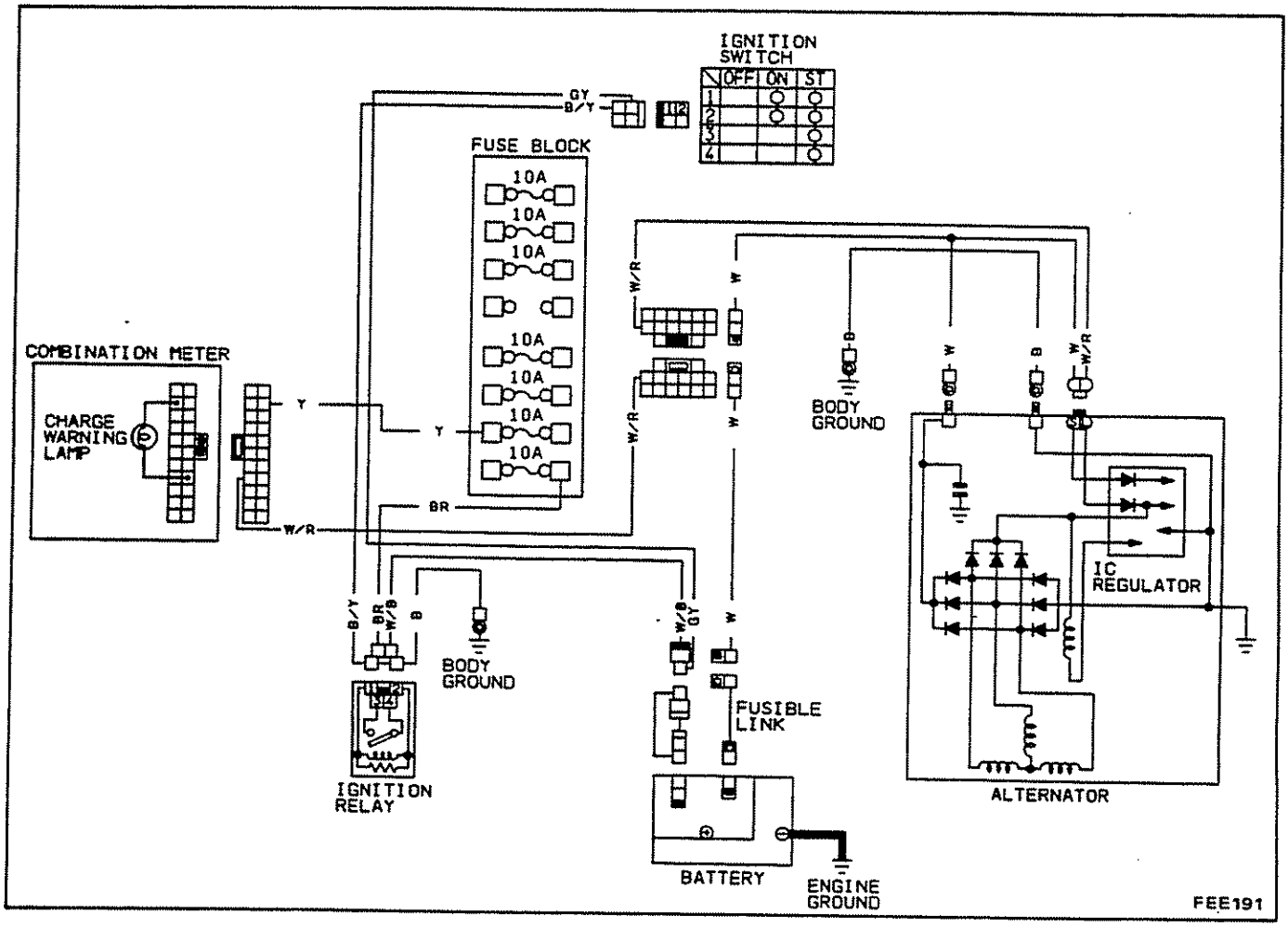
● Not in the specified value ... Adjust by adjusting plate.



CHARGING SYSTEM

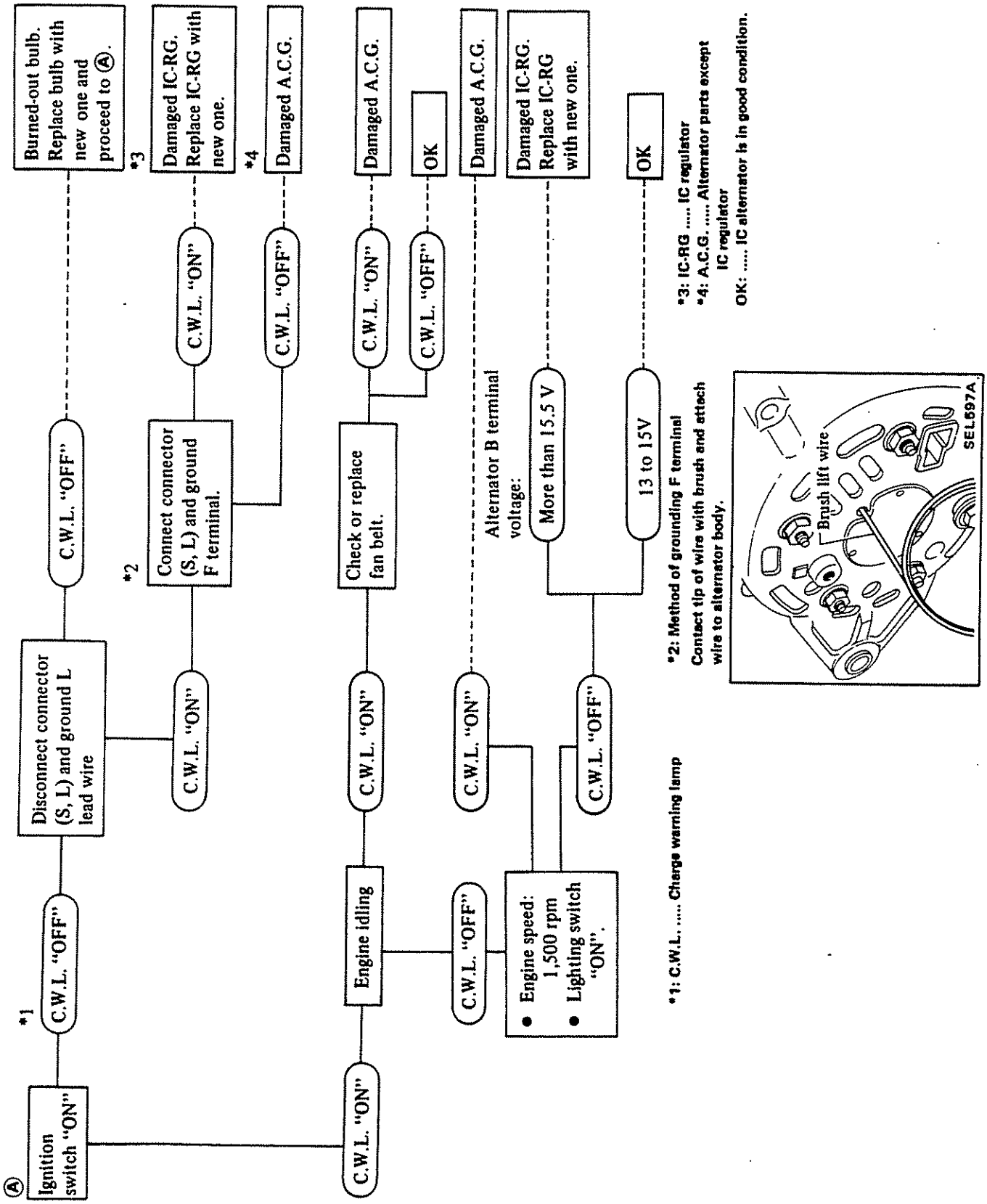
WARNING:
Before starting to work, be sure to turn ignition switch "OFF" and then disconnect battery ground cable.

WIRING DIAGRAM

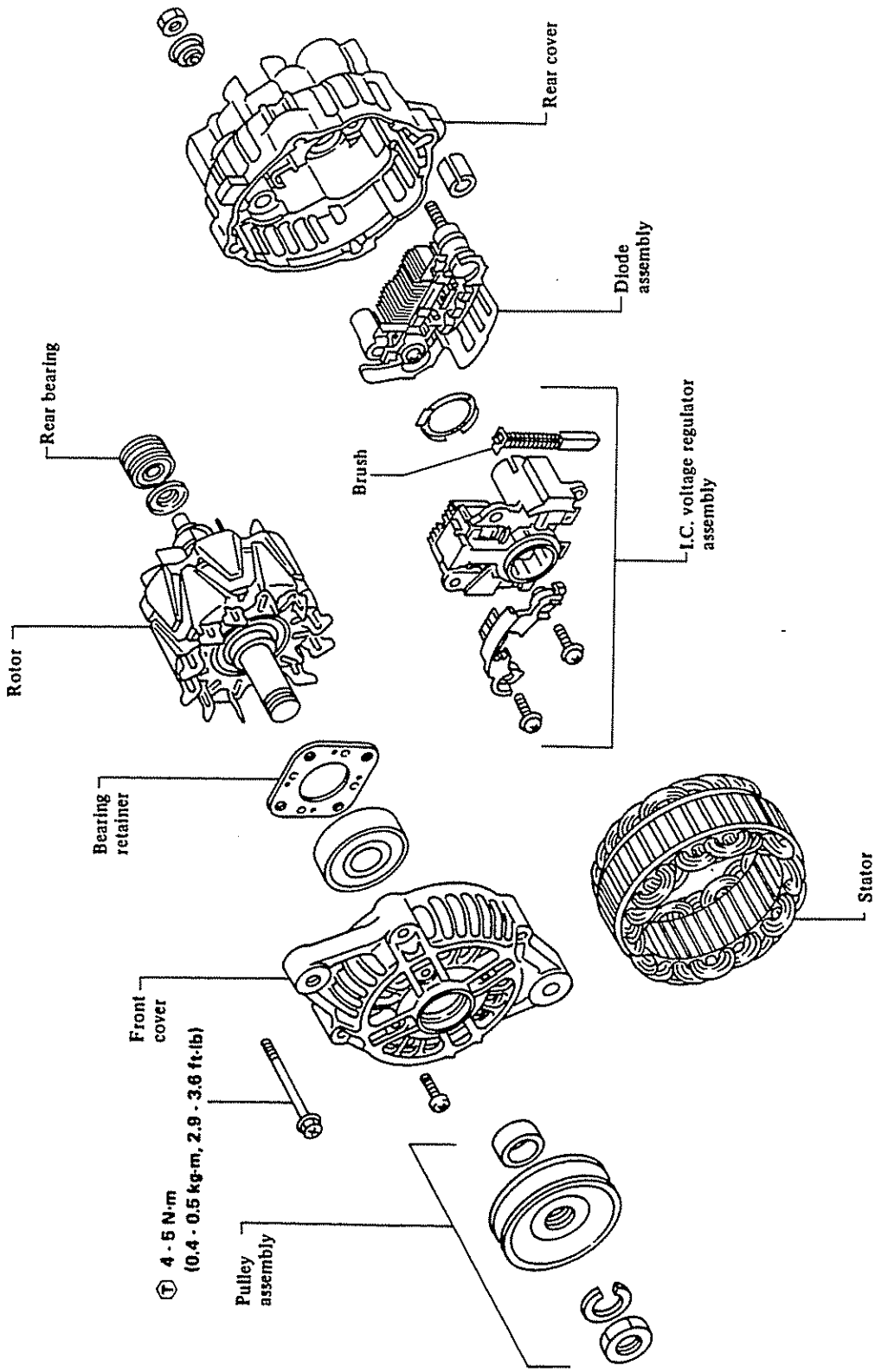


CHARGING SYSTEM TROUBLE-SHOOTING

- Before conducting an alternator test, make sure that the battery is fully charged.
- A 30-volt voltmeter and suitable test probes are necessary for the test.
- The alternator can be checked easily by referring to the Inspection Table.



ALTERNATOR

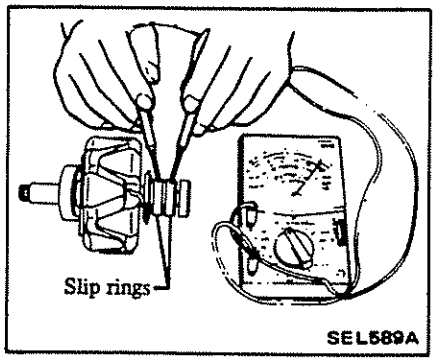


FEE192

INSPECTION

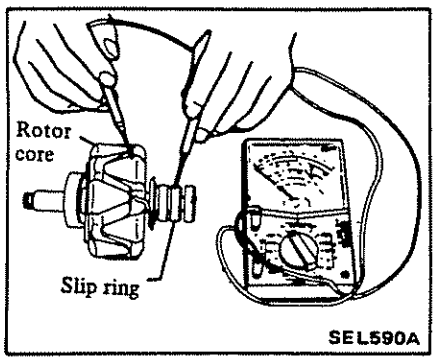
Rotor

1. Continuity test.



- No continuity ... Replace rotor.

2. Insulation test.



- Continuity exists ... Replace rotor.

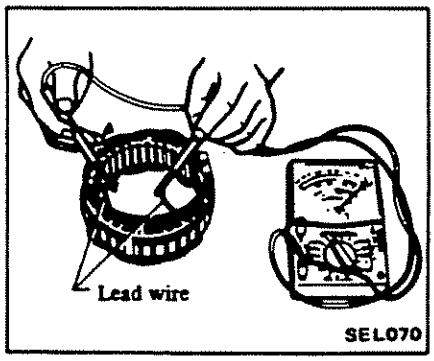
3. Check slip ring for wear.

Slip ring outer diameter:
Refer to S.D.S.

If necessary, replace rotor assembly.

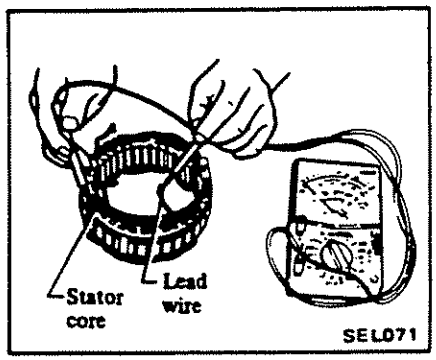
Stator

1. Continuity test



- No continuity ... Replace stator.

2. Insulation test



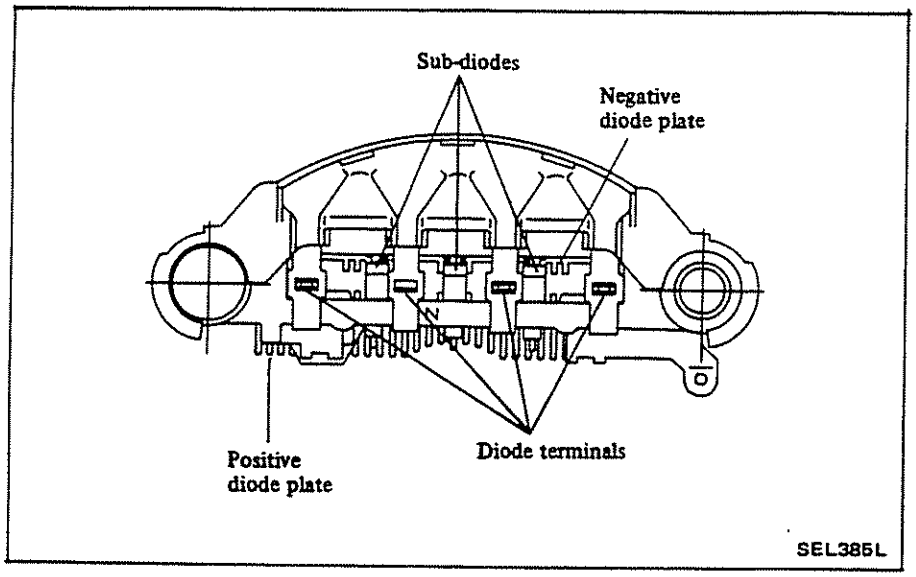
- Continuity exists ... Replace stator.

Diode

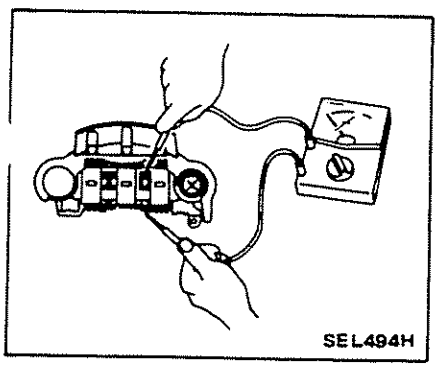
Main diodes

- Use an ohmmeter to check condition of diodes as indicated in chart below.
- If any of the test results is not satisfactory, replace diode assembly.

	Ohmmeter probes		Continuity
	Positive (+)	Negative (–)	
Diodes check (Positive side)	Positive diode plate	Diode terminals	Yes
	Diode terminals	Positive diode plate	No
Diodes check (Negative side)	Negative diode plate	Diode terminals	No
	Diode terminals	Negative diode plate	Yes



- Attach ohmmeter's probe to each end of diode to check for continuity.
- Continuity is N.G. ... Replace diode assembly.



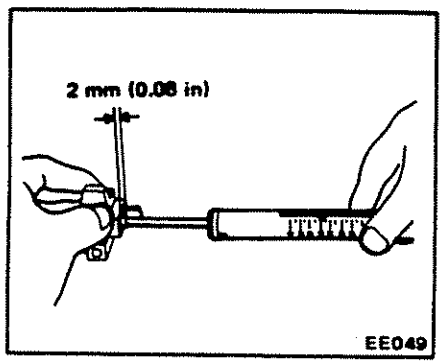
Brush

1. Check smooth movement of brush.
- Not smooth ... Check brush holder and clean.
2. Check brush for wear.
3. Check brush pig tail for damage.
- Damaged ... Replace.
4. Check brush spring pressure.

Measure brush spring pressure with brush projected approximately 2 mm (0.08 in) from brush holder.

Spring pressure:
Refer to S.D.S.

When brush is worn, pressure decreases approximately 0.196 N (20 g, 0.71 oz) at 1 mm (0.04 in) wear.

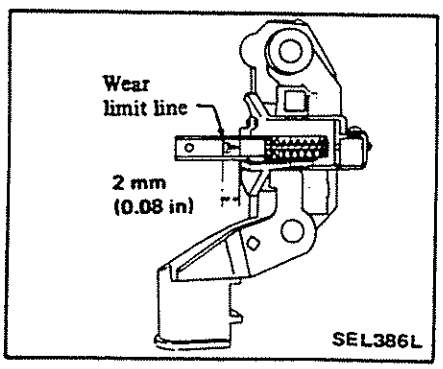


- Not in the specified value ... Replace brush assembly.

ASSEMBLY

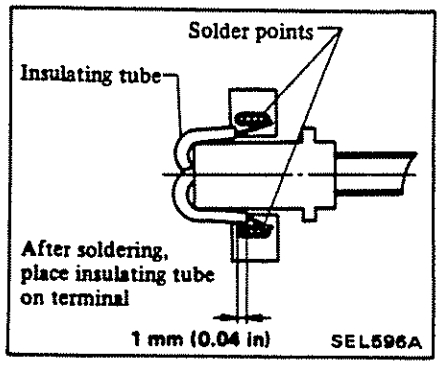
1. When soldering each stator coil lead wire to diode assembly terminal, carry out the operation as fast as possible.
2. When soldering brush lead wire, observe the following.

(1) Position brush so that its wear limit line protrudes 2 mm (0.08 in) beyond end face of brush holder.

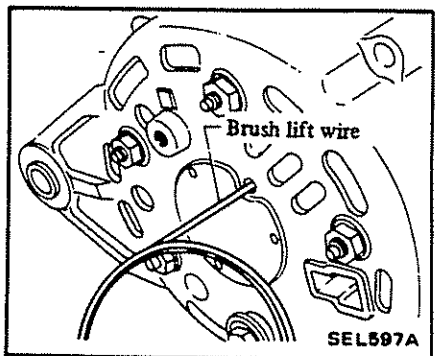


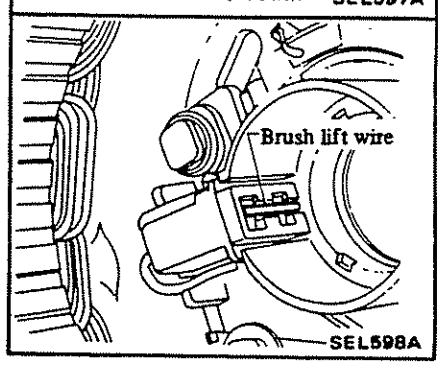
(2) Coil lead wire 1.5 times around terminal groove. Solder outside of terminal.

When soldering, be careful not to let solder adhere to insulating tube as it will weaken the tube and cause it to break.



3. Tighten pulley nut and make sure that deflection of V-groove is proper.
4. Before installing front and rear sides of alternator, push brush up with fingers and retain brush, by inserting brush lift wire into brush lift hole from outside.





5. After installing front and rear sides of alternator, pull brush lift wire by pushing toward outside of cover.

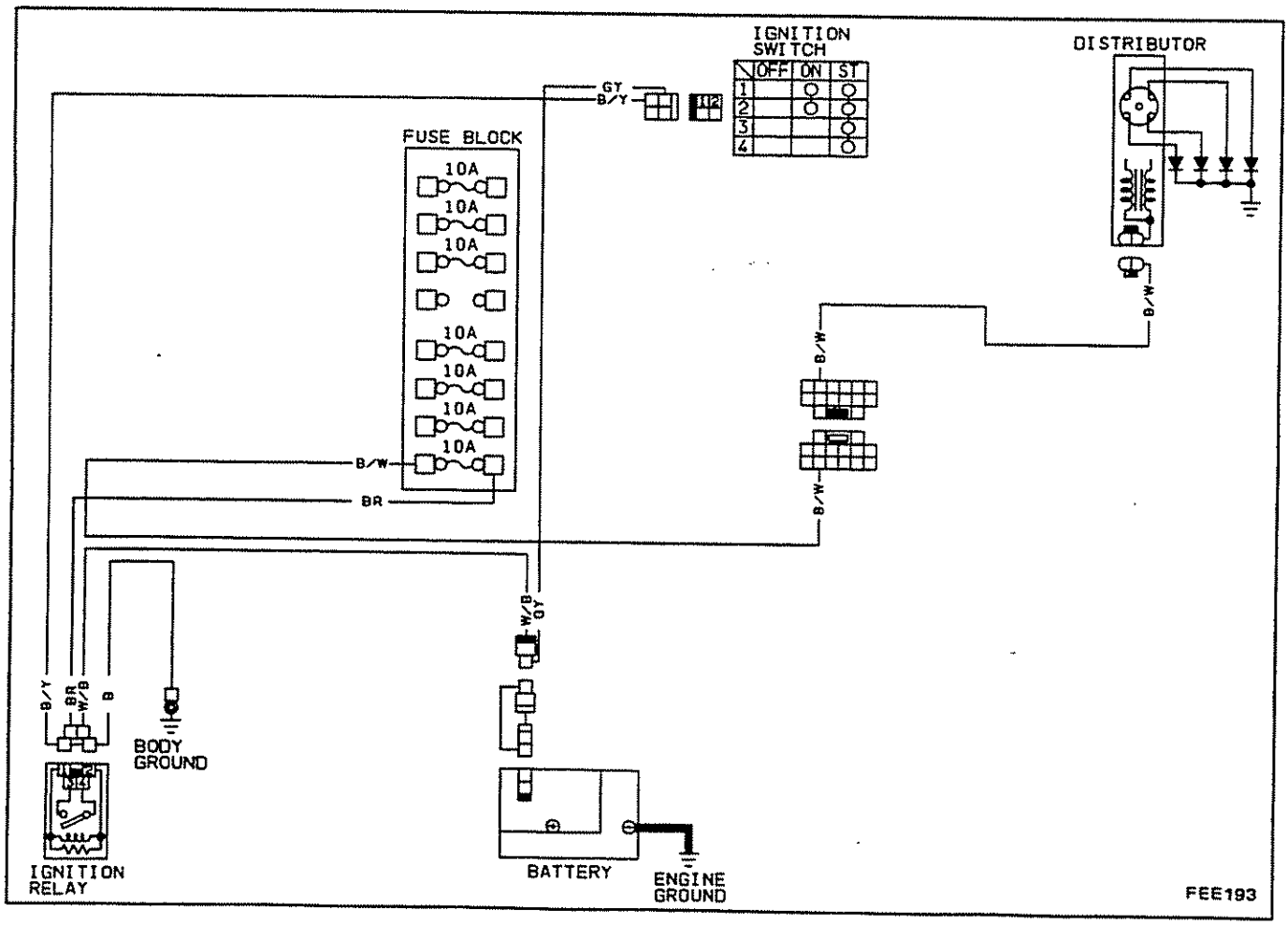
Do not pull brush lift wire by pushing toward center of cover as it will damage slip ring sliding surface.

6. Tighten through-bolts.

IGNITION SYSTEM

WARNING:
Before starting to work, be sure to turn ignition switch "OFF" and then disconnect battery ground cable.

WIRING DIAGRAM



IC IGNITION SYSTEM

IC IGNITION SYSTEM TROUBLE-SHOOTING

Engine turns erratically.

Engine cranks but does not start.

Check ignition timing.

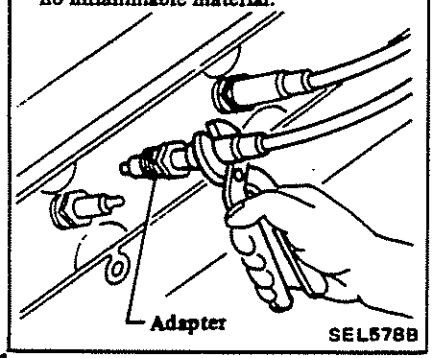
N.G. → Adjust.

O.K. →

Attach adapter *1 to high tension cable and position tip of adapter approx. 6 mm (0.24 in) away from cylinder block. With adapter held in that position, crank engine to see if spark jumps across gaps between tip and cylinder block at regular intervals.

Before cranking, disconnect fuel cut solenoid harness.

Before operation, make sure there is no inflammable material.



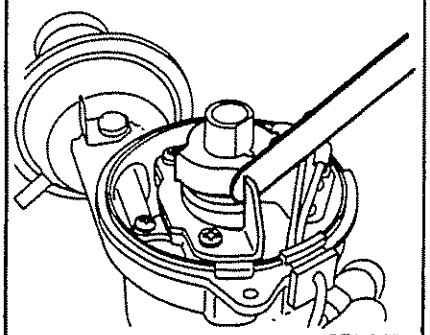
SEL578B

N.G.

Check air gap between reluctor and stator.

O.K.

Specified air gap ... Refer to S.D.S.



SEL640B

Check for burned or fouled spark plug.

N.G. → Clean or replace.

O.K. → Check fuel system.

Check IC ignition system.

IC Ignition System is checked using a volt-ohm-milliam-meter (V.O.M.). Follow the steps in the sequence indicated. If a fault is found, correct the problem before continuing. If all tests indicate "O.K." replace the IC Ignition Unit. DO NOT REPLACE THE UNIT UNTIL ALL TESTS HAVE BEEN COMPLETED AND INDICATE "O.K.".

Go to test table.

⚠ WARNING:

When current is flowing, never touch with bare hand high tension cables or any other parts with high voltage. If parts are moist, touching them could cause an electric shock, even if they are insulated. Always wear dry, well-insulated gloves or wrap affected parts with dry cloth before handling.

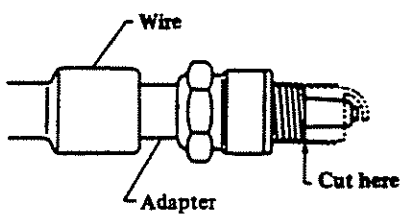
NOTE:

1. **When performing the following tests, use a multitester which can measure accurately in the following ranges; 0 to 20V. D.C.; 0 to 1,000Ω; 0 to 10V A.C.; 0 to 50,000Ω.**
2. **If possible, start the vehicles and let it run for 5 to 15 minutes with the hood closed. This will bring all components to normal operating temperature, and will make it easier to diagnose intermittent problems.**
3. **It is not necessary to disconnect the harness connectors when performing the tests which follow. Simply insert the meter probes into the back of appropriate connector cavity.**

*1:

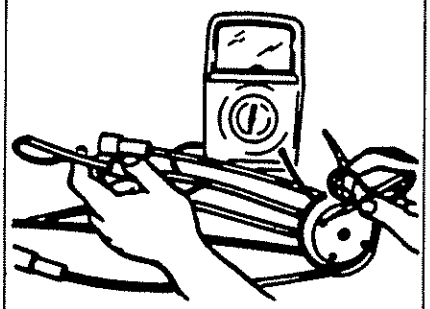
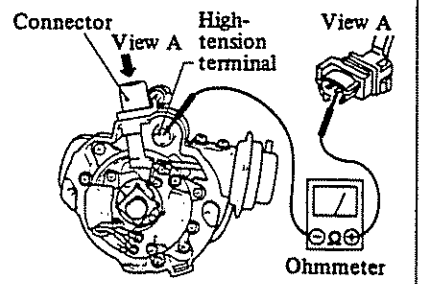
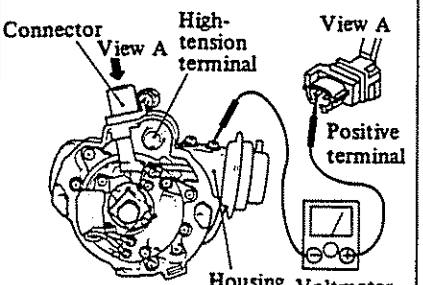
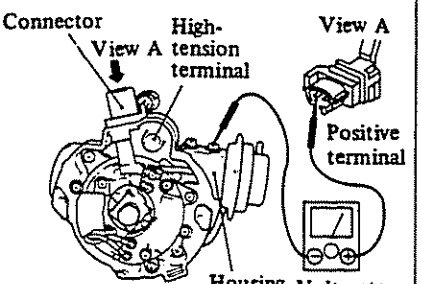
Preparation of spark plug for checking

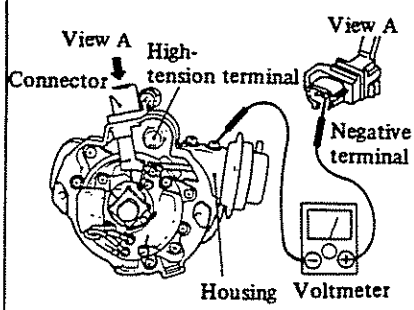
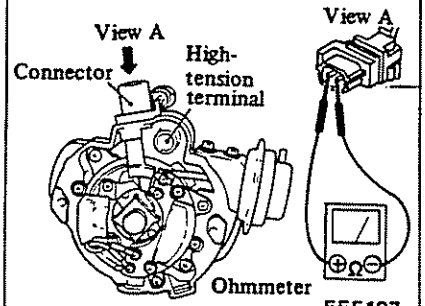
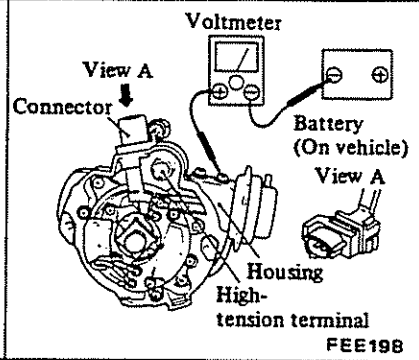
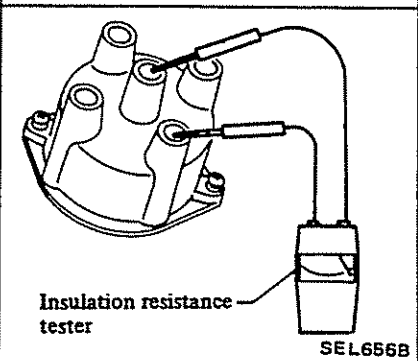
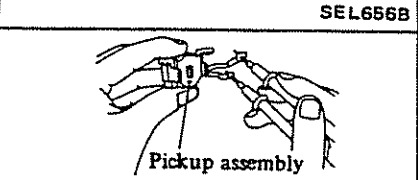
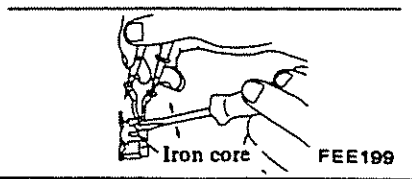
Many things can be utilized as an adapter. However, it is recommended that a used spark plug whose threaded portion has been half cut off as shown in the figure.



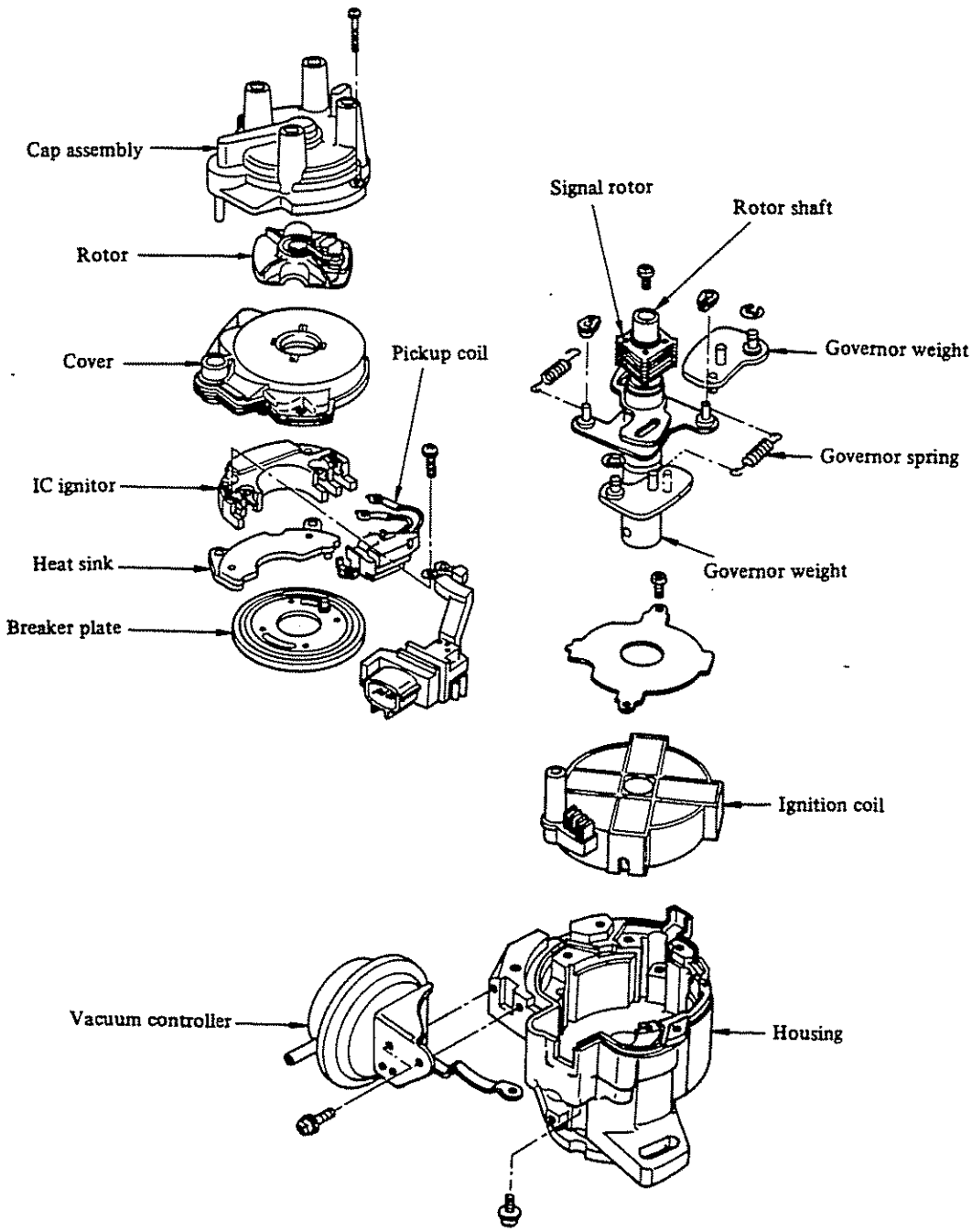
SEL581B

Test table

TEST	TEST METHOD	CONDITIONS	RESULT	ACTION
1. Secondary Wiring	 EF125	1. Connect ohmmeter as illustrated and measure the resistance of each high tension cable.	Resistance readings less than 30,000 ohms	Distributor cap and high tension cables – O.K. Proceed to Step 2.
			Resistance readings greater than 30,000 ohms	Replace high tension cable(s) and/or distributor cap as required.
2. Ignition Coil Secondary Circuit	 FEE194	1. Ignition key in "OFF" position. 2. Connect ohmmeter between positive terminal or negative terminal and high-tension terminal as illustrated.	20,000 - 29,000 ohms	Ignition coil secondary windings – O.K. Proceed to Step 3 for California
			Resistance reading not between 20,000 - 29,000 ohms.	Faulty ignition coil – replace.
3. Power Supply Circuit	 FEE195	1. Connect voltmeter as illustrated and set to appropriate scale. 2. Turn ignition key to "ON" position.	Above 11 volts	Proceed to Step 4.
			Below 11 volts	Check wiring from ignition switch to IC unit.
4. Power Supply Circuit (Cranking)	 FEE195	1. Connect voltmeter as illustrated and set to appropriate scale. 2. Turn key to "START" position and observe voltmeter while engine is cranking.	Voltage reading is less than 1 volt below battery cranking voltage and is greater than 8.6 volts.	Proceed to Step 5.
			Voltage reading is more than 1 volt below battery cranking voltage and/or is below 8.6 volts.	Check ignition switch and wiring from switch to IC unit.

TEST	TEST METHOD	CONDITIONS	RESULT	ACTION
5. Ignition Primary Circuit		1. Connect voltmeter as illustrated and set to appropriate scale. 2. Ignition key in "ON" position.	Above 11 volts	Proceed to Step 7.
			Below 11 volts	Proceed to Step 6.
6. Ignition Coil Primary Circuit		1. Ignition key in "OFF" position 2. Connect ohmmeter as illustrated.	0.9 - 1.2 ohms	Ignition coil primary winding O.K. Check ignition switch and wiring from ignition switch to coil and IC unit.
			Resistance reading not between 0.9 - 1.2 ohms	Faulty ignition coil – replace.
7. I.C. Unit Ground Circuit		1. Connect voltmeter as illustrated and set to appropriate scale. 2. Turn key to "START" position and observe voltmeter while engine is cranking.	0.5 volts or less	Proceed to Step 8.
			More than 0.5 volts	Check distributor ground, wiring from chassis ground to battery including battery cable connections.
8. Cap and Rotor Head		1. Measure insulation resistance between electrodes on ignition coil and side of spark plug.	50 megaohms or more	Cap and rotor head – O.K. Proceed to Step 9.
			Less than 50 megaohms	Replace cap and rotor head.
9. Pickup Coil	 	1. Remove IC ignition unit and pickup coil. 2. Connect ohmmeter as illustrated. 3. Ensure ohmmeter pointer deflects when screwdriver blade passes near pickup assembly's iron core.	420 - 540 ohms	Pickup coil – O.K. Proceed to Step 10.
			Resistance reading not between 420 - 540 ohms	Replace pickup coil.
10. I.C. Ignition	If all tests are good, replace IC ignition unit assembly.			

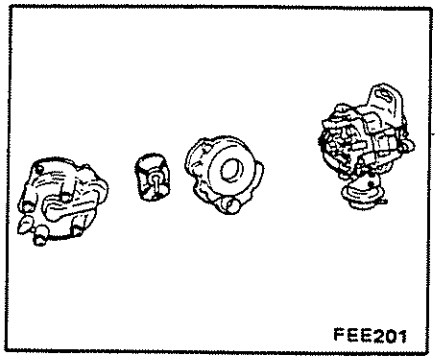
DISTRIBUTOR



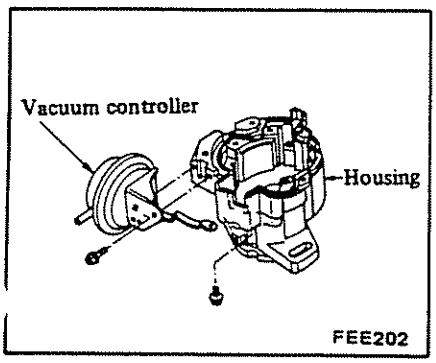
FEE200

DISASSEMBLY

1. Remove cap and rotor head.

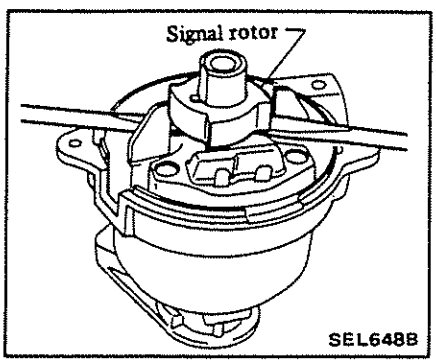


2. Remove vacuum controller.



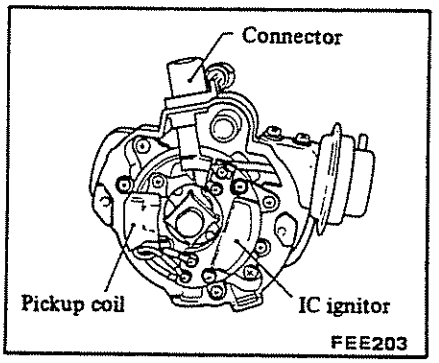
3. Insert a flat-bladed screwdriver under lower side of signal rotor, and pry signal rotor from shaft. Remove roll pin from signal rotor.

CAUTION:
When removing signal rotor, be careful not to distort or damage the teeth.

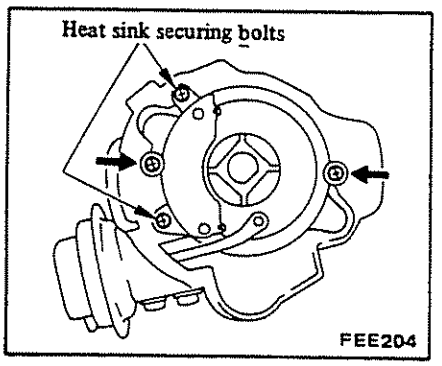


4. Remove four screws securing pick-up coil and connector terminal to IC ignitor.
5. Remove four screws securing IC ignitor and pickup coil.
6. Slide connector out of housing.

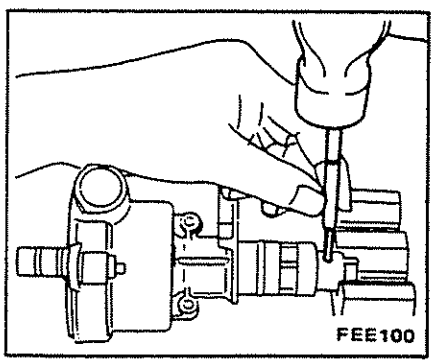
CAUTION:
Do not place pickup coil in an area where there are iron fillings.



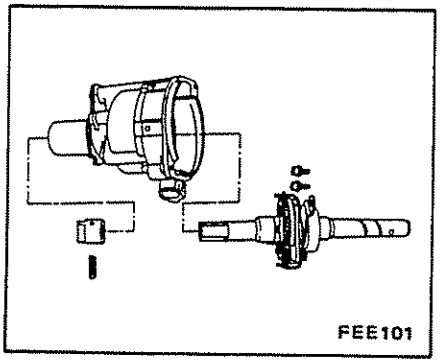
7. Remove heat sink and breaker plate securing bolts (shown by arrows), then remove heat sink.



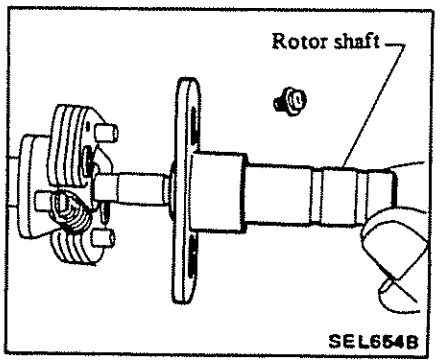
8. Knock roll pin out and remove collar.



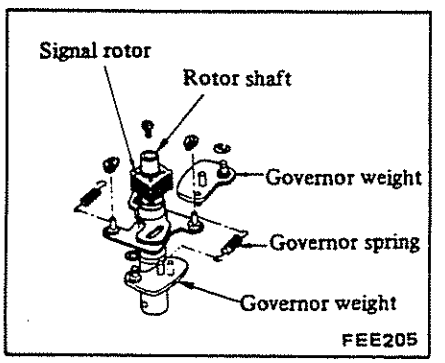
9. Remove two screws.
10. Draw out shaft assembly from housing.



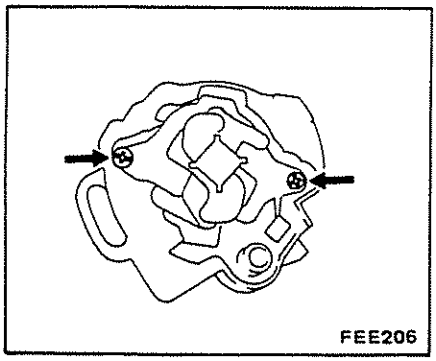
11. Unscrew rotor shaft setscrew. Remove rotor shaft.



12. Remove governor weight and governor spring from the shaft assembly.



13. Before removing ignition coil from housing, remove securing bolts (shown by arrows).



INSPECTION

Carbon point

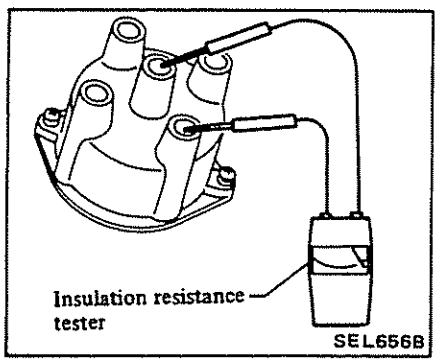
Check length of carbon point inside cap.

Carbon point length:
Refer to S.D.S.

Cap and rotor head

Measure insulation resistance between electrodes on ignition coil and side of spark plug.

Insulation resistance:
Refer to S.D.S.



- Less than specified value ... Replace.

Signal rotor

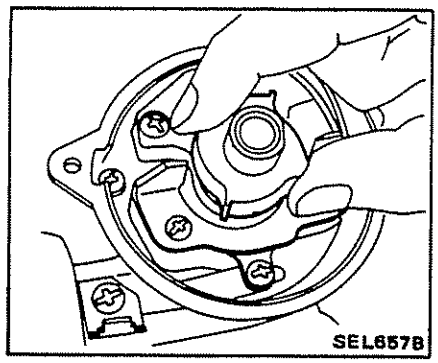
- Check signal rotor for bending or scratches. If necessary, replace.

Breaker plate

- If breaker plate shows any signs of binding or dragging, replace.

Centrifugal advance mechanical parts

- While preventing the shaft from turning, turn signal rotor counterclockwise by hand and release it. It should return to its original position.



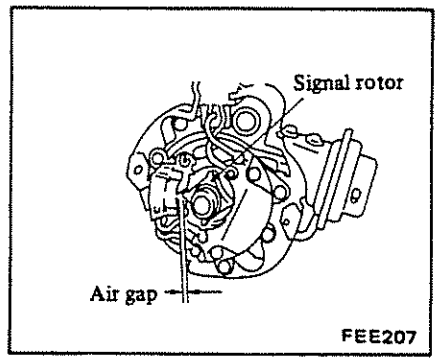
Vacuum advance mechanical parts

Apply negative pressure to vacuum controller with a vacuum pump to see if leakage is present. Also check breaker plate for smooth movement.

- If leak is found, replace vacuum controller.
- If breaker plate does not move smoothly, this condition could be due to sticky steel balls or pivot. Apply grease to steel balls or, if necessary, replace breaker plate assembly.

Air gap

Check air gap between signal rotor and pickup coil.



Air gap:
Refer to S.D.S.

ASSEMBLY

To assemble, reverse order of disassembly. Note the following:

Apply grease to:

- Shaft bearing metal
- Governor spring
- Frictional surface of governor weight
- Frictional surface of breaker plate

ENGINE REMOVAL
(ER)

—H15/H20-II/H25 ENGINE—

CONTENTS

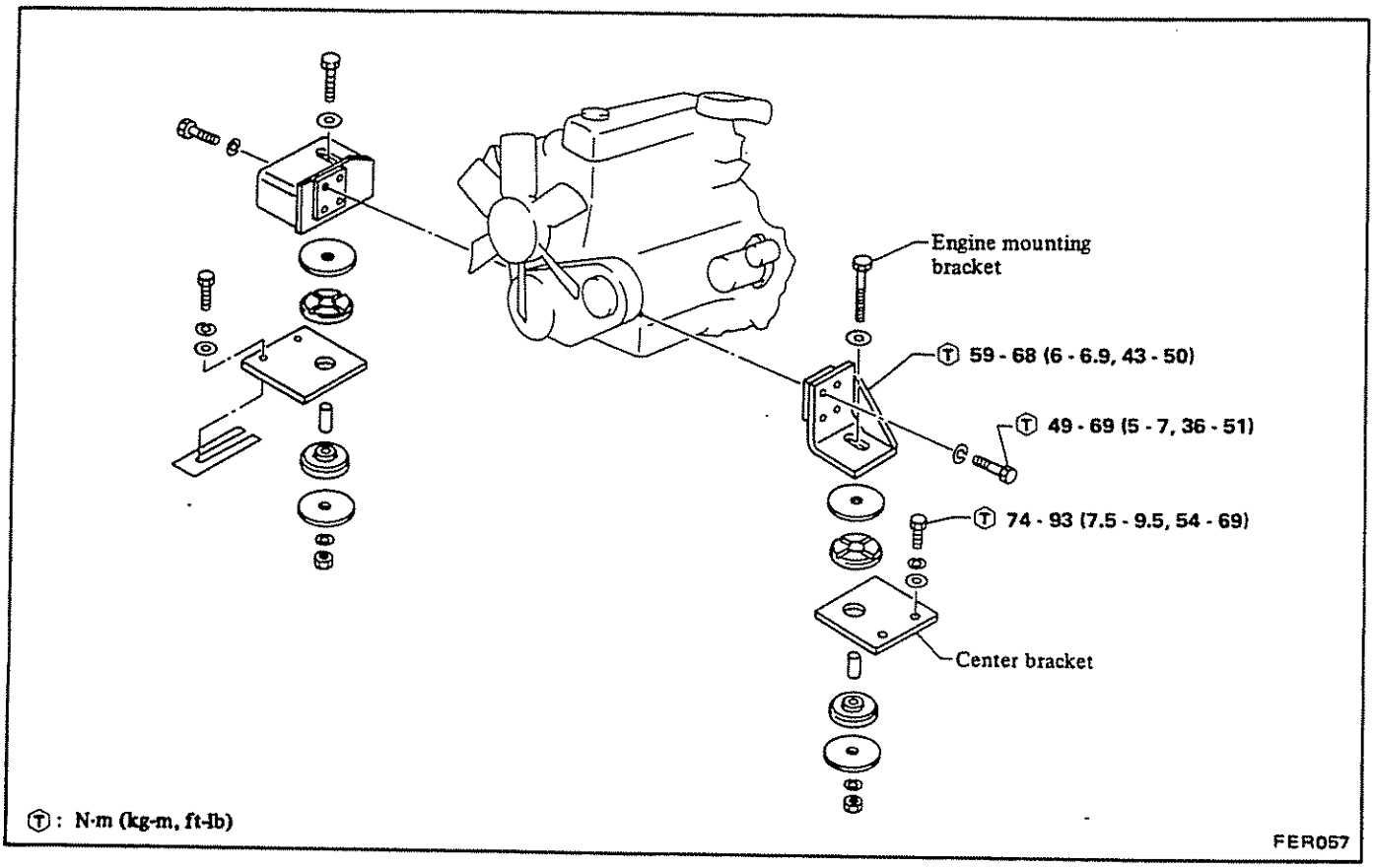
SERVICE DATA AND SPECIFICATIONS

TIGHTENING TORQUE

Unit	N·m	kg-m	ft-lb
Engine			
Engine to mounting bracket			
M10	59 - 68	6.0 - 6.9	43 - 50
Mounting bracket to center bracket			
M14	49 - 69	5 - 7	36 - 51
Center bracket			
M12	74 - 93	7.5 - 9.5	54 - 69

ENGINE REMOVAL AND INSTALLATION

CONSTRUCTION



DESCRIPTION

The removal and installation of the engine is rather heavy work. Safety precautions and precise operational procedures must be observed. There are two methods for engine removal.
They are Method 1 and Method 2 as described below.
Method 1 is used to remove only the engine assembly, while Method 2 is used to remove the engine, transmission and differential carrier as an assembly.

REMOVAL

⚠ WARNING:

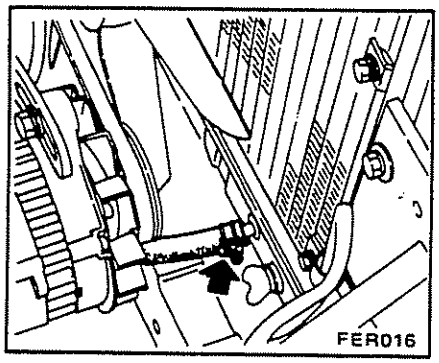
a. Before removal, the battery ground cable should be disconnected.
b. Place wheel chocks in front of front wheels and at rear of rear wheels.
c. Do not remove the engine until the exhaust system has completely cooled off.
d. Before raising engine, try loosening wires two or three times to make sure it is safe to do so.
e. When raising engine, be especially careful not to hit it against adjacent parts.

METHOD 1

1. Disconnect battery ground cable.
2. Place chocks on front and rear wheels to prevent lift truck from movement.
3. Remove top panel, radiator cover, floor board and top panel support assembly.
4. Remove radiator reservoir tank and air cleaner assembly.
5. Remove radiator shroud from radiator.
6. Open radiator drain cock to drain coolant.

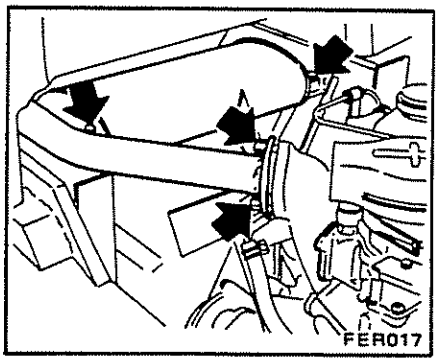
⚠ WARNING:
Before working on engine, check that coolant is cool.

7. Disconnect both upper and lower radiator hoses from radiator.
8. Disconnect two oil cooler hoses from radiator (A/T models). After disconnecting, plug hose openings to prevent oil from flowing out.

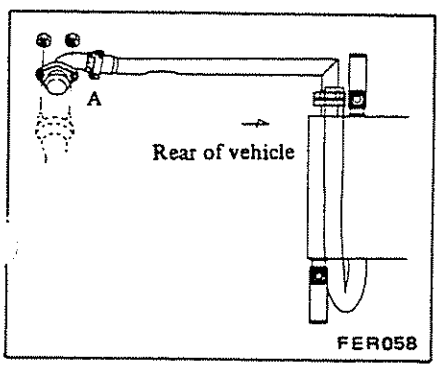


9. Remove radiator.
10. Remove muffler assembly.

⚠ WARNING:
Before removing muffler, check that it is cool.

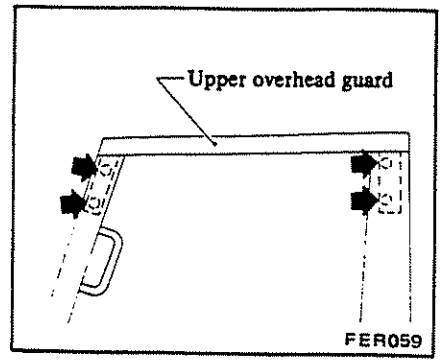


⚠ WARNING:
On 1 ton (2,000 lb) models, do not attempt to disassemble part "A" (see Figure below).

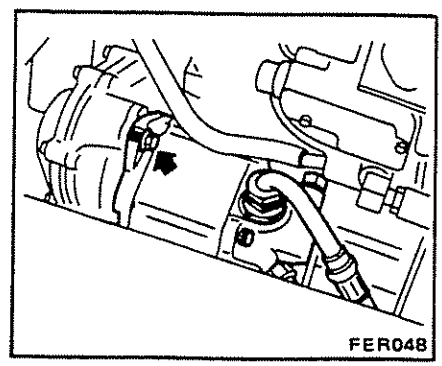


11. Disconnect accelerator and choke control wires from carburetor.
12. Disconnect engine ground cable from engine.
13. Disconnect wires from the following parts.
- Inhibitor switch
- Back-up lamp switch
- Distributor
- Ignition coil
- Starter
- Alternator
- Carburetor
- Water thermo sensor
- Oil pressure switch
- Oil thermo sensor (A/T models)

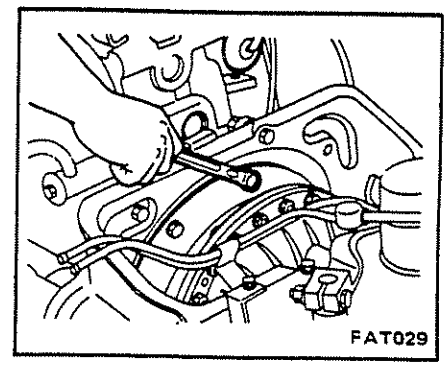
14. Disconnect fuel hose and vacuum hose from engine.
15. Remove upper overhead guard.



16. Attach wire ropes to engine slingers and slightly lift engine.
17. Remove engine mounting center bolts from both sides.
18. Remove hydraulic oil pump from engine and support it at body side.



19. Remove drive plate securing bolts (A/T models) or clutch assembly.



20. Support transmission with wooden block.
21. Remove bolts securing engine to transmission housing, and separate engine and transmission.
22. Gradually lift engine assembly and move it away from lift truck.

⚠ WARNING:
Be careful not to hit engine assembly against any adjacent parts while it is being lifted.

Approx. engine weight:

H15	**170 kg (375 lb)**
H20-II	**170 kg (375 lb)**
H25	**170 kg (375 lb)**

METHOD 2

1. Use the same procedures (steps 1 through 15) as under Method 1.

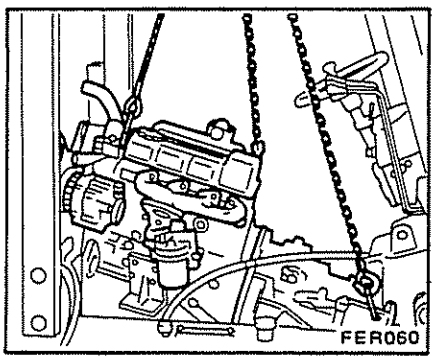
Refer to Method 1.

2. Remove two bolts (Hand brake cable retaining bolts) securing engine to transmission.
3. Drain brake fluid.
4. Disconnect vacuum hose from brake booster.
5. Remove brake tubes from brake master cylinder.

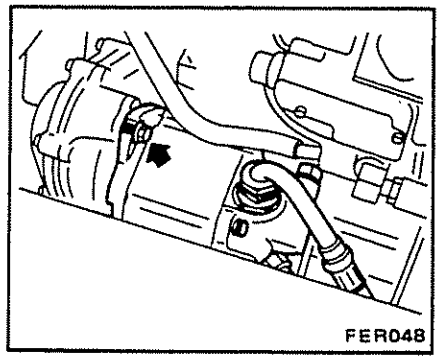
Use tools GG94310000 to remove brake flare nut. Never use open end or adjustable wrench.

6. Remove inching rod.
7. Remove pedal bracket assembly with pedals, brake booster and master cylinder.
8. Remove F-R gear shift rod from control rod. (A/T models)
Remove F-R lever and gear shift lever (M/T models).
9. Drain A/T fluid and differential oil.

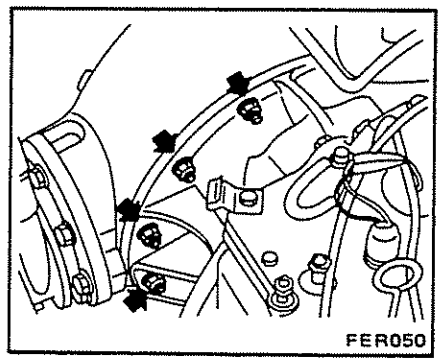
10. Remove micron filter with bracket.
11. Remove steering wheel.
12. Remove both sides of drive shaft.
13. Attach wire ropes to engine slingers and gear carrier housing as shown below, and slightly lift engine.



14. Remove engine mounting center bolts from both sides.
15. Remove hydraulic oil pump from engine and support it at body side.



16. Remove nuts securing differential carrier housing to drive axle housing.



17. Gradually lift engine with transmission and differential carrier and move it away from lift track.

⚠ WARNING:
Carefully separate differential carrier and drive axle housing. Be careful not to hit engine with transmission and differential carrier against any adjacent parts while it is being lifted.

Approx. engine weight:

H15	350 kg (772 lb)
H20-II	350 kg (772 lb)
H25	350 kg (772 lb)

INSTALLATION

Installation is in the reverse order of removal.

CAUTION:
a. **When installing, be sure to check that electrical harnesses are correctly connected.**
b. **After installation, adjust accelerator control system.**
c. **Do not forget to add engine coolant.**

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OVERSEAS SALES DEPARTMENT
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