

NISSAN

MODEL **A12**

&

A15

INDUSTRIAL ENGINE
SERVICE MANUAL



NISSAN

Model A12 & A15 Industrial Engine

FOREWORD

This service manual has been prepared primarily for the purpose of assisting service personnel in providing effective service and maintenance of the model A12 & A15 industrial engine.

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/DATSUN dealer for information.

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

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HOW TO USE THIS MANUAL

- ▶ This Service Manual is designed as a guide for servicing the model A12 & A15 industrial engine.
- ▶ A **QUICK REFERENCE INDEX** is provided on the first page. Refer to this index along with the index of the particular section you wish to consult.
- ▶ The first page of each section lists the contents and gives the page numbers for the respective topics.
- ▶ **SERVICE DATA AND SPECIFICATIONS** are contained in each section.
- ▶ A list of **SPECIAL SERVICE TOOLS** is included in each section. The special service tools are designed to assist you in performing repair safely, accurately and quickly.
- ▶ The measurements given in this manual are primarily expressed with the SI unit (International System of Unit), and alternately expressed in the metric system and in the yard/pound system.
- ▶ In the text, the following abbreviations are used:
 - S.D.S. : Service Data and Specifications
 - Ⓣ : Tightening Torque
- ▶ The captions **CAUTION** and **WARNING** warn you of steps that must be followed to prevent personal injury and/or damage to some part of the engine.



IMPORTANT SAFETY NOTICE

The proper performance of service is essential for both the **safety of the mechanic and the efficient functioning of the engine.**

The service methods in this Service Manual are described in such a manner that the service may be performed safely and accurately.

Special service tools have been designed to permit safe and proper performance of service. Be sure to use them.

Service varies with the procedures used, the skills of the mechanic and the tools and parts available. Accordingly, anyone using service procedures, tools or parts which are not specifically recommended by NISSAN must first completely satisfy himself that neither his safety nor the engine's safety will be jeopardized by the service method selected.

GENERAL INFORMATION



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GENERAL SPECIFICATIONS

GENERAL SPECIFICATIONS

Engine model	A12	A15
Item		
Engine general specifications	Gasoline	
Classification	Gasoline	
Cycle	4	
No. of cylinders and arrangement	4, in-line	
Valve arrangement	O.H.V. (Overhead valve)	
Bore x stroke mm (in)	73 x 70 (2.87 x 2.76)	76 x 82 (2.99 x 3.23)
Displacement cm ³ (cu in)	1,171 (71.45)	1,488 (90.80)
Compression ratio	9.0	
Number of piston rings	2	
Oil	1	
Number of main bearings	5	
Valve clearance (Hot) mm (in)		
Intake	0.35 (0.014)	
Exhaust	0.35 (0.014)	
Engine idle speed rpm	650	
Ignition timing at idle speed B.T.D.C. degree/rpm	12°/650	10°/650
Recommended minimum octane number (RON)	88	
Engine oil capacity ℓ (US qt, Imp qt)		
With oil filter	3.2 (3-3/8, 2-7/8)	
Without oil filter	2.7 (2-7/8, 2-3/8)	

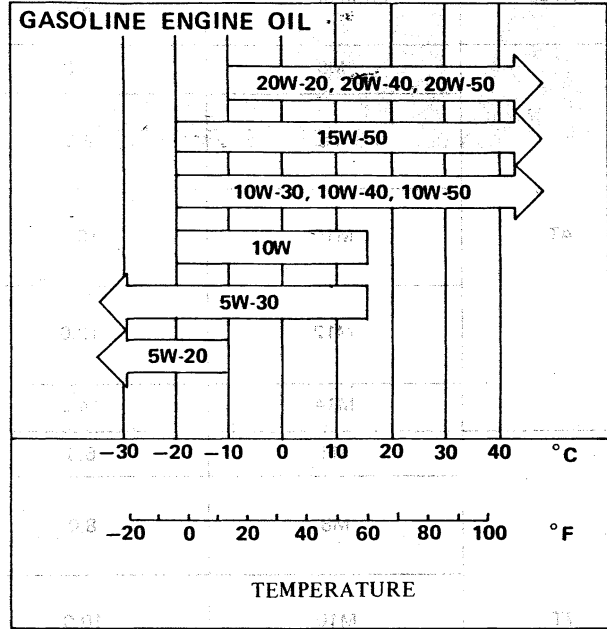
Engine model	A12	A15	
Item			
Lubrication system	Trochoid gear		
Oil pump type	Trochoid gear		
Oil filter type	Paper element (Cartridge)		
Cooling system	Centrifugal		
Water pump type	Centrifugal		
Thermostat operating temperature °C (°F)	76.5 (170) ... For tropical area 82 (180), 88 (190) ... For cold area		
Engine fuel system	Down draft, 1-barrel		
Carburetor type	Down draft, 1-barrel		
Air cleaner	Dry paper		
Filter type	Dry paper		
Alternator			
Model	MITSUBISHI	A1T24371	
Capacity	V-A	12-35	
Voltage regulator model	MITSUBISHI	ROB2220B5	
Starter motor			
Model	MITSUBISHI	M2T20181	
Capacity	kW	0.8	
Ignition system	1-3-4-2		
Firing order	1-3-4-2		
Ignition coil model	MITSUBISHI	HP5-13E10	
Distributor model	MITSUBISHI	T3T03571	T3T03581
Spark plug	NGK	B4ES	

RECOMMENDED LUBRICANTS

LUBRICANTS

Lubricant	Specifications	Remarks
Gasoline engine oil	API SD or SE	For further details, refer to the recommended SAE viscosity chart.
Anti-freeze	—	Ethylene glycol base

SAE VISCOSITY NUMBER



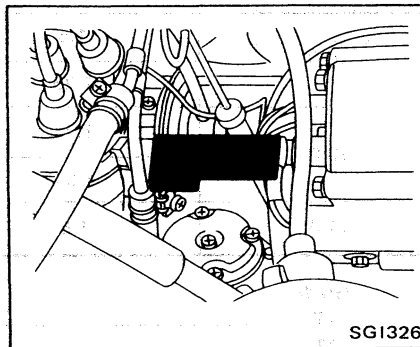
ENGINE SERIAL NUMBER LOCATION

The engine serial number is stamped on the right side of cylinder block.

A12 - XXXXXX X
A15 - XXXXXX X

Serial No.

Engine model



TIGHTENING TORQUE OF STANDARD BOLT

Grade	Nominal size	Diameter mm	Pitch mm	Tightening torque		
				N-m	kg-m	ft-lb
4T	M6	6.0	1.0	3 - 4	0.3 - 0.4	2.2 - 2.9
	M8	8.0	1.25	8 - 11	0.8 - 1.1	5.8 - 8.0
			1.0	8 - 11	0.8 - 1.1	5.8 - 8.0
	M10	10.0	1.5	16 - 22	1.6 - 2.2	12 - 16
			1.25	16 - 22	1.6 - 2.2	12 - 16
	M12	12.0	1.75	26 - 36	2.7 - 3.7	20 - 27
1.25			30 - 40	3.1 - 4.1	22 - 30	
M14	14.0	1.5	46 - 62	4.7 - 6.3	34 - 46	
7T	M6	6.0	1.0	6 - 7	0.6 - 0.7	4.3 - 5.1
	M8	8.0	1.25	14 - 18	1.4 - 1.8	10 - 13
			1.0	14 - 18	1.4 - 1.8	10 - 13
	M10	10.0	1.5	25 - 35	2.6 - 3.6	19 - 26
			1.25	26 - 36	2.7 - 3.7	20 - 27
	M12	12.0	1.75	45 - 61	4.6 - 6.2	33 - 45
1.25			50 - 68	5.1 - 6.9	37 - 50	
M14	14.0	1.5	76 - 103	7.7 - 10.5	56 - 76	
9T	M6	6.0	1.0	8 - 11	0.8 - 1.1	5.8 - 8.0
	M8	8.0	1.25	19 - 25	1.9 - 2.5	14 - 18
			1.0	20 - 27	2.0 - 2.8	14 - 20
	M10	10.0	1.5	36 - 50	3.7 - 5.1	27 - 37
			1.25	39 - 51	4.0 - 5.2	29 - 38
	M12	12.0	1.75	65 - 88	6.6 - 9.0	48 - 65
1.25			72 - 97	7.3 - 9.9	53 - 72	
M14	14.0	1.5	109 - 147	11.1 - 15.0	80 - 108	

1. Special parts are excluded.
2. This standard is applicable to bolts having the following marks embossed on the bolt head.

Grade	Mark
4T	4
7T	7
9T	9

MAINTENANCE

SECTION MA



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MAINTENANCE SCHEDULE

MAINTENANCE SCHEDULE

MAINTENANCE OPERATION Periodic maintenance should be performed after specified intervals have elapsed in month or hours, whichever comes first.	MAINTENANCE INTERVAL												
	Months	1	2	3	4	5	6	7	8	9	10	11	12
	Hundreds of hours	2	4	6	8	10	12	14	16	18	20	22	24
Retighten cylinder head bolts, manifolds & exhaust tube nuts & carburetor attaching nuts		X											
Adjust intake & exhaust valve clearance		X		X			X			X			X
Check drive belts for cracks, fraying, wear and tension		X	X	X	X	X	X	X	X	X	X	X	X
Change engine oil (1)		X	X	X	X	X	X	X	X	X	X	X	X
Replace engine oil filter (1)		X		X			X			X			X
Change engine anti-freeze coolant (L.L.C., Ethylene glycol base)													X
Change engine coolant (Soft water)													X
Clean radiator outside (2)													
Check cooling system hoses & connections (2)													
Clean or replace fuel strainer element (2)													
Check or replace fuel strainer (2)													
Check fuel lines (Hoses, piping, connections, etc.) (2)													
Clean & replace air cleaner element (Dry paper type) (1)	Clean	X	X	X	X	X		X	X	X	X	X	
	Replace						X						X
Check crankcase ventilation hose													X
Check & replace spark plugs	Check	X	X	X	X	X	X	X	X	X	X	X	
	Replace												X
Check distributor point, cap and rotor		X	X	X	X	X	X	X	X	X	X	X	X
Check ignition wiring													X
Adjust ignition timing		X	X	X	X	X	X	X	X	X	X	X	X
Adjust engine idle rpm		X	X	X	X	X	X	X	X	X	X	X	X

NOTE: (1) Under dusty or other dirty operating conditions, more frequent maintenance should be necessary.

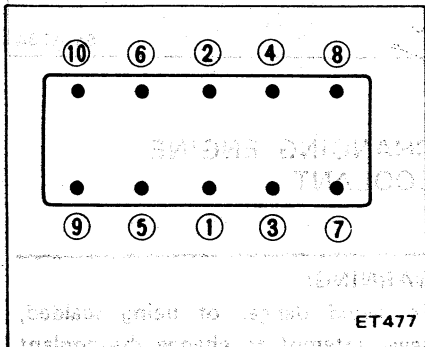
(2) Follow the original equipment manufacturer's (O.E.M.) instructions.

Check: Check, correct and replace if necessary.

ENGINE MAINTENANCE

RETIGHTENING CYLINDER HEAD

1. Warm up engine sufficiently.
2. Tightening should be made in the sequence shown.



Ⓣ : 69 - 74 N-m
(7.0 - 7.5 kg-m,
51 - 54 ft-lb)

RETIGHTENING MANIFOLD CARBURETOR AND EXHAUST TUBE

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

Ⓣ : Manifold nut and bolt
9 - 14 N-m
(0.9 - 1.4 kg-m,
6.5 - 10.1 ft-lb)

Carburetor nut
5 - 7 N-m
(0.5 - 0.7 kg-m,
3.6 - 5.1 ft-lb)

Exhaust tube nut
20 - 25 N-m
(2.0 - 2.6 kg-m,
14 - 19 ft-lb)

ADJUSTING INTAKE AND EXHAUST VALVE CLEARANCE

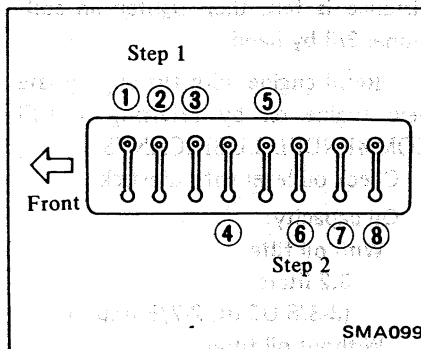
Adjustment should be made while engine is warm but not running.

1. Start engine and warm it up until water temperature indicator points to

- middle of gauge. 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 and ⑤.

(2) Set No. 4 cylinder in top dead center on its compression stroke and adjust valve clearance ④, ⑥, ⑦ and ⑧.

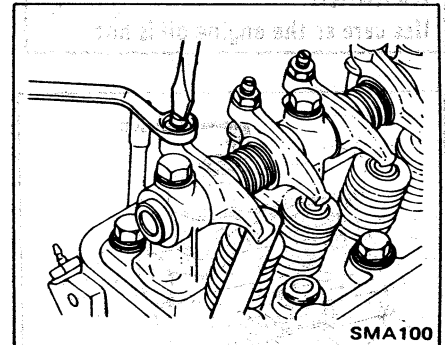


Valve clearance (Hot):
Intake and exhaust
0.35 mm (0.014 in)

If necessary adjust as follows:
Loosen valve rocker adjusting screw lock nut and turn adjusting screw until specified clearance is obtained.

After adjustment, tighten lock nut and recheck clearance.

Ⓣ : Adjusting screw lock nut
16 - 22 N-m
(1.6 - 2.2 kg-m,
12 - 16 ft-lb)



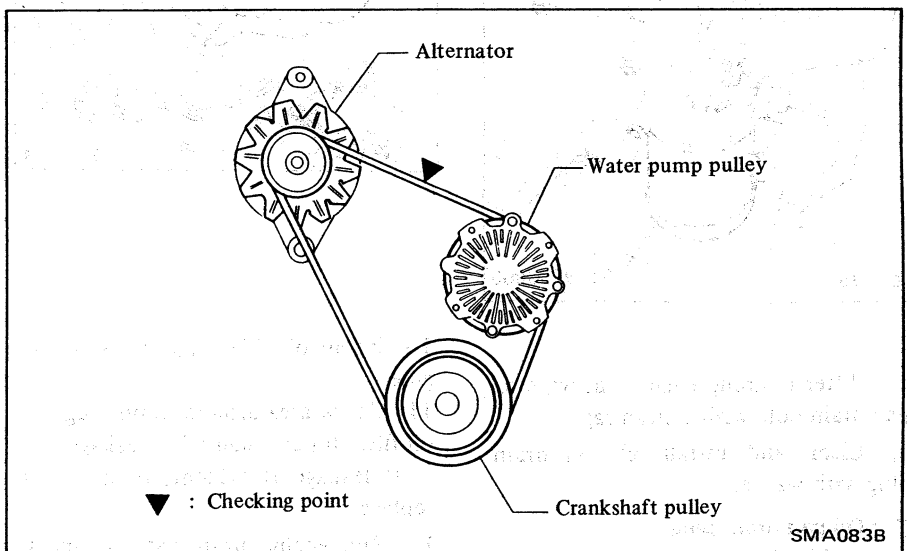
CHECKING AND ADJUSTING DRIVE BELTS

1. Inspect for cracks or damage. Replace if necessary.
2. Check drive belt deflections by pushing midway between pulleys.

Adjust if necessary.

Drive belt deflection:
8 - 12 mm (0.31 - 0.47 in)

Pushing force:
98 N (10 kg, 22 lb)



FAN AND ALTERNATOR BELT

1. Loosen the upper and lower alternator securing bolts until the alternator can be moved slightly.

2. Move the alternator with a prying bar until the belt tension is within the specified range. Then tighten the bolts securely.

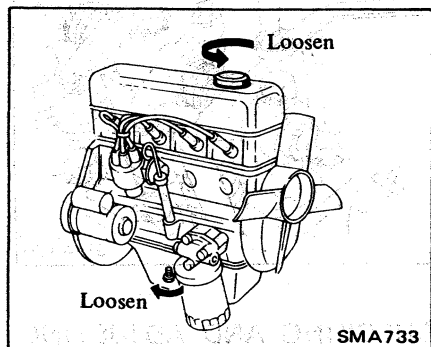
ENGINE MAINTENANCE

CHANGING ENGINE OIL AND REPLACING OIL FILTER

1. Start engine and warm it up until water temperature indicator points to middle of gauge, then turn off engine.
2. Remove oil filler cap and oil pan drain plug, and allow oil to drain.

WARNING:

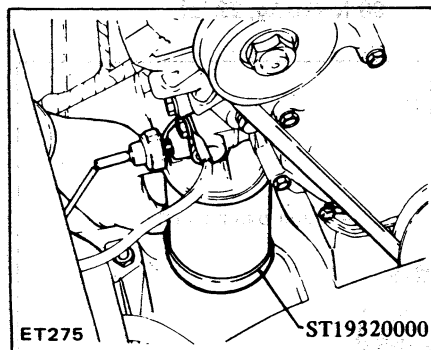
Use care as the engine oil is hot.



SMA733

- 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.

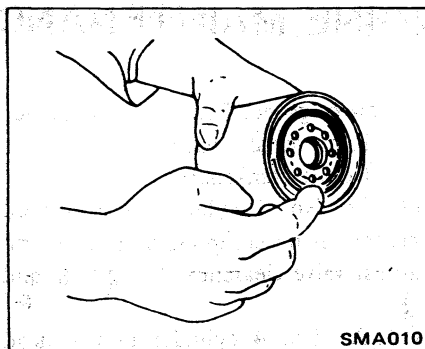
3. Using oil filter wrench, remove oil filter.



4. After draining engine oil, wipe oil pan drain hole with a clean rag.
5. Clean and install oil pan drain plug with washer.

Ⓣ : Oil pan drain plug
20 - 29 N·m
(2.0 - 3.0 kg·m, 14 - 22 ft·lb)

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



8. Install new oil filter by hand.

Screw in oil filter until a slight resistance is felt, then tighten an additional 2/3 by hand.

9. Refill engine with the appropriate new engine oil by referring to RECOMMENDED LUBRICANTS.

Check oil level with dipstick.

Oil capacity:

With oil filter

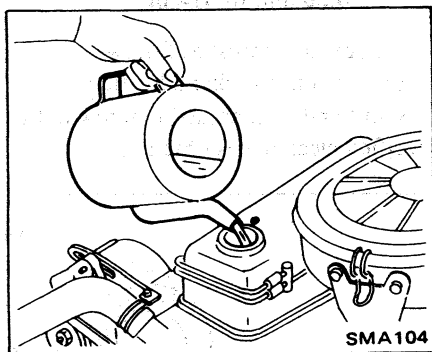
3.2 liters

(3-3/8 US qt, 2-7/8 Imp qt)

Without oil filter

2.7 liters

(2-7/8 US qt, 2-3/8 Imp qt)



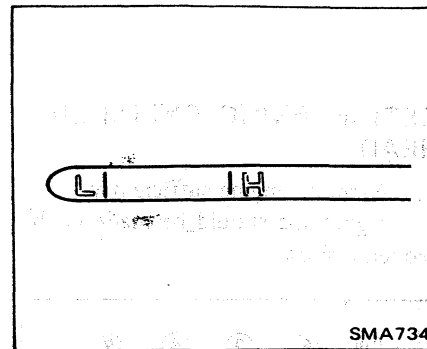
10. Install oil filler cap and start engine.

11. Check area around drain plug and oil filter for any sign of oil leakage.

If leakage is evident, retighten or replace.

12. Run engine until water temperature indicator points to middle of gauge. Then turn off engine and wait several minutes. Check oil level with dipstick. If necessary, add engine oil.

When checking oil level, park car on a level surface.



CHANGING ENGINE COOLANT

WARNING:

To avoid 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.

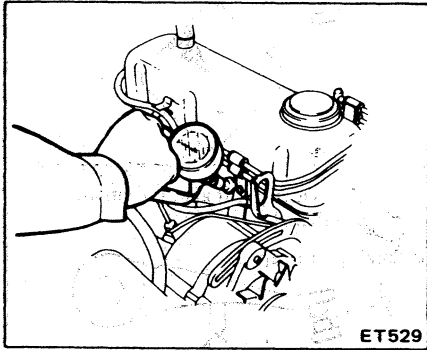
CHECKING COOLING SYSTEM, HOSES AND CONNECTIONS

Check hoses and fittings for loose connections or deterioration. Retighten or replace if necessary.

CHECKING ENGINE COMPRESSION PRESSURE

1. Warm up engine until water temperature indicator points to middle of gauge.
2. Remove all spark plugs.
3. Disconnect anti-dieseling solenoid valve connector.

4. Properly attach a compression tester to spark plug hole in cylinder being tested.



5. Depress accelerator pedal to fully open throttle and choke valve.
6. Crank engine and read gauge indication.
 - Run engine at about 350 rpm.
 - Engine compression measurement should be made as quickly as possible.

Compression pressure:

kPa (bar, kg/cm ² , psi)/at rpm
Standard
1,245 (12.45, 12.7, 181)/350
Minimum
981 (9.81, 10.0, 142)/350

7. If cylinder compression in one or more cylinders is low, pour a small amount of engine oil into cylinders through the spark plug holes and retest compression.
 - If adding oil helps the compression pressure, chances are that piston rings are 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 past the gasketed surface.
Oil and water in combustion chambers can result from this problem.

REPLACING FUEL FILTER

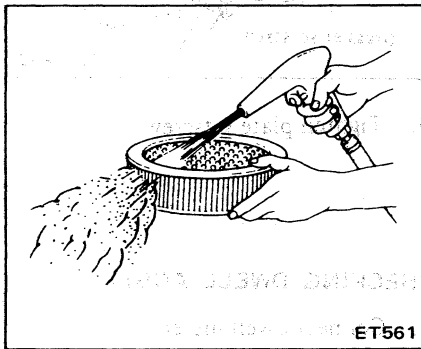
1. Check for a contaminated filter, and water deposit. If a malfunction is detected, replace as an assembly.
2. Replace fuel filter in accordance with the maintenance schedule.

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

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

CLEANING AND REPLACING AIR CLEANER ELEMENT (Dry paper type)

1. Remove air cleaner cover and filter element.
2. Blow dust off inner side of element with dry compressed air.



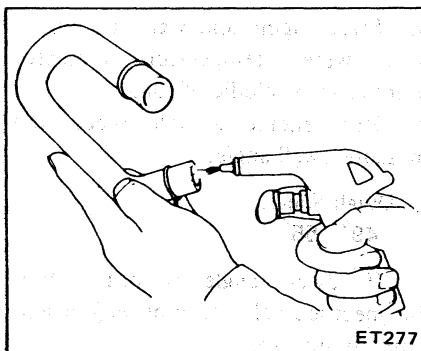
3. Wipe inside of air cleaner housing and cover with damp cloth.

Be careful not to drop into carburetor.

4. Install element and air cleaner cover.

CHECKING CRANKCASE VENTILATION HOSE

1. Check hoses and hose connections for leaks.
2. Check each hose for cracks or distortion.
3. Disconnect all hoses and blow them out with compressed air.

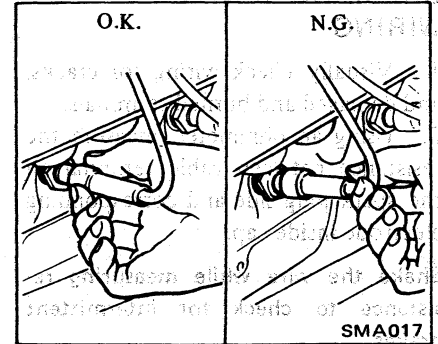


If any hose cannot be made free of obstructions, replace with a new one.

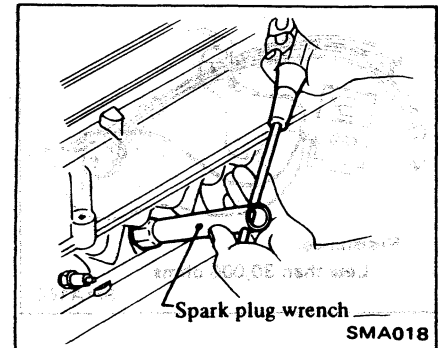
4. Insure that the flame arrester is surely inserted in the hose, between the air cleaner and rocker cover.

CHECKING AND REPLACING SPARK PLUGS

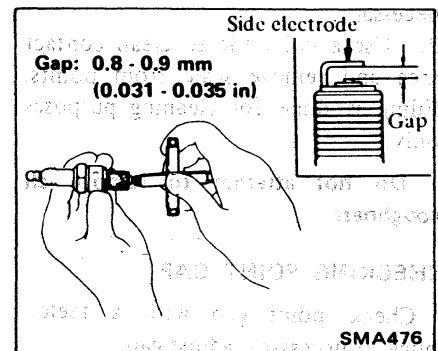
1. Disconnect spark plug wire at boot. Do not pull on the wires.



2. Remove spark plugs with spark plug wrench.



3. Clean plugs in sand blast cleaner. And inspect insulation for cracks or chips. If they are excessively worn, replace with new spark plugs.
4. Using feeler gauge, check spark plug gap.
If it is not within specified range, set gap by bending side electrode.



ENGINE MAINTENANCE

Spark plug:

Standard type
B4ES

5. Install spark plugs. Reconnect high tension cables according to Nos. indicated on them.

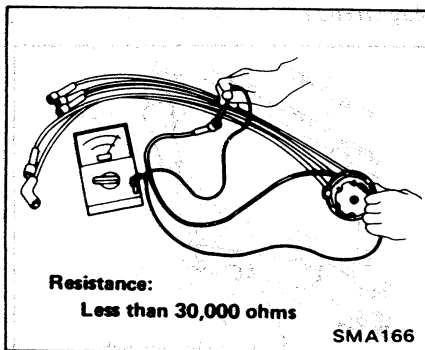
Ⓣ : Spark plug

15 - 20 N·m
(1.5 - 2.0 kg·m,
11 - 14 ft·lb)

CHECKING IGNITION WIRING

1. Visually check wiring for cracks, and damaged and burned terminals.
2. Using an ohmmeter, measure the resistance between cable terminal on the spark plug side and corresponding electrode inside cap.

Shake the wire while measuring resistance to check for intermittent brakes.



CHECKING AND REPLACING DISTRIBUTOR BREAKER POINTS

VISUAL CHECK

1. Inspect points for excessive burning or pitting. Replace points if necessary.
2. Use a point file to clean contact area and remove scale from points. Filing is done for cleaning purposes only.

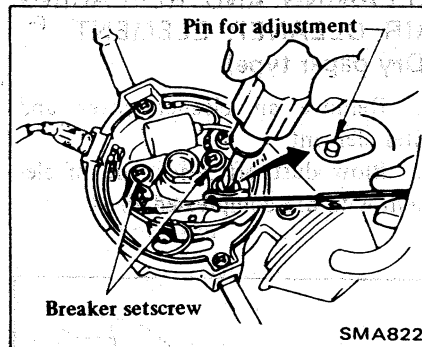
Do not attempt to remove all roughness.

CHECKING POINT GAP

Check point gap with a feeler gauge. If necessary, adjust gap.

1. Loosen breaker point plate setscrews.
2. Move breaker point plate by pivoting it around projected pin so that contact point gap can be adjusted to the specified value.

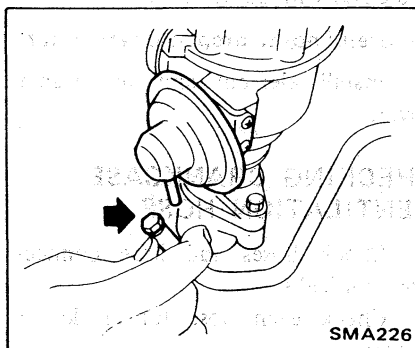
Distributor point gap:
0.45 - 0.55 mm (0.018 - 0.022 in)



3. Tighten plate setscrew.

CHECKING DWELL ANGLE

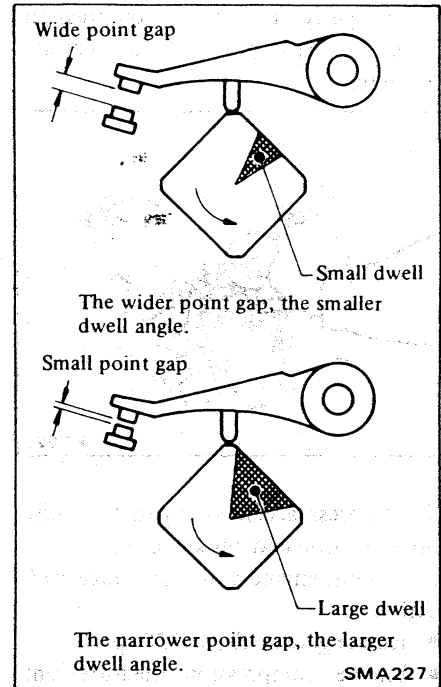
1. Connect dwell meter.
2. Disconnect distributor vacuum hose from distributor vacuum controller, and plug hose with proper plug.



3. Start engine and warm up engine until water temperature indicator points to the middle of gauge.
4. Run engine at idle speed and measure dwell angle.

Dwell angle:
49° - 55°

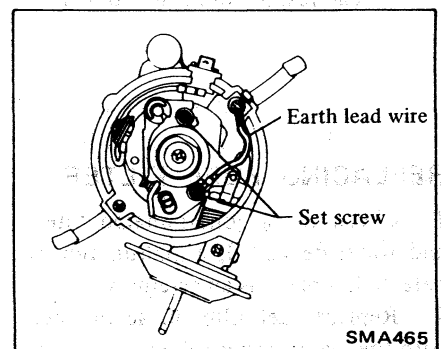
5. If dwell angle is not within the specified value turn off engine and adjust point gap.



6. Recheck dwell angle.
7. Repeat this procedure until specified point gap and dwell angle are obtained. If dwell angle is not within the specified valve when point gap is correct, cam lobe is worn. Replace cam.

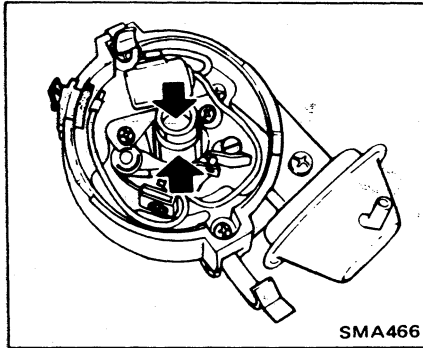
REPLACING DISTRIBUTOR BREAKER POINT

1. Remove earth lead wire and set screws and then remove breaker point.



ENGINE MAINTENANCE

2. Install new breaker point. Apply grease to distributor cam and head.



3. Check point gap and dwell angle. If necessary, adjust it.

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

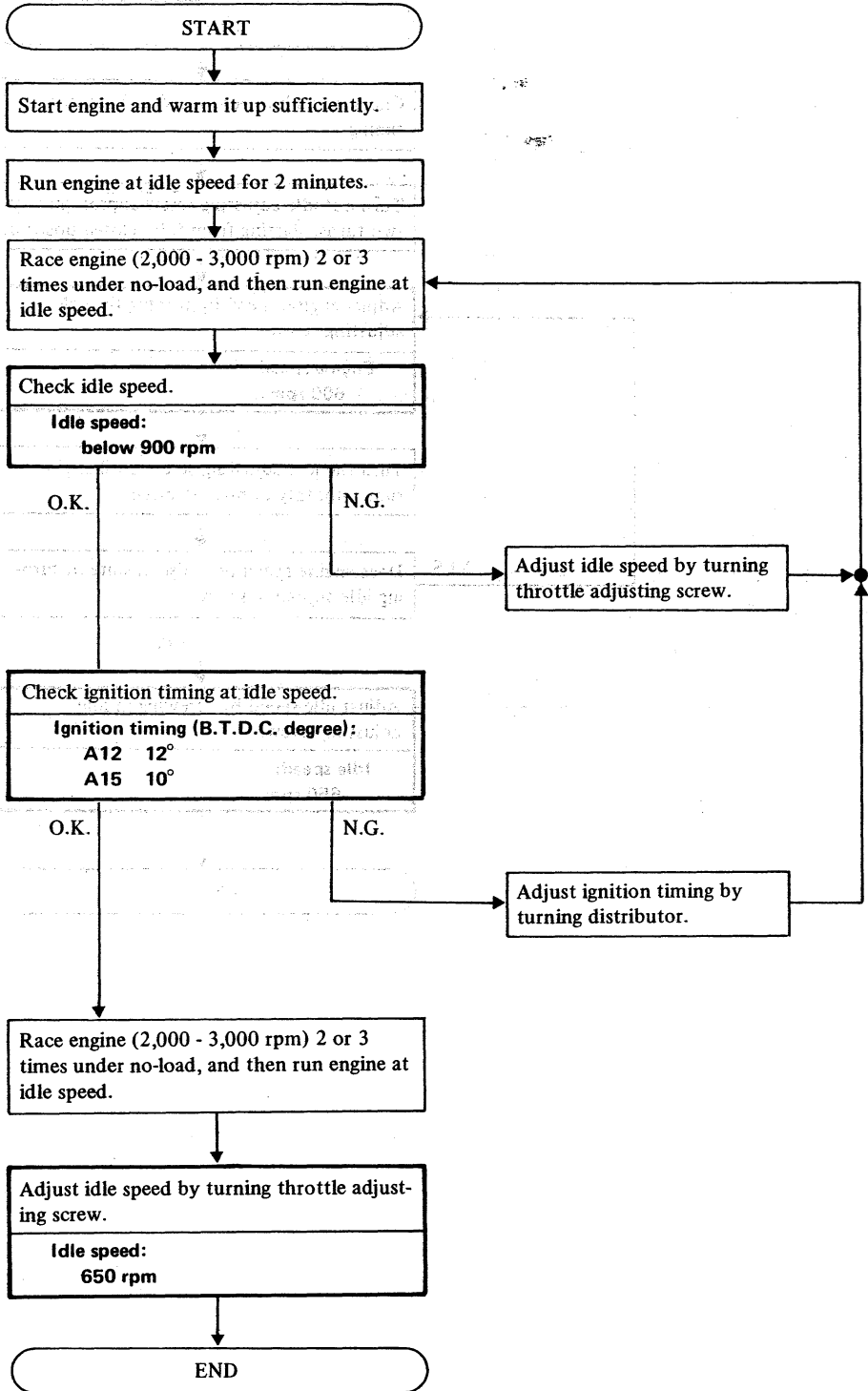
CAUTION:

- 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

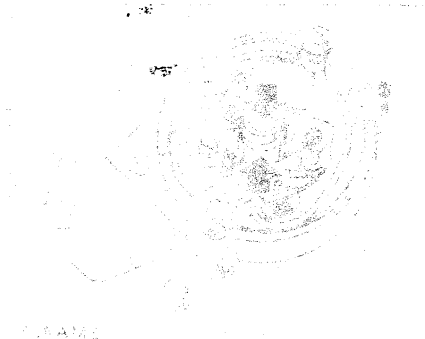
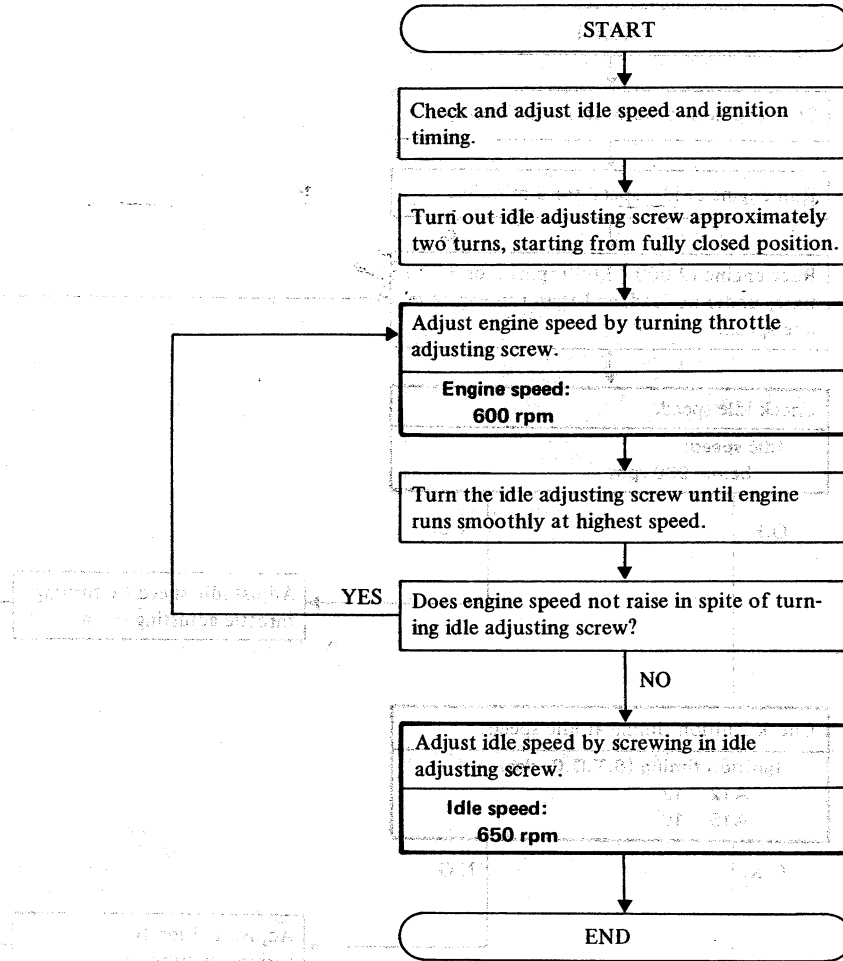
1. Make sure that the following parts are in good order.
 - Ignition system
 - Engine oil and coolant levels
 - Valve clearance
 - Float level at idling speed
2. Set shift lever in "Neutral" position.

Checking and adjusting idle-rpm and ignition timing



ENGINE MAINTENANCE

Checking and adjusting mixture ratio



CAUTION:
Idle mixture ratio is adjusted to factory and repairs no further adjustment is necessary. If adjustment is required, follow the following steps:
1. Do not attempt to screw the idle adjusting screw down completely. Doing so could cause damage to the valve which in turn will cause mixture ratio malfunctions.

CAUTION:
Idle mixture ratio is adjusted to factory and repairs no further adjustment is necessary. If adjustment is required, follow the following steps:
1. Do not attempt to screw the idle adjusting screw down completely. Doing so could cause damage to the valve which in turn will cause mixture ratio malfunctions.

- 1. Make sure that the following parts are in good order:
 - Ignition system
 - Engine oil and control levels
 - Valve clearance
 - Air filter level
 - Fuel filter level

SERVICE DATA AND SPECIFICATIONS

INSPECTION AND ADJUSTMENT

Valve clearance (Hot)	mm (in)	
Intake		0.35 (0.014)
Exhaust		0.35 (0.014)
Drive belt deflection	mm (in)	8 - 12 (0.31 - 0.47)
Applied pushing force	N (kg, lb)	98 (10, 22)
Engine oil capacity	ℓ (US qt, Imp qt)	
With oil filter		3.2 (3-3/8, 2-7/8)
Without oil filter		2.7 (2-7/8, 2-3/8)
Engine compression pressure	kPa (bar, kg/cm ² , psi)/rpm	
Standard		1,245 (12.45, 12.7, 181)/350
Minimum		981 (9.81, 10.0, 142)/350
Spark plug		
Type		L47PW B4ES
Gap	mm (in)	0.8 - 0.9 (0.031 - 0.035)
Distributor		
Point gap	mm (in)	0.45 - 0.55 (0.018 - 0.022)
Dwell angle	degree	49° - 55°
High tension cable resistance	Ω	Less than 30,000
Ignition timing/idle speed		A12 12° B.T.D.C./650 rpm A15 10° B.T.D.C./650 rpm
Maximum engine speed under no-load		Less than 3,450 rpm
Continuous rated engine speed		2,800 rpm

TIGHTENING TORQUE

Unit	N-m	kg-m	ft-lb
Cylinder head bolt	69 - 74	7.0 - 7.5	51 - 54
Rocker shaft bracket bolt	20 - 25	2.0 - 2.5	14 - 18
Main bearing cap bolt	49 - 59	5.0 - 6.0	36 - 43
Flywheel fixing bolt	78 - 88	8.0 - 9.0	58 - 65
Connecting rod cap nut	31 - 37	3.2 - 3.8	23 - 27
Camshaft sprocket bolt	39 - 47	4.0 - 4.8	29 - 35
Locating plate bolt	5 - 8	0.5 - 0.8	3.6 - 5.8
Valve rocker adjusting nut	16 - 22	1.6 - 2.2	12 - 16
Oil strainer bolt	9 - 14	0.9 - 1.4	6.5 - 10.1
Oil pan bolt	4 - 6	0.4 - 0.6	2.9 - 4.3
Oil pan drain plug	20 - 29	2.0 - 3.0	14 - 22
Timing chain cover bolt	5 - 7	0.5 - 0.7	3.6 - 5.1
Crank pulley bolt	147 - 196	15 - 20	108 - 145
Water pump bolt	9 - 14	0.9 - 1.4	6.5 - 10.1
Fuel pump nut	9 - 14	0.9 - 1.4	6.5 - 10.1
Spark plug	15 - 20	1.5 - 2.0	11 - 14

MINOR 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 alternator belt.	Adjust.
	Malfunction in charging system.	Inspect.
	Wiring connection loose in starting circuit.	Correct.
	Faulty ignition switch.	Repair or replace.
Faulty starter motor.	Repair or replace.	

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 in trouble*
- Fuel system in trouble*
- Valve mechanism does not work properly*
- Low compression*

(Trouble-shooting procedure)

Check spark plug firstly 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.

Good spark occurs.

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

No spark occurs.

Check the current flow in primary circuit.

Very high current.

Inspect primary circuit for short.
Check breaker point operation.

Low or no current.

Check for loose terminal or disconnection in primary circuit.

Ignition system out of order	Burned distributor point.	Repair or replace.
	Improper point gap.	Adjust.
	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.	

MINOR TROUBLE DIAGNOSES AND CORRECTIONS

Condition	Probable cause	Corrective action
Fuel system out of order	Lack of fuel. Dirty fuel filter. Dirty or clogged fuel pipe. Fuel pump will not work properly. Carburetor choke will not work properly. Improper adjustment of float level. Improper idling. Dirty or clogged carburetor. Clogged breather pipe of fuel tank.	Supply. Replace. Clean. Repair or replace. Check and adjust. Correct. Adjust. Disassemble and clean. Repair and clean.
Low compression	Incorrect spark plug tightening or faulty gasket. Improper grade engine oil or low viscosity. Incorrect valve clearance. Compression leak from valve seat. Sticky valve stem. Weak or damaged valve springs. Compression leak at cylinder head gasket. Sticking or damaged piston ring. Worn piston ring or cylinder.	Tighten to normal torque or replace gasket. Replace with proper grade oil. Adjust. Remove cylinder head and lap valves. Correct or replace valve and valve guide. Replace. Replace gasket. Replace piston rings. Overhaul engine.
(Trouble-shooting procedure) Inject a small quantity of engine oil in spark plug hole, and then measure cylinder compression.		
	Compression increases. Compression does not change.	Malfunctioning cylinder or piston ring. Compression leaks from valve, cylinder head or head gasket.
IMPROPER ENGINE IDLING (Low engine idle speed)	Clogged or damaged carburetor jets. Incorrect idle adjustment. Clogged air cleaner filter.	Clean or replace. Adjust. Clean or replace filter.
Fuel system out of order	Damaged manifold gaskets or carburetor insulator. Improper float level adjustment. Loose or cracked vacuum hoses or air hoses from carburetor and intake manifold. Malfunctioning carburetor choke.	Replace gasket or insulator. Adjust. Check for loose connections or cracks. Check and adjust.
Low compression		Previously mentioned.

MINOR TROUBLE DIAGNOSES AND CORRECTIONS

Condition	Probable cause	Corrective action
Others	Incorrect valve clearance. Extremely low revolution. Malfunction of the ignition system (spark plug, high tension cable, ignition coil, etc.) Incorrect basic ignition timing. Faulty P.C.V. valve. Malfunction of choke valve or linkage. Incorrect idle adjustment. Clogged air cleaner filter. Loose manifold and cylinder head bolts.	Adjust. Adjust. Replace. Adjust. Replace. Adjust. Adjust idle speed. Replace air cleaner filter. Retighten bolts.
IMPROPER ENGINE IDLING (High engine idle speed)	Binding accelerator linkage. Incorrect idle adjustment. Malfunctioning carburetor choke. Malfunction of governor.	Check and correct accelerator linkage. Adjust. Check and adjust. Adjust governor or replace it, if necessary.
ENGINE POWER NOT UP TO NORMAL		
Low compression		Previously mentioned.
Ignition system out of order	Incorrect ignition timing. Damaged spark plugs. Worn distributor points. Damaged spark plugs.	Adjust. Clean, adjust or replace plugs. Dress, or replace points. Also check condenser. Clean, adjust or replace plugs.
Fuel system out of order	Malfunction of choke system. Clogged fuel pipe or needle valve. Dirty or clogged fuel filter. Fuel pump will not work properly. Clogged carburetor jets. Throttle valve does not open fully.	Adjust. Clean. Replace. Repair or replace. Disassemble and clean. Readjust.
Air intake system out of order	Clogged air cleaner. Air inhaling from manifold gasket or carburetor gasket. Faulty P.C.V. valve.	Clean or replace filter. Replace gasket. Replace.

MINOR TROUBLE DIAGNOSES AND CORRECTIONS

Condition	Probable cause	Corrective action
Overheating	Insufficient coolant. Loose fan belt. Worn or oiled fan belt. Inoperative thermostat. Worn water pump. Clogged or leaky radiator. Faulty radiator filler cap. Air in cooling system. Improper engine oil grade. Incorrect ignition timing. Clogged carburetor (lean mixture).	Replenish. Adjust fan belt. Replace. Replace. Replace. Flush, repair or replace. Replace. Retighten each part of cooling system. Replace with proper grade oil. Adjust. Overhaul carburetor.
Overcooling	Inoperative thermostat.	Replace.
Others	Improper governor adjustment.	Adjust governor to the specified conditions.
NOISY ENGINE		
Engine knocking	Overloaded engine. Carbon knocking. Timing knocking. Fuel knocking. Preignition (misusing of spark plug).	Use right gear in driving. Disassemble cylinder head and remove carbon. Adjust ignition timing. Use specified octane fuel. 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 in 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 in each cylinder and if the noise diminishes almost completely, this crankshaft bearing generates the noise.	Same as the case of crankshaft bearings.
Piston cylinder noise	When you hear an overlapping metallic 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 in 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 in each cylinder.	This may cause a wear on piston pin, or piston pin hole. Renew piston and piston pin assembly.

MINOR TROUBLE DIAGNOSES AND CORRECTIONS

Condition	Probable cause	Corrective action
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.
Others	An improper adjustment of valve clearance. Noise of timing chain. An excessive end-play on crankshaft.	Adjust. Adjust the tension of chain. Disassemble engine and renew main bearing.
ABNORMAL COMBUSTION (Backfire, afterfire, run-on, etc.)		
Improper ignition timing	Improper ignition timing. Improper heat range of spark plugs.	Adjust. Use specified spark plugs.
Fuel system out of order	Improper idle adjustment. Damaged carburetor or manifold gasket (backfire, afterfire). Clogged carburetor jet. Improper function of the float.	Adjust. Replace them with new parts. Disassemble carburetor and check it. Adjust the level, and check needle valve.
Faulty cylinder head, etc.	Improperly adjusted valve clearance. Excess carbon in combustion chamber. Damaged valve spring (backfire, afterfire).	Adjust. Remove head and get rid of carbon. Replace it with a new one.
EXCESSIVE OIL CONSUMPTION		
Oil leakage	Loose oil drain plug. Loose or damaged oil pan gasket. Loose or damaged chain cover gasket. Worn oil seal in front and rear of crankshaft. Loose or damaged rocker cover gasket. Improper tightening of oil filter. Loose or damaged oil pressure switch.	Tighten it. Renew gasket or tighten it. Renew gasket or tighten it. Renew oil seal. Renew gasket or tighten it (but not too much). Renew gasket and tighten it with the proper torque. Renew oil pressure switch or tighten it.
Excessive oil consumption	Cylinder and piston wear. Improper location of piston ring gap or reversely assembled piston ring. Damaged piston rings. Worn piston ring groove and ring. Fatigue of valve oil seal lip. Worn valve stem.	Overhaul cylinder and renew piston. Remount piston rings. Renew rings. Repair or renew piston and cylinder. Renew piston and piston ring. Replace seal lip with a new one. Renew valve or guide.

MINOR TROUBLE DIAGNOSES AND CORRECTIONS

Condition	Probable cause	Corrective action
Others	Inadequate quality of engine oil. Engine overheat. Malfunction of P.C.V. system.	Use the designated oil. Previously mentioned. Check or replace.
POOR FUEL ECONOMY See the explanation of the power decrease Others	Improper idle adjustment (Idle speed, ignition timing, mixture ratio). Fuel leakage. Improper governor adjustment.	Adjust it to the designated rpm. Repair or tighten the connection of fuel pipes. Adjust it to the designated rpm.
PROBLEM IN OTHER FUNCTIONS Decreased oil pressure Excessive wear on the sliding parts Scuffing of sliding parts	Inadequate oil quality. Overheat. Worn oil pump regulator valve. Functional deterioration of oil pump. Blocked oil filter. Increased clearance in various sliding parts. Blocked oil strainer. Inoperative oil gauge pressure switch. Oil pressure decreases. Improper quality or contamination of oil. Damaged air cleaner. Overheat or overcool. Improper fuel mixture. Decrease of oil pressure. Insufficient clearances. Overheat. Improper fuel mixture.	Use the designated oil. Previously mentioned. Disassemble oil pump and repair or renew it. Repair or replace it with a new one. Renew it. Disassemble and replace the worn parts with new ones. Clean it. Replace it with a new one. Previously mentioned. Exchange the oil with proper one and change element. Change element. Previously mentioned. Check the fuel system. Previously mentioned. Readjust to the designated clearances. Previously mentioned. Check the fuel system.

ENGINE MECHANICAL

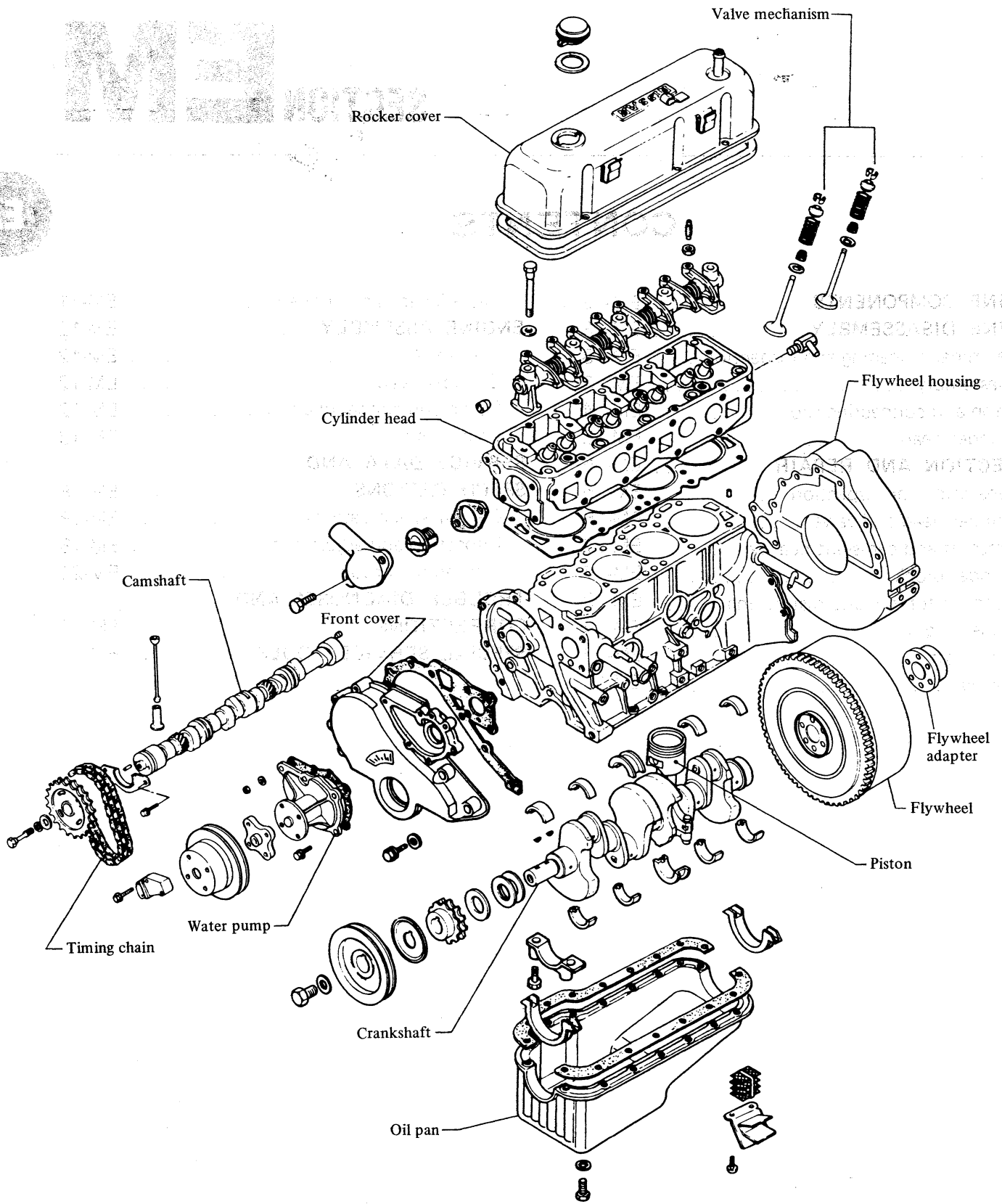
SECTION **EM**

EM

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ENGINE COMPONENTS



ENGINE DISASSEMBLY

PRELIMINARY CLEANING AND INSPECTION

Before disassembling engine, observe the following items:

1. Prior to disassembling, check outer parts for sign of leak past their gasketed surfaces.
2. Check carburetor and fuel pump for condition; fuel hoses for deterioration, cracks or otherwise leakage of fuel past their jointed or connected surfaces.
3. Wipe dust and mud off engine.
4. Inspect outer parts for visual faults and broken or missing parts such as bolts and nuts.
5. Check piping and electrical circuits for deterioration, breakage, fittings, discontinuity or insulation.

DISASSEMBLY

To remove engine from car, refer to Section ER for Removal.

1. Remove starting motor, then remove transmission from engine.
2. Remove clutch assembly.
3. Remove alternator, drive belt, alternator bracket and alternator adjusting bar.
4. Remove compressor bracket with idler pulley (If so equipped).

5. Remove water pump pulley.
6. Remove oil level gauge.
7. Remove distributor cap and high tension cables as an assembly.
8. Disconnect distributor vacuum line from distributor and remove distributor.
9. Disconnect fuel line from carburetor.
10. Remove fuel pump and fuel line.
11. Remove water outlet and thermostat.
12. Remove engine mounting bracket R.H.
13. Remove oil pump and filter assembly.

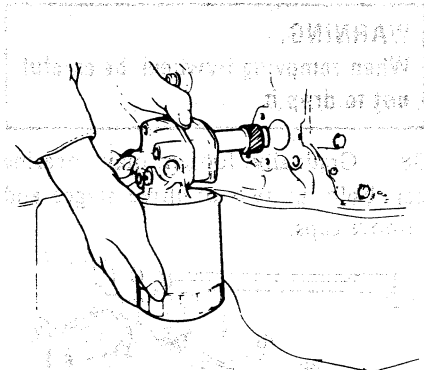


Fig. EM-3 Removing Oil Pump

14. Remove spark plugs.
15. Install Engine Attachment KV10102500 to cylinder block using engine mounting bracket R.H. attaching studs, fuel pump attaching studs and alternator bracket attaching bolt holes.
16. Mount engine on Engine Stand ST0501S000.

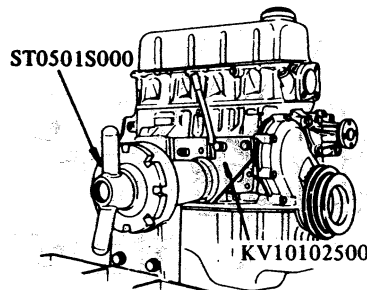
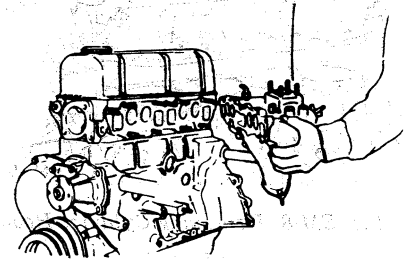


Fig. EM-4 Engine Mounted on Engine Stand

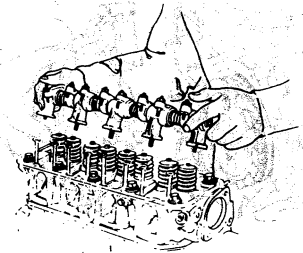
17. Remove engine mounting bracket L.H.
18. Disconnect air and vacuum from air horn.
19. Remove air horn and air horn brackets.
20. Remove vacuum switching valve assembly and bracket as a unit.
21. Remove carburetor and baffle plate.
22. Remove P.C.V. hose (Pipe connector to control valve) and water hose from intake manifold.
23. Remove intake and exhaust manifolds.



EM528

Fig. EM-5 Removing Manifolds

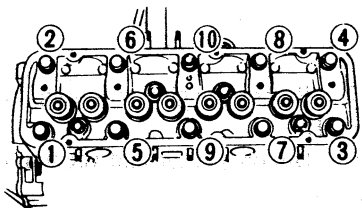
24. Remove rocker cover.
25. Loosen valve rocker adjusting nuts and turn adjusting screws out to disengage push rods. Then evenly loosen rocker shaft bolts.
26. Remove rocker shaft assembly.



EM453

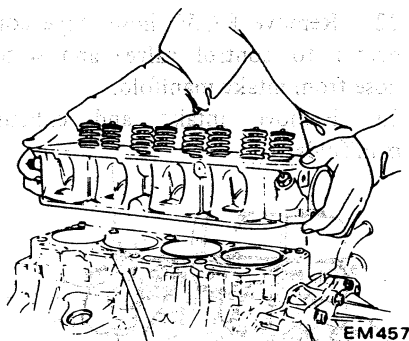
Fig. EM-6 Removing Rocker Shaft Assembly

27. Withdraw push rods, and keep them in correct order.
28. Loosen cylinder head bolts a little at a time in the sequence shown in Fig. EM-7, and remove cylinder head.



EM454

Fig. EM-7 Cylinder Head Bolt Loosening Sequence

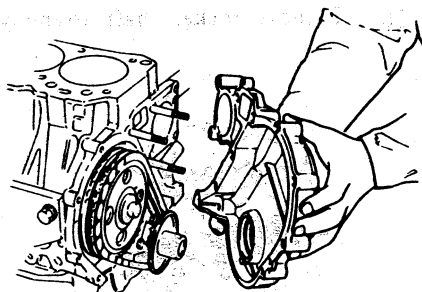


EM457

Fig. EM-8 Removing Cylinder Head

Note: Do not pry between head and block as gasket surfaces may become damaged.

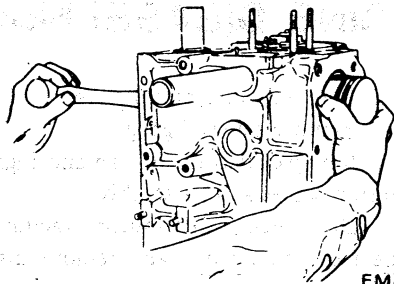
29. Invert engine.
30. Remove oil pan and oil strainer.
31. Invert engine.
32. Remove water pump.
33. Remove crank pulley and timing chain cover.



EM455

Fig. EM-9 Removing Timing Chain Cover

34. Remove oil thrower and chain tensioner.
35. Loosen camshaft sprocket bolt and remove both sprockets and timing chain.
36. Remove connecting rod caps and push piston and connecting rod assemblies out of the bores.



EM456

Fig. EM-10 Removing Piston and Connecting Rod Assembly

Note: Numbers are stamped on connecting rod and cap corresponding to each cylinder. Care should be taken to avoid wrong combination including bearing.

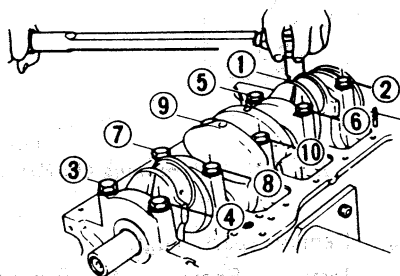
37. Remove flywheel and flywheel housing.

Lock crankshaft with hammer handle.

WARNING:

When removing flywheel, be careful not to drop it.

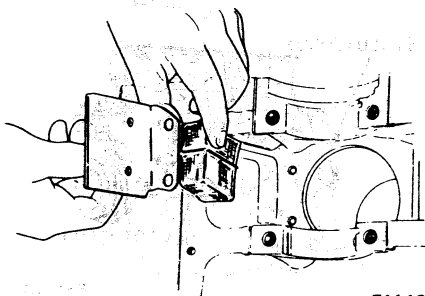
38. Gradually loosen main bearing cap bolts in two or three stages and remove caps.



EM458

Fig. EM-11 Main Bearing Cap Bolt Loosening Sequence

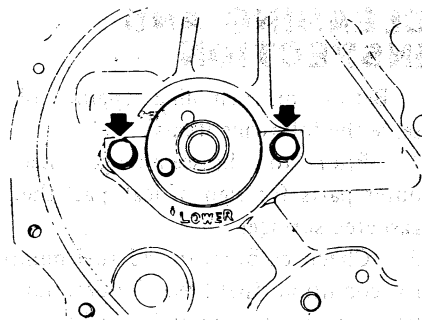
39. Remove rear oil seal.
40. Lift out crankshaft.
41. Remove main bearings from block and bearing caps.
42. Remove baffle plate and steel net.



EM460

Fig. EM-12 Removing Baffle Plate and Steel Net

43. Remove camshaft plate. Carefully remove camshaft by pulling it toward the front of engine.



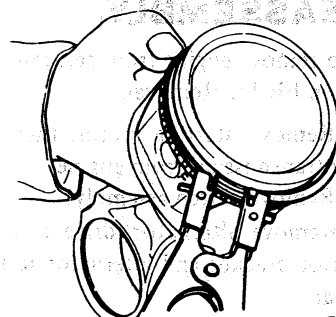
EM461

Fig. EM-13 Camshaft Plate

44. Remove valve lifters and keep them in order.

PISTON AND CONNECTING ROD

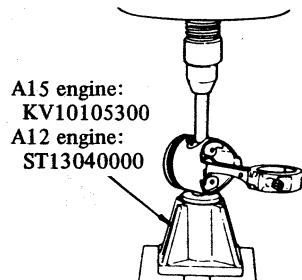
1. Remove piston rings with a ring remover.



EM292

Fig. EM-14 Removing Piston Ring

2. Press out piston pin with Piston Pin Press Stand KV10105300 or ST13040000.



A15 engine:
KV10105300
A12 engine:
ST13040000

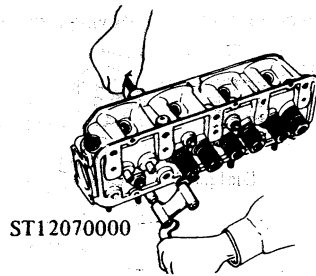
EM103

Fig. EM-15 Removing Piston Pin

Note: Keep disassembled parts in order.

CYLINDER HEAD

1. Using suitable valve spring compressor, compress valve spring and remove valve collet.
2. Release Valve Lifter and remove spring retainer, spring, oil seal, spring seat and valve.

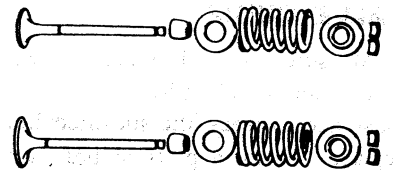


ST12070000

EM462

Fig. EM-16 Removing Valve

3. Place valve components in order.



EM463

Fig. EM-17 Valve Components

Note: Take care not to lose valve spring seat, oil seal, valve collet, and valve rocker guide.

INSPECTION AND REPAIR

PREPARATION FOR INSPECTION

1. Before cleaning, check for signs of water and oil leaks.
2. Clean oil and carbon deposits from all parts. They should be clean from gaskets and sealant.
3. Clean all oil holes with solvent and dry with compressed air. Make sure that they are not restricted.

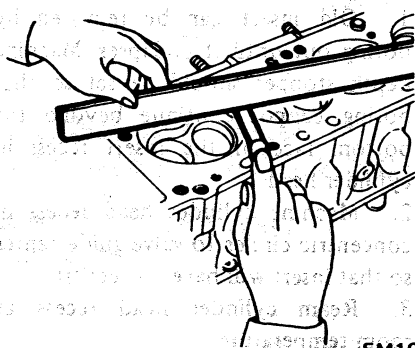
CYLINDER HEAD AND VALVE

CHECKING CYLINDER HEAD MATING FACE

1. Make a visual check for cracks and flaws.
2. Measure surface of cylinder head (on cylinder block side) for warpage. If beyond designated limit, correct surface with a surface grinder.

Warpage of surface:

Less than
0.1 mm (0.004 in)



EM108

Fig. EM-18 Checking Cylinder Head Surface

Note: Surface grinding limit

The grinding limit of cylinder head is determined by the cylinder block grinding in an engine.

Depth of cylinder head grinding is "A"

Depth of cylinder block grinding is "B"

The limit is as follows:

$$A + B = 0.2 \text{ mm (0.008 in)}$$

VALVE

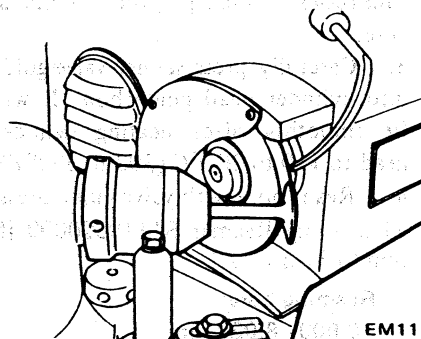
1. Check each of the intake and exhaust valve for worn, damaged or deformed valve caps or stems. Correct or replace the valve that is faulty.

For standard size of valve, refer to Service Data and Specifications.

2. Valve face or valve stem end surface should be refaced by using a valve grinder.

Note: When valve head has been worn down to 0.5 mm (0.020 in) in thickness, replace the valve.

Grinding allowance for valve stem end surface is 0.5 mm (0.020 in) or less.



EM111

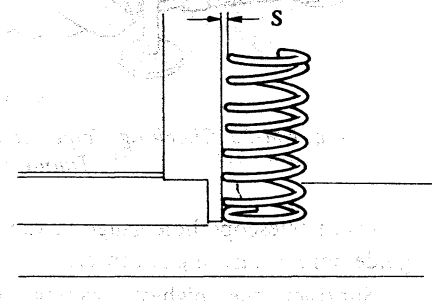
Fig. EM-19 Regrinding Valve Face

VALVE SPRING

1. Check valve spring for squareness using a steel square and surface plate. If spring is out of square "S" more than specified limit, replace with new ones.

Out of square ("S"):

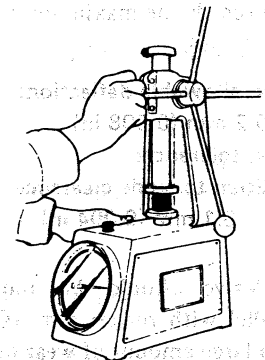
Less than
1.6 mm (0.063 in)



SEM288A

2. Measure the free length and the tension of each spring. If the measured value exceeds the specified limit, replace spring.

Refer to Service Data and Specifications.



EM113

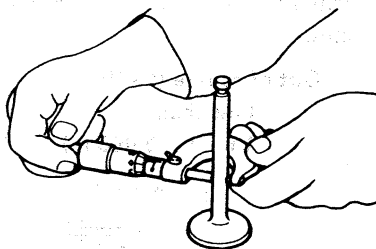
Fig. EM-21 Measuring Spring Tension

VALVE GUIDE

Measure the clearance between valve guide and valve stem. If the clearance exceeds the specified limit, replace the worn parts or both valve and valve guide. In this case, it is essential to determine if such a clearance has been caused by a worn or bent valve stem or by a worn valve guide.

Determining clearance

Precise measurement of clearance between valve stem and valve guide needs the aid of a micrometer and a telescope hole gauge. By using these gauges, check the diameter of valve stem in three places; top, center and bottom.



EM030

Fig. EM-22 Checking Valve Stem Diameter

Insert telescope hole gauge in valve guide bore, measuring at center.

Subtract the highest reading of valve stem diameter from valve guide bore to obtain the stem to guide clearance.

As an expedient, a valve is pushed in valve guide and moved to the right and left. If its tip deflects beyond the specified limit there, it will be known that the clearance between stem and guide exceeds the maximum limit.

Max. allowable deflection:

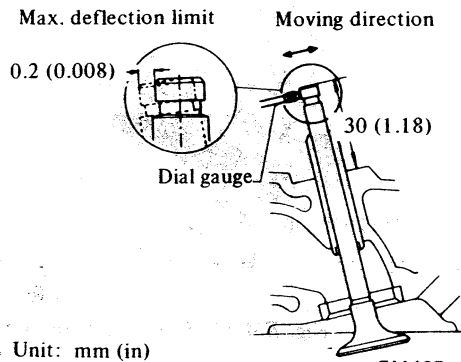
0.2 mm (0.008 in)

Max. tolerance:

Stem to guide clearance

0.1 mm (0.004 in)

Note: Valve should be moved in parallel with rocker arm. (Generally, a large amount of wear occurs in this direction.)

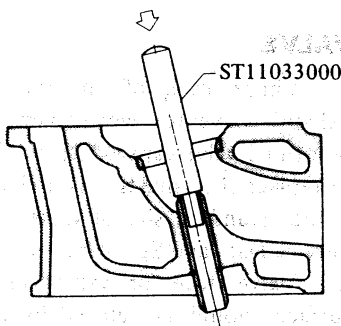


EM467

Fig. EM-23 Measuring Deflection between Valve Stem and Valve Guide

Replacement of valve guide

1. To remove old guides, use a drift and a press and drive them out from combustion chamber side toward rocker cover. Heating cylinder head to 150 to 200°C (302 to 392°F) will facilitate operation.



SEM186

Fig. EM-24 Driving Valve Guide out of Cylinder Head

2. Ream cylinder head valve guide hole using Reamer ST11081000 [12.2 mm (0.480 in) dia.] at room temperature.

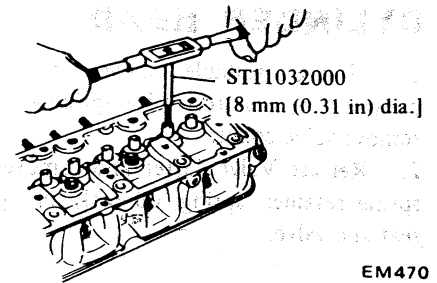
3. Carefully press service valve guide into cylinder head guide hole. It will fit smoothly after heating cylinder head to 150 to 200°C (302 to 392°F).

4. Ream bore with valve guide pressed in using Reamer ST110320000 [8 mm (0.31 in) dia.].

Reaming bore:

8.000 - 8.020 mm

(0.3150 - 0.3157 in)



EM470

Fig. EM-25 Reaming Valve Guide

5. Correct valve seat surface with new valve guide as the axis.

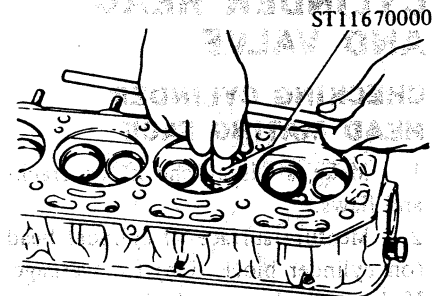
VALVE SEAT

Check valve seat for evidence of pitting at valve contact surface, and reface or replace if worn excessively.

Valve seat insert of 0.5 mm (0.020 in) oversize is available for service.

Refacing valve seat

When width of valve seat is wide or narrow beyond specifications, it should be refaced with valve seat with cutter or grinding stone.



EM471

Fig. EM-26 Refacing Valve Seat with Valve Seat Cutter

Replacing valve seat insert

1. Old insert can be removed by boring out until it collapses. Machine depth stopper should be set so that boring cannot continue beyond the bottom face of the insert recess in cylinder head.

2. Machine cylinder head recess in concentric circles to valve guide center so that insert will have correct fit.

3. Ream cylinder head recess at room temperature.

4. Heat cylinder head to temperature of 150 to 200°C (302 to 392°F).

5. Fit insert ensuring that it seats on bottom face of its recess.
6. Newly fitted valve seat should be cut or ground with suitable seat cutter or grinding stone.
7. Apply small amount of fine grinding compound to valve contacting face and put valve into guide. Lap valve against its seat until proper valve seating is obtained.

Remove valve and clean valve and valve seat.

VALVE ROCKER ARM AND SHAFT

1. Check rocker arm bore and shaft for scores or scuffs.
2. Check clearance between each rocker arm and shaft by measuring inner diameter of rocker arm bore and outer diameter of shaft.

If either clearance is not within specification, replace rocker arm and/or shaft.

3. Check valve end contact surface of rocker arm for abnormal wear or scuffs.

VALVE LIFTER AND PUSH ROD

1. Check valve lifter for wear or scuffs. Check bottom end of valve lifter to make sure it has a slight convex. Replace valve lifters that are scored, worn or have unsmooth bottom.
2. Check clearance between lifter hole on cylinder block and valve lifter. Replace valve lifter if clearance exceeds wear limit.
3. Check push rod for bending and damage.

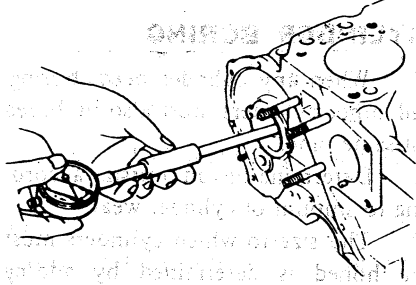
Check end of push rod for roughness or excessive wear.

CAMSHAFT AND CAMSHAFT BEARING

CAMSHAFT BEARING CLEARANCE

Journal diameters should be checked with a micrometer, and bearings with an inside dial gauge. Measurements should then be compared to

determine whether bearings are worn. If worn beyond 0.15 mm (0.0059 in), replace using Camshaft Bearing Drift ST16110000. In press-fitting a new bearing, make certain that oil holes in block and bearing are properly aligned.

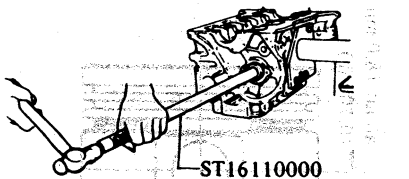


EM474

Fig. EM-27 Measuring Camshaft Bearing Inner Diameter

CAUTION:

- a. After replacing all bearings, finish bearing inner diameters by line boring.
- b. Install welch plug into cylinder block, applying sealant.



EM475

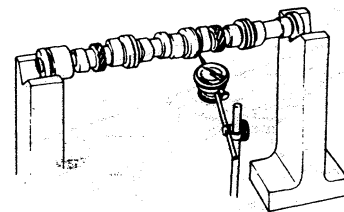
Fig. EM-28 Replacing Camshaft Bearings

CAMSHAFT ALIGNMENT

1. Check camshaft, camshaft journal and cam surface for bending, wear or damage. If fault is beyond limits, replace affected parts.
2. Camshaft can be checked for bend by placing it on V-blocks and using a dial gauge with it indicating finger resting on center journal.

Camshaft bend (Total indicator reading):

Less than 0.10 mm (0.0039 in)



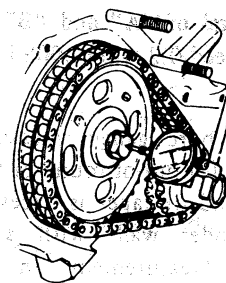
EM476

Fig. EM-29 Checking Camshaft Bend

3. Camshaft end play can be checked by installing camshaft, camshaft locating plate and camshaft sprocket in their respective positions. End play can then be checked with a dial gauge or feeler gauge. If end play exceeds the specified limit, replace locating plate.

Max. tolerance of camshaft end play:

0.10 mm (0.0039 in)



EM477

Fig. EM-30 Checking Camshaft End Play

VALVE TIMING

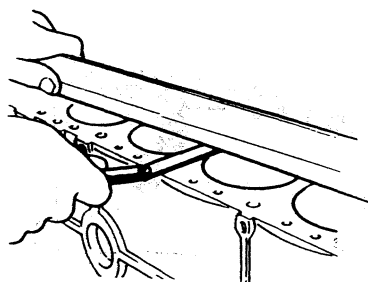
This diagram applies to all cylinders. If any valve is found beyond specifications, one possibility is that cam lobe is worn or damaged excessively, calling for replacement of camshaft.

CYLINDER BLOCK

1. Visually check cylinder block for cracks or flaws.
2. Measure top of cylinder block (cylinder head mating face) for warpage. If warpage exceeds limits, correct it.

Warpage of cylinder block surface:

Less than 0.10 mm (0.0039 in)



EM303

Fig. EM-31 Checking Cylinder Block Surface

Note: Surface grinding limit

Grinding limit of cylinder block is dependent upon cylinder head grinding of engine.

Depth of cylinder head grinding is "A"

Depth of cylinder block grinding is "B"

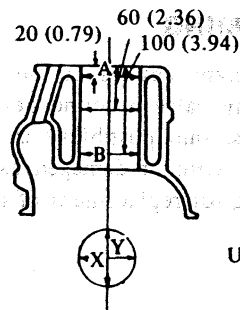
The limit is:

$$A + B = 0.2 \text{ mm (0.008 in)}$$

The total of "A" and "B" should not exceed 0.2 mm (0.008 in).

3. With bore gauge, measure cylinder bore for out-of-round or taper. If out-of-round or taper is excessive, re-bore cylinder walls with a boring machine. Measurement should be taken along bores for taper and around bores for out-of-round.

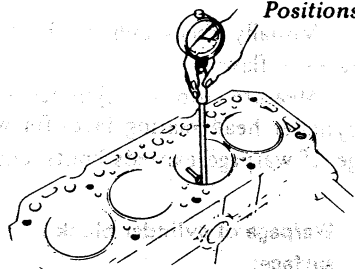
Out-of-round X-Y
Taper A-B



Unit: mm (in)

EM479

Fig. EM-32 Cylinder Bore Measuring Positions



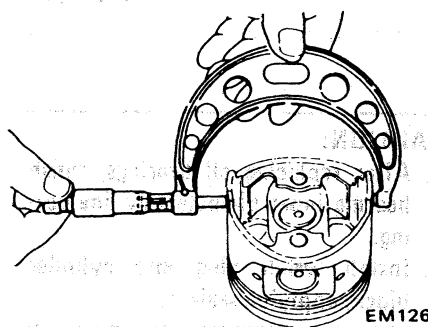
EM478

Fig. EM-33 Measuring Cylinder Bore Diameter

4. When wear, taper, or out-of-round is minor and within limits remove ridge at topmost portion of cylinder using a ridge reamer or similar tool.

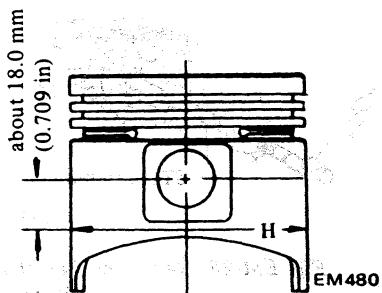
CYLINDER BORING

1. When any cylinder needs boring, all other cylinders must also be bored at same time.
2. Determine piston oversize according to amount of cylinder wear.
3. The size to which cylinders must be honed is determined by adding piston-to-cylinder clearance to the largest piston diameter (at piston skirt in thrust direction).



EM126

Fig. EM-34 Measuring Piston Diameter



EM480

Fig. EM-35 Piston Diameter Measuring Position

Calculation of cylinder bore diameter to be machined

$$D = A + B - C = A + [0.003 \text{ to } 0.023 \text{ mm (0.0001 to 0.0009 in)}]$$

Where

- D: Cylinder bore diameter to be machined
- A: Piston diameter as measured
- B: Piston to cylinder bore clearance = 0.023 to 0.043 mm (0.0009 to 0.0017 in)
- C: For honing allowance = 0.02 mm (0.0008 in)

CAUTION:

- a. To prevent strain due to cutting heat, bore the cylinders in the order of 2-4-1-3.
- b. Before boring any cylinder, install main bearing caps in place and tighten to the specification so that the crankshaft bearing bores will not become distorted from the boring operation.

4. Do not cut too much out of cylinder bore at a time. Cut 0.05 mm (0.0020 in) or so in diameter at a time.
5. Measurement of cylinder bore just machined requires the utmost care since it is expanded by cutting heat.
6. As a final step, cylinders should be honed to final size.
7. Measure finished cylinder bore for out-of-round or tapered part.
8. Measure piston to cylinder clearance.

This clearance can be checked easily with a feeler gauge and a spring balance hooked on feeler gauge, measuring amount of force required to pull out gauge from between piston and cylinder.

Feeler gauge used:

0.04 mm (0.0016 in)

Extracting force:

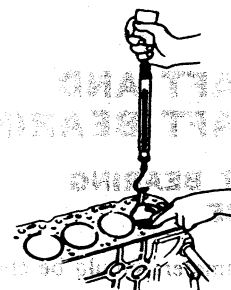
4.9 - 14.7 N

(0.5 - 1.5 kg,

1.1 - 3.3 lb)

Note:

- a. When measuring clearance, slowly pull feeler gauge straight upward.
- b. It is recommended that piston and cylinder be warmed to 20°C (68°F).



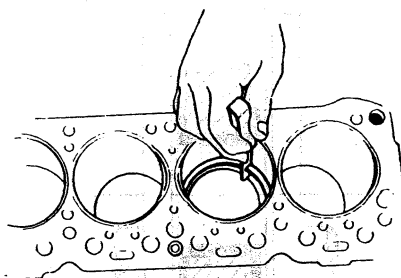
EM379

Fig. EM-36 Measuring Piston Fit in Cylinder

Note: If cylinder bore has worn beyond the wear limit from the largest over size cylinder bore diameter, use cylinder liner.

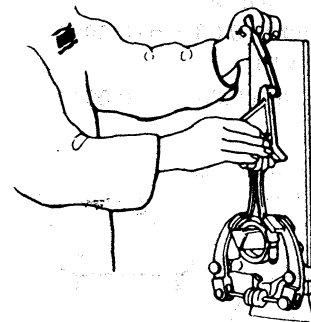
Undersize cylinder liners are available for service.

Interference fit of cylinder liner in cylinder block should be 0.08 to 0.09 mm (0.0031 to 0.0035 in).



EM482

Fig. EM-38 Measuring Ring Gap



EM133

Fig. EM-40 Checking Rod Alignment

PISTON, PISTON PIN AND PISTON RING

1. Remove carbon from piston and ring grooves with a carbon scraper and a curved steel wire. The wire will be useful in cleaning bottom land of ring groove. Clean out oil slots in bottom land of oil ring groove.

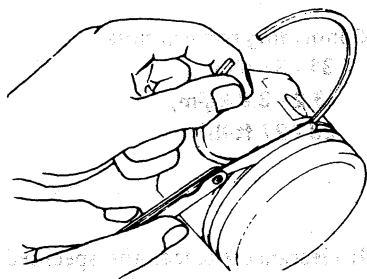
2. Check for damage, scratches and wear. Replace if fault is detected.

3. Measure side clearance of rings in ring grooves as each ring is installed.

If side clearance exceeds the specified limit, replace piston together with piston ring.

Max. tolerance of side clearance:

0.1 mm (0.004 in)



EM481

Fig. EM-37 Measuring Piston Ring Side Clearance

4. Measure ring gap with a feeler gauge, placing ring squarely in cylinder.

Ring should be placed to diameter at upper or lower limit of ring travel.

If ring gap exceeds the specified limit, replace ring.

Max. tolerance of ring gap:
1.0 mm (0.039 in)

Note:

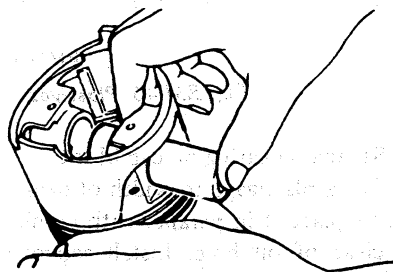
a. When piston ring only is to be replaced, without cylinder bore being corrected, measure the gap at the bottom of cylinder where the wear is minor.

b. Oversize piston rings are available for service. [0.5 mm (0.020 in), 1.0 mm (0.039 in) oversize].

5. Measure piston pin hole in relation to the outer diameter of pin. If wear exceeds limit, replace piston pin together with piston on which it is installed.

Piston pin to piston clearance:
0.008 - 0.012 mm
(0.0003 - 0.0005 in)

Note: Determine the fitting of piston pin into piston pin hole to such an extent that it can be pressed smoothly by finger at room temperature. This piston pin must be a tight press fit into connecting rod.



EM131

Fig. EM-39 Piston Pin Fitting

CONNECTING ROD

1. If a connecting rod has any flaw on either side of thrust face and large end, correct or replace it.

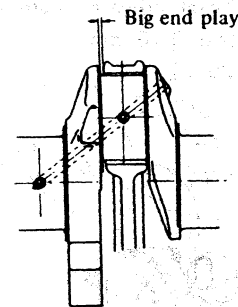
Bend and torsion
[per 100 mm (3.94 in) length]:
Less than
0.05 mm (0.0020 in)

2. Check connecting rod for bend or torsion using a connecting rod aligner. If bend or torsion exceeds limit, correct or replace.

3. When replacing connecting rod, select rod so weight difference between cylinders is within 5 gr (0.18 oz).

4. Install connecting rods with bearings on to corresponding crank pins and measure thrust clearance. If measured value exceeds limit, replace connecting rod.

Max. tolerance of big end play:
0.4 mm (0.016 in)



EM483

Fig. EM-41 Checking Big End Play

CRANKSHAFT

1. Repair or replace as required. If faults are minor, correct with fine crocus cloth.

2. Check with a micrometer journals and crank pins for taper and out-of-round. Measurement should be taken along journals for taper and around journals for out-of-round.

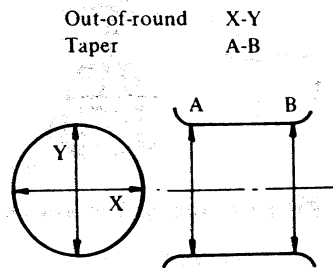
If out-of-round or taper exceeds the specified limit, replace or repair.

Out-of-round (X-Y):

Less than 0.03 mm (0.0012 in)

Taper (A-B):

Less than 0.03 mm (0.0012 in)



EM715

Fig. EM-42 Measurement Point

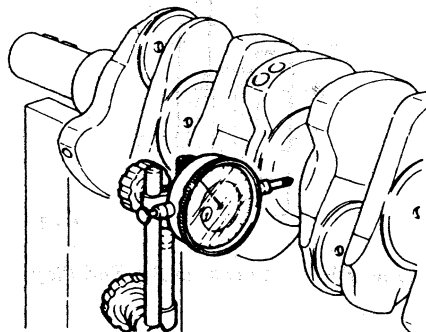
3. After regrinding crankshaft, finish it to the necessary size indicated in the chart under Service Data and Specifications by using an adequate undersize bearing according to the extent of required repair.

4. Crankshaft can be checked for bend by placing it on V-blocks and using a dial gauge with its indicating finger resting on center journal.

If bend exceeds the specified limit, replace or repair.

Bend (Total indicator reading):

Less than 0.10 mm
(0.0039 in)

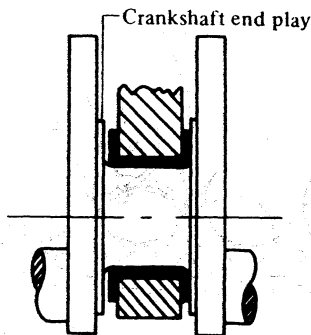


EM137

Fig. EM-43 Checking Crankshaft Bend

5. Measure crankshaft end play as shown in Fig. EM-44. If beyond the specified limit, replace main bearing.

Max. tolerance of end play:
0.3 mm (0.012 in)



EM486

Fig. EM-44 Checking Crankshaft End Play

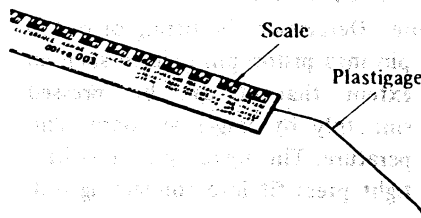
BEARING

MEASURING MAIN BEARING CLEARANCE

1. Thoroughly clean all bearings. Check for scratches, melt, score or wear.

Replace bearings, if fault is detected.

2. Crankshaft journals and bearings should be clean and free from dust and dirt before oil clearance is measured.



EM141

Fig. EM-45 Plastigage

3. Set main bearing on cap block.

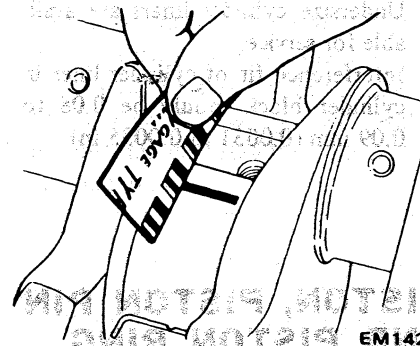
4. Cut a plastigage to width of bearing and place it in parallel with crank pin, clear of oil hole. Install cap on assembly and tighten them together to specified torque.

Ⓣ : Main bearing cap bolt

49 - 59 N-m
(5.0 - 6.0 kg-m,
36 - 43 ft-lb)

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

5. Remove cap, and compare width of plastigage at widest part with scale printed in plastigage envelope.



EM142

Fig. EM-46 Measuring Bearing Clearance

6. If clearance exceeds the specified value, replace bearing with an under-size bearing and grind crankshaft journal adequately.

Max. tolerance of main bearing clearance:

0.10 mm (0.0039 in)

MEASURING CONNECTING ROD BEARING CLEARANCE

1. Measure connecting rod bearing clearance in same manner as above.

Ⓣ : Connecting rod cap nuts

31 - 37 N-m
(3.2 - 3.8 kg-m,
23 - 27 ft-lb)

2. If clearance exceeds the specified value, replace bearing with an under-size bearing and grind the crankshaft journal adequately.

Max. tolerance of connecting rod bearing clearance:

0.10 mm (0.0039 in)

Note: Since bearings are precision insert type, it is not necessary to file bearing caps or to grind bearing surfaces with an emery cloth to correct bearing clearance.

MISCELLANEOUS COMPONENTS

CRANKSHAFT SPROCKET AND CAMSHAFT SPROCKET

1. Check tooth surface for flaws or wear. Replace sprocket if fault is found.

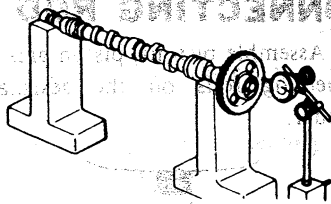
2. Install camshaft sprocket in position and check for runout.

If runout exceeds the specified limit, replace camshaft sprocket.

Runout:

(Total indicator reading)

Less than 0.1 mm (0.004 in)



EM309

Fig. EM-47 Checking Camshaft Sprocket Runout

CHAIN AND CHAIN TENSIONER

1. Check chain for stepped wear, scratches or other problems on roller links. Replace if necessary.

2. Check chain tensioner for wear, breakage or any other fault which would interfere with proper chain function. Replace if necessary.

FLYWHEEL

1. Check ring gear for damage and excessive wear. Replace if faulty.

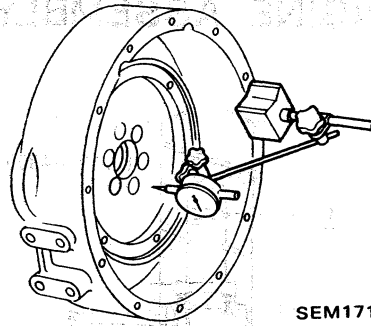
2. Check clutch disc contact surface with flywheel for damage or wear. Replace or repair if necessary.

3. Measure runout of clutch disc contact surface with a dial gauge.

Runout (Total indicator reading):

Less than 0.10 mm (0.0039 in)

Replace ring gear with its temperature kept below 300°C (572°F).

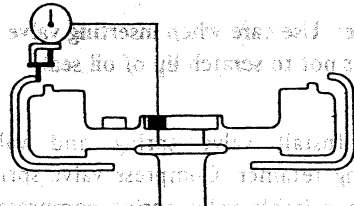


SEM171A

FLYWHEEL HOUSING

Checking flywheel housing bore

Readjust dial gauge so that the stem rides on the bore of the flywheel housing. Runout should not exceed 0.15 mm (0.0059 in).

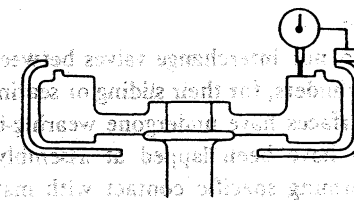


SEM716A

Checking driving ring surface of flywheel

Remove dial gauge base from flywheel, and bolt dial gauge to flywheel housing proper, and check flywheel.

The variation of the face runout of the surface to which the driving ring or clutch plate is bolted, should not exceed 0.1 mm (0.004 in).

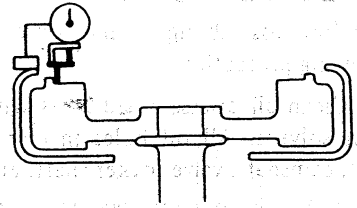


SEM164A

Checking driving pilot bore of flywheel

Readjust dial gauge so that the stem will ride on the driving ring pilot bore.

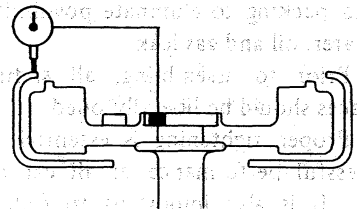
The eccentricity of the driving ring pilot bore should not exceed 0.1 mm (0.004 in).



SEM165A

Checking flywheel housing face

Bolt a dial gauge to the flywheel so that the dial gauge is vertical to the housing face and the dial gauge stem rides on the housing face. Runout should not exceed 0.15 mm (0.0059 in).

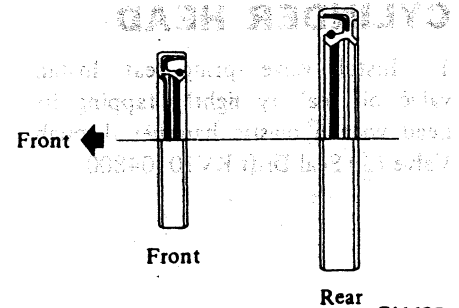


SEM717A

CRANKSHAFT FRONT AND REAR OIL SEAL

First check front and rear oil seals for worn or folded over sealing-lip or oil leakage. If necessary, replace with a new seal. When installing a new seal, pay attention to mounting direction.

Note: It is good practice to renew oil seal whenever engine is overhauled.



EM487

Fig. EM-49 Crankshaft Oil Seal

ENGINE ASSEMBLY

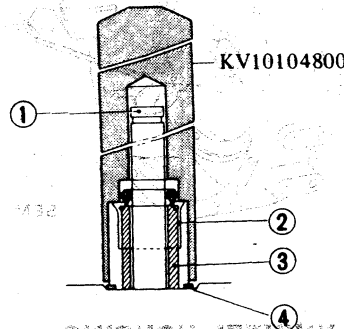
PRECAUTIONS

Before assembling engine, observe following precautions:

1. Clean all disassembled parts with clean solvent. All oil holes in crankshaft, camshaft, valve rocker shaft, etc. should be thoroughly cleaned to remove all traces of grinding chips or lint. Always use clean solvent.
2. In general, used gaskets, packings and oil seals should be replaced.
3. Under no circumstances should lockwashers be reused.
4. Place bolts, nuts and washers back in their original parts or from which they were removed.
5. Most packings serve best when liquid packing is applied to sealing surfaces. When designated, use suitable liquid packing to eliminate possibility of water, oil and gas leak.
6. Prior to assembling, all sliding surfaces should be liberally oiled.
7. Proper tightening is essential to successful performance of all car repairs. It is also important to follow correct tightening sequence in pulling up cylinder head. Be on alert at all times to amount of clearance permitted.
8. Cleanliness of tools or parts such as work bench used in making a repair is essential. When setting up a job every precaution should be taken that tools or parts are free of dirt, mud and oil. Do not work in dust and grit, for they are primary cause of wear in any engine.

CYLINDER HEAD

1. Install valve spring seat. Install valve oil seal by lightly tapping its head with a plastic hammer through Valve Lip Seal Drift KV10104800.



- 1 Valve
- 2 Lip seal
- 3 Valve guide
- 4 Valve spring seat

Fig. EM-50 Installing Valve Lip Seal

2. Insert valve into valve guide.

Note: Use care when inserting valve so as not to scratch lip of oil seal.

3. Install valve spring and valve spring retainer. Compress valve spring with suitable valve spring compressor and fit valve collets in place. Release Valve Lifter slowly.

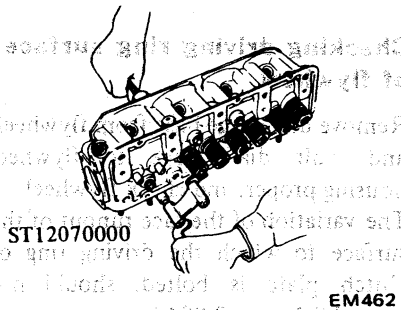


Fig. EM-51 Installing Valve

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 mating parts.
- b. Check to be sure that valves are properly seated on valve seats without foreign particles stuck in between.
- c. Valve spring is an uneven pitch type. Install spring facing white painted side to cylinder head surface.

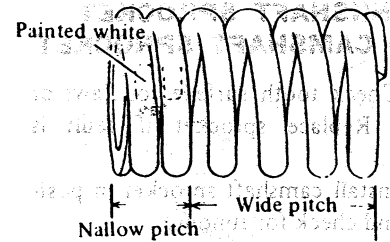


Fig. EM-52 Valve Spring

PISTON AND CONNECTING ROD

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

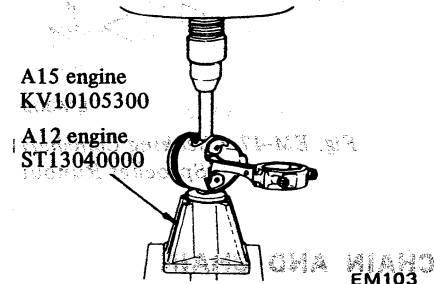


Fig. EM-53 Installing Piston Pin

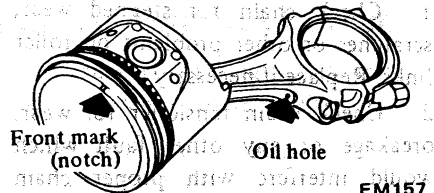


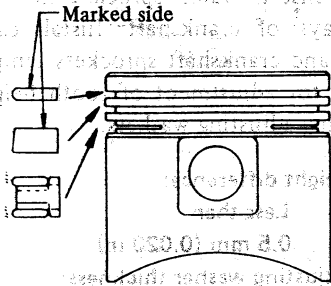
Fig. EM-54 Arranging Piston and Connecting Rod

Note:

- a. Piston pin is pressed into connecting rod. Fitting force is from 10 to 29 kN (1 to 3 t, 1.1 to 3.3 US ton, 1.0 to 3.0 Imp ton) and aid of Piston Pin Press Stand KV10105300 or ST13040000 is necessary. When pressing piston pin in connecting rod, apply engine oil to pin and small end of connecting rod.
- b. Arrange so oil jet hole of connecting rod big end is directed toward right side of cylinder block.
- c. Be sure to install piston in cylinders with notch mark of piston head toward front of engine.

2. Install piston rings

Note: Install so that stamped mark on ring faces upward.



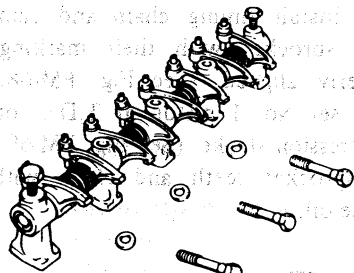
SEM385

Fig. EM-55 Installing Piston Ring

3. Fix bearings on connecting rod and connecting rod cap.

VALVE ROCKER SHAFT ASSEMBLY

Install parts, as shown in Fig. EM-56, in place on rocker shaft.



EM491

Fig. EM-56 Valve Rocker Shaft Assembly

ENGINE ASSEMBLY

1. The first step in engine assembly is to bolt Engine Attachment KV10102500 to right hand side of cylinder block. In succession, install block in Engine Stand ST0501S000 with engine bottom up.
2. Apply a light coat of engine oil to

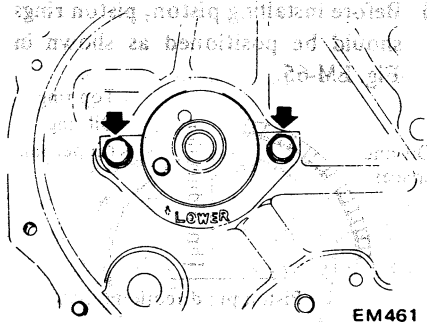
sliding surfaces of valve lifters; insert lifters in holes in cylinder block.

3. To install camshaft, be sure to coat sliding surfaces of camshaft bushings with a light coat of engine oil. Insert camshaft in cylinder block from front side of engine, exercising care not to damage camshaft bushings.

4. Install camshaft locating plate and tighten bolts to specified torque.

- Ⓢ : Camshaft locating plate
4 - 5 N-m
(0.4 - 0.5 kg-m,
2.9 - 3.6 ft-lb)

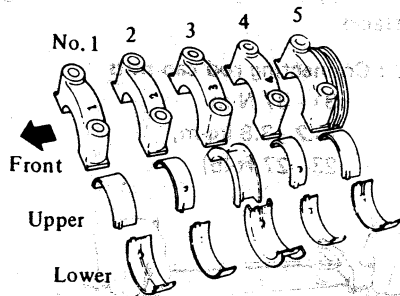
Note: Set locating plate so as the "Lower" mark comes to engine bottom side.



EM461

Fig. EM-57 Installing Camshaft Locating Plate

5. Install baffle plate and steel net.
6. Set main bearings at proper portion of cylinder block and caps.



EM492

Fig. EM-58 Main Bearings and Caps

Note:

- a. Center bearing (No. 3) is a flanged type for thrust force.
- b. Two internal bearings (No. 2 and No. 4) are of the same type.
- c. Front bearing (No. 1) is the same type as rear bearing (No. 5).

d. All bearings except No. 2 and No. 4 are not interchangeable between upper and lower bearings.

7. Apply engine oil to main bearing surfaces on both sides of cylinder block and cap.

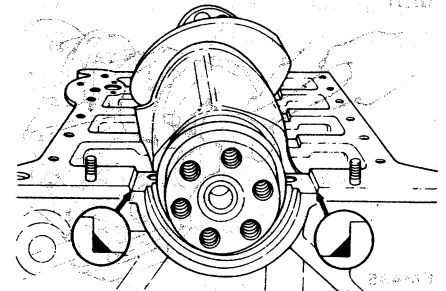
Install crankshaft.

8. Install main bearing cap and tighten bolts to specified torque.

- Ⓢ : Main bearing cap
49 - 59 N-m
(5.0 - 6.0 kg-m,
36 - 43 ft-lb)

Note:

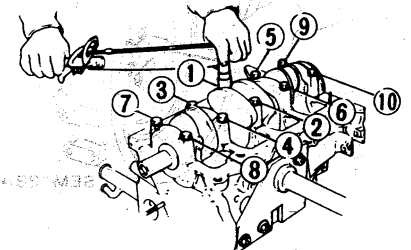
a. Apply seal to each rear main bearing contact corner of cylinder block as shown in Fig. EM-59.



EM493

Fig. EM-59 Applying Sealant

- b. Arrange parts so arrow mark on bearing cap faces toward front of engine.
- c. Prior to tightening bearing cap bolts, place bearing cap in proper position by shifting crankshaft in axial direction.
- d. Tighten bearing cap bolts gradually in two to three stages outwardly from center bearing in the sequence shown in Fig. EM-60.
- e. After securing bearing cap bolts, ascertain that crankshaft turns smoothly.



EM494

Fig. EM-60 Torque Sequence of bearing Cap Bolts

9. Make sure there is proper end play at crankshaft.

Crankshaft end play:

0.05 - 0.15 mm
(0.0020 - 0.0059 in)

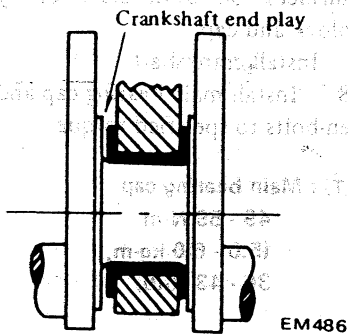
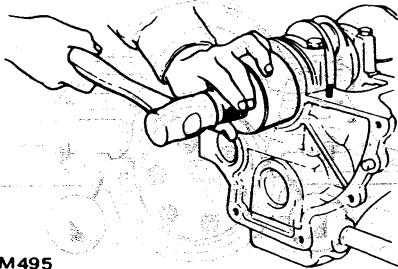


Fig. EM-61 Checking Crankshaft End Play

10. Install rear oil seal using suitable drift.



EM495

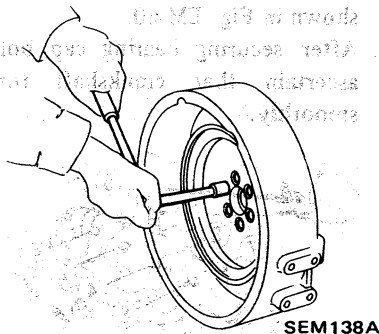
Fig. EM-62 Installing Rear Oil Seal

11. Install flywheel housing and tighten bolts to specified torque.

Ⓣ : 16 - 21 N·m
(1.6 - 2.1 kg·m,
12 - 15 ft·lb)

12. Install flywheel securely.

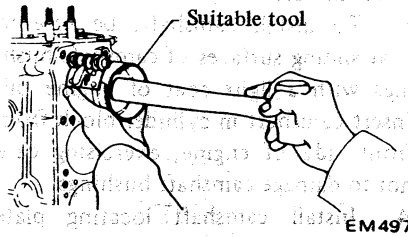
Ⓣ : 78 - 88 N·m
(8 - 9 kg·m,
58 - 65 ft·lb)



SEM138A

13. Rotate engine quarter turn and install piston-rod assembly using

suitable Piston Ring Compressor.

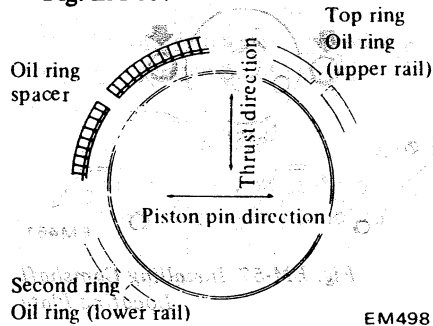


EM497

Fig. EM-64 Installing Piston Rod Assembly

Note:

- a. Insert pistons in corresponding cylinders.
- b. Apply engine oil to sliding parts.
- c. Arrange pistons so number stamped on piston head faces to front of engine.
- d. Before installing piston, piston rings should be positioned as shown in Fig. EM-65.

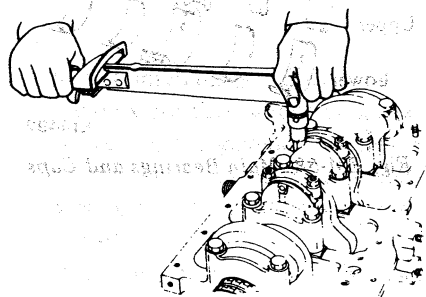


EM498

Fig. EM-65 Positioning Piston Ring Gap

14. Apply engine oil to bearing surfaces.

Ⓣ : Connecting rod cap nuts
31 - 37 N·m
(3.2 - 3.8 kg·m,
23 - 27 ft·lb)



EM499

Fig. EM-66 Tightening Connecting Rod Cap

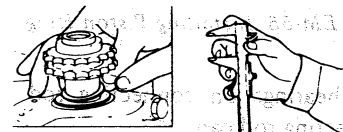
Note: Arrange connecting rods and connecting rod caps so cylinder numbers face in same direction.

15. Make sure there exists proper end play at connecting rod big end. See Fig. EM-41.

Big end play:
0.1 - 0.2 mm
(0.004 - 0.008 in)

16. Insert crank sprocket keys in keyways of crankshaft. Install camshaft and crankshaft sprockets temporarily for adjustment of tooth height by using adjusting washers.

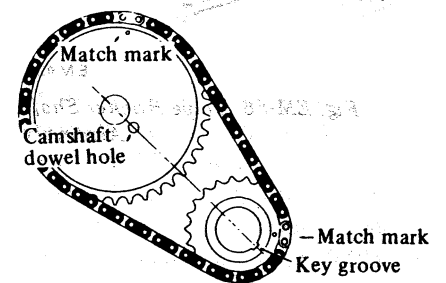
Height difference:
Less than
0.5 mm (0.020 in)
Adjusting washer thickness:
0.5 mm (0.020 in)



EM500

Fig. EM-67 Adjusting Sprocket Tooth Height

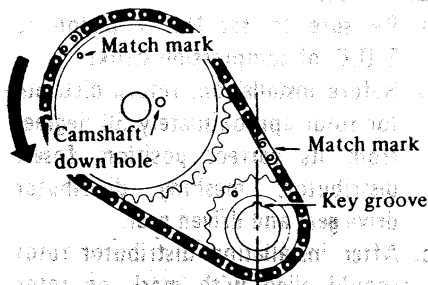
17. Install timing chain and camshaft sprocket with their markings properly aligned. (See Fig. EM-68.) Then set No. 1 piston at T.D.C. on compression stroke. (See Fig. EM-69.) Oil sprocket teeth and chain with engine oil.



EM501

Fig. EM-68 Aligning Markings

Note: Make sure camshaft sprocket dowel hole and crankshaft sprocket key are in line and both dowel hole and key are located downward.

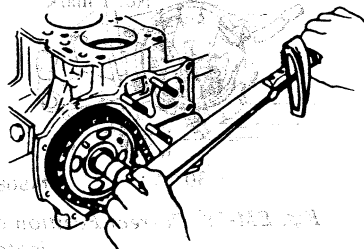


EM767

Fig. EM-69 Setting No. 1 Piston at T.D.C.

18. Tighten camshaft sprocket bolt.

- ⊕ : Camshaft sprocket bolt
39 - 47 N·m
(4 - 4.8 kg·m,
29 - 35 ft·lb)

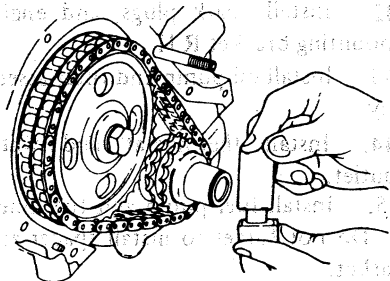


EM502

Fig. EM-70 Tightening Camshaft Sprocket Bolt

19. Install chain tensioner and tighten tensioner attaching bolts.

- ⊕ : Tensioner attaching bolt
6 - 8 N·m
(0.6 - 0.8 kg·m,
4.3 - 5.8 ft·lb)



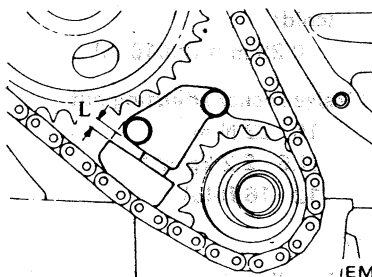
EM503

Fig. EM-71 Installing Chain Tensioner

20. Check projection "L" of tensioner spindle.

If projection "L" exceeds the specified limit, replace chain.

Correct projection "L":
Less than
15 mm (0.59 in)



EM504

Fig. EM-72 Checking Projection of Tensioner Spindle

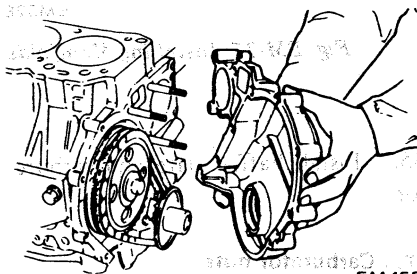
21. Correctly install oil thrower in front of camshaft sprocket.

22. Press new oil seal in timing chain cover. (Front cover oil seal should be replaced when front cover is disassembled.)

23. Install timing chain cover with gasket in place.

Note: When installing oil seal, apply coating of engine oil to mating shaft to prevent scratches and fold-end lip. Also apply coating of oil to periphery of oil seal.

- ⊕ : Timing chain cover bolts
5 - 7 N·m
(0.5 - 0.7 kg·m,
3.6 - 5.1 ft·lb)



EM455

Fig. EM-73 Installing Timing Chain Cover

24. Install water pump with gasket in place.

- ⊕ : Water pump attaching bolts
9 - 14 N·m
(0.9 - 1.4 kg·m,
6.5 - 10.1 ft·lb)

25. Install crank pulley, then confirm and set No. 1 piston at T.D.C. on compression stroke.

- ⊕ : Crank pulley bolt
147 - 196 N·m
(15 - 20 kg·m,
108 - 145 ft·lb)

26. Invert engine. Install oil strainer and oil pan using new gasket and oil seal.

Note: Give coating of sealant to seam between oil pan gasket and oil pan oil seal.

- ⊕ : Oil pan bolts
4 - 6 N·m

- (0.4 - 0.6 kg·m,
2.9 - 4.3 ft·lb)

27. Install gasket and cylinder head.

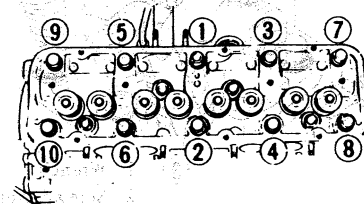
Note: Do not apply sealant to any other part of cylinder block and head surface.

28. Tighten cylinder head bolts.

- ⊕ : Cylinder head bolts
69 - 74 N·m
(7.0 - 7.5 kg·m,
51 - 54 ft·lb)

Note:

- a. One of cylinder head bolts is smaller in diameter than others and has a hollow head. It should be installed on right side center of cylinder head.
- b. Tightening should be made in two or three steps, finally torquing to specification.
- c. Retighten cylinder head bolt after engine has been warmed up.



EM505

Fig. EM-74 Cylinder Head Bolt Tightening Sequence

29. Apply engine oil to both ends of push rods and insert in proper sequence.

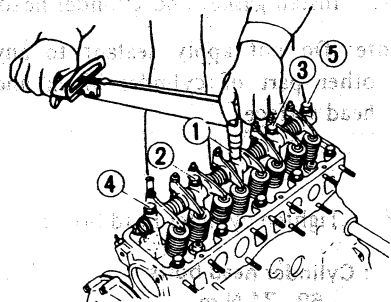
30. Apply engine oil to valve stem end and rocker arm contact surfaces. Position rocker shaft assembly on cylinder head.

31. Tighten rocker shaft bracket bolts to specified torque.

Ⓣ : **Rocker shaft bracket bolts**

20 - 25 N-m
(2.0 - 2.5 kg-m,
14 - 18 ft-lb)

Note: Tightening should be done in two or three stages outwardly from center bracket.



EM506

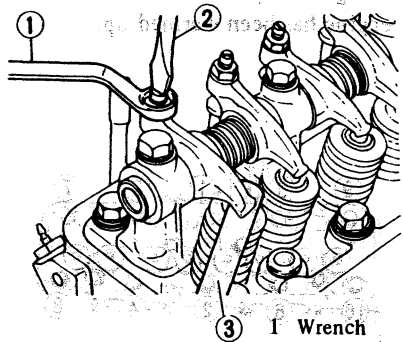
Fig. EM-75 Rocker Shaft Bolt Tightening Sequence

32. Adjust valve clearance to specified value.

Note:

a. First set clearance to 0.25 mm (0.0098 in) when engine is cold.

b. After engine has been assembled, warm it up and finally adjust clearance to specification. For details, refer to Adjusting Intake and Exhaust Valve Clearance in MA Section.



EM507

Fig. EM-76 Adjusting Valve Clearance

Valve clearance
(Intake and exhaust):

(hot)
0.35 mm (0.014 in)

(cold)
0.25 mm (0.010 in)

Ⓣ : **Valve rocker adjusting nut**

16 - 22 N-m
(1.6 - 2.2 kg-m,
12 - 16 ft-lb)

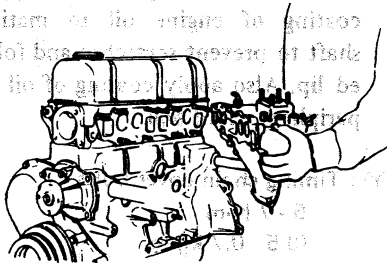
33. Install rocker cover.

34. Install intake and exhaust manifolds.

Ⓣ : **Manifold nuts**

15 - 20 N-m
(1.5 - 2.0 kg-m,
11 - 14 ft-lb)

Note: When installing intake and exhaust manifolds, locate bolt in center of fitting hole.



EM528

Fig. EM-77 Installing Manifolds

35. Install baffle plate and carburetor.

Ⓣ : **Carburetor nuts**

4 - 6 N-m
(0.4 - 0.6 kg-m,
2.9 - 4.3 ft-lb)

36. Install vacuum switching valve assembly and bracket.

37. Install air horn bracket and air horn.

38. Connect air and vacuum hoses to air horn.

39. Install pipe connector to P.C.V. valve hose and engine mounting bracket L.H.

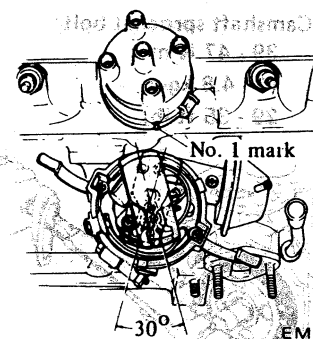
40. Install distributor.

CAUTION:

a. Be sure to set No. 1 piston to T.D.C. of compression stroke.

b. Before installation, return distributor rotor approximately 30 degrees from its correct position. Insert distributor, meshing distributor drive gear and driven gear.

c. After installation distributor rotor should align with mark on rotor cap.



EM508

Fig. EM-78 Correct Position of Rotor

41. Dismount engine from Engine Stand ST050IS000 and place it on suitable engine stand.

Remove Engine Attachment KV10102500.

42. Install spark plugs, and engine mounting bracket R.H.

43. Install oil pump and filter assembly.

44. Install thermostat and water outlet.

45. Install fuel pump and fuel lines. Do not forget to install spacer and gasket.

46. Install distributor vacuum line.

47. Install distributor cap and high tension cables as an assembly. Connect high tension cables.

48. Insert oil level gauge.

49. Install alternator bracket, adjusting bar, water pump pulley, alternator

and drive belt.

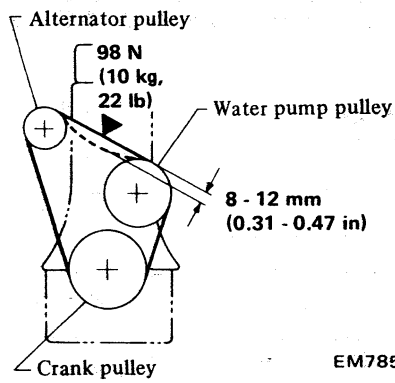
Be sure that belt deflection is held within specified range when moderate force is applied midway between pulleys.

Belt deflection:

**8 - 12 mm
(0.31 - 0.47 in)**

Force:

98 N (10 kg, 22 lb)



EM785

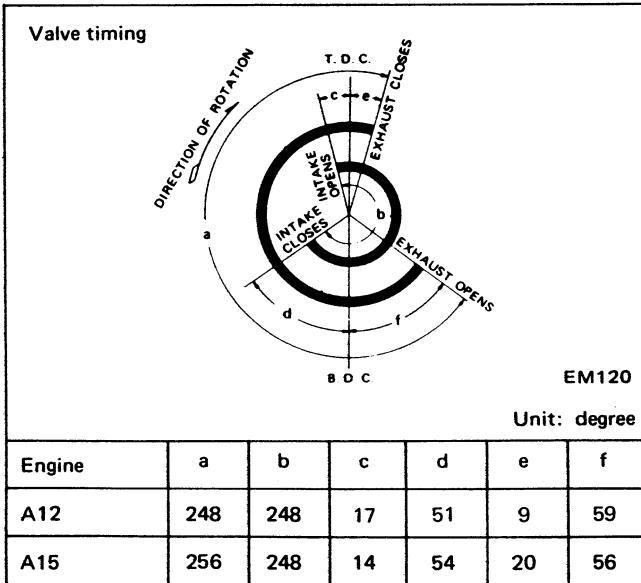
Fig. EM-79 Drive Belt Tension

50. Install compressor bracket with idler pulley (If so equipped).

SERVICE DATA AND SPECIFICATIONS

GENERAL SPECIFICATIONS

Engine model	A12	A15
Cylinder arrangement	4, in-line	
Displacement cm ³ (cu in)	1,171 (71.45)	1,488 (90.80)
Bore and Stroke mm (in)	73.0 x 70.0 (2.874 x 2.756)	76.0 x 82.0 (2.992 x 3.228)
Valve arrangement	O.H.V.	
Firing order	1-3-4-2	
Number of piston rings	Compression	2
	Oil	1
Number of main bearings	5	
Compression ratio	9.0	



INSPECTION AND ADJUSTMENT

CYLINDER HEAD

Unit: mm (in)

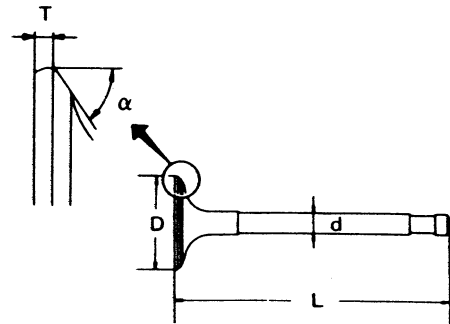
	Standard	Limit
Head surface flatness	Less than 0.05 (0.0020)	0.1 (0.004)

VALVE

Valve

Unit: mm (in)

		A12	A15
Valve head diameter "D"	Intake	35.0 (1.378)	37.0 (1.457)
	Exhaust	29.0 (1.142)	30.0 (1.181)
Valve stem diameter "d"	Intake	7.960 - 7.975 (0.3134 - 0.3140)	
	Exhaust	7.945 - 7.960 (0.3128 - 0.3134)	
Valve length "L"	103.5 - 104.0 (4.0748 - 4.0945)		
Valve seat angle "α"	45° 30'		
Valve margin "T"	Standard	1.3 (0.051)	
	Limit	0.5 (0.020)	
Valve stem end surface grinding limit	0.5 (0.020)		
Valve clearance (In. & Ex.)	Hot	0.35 (0.014)	
	Cold*	0.25 (0.010)	



SEM188

Cold*: Used as approximate values during engine assembly, clearances should ultimately be adjusted to the above hot values.

Valve spring

Free height	mm (in)	46.5 (1.831)
Pressure height	mm/N (mm/kg, in/lb)	30.2/533.5 - 613.9 (30.2/54.4 - 62.6, 1,189/120.0 - 138.0)
Out of square limit	mm (in)	1.6 (0.063)

SERVICE DATA AND SPECIFICATIONS

Valve guide

Unit: mm (in)

Outer diameter	Standard	12.033 - 12.044 (0.4737 - 0.4742)
	O/S*	12.233 - 12.244 (0.4816 - 0.4820)
Inner diameter		8.000 - 8.020 (0.3150 - 0.3157)
Cylinder head valve guide hole diameter	Standard	12.000 - 12.011 (0.4724 - 0.4729)
	O/S*	12.200 - 12.211 (0.4803 - 0.4807)
Interference fit of valve guide		0.022 - 0.044 (0.0009 - 0.0017)
Valve stem clearance	Standard	Intake 0.025 - 0.060 (0.0010 - 0.0024)
		Exhaust 0.040 - 0.075 (0.0016 - 0.0030)
	Limit	0.10 (0.0039)
Valve deflection limit		0.2 (0.008)

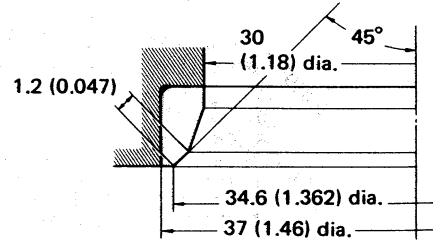
*: Values for OS guides apply to finished size

Valve seat

Unit: mm (in)

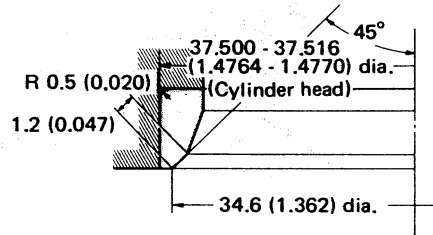
A12 engine

INTAKE
Standard



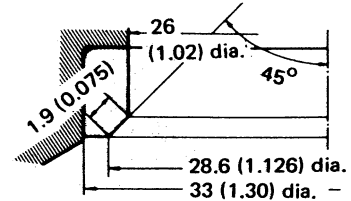
SEM457

Oversize



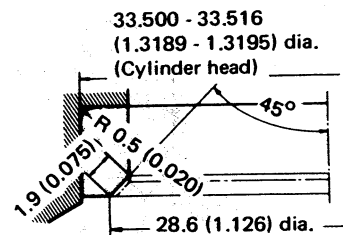
SEM458

EXHAUST
Standard



SEM190

Oversize



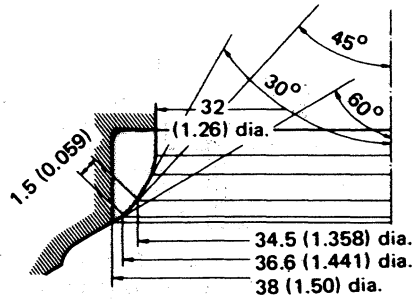
SEM192

SERVICE DATA AND SPECIFICATIONS

Unit: mm (in)

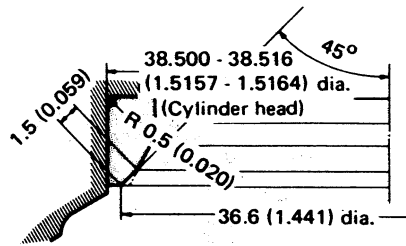
A15 engine

INTAKE
Standard



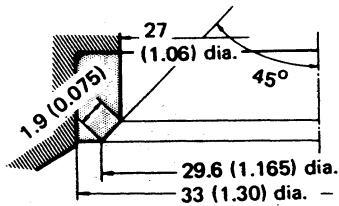
SEM189

Oversize



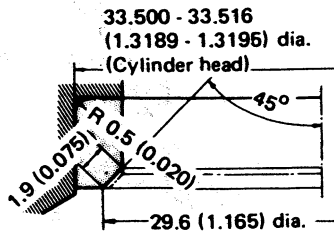
SEM191

EXHAUST
Standard



SEM190

Oversize

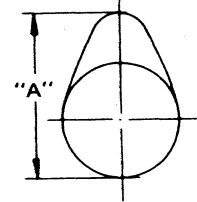


SEM192

CAMSHAFT

Unit: mm (in)

Engine		A12	A15	
Journal diameter	No. 1	43.783 - 43.796 (1.7237 - 1.7242)		
	No. 2	43.283 - 43.296 (1.7041 - 1.7046)		
	No. 3	42.783 - 42.796 (1.6844 - 1.6849)		
	No. 4	42.283 - 42.296 (1.6647 - 1.6652)		
	No. 5	41.208 - 41.221 (1.6224 - 1.6229)		
Bend [T.I.R.]	Std.	Less than 0.015 (0.0006)		
	Limit	0.05 (0.0020)		
End play	Std.	0.01 - 0.05 (0.0004 - 0.0020)		
	Max.	0.10 (0.0039)		
Cam lobe height "A"	In.	Std.	36.200 - 36.250 (1.4252 - 1.4272)	
		Limit	35.700 (1.4055)	
	Ex.	Std.	36.200 - 36.250 (1.4252 - 1.4272)	35.930 - 35.980 (1.4146 - 1.4165)
		Limit	35.700 (1.4055)	35.430 (1.3949)

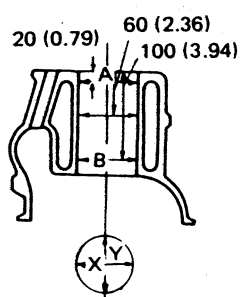


EM671

CYLINDER BLOCK

Cylinder block

Unit: mm (in)

		A12	A15
Surface flatness	Std.	Less than 0.05 (0.0020)	
	Limit	0.1 (0.004)	
Cylinder bore dia.	Std.	73.000 - 73.050 (2.8740 - 2.8760)	76.000 - 76.050 (2.9921 - 2.9941)
	O/S	0.02 (0.0008)	
Out-of round limit (X-Y)		0.02 (0.0008)	
Taper limit (A-B)		0.02 (0.0008)	
Difference of bore dia. between cylinders		Less than 0.05 (0.0020)	
			
EM479			

Cylinder liner

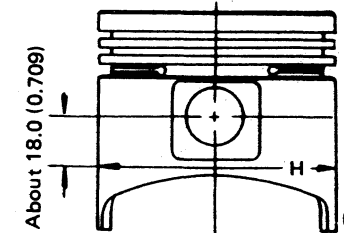
Unit: mm (in)

		A12	A15
Liner outer dia.	4.0 (0.157)	77.00 - 77.05 (3.0315 - 3.0335)	80.00 - 80.05 (3.1496 - 3.1516)
	4.5 (0.177)	77.50 - 77.55 (3.0512 - 3.0531)	80.50 - 80.55 (3.1693 - 3.1713)
	5.0 (0.197)	78.00 - 78.05 (3.0709 - 3.0728)	81.00 - 81.05 (3.1890 - 3.1909)
Interference fit liner to block		0.080 - 0.090 (0.0031 - 0.0035)	
Gap "T" liner to block		0 - 0.05 (0 - 0.0020)	

PISTON

Piston

Unit: mm (in)

		A12	A15
Piston skirt dia. "H"	Std.	72.967 - 73.017 (2.8727 - 2.8747)	75.967 - 76.017 (2.9908 - 2.9928)
	0.02 (0.0008)	72.987 - 73.037 (2.8735 - 2.8755)	75.987 - 76.037 (2.9916 - 2.9936)
	0.50 (0.0197)	73.467 - 73.517 (2.8924 - 2.8944)	76.467 - 76.517 (3.0105 - 3.0125)
	1.00 (0.0394)	73.967 - 74.017 (2.9121 - 2.9140)	76.967 - 77.017 (3.0302 - 3.0322)
Piston clearance to cylinder block		0.025 - 0.045 (0.0010 - 0.0018)	
Difference of piston with connecting weight between cylinders g (oz)		Less than 5 (0.18)	
			
EM480			

Piston pin

Unit: mm (in)

Engine	A12	A15
Piston pin dia.	17.447 - 17.452 (0.6869 - 0.6871)	18.995 - 19.000 (0.7478 - 0.7480)
Pin clearance to piston	0.008 - 0.012 (0.0003 - 0.0005)	
Interference fit of piston pin to connecting rod	0.017 - 0.035 (0.0007 - 0.0014)	

Always replace pistons and piston pins as a set.

SERVICE DATA AND SPECIFICATIONS

Piston ring

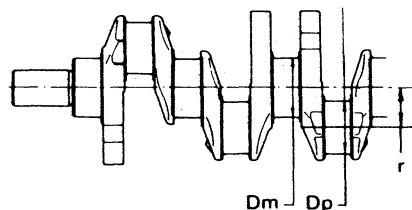
Unit: mm (in)

Engine		A12	A15
Side clearance	Top	0.04 - 0.07 (0.0016 - 0.0028)	0.03 - 0.07 (0.0012 - 0.0028)
	2nd	0.04 - 0.07 (0.0016 - 0.0028)	0.03 - 0.06 (0.0012 - 0.0024)
	Limit	0.10 (0.0039)	
Gap	Top	0.20 - 0.35 (0.0079 - 0.0138)	0.15 - 0.30 (0.0059 - 0.0118)
	2nd	0.20 - 0.35 (0.0079 - 0.0138)	0.15 - 0.30 (0.0059 - 0.0118)
	Oil (rail)	0.30 - 0.90 (0.0118 - 0.0354)	
	Limit	1.00 (0.0394)	

CRANKSHAFT

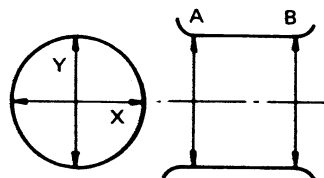
Unit: mm (in)

Engine		A12	A15
Main journal dia. "Dm"		49.943 - 49.964 (1.9663 - 1.9671)	
Pin journal dia. "Dp"		44.954 - 44.974 (1.7698 - 1.7706)	
Center distance "r"		35.0 (1.378)	41.0 (1.614)
Out-of-round (X-Y) and taper (A-B)	Std.	Less than 0.05 (0.0020)	
	Limit	0.03 (0.0012)	
Bend [T.I.R.]	Std.	Less than 0.05 (0.0020)	
	Limit	0.10 (0.0039)	
Free end play	Std.	0.05 - 0.15 (0.0020 - 0.0059)	
	Limit	0.30 (0.0118)	



EM777

Out-of-round X-Y
Taper A-B



EM715

CONNECTING ROD

Unit: mm (in)

Engine		A12	A15
Center distance		121.5 (4.78)	133 (5.24)
Bend, Torsion [per 100 mm (3.94 in)]	Std.	Less than 0.025 (0.0010)	
	Limit	0.05 (0.0020)	
Piston pin bore dia.		17.414 - 17.430 (0.6856 - 0.6862)	18.962 - 18.978 (0.7465 - 0.7472)
Big end play	Std.	0.1 - 0.2 (0.004 - 0.008)	
	Limit	0.4 (0.016)	
Difference of connecting rod assembly weight between cylinders g (oz)		Less than 5 (0.18)	

SERVICE DATA AND SPECIFICATIONS

FLYWHEEL

Unit: mm (in)

Runout limit [T.I.R.]	0.15 (0.0059)
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CAMSHAFT SPROCKET

Unit: mm (in)

Runout limit [T.I.R.]	0.10 (0.0039)
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BEARING

Unit: mm (in)

Bearing clearance		
Main bearing	Std.	0.026 - 0.090 (0.0010 - 0.0035)
	Limit	0.10 (0.0039)
Connecting rod bearing	Std.	0.030 - 0.079 (0.0012 - 0.0031)
	Limit	0.10 (0.0039)
Camshaft bearing	Std.	No. 1 & 5 0.037 - 0.060 (0.0015 - 0.0024)
		No. 2 & 4 0.027 - 0.050 (0.0011 - 0.0020)
		No. 5 0.040 - 0.063 (0.0016 - 0.0025)
	Limit	0.15 (0.0059)
	Main bearing Crankshaft main journal dia.	
	Std.	49.943 - 49.964 (1.9663 - 1.9671)
	0.25 (0.0098)	49.701 - 49.714 (1.9567 - 1.9572)
	U/S 0.50 (0.0197)	49.451 - 49.464 (1.9469 - 1.9474)
	0.75 (0.0295)	49.201 - 49.214 (1.9370 - 1.9376)
Connecting rod bearing Crankshaft pin journal dia.		
	Std.	44.954 - 44.974 (1.7698 - 1.7706)
	0.08 (0.0031)	44.881 - 44.894 (1.7670 - 1.7675)
	U/S 0.25 (0.0098)	44.711 - 44.724 (1.7603 - 1.7608)
	0.50 (0.0197)	44.461 - 44.474 (1.7504 - 1.7509)
	0.75 (0.0295)	44.211 - 44.224 (1.7406 - 1.7411)

unit: mm (in)

Camshaft bearing	Camshaft journal dia.	Finish of bearing inner dia.
Std.	No. 1	43.783 - 43.796 (1.7237 - 1.7242)
	No. 2	43.283 - 43.296 (1.7041 - 1.7046)
	No. 3	42.783 - 42.796 (1.6844 - 1.6849)
	No. 4	42.283 - 42.296 (1.6647 - 1.6652)
	No. 5	41.208 - 41.221 (1.6224 - 1.6229)
U/S 0.25 (0.0098)	No. 1	43.533 - 43.546 (1.7139 - 1.7144)
	No. 2	43.033 - 43.046 (1.6942 - 1.6947)
	No. 3	42.533 - 42.546 (1.6745 - 1.6750)
	No. 4	42.033 - 42.046 (1.6548 - 1.6554)
	No. 5	40.958 - 40.971 (1.6125 - 1.6130)
U/S 0.50 (0.0197)	No. 1	43.283 - 43.296 (1.7041 - 1.7046)
	No. 2	42.783 - 42.796 (1.6844 - 1.6849)
	No. 3	42.283 - 42.296 (1.6647 - 1.6652)
	No. 4	41.783 - 41.796 (1.6450 - 1.6455)
	No. 5	40.708 - 40.721 (1.6027 - 1.6032)
U/S 0.75 (0.0295)	No. 1	43.033 - 43.046 (1.6942 - 1.6947)
	No. 2	42.533 - 42.546 (1.6745 - 1.6750)
	No. 3	42.033 - 42.046 (1.6548 - 1.6554)
	No. 4	41.533 - 41.546 (1.6352 - 1.6357)
	No. 5	40.458 - 40.471 (1.5928 - 1.5933)

TIGHTENING TORQUE

Unit	N·m	kg·m	ft·lb
Cylinder head bolt	69 - 74	7.0 - 7.5	51 - 54
Rocker shaft bracket bolt	20 - 25	2.0 - 2.5	14 - 18
Main bearing cap bolt	49 - 59	5.0 - 6.0	36 - 43
Flywheel fixing bolt	78 - 88	8.0 - 9.0	58 - 65
Connecting rod cap nut	31 - 37	3.2 - 3.8	23 - 27
Camshaft sprocket bolt	39 - 47	4.0 - 4.8	29 - 35
Locating plate bolt	5 - 8	0.5 - 0.8	3.6 - 5.8
Valve rocker adjusting nut	16 - 22	1.6 - 2.2	12 - 16
Oil strainer bolt	9 - 14	0.9 - 1.4	6.5 - 10.1
Oil pan bolt	4 - 6	0.4 - 0.6	2.9 - 4.3
Oil pan drain plug	20 - 29	2.0 - 3.0	14 - 22
Timing chain cover bolt	5 - 7	0.5 - 0.7	3.6 - 5.1
Crank pulley bolt	147 - 196	15 - 20	108 - 145
Water pump bolt	9 - 14	0.9 - 1.4	6.5 - 10.1
Fuel pump nut	9 - 14	0.9 - 1.4	6.5 - 10.1
Spark plug	15 - 20	1.5 - 2.0	11 - 14
Flywheel adapter bolt	16 - 21	1.6 - 2.1	12 - 15
Flywheel housing bolt	16 - 21	1.6 - 2.1	12 - 15

TROUBLE DIAGNOSES AND CORRECTIONS

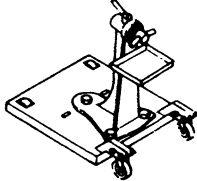
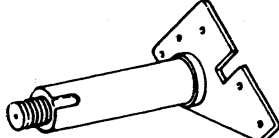
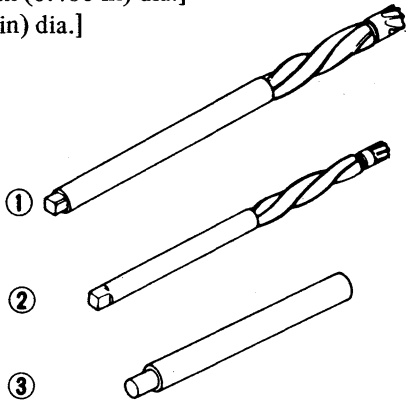
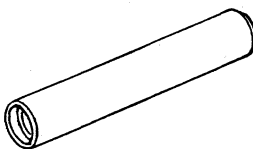
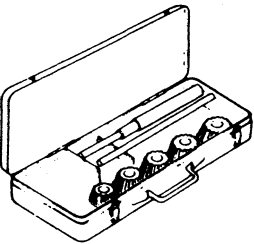
Condition	Probable cause	Corrective action
I. Noisy engine Knocking of crankshaft and bearing.	Loose main bearing. Seized bearing. Bent crankshaft. Uneven wear of journal. Excessive crankshaft end play.	Replace. Replace. Repair or replace. Correct. Replace center bearing.
Piston and connecting rod knocking.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

TROUBLE DIAGNOSES AND CORRECTIONS

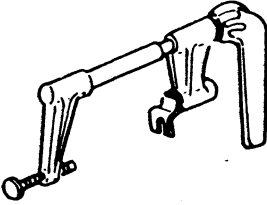
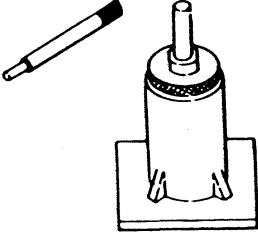
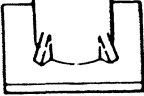
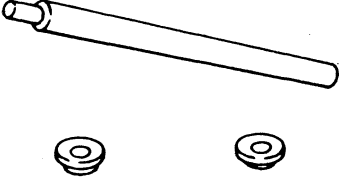
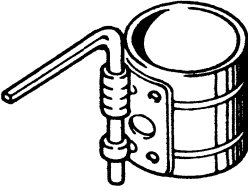
Condition	Probable cause	Corrective action
Seized valve seat.	Improper valve clearance. Weakened valve spring. Thin valve head edge. Narrow valve seat. Overheating. Over speeding. Stuck valve guide.	Adjust. Replace. Replace valve. Reface. Repair or replace. Drive at proper speed. Repair.
Excessively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

SPECIAL SERVICE TOOLS

*Special tool or a commercial equivalent

Tool number	Tool name	Application	
		A12	A15
ST0501S000* ① ST05011000 ② ST05012000	Engine stand assembly Engine stand Base 	X	X
KV10102500*	Engine attachment 	X	X
KV101039S0* ① ST11081000 ② ST11032000 ③ ST11033000	Valve guide reamer set Reamer [12.2 mm (0.480 in) dia.] [8.0 mm (0.315 in) dia.] Valve guide drift 	X	X
KV10104800	Valve lip seal drift 	X	X
ST11670000*	Valve seat cutter set 	X	X

SPECIAL SERVICE TOOLS

Tool number	Tool name	Application	
		A12	A15
ST12070000*	Valve lifter 	X	X
KV10105300*	Piston pin press stand 	-	X
ST13040000*	Piston pin press stand 	X	-
ST16110000*	Camshaft bearing drift 	X	X
EM03470000*	Piston ring compressor 	X	X

ENGINE LUBRICATION & COOLING SYSTEMS

SECTION **LC**

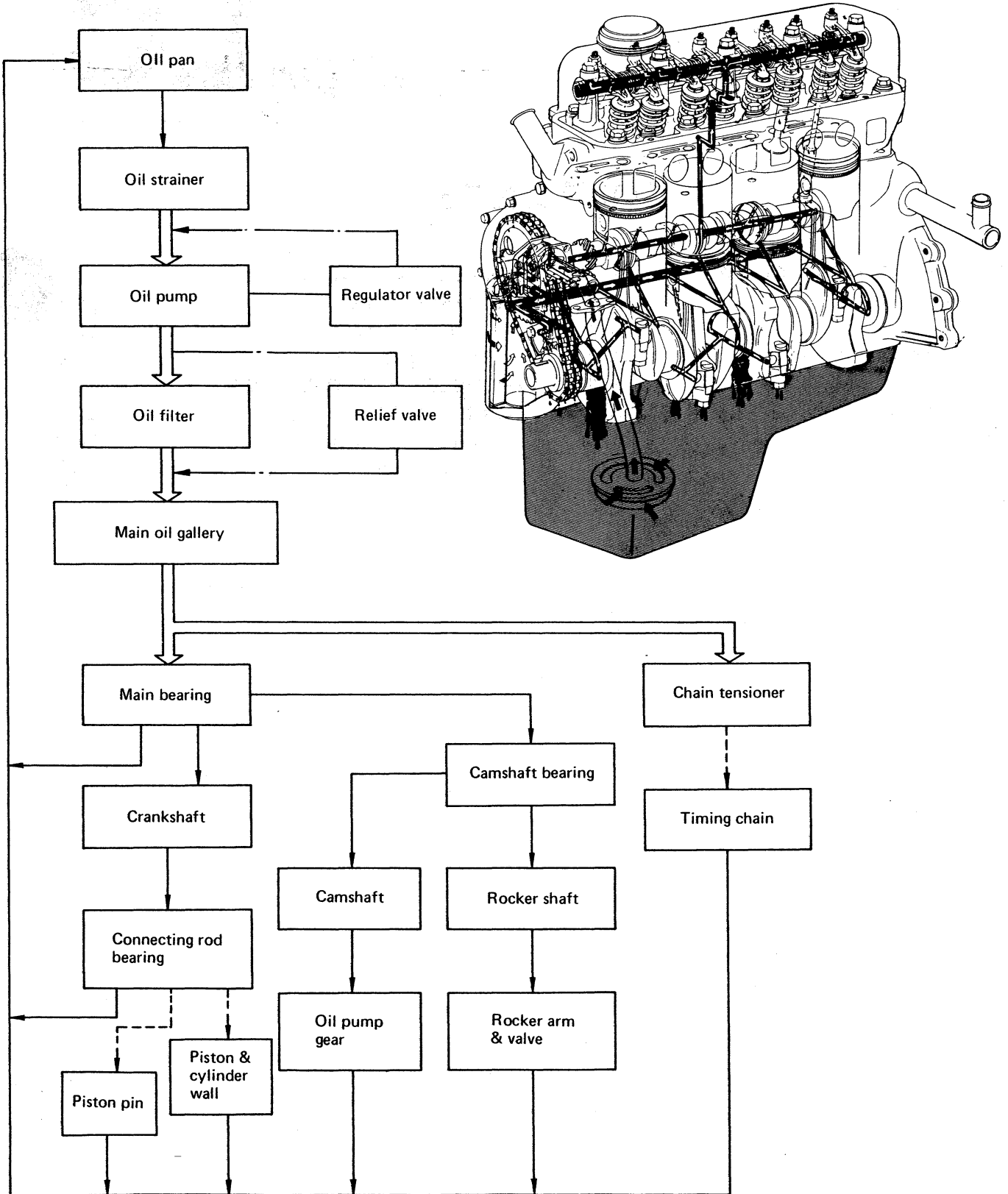
CONTENTS

ENGINE LUBRICATION SYSTEM	LC-2	SERVICE DATA AND	
Lubrication circuit	LC-2	SPECIFICATIONS	LC-8
Oil pump	LC-3	Inspection and adjustment	LC-8
Oil pressure regulator valve	LC-4	Tightening torque	LC-8
Oil filter	LC-4	TROUBLE DIAGNOSES AND	
COOLING SYSTEM	LC-5	CORRECTIONS	LC-9
Cooling circuit	LC-5	Lubrication system	LC-9
Thermostat	LC-6	Cooling system	LC-9
Water pump	LC-6		

LC

ENGINE LUBRICATION SYSTEM

LUBRICATION CIRCUIT

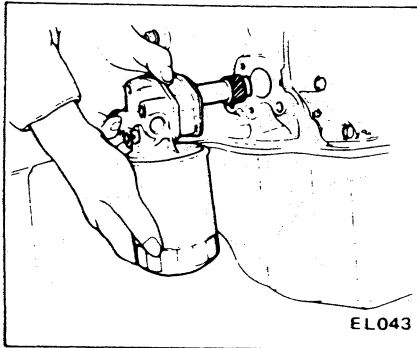


ENGINE LUBRICATION SYSTEM

OIL PUMP

REMOVAL

1. Place a suitable container under oil pump.
2. Remove bolts securing oil pump (with attached filter) and withdraw as an assembly.
3. Separate oil filter from oil pump.
4. Clean off old gasket from mating surfaces.



INSTALLATION

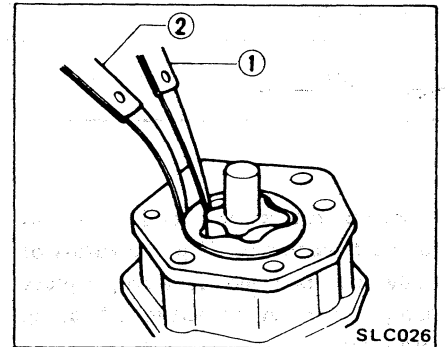
1. Install oil filter to oil pump.
2. Locate oil pump with filter on cylinder block, using a spacer and new gasket. Secure with bolts.

⊕ : Oil pump mounting bolts
 8.8 - 13.7 N·m
 (0.9 - 1.4 kg·m,
 6.5 - 10.1 ft·lb)

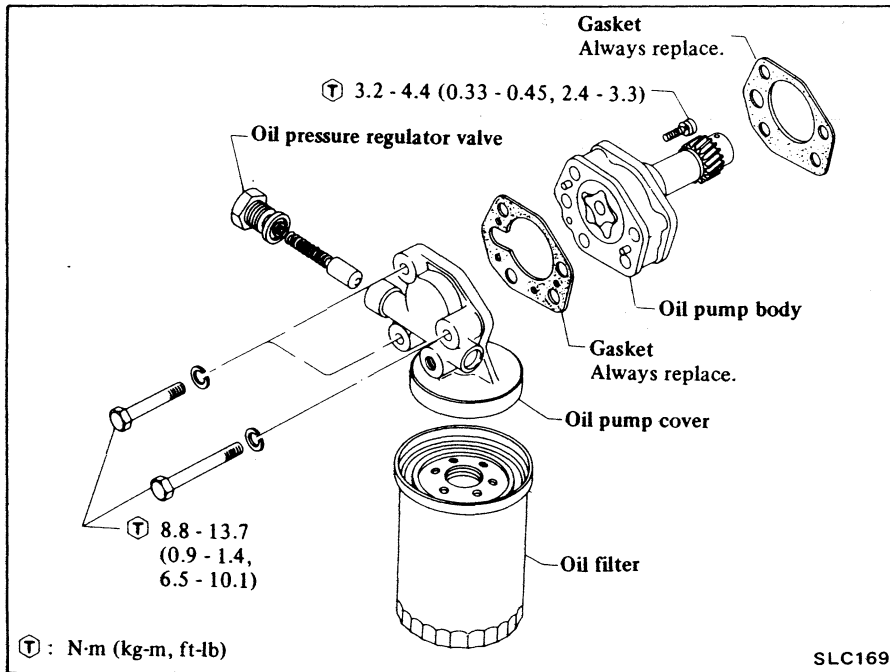
3. Check oil level and add oil if necessary.
4. Start engine and check for oil leaks.

INSPECTION

1. Inspect the following for wear or damage.
 - Pump body and cover
 - Pump rotors and rotor shaft
 - Regulator valve and spring
2. Using a feeler gauge, check the following clearances.
 - Rotor tip clearance ①
 - Outer rotor to body clearance ②

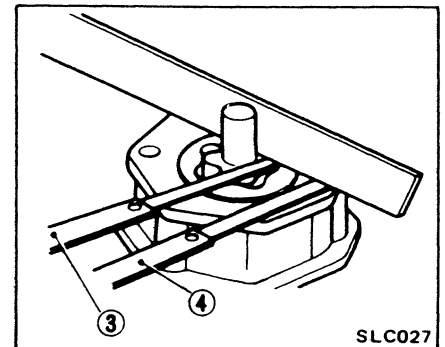


DISASSEMBLY AND ASSEMBLY



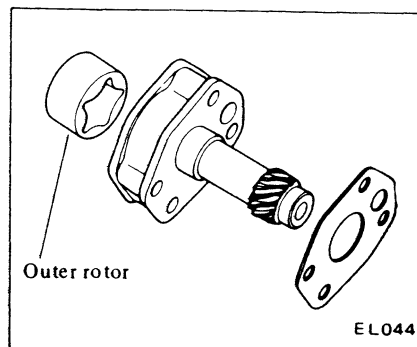
3. Using a feeler gauge and a straight edge, check the following gaps:

- Rotor to straight edge ③
- Oil pump body to straight edge ④



⊕ : Oil pump cover bolts
 3.2 - 4.4 N·m
 (0.33 - 0.45 kg·m,
 2.4 - 3.3 ft·lb)

Always replace with a new gasket.



ENGINE LUBRICATION SYSTEM

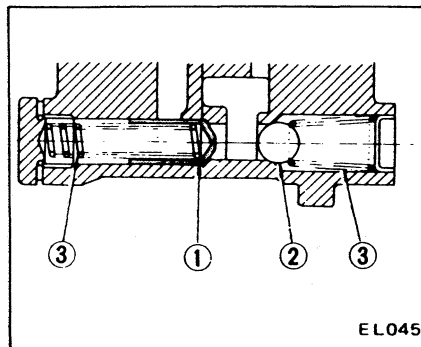
		Standard	Wear limit
Outer rotor to body	mm (in)	0.15 - 0.21 (0.0059 - 0.0083)	0.50 (0.0197)
Rotor tip clearance	mm (in)	Less than 0.12 (0.0047)	0.20 (0.0079)
Rotor to straight edge	mm (in)	0.05 - 0.12 (0.0020 - 0.0047)	—
Oil pump body to straight edge	mm (in)	0.05 - 0.12 (0.0020 - 0.0047)	—
Rotor side clearance	mm (in)	0.04 - 0.08 (0.0016 - 0.0031)	0.20 (0.0079)

Pump rotors and body are not serviced separately. If pump rotors or body are damaged or worn, replace pump rotor set or entire oil pump assembly.

OIL PRESSURE REGULATOR VALVE

INSPECTION

Check the valve spring surface and the valve spring, and replace the entire valve assembly if necessary.



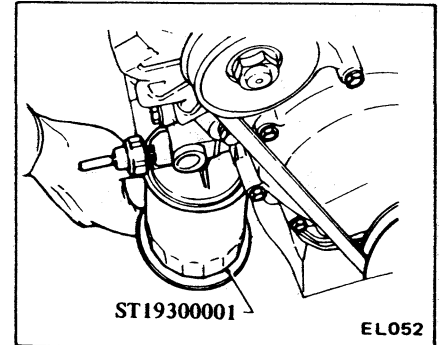
- 1 Regulator valve
- 2 Relief valve
- 3 Valve spring

OIL FILTER

REMOVAL AND INSTALLATION

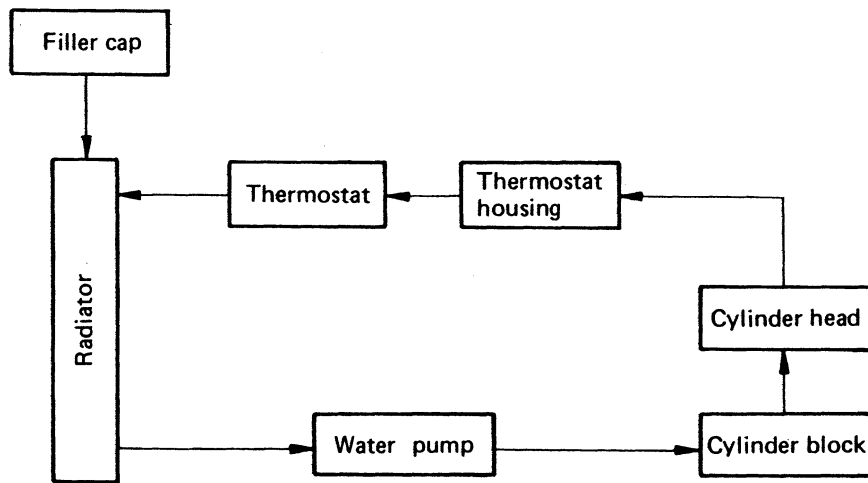
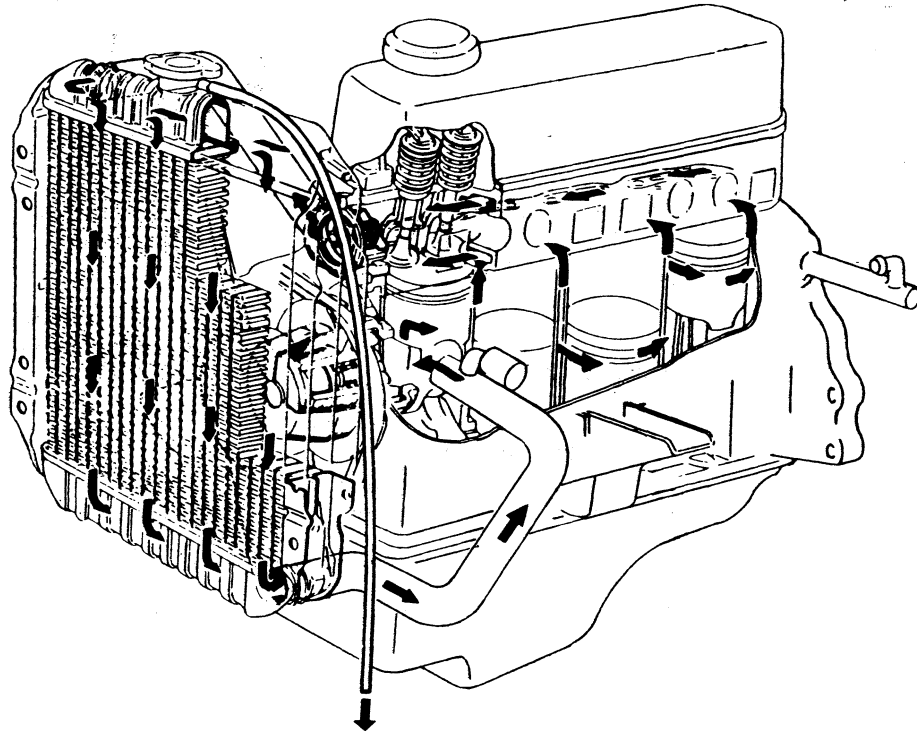
When removing the oil filter, use the Tool. When installing it, sparingly apply oil on the oil seal and fasten it by hand.

Do not overtighten filter, or oil leakage may occur.



COOLING SYSTEM

COOLING CIRCUIT

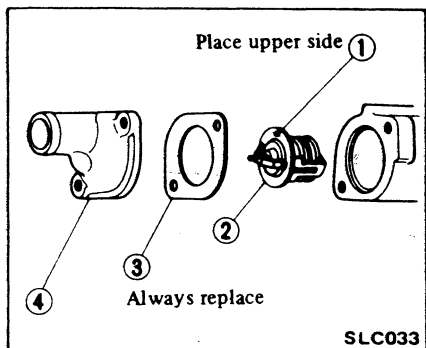


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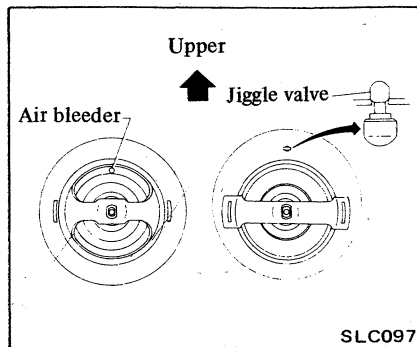
COOLING SYSTEM

THERMOSTAT

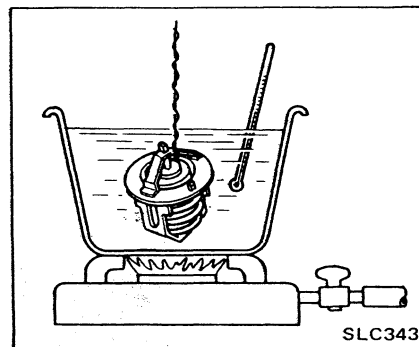
REMOVAL AND INSTALLATION



- 1 Jiggle valve
- 2 Thermostat
- 3 Gasket
- 4 Water outlet



- (2) Install water outlet.
- 3. Check for leakage.



- 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.

1. Drain coolant partially and disconnect upper radiator hose at water outlet.

2. When installing, observe the following:

(1) Replace gasket with new one.

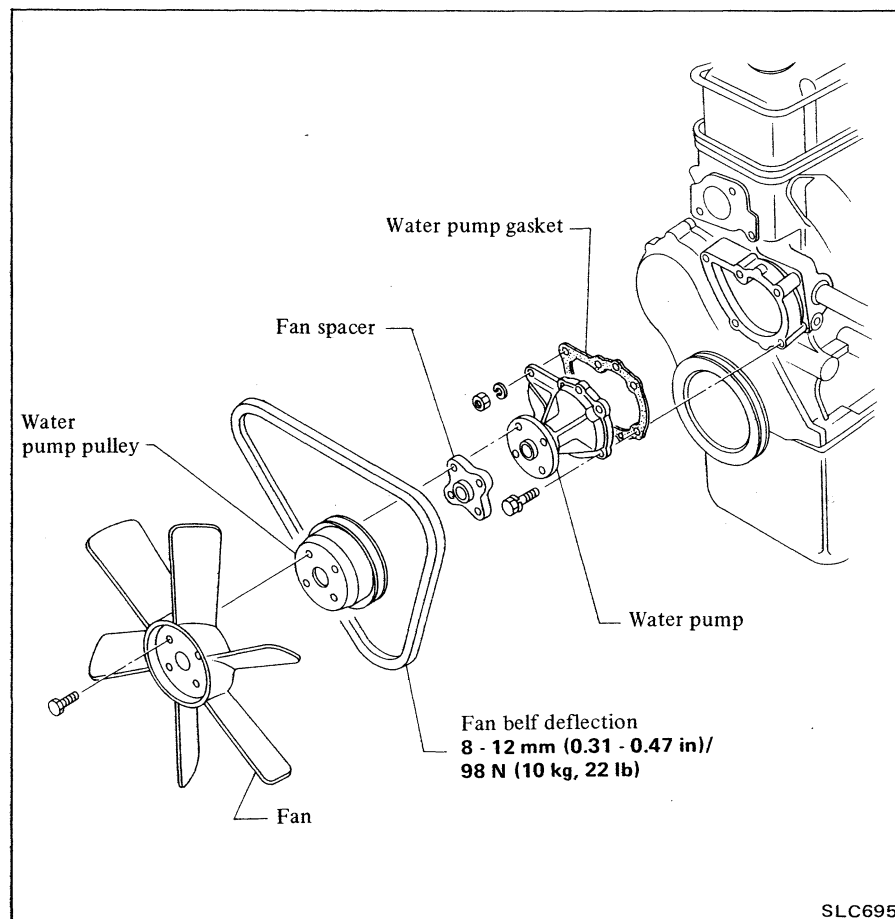
Place thermostat's jiggle valve or air bleeder on upper portion.

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 max. valve lift. (Refer to S.D.S.)

WATER PUMP



COOLING SYSTEM

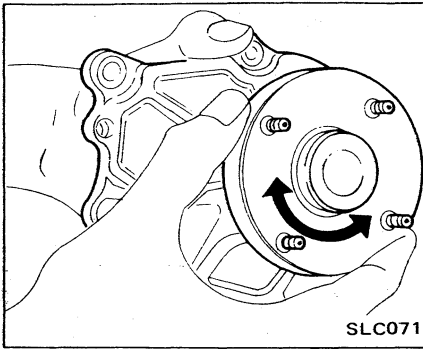
DISASSEMBLY

Water pump is made of aluminum and its bearing outer race is of a press fit type. For this reason, water pump should not be disassembled.

INSPECTION

Inspect pump assembly for the following conditions and replace if necessary.

1. Badly rusted or corroded body assembly and vane.
2. Excessive end play or roughness of bearings in operation.



If excessive mechanical seal squeak occurs when engine is running, use pump seal lubricant.

SERVICE DATA AND SPECIFICATIONS

INSPECTION AND ADJUSTMENT

Oil pump

Unit: mm (in)

	Standard	Wear limit
Rotor tip clearance	Less than 0.12 (0.0047)	0.20 (0.0079)
Outer rotor to body clearance	0.15 - 0.21 (0.0059 - 0.0083)	0.50 (0.0197)
Rotor side clearance (rotor to bottom cover)	0.04 - 0.08 (0.0016 - 0.0031)	0.20 (0.0079)

Thermostat

	Frigid type	Standard type	Tropical type
Valve opening temperature °C (°F)	88 (190)	82 (180)	76.5 (170)
Max. valve lift mm/°C (in/°F)	8/100 (0.31/212)	8/95 (0.31/203)	8/90 (0.31/194)

TIGHTENING TORQUE

	N-m	kg-m	ft-lb
Oil pump mounting bolts	9 - 14	0.9 - 1.4	6.5 - 10.1
Oil pump cover bolts	3.8 - 5.1	0.39 - 0.52	2.8 - 3.8
Regulator valve cap	39 - 49	4 - 5	29 - 36
Water pump securing bolt	9 - 14	0.9 - 1.4	6.5 - 10.1

TROUBLE DIAGNOSES AND CORRECTIONS

LUBRICATION SYSTEM

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

COOLING SYSTEM

Condition	Probable cause	Corrective action
Water leakage	Damaged radiator seams. Leaks from heater connections or plugs. Leaks from water pump shaft seal. Leaks from water temperature gauge. Leaks from gaskets or small cracks. Loose joints. Damaged cylinder head gasket. Cracked cylinder block. Cracked cylinder head. Loose cylinder head bolts.	Repair. Repair. Replace as pump assembly. Tighten or repair. Tighten or use Nissan System Sealer or equivalent. Tighten. Replace. Check engine oil for contamination and refill as necessary. Replace. Check engine oil in crankcase for mixing with water by pulling oil level gauge. Replace. Tighten.
Poor circulation	Restriction in system. Insufficient coolant. Inoperative water pump. Loose fan belt. Inoperative thermostat.	Check hoses for crimps, and clear the system of rust and sludge by flushing radiator. Replenish. Replace. Adjust. Replace.

ENGINE FUEL

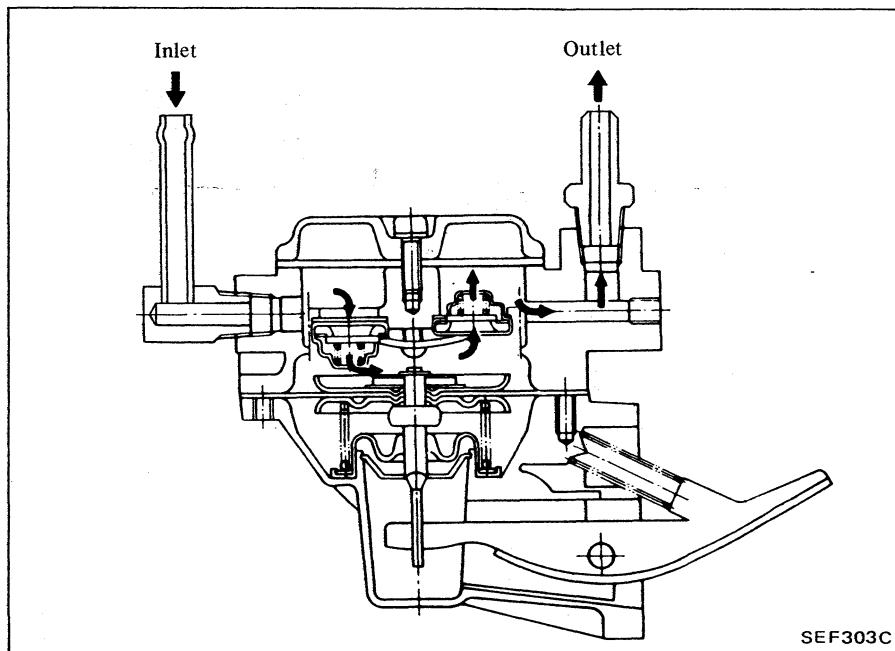
SECTION **EF**

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FUEL PUMP	EF- 2	SERVICE DATA AND	
Operating test	EF- 2	SPECIFICATIONS	EF-10
Inspection	EF- 2	Fuel pump	EF-10
CARBURETOR	EF- 3	Carburetor	EF-10
Inspection and adjustment	EF- 4	Governor	EF-10
Major service operations	EF- 6	TROUBLE DIAGNOSES AND	
GOVERNOR	EF- 7	CORRECTIONS	EF-11
Disassembly	EF- 7	Carburetor	EF-11
Inspection	EF- 7	Governor	EF-12
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EF

FUEL PUMP



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 submerge the pump in a fuel bath and check for air leaks.

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

OPERATING TEST

STATIC 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.

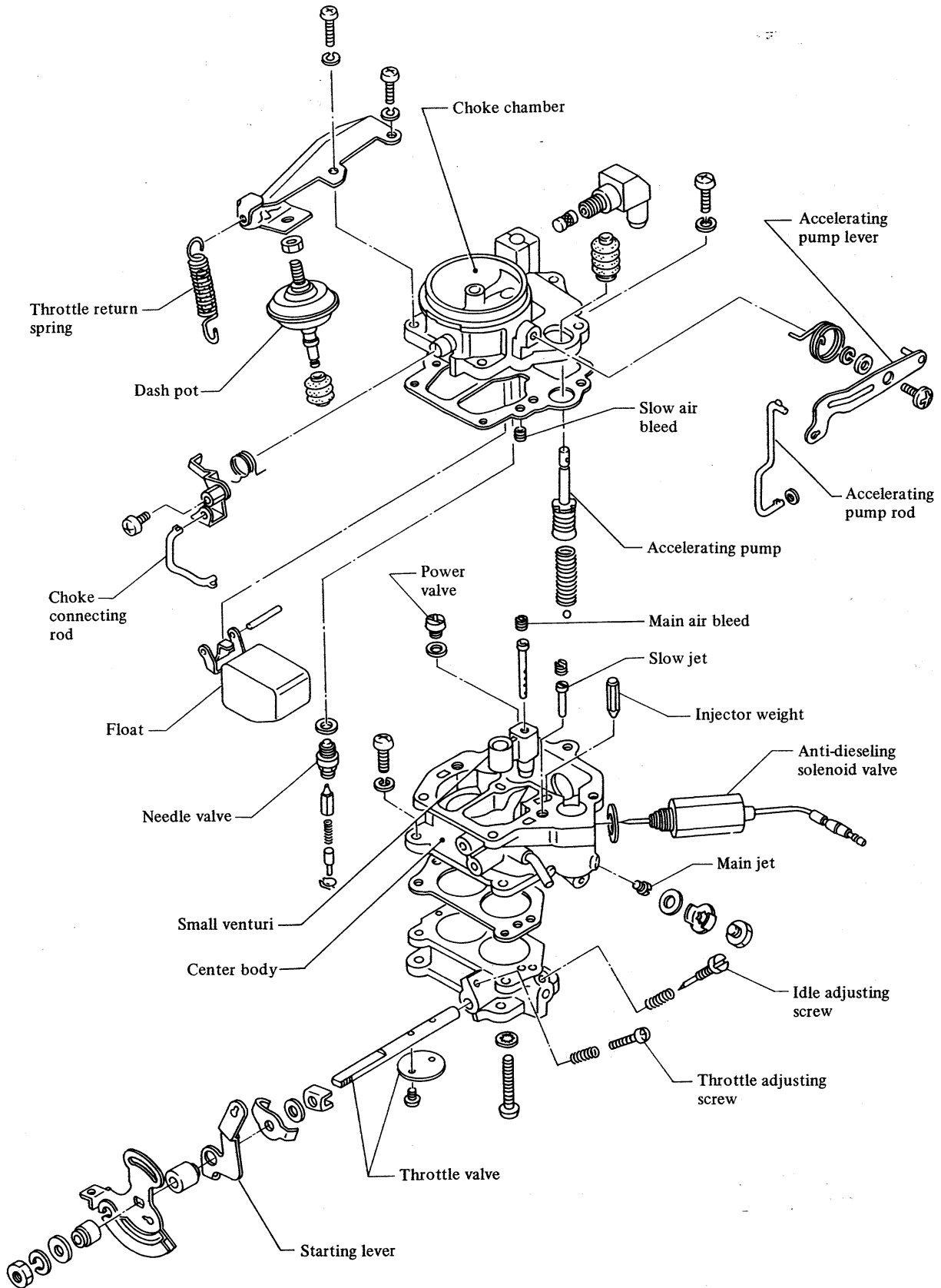
Locate this T-connector as close to carburetor as possible.

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 static fuel pressure in the line. The gauge reading should be within the specified value.

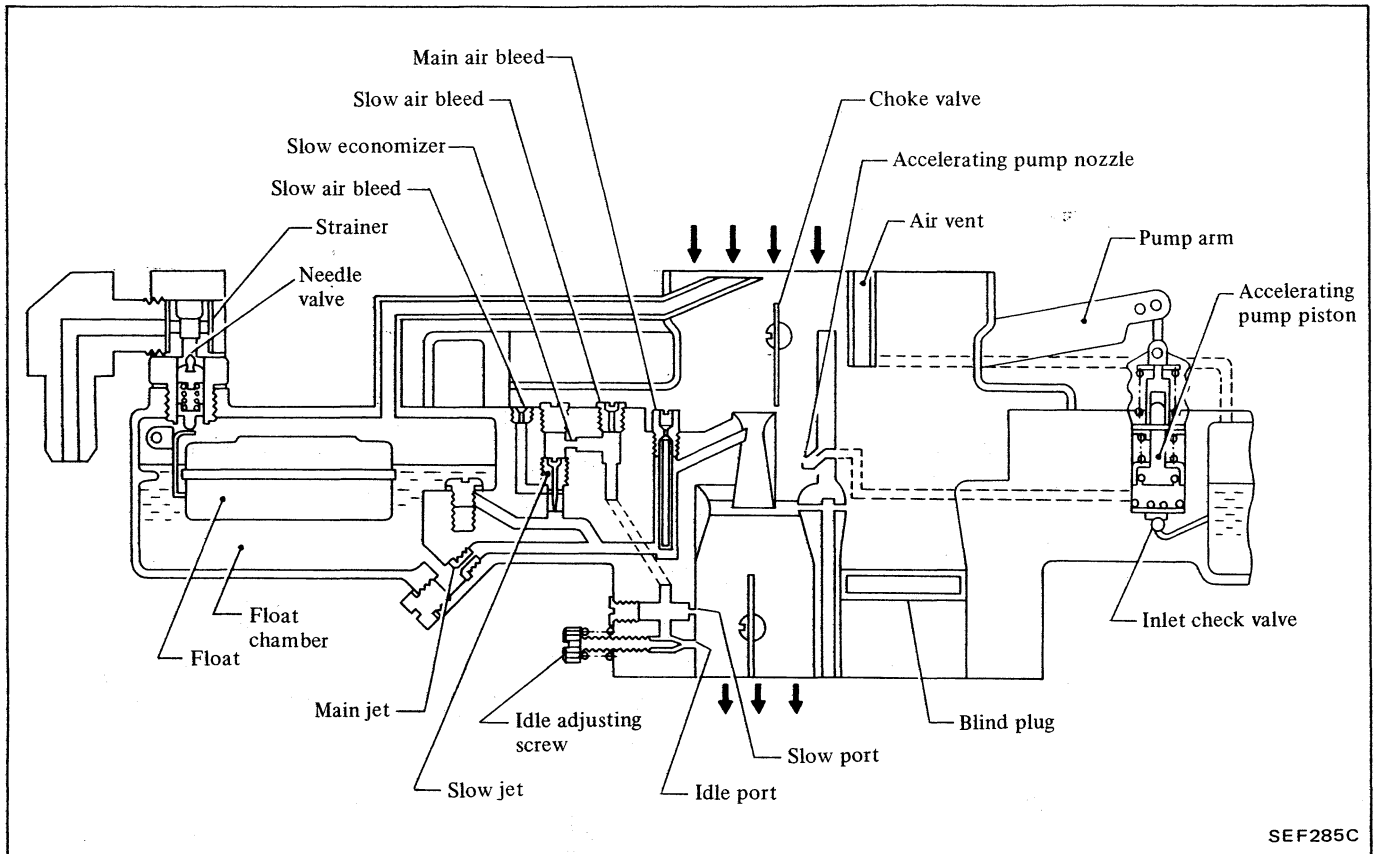
A12 and A15
16.7 - 23.5 kPa
(0.167 - 0.235 bar,
0.17 - 0.24 kg/cm²,
2.4 - 3.4 psi)

CARBURETOR

CARBURETOR



CARBURETOR



SEF285C

INSPECTION AND ADJUSTMENT

IDLE RPM AND MIXTURE RATIO

Refer to section MA for Inspection and Adjustment of idle rpm and mixture ratio.

FUEL LEVEL

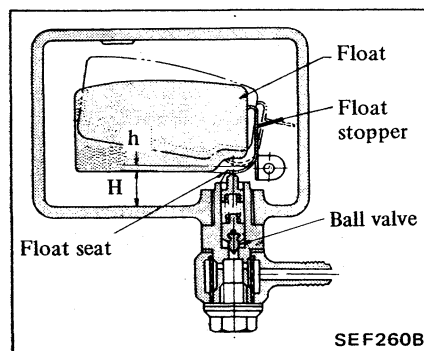
Fuel level is factory-adjusted and needs no adjustment. Adjust only when overhauling or replacing inner parts. Use the following procedure.

Top float position "H"

Turn down carburetor and check float position "H".

Top float position "H":
12.0 mm (0.472 in)

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



Bottom float position "h"

Check clearance "h" (between float seat and ball valve stem) when float is fully raised.

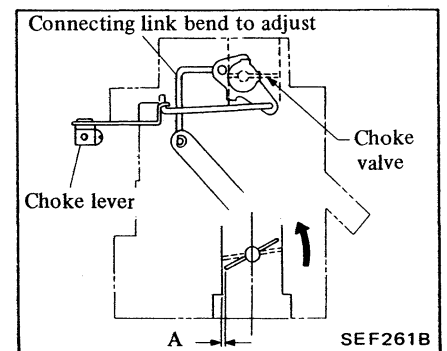
Clearance "h":
1.3 - 1.7 mm (0.051 - 0.067 in)

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

FAST IDLE

Check clearance "A" between throttle valve and inner wall by pulling out choke lever completely.

Clearance "A":
1.28 mm (0.0504 in)



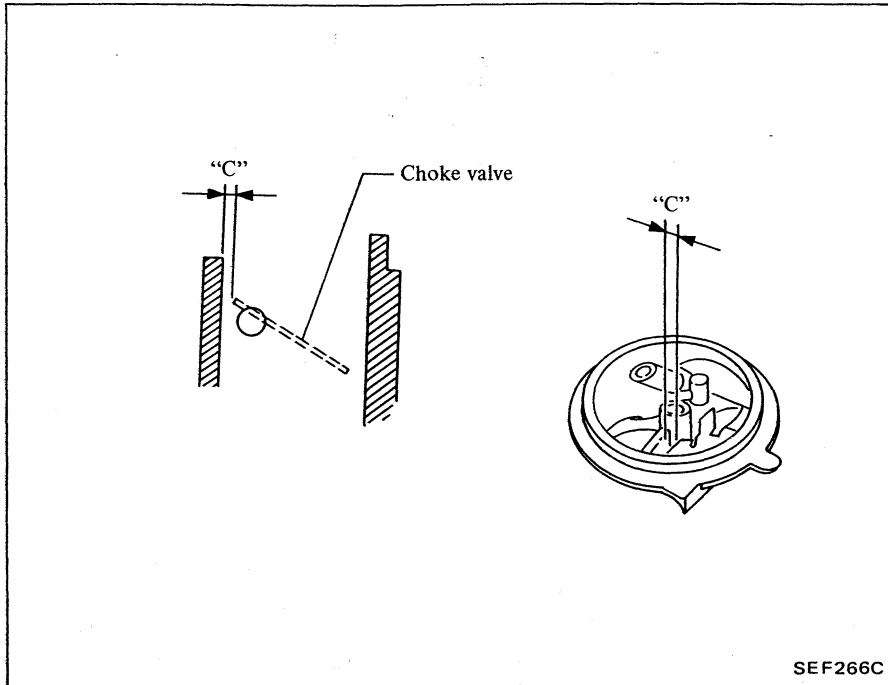
If out of specification, make adjustments by bending choke connecting rod.

CARBURETOR

If throttle valve fails to open fully, unloader becomes inoperative, resulting in poor acceleration after engine is started.

In this condition, check clearance "C" between choke valve and carburetor body.

Clearance "C"
2.01 mm (0.0791 in)



JET AND AIR BLEED

CAUTION:

- Be sure to use a screwdriver of proper size.
- Be careful not to scratch or nick jet and air bleed.
- To clean jet and air bleed, use solvent and compressed air.

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

ACCELERATOR PUMP

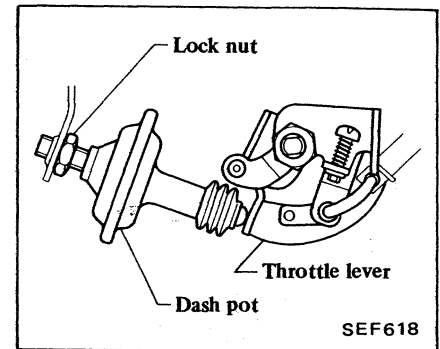
When accelerator pump is operated by opening throttle lever by hand with engine stopped, remove air horn and check pump injector located at primary port if it injects fuel smoothly without delay.

DASH POT

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

Dash pot touch speed:
1,900 - 2,100 rpm

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



- Tighten lock nut and make sure that engine speed drops smoothly from 2,000 to 1,000 rpm in approximately three seconds.
- If it becomes necessary to remove carburetor for dash pot adjustment, proceed as follows:
 - Adjust gap between primary throttle valve and inner carburetor wall when dash pot stem comes in contact with throttle arm.

Dash pot gap
0.76±0.1 mm
(0.0299±0.004 in)

- Tighten dash pot lock nut.
- After reinstalling carburetor on engine, ensure dash pot touching engine speed is within the specification.

ANTI-DIESELING SOLENOID VALVE

Start the engine and keep at idling speed. Disconnect the lead wire for the anti-dieseling solenoid at the connector.

If the engine does not stop when the lead wire is disconnected, the solenoid is stuck. Reconnect the lead wire and start the engine. Then turn off the ignition switch.

If the engine does not stop when the ignition switch is turned off, this indicates that the striking solenoid valve is stuck or short-circuited.

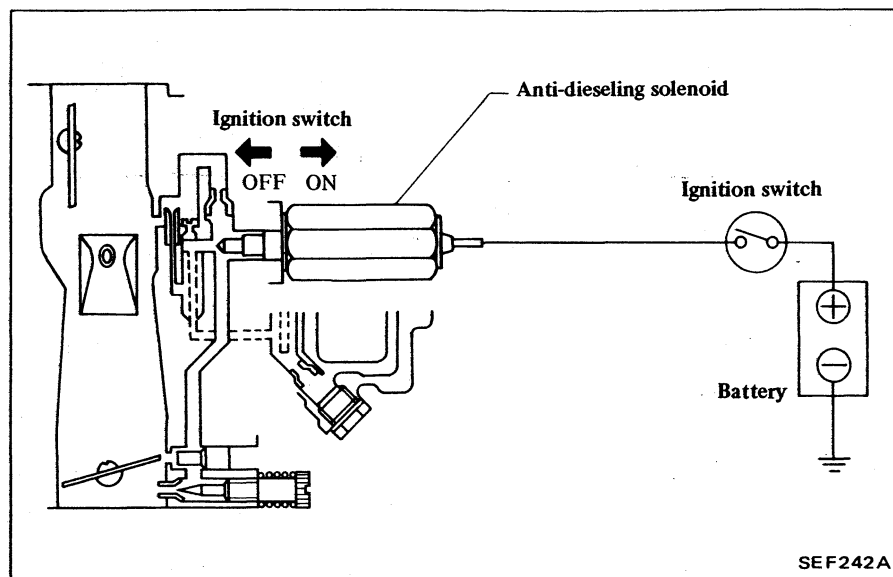
If the harness is in good condition, replace the solenoid valve as a unit.

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

CARBURETOR

After replacement, start engine and check to be sure that fuel is not

leaking, and that anti-dieseling solenoid is in good condition.



MAJOR SERVICE OPERATIONS

The perfectly adjusted carburetor delivers the proper fuel and air ratios at all speeds for the particular engine for which it was designed. By completely disassembling at regular intervals, which will allow cleaning of all parts and passages, the carburetor can 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.

REMOVAL

Remove carburetor from engine, taking sufficient care to the following:

PRECAUTIONS:

- When disconnecting fuel lines, do not spill fuel from fuel pipe.
- When removing carburetor, do not drop any nut or bolt into intake manifold.
- Be careful not to bend or scratch any part.

CLEANING AND INSPECTION

Dirt, gum, water or carbon contamination in or on exterior moving parts of a carburetor are often responsible for unsatisfactory performance. For this reason, efficient carburetion depends upon careful cleaning and inspection while servicing.

1. Blow all passages and castings with compressed air and blow off all parts until dry.

Do not pass drills or wires through calibrated jets or passages as this may enlarge orifice and seriously affect carburetor calibration.

2. Check all parts for wear. If wear is noted, damaged parts must be replaced. Note especially the following:

- Check float needle and seat for wear. If wear is noted, assembly must be replaced.

- Check throttle and choke shaft bores in throttle chamber and choke chamber for wear or out-of-roundness.

- Inspect idle adjusting needle for burrs or ridges. Such a condition requires replacement.

3. Inspect gaskets to see if they appear hard or brittle or if edges are torn or distorted. If any such condition is noted, they must be replaced.

4. Check filter screen for dirt or lint. Clean, and if screen is distorted or remains plugged, replace.

5. Check linkage for operating condition.

6. Inspect operation of accelerating pump. Pour fuel into float chamber and make throttle lever operate. Check condition of fuel injection from the accelerating nozzle.

Jets

Carburetor performance depends on jets and air bleeds. That is why these components must be fabricated with utmost care. To clean them, use cleaning solvent and blow air on them. Larger inner numbers stamped on the jets indicate larger diameters. Accordingly, main and slow jets with larger numbers provide richer mixture; the smaller numbers the leaner mixture. Conversely, the main and slow air bleeds, through which air to passes, make the fuel leaner if they bear larger numbers; the smaller numbers the richer fuel.

ASSEMBLY

1. Thoroughly wash all the parts before assembling.

2. Inspect gaskets to see if they appear hard or brittle or if edges are torn or distorted.

If any of such undesirable conditions is noted, they must be replaced.

3. Install jet and air bleed having the same size number as that of original one.

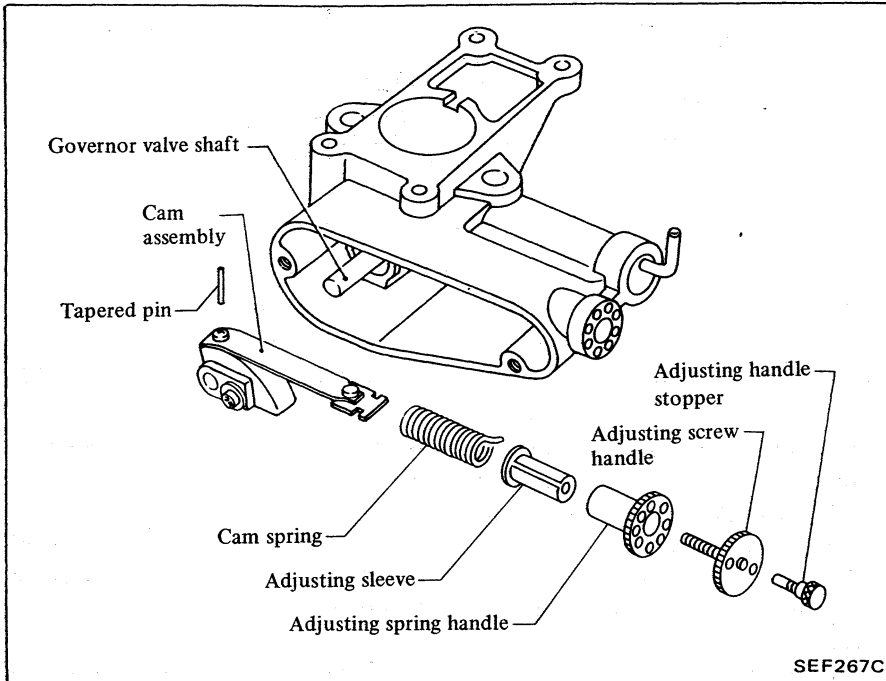
4. After reassembling carburetor, check each rotating portion or sliding portion for smooth operation.

GOVERNOR

DISASSEMBLY

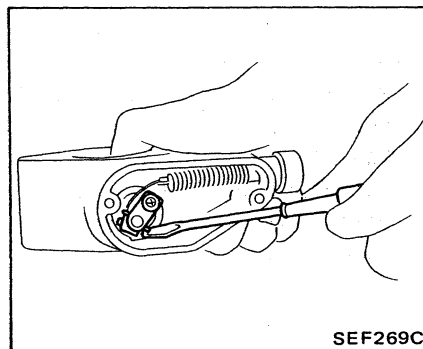
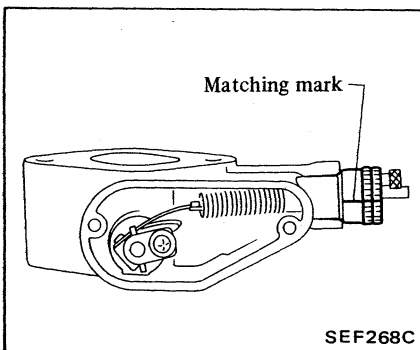
Do not attempt to disassemble governor unless necessary, especially cam

assembly which requires precise adjustment of cam and cam plate.



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

4. Remove adjusting spring handle.
5. Drive tapered pin out of camshaft from the lower end; then remove tapered pin.



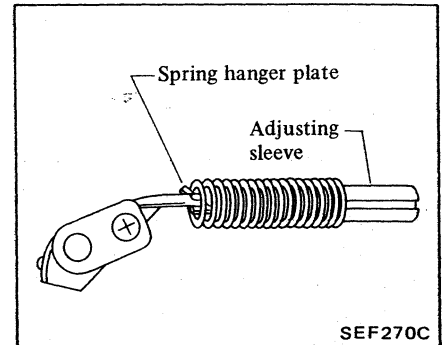
2. Unlock lock wire and remove adjusting handle stopper.

3. Remove adjusting screw handle by turning it while holding adjusting spring handle to prevent it from turning.

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

6. Remove cam, cam band, spring and adjusting sleeve from camshaft as a unit. Be careful not to deform cam band.

When it is necessary to further disassemble it, record number of spring's active turns, screwed-in state of spring ends, hanger plate and adjusting sleeve, as well as relative location of groove in adjusting sleeve and cam band.



7. Remove adjusting sleeve, cam spring and cam band.

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.

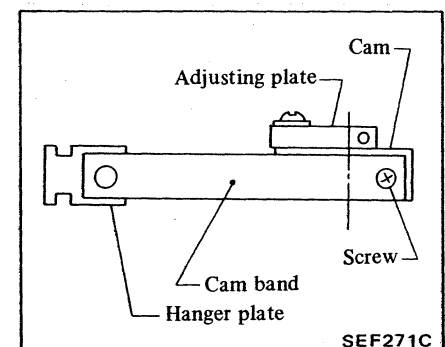
ASSEMBLY

To assemble, reverse disassembling procedures.

Observe the following:

Cam band

1. Pay attention to direction of cam band and install cam band on side which coincides with spring hanger plate.



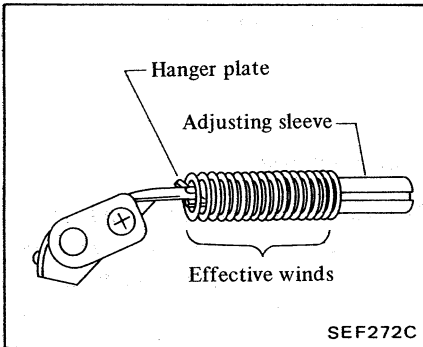
GOVERNOR

2. Install cam band along contour of cam with screws while pressing it against cam. If a new cam band is used, squeeze it through beforehand to facilitate installation.

Cam spring

Pay attention to direction of cam spring and install end which coincides with spring hanger block first.

1. Turn cam spring 1 to 1-1/2 rotations while holding hanger block.
2. Next, screw adjusting sleeve in while holding spring so that active turns of spring and location of groove in sleeve are exactly same as before. If any part is replaced or original active turns of spring or position of groove is unknown, set spring so that it has 17 to 18 active turns.



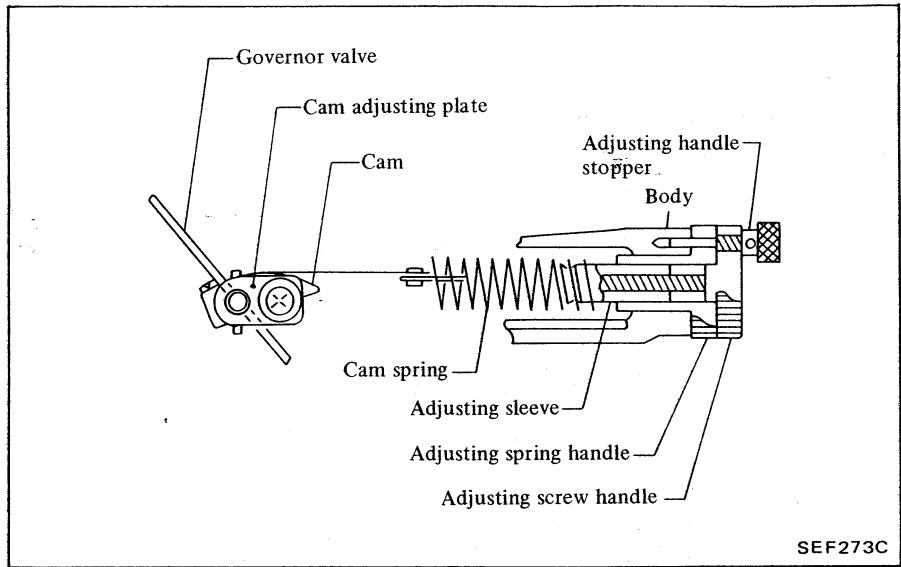
ADJUSTMENT

Max. speed under no-load	3,550 rpm
--------------------------	-----------

Rated engine speed	2,800 rpm
--------------------	-----------

Allowable hunting	3 times, max.
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ADJUSTMENT MECHANISM



- Adjusting sleeve moves in or out by turning adjusting screw 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. Turning adjusting spring handle causes adjusting sleeve to move in or out while sleeve itself is rotating. 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.
- Output characteristics change considerably when relative position of cam and cam adjusting plate is changed. (Do not attempt to adjust relative position unless necessary, because it greatly influences output characteristics.)

TEMPORARY ADJUSTMENT

1. Turn adjusting spring handle until active turns of spring are in 17 to 18 range.
2. Turn adjusting screw handle until adjusting sleeve is disengaged. From that position, turn handle clockwise 12 to 13 rotations.

Whenever governor is re-assembled, making this temporary adjustment (same as that which was adjusted before disassembly) reduces number of subsequent repetitive adjustment operations required.

3. After temporary adjustment has been made, start engine until temperatures of engine oil and coolant are in 70 to 80°C (158 to 176°F) range.
4. After engine has warmed up, properly adjust valve clearances, advance angle, distributor's point gap, idle speed, etc., prior to making final adjustments.

ADJUSTMENT OF MAXIMUM SPEED UNDER NO-LOAD

1. Completely open carburetor's throttle valve with engine under no-load.
2. Turn adjusting screw (outer) handle until engine speed is within specification.

A12 3,300 - 3,500 rpm

A15 3,300 - 3,550 rpm

Engine speed increases by turning adjusting screw handle clockwise, and vice versa.

One-sixteenth rotation of handle changes engine speed by approximately 30 rpm.

GOVERNOR

ADJUSTMENT OF RATED OUTPUT

Make final adjustments after adjusting maximum speed under no-load.

1. Apply total load of auxiliary equipment to engine and completely open carburetor's throttle valve.

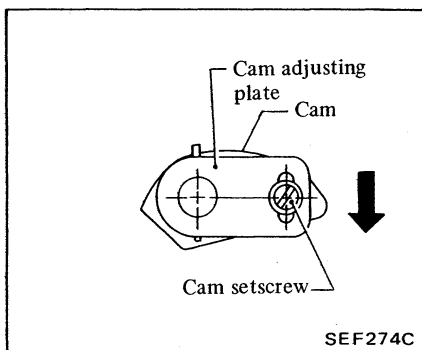
2. With engine held under fully loaded condition, check engine speed. Engine speed should be equivalent to specified value.

a. Turn adjusting spring (inner) handle approximately 1/8 rotation clockwise and turn adjusting screw (outer) handle an equal amount counterclockwise. Then, re-adjust maximum speed under no-load.

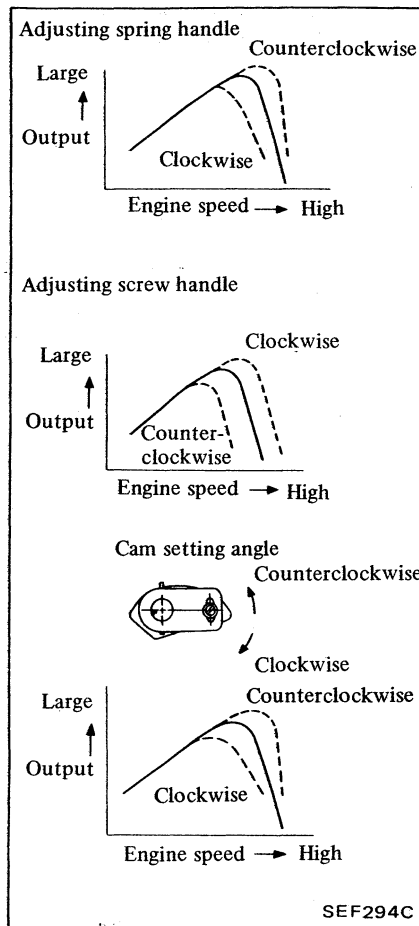
b. Rated output can be increased by increasing maximum speed under no-load. Because of this, when maximum speed can be increased to reach specified maximum speed, turn adjusting screw handle clockwise so that engine speed reaches maximum allowable speed of 3,450 rpm.

c. If engine output is still insufficient when steps a and b above are repeated, cam needs to be adjusted; however, since adjusting cam greatly affects engine operating condition (which is manifested by "engine hunting" described below), cam should not be adjusted unless necessary.

Moving cam setscrew in direction indicated by arrow in figure below increases engine output; however, engine hunting also tends to occur.



The relationship between adjustment methods and engine speeds is illustrated in figure below.



d. If above adjustments are made on an engine which has been used for a long time, engine itself will not produce sufficient output. In such a case, engine needs to be overhauled.

CHECKING FOR ENGINE HUNTING

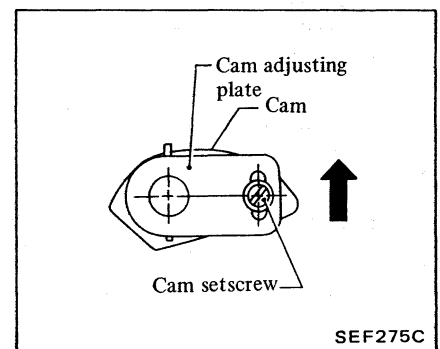
Hunting refers to the state in which engine speed changes abruptly and engine vibrates during operation.

After both maximum speed under no-load and rated output have been adjusted, perform the following checks:

1. Idle engine.
2. Depress accelerator pedal quickly to see if engine hunting occurs more than three times.
3. If it occurs more than three times, proceed as follows:
 - a. Turn adjusting spring handle 1/8 rotation counterclockwise for each time and repeat maximum speed adjustment under no-load.
 - b. If this does not eliminate engine hunting, cam needs to be adjusted; however, since cam adjustment greatly influences engine performance, it should not be adjusted unless necessary.

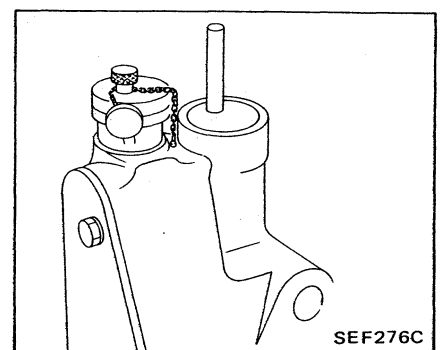
Turning cam setscrew in direction indicated by arrow (in figure below) reduces engine hunting.

If cam setting should be changed, maximum speed under no-load should also be adjusted over again.



GOVERNOR SEAL

After breaking governor seal and adjusting/replacing governor, be sure to secure adjusting handle stopper with a wire (furnished as a service part). Pass wire through hole in stopper and that on the body side with pliers and then seal it.



SERVICE DATA AND SPECIFICATIONS

FUEL PUMP

Fuel pump capacity (US fl oz, ml Imp ft oz)/minute at 1,500 rpm	More than 900 (30.4, 31.7)
Fuel pump pressure kPa (bar, kg/cm ² , psi)	23.5 (0.235, 0.24, 3.4)

CARBURETOR

Engine	A12	A15
Carburetor model	DCG26-6	
Choke type	Manual	
Inlet diameter mm (in)	59 (2.32)	
Outlet diameter mm (in)	26 (1.02)	
Venturi diameter mm (in)		
Large	22 (0.87)	
Small (inner dia. - outer dia.)	8 - 13 (0.31 - 0.51)	
Main jet	#112	#115
Main air bleed	#55	#55
Slow jet	#48	#48
Slow air bleed		
No. 1	#170	#170
No. 2		
Power jet	#45	#45
Fast idle opening mm (in)	1.17 - 1.38 (0.0461 - 0.0543)	1.68 - 1.88 (0.0661 - 0.0740)
Float level adjustment mm (in)		
Top float position "H"	12.0 (0.472)	
Bottom float position "h" (Clearance "L")	1.3 - 1.7 (0.051 - 0.067)	
Main jet variation		
0	#112	#115
1,000 m (3,300 ft)	#98	#112
2,000 m (6,600 ft)	#94	#99
3,000 m (9,900 ft)	#92	#96
4,000 m (13,000 ft)	#88	#94

GOVERNOR

Type	Pneumatic	
Speed control system	By controlling mixture amount	
Operation of control mechanism	By suction negative pressure	
Max. no-load speed rpm		3,450
Rated engine speed rpm		2,800
No. of allowable hunting repetitions	3 times (Max.)	
Standard set		
Active cam spring coils when mounted	17 - 18	
Screw handle adjustment	12 - 13 turns clockwise	

TROUBLE DIAGNOSES AND CORRECTIONS

CARBURETOR

In the following table, the symptoms and causes of carburetor problems and remedies for them are listed

to facilitate quick repairs.

There are various causes of engine malfunctions. It sometimes happens that a carburetor which has no fault seems apparently to have some prob-

lems, when in fact the electrical system is faulty. Therefore, whenever the engine has problems, electrical system must be checked first before making carburetor adjustment.

Condition	Probable cause	Corrective action
Overflow	Float damaged. Dirt accumulated on ball valve. Fuel pump pressure too high. Ball valve seat improper.	Replace. Clean ball valve. Repair pump. Repair or replace.
Excessive fuel consumption	Fuel level improper. Main jet or slow jet size too large. Main air bleed or slow air bleed clogged. Main jet or slow jet damaged. Choke valve does not fully open. Outlet valve seat of accelerator pump improper. Idle adjustment incorrect.	Adjust, or repair float system parts. Replace with the specified one. Clean. Replace. Adjust. Lap. Adjust.
Power shortage	Main jet clogged or damaged. Throttle valve does not open fully. Fuel filter clogged. Vacuum jet or passage clogged. Power valve operating improperly. Malfunctioning fuel pump.	Clean or replace. Adjust. Replace. Clean. Adjust. Repair or replace.
Improper idling	Idle adjustment incorrect. Slow jet or slow air bleed clogged. Throttle valve does not close. Throttle valve shaft worn. Manifold/carburetor tightening improper. Packing between manifold/carburetor faulty. Fuel overflow.	Adjust. Clean. Adjust. Replace. Correct. Replace gasket. See above item.
Engine hesitation	Main jet or slow jet clogged. By-pass hole, idle passage clogged. Emulsion tube clogged. Idling adjustment incorrect.	Clean. Clean tube. Clean. Correct adjustment.
Engine does not start.	Fuel overflow. No fuel fed to engine. Idle adjustment incorrect. Fast idle adjustment incorrect.	See above item. Check pump, fuel pipe and needle valve. Adjust. Adjust.

TROUBLE DIAGNOSES AND CORRECTIONS

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.	Broken cam band. Broken or fatigued spring.	Replace.
Engine speed too low.	• Incorrect adjustment of cam spring. Fatigued cam spring.	Adjust. Replace cam-band kit.
Too high engine 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).	Improper adjustment of cam spring. Sticking of stabilizer piston. Sticking of governor valve shaft.	Adjust. Replace governor assembly. Replace governor assembly.

ELECTRICAL SYSTEM

SECTION **EL**

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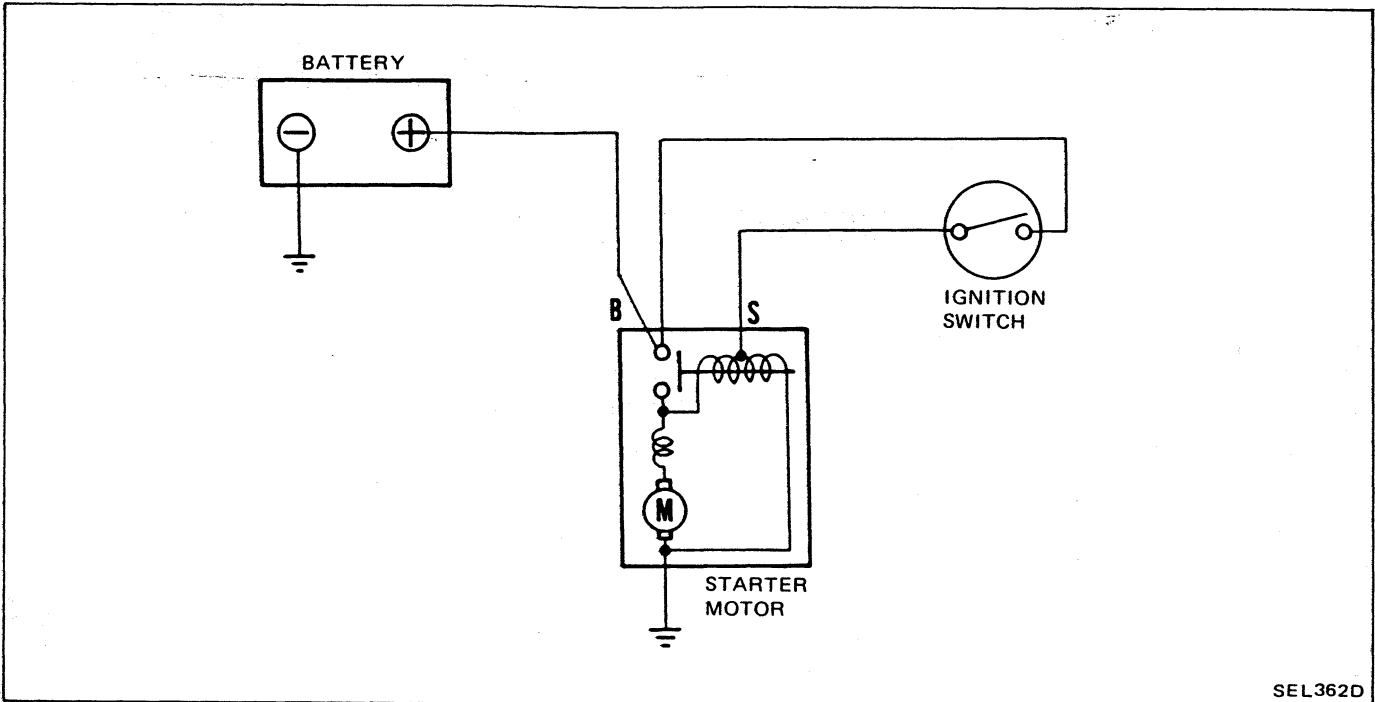
STARTING SYSTEM	EL- 2	Description	EL-15
Schematic	EL- 2	Distributor	EL-16
Starter motor	EL- 3	SERVICE DATA AND	
CHARGING SYSTEM	EL- 7	SPECIFICATIONS	EL-18
Description	EL- 7	Starter motor	EL-18
Schematic	EL- 8	Alternator	EL-18
Charging system trouble-shooting	EL- 8	Voltage regulator	EL-18
Alternator	EL- 9	Distributor	EL-19
Voltage regulator	EL-12	Ignition coil	EL-19
IGNITION SYSTEM	EL-15	Spark plug	EL-19

EL

STARTING SYSTEM

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

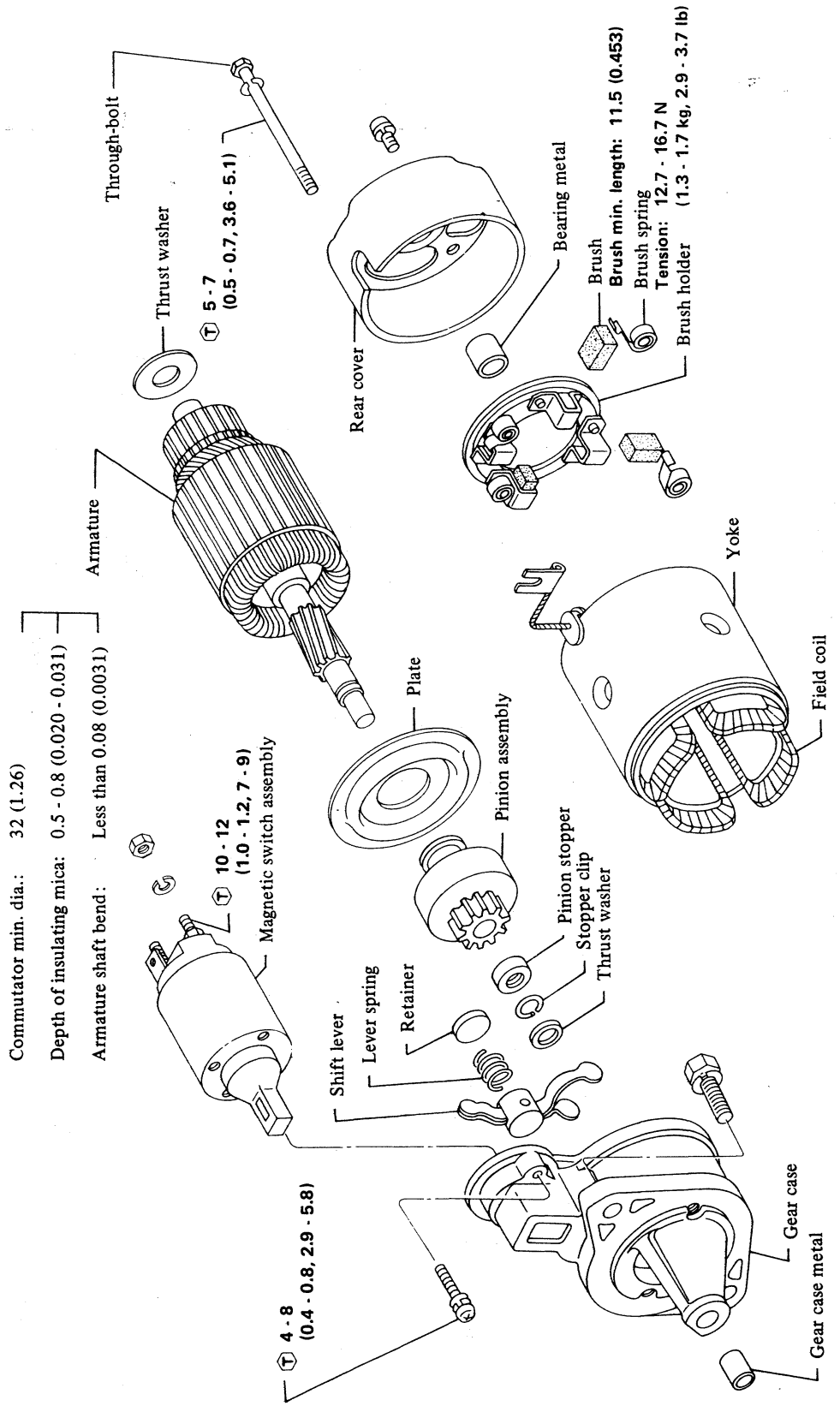
SCHEMATIC



STARTING SYSTEM

STARTER MOTOR

M2T20181

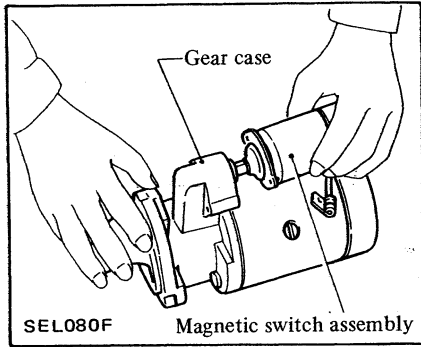


Ⓣ : N·m (kg-m, ft-lb)
 Unit: mm (in)

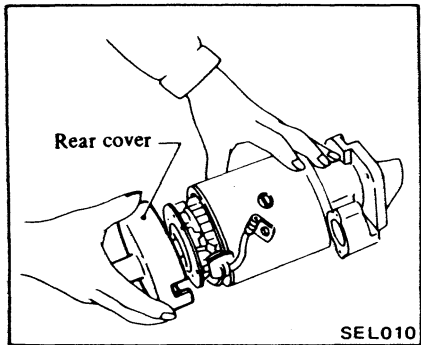
STARTING SYSTEM

DISASSEMBLY

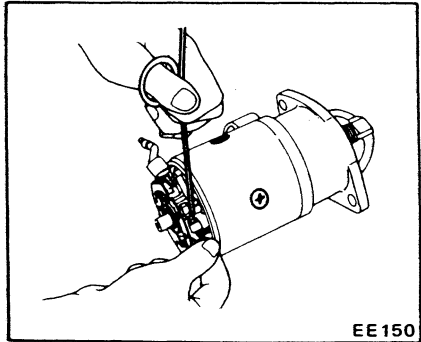
1. Remove magnetic switch.



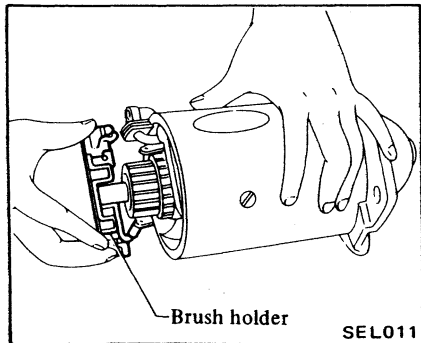
2. Remove rear cover.



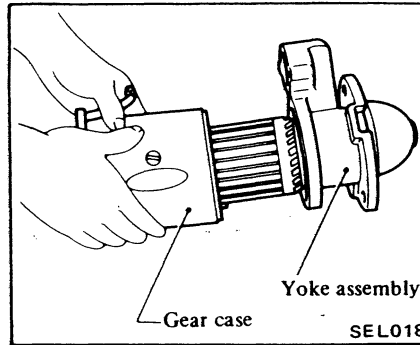
3. Lift up brush springs.



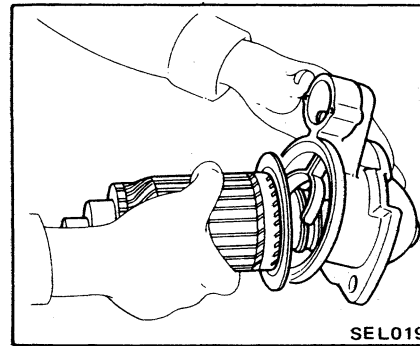
4. Remove brush holder



5. Remove yoke.

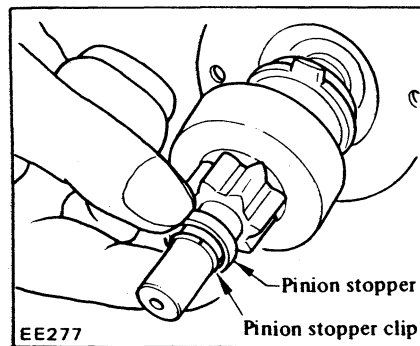


6. Withdraw armature and shift lever.



7. Remove overrunning clutch.

- Remove pinion stopper clip, pushing pinion stopper toward clutch side.

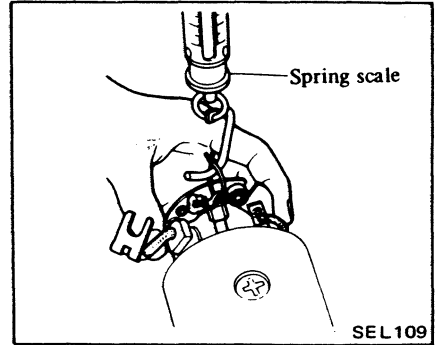


Brush spring

Check brush spring tension.

Spring tension:
13.7 - 17.7 N
(1.4 - 1.8 kg,
3.1 - 4.0 lb)

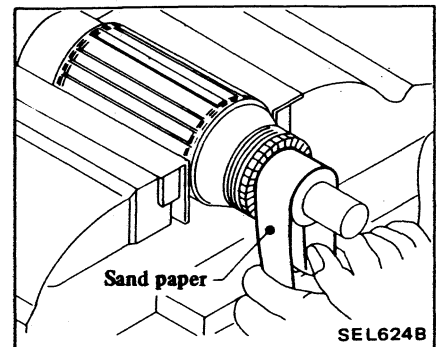
- Not in the specified value. ... Repair or replace.



INSPECTION

Armature assembly

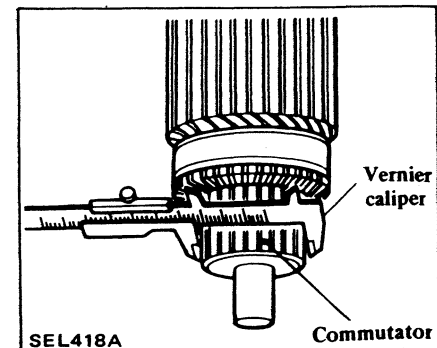
- Check commutator surface.
 - Rough ... Sand lightly with No. 500 ~600 sandpaper.



- Check diameter of commutator.

Commutator minimum diameter:
Refer to S.D.S.

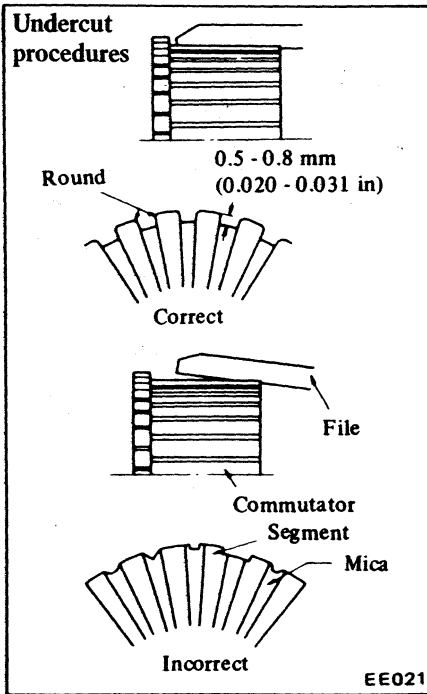
- Less than specified value ... Replace.



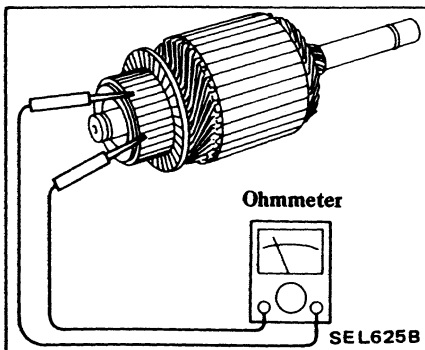
STARTING SYSTEM

3. 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)

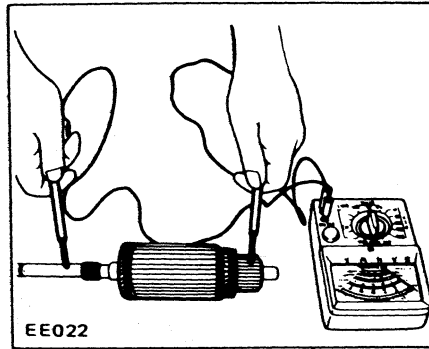


4. Continuity test (between two segments side by side).



- No continuity ... Replace.

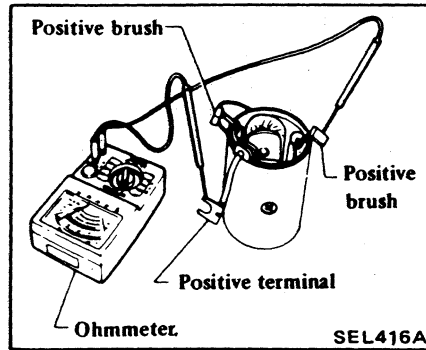
5. Insulation test (between each commutator bar and shaft).



- Continuity exists ... Replace.

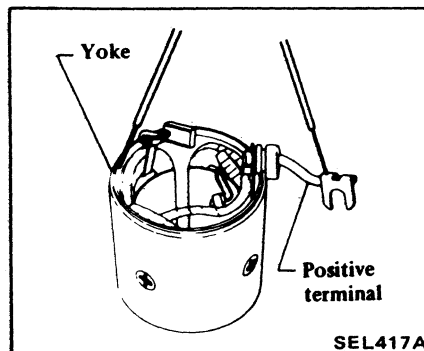
Field coil

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).

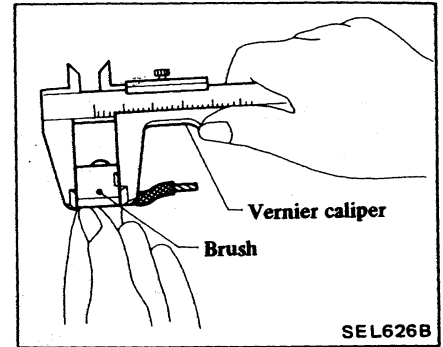


- Continuity exists ... Replace field coil.

Brush

Check wear of brush.

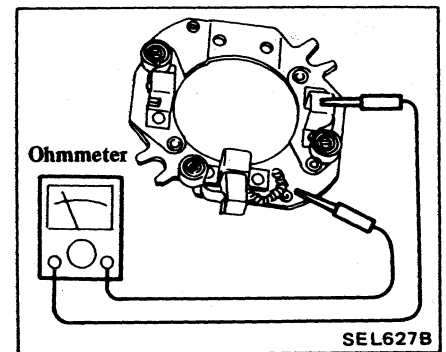
Wear limit length: Refer to S.D.S.



- Excessive wear ... Replace.

Brush holder

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



- Continuity exists ... Replace.

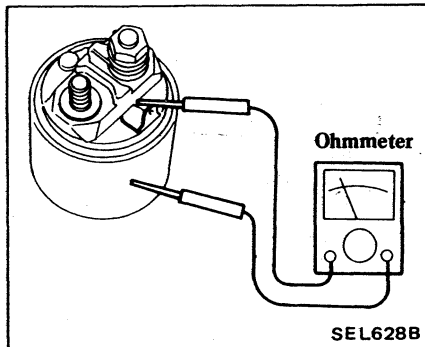
2. Check brush holder to see if it moves smoothly.

- If brush holder is bent, replace it; if sliding surface is dirty, clean.

STARTING SYSTEM

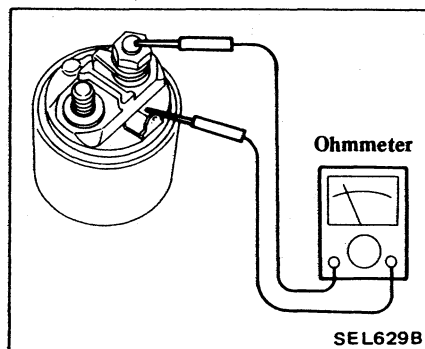
Magnetic switch

1. Continuity test (between "S" terminal and switch body).



- No continuity ... Replace.

2. Continuity test (between "S" terminal and "M" terminal).

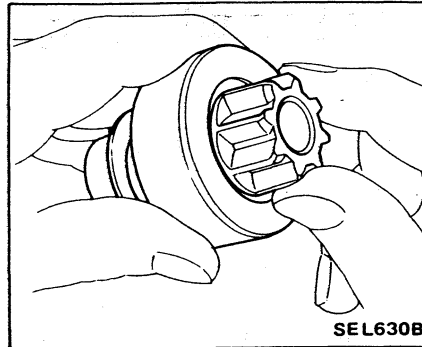


- No continuity ... Replace.

Pinion assembly

1. Check clutch.

Check pinion to see that it locks properly when turned in "drive" direction and rotates smoothly when turned in reverse.



- Pinion 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.)

ASSEMBLY

- a. Apply grease to:

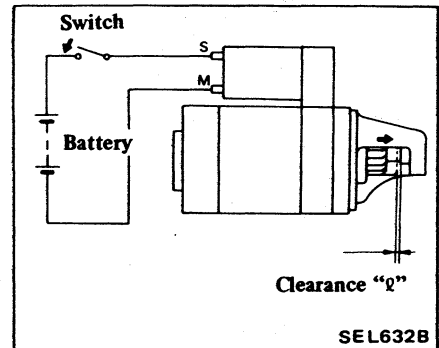
- Rear cover metal
- Gear case metal
- Frictional surface of pinion
- Moving portion of shift lever
- Plunger of magnetic switch

- b. Check pinion to see if its engagement length is correct.

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

Clearance "q":

Refer to S.D.S.



CHARGING SYSTEM

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

DESCRIPTION

The charging circuit consists of the battery, alternator, regulator and necessary wiring to connect these parts.

When the ignition switch is set to "ON", current flows from the battery to ground through the ignition switch, voltage regulator IG terminal, primary side contact point "P1", movable contact point "P2", voltage regulator "F" terminal, alternator "F" terminal, rotor (field) coil and alternator "E" terminal, as shown in Figure by full line arrow marks. Then the rotor in the alternator is excited. On the other hand, current flows from the battery to ground through the ignition switch, warning lamp, voltage regulator "L" terminal, lamp side contact point "P4", movable contact point "P5", and voltage regulator "E" terminal, as shown by dotted line arrow marks. Then, the warning lamp lights.

When the alternator begins to op-

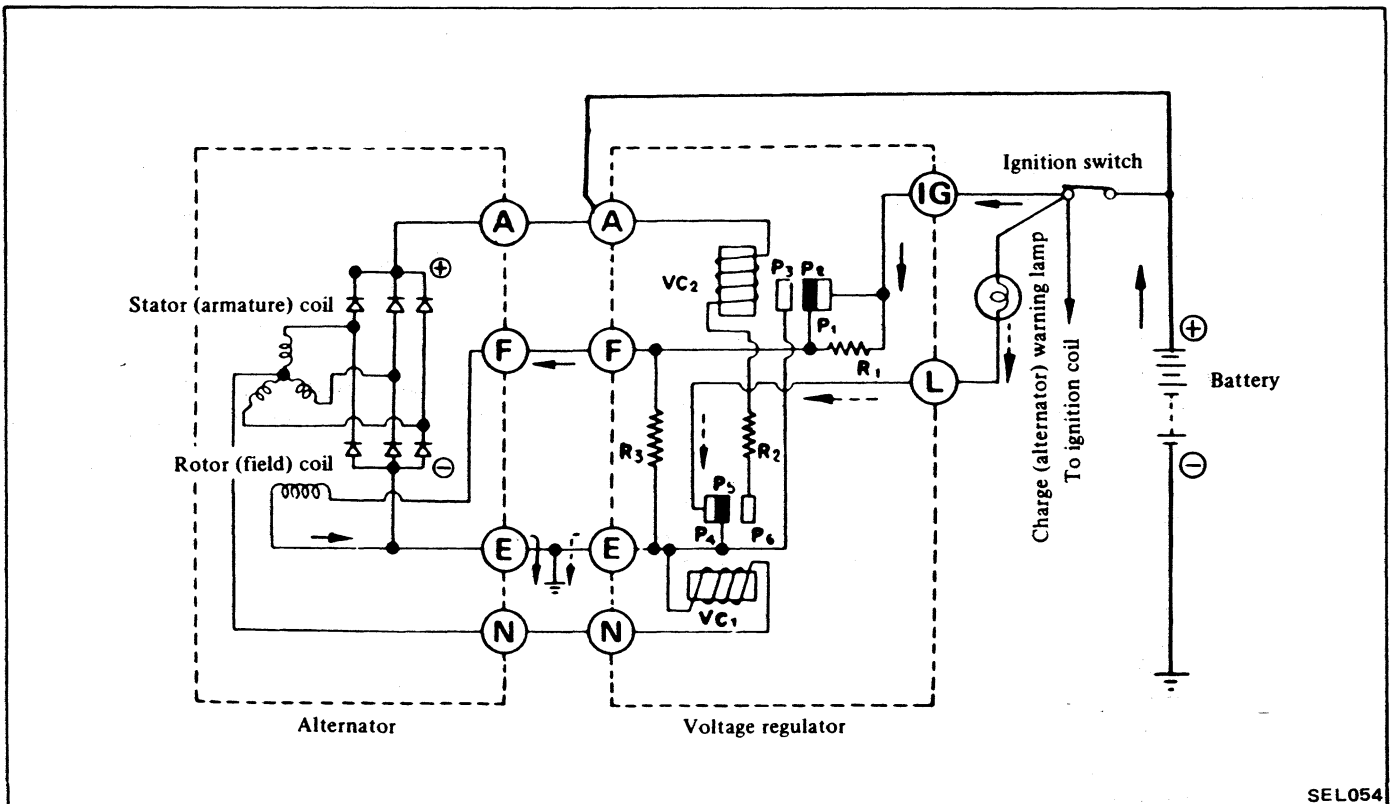
erate, three-phase alternating current is induced in the stator (armature) coil. This alternating current is rectified by the positive and negative silicon diodes. The rectified direct current output reaches the alternator "A" and "E" terminals.

On the other hand, the neutral point voltage reaches "N" and "E" terminals (nearly a half of the output voltage), and current flows from voltage regulator "N" terminal to "E" terminal or ground through the coil "VC1" by the dotted line arrow marks. Then, the coil "VC1" is excited, and the movable contact point "P5" comes into contact with voltage winding side contact point "P6". This action turns off the warning lamp and completes the voltage winding circuit, as shown by the full line arrow marks.

When the alternator speed is increased or the voltage starts to rise excessively, the movable contact point "P2" is separated from the primary side contact "P1" by the magnetic

force of coil "VC2". Therefore, register "R1" is applied into the rotor circuit and output voltage is decreased. As the output voltage is decreased, the movable contact point "P2" and primary side contact "P1" comes into contact once again, and the alternator voltage increases. Thus, the rapid vibration of the movable contact point "P2", maintains an alternator output voltage contact.

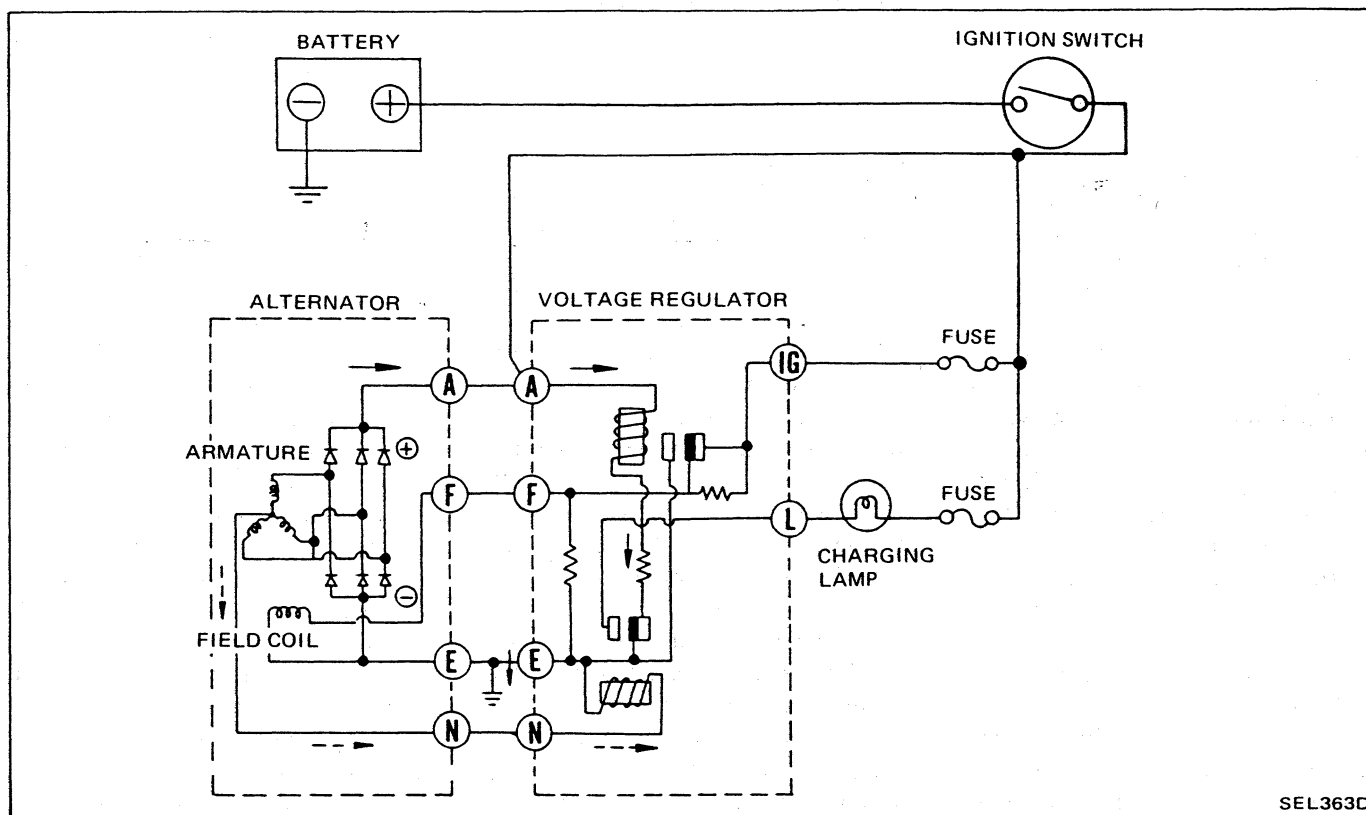
When the alternator speed is further increased or the voltage starts to rise excessively, the movable contact point "P2" comes into contact with secondary side contact point "P3". Then, the rotor current is shut off and alternator output voltage is decreased immediately. This action separates movable contact "P2" from secondary contact "P3". Thus, the rapid vibration of the movable contact point "P2" or breaking and completing the rotor circuit maintains constant alternator output voltage.



SEL054

CHARGING SYSTEM

SCHEMATIC



SEL363D

CHARGING SYSTEM TROUBLE-SHOOTING

Before conducting an alternator test, make sure battery is fully charged.

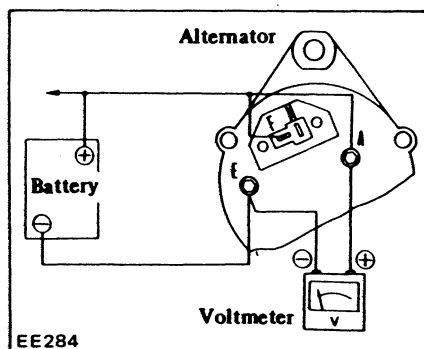
To conduct test, it is necessary to use a 30-volt voltmeter and suitable test probes.

Set up a test circuit as shown in Figure and test alternator in manner indicated in flow chart below:

1. Disconnect connectors at alternator.
2. Connect "A" terminal to "F" terminal.
3. Connect one test probe from voltmeter positive terminal to "A" terminal. Connect the other test probe to ground. Make sure that voltmeter registers battery voltage.
4. Turn on headlights and switch to High Beam.
5. Start engine.
6. Increase engine speed gradually until it is approximately 1,100 rpm, and take the voltmeter reading.

Measured value: Below 12.5 volts
Alternator is run-down. Remove and check it for condition.

Measured value: Over 12.5 volts
Alternator is in good condition.

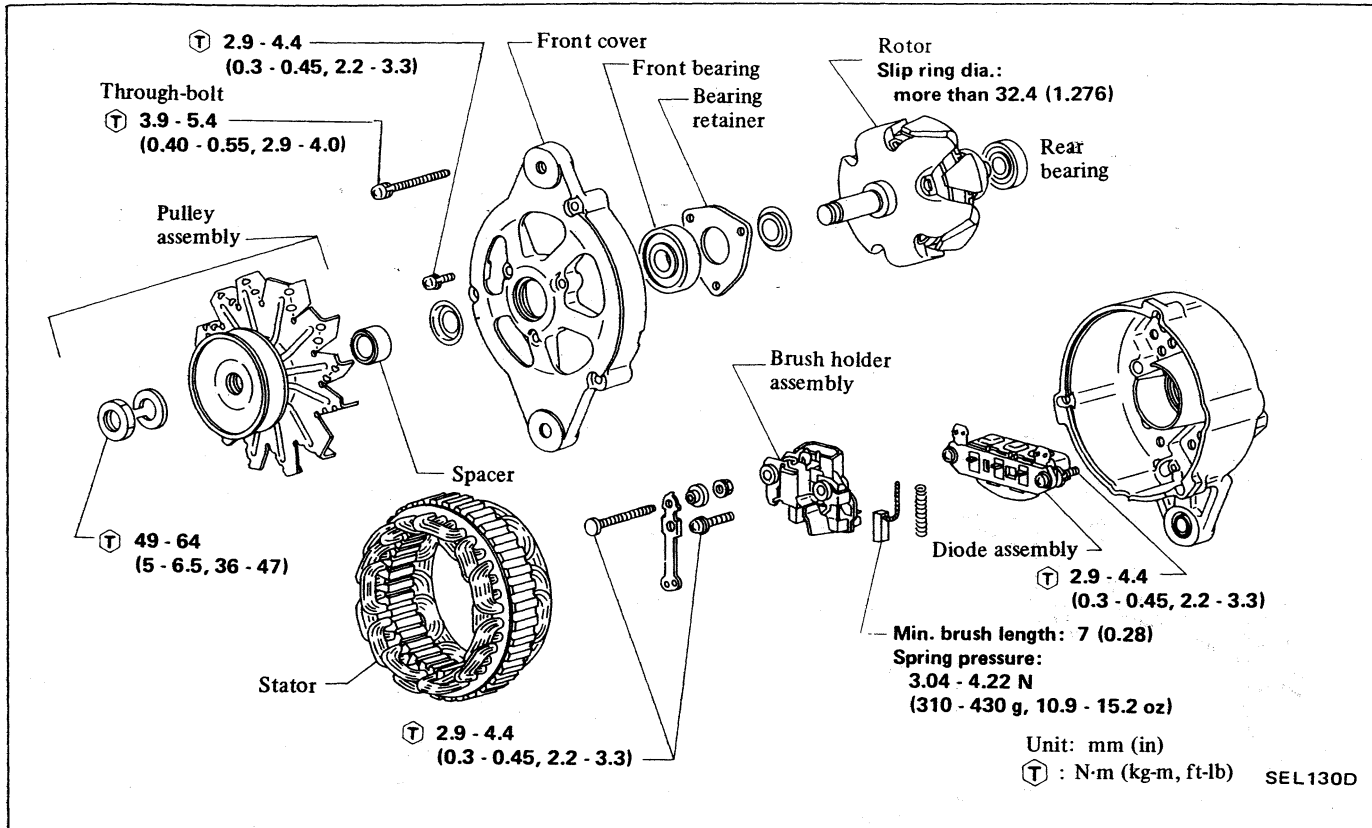


EE284

- a. Do not run engine at more than 1,100 rpm while test is being conducted on alternator.
- b. Do not race engine.

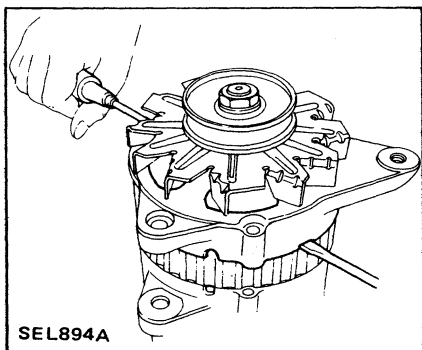
CHARGING SYSTEM

ALTERNATOR

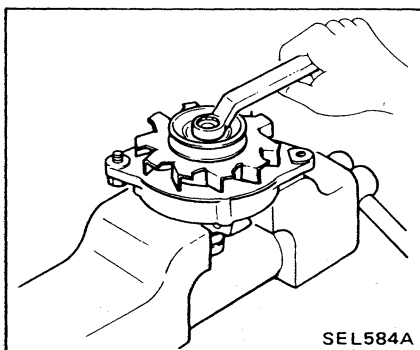


DISASSEMBLY

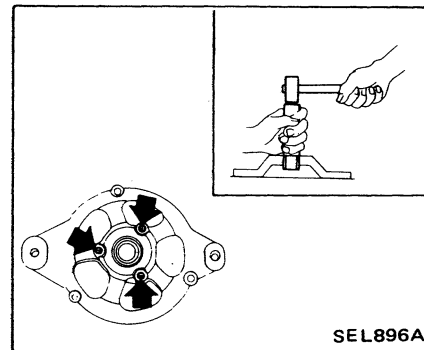
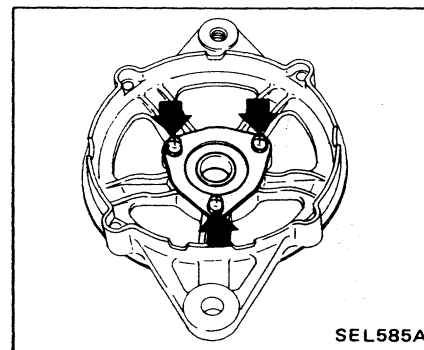
1. Remove through-bolts.
2. Separate front cover and rear cover.



3. Separate front cover and rotor shaft.
 - (1) Place rear cover side of rotor in a vice.
 - (2) Remove pulley nut.
 - (3) Take out pulley, fan and front cover.



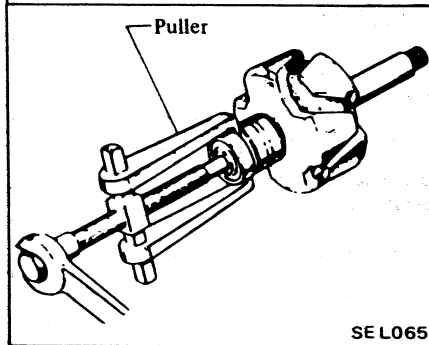
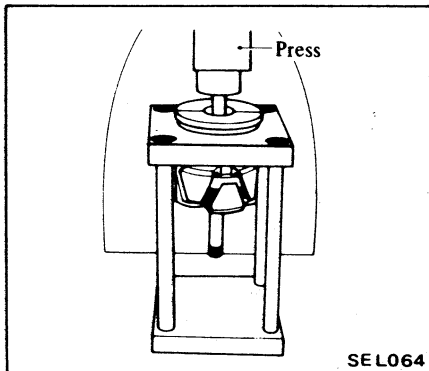
4. Remove bearing retainer and take out bearing.



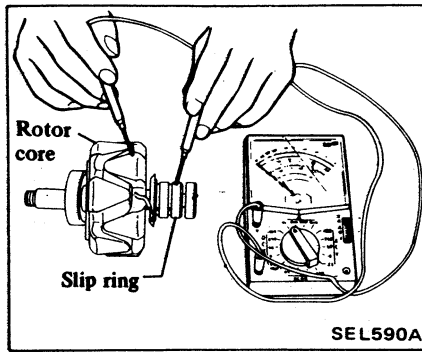
CHARGING SYSTEM

Rotor

Pull rear bearing off rotor assembly.



2. Insulation test.



- Continuity exists ... Replace rotor.

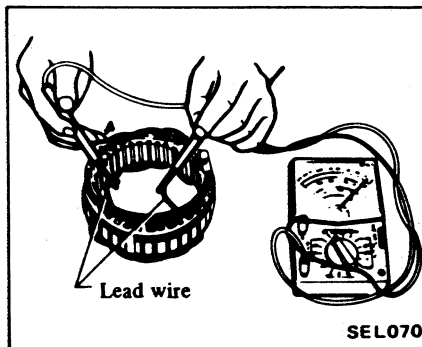
3. Check slip ring for wear.

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

If necessary, replace rotor assembly.

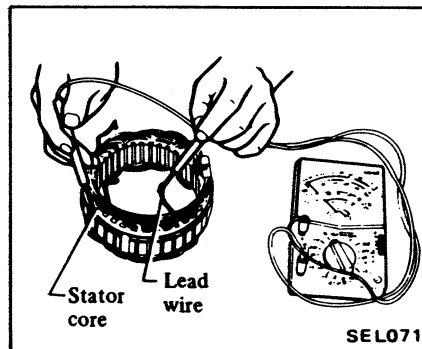
Stator

1. Continuity test



- No continuity ... Replace stator.

2. Insulation test



- Continuity exists ... Replace stator.

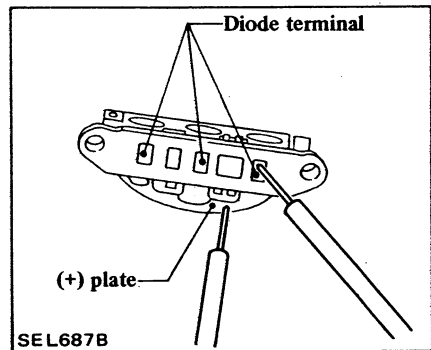
Diode

Perform a continuity test on diodes in both directions, using an ohmmeter.

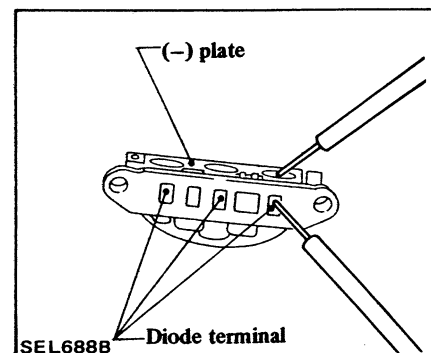
Circuit tester terminal		Conduction
Positive	Negative	
(+) plate Holder plate	Diode terminal	Yes
Diode terminal	(+) plate Holder plate	No
(-) plate	Diode terminal	No
Diode terminal	(-) plate	Yes

Some ohmmeters use a reverse polarity, in which case continuity will be exactly opposite from the chart above.

Positive diode



Negative diode

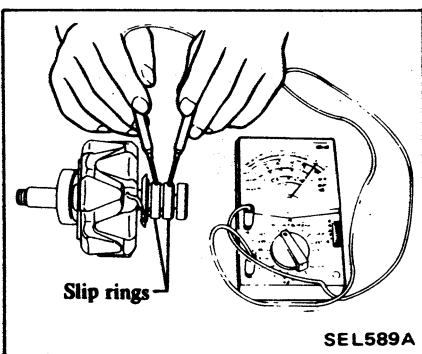


- If a diode is faulty, replace all diodes as a unit.

INSPECTION

Rotor

1. Continuity test.

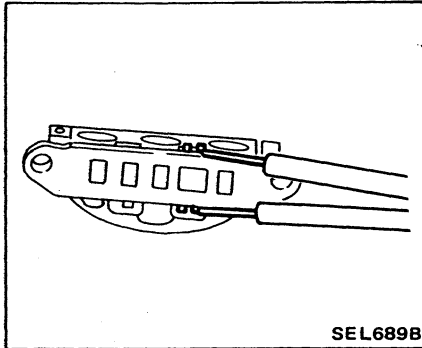


- No continuity ... Replace rotor.

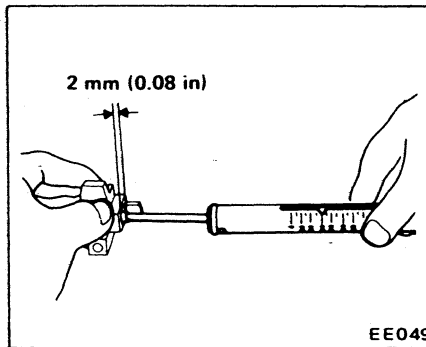
CHARGING SYSTEM

Sub-diode

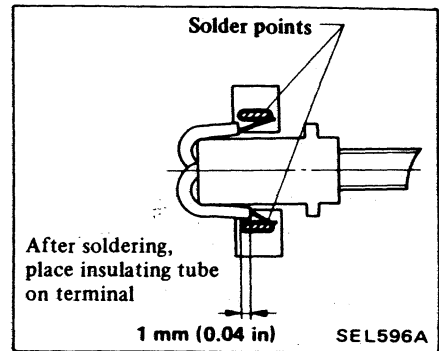
Perform a continuity test on sub-diodes by attaching probes of an ohmmeter to diode terminals. If continuity exists or does not exist in both directions, diode is faulty and all diodes should be replaced as a unit.



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



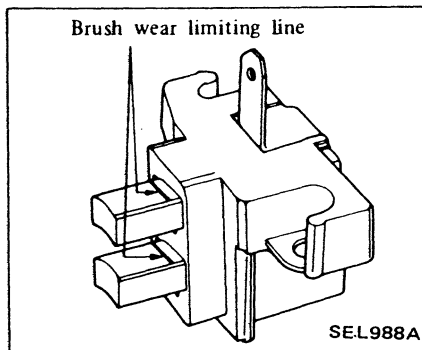
- Not in the specified value ... Replace.



Brush

1. Check smooth movement of brush.
 - Not smooth ... Check brush holder and clean.
2. Check brush for wear.

Min. brush length:
8.0 mm (0.315 in)



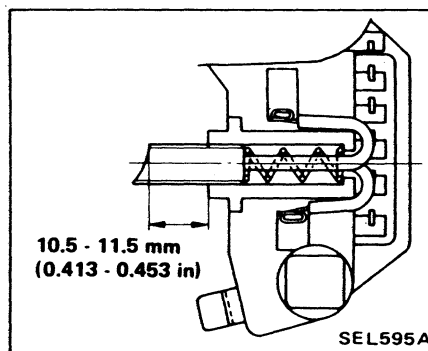
- Less than the specified value ... Replace.
3. Check brush pig tail for damage.
 - Damaged ... Replace.
 4. Check brush spring pressure.

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

Spring pressure:
3.040 - 4.217 N
(310 - 430 g,
10.93 - 15.17 oz)

ASSEMBLY

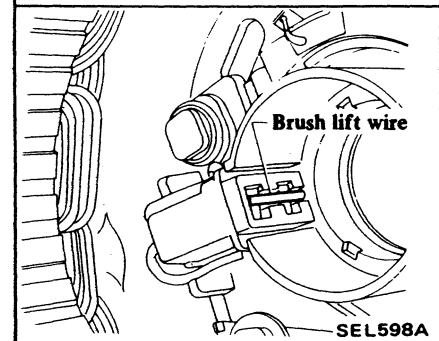
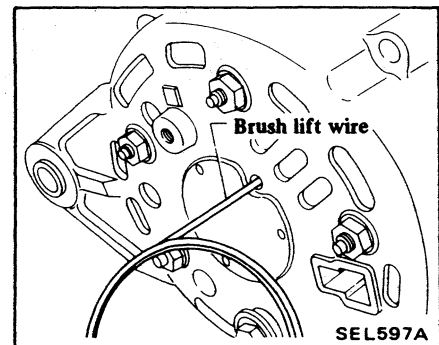
1. When soldering each stator coil lead wire to diode assembly terminal, carry out the operation as fast as possible.
2. When soldering brush lead wire, observe the following.
 - (1) Position brush so that it extends 11 mm (0.43 in) from brush holder.



- (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 center.

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

6. Tighten through-bolts.

VOLTAGE REGULATOR

MEASUREMENT OF REGULATING VOLTAGE

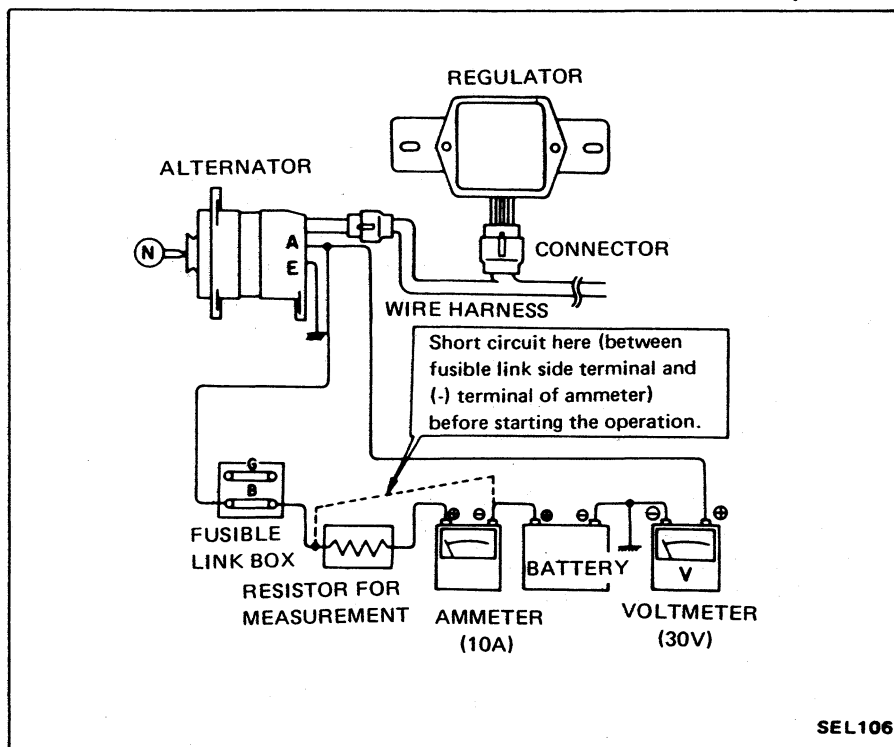
1. Connect DC voltmeter (15-30V), DC ammeter (15-30A), battery and resistor (0.25Ω) with cables as shown. Check to be sure that all electrical loads such as lamps, air conditioner, radio, etc. are turned off.

CAUTION:

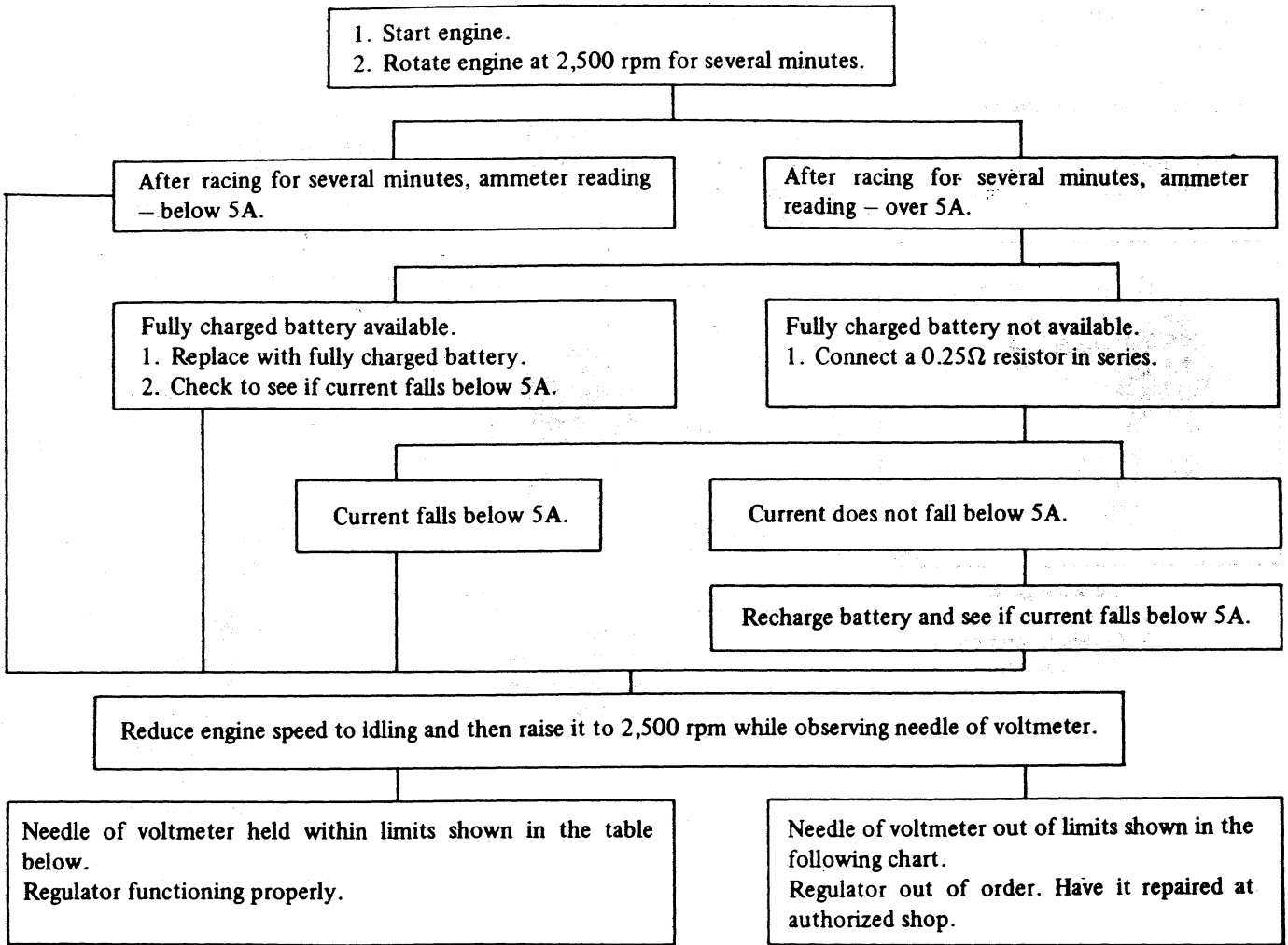
Before starting engine, be sure to make short circuit with a cable as shown in Figure.

Failure to follow this caution causes a damaged ammeter.

2. Refer to the following chart to determine if regulator and relative parts are in good condition:



CHARGING SYSTEM



Temperature °C (°F)	Voltage V (RQB2220B)
-10 (14)	14.75 - 15.25
0 (32)	14.60 - 15.10
10 (50)	14.45 - 14.95
20 (68)	14.30 - 14.80
30 (86)	14.15 - 14.65
40 (104)	14.00 - 14.50

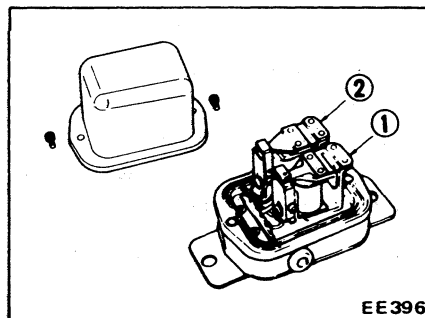
- Do not measure voltage immediately after driving. Do this while regulator is cold.
- To measure voltage, raise engine speed gradually from idling to rated speed.
- Voltage may be approximately 0.3V higher than the rated for two to three minutes after engine is started, or more specifically, when regulator becomes self-heated. Measurements should then be made within one minute after starting engine, or when regulator is cold.

d. The regulator is of a temperature-compensating type. Before measuring voltage, be sure to measure surrounding temperature.

ADJUSTMENT

Voltage regulator

Adjusting regulating voltage

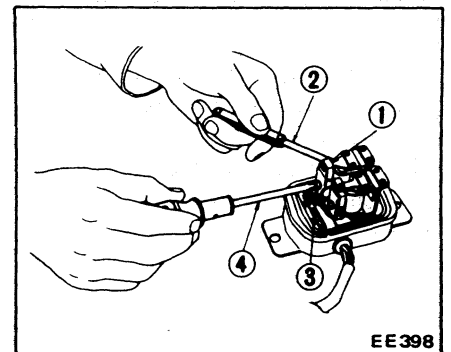


- Charge relay
- Voltage regulator

- Inspect contact surface.
Rough ... Lightly polish with sand paper (#500 or 600).

- Measure each gap. Adjust core gap and point gap in that order. No adjustment is required for yoke gap.
- Adjusting core gap
Loosen screw which is used to secure contact set on yoke, and move contact upward or downward properly.

Core gap:
Refer to S.D.S.



- Contact set
- Thickness gauge
- 4 mm (0.16 in) dia. screw
- Crosshead screwdriver

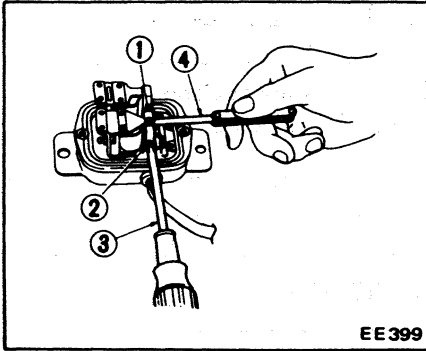
CHARGING SYSTEM

4. Adjusting point gap

Loosen screw used to secure upper contact, and move upper contact upward or downward adequately.

Point gap:

Refer to S.D.S.

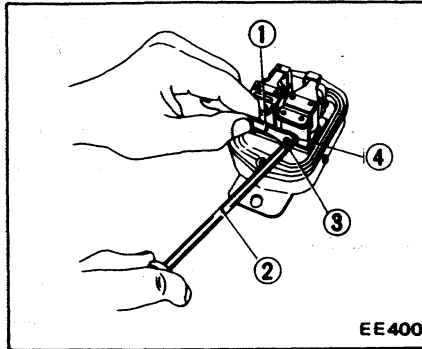


- 1 Thickness gauge
- 2 3 mm (0.12 in) dia. screw
- 3 Crosshead screwdriver
- 4 Upper contact

5. Adjusting voltage

Adjust regulating voltage as follows:

Loosen lock nut securing adjusting screw. Turn this screw clockwise to increase, or counterclockwise to decrease, regulating voltage.

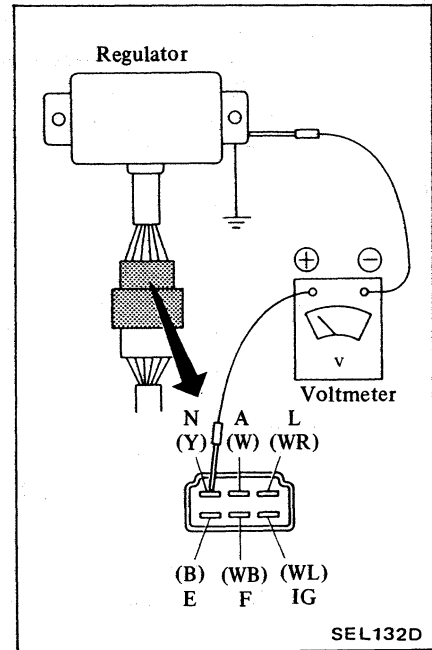


- 1 Wrench
- 2 Crosshead screwdriver
- 3 Adjusting screw
- 4 Lock nut

Charge relay

Normal relay operating voltage is 8 to 10V as measured at alternator "A" terminal. Relay itself, however, operates at 4 to 5V.

Use a DC voltmeter, and set up a circuit as shown in Figure.



1. Connect positive terminal of voltmeter of regulator lead connector "N" terminal with negative terminal grounded.
2. Start engine and keep it idle.
3. Take voltmeter reading.

0 volts

1. Check for continuity between "N" terminals of regulator and alternator.
2. Alternator circuit defective if continuity exists.

Below 5.2 volts

- (Pilot lamp remains lit.)
1. Check fan belt tension.
 2. If correct, remove regulator and adjust as necessary.

Over 5.2 volts

- (Pilot lamp remains lit.)
- Pilot lamp relay coil or contact points out of order.
Replace regulator.

Over 5.2 volts

- (Pilot lamp does not light.)
Pilot lamp relay assembly is in good condition.

IGNITION SYSTEM

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

DESCRIPTION

The ignition circuit consists of the ignition switch, coil, distributor, wiring, spark plugs and battery.

The circuit is equipped with a resistor. During cranking, electrical current bypasses the resistor, thereby connecting the ignition coil directly to battery. This provides full battery voltage at coil and keeps ignition voltage as high as possible.

Low voltage current is supplied by the battery or alternator and flows through the primary circuit. It consists of the ignition switch, resistor, primary winding of the ignition coil, distrib-

utor contact points, condenser and all connecting low tension wiring.

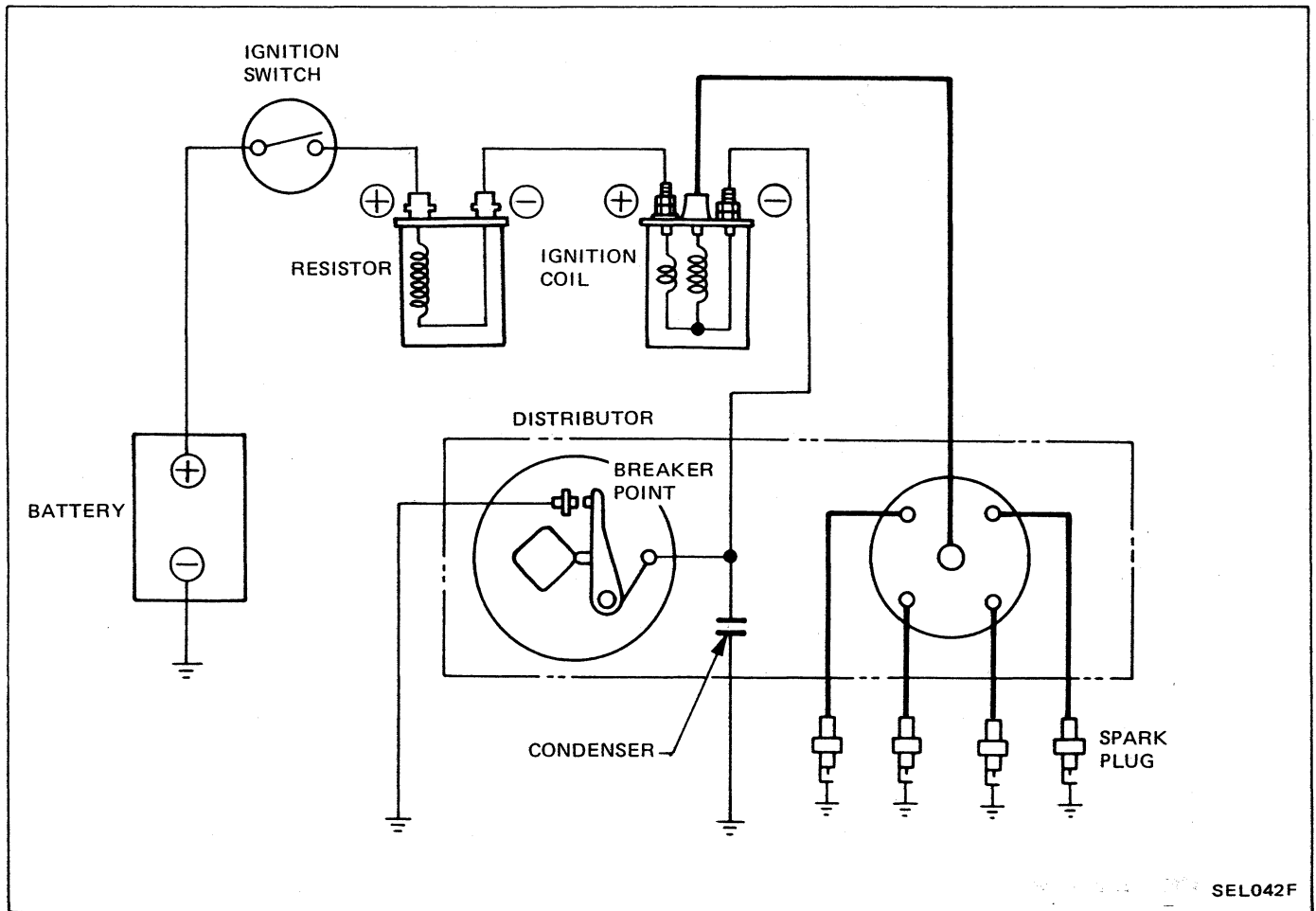
High voltage current is produced by the ignition coil and flows through the secondary circuit, resulting in high voltage spark between the electrodes of the spark plugs in engine cylinders. This circuit contains the secondary winding of the ignition coil, high tension wiring, distributor rotor and cap.

When the ignition switch is turned on and the distributor contact points are closed, the primary current flows through the primary winding of the coil and through the contact points to ground.

When the contact points are opened

by the revolving distributor cam, the magnetic field built up in the primary winding of the coil moves through the secondary winding of the coil inducing high voltage. The high voltage is produced every time the contact points open. The high voltage current flows through the high tension wire to the distributor cap. Then the rotor distributes the current to one of the spark plug terminals in the distributor cap.

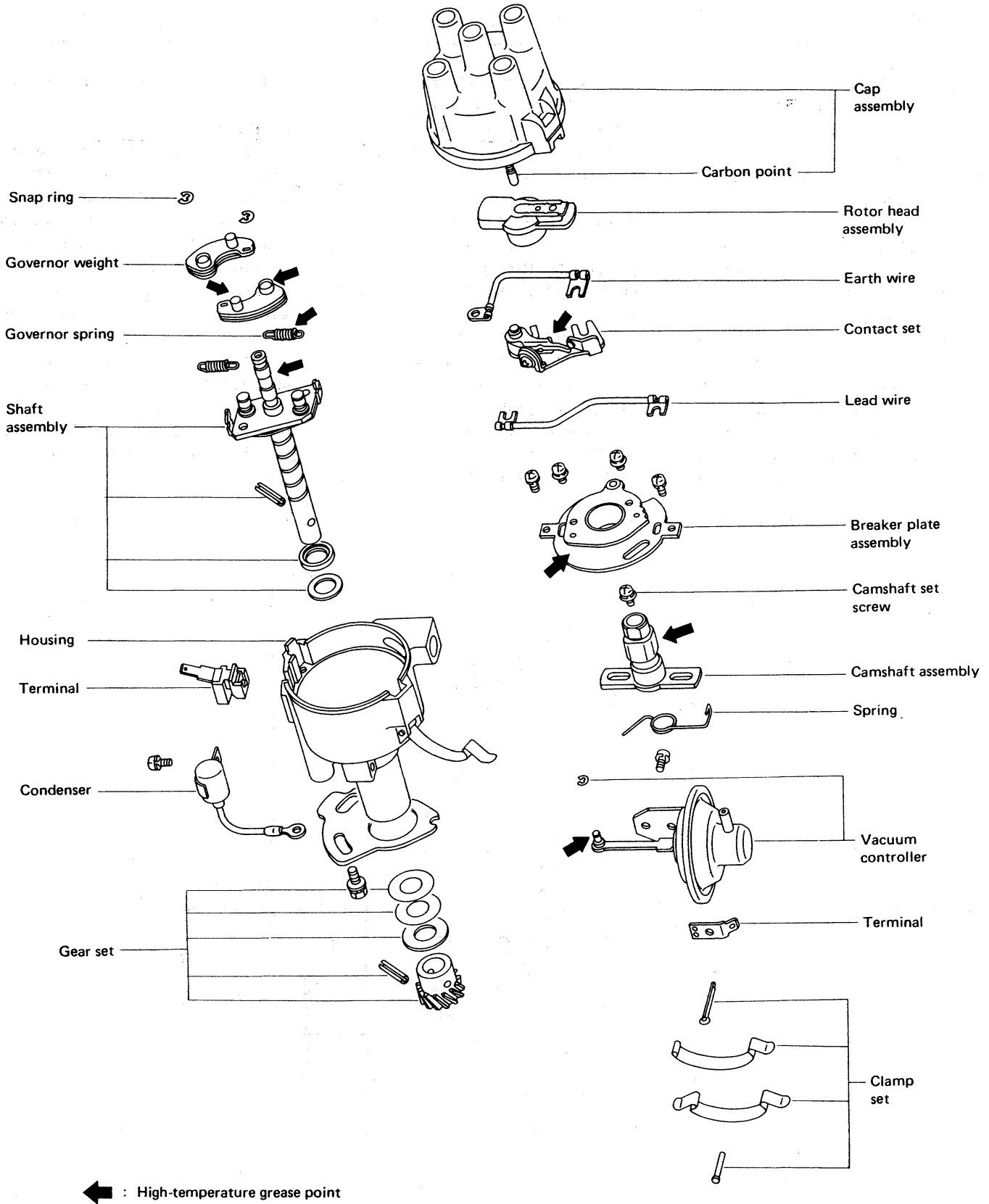
The spark is obtained when the high voltage current jumps the gap between the insulated electrode and the ground side electrode of the spark plug. This process is repeated for each power stroke of the engine.



SEL042F

IGNITION SYSTEM

DISTRIBUTOR



SEL057D

IGNITION SYSTEM

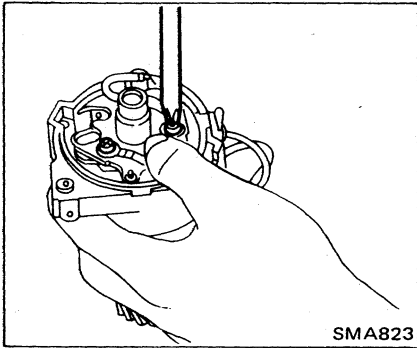
CHECKING AND ADJUSTMENT

Cap and rotor head

Check cap and rotor head for dust, carbon deposits and cracks.

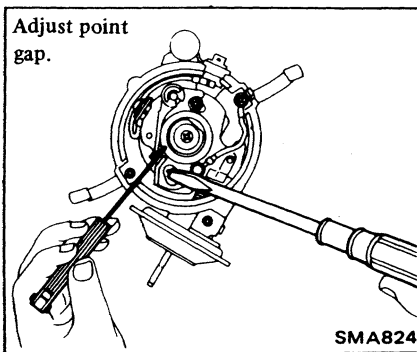
Contact point

1. Check the point surface. Take off any irregularities with fine sandpaper (No. 500 or 600) or with oil stone.
2. Adjust point gap. Loosen breaker plate set screws.



Move breaker plate by pivoting around projected pin so that contact point gap can be adjusted to the specified value. Turning breaker plate clockwise will decrease contact point gap, and turning counterclockwise will increase contact point gap.

Point gap:
Refer to S.D.S.



Tighten breaker plate set screws.

Condenser

Checking of condenser is made by a capacity tester. This can also be made by a circuit tester with its range set to high resistance reading. When needle of tester swings violently and then moves back to infinite gradually, it is

an indication that condenser is in good condition.

If needle shows any steady reading or if it registers zero, the likelihood is that transformer is out of order, calling for replacement.

Condenser capacity:

0.2 - 0.24 μ F

Condenser insulation resistance:

More than 5M Ω

Advance mechanism

Specifications

Refer to S.D.S.

Vacuum advance mechanism mechanical parts

1. Check vacuum inlet for signs of leakage at its connection.
2. Check vacuum diaphragm for air leak. If leak is found, replace vacuum controller assembly.
3. Inspect breaker plate for smooth moving.

If 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 as an assembly.

Centrifugal advance mechanical parts

When cause of engine malfunction is traced to centrifugal advance mechanical part, use distributor tester to check its characteristic.

When nothing is wrong with its characteristic, conceivable causes are breakdown or abnormal wearing-out of driving part or others. So do not disassemble it.

In case of improper characteristic, take off contact breaker assembly part and check closely cam assembly, governor weight, shaft and governor spring, etc. In case centrifugal advance mechanical part is reassembled, be sure to check advance characteristic with distributor tester.

DISASSEMBLY

Disassemble distributor, noting the following especially.

CAUTION:

Put match mark across cam and shaft so that original combination can be restored at assembly.

CAUTION:

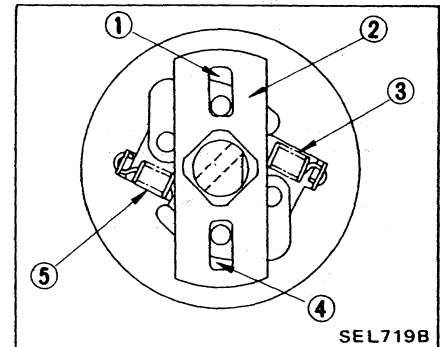
Inscribe a match mark across spring and mating part so that spring can be replaced in its original position during assembly.

Be careful not to stretch or deform governor spring.

ASSEMBLY

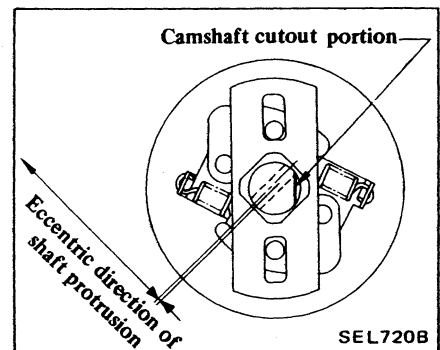
Carefully observe the following instructions.

1. Install governor spring to shaft so that relative positions of the two are as shown in figure below.



- 1 Short rectangular
- 2 Cam shaft
- 3 Governor spring "B" (Rectangular hook type)
- 4 Long rectangular hole
- 5 Governor spring "A" (Circular hook type)

2. Install camshaft to shaft so that relative positions of notch in camshaft and protrusion on lower end of shaft are as shown in figure below.



3. After assembly, check operation of governor before installing it on engine.
4. Ignition timing should be tested with unit mounted on engine.

SERVICE DATA AND SPECIFICATIONS

STARTER MOTOR

Model	MITSUBISHI M2T20181	
Nominal output	kW	0.8
System voltage	V	12
Weight	kg (lb)	4.2 (9.3)
No load		
Terminal voltage	V	11.5
Current	A	Less than 50
Revolution	rpm	More than 7,400
Minimum length of brush	mm (in)	11.5 (0.45)
Brush spring tension	N (kg, lb)	12.7 - 16.7 (1.3 - 1.7, 2.9 - 3.7)
Outer diameter of commutator	mm (in)	32 (1.26)
Depth of mica		
Wear limit	mm (in)	0.2 (0.008)
Repair accuracy	mm (in)	0.5 - 0.8 (0.020 - 0.031)
Clearance between armature shaft and bearing		
Wear limit	mm (in)	0.2 (0.008)
Repair accuracy	mm (in)	0.03 - 0.10 (0.0012 - 0.0039)
Gap "ℓ" between pinion front edge and pinion stopper	mm (in)	0.5 - 2.0 (0.020 - 0.079)

ALTERNATOR

Model	MITSUBISHI A1T24371	
Nominal rating	V-A	12 - 35
Ground polarity	Negative	
Minimum revolution under no load (When 14 volts is applied)	rpm	Less than 1,000
Hot output current	A/rpm	More than 27.5/2,500 More than 35/5,000
Pulley ratio	2.25	
Minimum length of brush	mm (in)	More than 7 (0.28)
Brush spring pressure	N (g, oz)	3.040 - 4.217 (310 - 430, 10.93 - 15.17)
Slip ring outer diameter	mm (in)	More than 32.4 (1.276)

VOLTAGE REGULATOR

Model	MITSUBISHI RQB2220B5	
Regulator voltage [at 20°C (68°F)] (With fully charged battery)	V	14.3 - 15.3
Voltage coil resistance [at 20°C (68°F)]	Ω	23.6
Rotor coil inserting resistance [at 20°C (68°F)]	Ω	10
Voltage coil series resistance [at 20°C (68°F)]	Ω	38
Core gap	mm (in)	0.7 - 1.3 (0.028 - 0.051)
Point gap	mm (in)	0.3 - 0.45 (0.012 - 0.018)
Charge relay		
Release voltage at "N" terminal	V	4.2 - 5.2
Voltage coil resistance	Ω	23.6
Core gap	mm (in)	0.9 - 1.4 (0.035 - 0.055)
Point gap	mm (in)	0.7 - 1.1 (0.028 - 0.043)

SERVICE DATA AND SPECIFICATIONS

DISTRIBUTOR

Model	A12	A15
	MITSUBISHI T3T03571	MITSUBISHI T3T03581
Firing order	1-3-4-2	
Rotating direction	Counterclockwise	
Dwell angle at point gap 0.5 mm (0.020 in) degree	49° - 55°	
Point gap mm (in)	0.45 - 0.55 (0.018 - 0.022)	
Cap insulation resistance MΩ	50	
Rotor head insulation resistance MΩ	50	
Cap carbon point length mm (in)	More than 3 (0.12)	
Vacuum advance [Distributor degree/ distributor kPa (mbar, mmHg, inHg)]	0° /18.7 - 21.3 (187 - 213, 140 - 160, 5.51 - 6.30) 7.5° - 9.5° / 36.0 - 40.0 (360 - 400, 270 - 300, 10.63 - 11.81)	0° /12.7 - 15.3 (127 - 153, 95 - 115, 3.74 - 4.53) 11° - 13° / 37.3 - 42.7 (373 - 427, 280 - 320, 11.02 - 12.60)
Centrifugal advance [Distributor degree/ distributor rpm]	0° /470 - 625 10.5° - 12.5° /2,400	0° /500 - 620 10.5° - 12.5° /2,400

IGNITION COIL

Model	MITSUBISHI HP5-13E10	
Primary voltage	V	12
Spark gap	mm (in)	More than 7 (0.28)
Primary resistance [at 20°C (68°F)]	Ω	1.5±10%

SPARK PLUG

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)
Tightening torque	N·m (kg-m, ft-lb)	15 - 20 (1.5 - 2.0, 11 - 14)



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