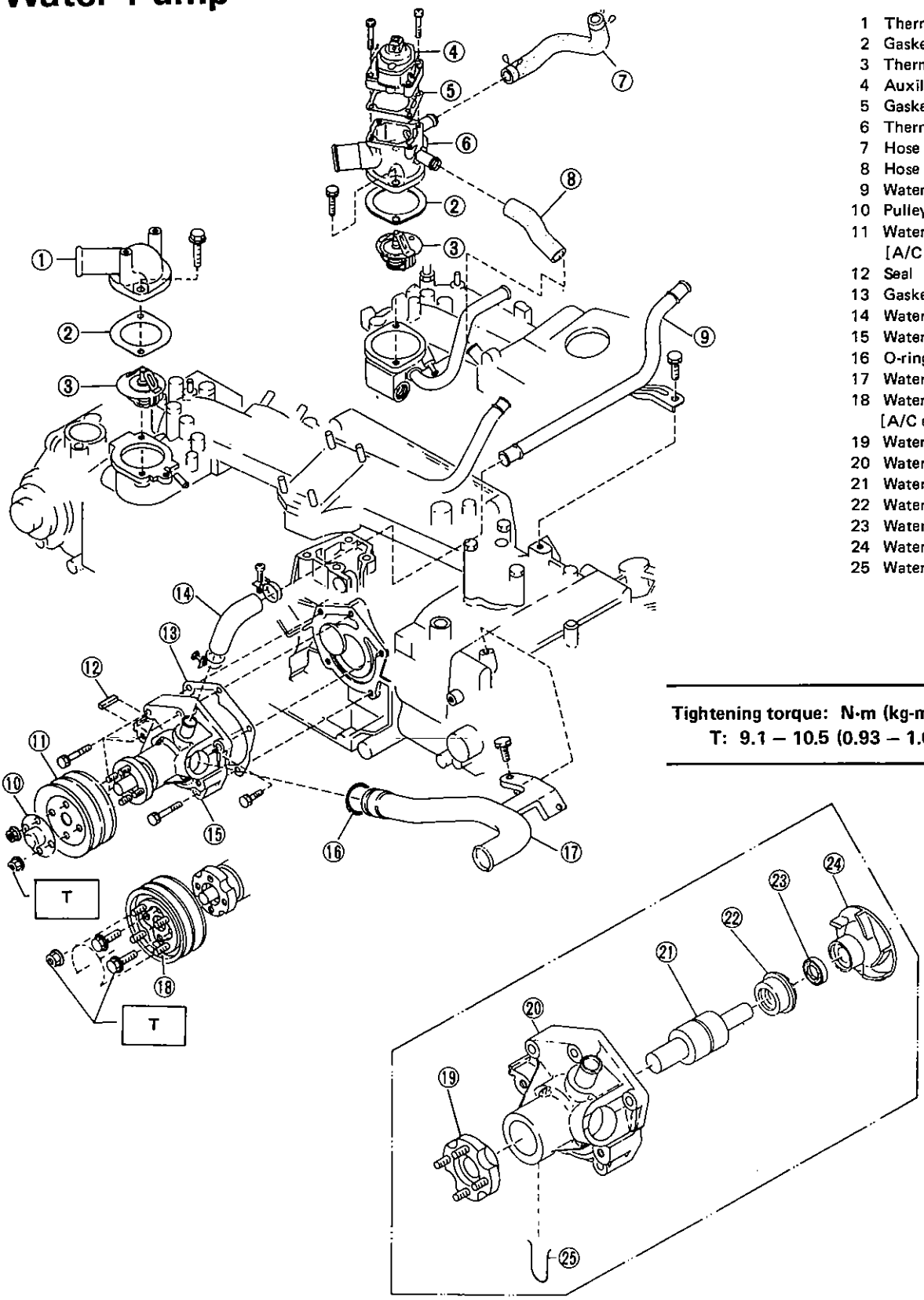
Radiator	Type				Cross flow, pressure type
	Radiation capacity	Non-TURBO	MT (Except 4WD dual-range)		40.007 kW (34,400 kcal/h, 136,499 BTU/h)
			AT and 4WD dual-range		45.822 kW (39,400 kcal/h, 156,339 BTU/h)
		TURBO	MT		47.683 kW (41,000 kcal/h, 162,688 BTU/h)
			AT	Except Canada	56.522 kW (48,600 kcal/h, 192,845 BTU/h)
				Canada	47.683 kW (41,000 kcal/h, 162,688 BTU/h)
	Core dimensions	Non-TURBO and TURBO MT			645 x 322 x 16 mm (25.39 x 12.68 x 0.63 in)
		TURBO AT			645 x 322 x 32 mm (25.39 x 12.68 x 1.26 in)
	Pressure range in which cap valve is open				Above 88 ± 10 kPa (0.9 ± 0.1 kg/cm^2, 13 ± 1.4 psi) Below -4.9 to -10 kPa (-0.05 to -0.1 kg/cm^2, -0.7 to -1.4 psi)
	Fins				Corrugated fin type
Reserve tank	Capacity				1.2ℓ (2.5 US pt, 2.1 Imp pt)

SERVICE DATA

Water pump	Clearance between impeller and case		0.5 – 0.9 mm (0.020 – 0.035 in)
	Distance between pulley attaching surface of hub and pump case surface, which mates with gasket	A/C equipped model	103.6 – 104.2 mm (4.08 – 4.10 in)
		A/C not equipped model	109.7 – 110.1 mm (4.32 – 4.33 in)

COMPONENT PARTS

Water Pump

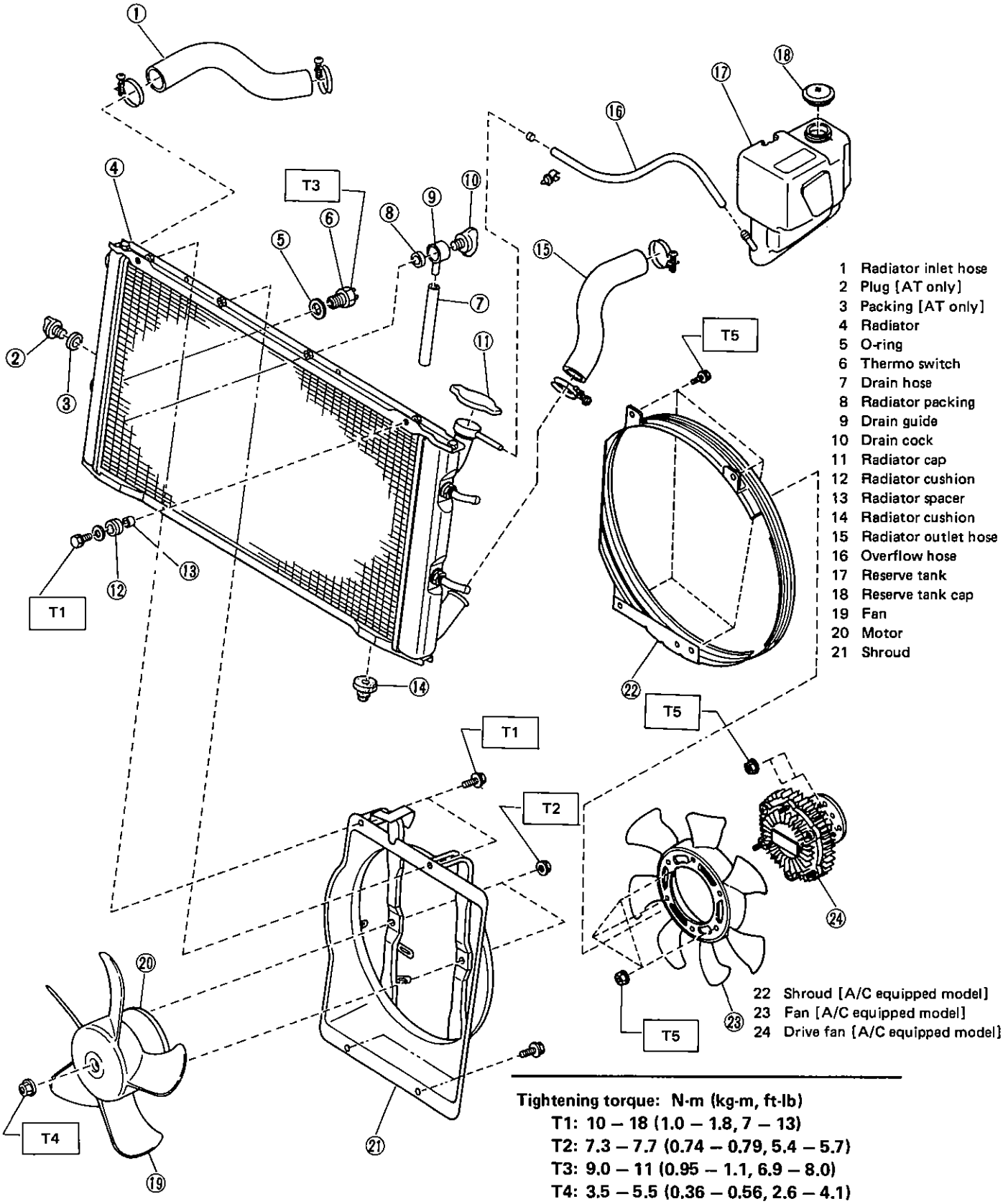


1 Thermostat cover [SPFI]
2 Gasket
3 Thermostat
4 Auxiliary air valve [MPFI]
5 Gasket
6 Thermostat cover [MPFI]
7 Hose (to air intake duct)
8 Hose (to intake manifold)
9 Water by-pass pipe
10 Pulley cover
11 Water pump pulley [A/C not-equipped model]
12 Seal
13 Gasket
14 Water by-pass hose
15 Water pump ASSY
16 O-ring
17 Water pipe
18 Water pump pulley [A/C equipped model]
19 Water pump hub
20 Water pump case
21 Water pump shaft
22 Water pump mechanical seal
23 Water pump plate
24 Water pump impeller
25 Water pump clip

Tightening torque: N·m (kg-m, ft-lb)
T: 9.1 – 10.5 (0.93 – 1.07, 6.7 – 7.7)

Fig. 4 L2-1551

Radiator and Cooling Fan



1 Radiator inlet hose
2 Plug [AT only]
3 Packing [AT only]
4 Radiator
5 O-ring
6 Thermo switch
7 Drain hose
8 Radiator packing
9 Drain guide
10 Drain cock
11 Radiator cap
12 Radiator cushion
13 Radiator spacer
14 Radiator cushion
15 Radiator outlet hose
16 Overflow hose
17 Reserve tank
18 Reserve tank cap
19 Fan
20 Motor
21 Shroud
22 Shroud [A/C equipped model]
23 Fan [A/C equipped model]
24 Drive fan [A/C equipped model]

Tightening torque: N-m (kg-m, ft-lb)
T1: 10 – 18 (1.0 – 1.8, 7 – 13)
T2: 7.3 – 7.7 (0.74 – 0.79, 5.4 – 5.7)
T3: 9.0 – 11 (0.95 – 1.1, 6.9 – 8.0)
T4: 3.5 – 5.5 (0.36 – 0.56, 2.6 – 4.1)
T5: 5.5 – 9.5 (0.56 – 0.97, 4.1 – 7.0)

Fig. 5

L2-1397

SERVICE PROCEDURE

Water Pump

REMOVAL

1) Drain coolant and disconnect the radiator outlet hose and water by-pass hose from the water pump.
2) Loosen pulley nuts so that they can be turned by hand.
3) Loosen alternator ASSY mounting bolts and remove drive belt.
4) Remove front belt cover. Refer to 2-3 "Engine Disassembly" for procedures.

Be careful not to spill coolant on drive belt. If spilled, wipe clean immediately.

DISASSEMBLY

a. Do not disassemble water pump unless absolutely necessary. It is advisable to replace water pump ASSY.
b. In case of disassembling water pump, be sure to check "runout" of water pump hub after assembling. If it is outside specifications, replace water pump ASSY.

1) Remove water pump pulley.
2) Insert a screwdriver into the slit in water pump case and lift end of water pump clip.

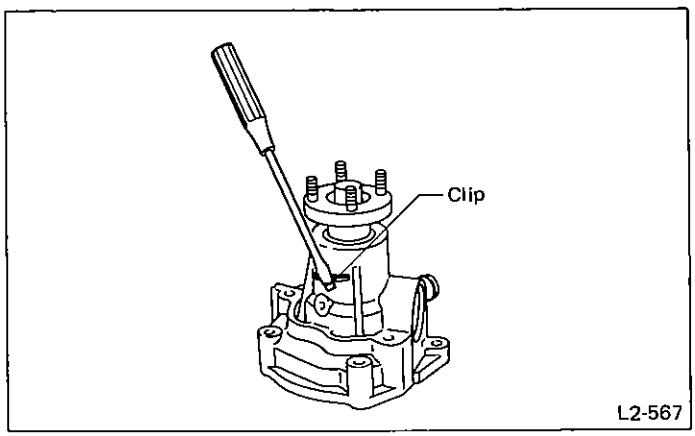


Fig. 6

3) Extract water pump clip with pliers.
4) Using a press, drive hub from water pump ASSY.

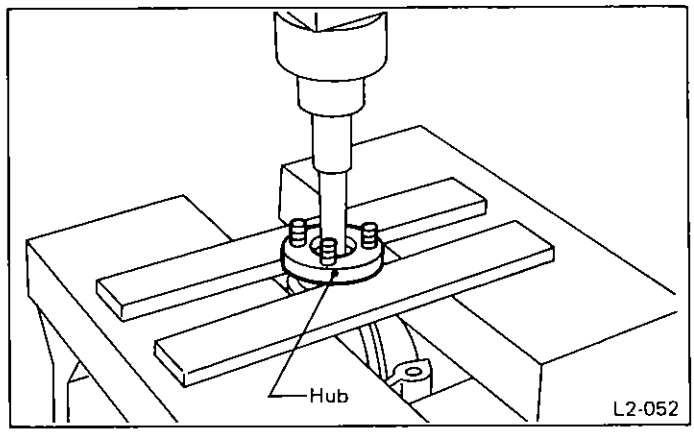


Fig. 7

5) Remove shaft, impeller, and mechanical seal from water pump case as a unit.

Do not press the shaft, or the bearings will be damaged. Press the bearing outer race.

6) Remove impeller from shaft with a press.

INSPECTION

1) Clean all the disassembled parts thoroughly.
2) Inspect the pump shaft for wear, damage, and operation.
3) Inspect the impeller surface that contacts the mechanical seal for wear and damage.
4) Inspect the mechanical seal and plate for wear, crack and damage.
5) Inspect the other parts for crack, wear and damage, and replace if defective.

ASSEMBLY

1) Heat water pump case to a temperature of 80 to 100°C, (176 to 212°F), and press shaft into bore in water pump case. Do not press any section other than outer race.

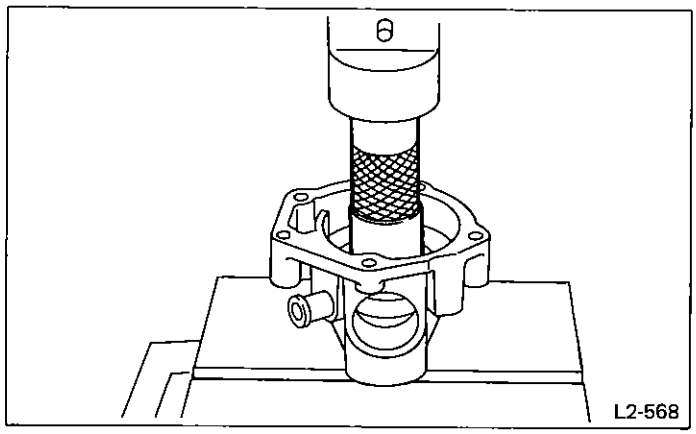


Fig. 8

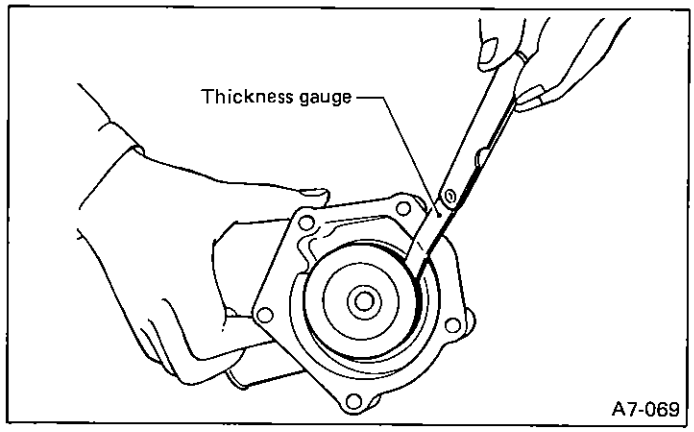


Fig. 10

2) **Be sure to install a new mechanical seal.**
Press the seal into the pump case with the carbon washer of the seal facing the impeller.

3) Apply coolant on the sliding surface between mechanical seal and impeller.
With a thin coat of oil on the shaft surface, install the impeller onto the pump shaft with a press.

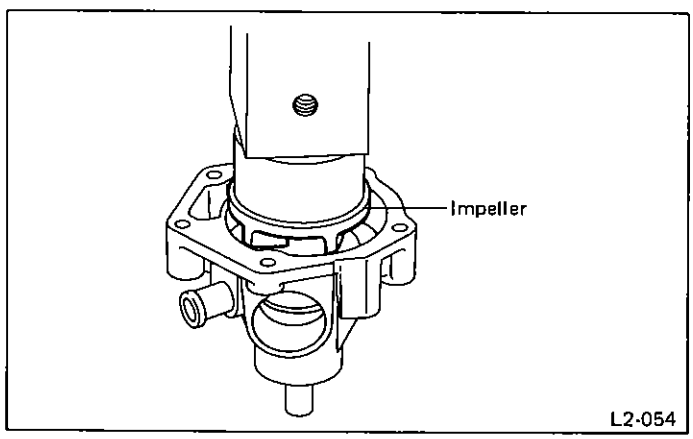


Fig. 9

4) Check for the following clearance after installation and correct if defective.

Clearance between impeller and pump case:
0.5 – 0.9 mm (0.020 – 0.035 in)

5) Before pressing, apply oil on the pump shaft.
Support the impeller side of the pump shaft end and install the hub by using a press until the distance "L" between the pump case surface, which mates with the gasket, and the pulley attaching surface of the hub becomes specified value.

After pressing water pump hub into place, measure "runout". If it exceeds 0.05 mm (0.0020 in), replace water pump ASSY.

"L":
A/C equipped model
103.6 – 104.2 mm (4.08 – 4.10 in)
A/C not-equipped model
109.7 – 110.1 mm (4.32 – 4.33 in)

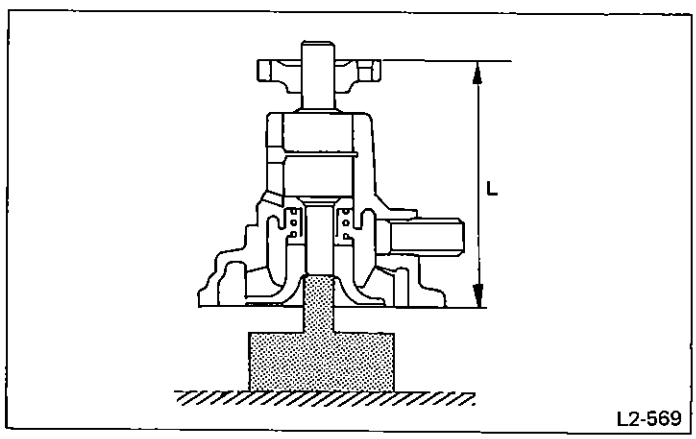


Fig. 11

6) Looking through slit in water pump case, ensure that groove on water pump case is aligned with groove on outer surface of shaft.
Insert water pump clip into grooves and drive it into place with a plastic hammer.

Be careful not to deform the clip.

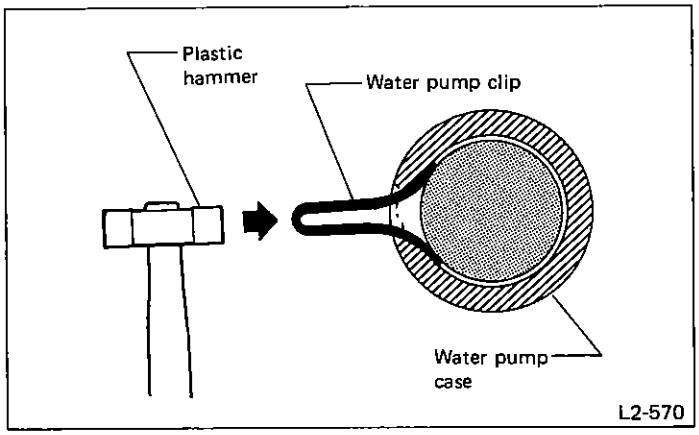


Fig. 12

7) Rotate water pump shaft by hand. It should turn smoothly without emitting noise.

INSTALLATION

Installation is in the reverse order of removal procedures. Observe the following:

1) Replace the gasket with a new one.

2) After reinstalling the water pump, adjust the drive belt tension and run the engine to make sure that neither water leakage nor abnormal noise exists.

Thermostat

REMOVAL AND INSTALLATION

1) Remove the thermostat case cover and gasket, and pull out the thermostat.

2) Install the thermostat in the intake manifold, and install the thermostat cover together with a gasket.

a. When reinstalling the thermostat, use a new gasket.

b. The thermostat must be installed with the jiggle pin upward.

INSPECTION

Replace the thermostat if the valve does not close completely at an ambient temperature or if the following test shows unsatisfactory results.

Immerse the thermostat and a thermometer in water. Raise water temperature gradually, and measure the temperature and valve lift when the valve begins to open and when the valve is fully opened. During the test, agitate the water for even temperature distribution. The measurement should be to the specification.

Starts to open:
86.5 – 89.5°C (188 – 193°F)
Fully opens:
100°C (212°F)

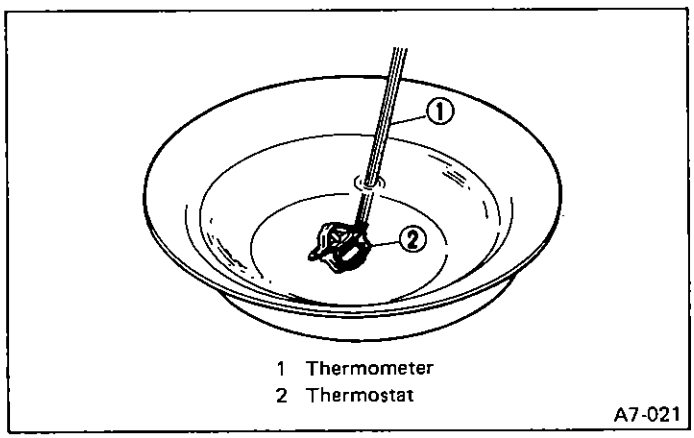


Fig. 13

Thermometer

INSPECTION

1) To test the thermometer, connect the gauge section and the sensor unit in series.

2) The thermometer performance data are shown below.

Temperature	Resistance
[120°C (248°F)]	14.9 – 17.3Ω
100°C (212°F)	26.2 – 29.3Ω
80°C (176°F)	47.5 – 56.8Ω
[50°C (122°F)]	133.9 – 178.9Ω

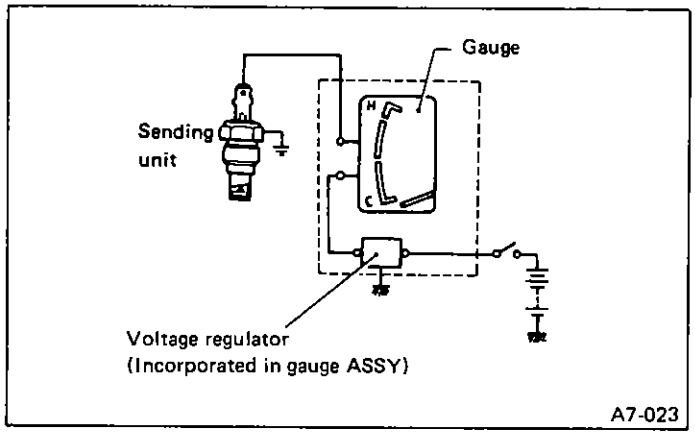


Fig. 14

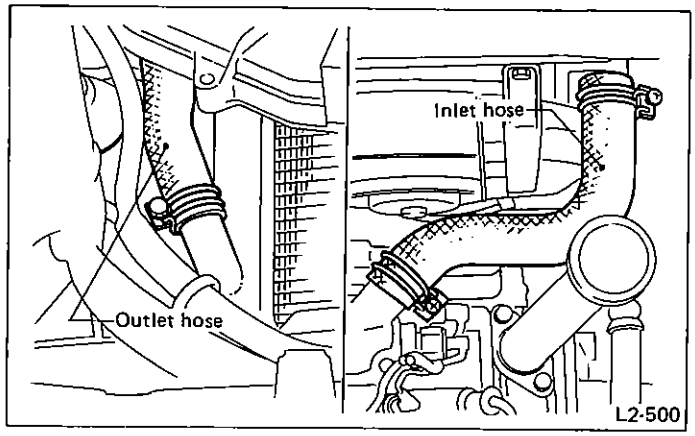


Fig. 15

PRECAUTIONS FOR HANDLING

1) When testing, do not apply battery voltage directly to the temperature gauge or sensor unit, because these two parts are designed to be connected in series.
If the battery voltage is applied to only one of them, the heating wire on gauge or thermistor may be damaged.
2) Connect the wire firmly to the terminals. When the gauge reading is abnormal, inspect not only the gauge but also the grounding wire or the terminal for loose connections.
3) Use care not to short or ground the terminals or wirings, otherwise troubles described in 1) may occur.
4) Use care not to drop or strike either the gauge or unit, since these are precision products.
5) Make sure that the gauge needle indicates C when the ignition switch is not turned on.

Radiator

REMOVAL

1) Drain coolant.
2) Disconnect ground cable from battery terminal.
3) Loosen hose clamps and disconnect both inlet and outlet hoses from radiator.
4) Disconnect oil cooler's inlet and outlet hoses at radiator location (A/T model).

Catch both coolant and oil remained in the hoses into containers.

5) Disconnect lead wire connector from fan motor.
6) Disconnect main harness connector from thermoswitch.

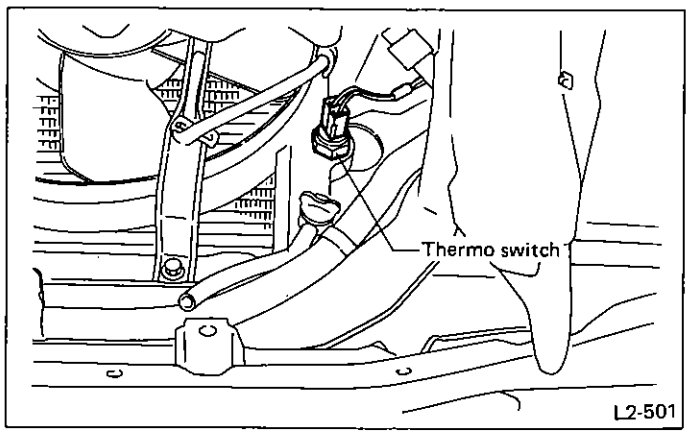


Fig. 16

7) Remove two radiator mounting bolts.
8) Lift radiator up and away from vehicle with radiator cap facing up to prevent remaining coolant from spilling.

INSPECTION

Check all removed parts and replace if defective.
1) A clogged radiator should be cleaned.
2) A deteriorated hose should be replaced.
3) Check the valve opening pressure of the pressure cap with a cap tester. If the pressure is out of specification, replace the cap ASSY.

Cap valve opening pressure:
Positive pressure side
78.5 to 98.1 kPa
(0.8 to 1.0 kg/cm^2, 11.4 to 14.2 psi)
Negative pressure side
−4.9 to −9.8 kPa
(−0.05 to −0.1 kg/cm^2, −0.7 to −1.4 psi)

INSTALLATION

1) Attach radiator mounting cushions to pins on the lower side of radiator.

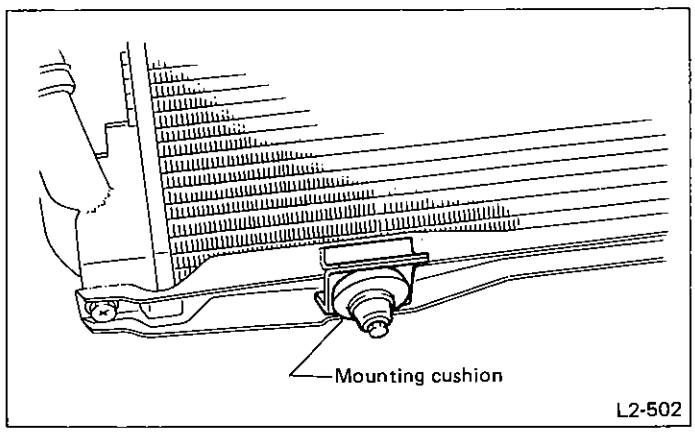


Fig. 17

2) Fit cushions, on lower side of radiator, into holes on body side and install radiator.

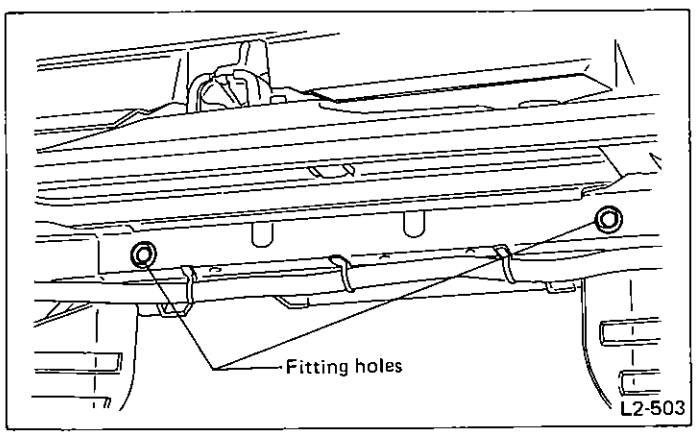


Fig. 18

3) Tighten two radiator mounting bolts.
4) Connect main harness connector to thermoswitch.
5) Connect lead wire connector to fan motor.
6) Connect both inlet and outlet hoses to radiator with marked sides facing up and tighten with hose clamps.

Be careful not to twist hoses.

7) Connect both inlet and outlet hoses to radiator's oil cooler and tighten with hose clamps (A/T model).
8) Pour coolant into radiator.
9) Connect ground cable to battery terminal.

Cooling Fan and Fan Motor

REMOVAL

1) Disconnect ground cable from battery terminal.
2) Disconnect lead wire connector from fan motor and remove harness from shroud.
3) Remove bolts holding shroud to radiator and detach shroud.

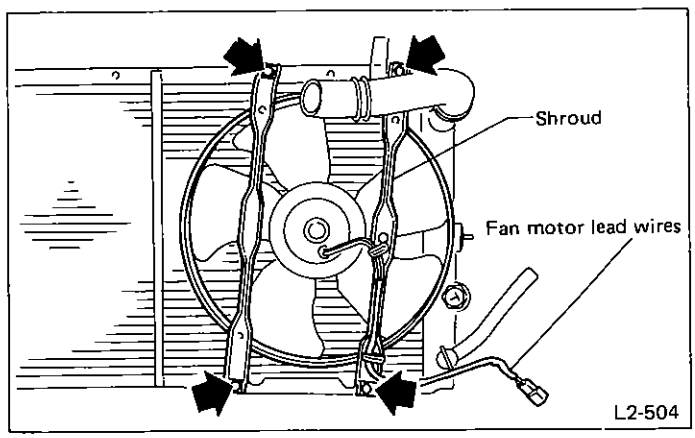


Fig. 19

4) Remove fan motor mounting nuts and detach fan motor from shroud.
5) Remove cooling fan mounting nuts and detach cooling fan from fan motor.

INSTALLATION

Installation is in the reverse order of removal procedures. Observe the following:

1) Before installing cooling fan motor, apply a coat of sealant to threads and tighten nuts.

2) Make sure cooling fan does not come into contact with shroud when installed.

3) After installation, make sure there is no unusual noise or vibration when fan is rotated.

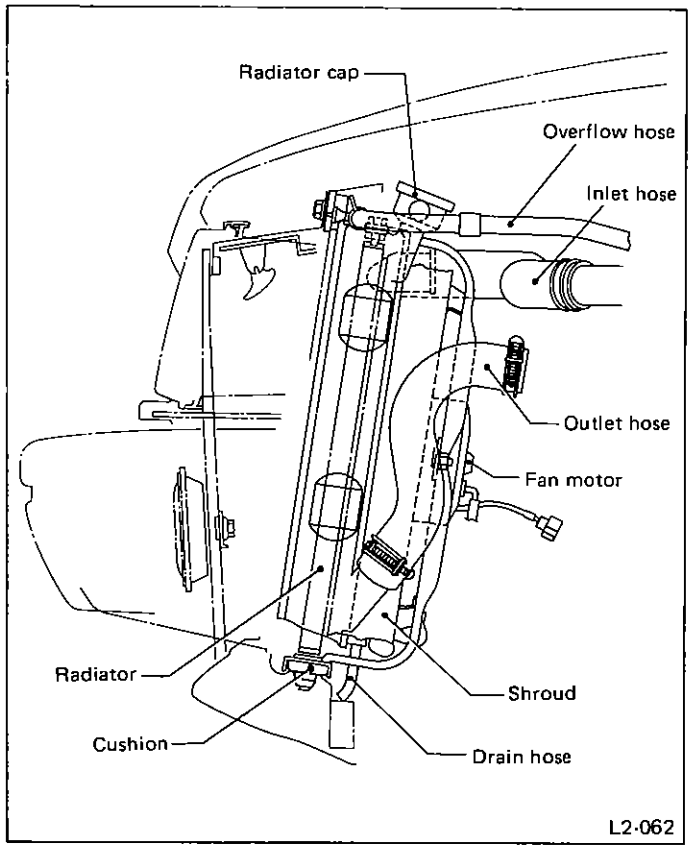


Fig. 20

TROUBLESHOOTING

Trouble	Possible cause	Corrective action
Over-heating	a. Insufficient coolant.	Replenish coolant, inspect for leakage, and repair.
	b. Loose drive belt.	Adjust drive belt tension.
	c. Oil on drive belt.	Replace.
	d. Malfunction of thermostat.	Replace.
	e. Malfunction of water pump.	Repair or replace.
	f. Clogged coolant passage.	Clean.
	g. Improper ignition timing.	Adjust.
	h. Clogged or leaking radiator.	Clean or repair, or replace.
	i. Improper engine oil.	Replace.
	j. Air-fuel mixture too thin.	Inspect and repair fuel system.
	k. Excessive back pressure in exhaust system.	Clean or replace.
	l. Insufficient clearance between piston and cylinder.	Adjust or replace.
	m. Slipping clutch.	Repair or replace.
	n. Dragging brake.	Adjust.
	o. Improper transmission oil.	Replace.
	p. Defective thermostat.	Replace.
	q. Malfunction of electric fan.	Replace thermoswitch or motor.
Over-cooling	a. Atmospheric temperature extremely low.	Partly cover radiator front area.
	b. Defective thermostat.	Replace.
Coolant leaks	a. Loosened or damaged connecting units on hoses.	Repair or replace.
	b. Leakage from water pump.	Repair or replace.
	c. Leakage from intake manifold.	Repair or replace.
	d. Leakage around cylinder head gasket.	Retighten cylinder head nuts or replace gasket.
	e. Damaged or cracked cylinder head and crankcase.	Repair or replace.
	f. Damaged or cracked thermostat case.	Repair or replace.
	g. Leakage from radiator.	Repair or replace.
Noise	a. Defective drive belt.	Replace.
	b. Defective electric fan.	Replace.
	c. Defective water pump bearing.	Replace.
	d. Defective water pump mechanical seal.	Replace.

FUEL INJECTION SYSTEM 2-7

SUBARU

1989

Single Point Fuel Injection System

MECHANISM AND FUNCTION

General

For conventional carburetors, the SPFI system substitutes a throttle chamber containing one fuel injector. It electronically controls the amount of fuel injection from the fuel injector and supplies the optimum mixture to suit all operating conditions of the engine.

The features of this SPFI system are as follows:

1) The reduction in the number of components results in easy servicing.

2) More precise control of the air-fuel mixture can be achieved by using an increased number of input signals transmitting engine operating conditions to the control unit.

3) The adoption of a hot wire type air flowmeter not only eliminates the need for high-altitude compensation, but also improves driving performance at high altitudes.

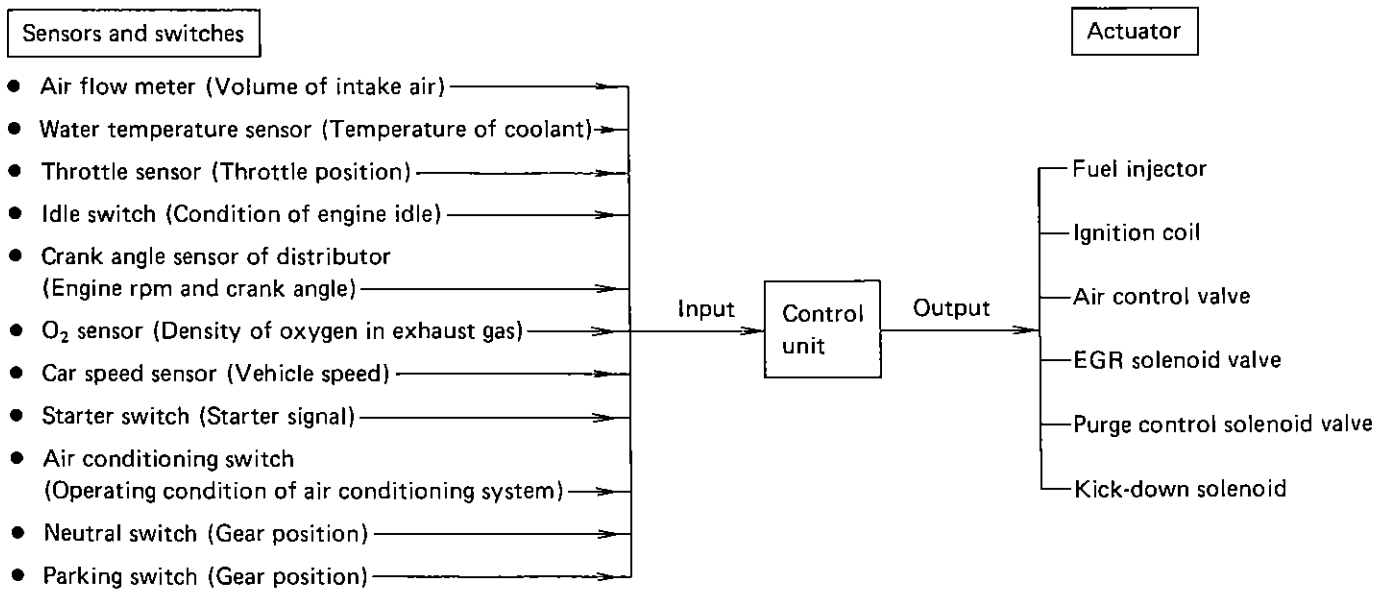
4) The air control valve automatically regulates the idle speed to the set value under various conditions.

5) The ignition timing is electrically controlled, thereby allowing the use of complicated spark advances characteristics.

6) The aging of the air flow meter and fuel injector is automatically corrected so that they maintain their original performance.

7) Trouble diagnosis can easily be accomplished by the built-in self-diagnosis function.

FLOW OF INPUT AND OUTPUT SIGNALS



Air Flow Meter

The SPFI system employs a hot-wire type air flow meter.
This air flow meter converts the amount of air taken into the engine into an electric signal by utilizing the heat transfer phenomenon between the incoming air and a heating resistor (hot wire) located in the air intake.
The features of this flow meter type are as follows:

1) High-altitude compensation is made automatically.
2) Quick response.
3) There are no moving parts.
4) It is compact.

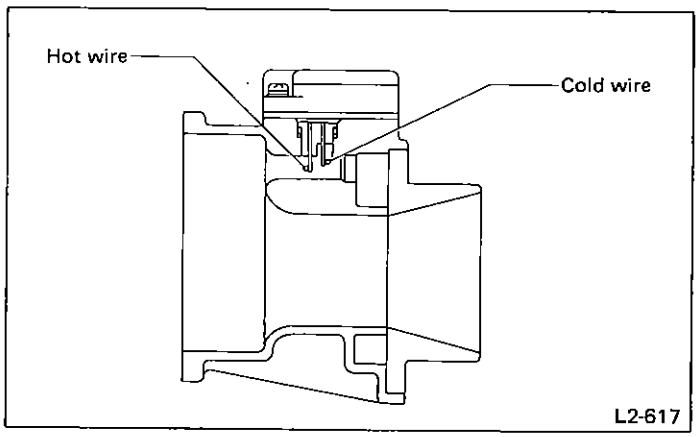


Fig. 1

PRINCIPLE OF OPERATION

The cold wire detects the temperature of inflowing air. Electric current flows in the hot wire so that the temperature difference between the hot and cold wires may be kept constant.
Then, the following relationship exists:

$$I^2R = (a + b\sqrt{PU})(T_H - T_C)$$

T_H: Hot wire temperature
T_C: Cold wire temperature
U : Velocity of flow
P : Inflowing air density
I : Hot wire current
R : Hot wire resistance
a : Constant
b : Constant

And it becomes as follows:

$$E \propto f(Q^{\frac{1}{4}})$$

E : Hot wire voltage
Q : Air flow (kg/h)

That is, the mass flow of inflowing air can be calculated by reading the voltage of the hot wire.

Throttle Chamber ASSY

The throttle chamber ASSY of the SPFI system contains an injector, throttle sensor, air control valve and pressure regulator that are combined in a body.
This throttle chamber ASSY is a single-bore, down-draft type equipped with an injector in the intake passage of the throttle valve. It consists of the following systems:

1) Fuel system
2) By-pass air control system
3) Throttle sensor system

FUEL SYSTEM

Fuel is fed from the fuel inlet pipe ① and injected from the injector ④. Also, fuel flows around the injector to cool it.
The pressure regulator ③ regulates fuel pressure and returns un-injected fuel to the fuel tank through the fuel return pipe ②.
The injector is operated by a signal from the SPFI control unit, based on engine speed and load.

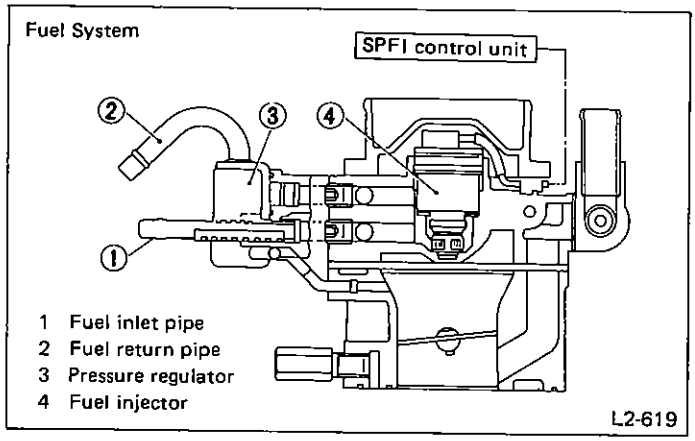


Fig. 2

BY-PASS AIR CONTROL SYSTEM

An air passage by-passing the throttle valve is provided to route air directly into the lower course of the throttle valve. The air control valve ① is located in the middle of this air passage and provides controls the amounts of air at engine starting, idle speed, etc.

The air control valve is driven by signals from the SPFI control unit and regulates the opening of the by-pass to maintain idle speed at the set value.

Using the air control valve, the system can provide the following functions:

1) Improved warm-up performance
2) Compensation of idle speed according to altitude
3) Compensation of idle speed with the air conditioner in operation
4) Compensation for idle speed fluctuation with aging

By-pass air control system

1 Air control valve
2 Air inlet pipe
3 Air outlet pipe
4 Idle adjusting screw

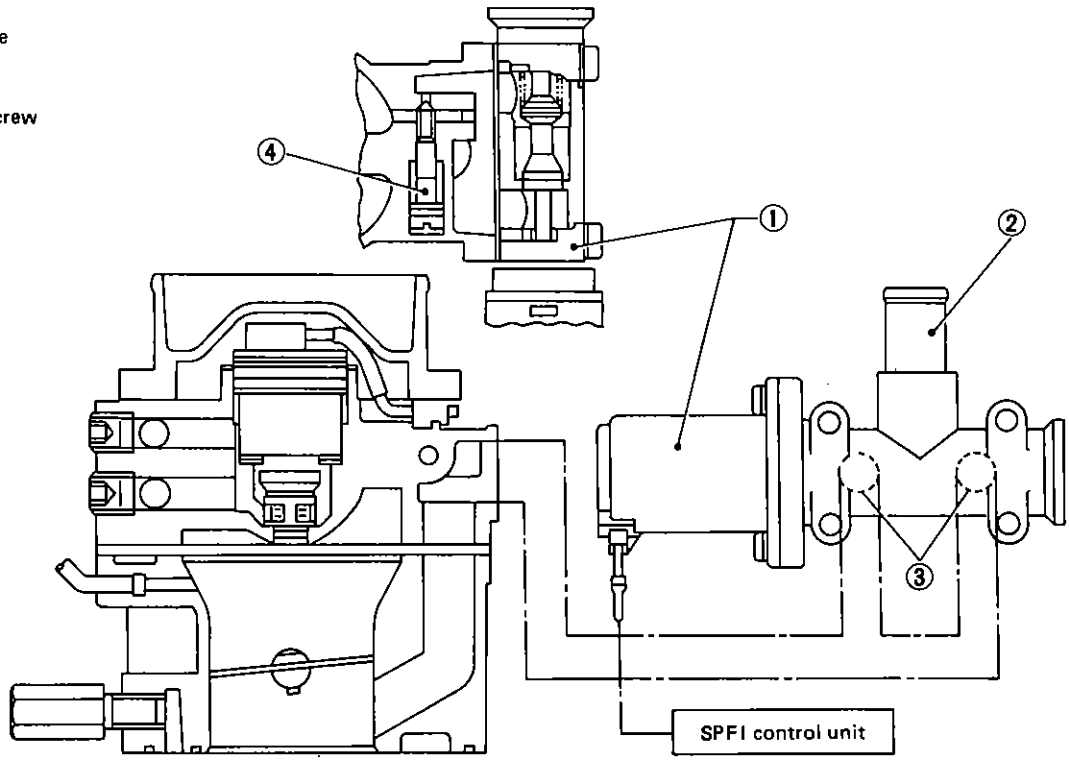


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Fig. 3

THROTTLE SENSOR SYSTEM

A throttle position sensor is provided with a potentiometer and idle switch interlocked with the throttle valve shaft is utilized.

This throttle position sensor sends the SPFI control unit a potentiometer output signal corresponding to the opening of the throttle valve and an idle switch signal that turns ON only when the throttle is opened nearly to the idle position.

Using these signals, the SPFI control unit precisely controls the air-fuel ratio during acceleration and deceleration as well as idling.

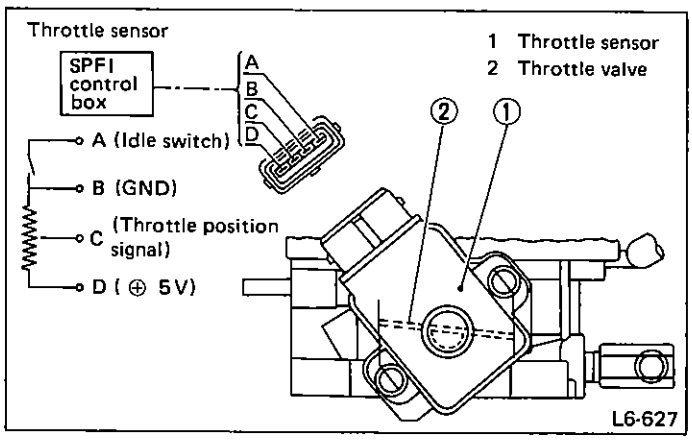


Fig. 4

Ignition System

The ignition system consists of a distributor containing a photoelectric crank-angle sensor, an ignition coil equipped with a power transistor, and the SPFI control unit. The crank-angle signal and reference signal detected by the photoelectric crank-angle sensor are sent to the SPFI control unit.

The SPFI control unit determines the optimum ignition timing from these signals and other engine operating parameters, and transmits an ignition signal to the ignition coil igniter.

The igniter amplifies this ignition signal and causes the primary current to flow intermittently in the ignition coil. Because of its accurate electric control, the system permits setting complicated spark-advance characteristics that cannot be realized in the mechanical type.

For further details of the distributor and ignition coil, refer to subsection 6-1, "ENGINE ELECTRICAL SYSTEM".

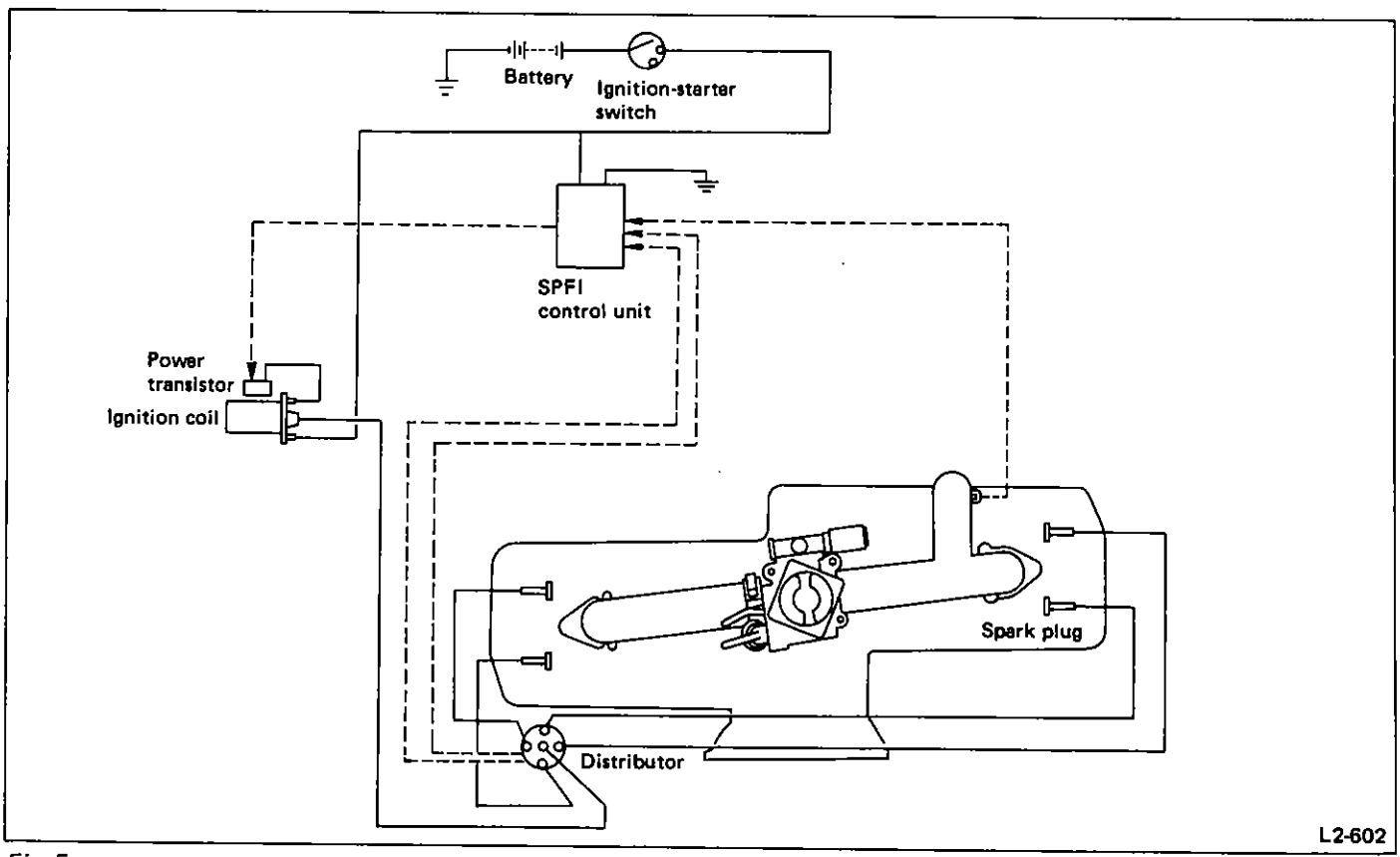


Fig. 5

Air-Fuel Ratio Learning Control System

This system has been developed to stabilize the quality of the hot-wire type air flow meter and fuel injector and to maintain their original performance by correcting their qualitative variation and aging.

By learning the feedback control amount of the O_2 sensor, the system controls the SPFI control unit to automatically set a coefficient of correction; thereby, the fuel injector always achieves fuel injection under the optimum condition.

O_2 Sensor

The O_2 sensor is mounted on the center exhaust pipe between the turbocharger and the rear exhaust pipe. It is used to sense oxygen concentration in the exhaust gas. If the fuel ratio is leaner than the stoichiometric ratio in the mixture (i.e. excessive amount of air), the exhaust gas contains more oxygen. To the contrary, if the fuel ratio is richer than the stoichiometric ratio, the exhaust gas hardly contains oxygen.

Therefore, examination of the oxygen concentration in exhaust gas makes it possible to show whether the air/fuel ratio is leaner or richer than the stoichiometric ratio.

The O_2 sensor has a zirconia tube (ceramic) which generates voltage if there is a difference in oxygen concentration between the inside and outside of the tube. Platinum is coated on the inside and outside of the zirconia tube for the purpose of catalysis and electrode provision. The hexagon screw on the outside is grounded to the exhaust pipe, and the inside is connected to the SPFI control unit through the harness.

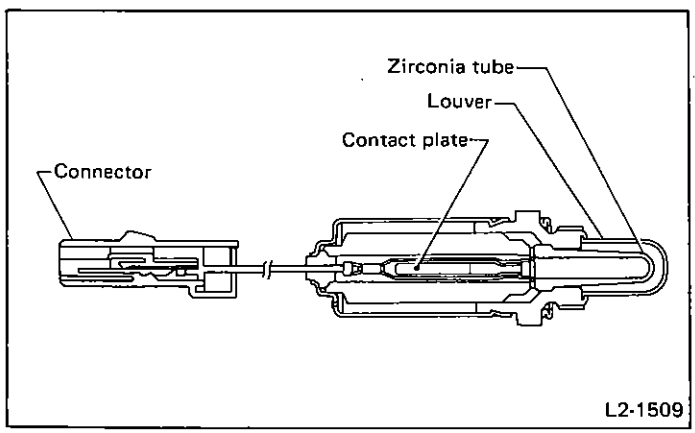


Fig. 6

When rich air-fuel mixture is burnt in the cylinder, the oxygen in the exhaust gases reacts almost completely through the catalytic action of the platinum coating on the surface of the zirconia tube. This results in very large difference in the oxygen concentration between the inside and outside, and the electromotive force generated is large.

When a lean air-fuel mixture is burnt in the cylinder, oxygen remains in the exhaust gases even after the catalytic action, and this results in small difference in the oxygen concentration. The electromotive force is very small.

The difference in oxygen concentration changes greatly in the vicinity of the optimum air-fuel ratio, and hence the change in the electromotive force is also large. By inputting this information into the MPFI control unit, the air-fuel ratio of the supplied mixture can be determined easily. The O_2 sensor does not generate much electromotive force when the temperature is low. The characteristics of the electromotive force stabilize at temperatures of approximately 300 to 400°C (572 to 752°F).

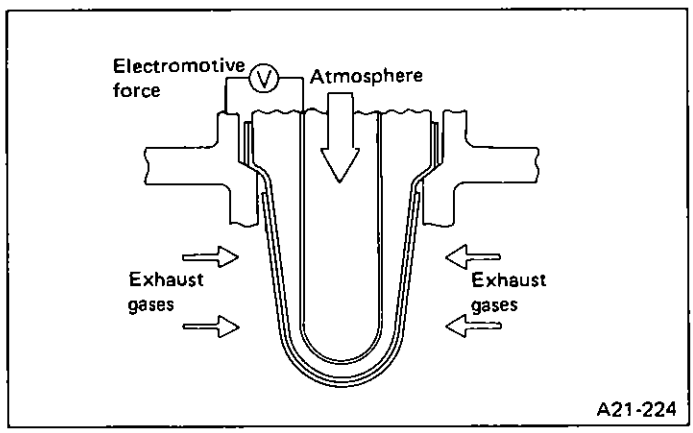


Fig. 7

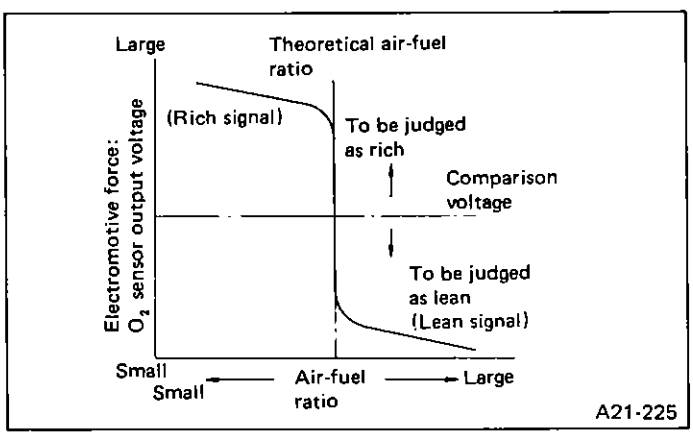


Fig. 8

Coolant Thermosensor

The coolant thermosensor is located on the thermocasing of the intake manifold. Its thermistor changes resistance with respect to temperature. A water temperature signal converted into resistance is transmitted to the control unit to control the amount of fuel injection, ignition timing, purge control solenoid valve, etc.

Kick-Down Control System

(AT model only)

KICK-DOWN CONTROL

A throttle sensor is used in place of the previous kick-down switch. It transmits a signal to the control unit to set the throttle valve to a specified position. When the throttle valve is in that position, the kick-down control relay turns on.

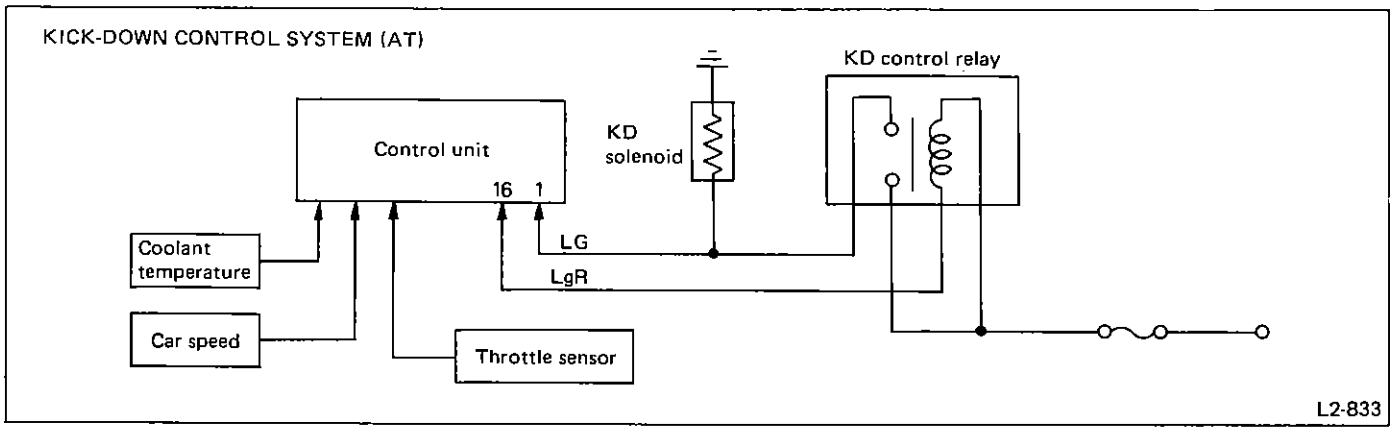


Fig. 9

EGR Gas Temperature Sensor

(California model only)

The EGR gas temperature sensor is located in the EGR gas passage on the intake manifold. An EGR gas temperature signal converted into resistance is transmitted to the control unit for EGR system diagnosis.

SCHEMATIC DRAWING OF SPFI SYSTEM

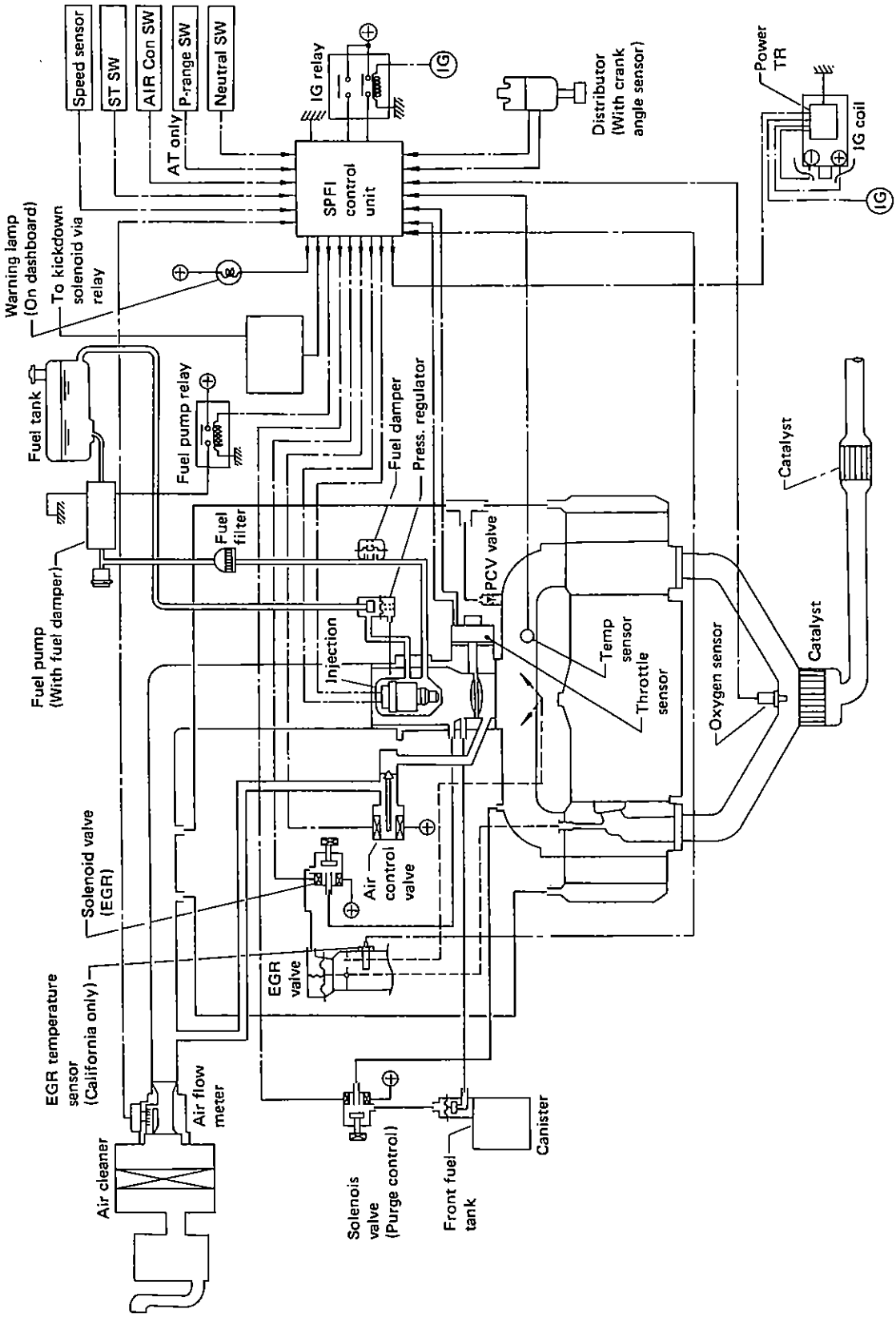
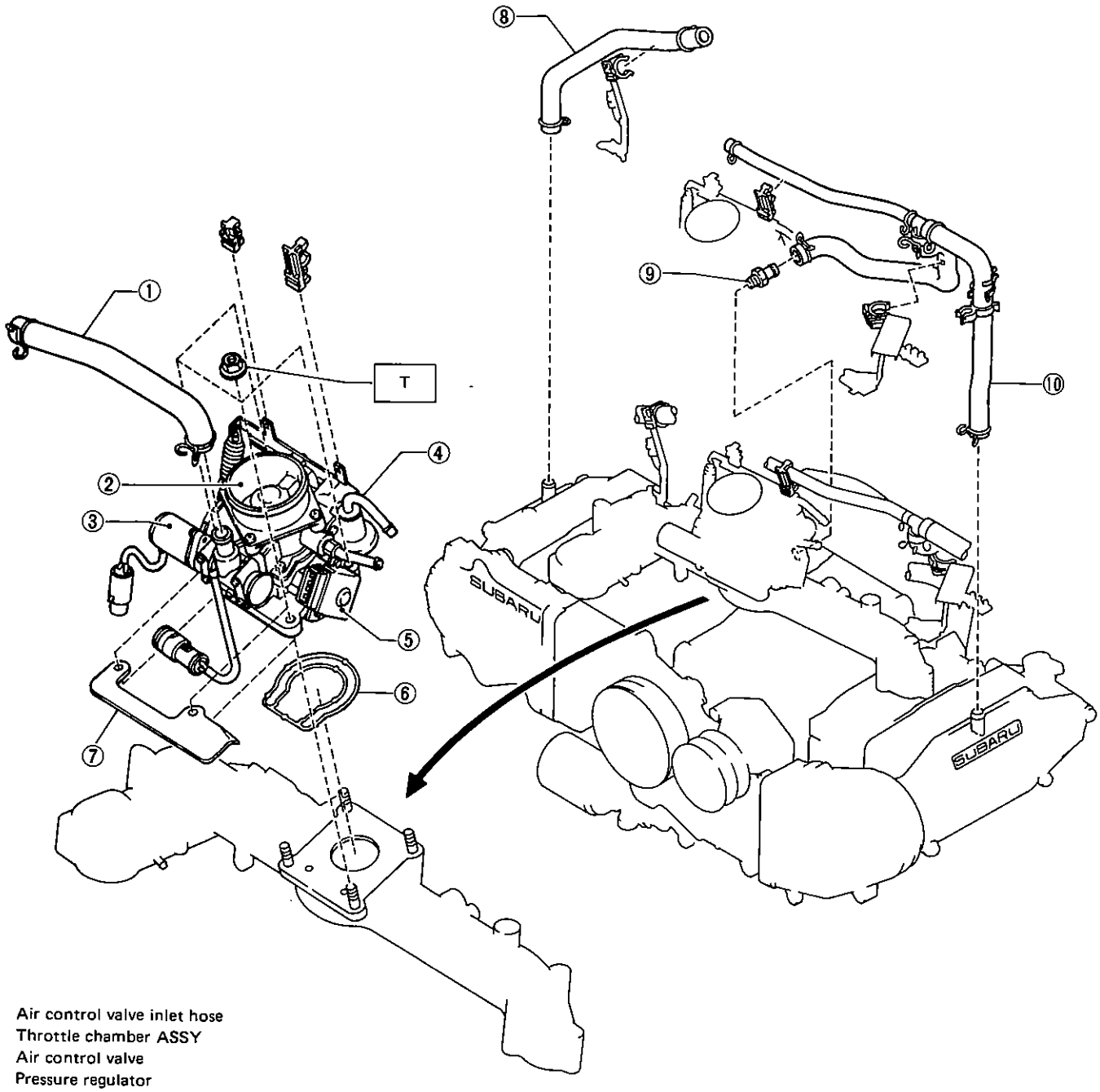


Fig. 10

L2-1463

COMPONENT PARTS

Throttle Chamber



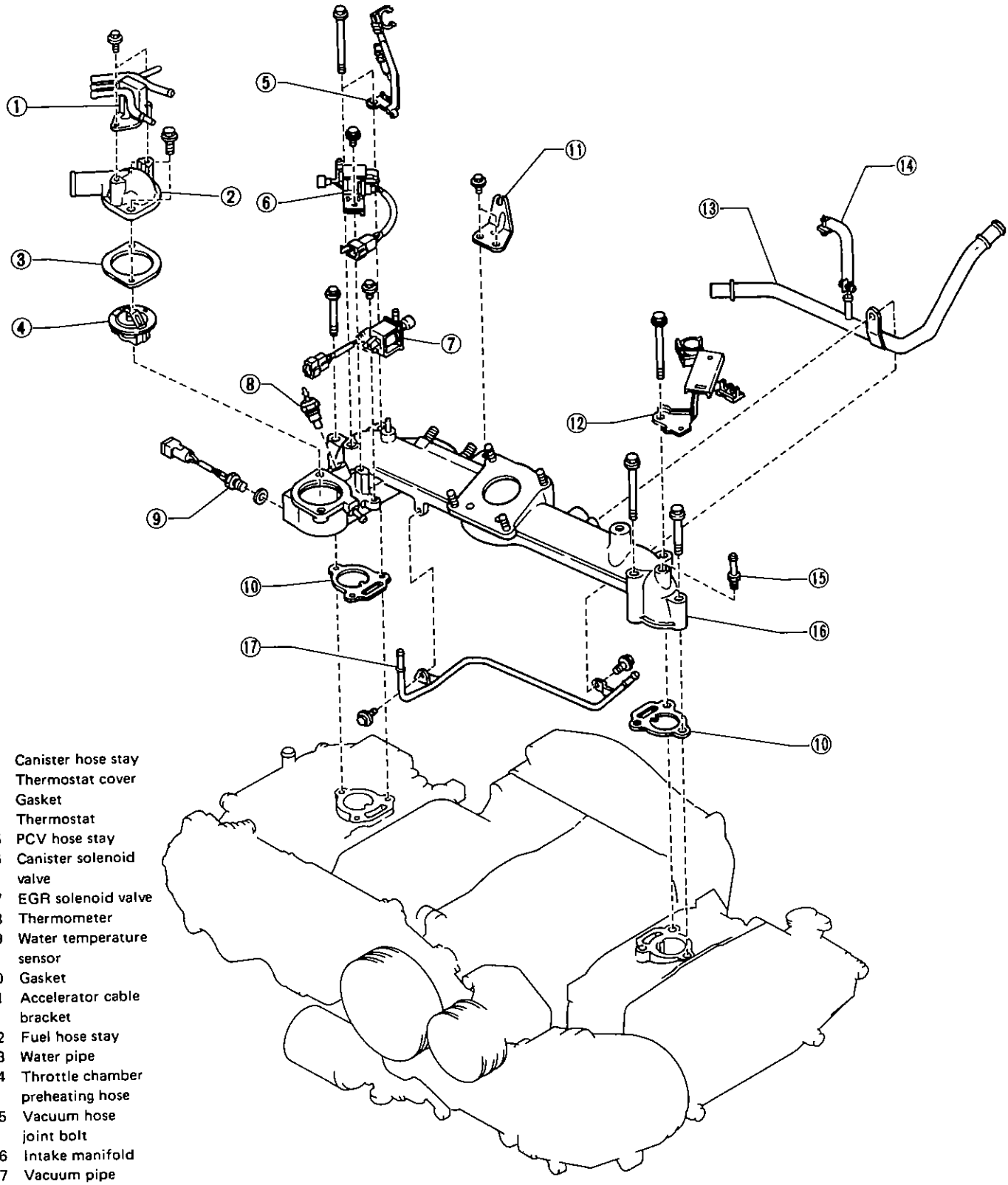
1 Air control valve inlet hose
2 Throttle chamber ASSY
3 Air control valve
4 Pressure regulator
5 Throttle sensor
6 Gasket
7 Plate
8 PCV hose
9 PCV valve
10 PCV hose

Tightening torque N·m (kg-m, ft-lb):
T: 18 – 21 (1.8 – 2.1, 13 – 15)

Fig. 11

L2-834

Intake Manifold

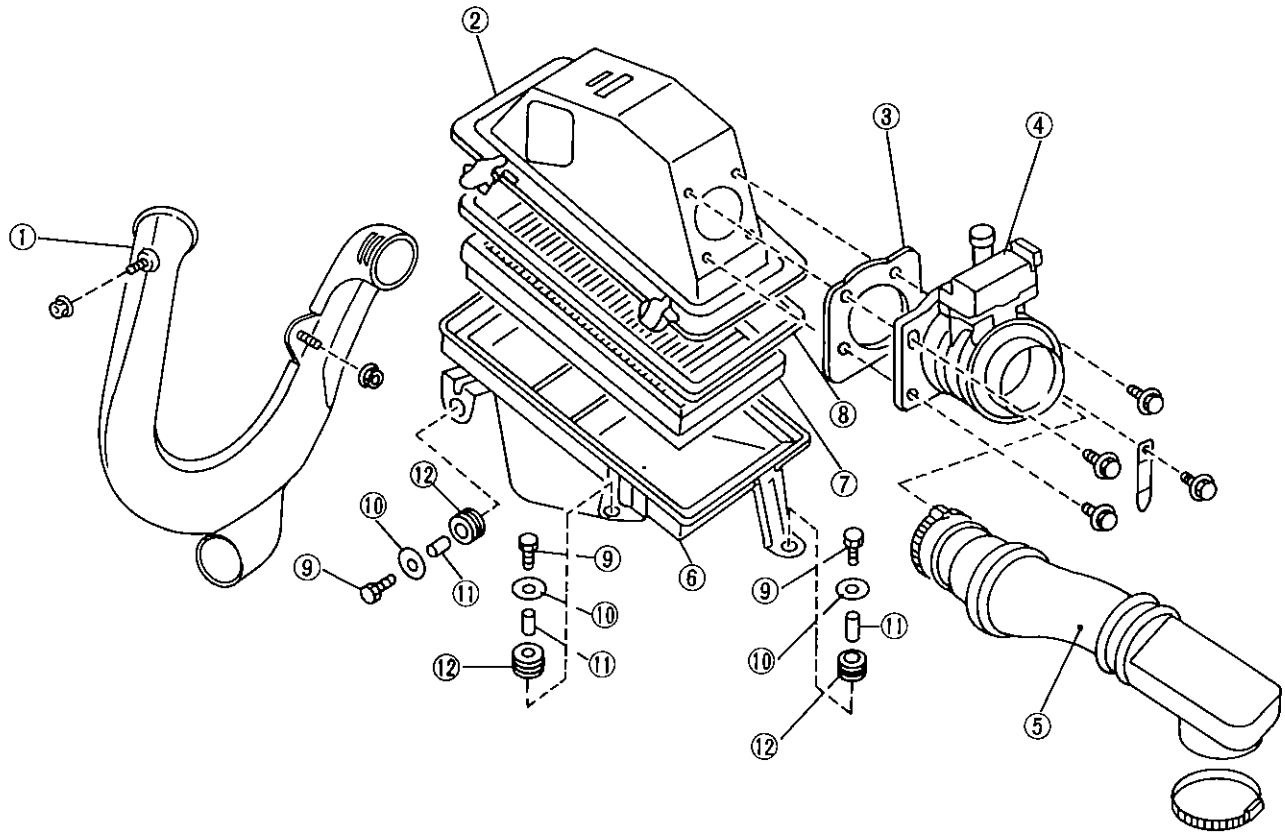


1 Canister hose stay
2 Thermostat cover
3 Gasket
4 Thermostat
5 PCV hose stay
6 Canister solenoid valve
7 EGR solenoid valve
8 Thermometer
9 Water temperature sensor
10 Gasket
11 Accelerator cable bracket
12 Fuel hose stay
13 Water pipe
14 Throttle chamber preheating hose
15 Vacuum hose joint bolt
16 Intake manifold
17 Vacuum pipe

L2-623

Fig. 12

Air Intake System



1 Air intake duct
2 Upper case
3 Gasket
4 Air flow meter ASSY
5 Air intake boot
6 Lower case
7 Air cleaner element
8 Gasket
9 Bolt
10 Washer
11 Spacer
12 Grommet

L2-836

Fig. 13

SERVICE PROCEDURE

Precautions in Servicing

1) Never connect the battery in reverse polarity.
- The SPFI control unit will be destroyed instantly.
- The fuel injector and other part will be damaged in just a few minutes more.

2) Do not disconnect the battery terminals while the engine is running.
- A large counter electromotive force will be generated in the alternator, and this voltage may damage the electronic parts such as SPFI control unit, etc.

3) Before disconnecting the connectors of each sensor and the SPFI control unit, be sure to turn off the ignition switch.
- Otherwise, the SPFI control unit may be damaged.

4) The connectors to each sensor in the engine compartment and the harness connectors on the engine side and body side are all designed to be waterproof. However, it is still necessary to take care not to allow water to get into the connectors when washing the vehicle, or when servicing the vehicle on a rainy day.

5) Every SPFI-related part is a precision part. Do not drop them.

6) Observe the following cautions when installing a radio in SPFI equipped models.

a. The antenna must be kept as far apart as possible from the control unit.
(The SPFI control unit is located under the steering column, inside of the instrument panel lower trim panel.)
b. The antenna feeder must be placed as far apart as possible from the SPFI control unit and SPFI harness.
c. Carefully adjust the antenna for correct matching.
d. When mounting a large power type radio, pay special attention to items a. thru c. above.

- Incorrect installation of the radio may affect the operation of the SPFI control unit.

7) Before disconnecting the fuel hose, disconnect the fuel pump connector and crank the engine for more than five seconds to release pressure in the fuel system. If engine starts during this operation, run it until it stops.

8) Do not disassemble components other than those mentioned in the manual.

9) The coolant thermosensor is identical to that in the MPFI system. Refer to item "MPFI system".

Air Flow Meter

INSPECTION

1) Check for leaks or damage in the connection between the air intake boot and air flow meter. Repair any defect noted.

2) Remove the connectors from the air flow meter, the air intake boot, and the air flow meter for the air cleaner case in the order stated.

3) Check the exterior of the air flow meter for damage.

4) Check for foreign matter, water, or oil in the air passages, especially in the by-pass. If any abnormality is noticed, replace the air flow sensor.

5) If no defect is found in the visual checks above, conduct the following inspections.

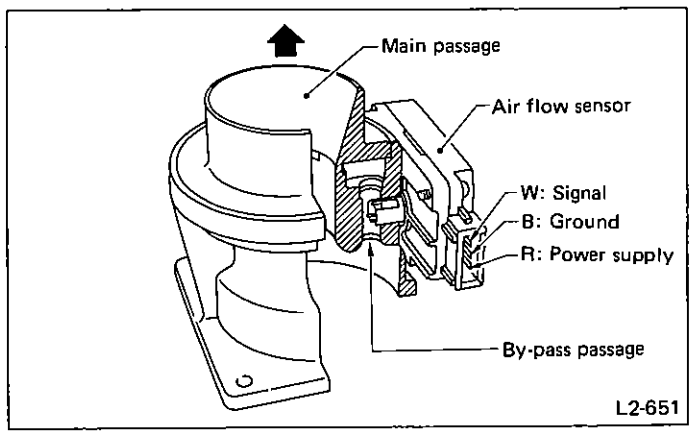


Fig. 14

Be careful not to short-circuit the power source.

(1) Turn the ignition switch OFF.
(2) Install the air flow meter on the air cleaner.
(3) Disconnect a connector from the air flow meter and remove the rubber cover from the connector.

Conduct the following checks by attaching the tester check pins to the connector terminals on the side from which the rubber cover has been removed.

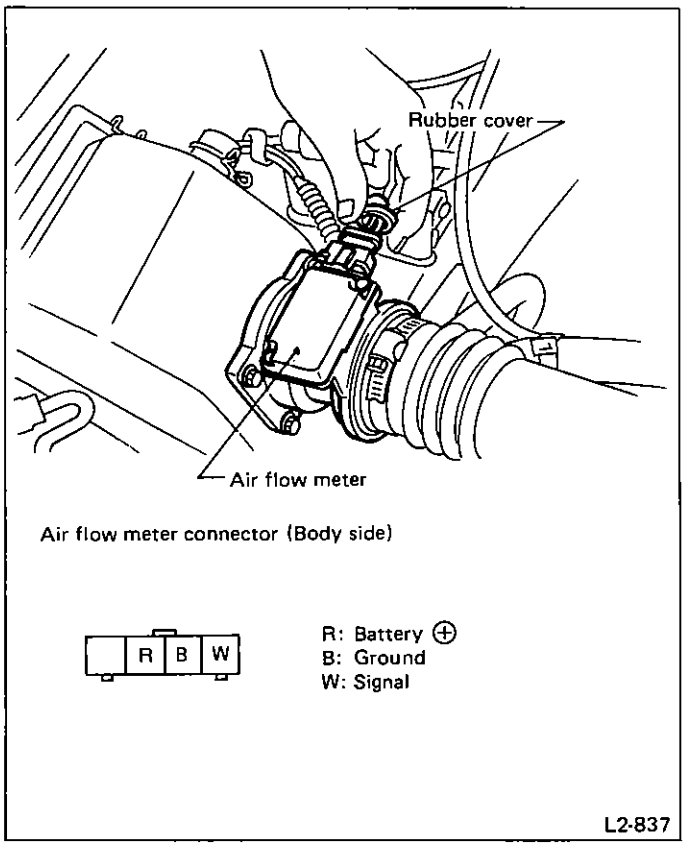


Fig. 15

(4) Measure resistance between the body and ground terminal (B).

Specified resistance:
10Ω, max.

If resistance is greater than 10 ohms, check the harness and internal circuits of the control unit for discontinuity.

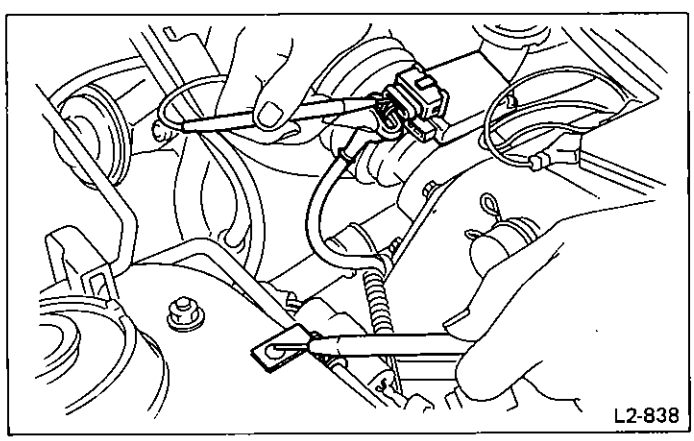


Fig. 16

(5) Turn the ignition switch ON (with the engine off).
(6) Measure voltage across power terminal (R) and the body.

Specified voltage:
10V, min.

If voltage is outside specifications, check the power line (battery, fuse, control unit, harness connector, etc.).

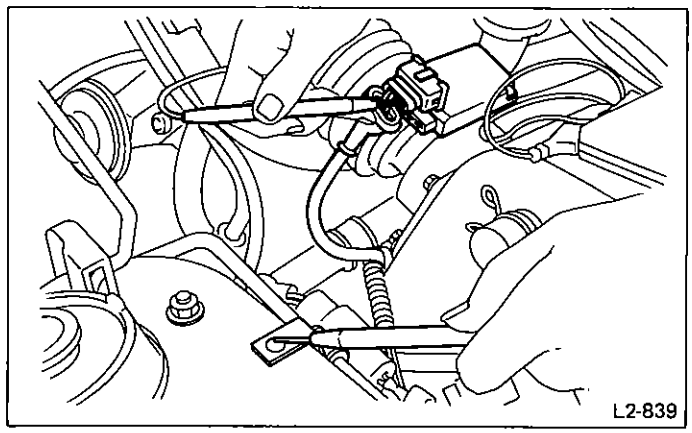


Fig. 17

(7) Connect the connector to air flow meter.
(8) Attach the positive lead ⊕ of the tester to signal terminal (W) and the negative lead ⊖ to ground terminal (B) and measure voltage across the two terminals.

Specified voltage:
0.1 – 0.5V

If voltage is not within the specified range, replace the air flow meter.

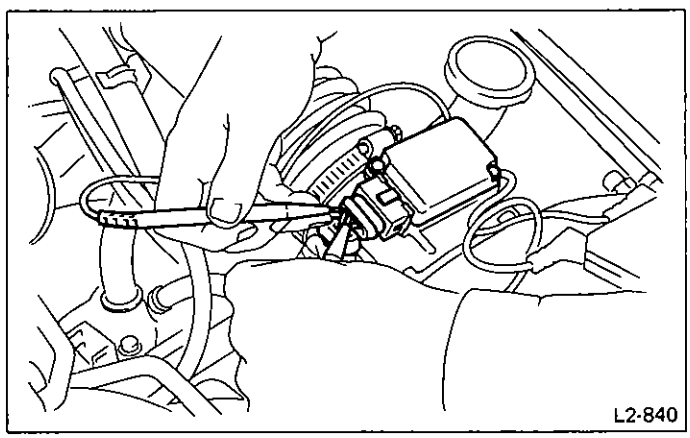


Fig. 18

(9) Remove the upper section of the air cleaner.
(10) Blow air from the air cleaner side to check if voltage across terminals (W) and (B) is higher than that measured in step (7) above.

If not, replace the air flow meter.

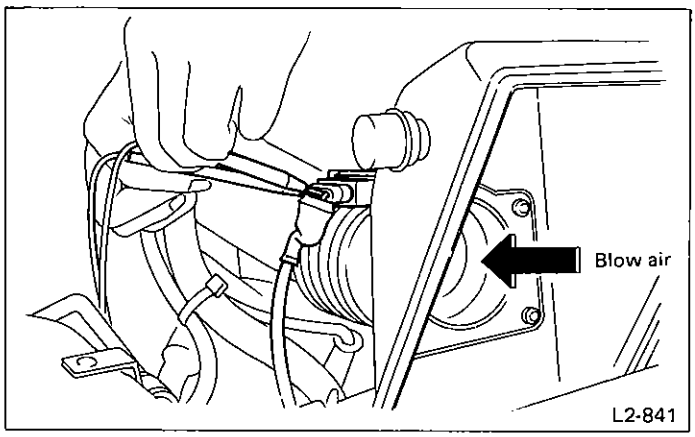


Fig. 19

Throttle Chamber ASSY

INSPECTION AND ADJUSTMENT

IGNITION TIMING

1) Warm up the engine.
2) Turn the ignition switch OFF.
3) Disconnect the connector of the throttle sensor.
4) Ensure that the resistance between the throttle sensor terminals Ⓐ and Ⓑ is 0Ω when the accelerator pedal is released.

If it is ∞Ω, adjust idle contact by referring to the following subsection, "THROTTLE SENSOR".

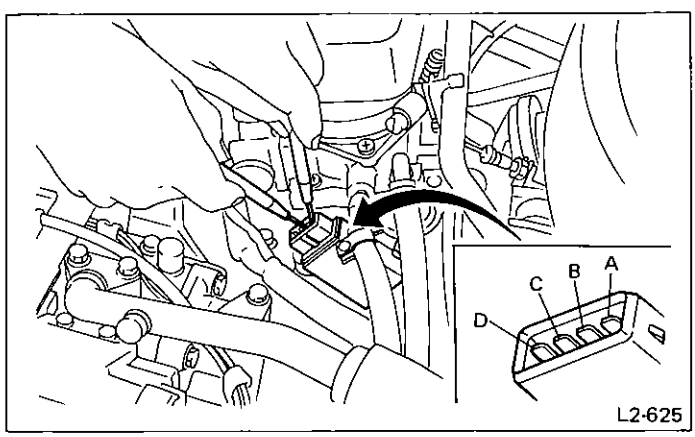


Fig. 20

5) Connect the connector of the throttle sensor.
6) Connect the test mode connector.
7) Start the engine and run it at idle speed. Do not depress the accelerator pedal.
8) Check and adjust ignition timing.

Specified ignition timing:
20° BTDC

The specified ignition timing can be obtained regardless of engine speed when the engine is idling without depressing the accelerator pedal.

9) Stop the engine.
10) Disconnect the test mode connector.

IDLE SPEED

1) Disconnect air control valve harness at throttle chamber ASSY.
2) Adjust idling speed to 550±50 rpm by turning in or out IAS.

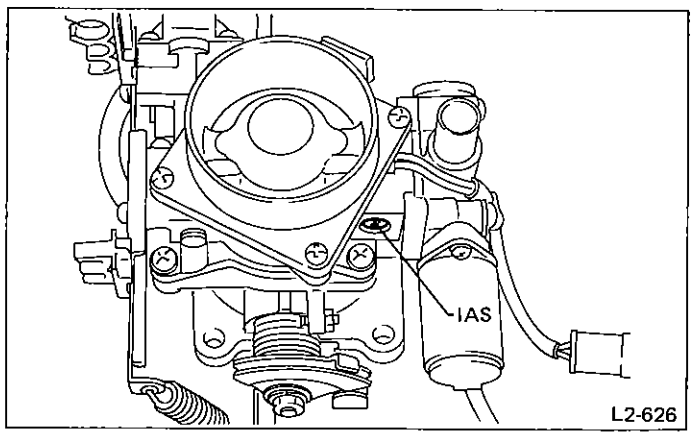


Fig. 21

3) Reconnect air control valve harness, and ensure engine idles at 700±100 rpm.
4) If engine idling speed is less than 600 rpm, the connector has faulty contact or the harness is broken.

THROTTLE SENSOR

Idle contact

Insert a thickness gauge between the stopper screw of the throttle chamber and stopper, and check for continuity between Ⓐ and Ⓑ.

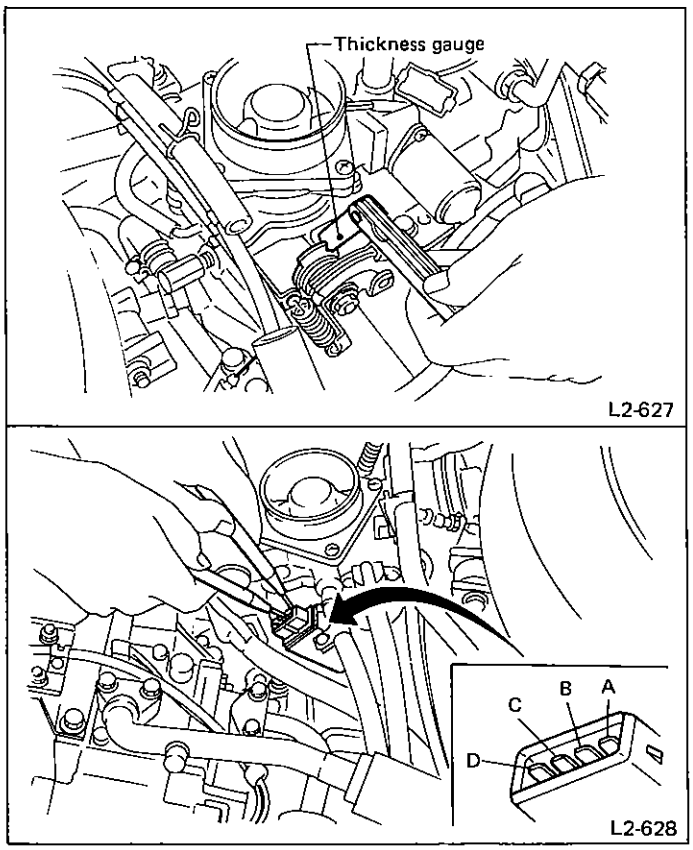


Fig. 22

1) Make sure that Ⓐ and Ⓑ are conducting when the throttle is closed fully.
2) Make sure that Ⓐ and Ⓑ are not conducting when the throttle is open fully.
3) Make sure that Ⓐ and Ⓑ are conducting when the thickness of gauge is 0.31 mm (0.0122 in) [this corresponds to throttle opening of 1.0°].
4) Make sure that Ⓐ and Ⓑ are not conducting when the thickness of gauge is 0.79 mm (0.0311 in) [this corresponds to throttle opening of 2.5°].
5) If the above standard is not satisfied, loosen the screws (two) securing the throttle sensor to the throttle chamber, and turn the throttle sensor main body until the correct adjustment is obtained.

If it can not be obtained, replace the throttle sensor with a new one.

Throttle opening signal

Checking resistance between Ⓑ and Ⓓ and between Ⓑ and Ⓒ (changes with the opening of the throttle valve).
1) Check that a resistance of 3.5 to 6.5 kΩ exists between Ⓑ and Ⓓ.
2) Check that resistance between Ⓑ and Ⓒ is less than 1 kΩ with the throttle valve fully closed and greater than 2.4 kΩ with the valve fully opened (about 80% of the resistance between Ⓑ and Ⓓ).
3) Check that resistance between Ⓑ and Ⓒ increases continuously when the throttle valve is moved from the fully closed to the fully opened position.
4) Check that resistance between Ⓑ and Ⓒ decreases continuously when the throttle valve is moved from the fully opened to the fully closed position.

If any defect is found in the above checks, replace the throttle sensor with a new one.

FUEL INJECTOR

Using a stethoscope or long-type screwdriver, make sure of operating noise (clicking sound) of the injector.
If the operating noise cannot be heard on the injector;
1) Check resistance of the injector on the control side.
   (1) Turn the ignition switch OFF (engine off).
   (2) Disconnect the connector from the control unit.
   (3) Measure resistance between terminal 43 (RW) and terminal 48 (RB) of the harness connector.

Specified resistance:
0.5 – 2 Ω

a. Attach the check pin of the tester to the terminals from the rear of the connector. Use clips of hairpins if necessary to attach the check pin to the terminals.
b. If resistance is outside the specified range, check the following:

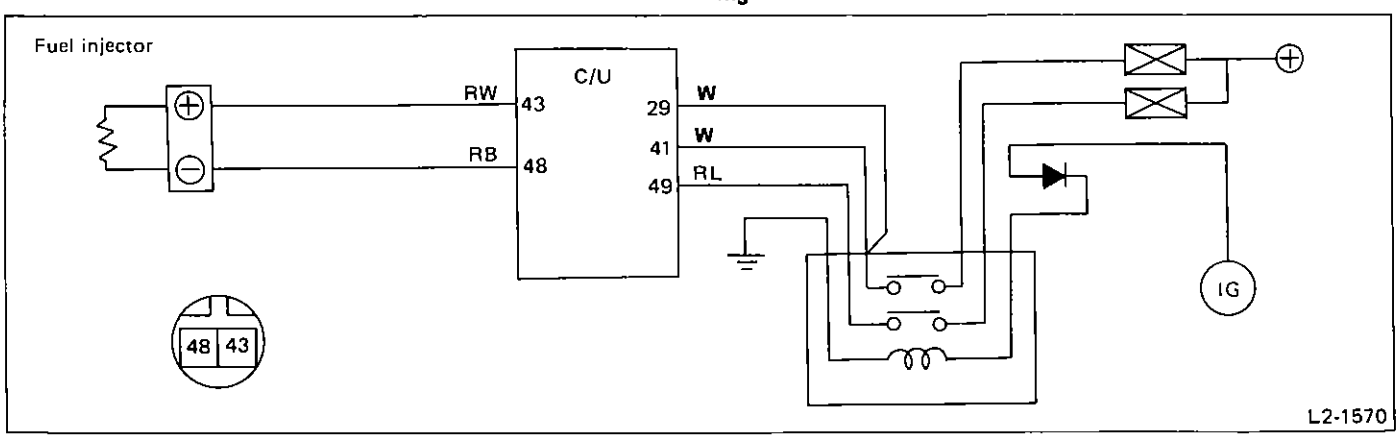


Fig. 23

2) Check the injector for discontinuity.
(1) Disconnect the connector from the injector.
(2) Measure resistance between the terminals of the connector on the injector side.

Specified resistance:
0.5 – 2Ω

If resistance is outside the specified range, replace the injector.

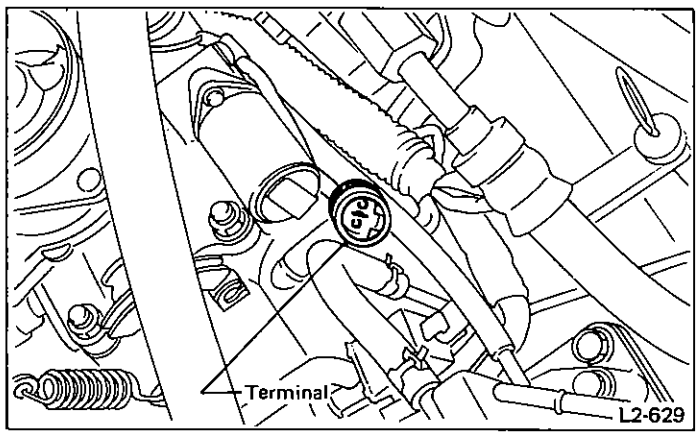


Fig. 24

3) Check the injector for insulation.
Measure resistance between each terminal of the connector on the injector side and the body.

Specified insulation resistance:
1 MΩ, min.

a. If insulation resistance is less than the specified value, replace the injector.
b. If the value measured in step 1) above is outside the 0.5 to 2Ω range (although the values measured in 2) and 3) are within specifications), check the harness for discontinuity and the connector for poor connection.

AIR CONTROL VALVE

1) Disconnect the connector to the air control valve while the engine is idling. At this time, check that engine speed drops.
2) Check that the engine resumes original speed when the connector is connected.

Disconnecting the connector causes a big change in rpm when the engine is cold. However, when the engine is warm, it causes a smaller change or almost no change.

3) When the engine shows no change in speed in the above check, inspect the following.
(1) Stop the engine and disconnect the connector from the air control valve.
(2) Turn the ignition switch ON (engine off).
(3) Measure voltage across the body and power terminal (BW) of the air control valve connector (body side).

Specified voltage:
10V, min.

If voltage is less than the specified value, check the harness.

(4) Turn the ignition switch OFF (engine off).
(5) Measure resistance between each terminal of the connector on the air control valve side.

Specified resistance:
7.3 – 13Ω [at –20 to 80°C (–4 to 176°F)]

If resistance is outside the specified range, replace the air control valve.

(6) Measure insulation resistance between the body and each terminal of the connector on the air control valve side.

Specified insulation resistance:
1 MΩ, min.

If insulation resistance is less than the specified value, replace the air control valve.

(7) Connect the air control valve connector.
(8) Disconnect the connector from the control unit.
(9) Turn the ignition switch ON (engine off).
(10) Measure voltage across the body and terminal 45 (GR) of the control unit connector.

Specified voltage:
10V, min.

If voltage is less than the specified value, check the harness between the air control valve and the control unit.

(11) Turn the ignition switch OFF (engine off).
(12) Connect the connector to the control unit.
(13) Monitor the voltage across the body and terminal 45 (GR) of the control unit connector.
Turn the ignition switch ON (engine off).

Specified voltage:
1 V, max. (for approximately one minute after ignition turns ON)
10 V, min. (one minute after ignition turns ON)

If voltage is not within the specified range, the problem is either poor contact of the terminal or faulty control unit.

(14) Turn the ignition switch OFF (engine off).
(15) Disconnect the air control valve hose.
(16) Turn the ignition switch ON (engine off).
(17) Look through the open end of the pipe (from which the air control valve hose is disconnected) to make sure the valve moves from the fully-closed position to the fully-open position one minute after the ignition switch is turned ON.

If the valve does not operate properly, replace the air control valve.

PRESSURE REGULATOR

The pressure regulator adjusts the fuel pressure to 147 kPa (1.5 kg/cm^2, 21 psi) compared to the throttle vore pressure of throttle chamber.

a. Before disconnecting the fuel hose, first disconnect the fuel pump connector and crank the engine (more than five seconds) to release the pressure in the fuel system. If the engine is started by this cranking, run it until it stops.
b. Be sure to clamp the hose at the connecting portion.

1) Disconnect the fuel hose at the fuel delivery pipe of throttle chamber and install a fuel pressure gauge.
2) Measure the fuel pressure when the engine is at idle speed.

Standard:
137 – 167 kPa (1.4 – 1.7 kg/cm^2, 20 – 24 psi)

DISASSEMBLY

FUEL INJECTOR

1) Remove injector cap and gasket.

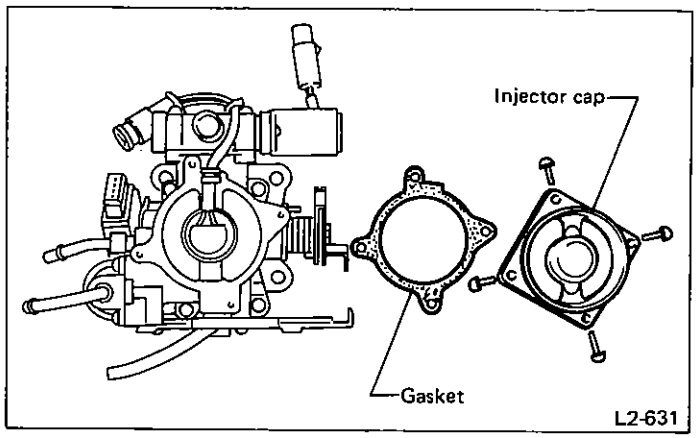


Fig. 25

2) Hold the injector using a pliers, then pull out the injector from chamber ASSY.

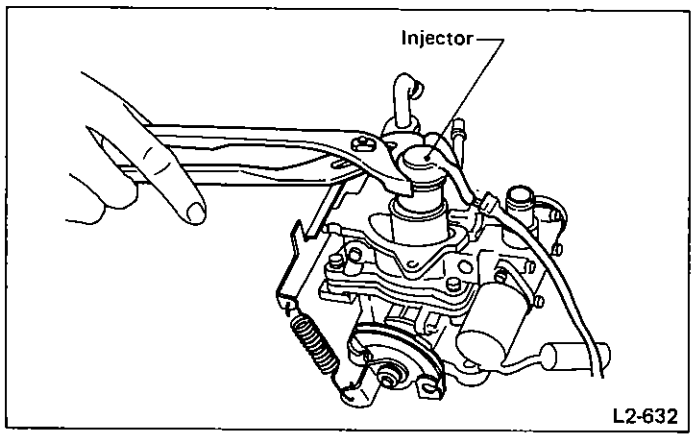


Fig. 26

3) Remove the injector and O-ring from the chamber ASSY.

Be careful not to damage the nozzle on the point of the injector.

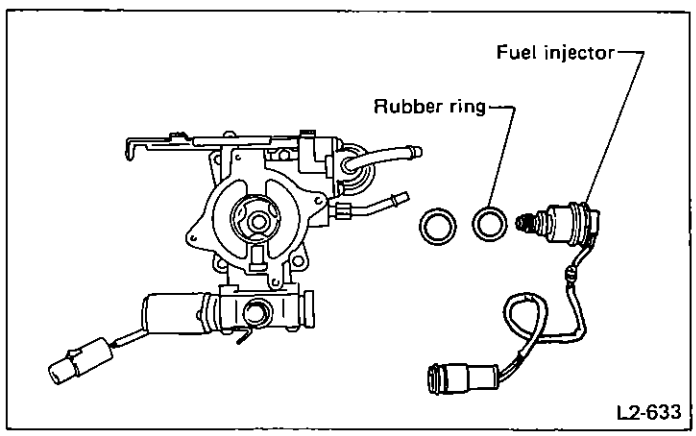


Fig. 27

AIR CONTROL VALVE

1) Remove the injector lead wire from the clamp.
2) Remove the air control valve, gasket and lead wire from the venturi chamber.

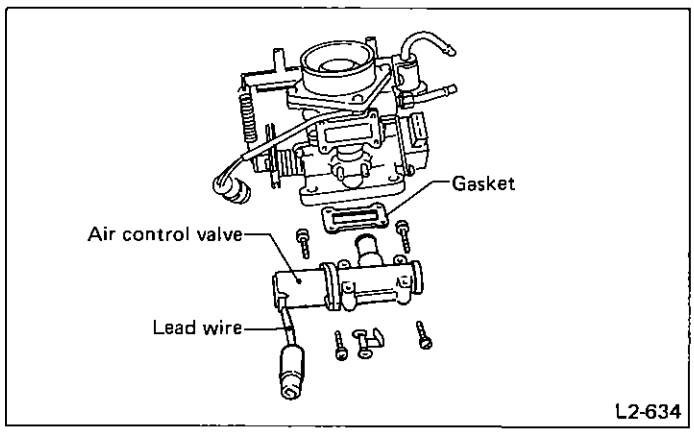


Fig. 28

THROTTLE SENSOR

1) Remove the two screws securing the throttle sensor to the throttle chamber.
2) Remove the throttle sensor by pulling it in the axial direction of the throttle shaft.

Pay attention to the O-ring attached to the throttle sensor mounting face of the throttle chamber.

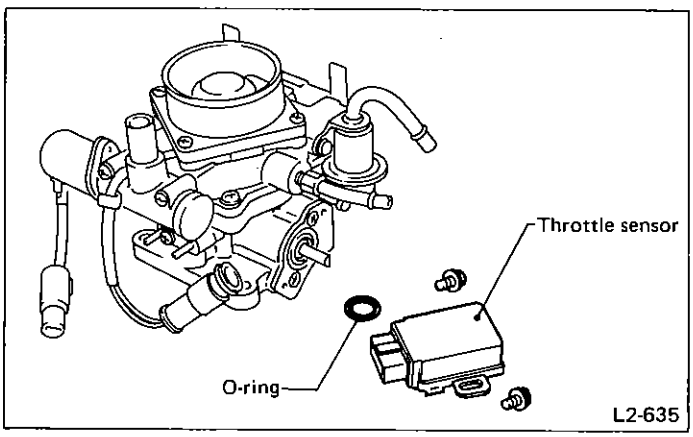


Fig. 29

PRESSURE REGULATOR

1) Remove the two screws securing the pressure regulator to the venturi chamber.
2) Pull the pressure regulator to remove.

Pay attention to the O-ring attached to the pressure regulator mounting face of the venturi chamber.

THROTTLE DRUM

1) Remove the throttle return spring from the spring lever.
2) Remove the nut first and then the washer and spring lever from the throttle shaft.
3) Remove the throttle drum from the throttle shaft.

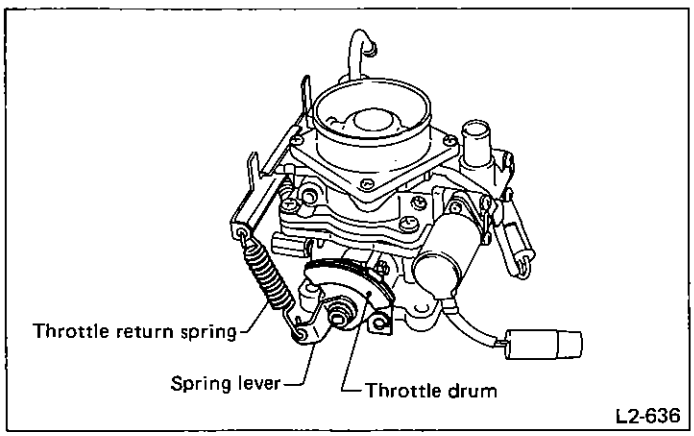


Fig. 30

ASSEMBLY

Assembly is in the reverse order of disassembly procedure.

Coolant Thermosensor

INSPECTION

Put the thermosensor in water of various temperatures and measure the resistance between terminals using a circuit tester.

Water temperature °C (°F)	Resistance value
−10 (14)	7 – 11.5 kΩ
20 (68)	2 – 3 kΩ
50 (122)	700 – 1,000 Ω

If the resistance value is too much out of these ranges, replace the thermosensor with a new one.

Air Intake System

INSTALLATION

Insert the air intake boot until it securely bottoms against the throttle chamber.

Make sure the throttle chamber screw is positioned in the center of the cutout section of the boot when the boot is installed.

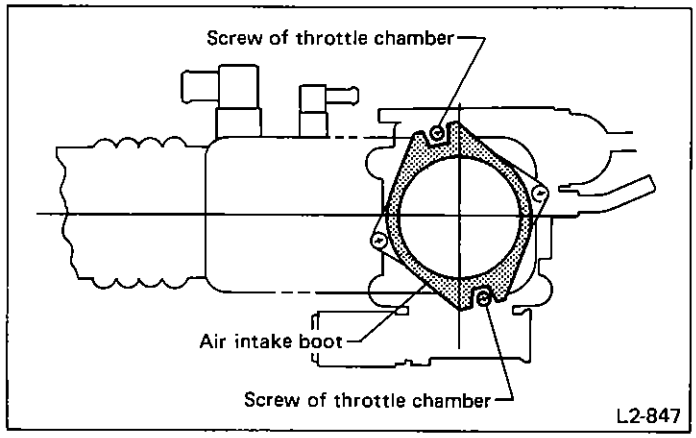


Fig. 31

TROUBLESHOOTING

General Troubleshooting Table

***: The CHECK ENGINE light blinks.**
***1: The CHECK ENGINE light blinks when contact is resumed during inspection (although poor contact is present in the D-check).**
***2: The CHECK ENGINE light lights when abnormality is detected in the D-check mode if the idle switch persistently remains off with the accelerator pedal released.**
***3: The CHECK ENGINE light lights when the specified performance characteristics are unusual with the throttle valve in the slightly-opened position.**

Symbols shown in the table refer to the degree of possibility of the reason for the trouble ("Very often" to "Rarely").
◎ : Very often
○ : Sometimes
△ : Rarely
☆ : Occurs only in extremely low temperatures

TROUBLE		
1	Engine will not start.	No initial combustion
2		Initial combustion occur.
3		Engine stalls after initial combustion.
4	Rough idle and engine stall.	
5	Inability to drive at constant speed	
6	Inability to accelerate and decelerate	
7	Engine does not return to idle.	
8	Afterburning in exhaust system	
9	Knocking	
10	Excessive fuel consumption	
11	Inability to "kick-down" and upshift	
U	CHECK ENGINE light operation	U-check mode & read memory mode
D		D-check mode

TROUBLE No.											CHECK ENGINE light		POSSIBLE CAUSE
1	2	3	4	5	6	7	8	9	10	11	U	D	
													AIR FLOW METER
		☆	◎				△	△	○		ON	ON	• Connector not connected
		△	◎	◎	◎		◎	○	△		ON	*1	• Poor contact of terminal
		☆	◎				△	○	△		ON	ON	• Short circuit
		☆	◎				△	△	○		ON	ON	• Discontinuity of wiring harness
		○	○	○	○		△	◎	○		OFF	*	• Performance characteristics unusual
													COOLANT THERMOSENSOR
	☆	○	☆		○		○	○	○		ON	ON	• Connector not connected
	△	△	◎	○	○	△	◎	◎	○		ON	*1	• Poor contact of terminal
	☆	○	☆		○		○	○	○		ON	ON	• Short circuit
	☆	○	☆		○		○	◎	○		ON	ON	• Discontinuity of wiring harness
	☆	○	○	△	○	○	◎	◎	◎		OFF	*	• Performance characteristics unusual
													IDLE SWITCH OF THROTTLE SENSOR
			◎	○	◎	◎	◎				ON	ON	• Connector not connected
			◎	○		◎	◎				ON	*1	• Poor contact of terminal
			◎	◎	△		◎				ON	ON	• Short circuit
			◎		△	◎	◎				ON	ON	• Discontinuity of wiring harness
			◎			◎	◎				OFF	*2	• Improper adjustment
1	2	3	4	5	6	7	8	9	10	11	U	D	

TROUBLE No.											CHECK ENGINE light		POSSIBLE CAUSE
1	2	3	4	5	6	7	8	9	10	11	U	D	
				◎	◎		◎			○	ON	*1	THROTTLE SENSOR ● Poor contact of terminal
△			◎		◎		◎			◎	ON	ON	● Short circuit
			△		◎		◎			◎	ON	ON	● Discontinuity of wiring harness
	○	○	△	○	◎		◎			◎	OFF	*3	● Performance characteristics unusual
								△			OFF	*	PRESSURE REGULATOR ● Sensing hose cracked or disconnected
	△				○		○		◎		OFF	*	● Fuel pressure too high
○	○	○	◎	◎	◎		◎				OFF	*	● Fuel pressure too low
○											ON	ON	FUEL INJECTOR ● Connector not connected
	○	○	◎	◎	◎		○				ON	*1	● Poor contact of terminal
○											ON	ON	● Short circuit
○											ON	ON	● Discontinuity of wiring harness
	○	○	◎	◎	◎		◎		◎		OFF	*	● Performance characteristics unusual
	○	○	○	○	○						OFF	*	● Clogged filter
○	△										OFF	*	● Stuck open
			○				○		○		OFF	*	● Slight leakage from seat
													AIR CONTROL VALVE
	○	△	◎								ON	ON	● Connector not connected
	△	○	◎								ON	*1	● Poor contact of terminal
			○				○				ON	ON	● Short circuit
	○	△	◎								ON	ON	● Discontinuity of wiring harness
			◎			◎					OFF	*	● IAS improperly adjusted
						◎					OFF	*	● Stuck open
	○	○	◎								OFF	*	● Stuck closed
													CRANK ANGLE SENSOR
◎											ON	ON	● Connector not connected
	○	○	◎	◎	◎		○	○			ON	*1	● Poor contact of terminal
◎											ON	ON	● Short circuit
◎											ON	ON	● Discontinuity of wiring harness
													POWER TRANSISTOR OF IGNITION COIL
◎											OFF	*	● Connector not connected
	○	○	◎	◎	◎		○	△			OFF	*	● Poor contact of terminal
◎											OFF	*	● Short circuit
◎											OFF	*	● Discontinuity of wiring harness
1	2	3	4	5	6	7	8	9	10	11	U	D	

Self-diagnosis System

General

The self-diagnosis system detects and indicates a fault in various inputs and outputs of the complex electronic control. The warning lamp (CHECK ENGINE light) on the instrument panel indicates occurrence of a fault or trouble, and also the light emitting diode (LED) in the control unit indicates a trouble code.

Further, against such a failure of sensors as may disable the drive, the fail-safe function is provided to ensure the minimal driveability.

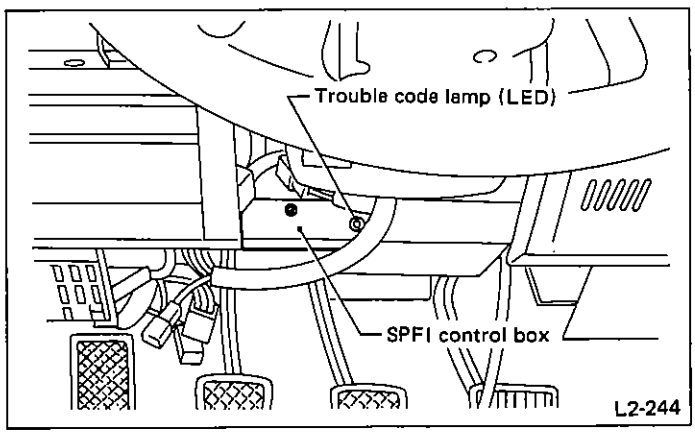


Fig. 32

SELF-DIAGNOSIS FUNCTION

The SPFI control unit executes the computational processing on the input information received from various sensors and produces the output information for driving the fuel injector, fuel pump, etc.

Along with this computational processing, it reads out all the input/output information to examine matching with the predetermined levels (proper values or ranges). If a predetermined level is not satisfied, i.e., a fault is found, the warning lamp is signaled to a driver. In this fashion, the self-diagnosis function is performed.

FAIL-SAFE FUNCTION

For the part which has been judged faulty in the self-diagnosis, the SPFI control unit generates the associated pseudo signal (only when convertible to electric signal) and carries out the computational processing. In this fashion, the fail-safe function is performed.

Function of Self-Diagnosis

The self-diagnosis function has four modes: U-check mode, Read memory mode, D-check mode and Clear memory mode. Two connectors (Read memory and Test mode) and two lamps (CHECK ENGINE light and O_2 monitor) are used. The connectors are for mode selection and the lamps monitor the type of problem.

RELATIONSHIP BETWEEN MODES AND CONNECTORS

Mode	Engine	Read memory connector	Test mode connector
U-check	Ignition ON	DISCONNECT	DISCONNECT
Read memory	Ignition ON	CONNECT	DISCONNECT
D-check	Ignition ON	DISCONNECT	CONNECT
Clear meory	Ignition ON (engine on)	CONNECT	CONNECT

U-CHECK MODE

The U-check is a user-oriented mode in which only the SPFI components necessary for start-up and drive are diagnosed. On occurrence of a fault, the warning lamp (CHECK ENGINE light) is lighted to indicate to the user that the dealer's inspection is necessary. The diagnosis of other parts which do not give significant adverse effect to start-up and drive are excluded from this mode in order to avoid unnecessary uneasiness to be taken by the user.

READ MEMORY MODE

This mode is used by the dealer to read the problems which have occurred in the past (even when the vehicle is brought in with the monitor lamps off). It is most effective in detecting poor contact or connections of connectors, harnesses, etc.

D-CHECK MODE

This mode is used by the dealer to check the entire SPFI system and detect faulty parts.

CLEAR MEMORY MODE

This mode is used by the dealer to clear the trouble code from the memory after the affected part is repaired.

Basic Operation of Self-diagnosis System

NO TROUBLE

O : CONNECT X : DISCONNECT

Engine	Read memory connector	Test mode connector	CHECK ENGINE light	O_2 monitor lamp	Remarks
ON	X	X	OFF	O_2 monitor	
ON	O	X	OFF	O_2 monitor	
*ON	X	O	** OFF → Blink	OFF	Vehicle specification code is outputted when CHECK ENGINE light is OFF.
*ON	O	O	OFF → Blink	OFF	All memory stored in control unit is cleared after CHECK ENGINE light blinks.
OFF (Ignition switch ON)	O	X	ON	Vehicle specification code	Before starting the engine, the self-diagnosis system assumes the engine to be in a NO TROUBLE condition.
OFF (Ignition switch ON)	X	X	ON	Vehicle specification code	
OFF (Ignition switch ON)	X	O	ON	Vehicle specification code	
OFF (Ignition switch ON)	O	O	ON	Vehicle specification code	

TROUBLE

Engine	Read memory connector	Test mode connector	CHECK ENGINE light	O_2 monitor lamp	Remarks
ON	X	X	ON	Trouble code	
ON	O	X	ON	Trouble code (memory)	
*ON	X	O	** OFF → ON	Trouble code	Vehicle specification code is outputted when CHECK ENGINE light is OFF.
*ON	O	O	OFF → ON	Trouble code	
OFF (Ignition switch ON)	O	X	ON	Trouble code (memory)	
STALL (Ignition switch ON)	X	X	ON	Trouble code	
STALL (Ignition switch ON)	X	O	ON	Trouble code	
STALL (Ignition switch ON)	O	O	ON	Trouble code	

***: Ignition timing is set to 20° BTDC (when the engine is on, test mode connector is connected, and idle switch is ON).**
****: CHECK ENGINE light remains off until engine is operated at speed greater than 2,000 rpm for at least 40 seconds.**

List of Trouble Codes

Trouble code	Item	Page
11	Crank angle sensor (No reference pulse)	p49
12	Starter switch (Continuously in ON or OFF position while cranking)	p51
13	Crank angle sensor (No position pulse)	p52
14	Fuel injector (Abnormal injector output)	p54
21	Water temperature sensor (Open or shorted circuit)	p55
23	Air flow meter (Open or shorted circuit)	p56
24	Air control valve (Open or shorted circuit)	p57
31	Throttle sensor (Open or shorted circuit)	p58
32	O_2 sensor (Abnormal sensor signal)	p59
33	Car-speed sensor (No signal is present during operation)	p60
34	EGR solenoid valve (Solenoid switch continuously in ON or OFF position, or *clogged EGR line)	p61
35	Purge control solenoid valve (Solenoid switch continuously in ON or OFF position)	p62
42	Idle switch (Abnormal idle switch signal in relation to throttle sensor output)	p63
45	Kick-down control relay (Continuously in ON or OFF position)	p64
51	Neutral switch (Continuously in ON position)	p65 or p66
*55	EGR gas temperature sensor (Open or short circuit)	p67
61	Parking switch (Continuously in ON position)	p68

***: California model only**

List of Specification Codes

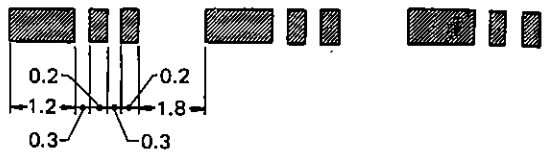
Specification codes	Specification
05	MT, Federal and Canada
06	MT, Cal
07	AT, Federal and Canada
08	AT, Cal

How to Read Trouble Codes (Flashing)

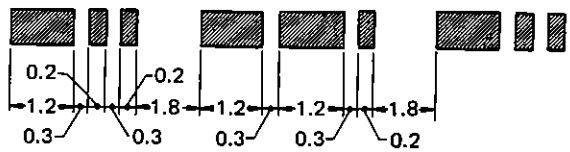
The O_2 monitor lamp flashes the code corresponding to the faulty part.
The long segment (1.2 sec on) indicates a "ten", and the short segment (0.2 sec on) signifies a "one".

Example:

When only one part has failed:
Flashing code 12
(unit: second)



When two or more parts have failed:
Flashing codes 12 and 21
(unit: second)



L2-848

Fig. 33

SPFI System Layout

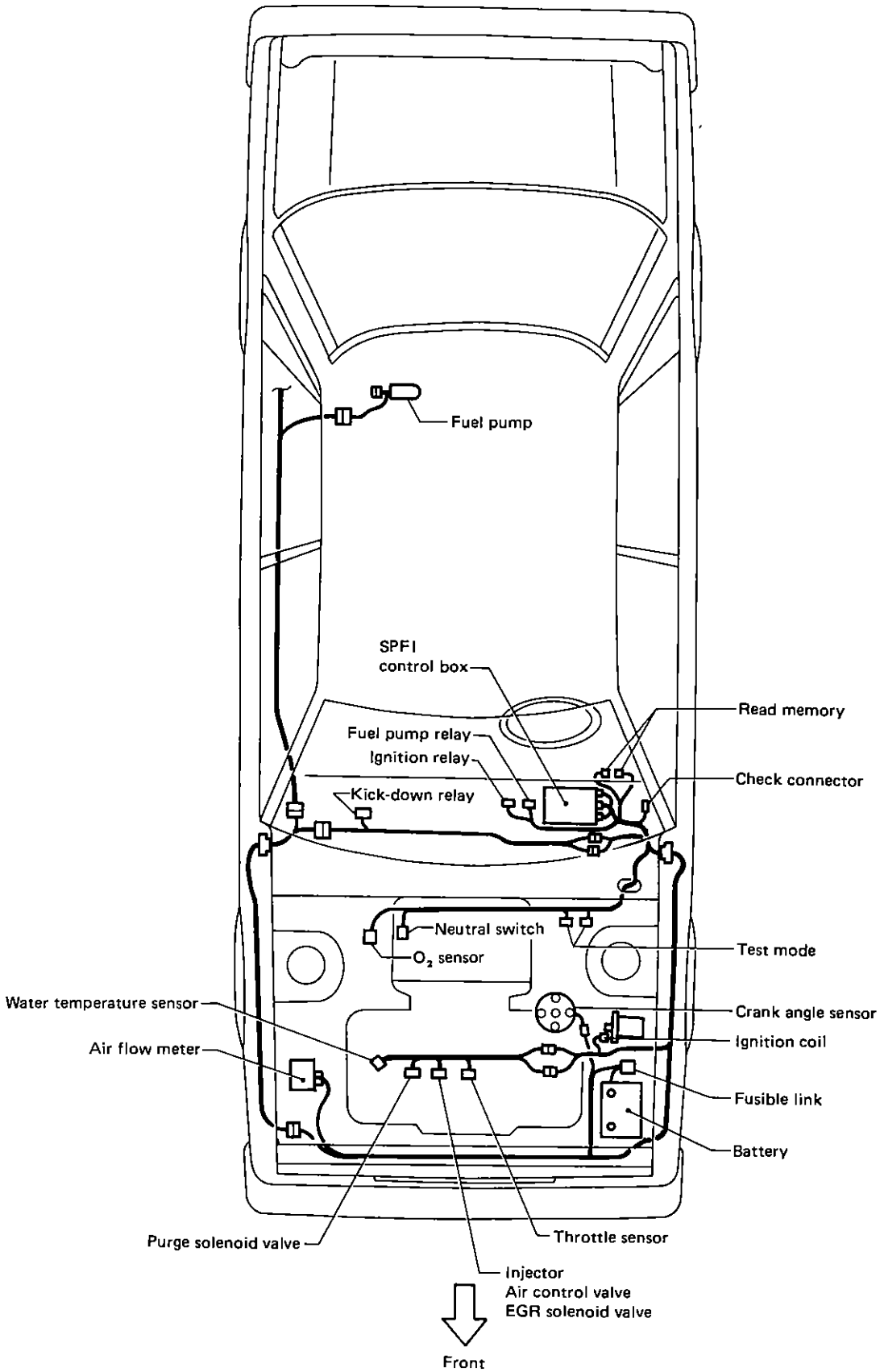


Fig. 35

L2-850

Connector Terminal

CONTROL UNIT CONNECTOR

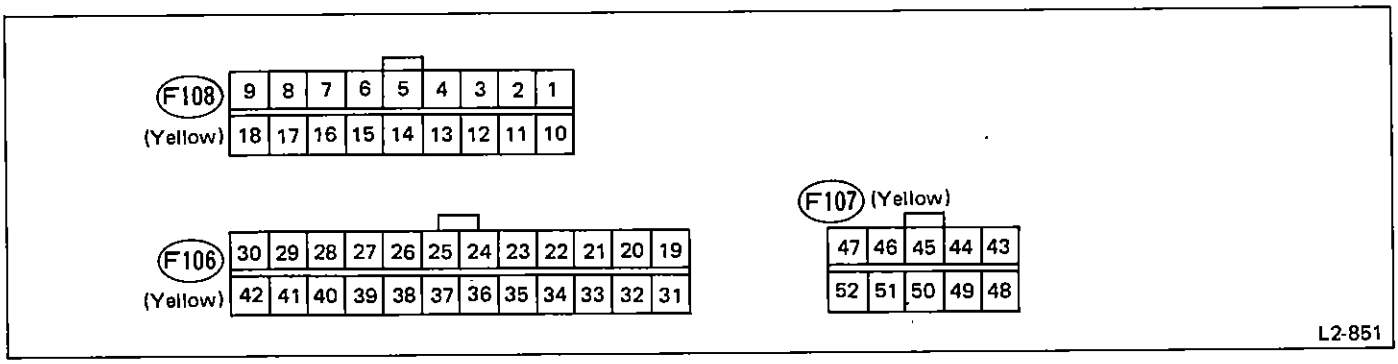
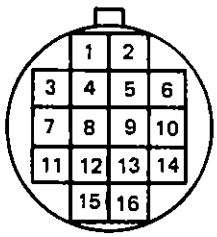


Fig. 36

1	LG	Kick-down control	27	BW	Power (input)
2	RL	CHECK ENGINE light	28	GW	Self-shutoff signal
3	R	Test 4	29	W	Power (input)
4	LR	EGR solenoid (control)	30	BR	GND
5	GL	Purge control solenoid	31	Br	Test mode connector (used at line end only)
6	LY	Air conditioner signal	32	BR	Test mode connector (used at line end only)
7	–	———	33	Lg	49-state/Cal identification
8	W	Air flow meter (signal)	34	SA	O_2 sensor
9	B	Air flow meter (GND)	35	B	GND
10	Y	Line end cord output	36	WR	EGR monitor
11	L	Line end cord output	37	LgR	Test mode connector (used at line end only)
12	RL	Line end cord output	38	RL	Ignition switch
13	YR	Inhibitor switch (AT models only)	39	LgW	Clear memory
14	YG	Neutral switch	40	–	———
15	YL	Parking switch (AT models only)	41	W	Power (input)
16	LgR	Kick-down monitor	42	BR	GND
17	R	Air flow meter power (output)	43	RW	Injector ⊕
18	LgY	Starter switch	44	BR	GND
19	GB	Crank angle sensor power (output)	45	GR	Air control valve
20	GY	Crank angle sensor signal (reference)	46	GY	A/C control
21	BW	Crank angle sensor signal (position)	47	LB	Fuel pump
22	YG	Car-speed sensor	48	RB	Injector ⊖
23	WB	Water temperature sensor	49	RL	Power (input)
24	LG	Idle switch	50	BY	GND
25	W	Throttle sensor (signal)	51	B	GND
26	R	Throttle sensor power (output)	52	WY	Ignition control

Intermediate connector I (body side) . . . (F41)

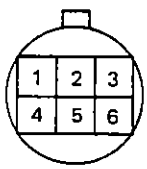


L2-912

Fig. 37

1	BR	Ground
2	YB	Oil pressure (to combination meter)
3	–	———
4	YG	Thermometer (to combination meter)
5	B	Injector ⊖
6	B	Shield
7	LG	Idle switch
8	–	———
9	R	Throttle sensor (power)
10	W	Injector ⊕
11	BY	Ground
12	W	Throttle sensor (signal)
13	B	Ground
14	B	Ground
15	RL	Power supply
16	BR	Ground

Intermediate connector II (body side) . . . (F42) (Black)



L2-853

Fig. 38

1	GR	Air control valve (control)
2	Lg	Identification of specifications
3	GL	Purge solenoid (control)
4	WR	EGR gas temperature sensor
5	LR	EGR solenoid (control)
6	WB	Water temperature signal

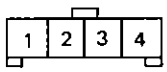
Air control valve connector . . . (E10) (Black)

L2-854

Fig. 39

1	W	Air control valve control
2	BW	IG power supply

Air flow meter connector . . . (F20) (Black)

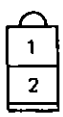


L2-855

Fig. 40

1	–	———
2	R	Air flow meter power supply
3	B	Ground
4	W	Air flow meter signal

Purge solenoid valve connector . . . (E13) (Black)

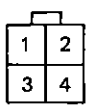


L2-856

Fig. 41

1	GL	Canistor solenoid valve control
2	BW	IG power supply

Crank angle sensor connector . . . (F93)



L2-1511

Fig. 42

1	GB	Power supply
2	GY	Ref. sign
3	BW	Pos. sign
4	B	Ground

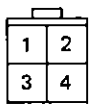
EGR solenoid valve connector . . . (E11)

L2-858

Fig. 43

1	LR	EGR solenoid valve control
2	BW	IG power supply

Fuel pump relay connector . . . (F78) (Blue)



L2-859

Fig. 44

1	BW	IG power supply
2	BW	IG power supply
3	LB	Fuel pump control
4	LW	Fuel pump

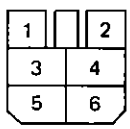
Ignition coil connector . . . (F43) (Black)

L2-1571

Fig. 45

1	BW	IG power supply
2	WY	Ignition coil control

Ignition relay connector . . . (F79) (Brown)

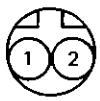


L2-861

Fig. 46

1	GW	Self shutoff control
2	B	Ground
3	R	Battery ⊕
4	BW	Battery ⊕
5	RL	(Injector) power supply
6	W	SPFI control unit power supply

Injector connector . . . (E9) (Black)

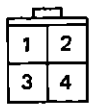


L2-862

Fig. 47

1	RB	Injector ⊖
2	RW	Injector ⊕

KD relay connector . . . (i48)



L2-859

Fig. 48

1	BW	IG power supply
2	BW	IG power supply
3	LG	SPFI C/U (for KD control)
4	L	KD solenoid

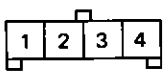
Neutral switch connector (MT) . . . (F56)

L2-854

Fig. 49

1	BR	Ground
2	YG	Neutral signal

Throttle sensor connector . . . (E8) (Black)



L2-865

Fig. 50

1	R	Battery ⊕
2	G	Throttle position signal
3	B	Ground
4	LG	Idle switch signal

Water temperature sensor . . . (E12) (Black)

L2-1572

Fig. 51

1	BR	Ground
2	WB	Water temperature signal

EGR gas temperature sensor . . . (F34)

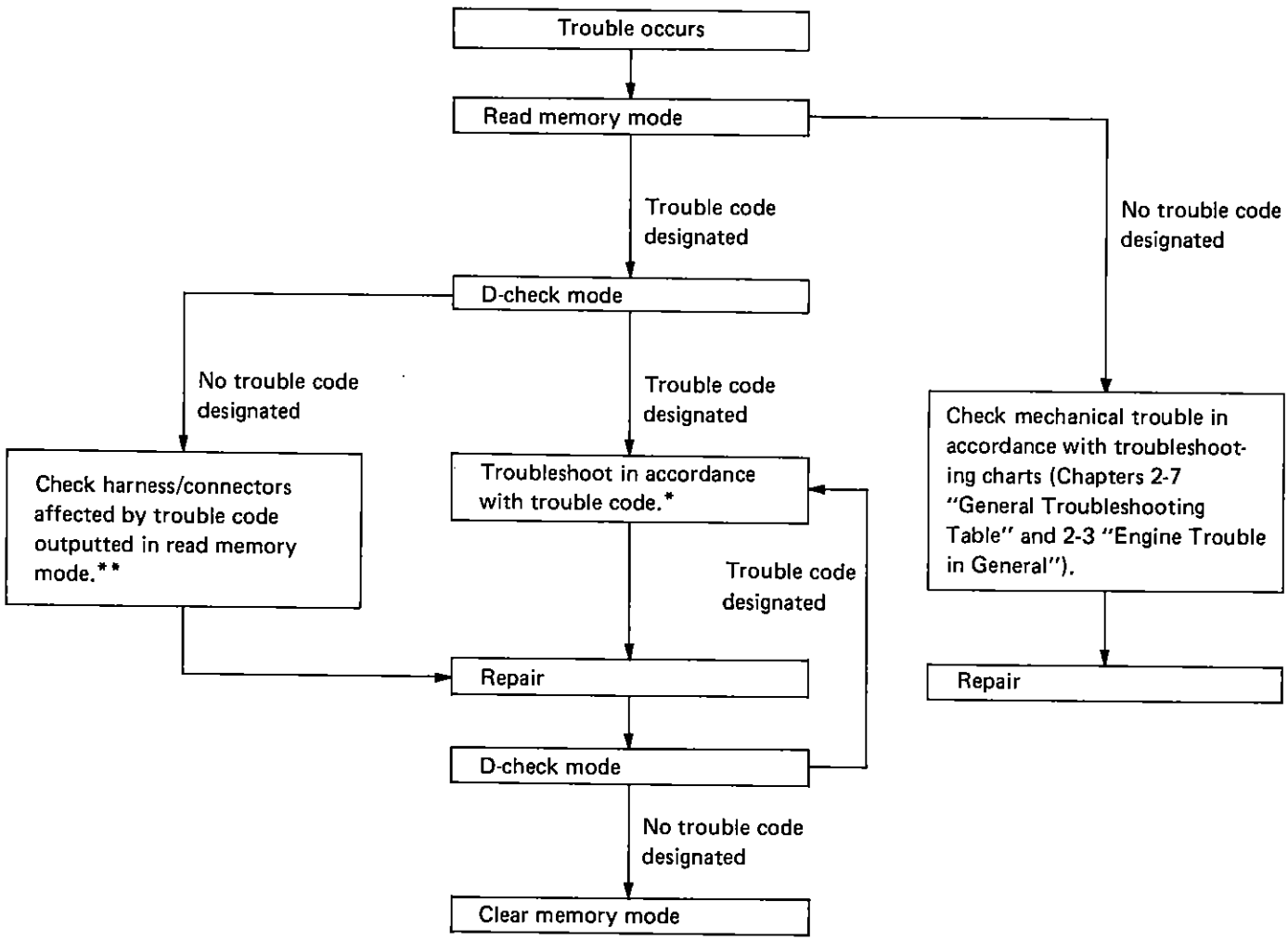
L2-862

Fig. 52

1	WR	EGR gas temperature signal
2	B	Ground

Troubleshooting Chart for Self-diagnosis System

Basic Troubleshooting Procedures



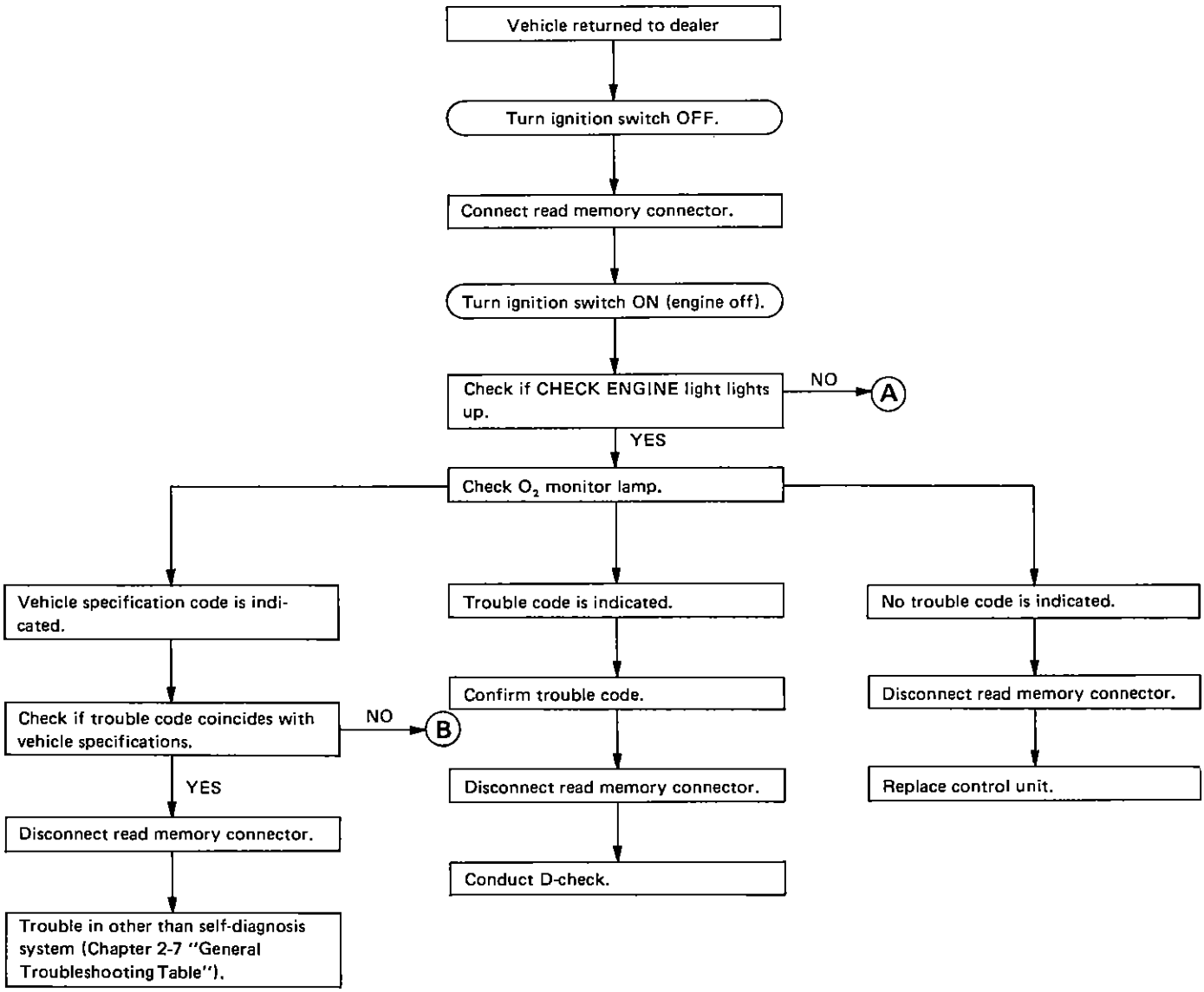
*: When more than one trouble code is outputted, begin troubleshooting with the smallest trouble code number and proceed to the next higher code.
After correcting each problem, conduct the D-check and ensure that the corresponding trouble code no longer appears.

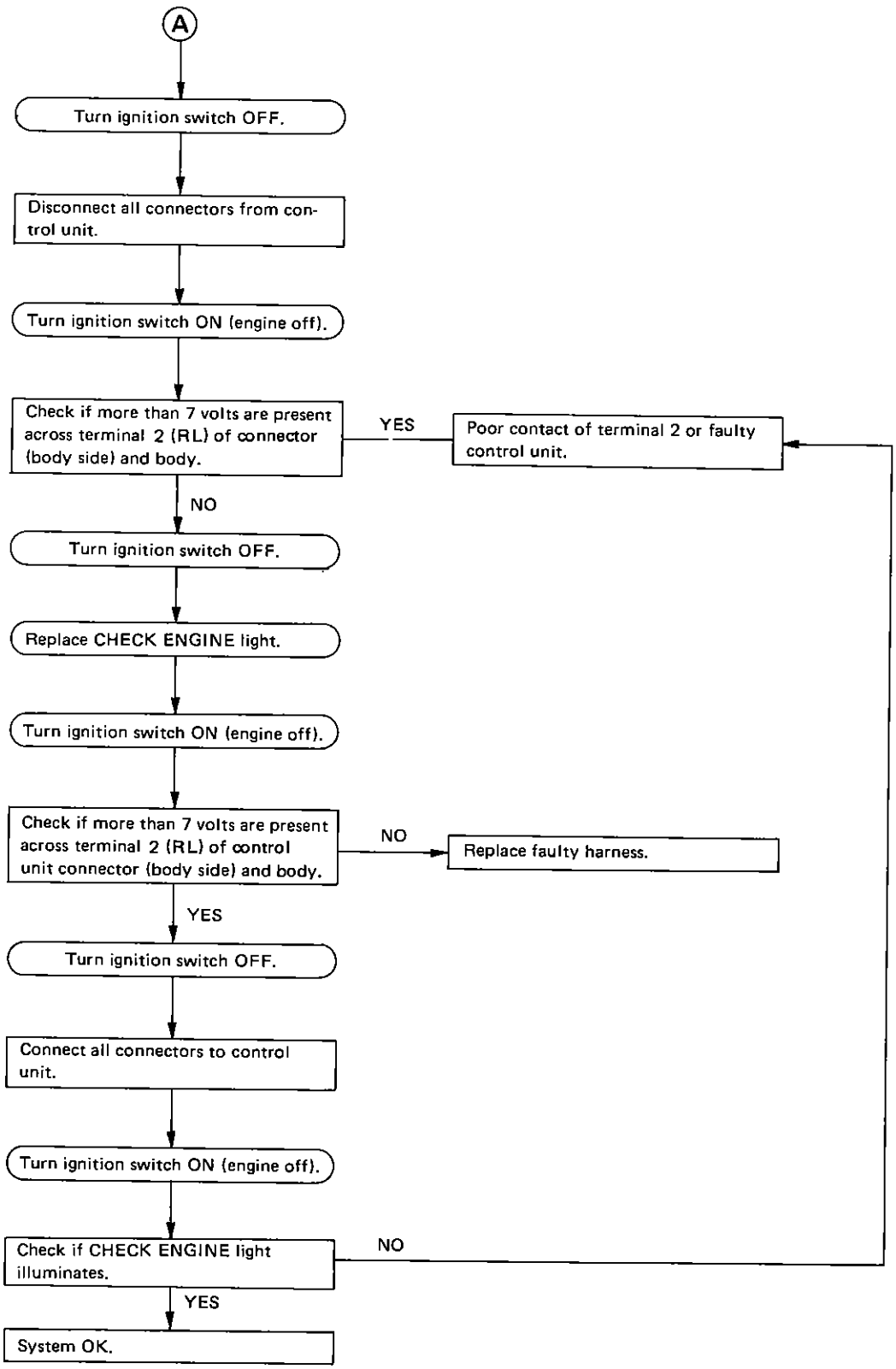
**: When more than one trouble code is outputted, check all related harness connectors, starting with that corresponding to the smallest trouble code number and proceeding to the next higher code.

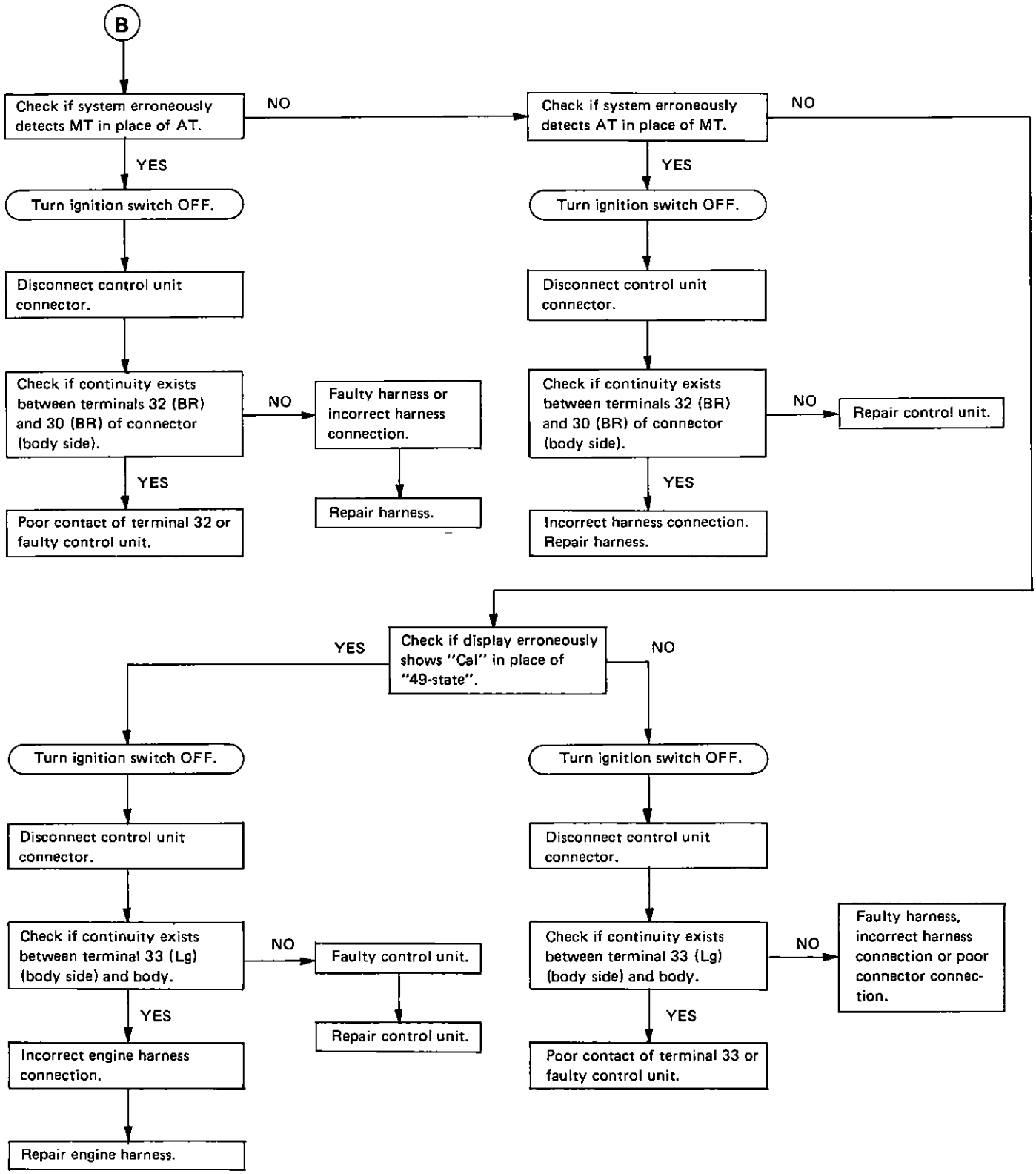
a. Check the connector while it is connected unless specified otherwise.
b. Be sure to check again from the beginning in order to prevent secondary trouble caused by repair work.
c. When checking with the vacuum hose disconnected from the vacuum switch at E/G on, be sure to plug the hose.

READ MEMORY MODE

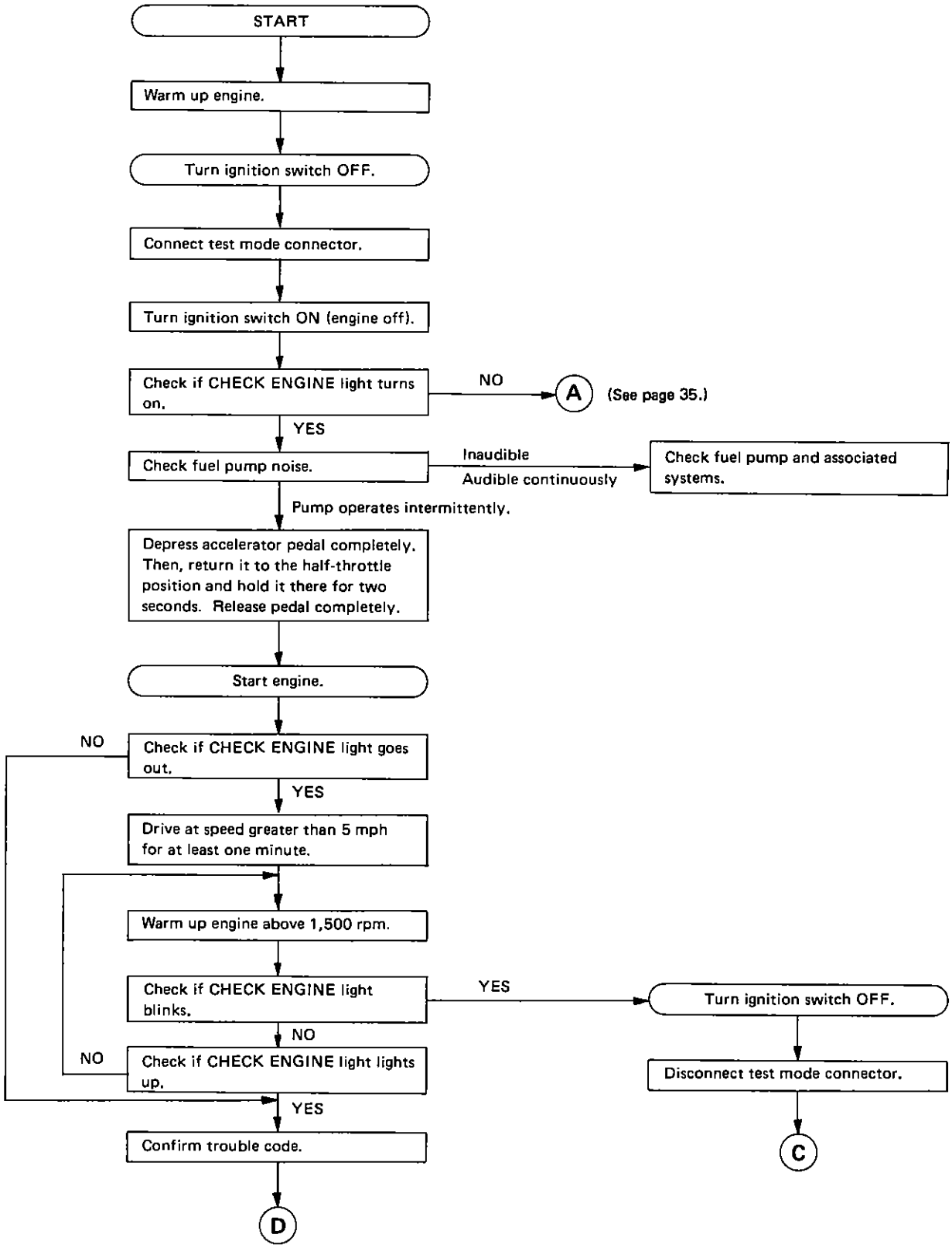
WHEN VEHICLE IS RETURNED TO DEALER BECAUSE CHECK ENGINE LIGHT LIGHTS UP

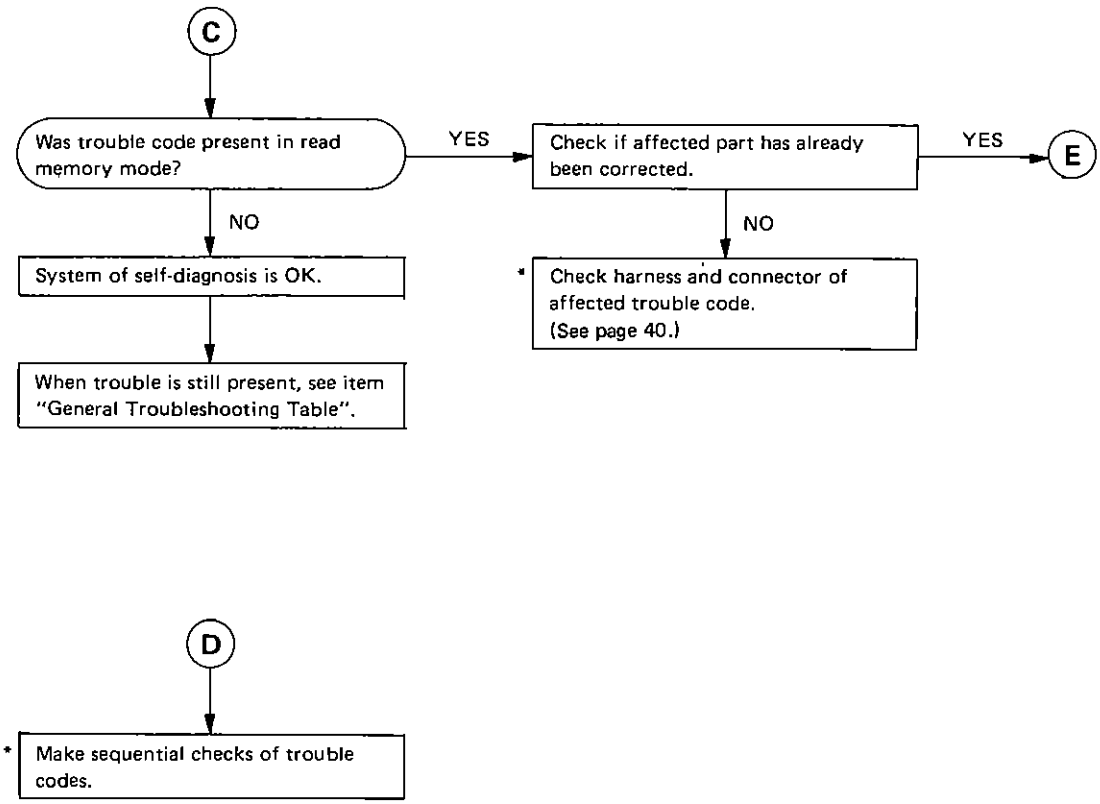



A
Turn ignition switch OFF.
Disconnect all connectors from control unit.
Turn ignition switch ON (engine off).
Check if more than 7 volts are present across terminal 2 (RL) of connector (body side) and body.
YES
Poor contact of terminal 2 or faulty control unit.
NO
Turn ignition switch OFF.
Replace CHECK ENGINE light.
Turn ignition switch ON (engine off).
Check if more than 7 volts are present across terminal 2 (RL) of control unit connector (body side) and body.
NO
Replace faulty harness.
YES
Turn ignition switch OFF.
Connect all connectors to control unit.
Turn ignition switch ON (engine off).
Check if CHECK ENGINE light illuminates.
NO
YES
System OK.


B
Check if system erroneously detects MT in place of AT.
NO
Check if system erroneously detects AT in place of MT.
NO
YES
Turn ignition switch OFF.
Disconnect control unit connector.
Check if continuity exists between terminals 32 (BR) and 30 (BR) of connector (body side).
NO
Faulty harness or incorrect harness connection.
Repair harness.
YES
Poor contact of terminal 32 or faulty control unit.
Check if continuity exists between terminals 32 (BR) and 30 (BR) of connector (body side).
NO
Repair control unit.
YES
Incorrect harness connection. Repair harness.
Check if display erroneously shows "Cal" in place of "49-state".
YES
NO
Turn ignition switch OFF.
Disconnect control unit connector.
Check if continuity exists between terminal 33 (Lg) (body side) and body.
NO
Faulty control unit.
Repair control unit.
YES
Incorrect engine harness connection.
Repair engine harness.
Turn ignition switch OFF.
Disconnect control unit connector.
Check if continuity exists between terminal 33 (Lg) (body side) and body.
NO
Faulty harness, incorrect harness connection or poor connector connection.
YES
Poor contact of terminal 33 or faulty control unit.

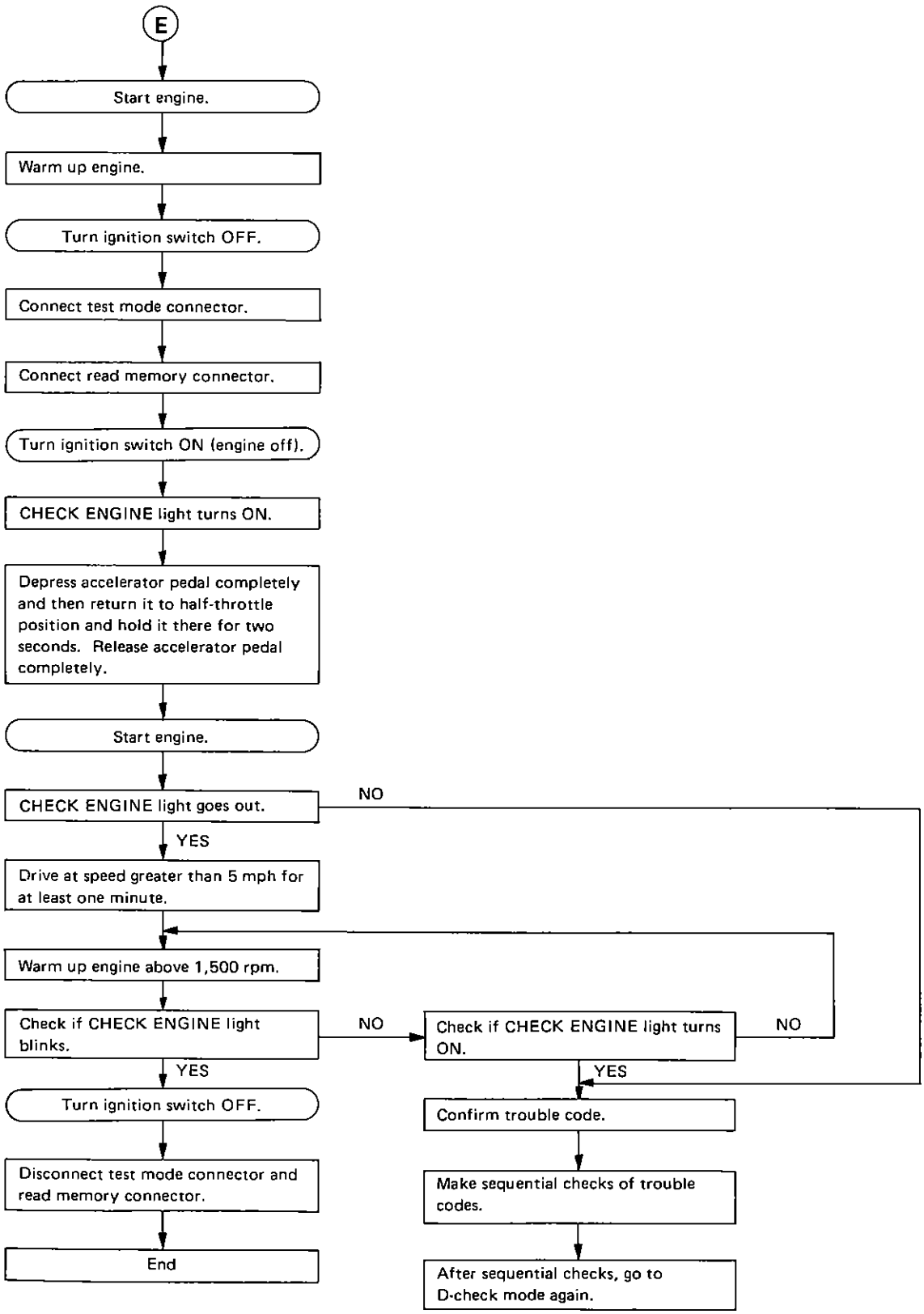
D-CHECK MODE


START
Warm up engine.
Turn ignition switch OFF.
Connect test mode connector.
Turn ignition switch ON (engine off).
Check if CHECK ENGINE light turns on.
NO
A
(See page 35.)
YES
Check fuel pump noise.
Inaudible
Audible continuously
Check fuel pump and associated systems.
Pump operates intermittently.
Depress accelerator pedal completely. Then, return it to the half-throttle position and hold it there for two seconds. Release pedal completely.
Start engine.
NO
Check if CHECK ENGINE light goes out.
YES
Drive at speed greater than 5 mph for at least one minute.
Warm up engine above 1,500 rpm.
Check if CHECK ENGINE light blinks.
YES
Turn ignition switch OFF.
NO
NO
Check if CHECK ENGINE light lights up.
Disconnect test mode connector.
YES
Confirm trouble code.
C
D



***: When more than one trouble code is outputted, sequentially check the trouble codes, starting with the smallest code number. After correcting each trouble, reconduct D-check and make sure the corresponding trouble code is no longer present.**

CLEAR MEMORY MODE



Checking Harnesses and Connectors Related to Trouble Codes

When a trouble code is outputted in the read memory mode but not in the D-check mode, check the affected harness and connector terminal as described below.

CHECKING TERMINALS OF CONTROL UNIT CONNECTOR (BODY SIDE)

1) When terminals are not locked securely, insert into connectors until they lock.

2) When terminals are considered to be open:
   (1) Method of judging "OK" and "Faulty":
   a. Pull out the terminal from the connector (body side).
   b. Insert this terminal (female) into the terminal (male) of the connector (control unit).
   c. Check "pull" force required to disconnect the female terminal from the male terminal.
   If the terminal is loose, it is considered to be faulty.
   (2) When terminals are faulty:
   Pinch the terminal using a pair of nose pliers. If the terminal is still loose, replace it or the harness ASSY.

SYMPTOMS RESULTING FROM POOR CONTACT OF CONTROL UNIT CONNECTOR TERMINALS AND RELATED TROUBLE CODES

Terminal No.	Lead color	Trouble code	Symptom affected by poor terminal contact	At instantaneous poor contact
1	LG	45	Kick-down no longer occurs.	Shocks occur during kick-down.
2	RL	–	When ignition is ON (engine off), O_2 sensor monitor lamp remains off.	No shocks occur.
3	R	–	When ignition is ON (engine on), O_2 sensor monitor lamp remains off.	No shocks occur.
4	LR	34	EGR solenoid fails to operate.	Shocks rarely occur.
5	GL	35	Purge control solenoid fails to operate.	Shocks rarely occur.
6	LY	–	Idle speed does not increase when air conditioning system turns on.	Idle speed decreases slightly when air conditioning system turns on.
8	W	23	Shock is felt at instantaneous poor contact.	
9	B	23	Same as above.	
14	YG	51	Idle speed is erroneous.	
15	YL	61	Same as above.	
16	LgR	45	Shock is not felt.	
17	R	23	Shock is felt at instantaneous poor contact.	
18	LgY	12	Starter does not start. When instantaneous poor contact occurs shock is rarely felt.	
19	GB	11	Engine stalls. Shock is felt and tachometer indication goes down.	
20	GY	11	Same as above.	
21	BW	13	Same as above.	

Terminal No.	Lead color	Trouble code	Symptom affected by poor terminal contact
22	YG	33	Shock is not felt.
23	WB	21	While engine is cold, idle speed is erroneous and shock is felt.
24	LG	42	While idling engine, speed is erroneous.
25	W	31	Shock is rarely felt and acceleration is poor.
26	R	31	Same as above.
28	GW	–	Restarting ability is poor and shock is not felt.
29	W	–	Shock is not felt.
30	BR	–	Same as above.
31	Br	–	Same as above.
32	BR	–	Same as above.
33	Lg	–	Same as above.
34	SA	–	Same as above.
35	B	–	Same as above.
36	WR	34	Same as above.
38	RL	–	Same as above.
39	LgW	–	Same as above.
41	W	–	Same as above.
42	BR	–	Same as above.
43	RW	14	Engine stalls and shock is felt.
44	BR	14	Same as above.
45	GR	24	Engine speed decreases.
46	GY	–	Air conditioning system does not turn off though the throttle valve is opened fully.
47	LB	–	Engine lacks power, engine stalls, shock is felt.
48	RB	14	Engine stalls and shock is felt.
49	RL	–	Slight shock is felt at instantaneous poor contact.
51	B	34	Speed decreases and engine stalls. Shock is felt.
52	WY	–	Engine misfires. When engine stops, shock is felt and tachometer indication goes down.

Troubleshooting for Engine Starting Failure

1. GROUND & CONTROL UNIT POWER SUPPLY

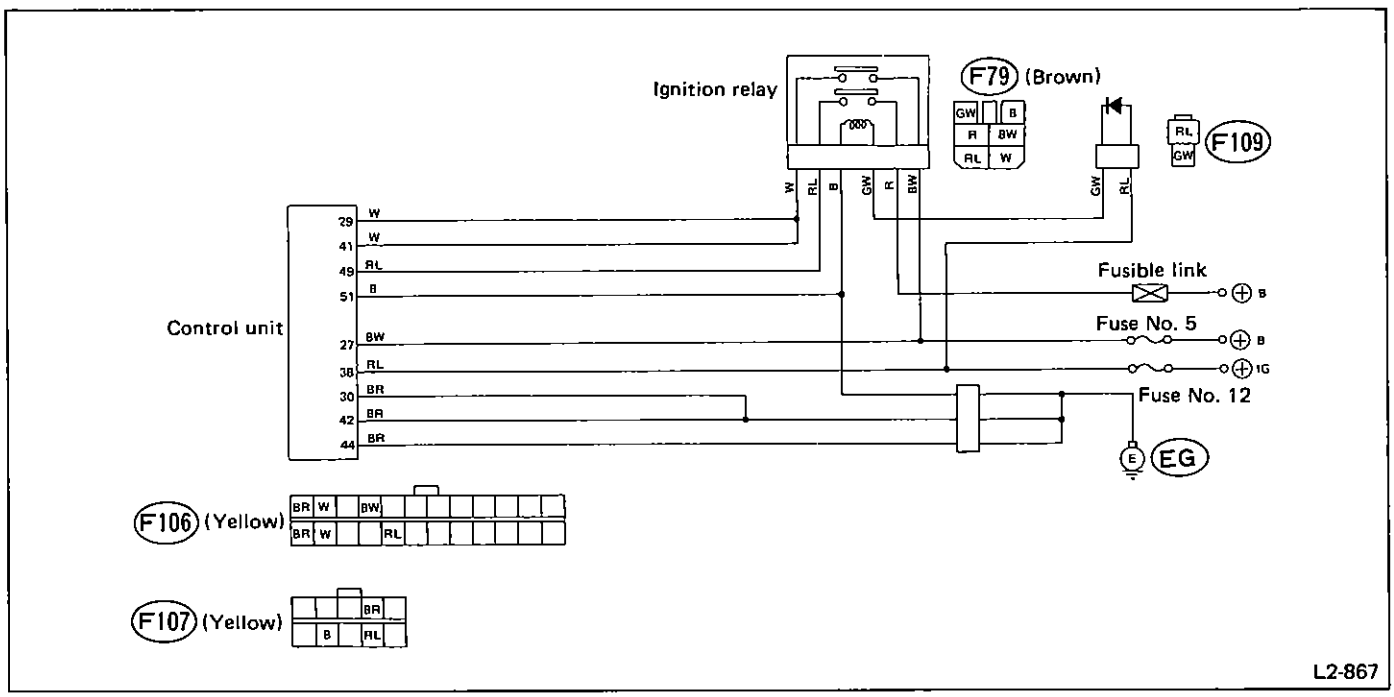
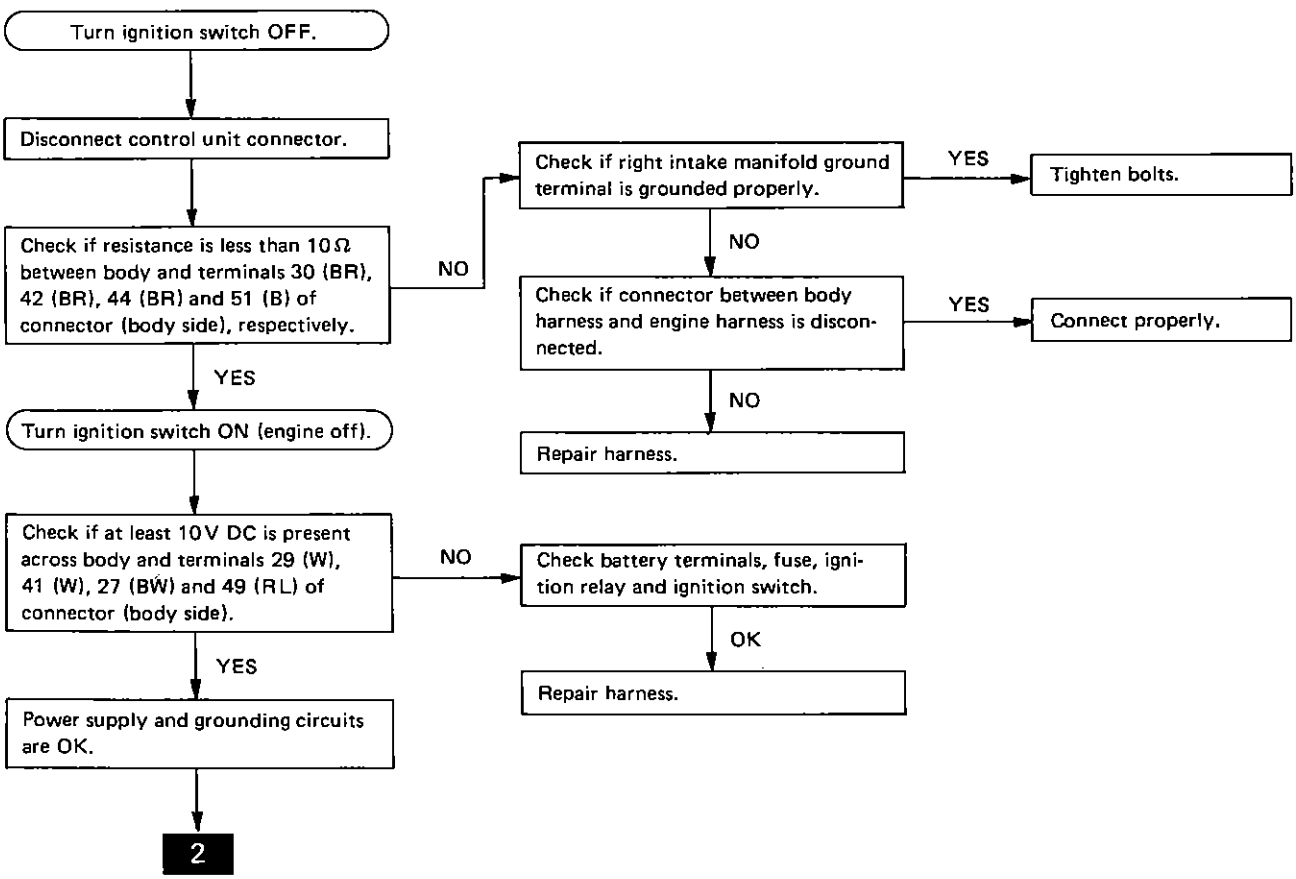


Fig. 53



2. IGNITION CONTROL SYSTEM

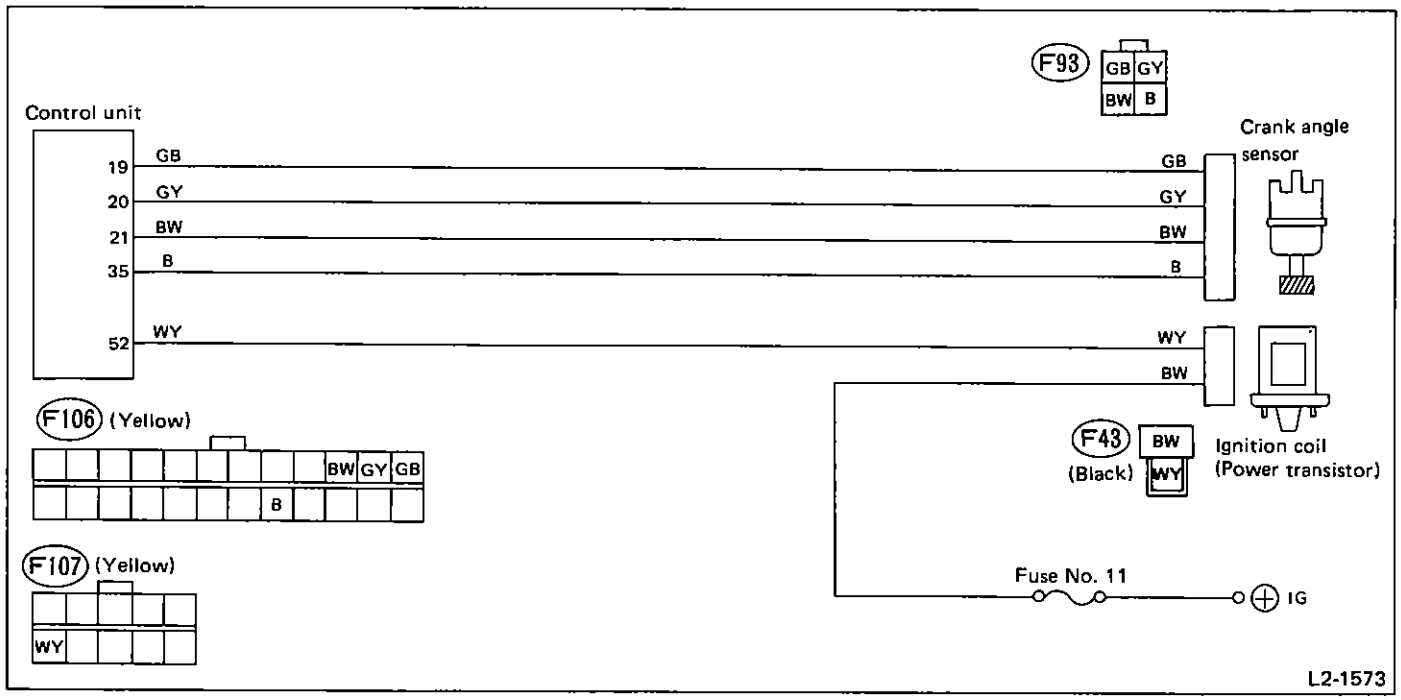
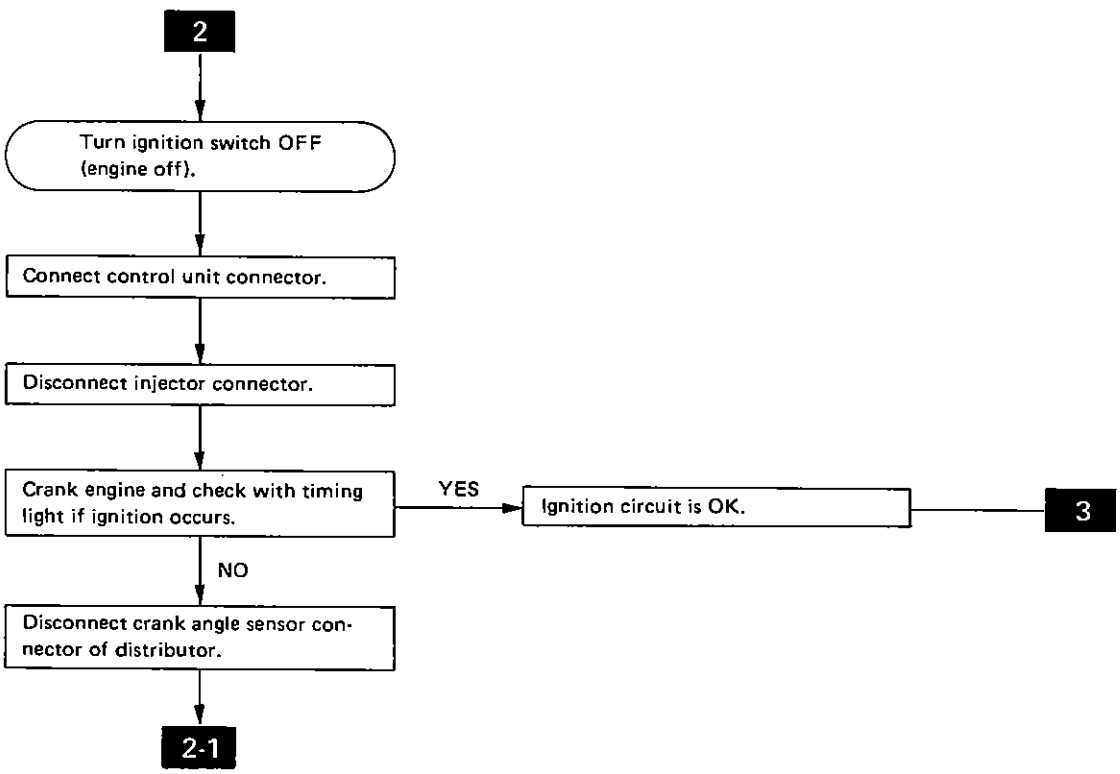
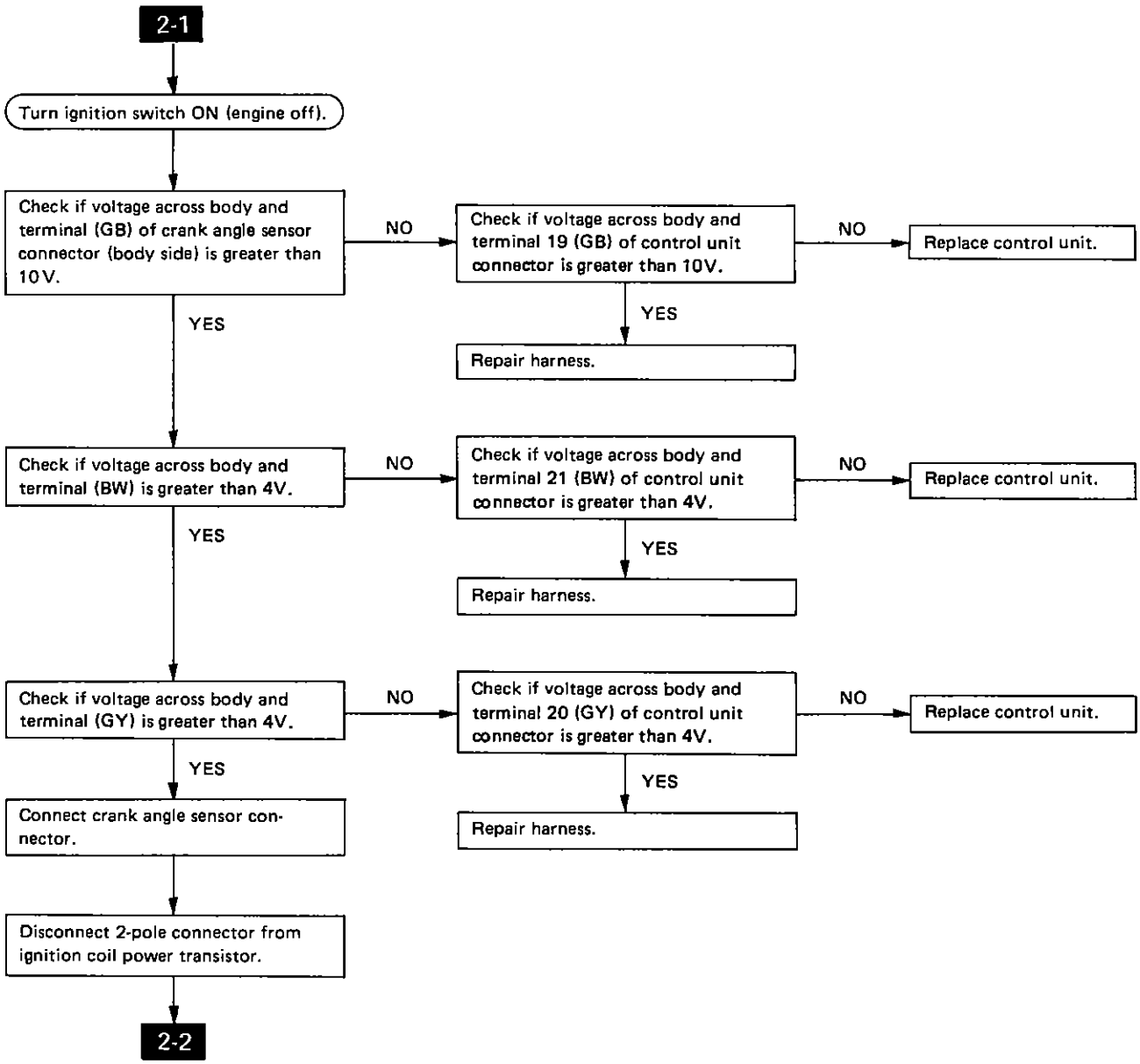
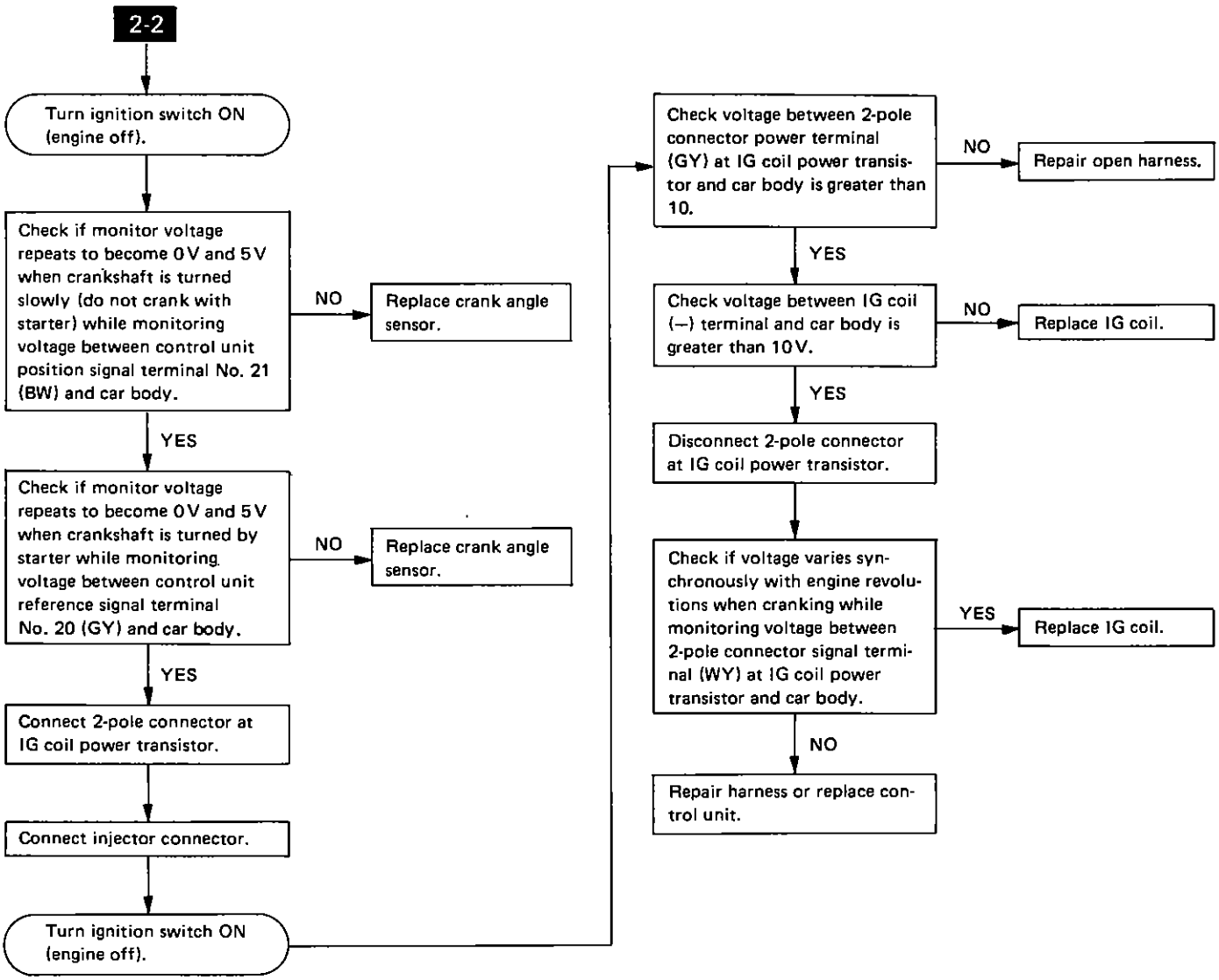


Fig. 54




2-1
Turn ignition switch ON (engine off).
Check if voltage across body and terminal (GB) of crank angle sensor connector (body side) is greater than 10V.
NO
Check if voltage across body and terminal 19 (GB) of control unit connector is greater than 10V.
NO
Replace control unit.
YES
Repair harness.
YES
Check if voltage across body and terminal (BW) is greater than 4V.
NO
Check if voltage across body and terminal 21 (BW) of control unit connector is greater than 4V.
NO
Replace control unit.
YES
Repair harness.
YES
Check if voltage across body and terminal (GY) is greater than 4V.
NO
Check if voltage across body and terminal 20 (GY) of control unit connector is greater than 4V.
NO
Replace control unit.
YES
Repair harness.
YES
Connect crank angle sensor connector.
Disconnect 2-pole connector from ignition coil power transistor.
2-2


2-2
Turn ignition switch ON (engine off).
Check if monitor voltage repeats to become 0 V and 5 V when crankshaft is turned slowly (do not crank with starter) while monitoring voltage between control unit position signal terminal No. 21 (BW) and car body.
NO
Replace crank angle sensor.
YES
Check if monitor voltage repeats to become 0 V and 5 V when crankshaft is turned by starter while monitoring voltage between control unit reference signal terminal No. 20 (GY) and car body.
NO
Replace crank angle sensor.
YES
Connect 2-pole connector at IG coil power transistor.
Connect injector connector.
Turn ignition switch ON (engine off).
Check voltage between 2-pole connector power terminal (GY) at IG coil power transistor and car body is greater than 10.
NO
Repair open harness.
YES
Check voltage between IG coil (–) terminal and car body is greater than 10 V.
NO
Replace IG coil.
YES
Disconnect 2-pole connector at IG coil power transistor.
Check if voltage varies synchronously with engine revolutions when cranking while monitoring voltage between 2-pole connector signal terminal (WY) at IG coil power transistor and car body.
YES
Replace IG coil.
NO
Repair harness or replace control unit.

3. FUEL PUMP (F/P) CIRCUIT

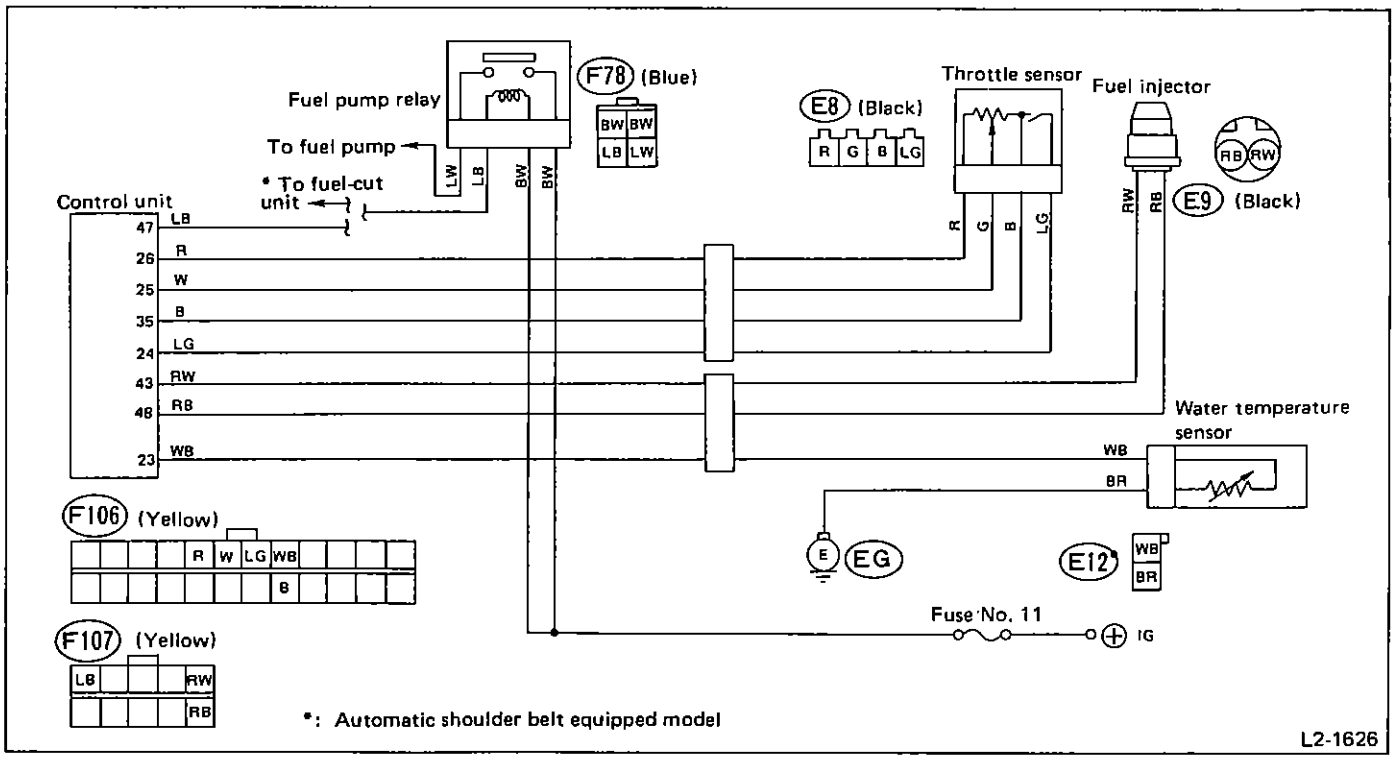
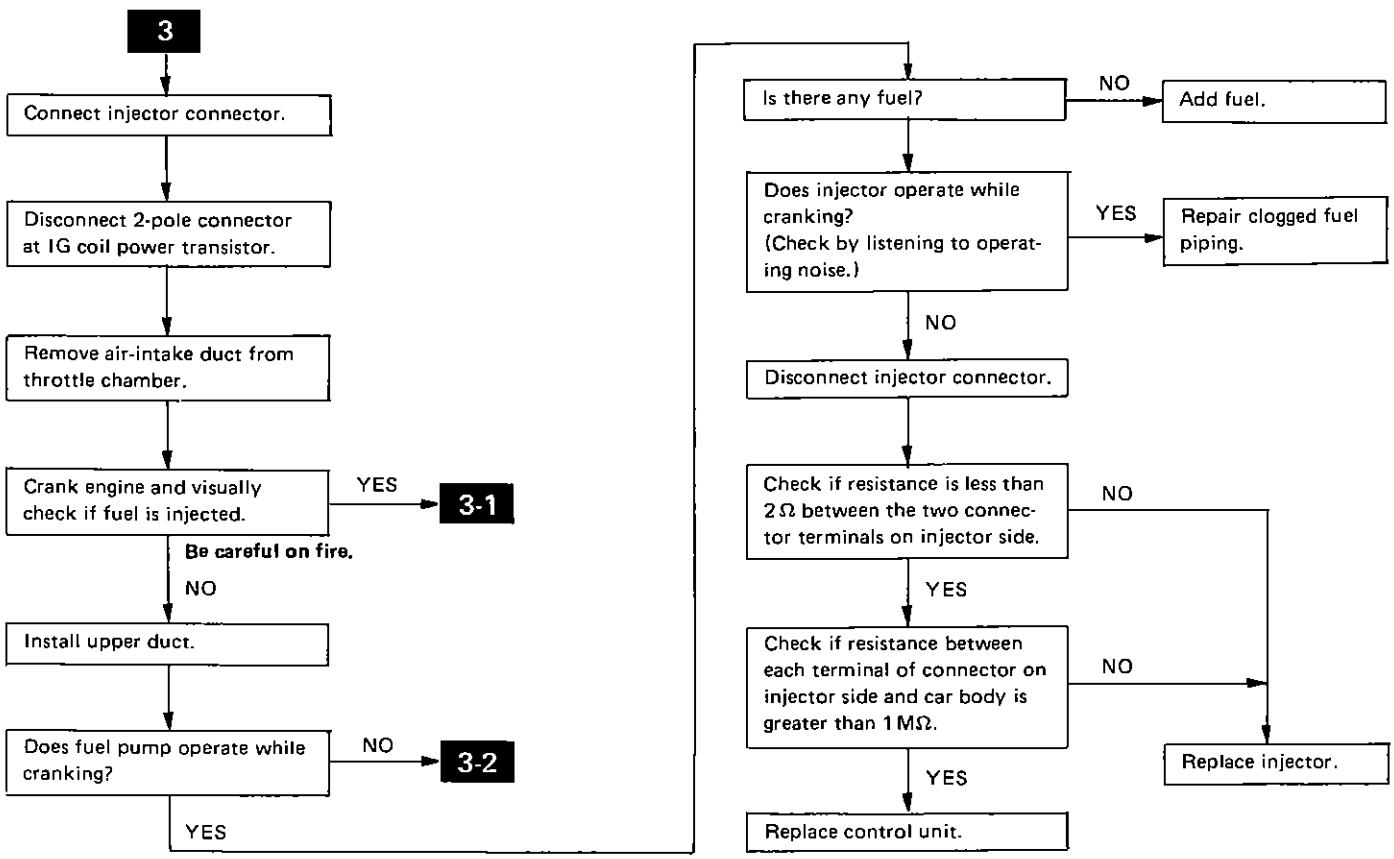
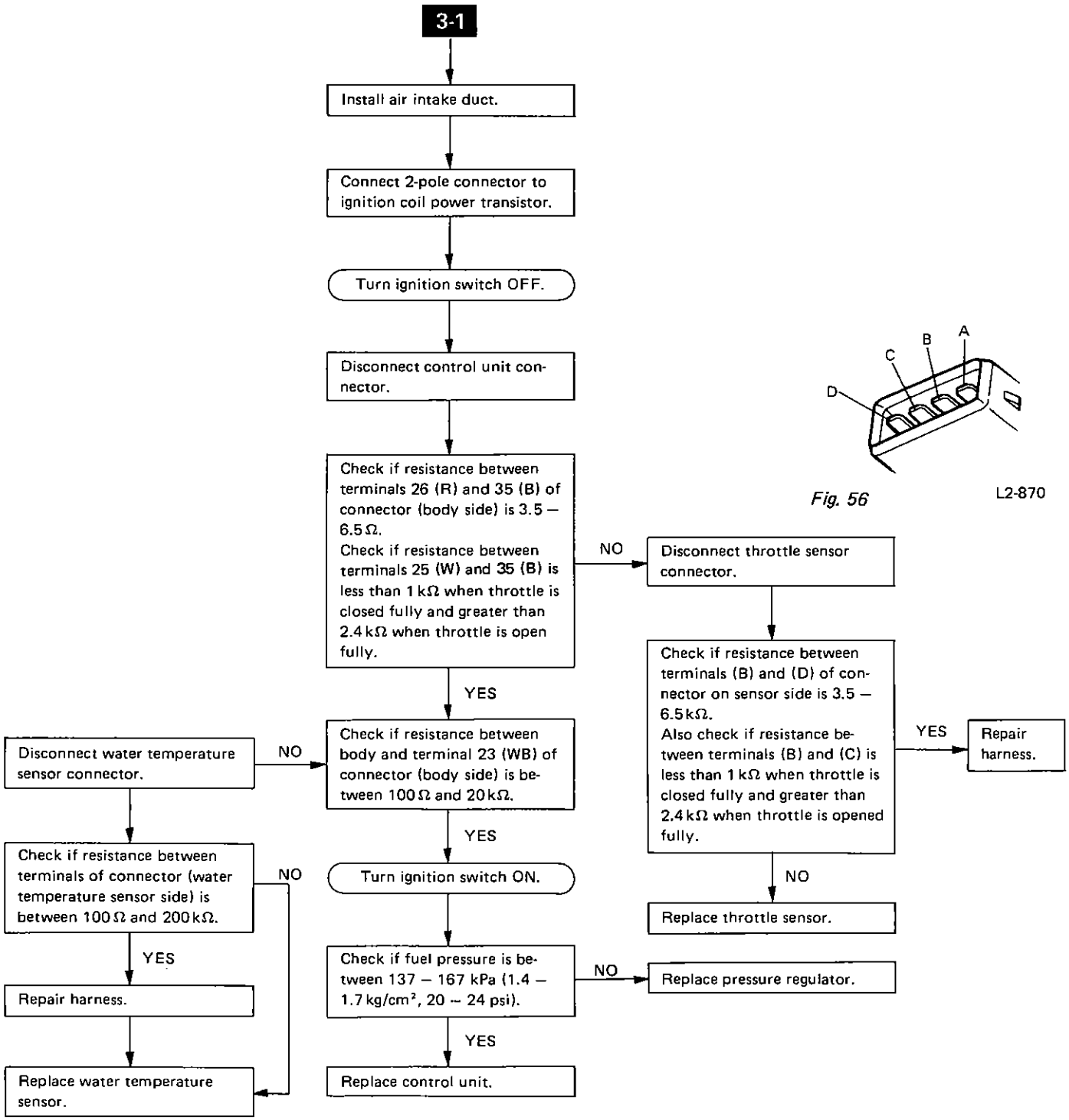


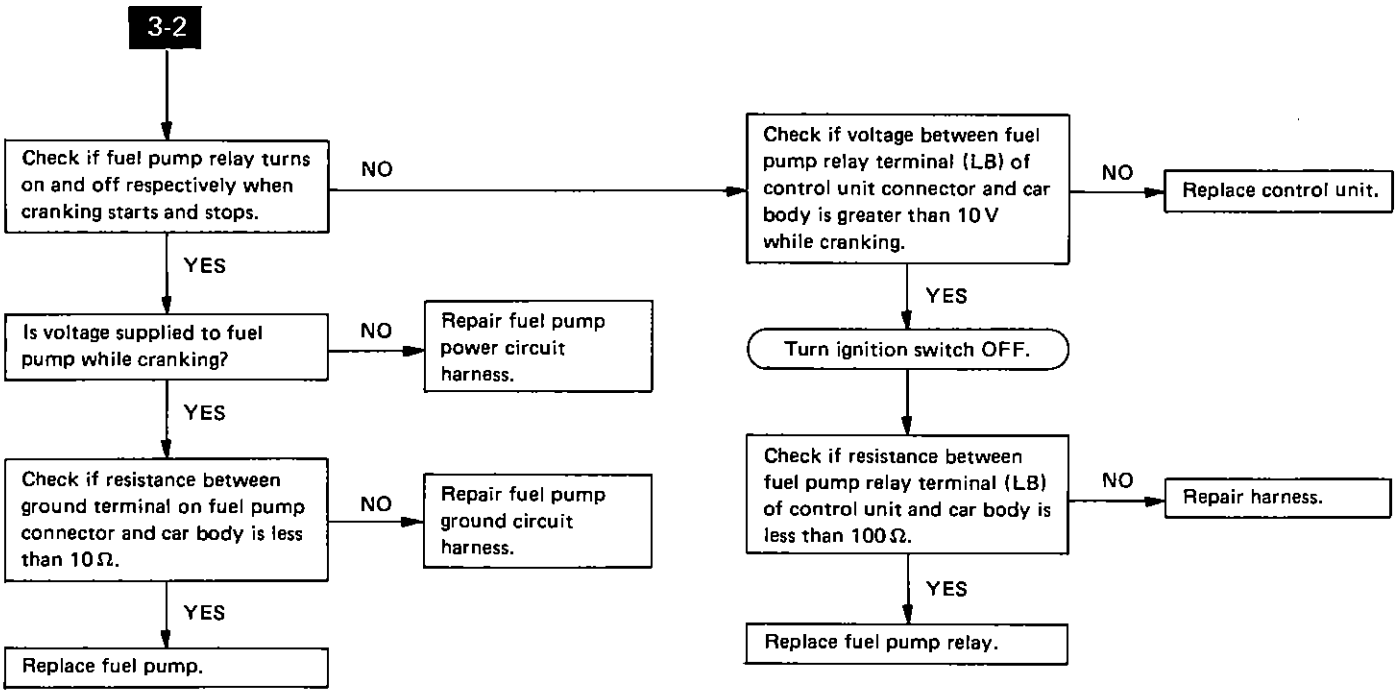
Fig. 55




3-1
Install air intake duct.
Connect 2-pole connector to ignition coil power transistor.
Turn ignition switch OFF.
Disconnect control unit connector.
Check if resistance between terminals 26 (R) and 35 (B) of connector (body side) is 3.5 – 6.5 Ω.
Check if resistance between terminals 25 (W) and 35 (B) is less than 1 kΩ when throttle is closed fully and greater than 2.4 kΩ when throttle is open fully.
NO
Disconnect throttle sensor connector.
Check if resistance between terminals (B) and (D) of connector on sensor side is 3.5 – 6.5 kΩ.
Also check if resistance between terminals (B) and (C) is less than 1 kΩ when throttle is closed fully and greater than 2.4 kΩ when throttle is opened fully.
YES
Repair harness.
NO
Replace throttle sensor.
YES
Check if resistance between body and terminal 23 (WB) of connector (body side) is between 100 Ω and 20 kΩ.
NO
Disconnect water temperature sensor connector.
Check if resistance between terminals of connector (water temperature sensor side) is between 100 Ω and 200 kΩ.
NO
YES
Repair harness.
Replace water temperature sensor.
YES
Turn ignition switch ON.
Check if fuel pressure is between 137 – 167 kPa (1.4 – 1.7 kg/cm², 20 – 24 psi).
NO
Replace pressure regulator.
YES
Replace control unit.

A
B
C
D

Fig. 56 L2-870


3-2
Check if fuel pump relay turns on and off respectively when cranking starts and stops.
NO
YES
Is voltage supplied to fuel pump while cranking?
NO
Repair fuel pump power circuit harness.
YES
Check if resistance between ground terminal on fuel pump connector and car body is less than 10Ω.
NO
Repair fuel pump ground circuit harness.
YES
Replace fuel pump.
Check if voltage between fuel pump relay terminal (LB) of control unit connector and car body is greater than 10V while cranking.
NO
Replace control unit.
YES
Turn ignition switch OFF.
Check if resistance between fuel pump relay terminal (LB) of control unit and car body is less than 100Ω.
NO
Repair harness.
YES
Replace fuel pump relay.

TROUBLE CODE (11): CRANK ANGLE SENSOR

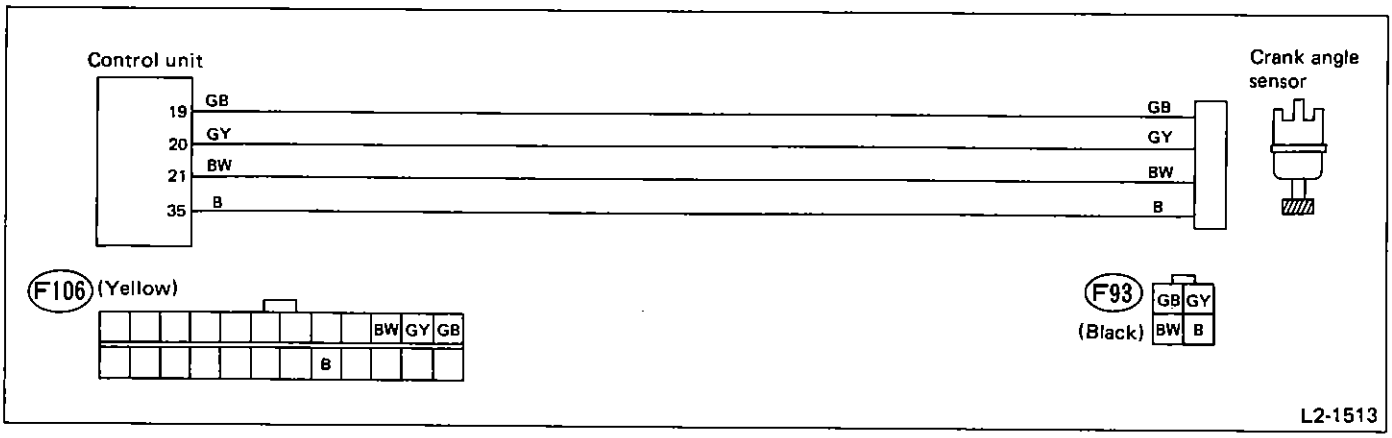
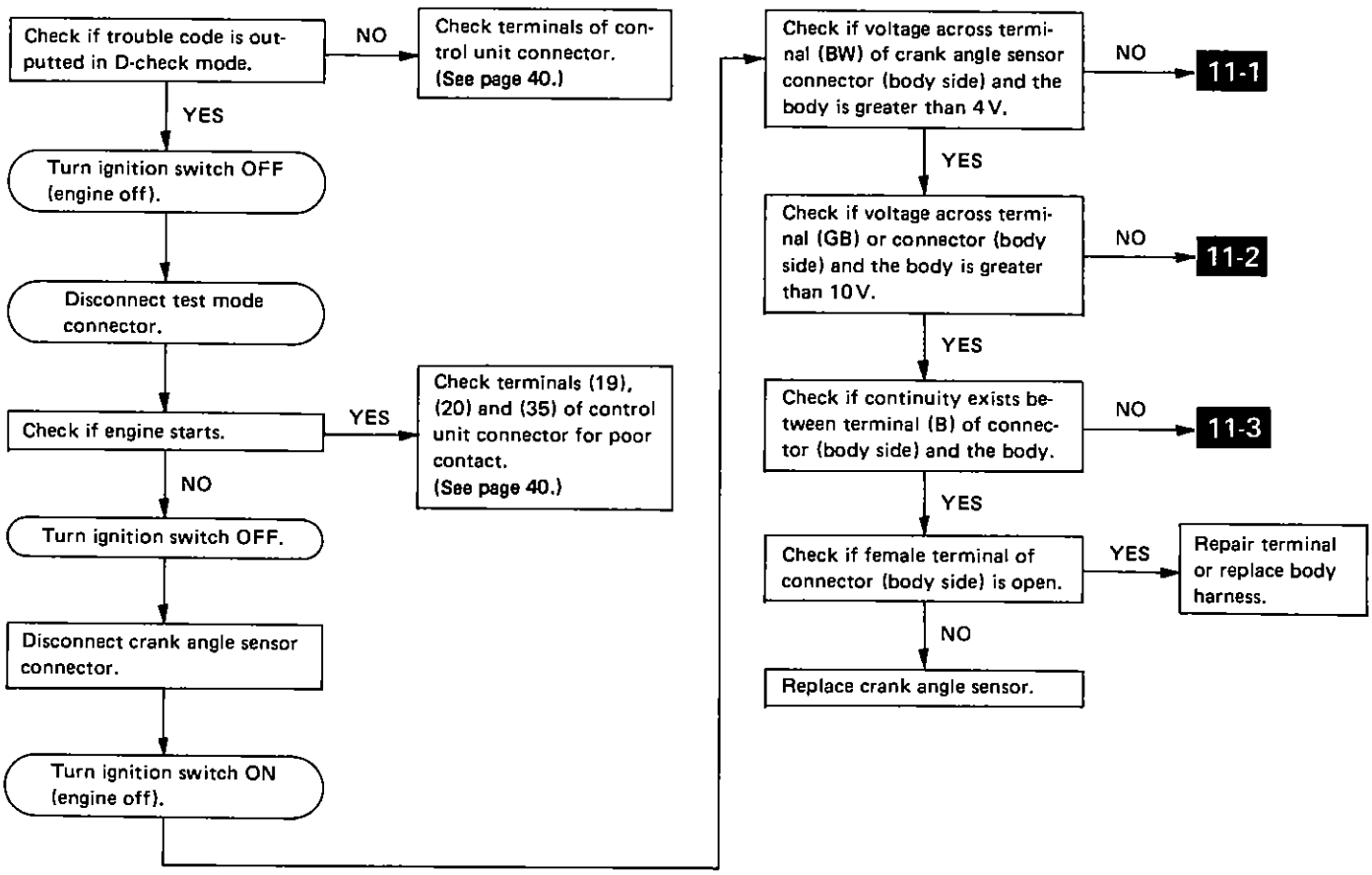
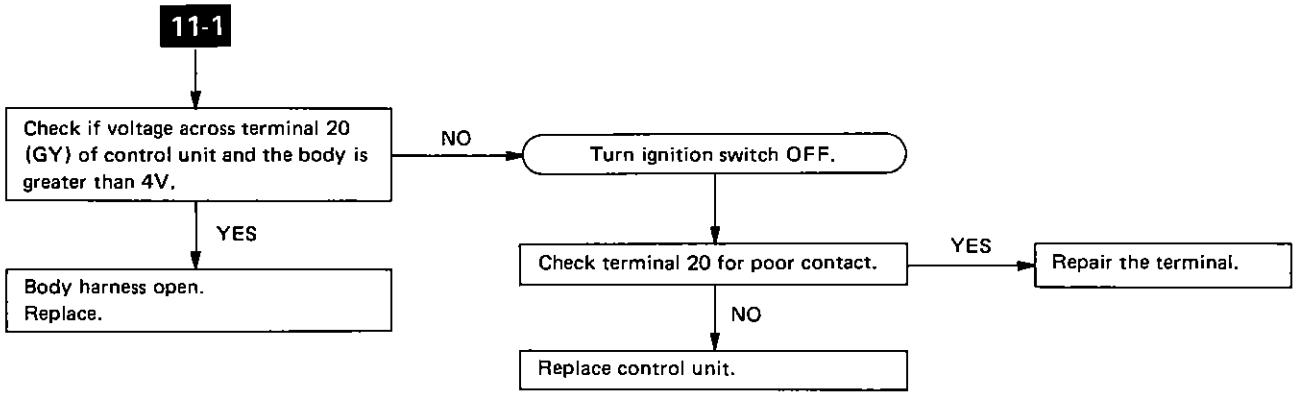
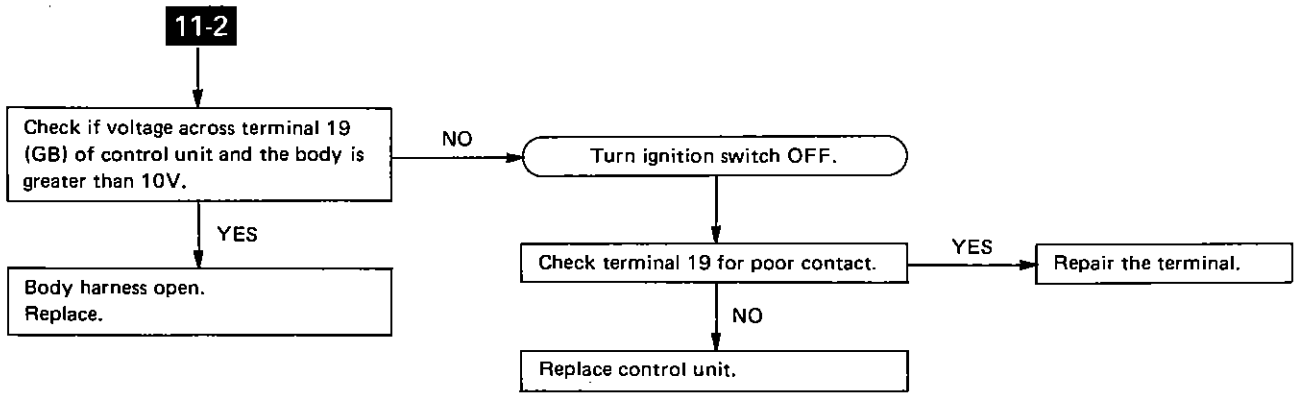
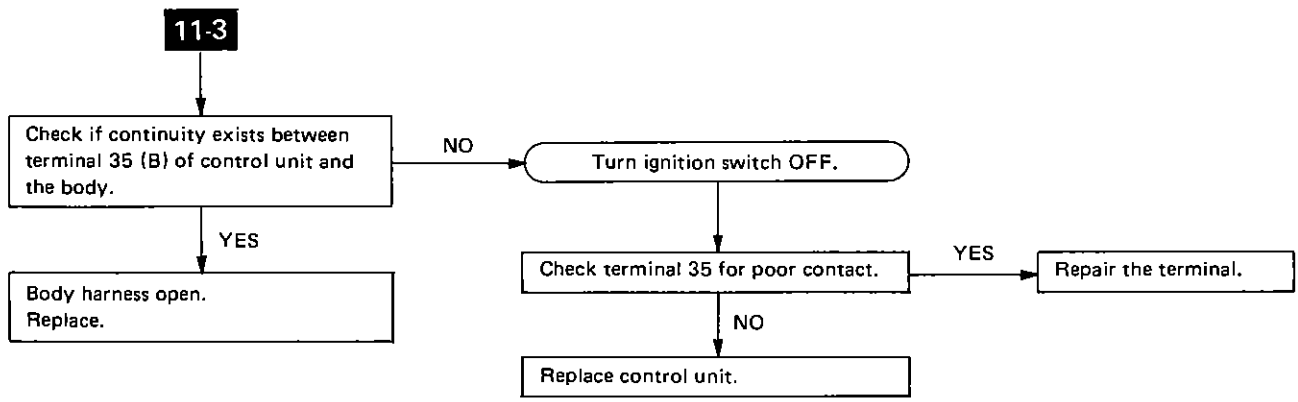


Fig. 57




11-1
Check if voltage across terminal 20 (GY) of control unit and the body is greater than 4V.
NO
Turn ignition switch OFF.
YES
Body harness open. Replace.
Check terminal 20 for poor contact.
YES
Repair the terminal.
NO
Replace control unit.


11-2
Check if voltage across terminal 19 (GB) of control unit and the body is greater than 10V.
NO
Turn ignition switch OFF.
YES
Body harness open. Replace.
Check terminal 19 for poor contact.
YES
Repair the terminal.
NO
Replace control unit.


11-3
Check if continuity exists between terminal 35 (B) of control unit and the body.
NO
Turn ignition switch OFF.
YES
Body harness open. Replace.
Check terminal 35 for poor contact.
YES
Repair the terminal.
NO
Replace control unit.

TROUBLE CODE (12): STARTER SWITCH

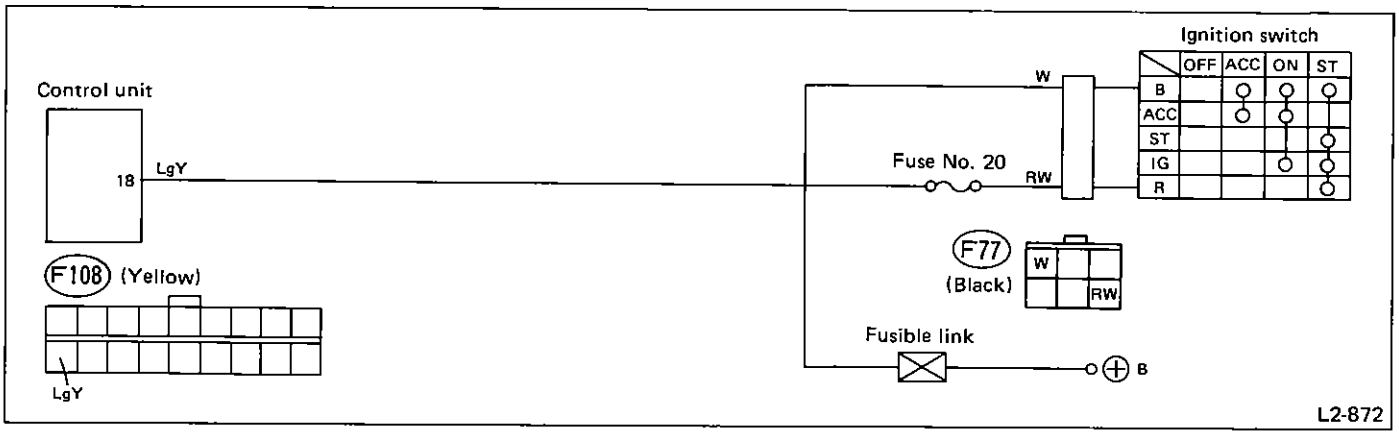
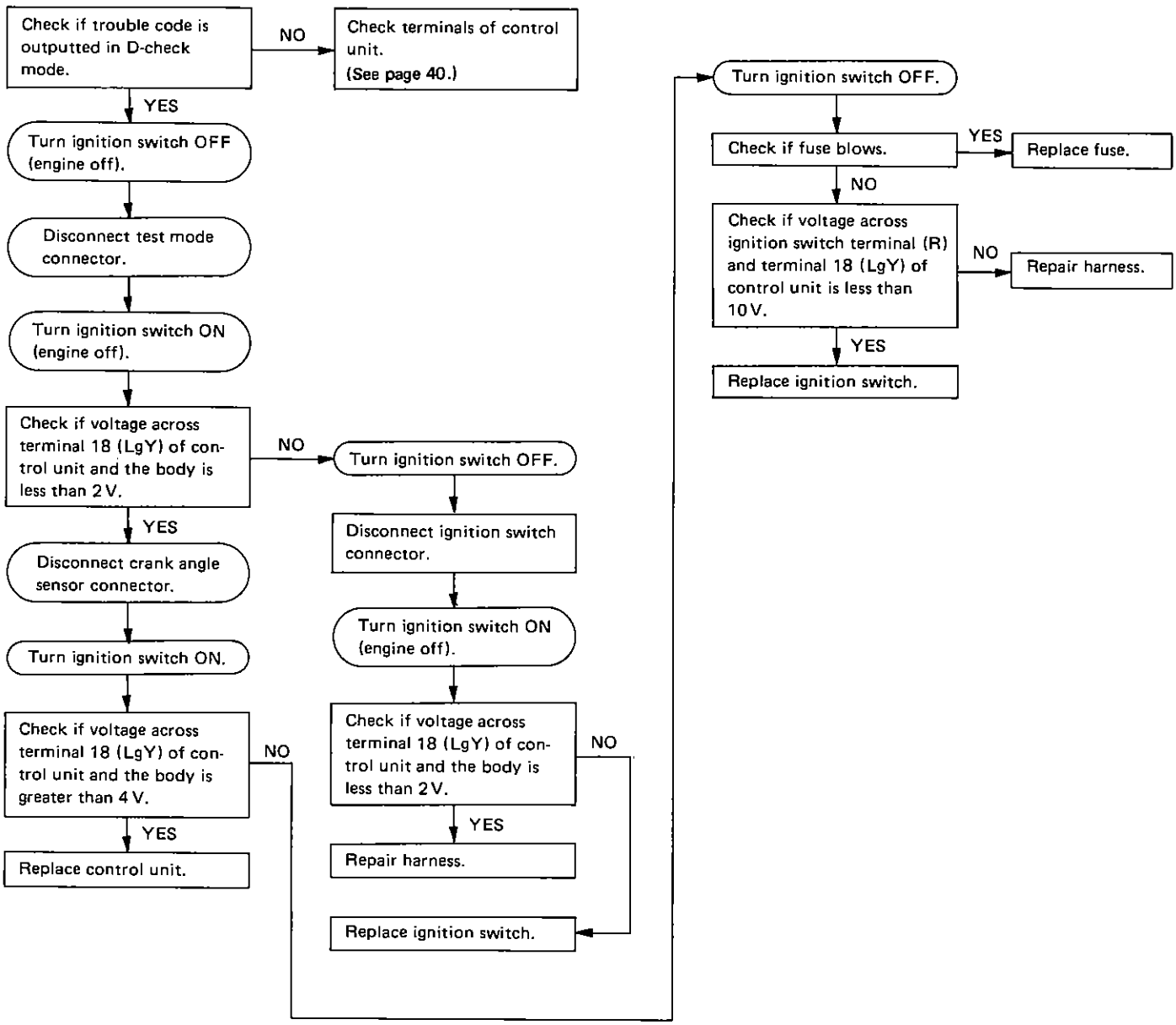


Fig. 58



TROUBLE CODE (13): CRANK ANGLE SENSOR

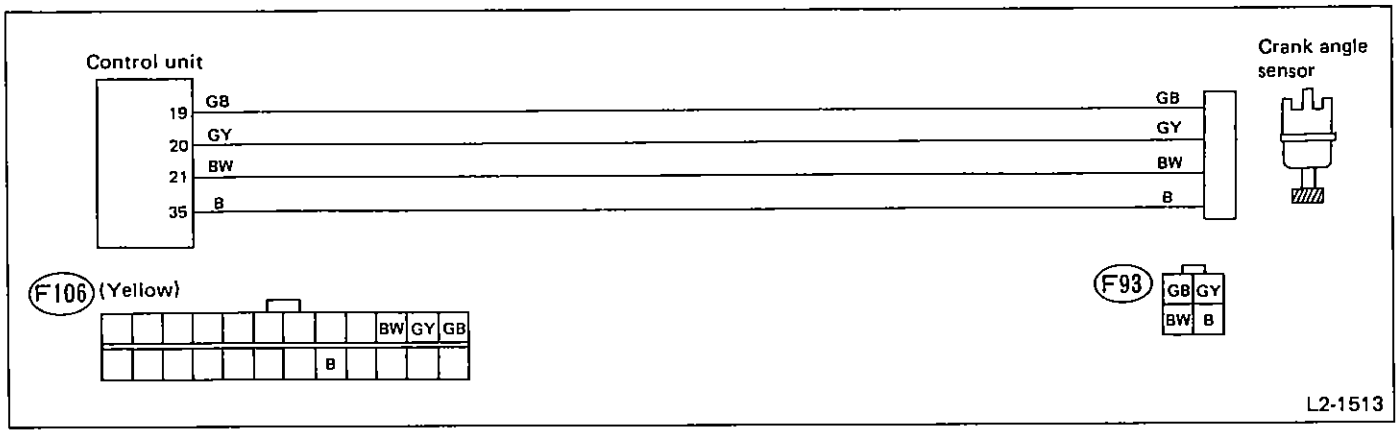
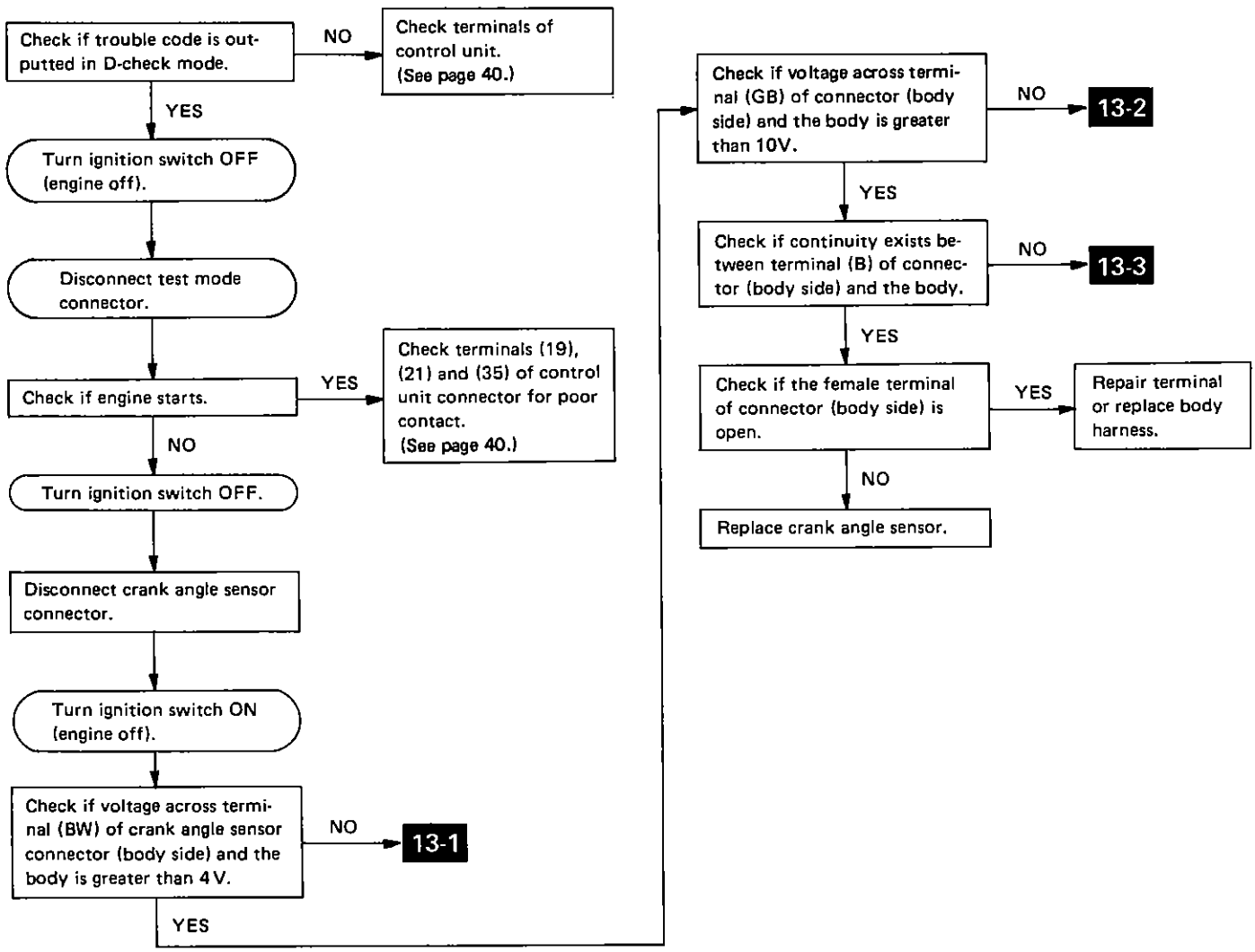
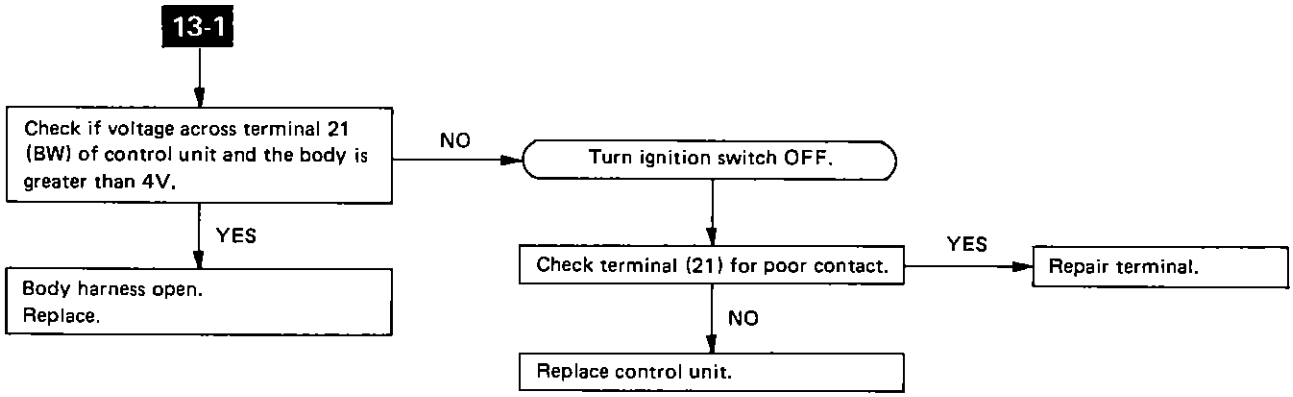
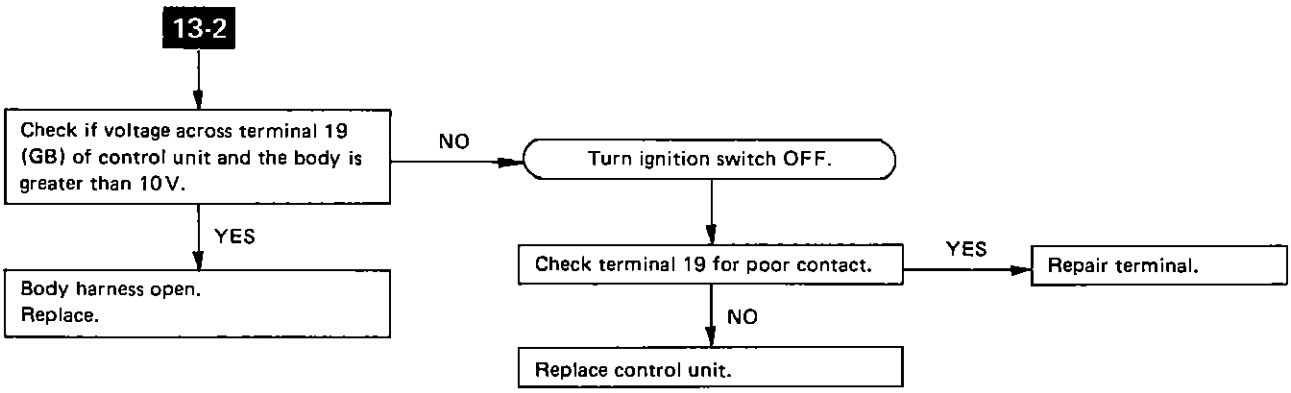
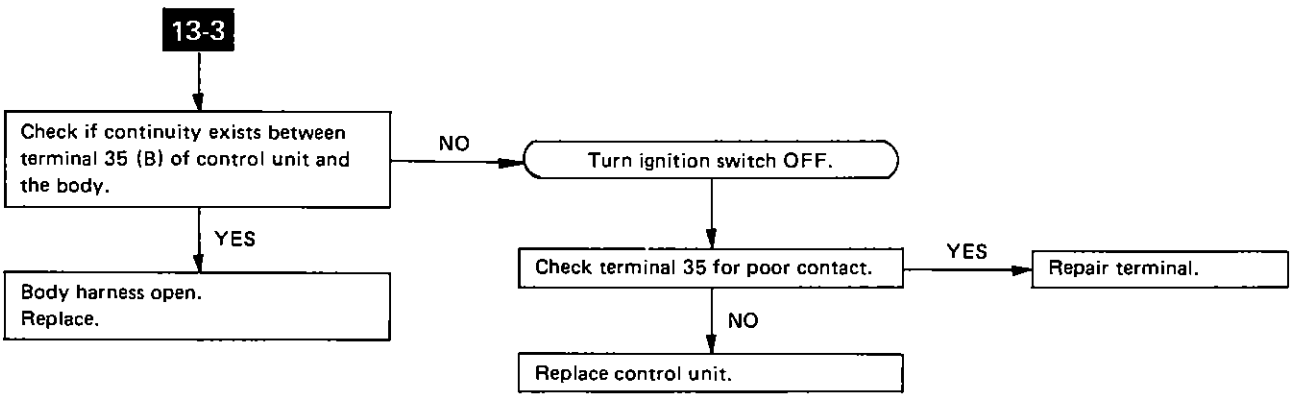


Fig. 59




13-1
Check if voltage across terminal 21 (BW) of control unit and the body is greater than 4V.
NO
Turn ignition switch OFF.
YES
Body harness open. Replace.
Check terminal (21) for poor contact.
YES
Repair terminal.
NO
Replace control unit.


13-2
Check if voltage across terminal 19 (GB) of control unit and the body is greater than 10V.
NO
Turn ignition switch OFF.
YES
Body harness open. Replace.
Check terminal 19 for poor contact.
YES
Repair terminal.
NO
Replace control unit.


13-3
Check if continuity exists between terminal 35 (B) of control unit and the body.
NO
Turn ignition switch OFF.
YES
Body harness open. Replace.
Check terminal 35 for poor contact.
YES
Repair terminal.
NO
Replace control unit.

TROUBLE CODE (14): FUEL INJECTOR

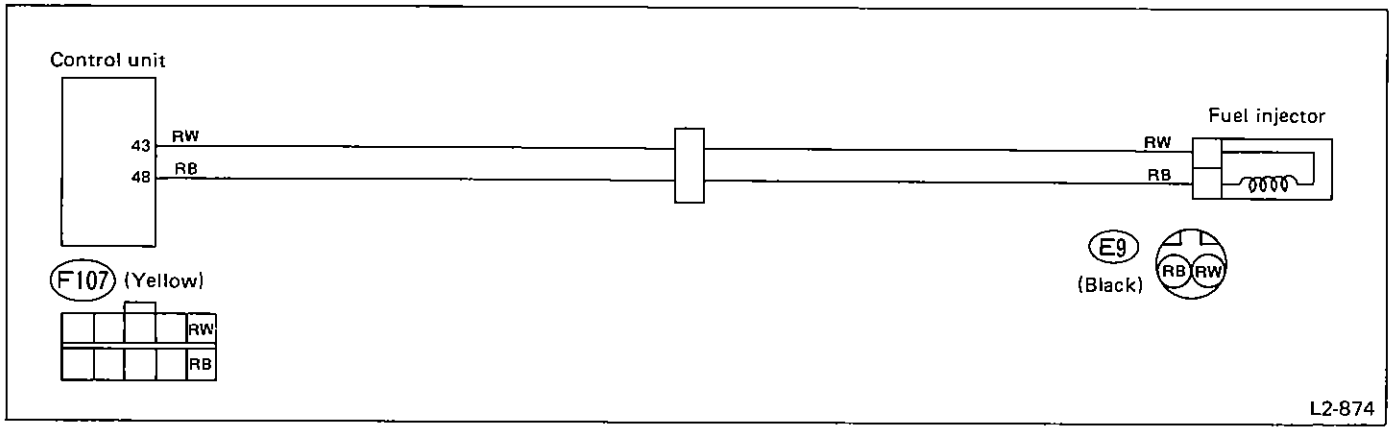
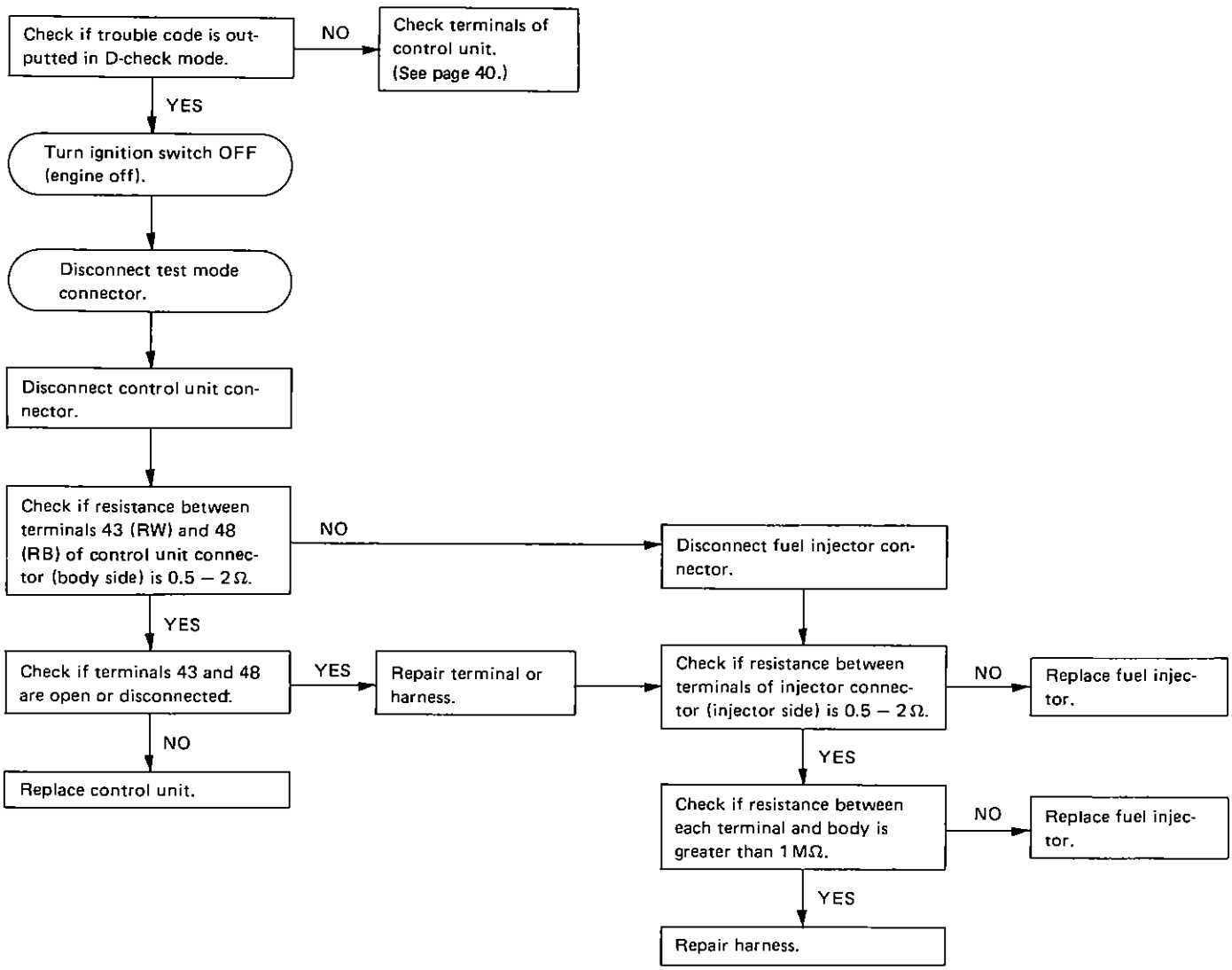


Fig. 60



TROUBLE CODE (21): WATER TEMPERATURE SENSOR

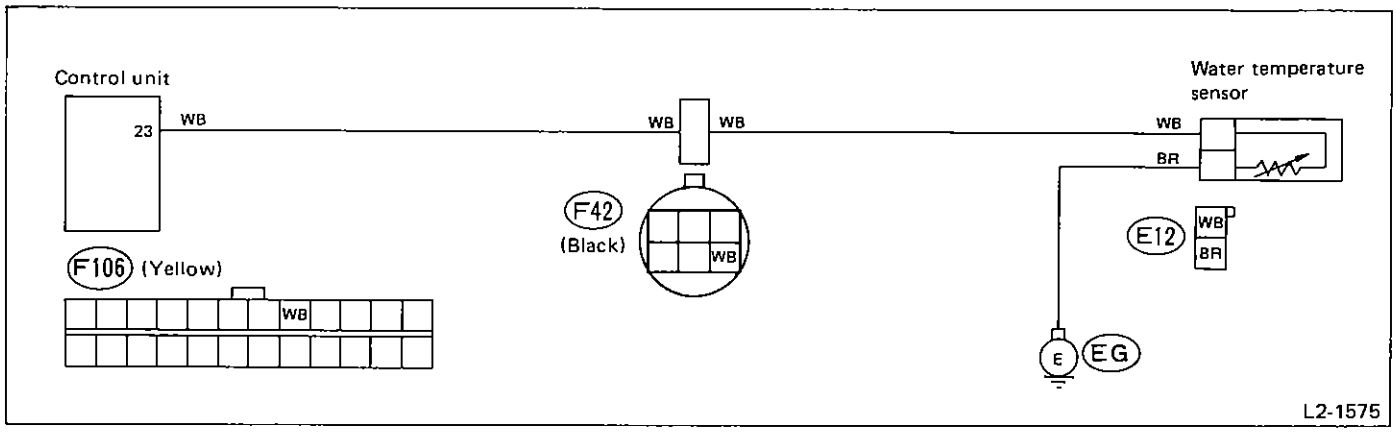
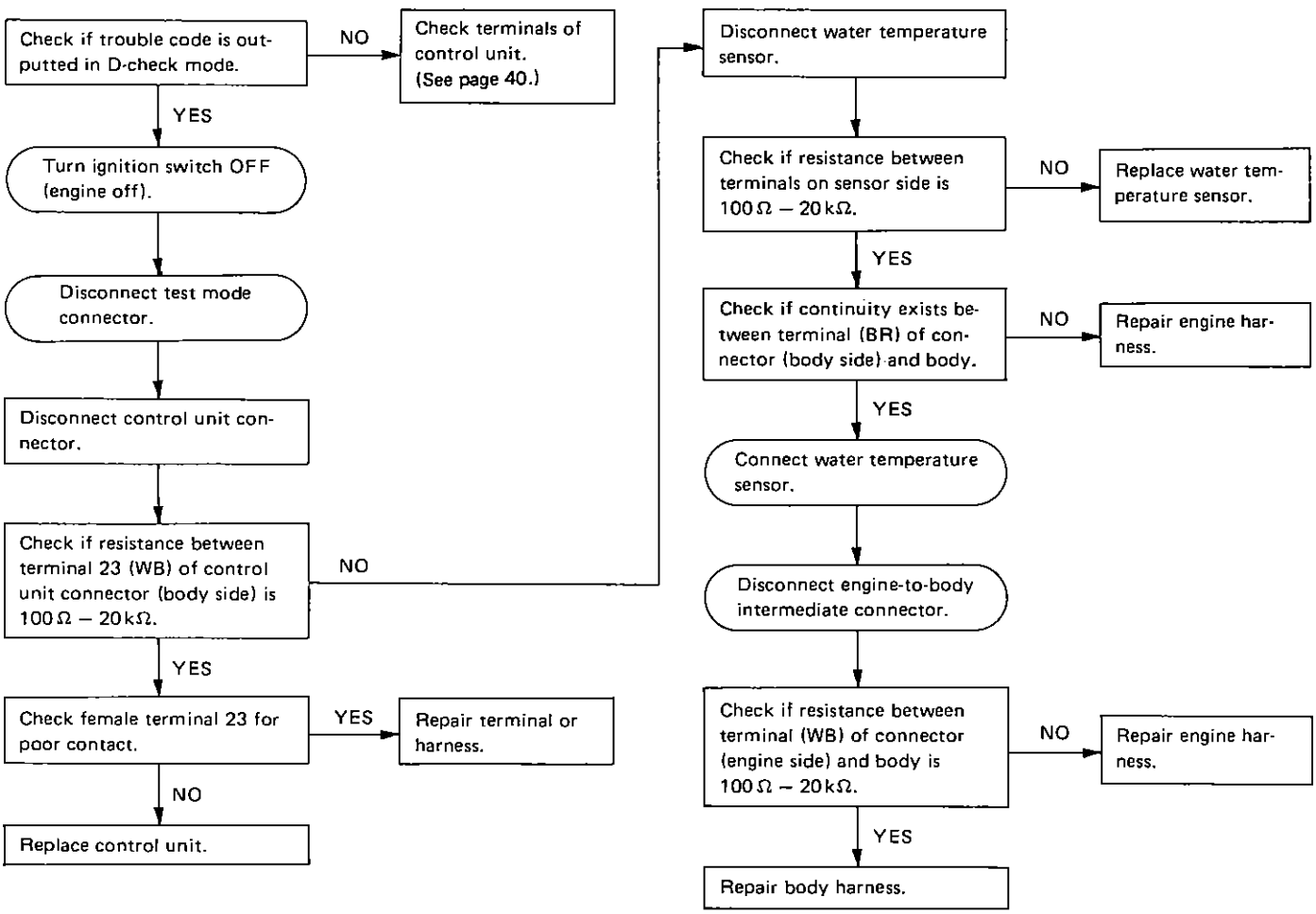


Fig. 61



TROUBLE CODE (23): AIR FLOW METER

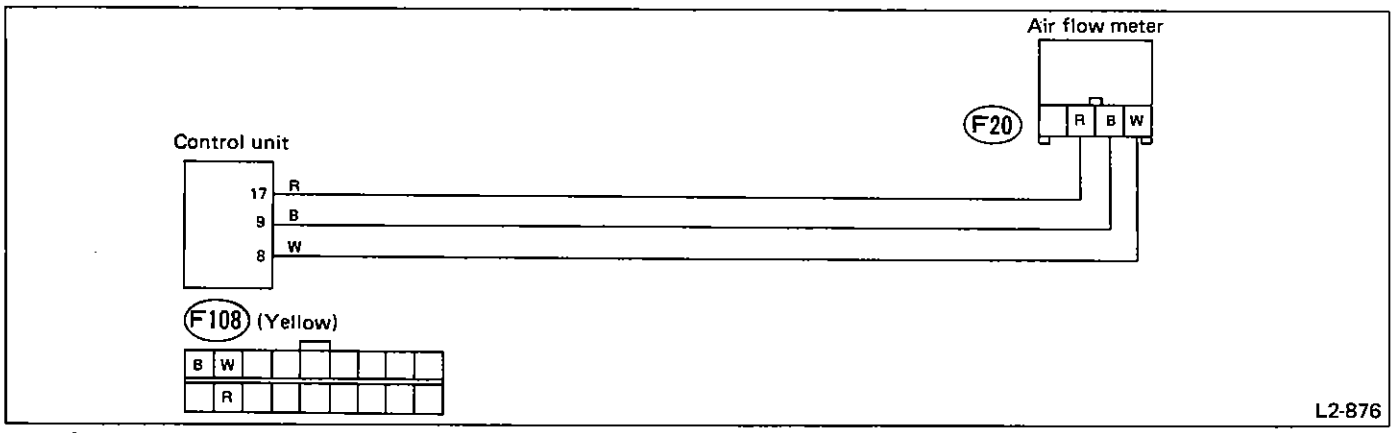


Fig. 62

*** Attach the tester check pin to the connector terminals on the side from which the rubber cover has been removed.**

Check if trouble code is outputted in D-check mode.
NO → Check terminals of control unit. (See page 40.)
YES
Turn ignition switch OFF (engine off).
Disconnect test mode connector.
Disconnect connector from air flow meter and remove rubber cover from connector.
* Check if resistance between terminal (B) of connector and body is less than 10Ω.
NO → Check if resistance between terminal 9 (B) of control unit connector and body is less than 10Ω (with control unit connector connected).
YES → Repair harness.
YES
Turn ignition switch ON (engine off).
NO
Disconnect control unit connector.
* Check if voltage across terminal (R) of connector and body is greater than 10V.
NO → Check if voltage across terminal 17 (R) of control unit connector and body is greater than 10V (with control unit connector connected).
YES → Repair harness.
NO
Turn ignition switch OFF (engine off).
Disconnect control unit connector.
Check if terminal 17 of connector (body side) is open or disconnected.
YES
Repair terminal or harness.
Check if terminal 9 of control unit connector (body side) is open or disconnected.
YES → Repair terminal or harness.
NO
Replace control unit.
YES
Connect connector to air flow meter.
* Check if voltage across terminals (W) and (B) of connector is 0.1 – 0.5V.
NO → Replace air flow meter.
YES
Remove upper side of air cleaner and air flow meter as a unit.
Blow air into air flow meter from air cleaner side to check if voltage across terminals (W) and (B) increases.
NO → Replace air flow meter.
YES
Check if voltage across terminal No. 8 (W) of control unit connector and body is 0.1 – 0.5V.
NO → Repair harness.
YES
Replace control unit.

TROUBLE CODE (24): AIR CONTROL VALVE

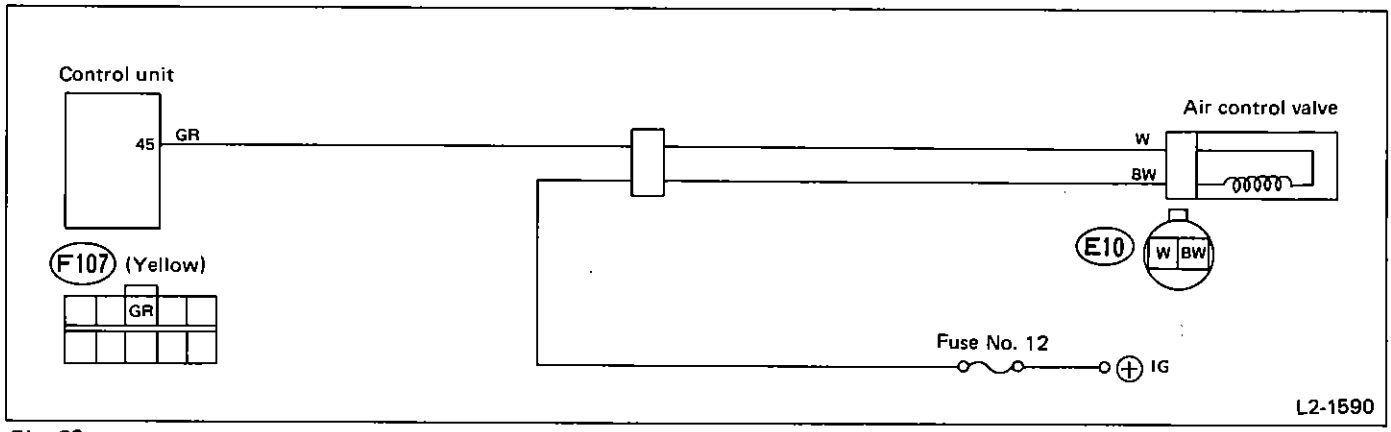
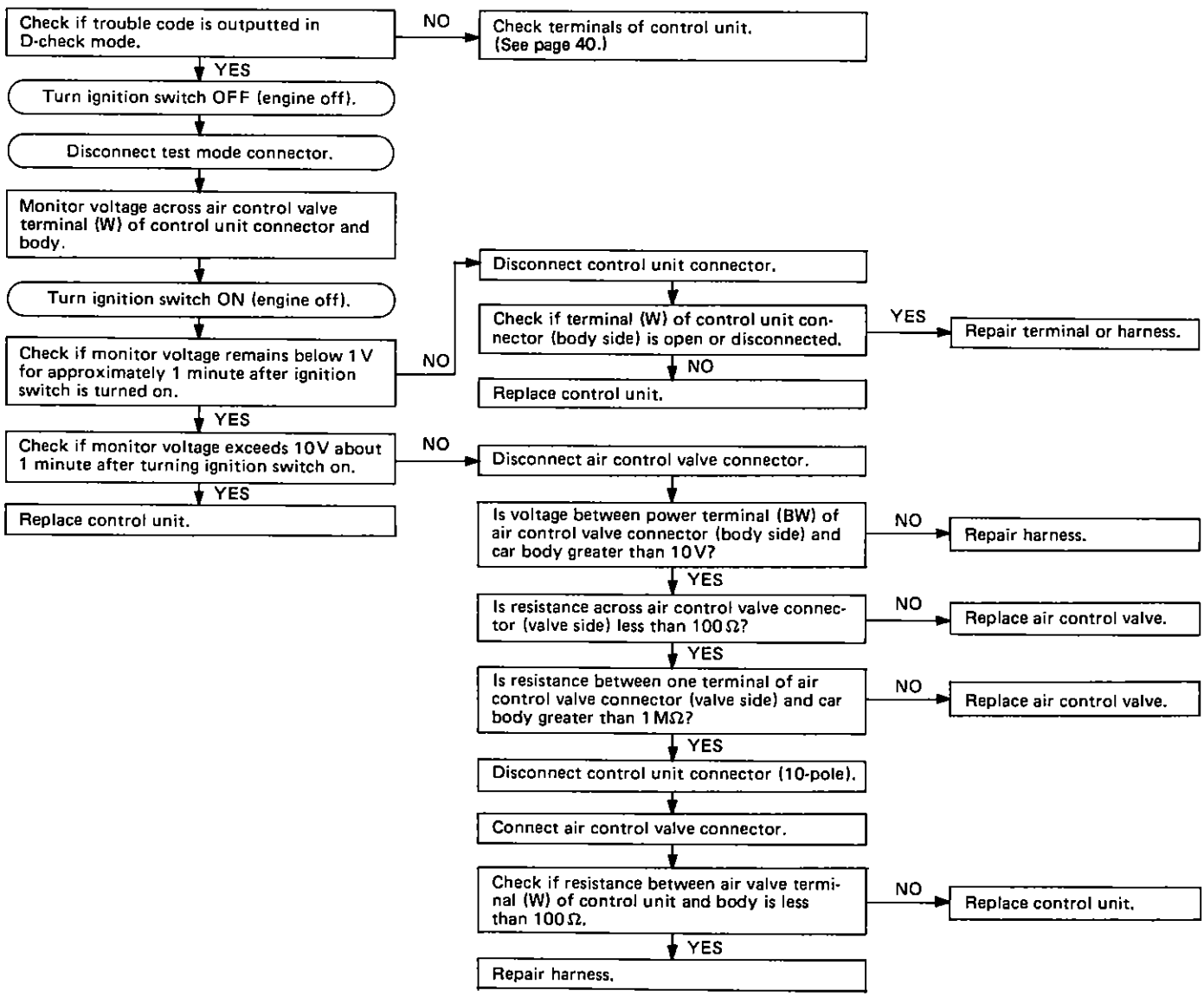


Fig. 63



TROUBLE CODE (31): THROTTLE SENSOR

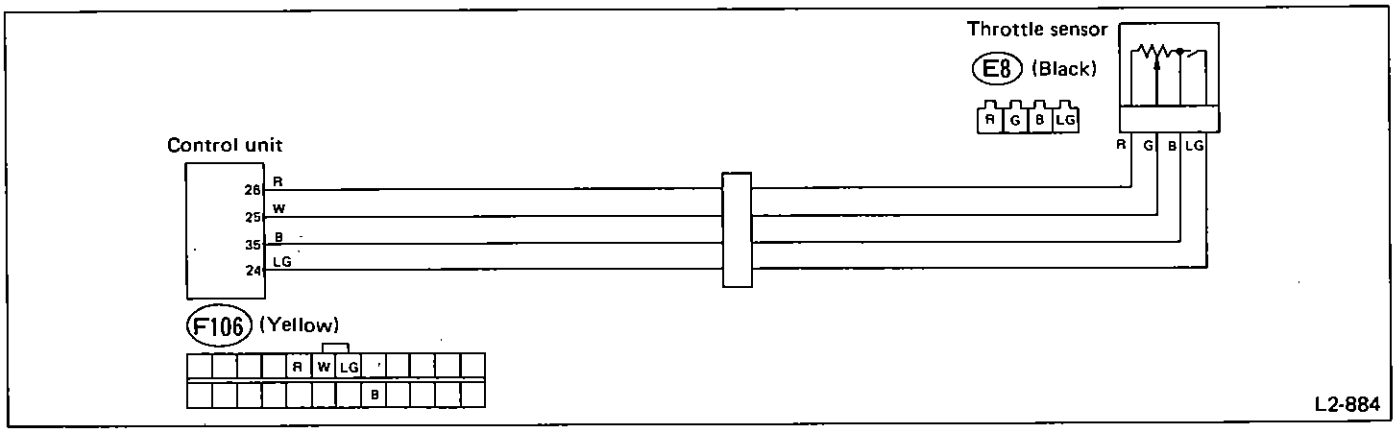


Fig. 64

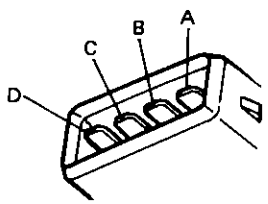


Fig. 65

TROUBLE CODE (32): O_2 SENSOR

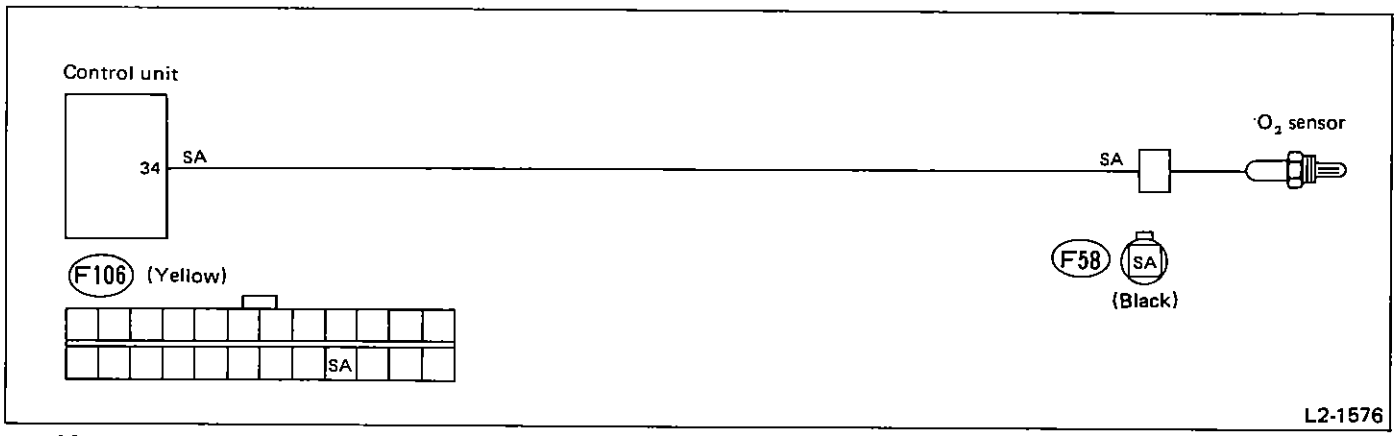
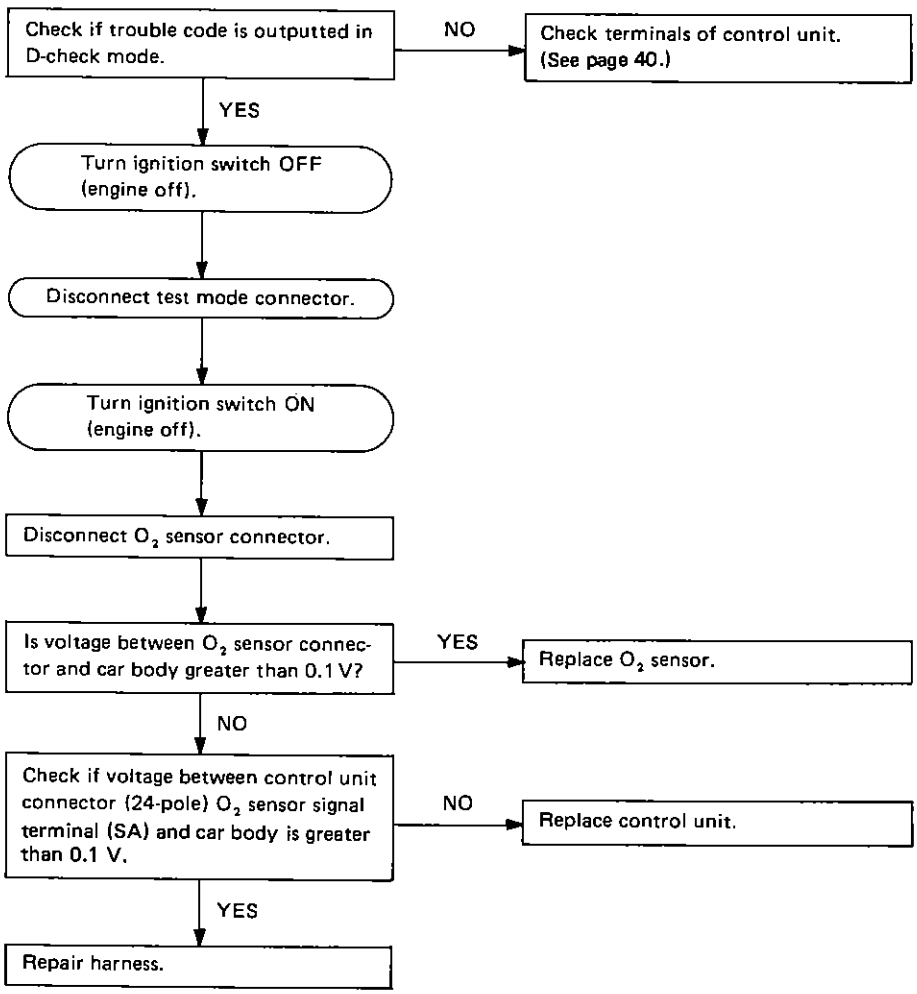


Fig. 66



TROUBLE CODE (33): SPEED SENSOR

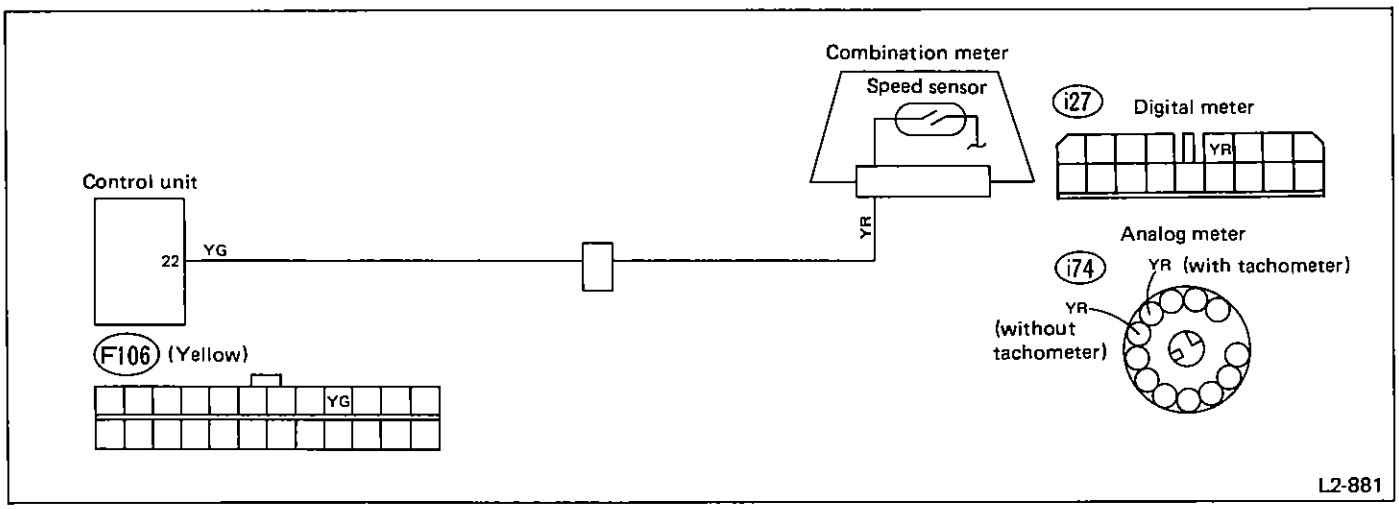


Fig. 3

Check if trouble code is outputted in D-check mode.
NO → Check terminals of control unit. (See page 40)
YES
Turn ignition switch OFF (engine off).
Disconnect test mode connector.
Turn ignition switch ON (engine on).
Check if voltage fluctuates above and below 2 V by slowly moving the car while monitoring voltage across speed signal terminal (YG) of control unit and body.
YES → Replace control unit.
NO
Is voltage between speed signal terminal (YG) of control unit and car body greater than 2 V?
NO → Turn ignition switch OFF (engine off).
YES
Disconnect combination meter.
Is voltage between combination meter connector car speed signal terminal (YR) and car body greater than 2 V?
YES → Replace speedometer for analog meter or computer/body ASSY for digital meter.
NO
Repair harness.

Turn ignition switch OFF (engine off).
Disconnect combination meter.
Is resistance between speed signal terminal (YG) of control unit and car body less than 10 Ω.
NO → Replace speedometer for analog meter or computer/body ASSY for digital meter.
YES
Repair harness.

TROUBLE CODE (34): EGR SOLENOID VALVE

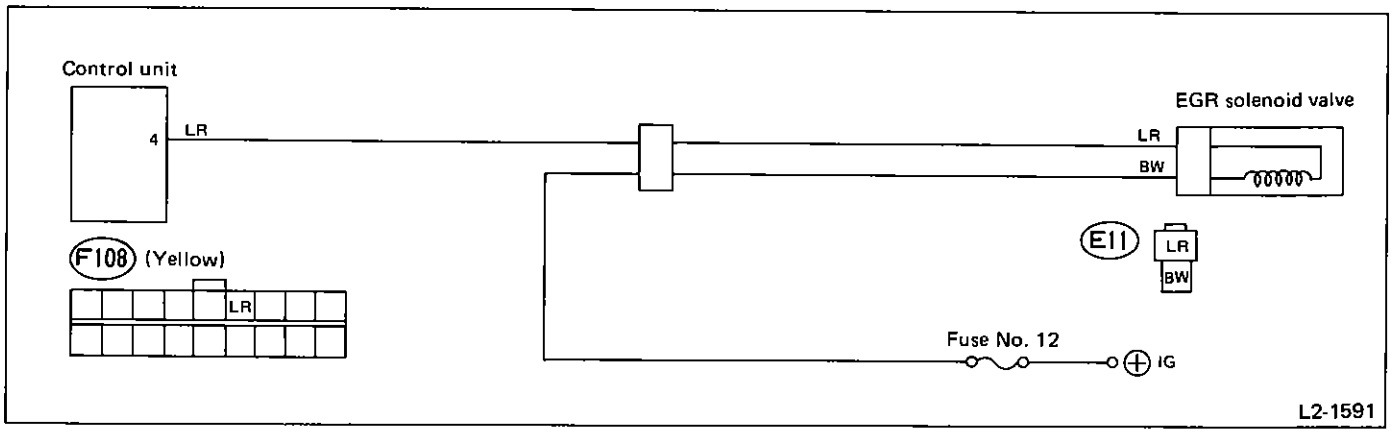
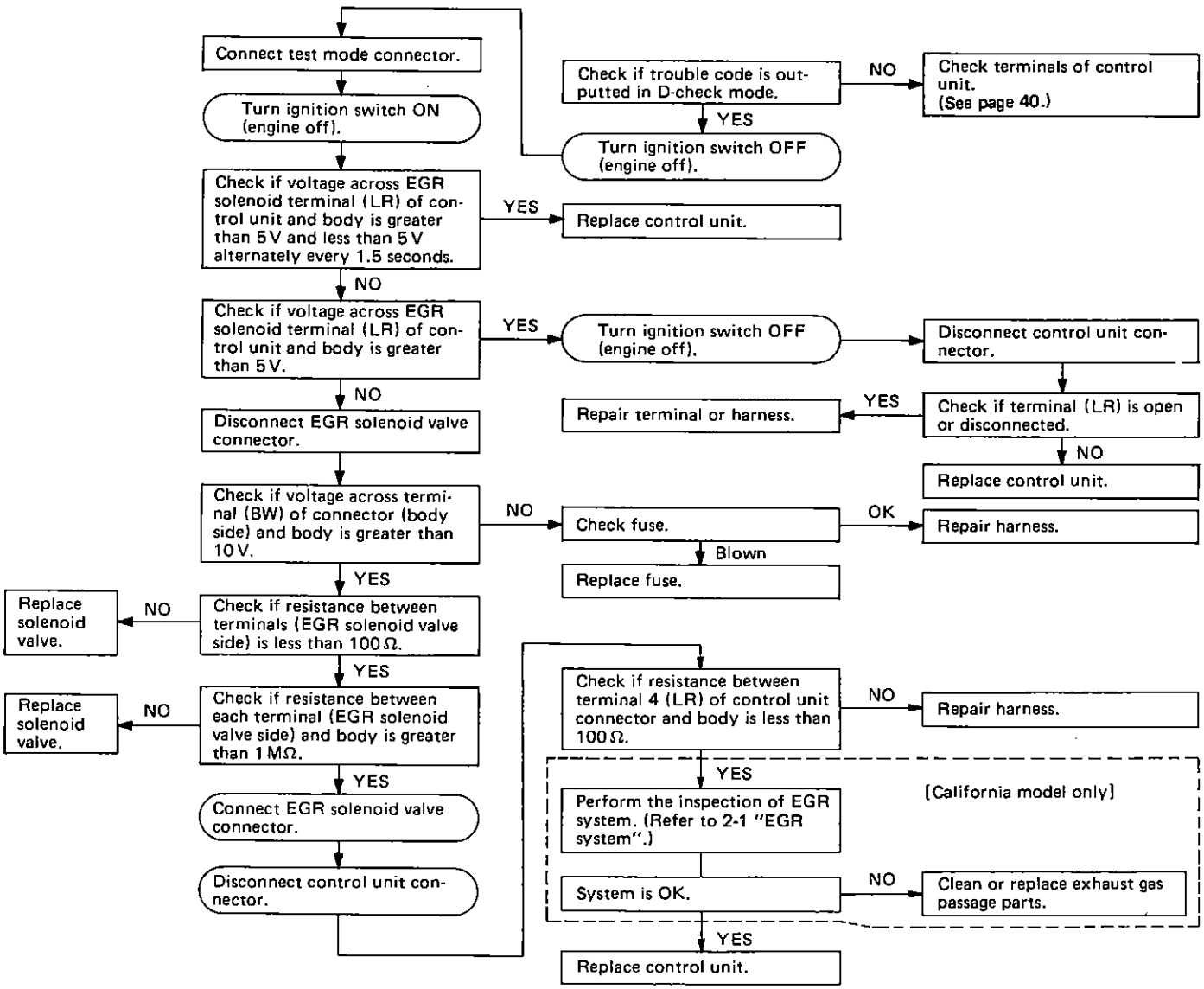


Fig. 68



TROUBLE CODE (35): PURGE CONTROL SOLENOID VALVE

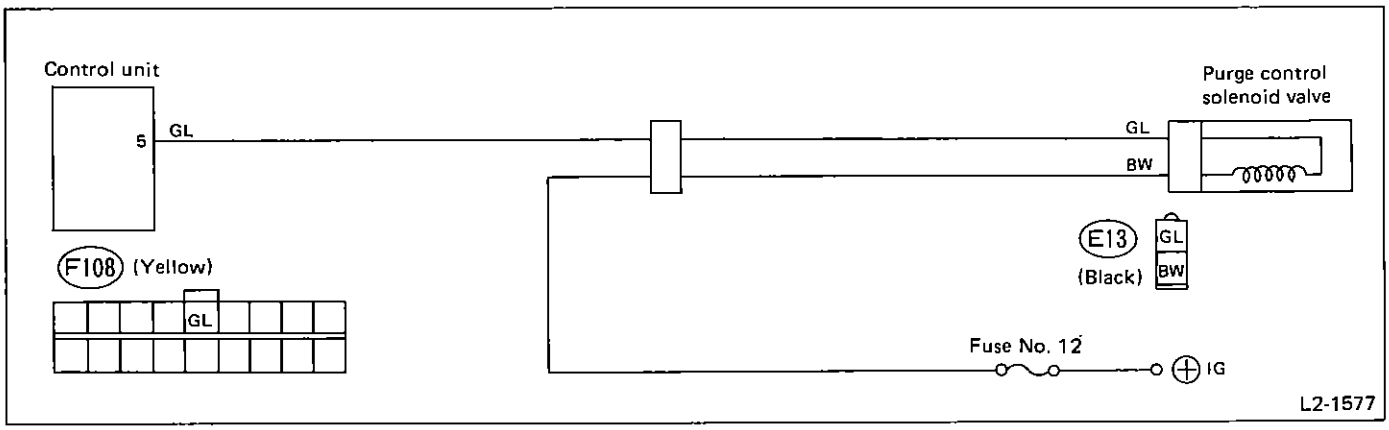
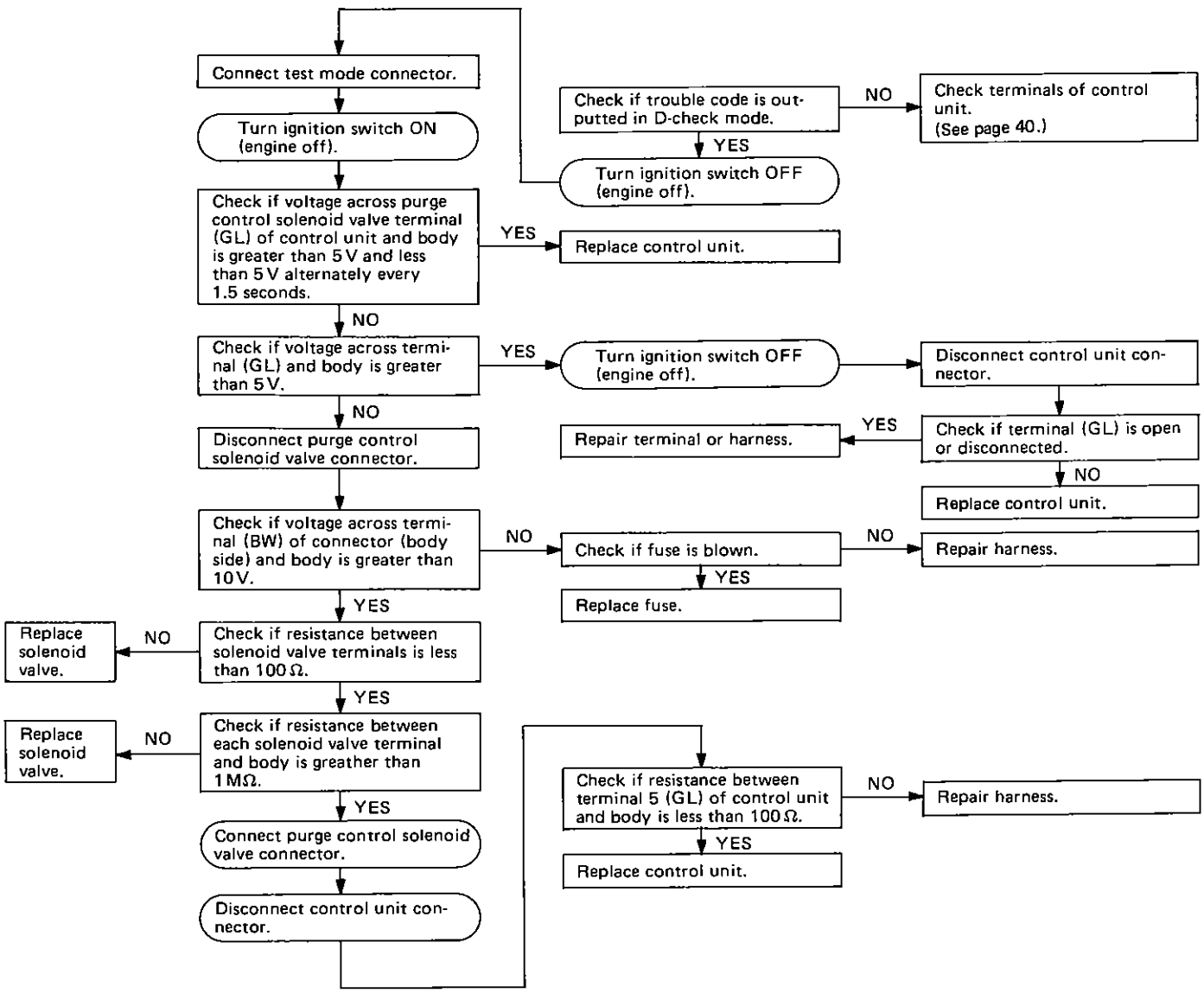


Fig. 69



TROUBLE CODE (42): IDLE SWITCH

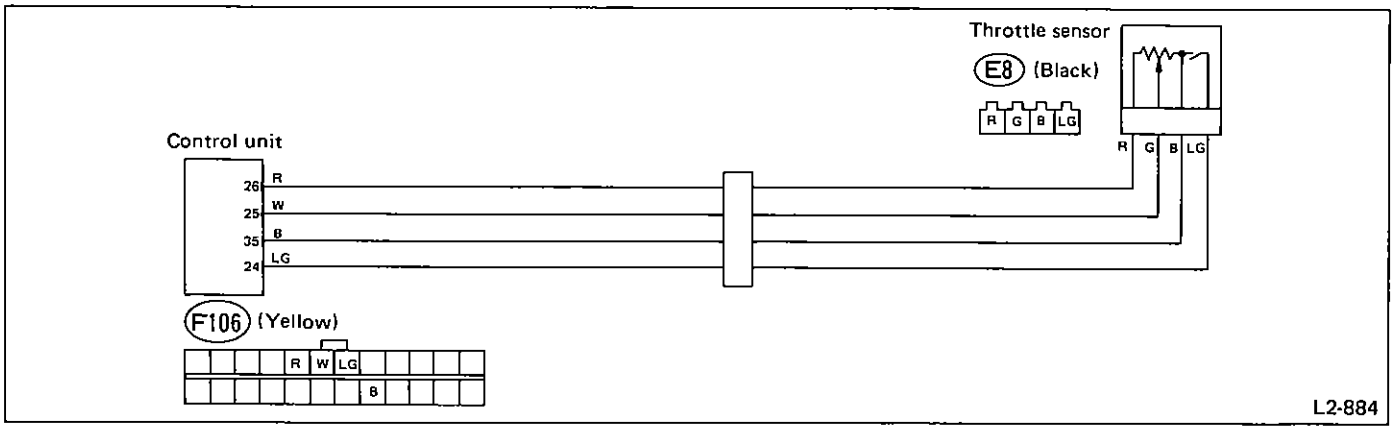


Fig. 70

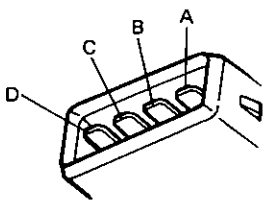
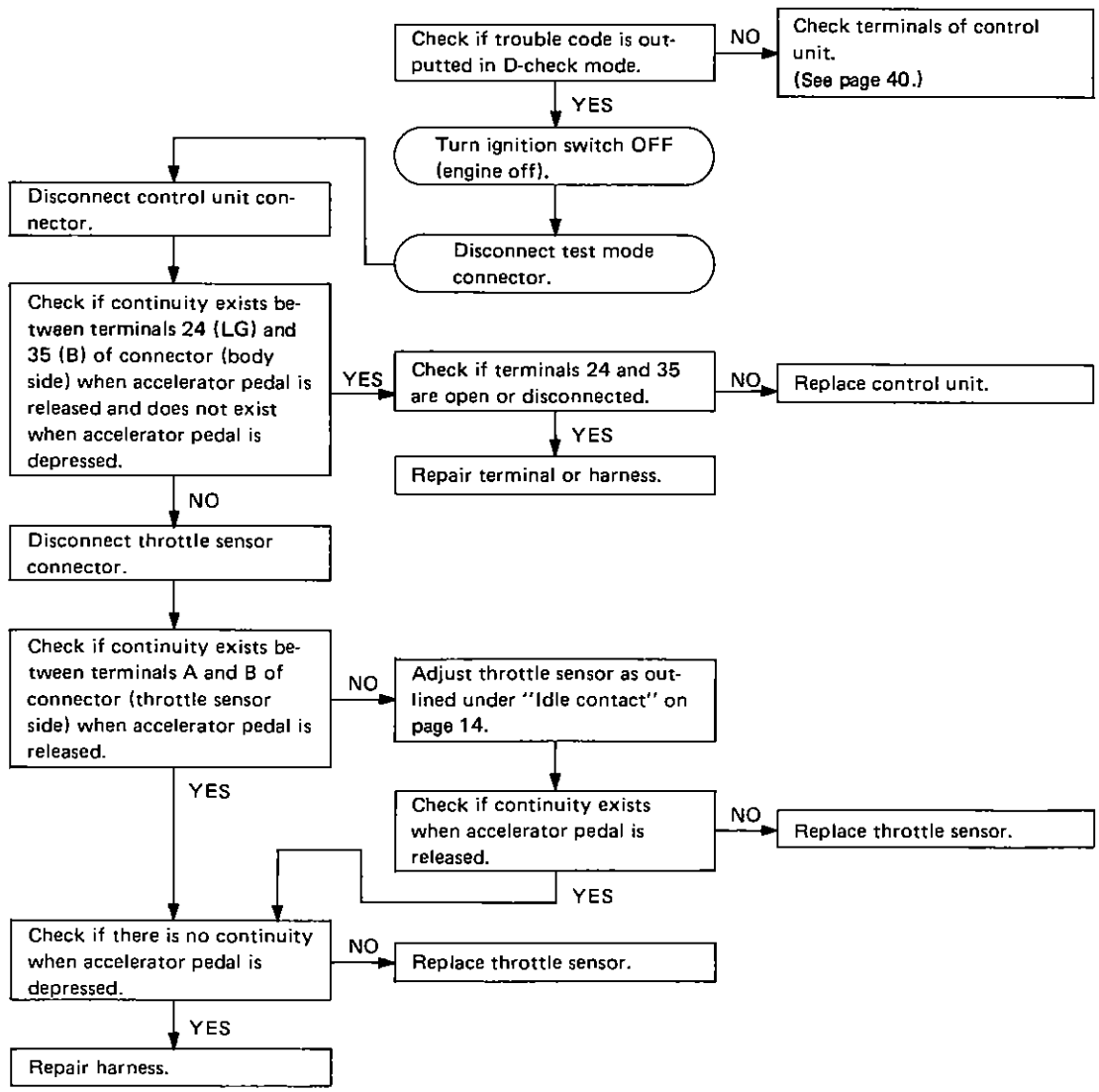


Fig. 71



TROUBLE CODE (45): KICK-DOWN CONTROL RELAY

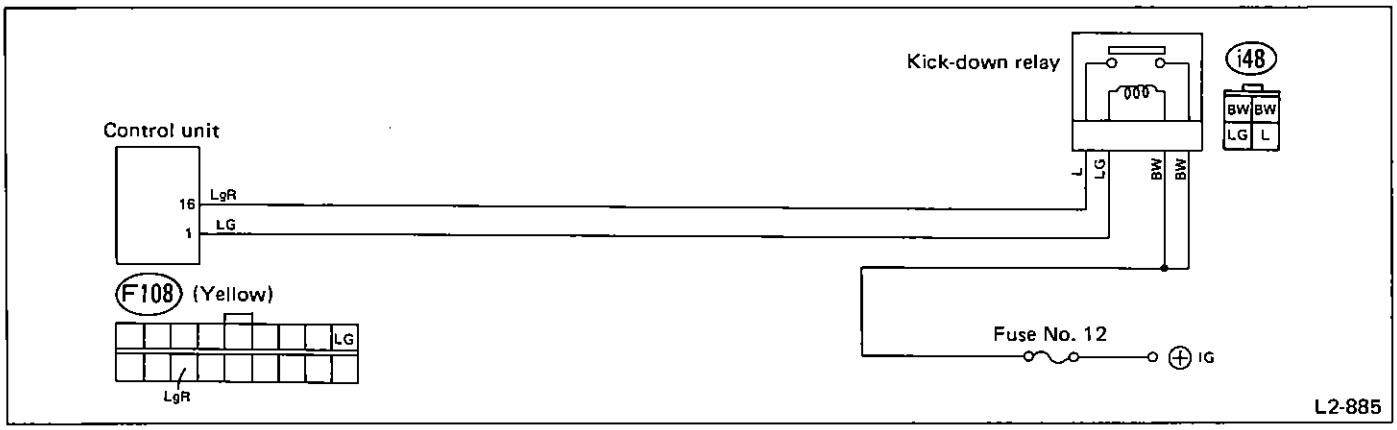
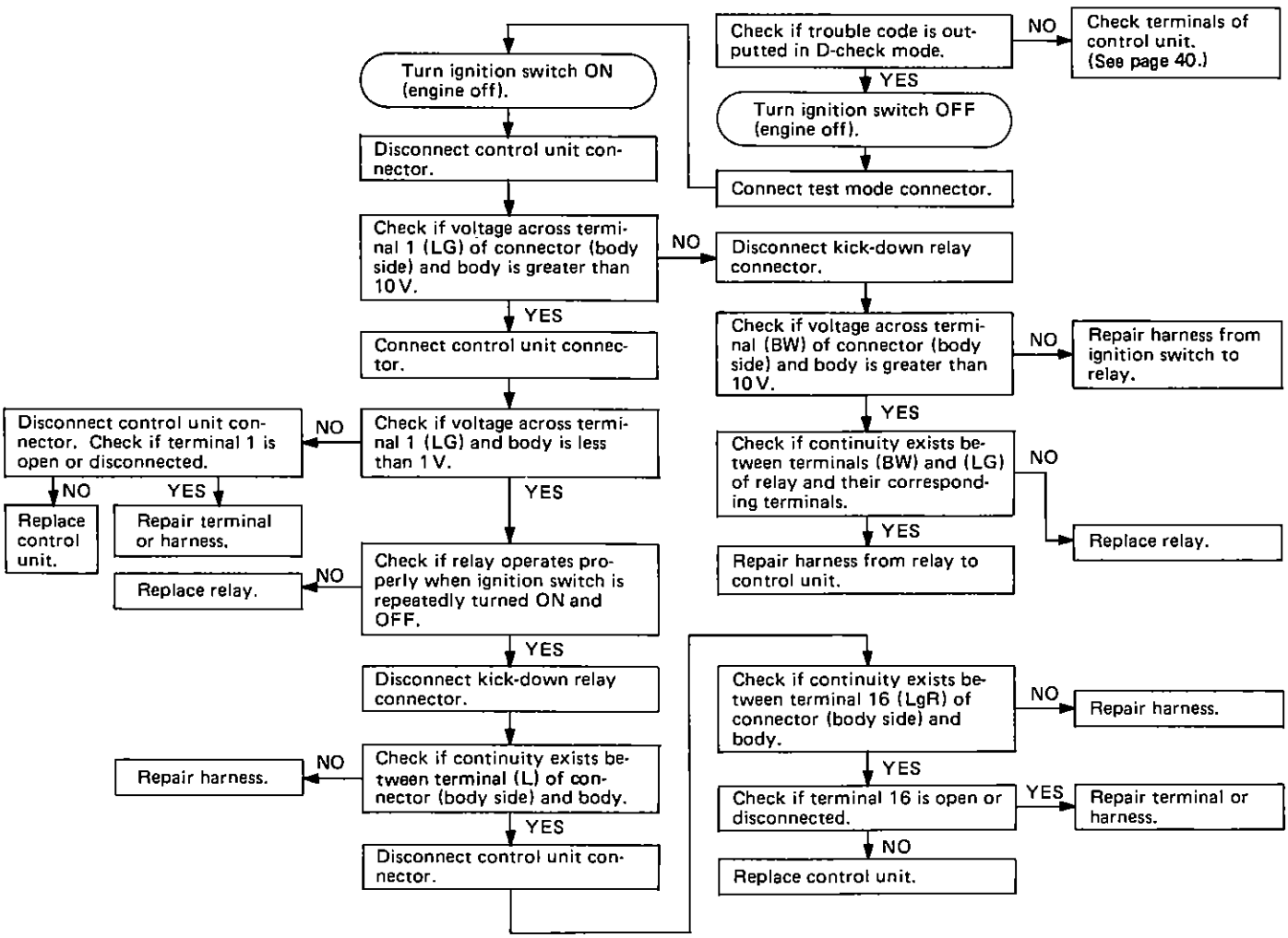


Fig. 72



TROUBLE CODE (51): NEUTRAL SWITCH [MT]

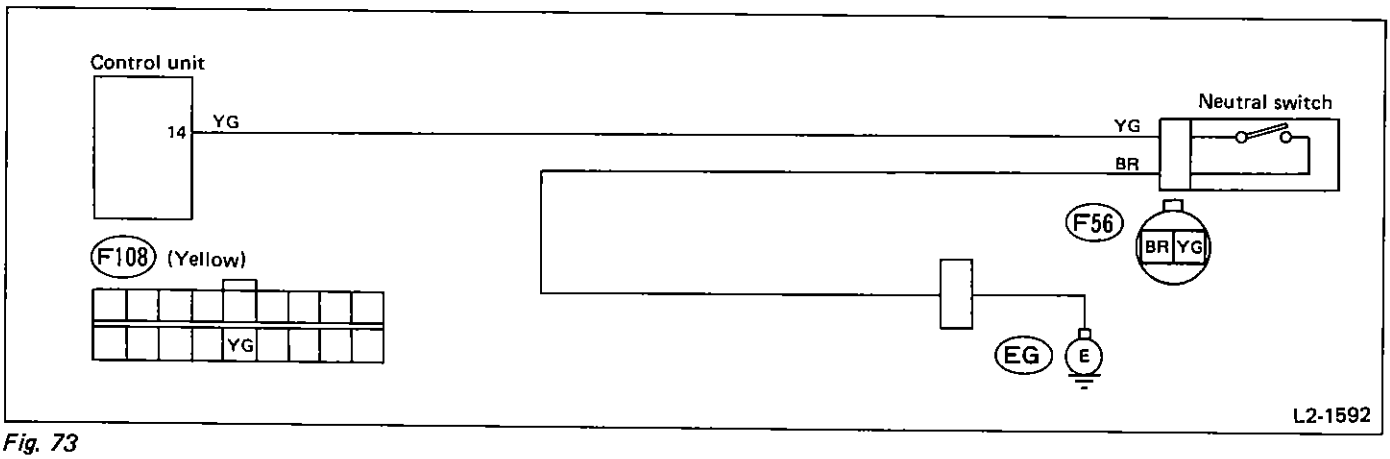
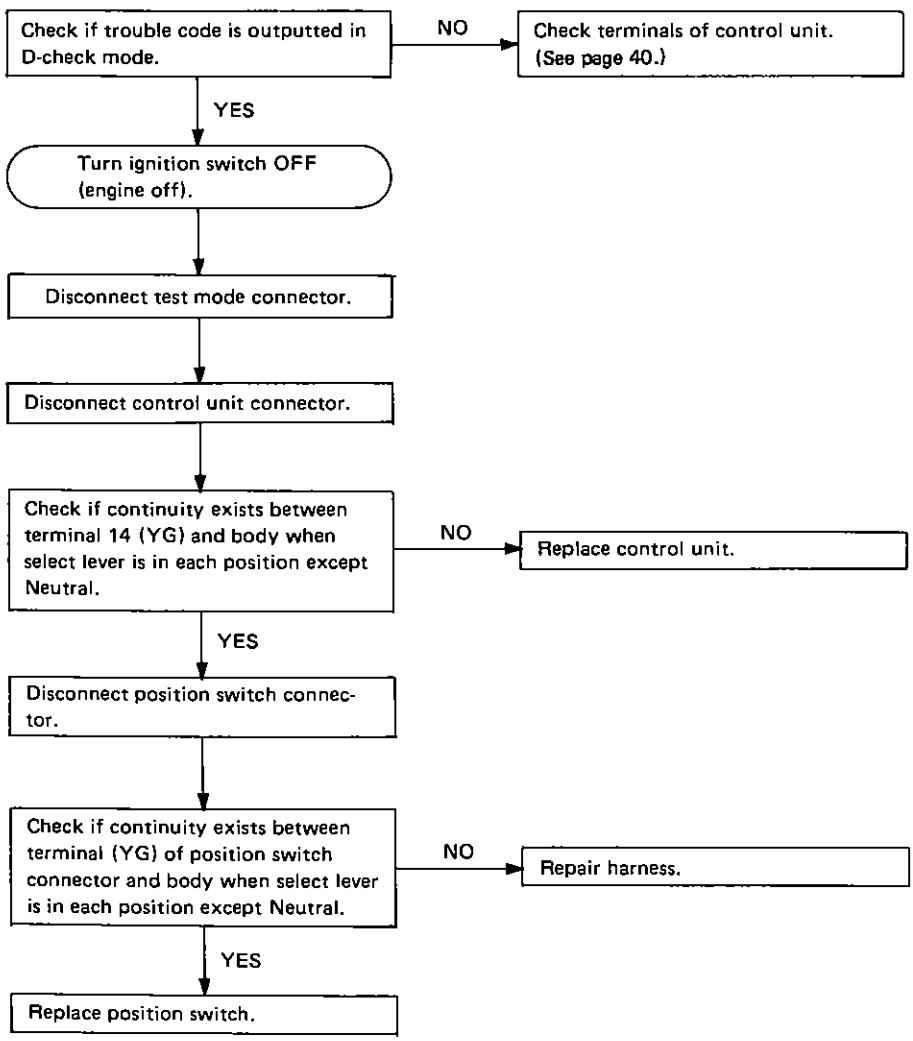


Fig. 73

Check if trouble code is outputted in D-check mode.
NO → Check terminals of control unit. (See page 40.)
YES
Turn ignition switch OFF (engine off).
Disconnect test mode connector.
Disconnect control unit connector.
Check if continuity exists between terminal 14 (YG) of control unit connector (body side) and body when switch is in each position except Neutral.
NO → Replace control unit.
YES
Connect control unit connector.
Disconnect neutral switch connector.
Check if resistance between body connector terminal (YG) and body is greater than 1 MΩ.
NO → Repair harness.
YES
Replace neutral switch.

TROUBLE CODE (51): NEUTRAL SWITCH [AT]

Fig. 74



TROUBLE CODE (55): EGR GAS TEMPERATURE SENSOR [California model only]

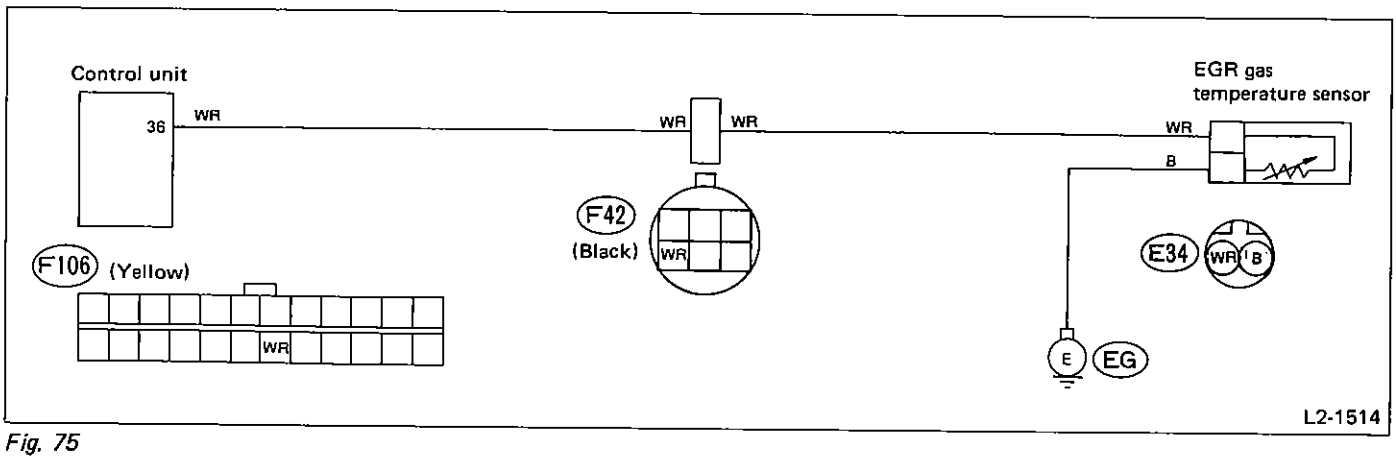
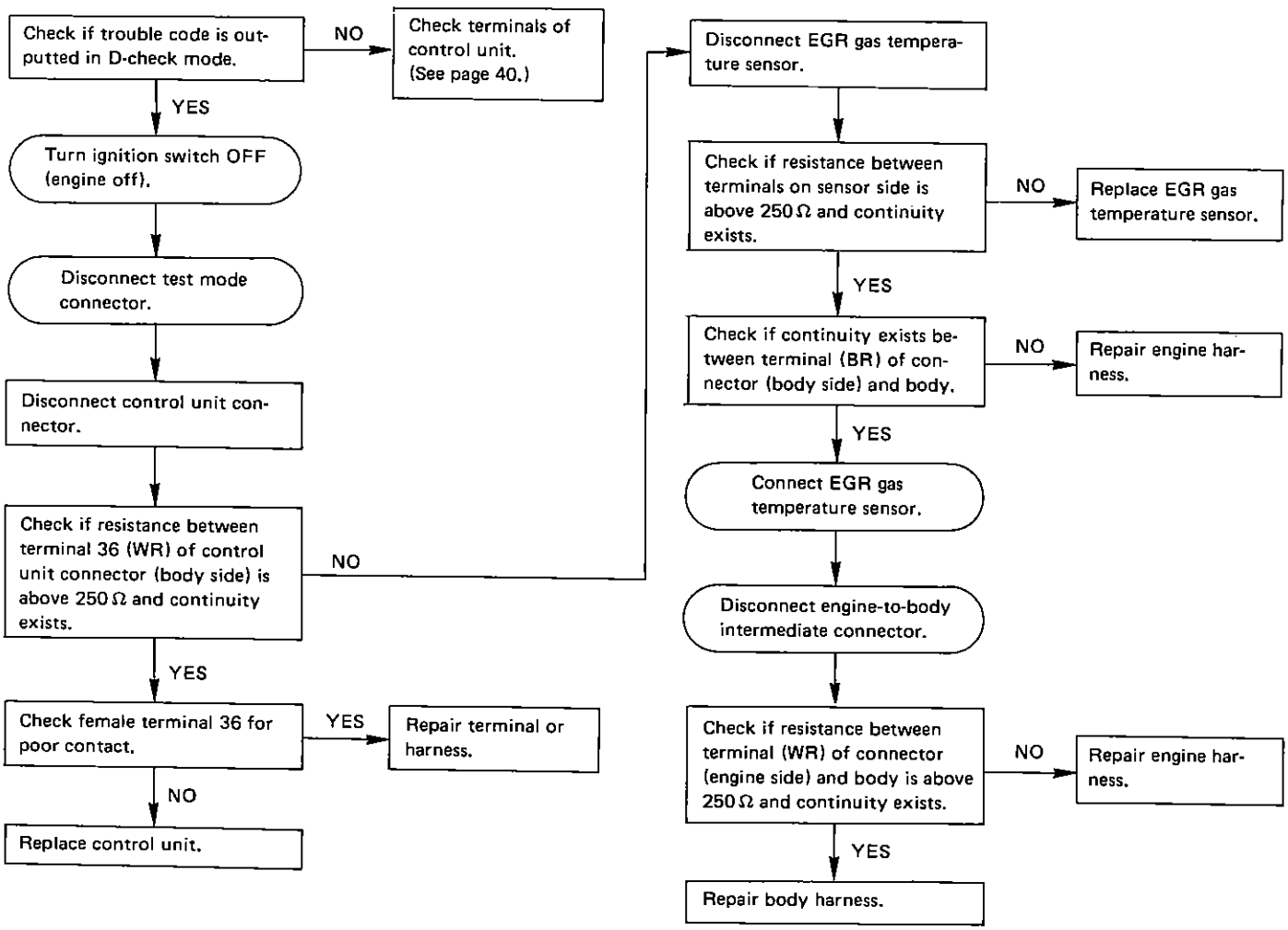
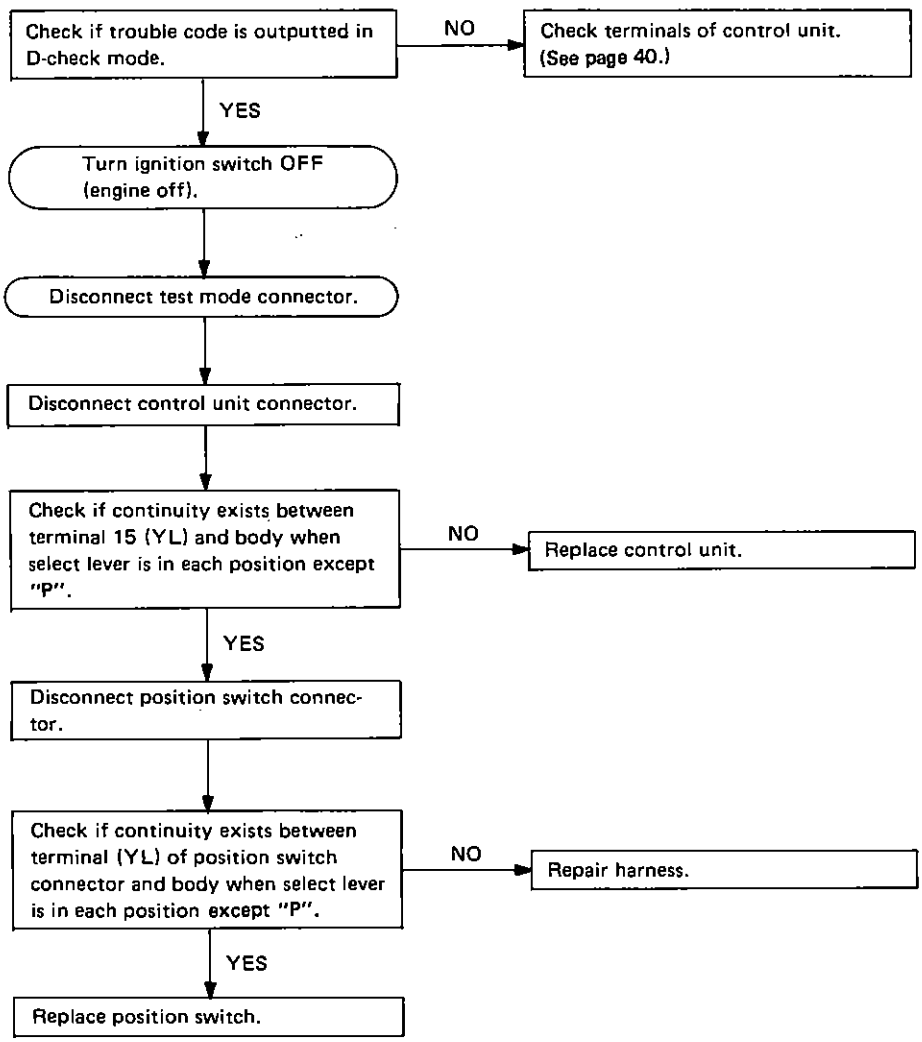


Fig. 75



TROUBLE CODE (61): PARKING SWITCH [AT]

Fig. 76



Troubleshooting Table for Throttle Chamber

1. Fuel leakage	
1) Damaged O-ring in fuel injector	Replace O-ring
2) Damaged O-ring in pressure regulator	Replace O-ring
3) Damaged gasket or loose screws	Replace gasket or tighten screws
4) Pressure regulator vacuum sensing hose out of place or cracked	Install or replace hose
2. No fuel is injected	
When fuel injector drive signal is normal and fuel pump and fuel line are in good condition	
1) Lead wire broken or improperly contacting in fuel injector	Replace fuel injector ASSY
2) Fuel injector seized	Repair cause of seizure and replace fuel injector ASSY
3) Pressure regulator regulating pressure too low	Replace pressure regulator ASSY
3. Excessive fuel consumption	
When fuel line (especially return circuit) is normal and both control system and ignition system are in good condition	
1) Pressure regulator regulating pressure too high	Replace pressure regulator ASSY
2) Fuel leaks	Refer to "Fuel leakage" in item 1 above
3) Throttle sensor improperly adjusted or abnormal output signal	Adjust or replace throttle sensor
4. Rough idle	
When fuel pump, fuel line, control system, ignition system and resistance are normal	
1) Damaged gasket or screws loose	Replace gasket or tighten screws
2) Pressure regulator vacuum sensing hose out of place or cracked	Install or replace hose
3) Improperly set or malfunctioning idle switch	Adjust or replace throttle sensor
4) Lead wire broken or improperly contacting in air control valve	Replace air control valve ASSY
5) Foreign matter in air control valve metering unit or contamination	Remove foreign matter or replace air control valve ASSY
6) Fuel injector nozzle tip contaminated or deformed	Clean or replace injector ASSY
7) Fuel injector filter clogged	Replace injector
8) Pressure regulator regulating pressure too low or unstable	Replace pressure regulator ASSY
9) Throttle chamber throttle valve orifice clogged	Clean

5. Engine lacks power and/or high-speed performance	
When fuel pump, fuel line, control system, ignition system and intake system are in good condition	
1) Pressure regulator regulating pressure too low	Replace pressure regulator ASSY
2) Fuel injector filter clogged	Replace fuel injector
3) Throttle sensor out of adjustment or abnormal output signal	Adjust or replace throttle sensor
4) Gasket damaged or screws loose	Replace gasket or tighten screws
5) Pressure regulator vacuum sensing hose out of place or cracked	Install or replace hose
6. Hesitation and/or insufficient acceleration performance	
When fuel pump, fuel line, control system, ignition system and intake system are in good condition	
1) Throttle sensor output signal abnormal	Replace throttle sensor ASSY
2) Pressure regulator regulating pressure too low	Replace pressure regulator ASSY
3) Fuel injector filter clogged	Replace fuel injector
4) Damaged gasket or screws loose	Replace gasket or tighten screws
5) Pressure regulator vacuum sensing hose out of place or cracked	Install or replace hose
7. Hard starting in cold weather	
When fuel pump, fuel line, control system and ignition system are in good condition	
1) Lead wire broken or improperly contacting in air control valve	Replace air control valve ASSY
2) Foreign matter caught in air control valve metering unit or contamination	Remove foreign matter or replace air control valve ASSY
3) Fuel injector filter clogged	Replace fuel injector
4) Pressure regulator regulating pressure too low	Replace pressure regulator ASSY
5) Throttle chamber throttle valve orifice clogged	Clean

Multi Point Fuel Injection System

MECHANISM AND FUNCTION

General

The Multi Point Fuel Injection (MPFI) system is a system that supplies the optimum air-fuel mixture to the engine for all the various operating conditions through the use of the latest electronic technology.

With this system fuel, which is pressurized at a constant pressure, is injected into the intake air passage of the cylinder head. The injection quantity of fuel is controlled by an intermittent injection system where the electro-magnetic injection valve (fuel injector) opens only for a short period of time, depending on the quantity of air required for one cycle of operation. In actual operation, the injection quantity is determined by the duration of an electric pulse applied to the fuel injector and this permits simple, yet highly precise metering of the fuel.

Further, all the operating conditions of the engine are converted into electric signals, and this results in additional features of the system, such as large improved adaptability, easier addition of compensating element, etc. The MPFI system also has the following features:

1) Reduced emission of harmful exhaust gases.
2) Reduced in fuel consumption.
3) Increased engine output.
4) Superior acceleration and deceleration.
5) Superior startability and warm-up performance in cold weather since compensation is made for coolant and intake air temperature.
6) Good matching with turbocharger.

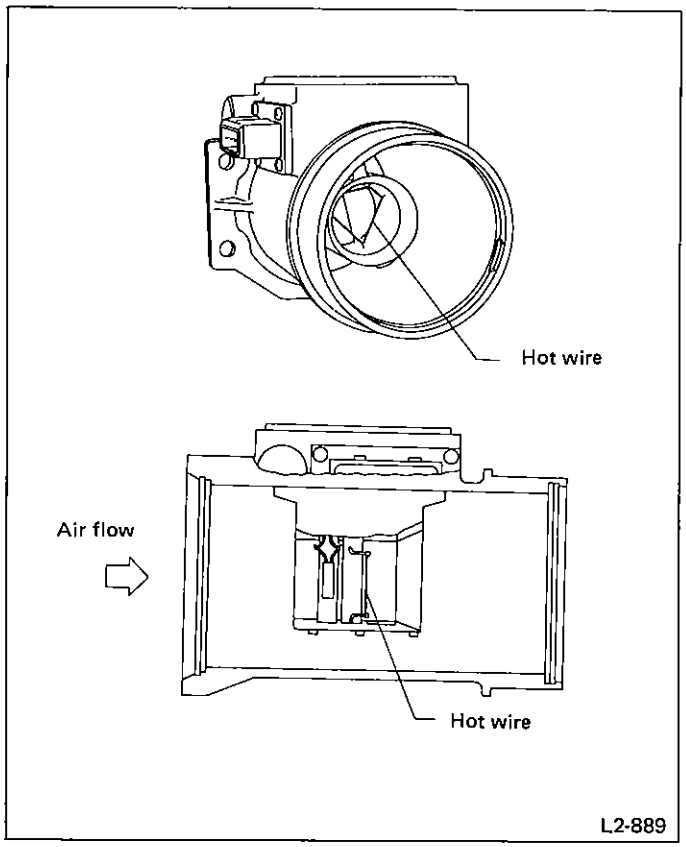


Fig. 77

Air Flow Meter

The MPFI TURBO system employs a hot-wire type air flow meter.

This air flow meter converts the amount of air taken into the engine into an electric signal by utilizing the heat transfer phenomenon between the incoming air and a heating resistor (hot wire) located in the air intake.

The features of this flow meter type are as follows:

1) High-altitude compensation is made automatically.
2) Quick response.
3) There are no moving parts.
4) It is compact.

Throttle Body

In response to the depressing stroke of the throttle pedal, the throttle body opens/closes its valve to regulate the air volume to be taken in the combustion chamber. Negative pressure (positive pressure at supercharging) generated according to the opening of the throttle valve is applied to the pressure ports for EGR control and canister purge. This pressure is used for controlling EGR valve and canister purge.

During idling, the throttle valve is almost fully closed and the air flow through the body is less than that passing through the carburetor. More than half of the air necessary for idling is supplied to the intake manifold via the idle bypass passage.

Turning the idle adjust screw on the idle bypass passage can change the air flow to adjust the number of revolutions in idling. Further, to prevent the number of revolutions from decreasing while the air conditioner is turned on, the fast idle bypass passage is provided which has the valve operated by the fast idle solenoid.

The fast idle engine rpm can be adjusted by turning the fast idle adjusting screw.

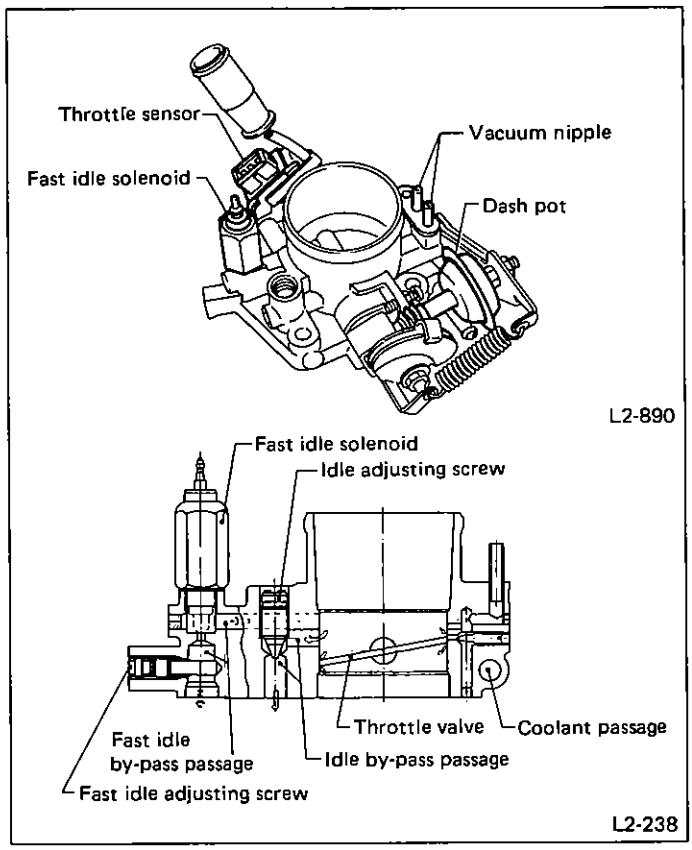


Fig. 78

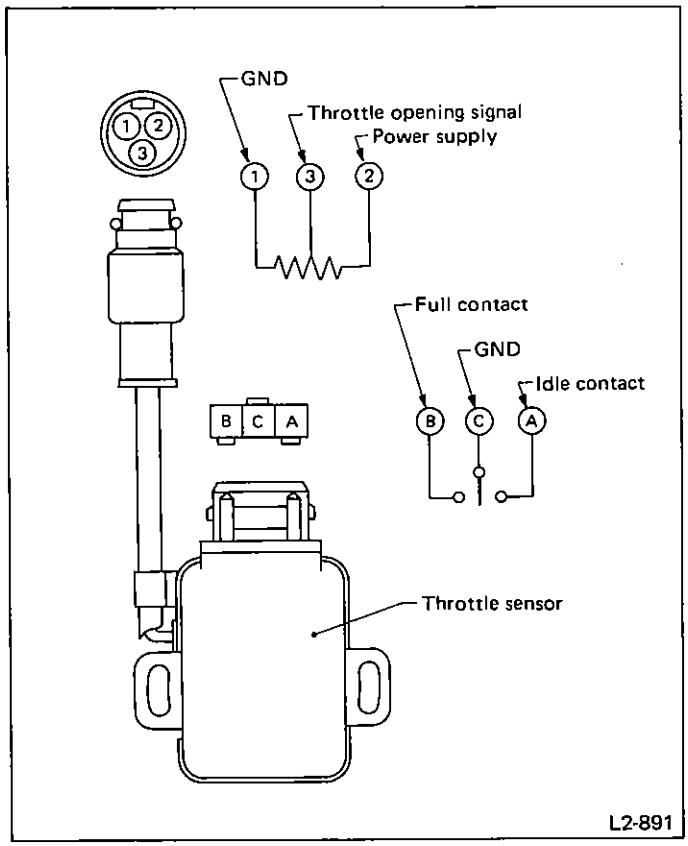


Fig. 79

THROTTLE SENSOR SYSTEM

A throttle position sensor is provided with a potentiometer and idle switch interlocked with the throttle valve shaft is utilized.

This throttle position sensor sends the MPFI control unit a potentiometer output signal corresponding to the opening of the throttle valve and an idle switch signal that turns ON only when the throttle is opened nearly to the idle position.

Using these signals, the MPFI control unit precisely controls the air-fuel ratio during acceleration and deceleration as well as idling.

Ignition System

The ignition system is composed of a battery, an ignition coil, a distributor, spark plugs, knock sensor, MFFI control unit and wires.

The crank angle sensor built-in distributor detects the reference crank angle and the positioned crank angle. Electronic signal of both angles is transmitted to MPFI control unit which is used in common by fuel injection system.

The MPFI control unit calculates the spark advance angle and determines the spark timing.

The electronic signal of spark timing determined by control unit is transmitted to the power transistor where it makes the primary circuit to ignition coil, whereby high voltage current is generated in the secondary circuit.

The high voltage of secondary circuit is distributed to the spark plug of each cylinder and discharged there.

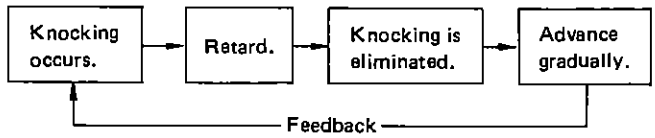
UNDER NORMAL OPERATING CONDITIONS

The spark advance angle is calculated from the following three factors.

1) Engine speed compensation.
2) Advance when starting the engine.
3) Advance in all driving conditions except starting the engine, after engine speed exceeds the preset value.

WHEN KNOCKING OCCURS

A signal is transmitted from the knock sensor to the MPFI control unit. The MPFI control unit then retards spark timing to prevent engine knocking.



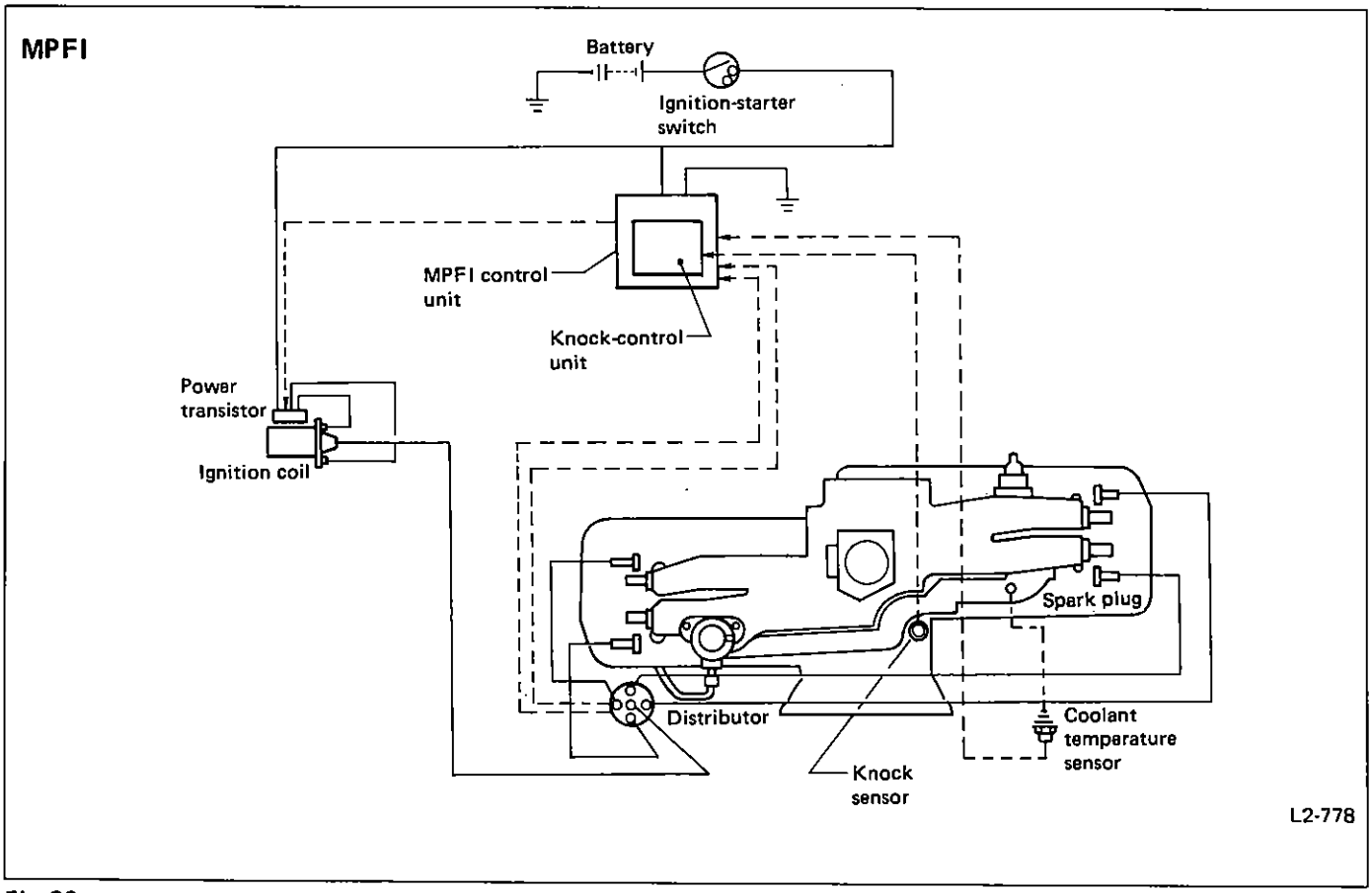


Fig. 80

KNOCK SENSOR

The knock sensor is installed on the cylinder block, and senses knocking signals from each cylinder.

This knock sensor is a piezo-electric type which converts knocking vibrations into electric signals.

It consists of a piezo-electric element, weight, and case.

If knocking occurs in the engine, the weight in the case moves causing the piezo-electric element to generate a voltage.

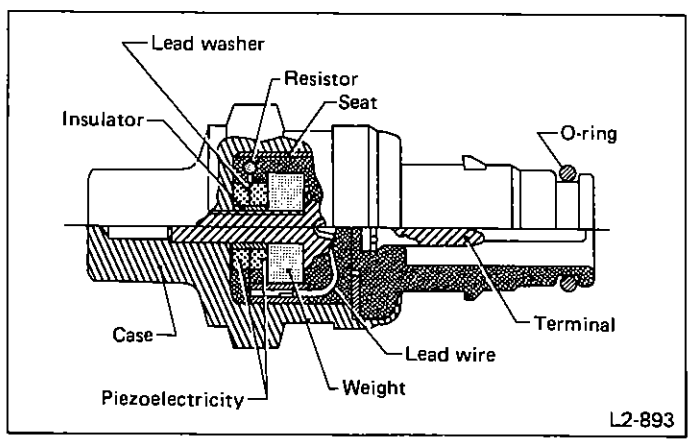


Fig. 81

Air-Fuel Ratio Learning Control System

This system has been developed to stabilize the quality of the hot-wire type air flow meter and fuel injector and to maintain their original performance by correcting their qualitative variation and aging.

By learning the feedback control amount of the O_2 sensor, the system controls the control unit to automatically set a coefficient of correction; thereby, the fuel injector always achieves fuel injection under the optimum condition.

O_2 Sensor

The O_2 sensor is mounted on the center exhaust pipe between the turbocharger and the rear exhaust pipe. It is used to sense oxygen concentration in the exhaust gas. If the fuel ratio is leaner than the stoichiometric ratio in the mixture (i.e. excessive amount of air), the exhaust gas contains more oxygen. To the contrary, if the fuel ratio is richer than the stoichiometric ratio, the exhaust gas hardly contains oxygen.

Therefore, examination of the oxygen concentration in exhaust gas makes it possible to show whether the air/fuel ratio is leaner or richer than the stoichiometric ratio.

The O_2 sensor has a zirconia tube (ceramic) which generates voltage if there is a difference in oxygen concentration between the inside and outside of the tube. Platinum is coated on the inside and outside of the zirconia tube for the purpose of catalysis and electrode provision. The hexagon screw on the outside is grounded to the exhaust pipe, and the inside is connected to the MPFI control unit through the harness.

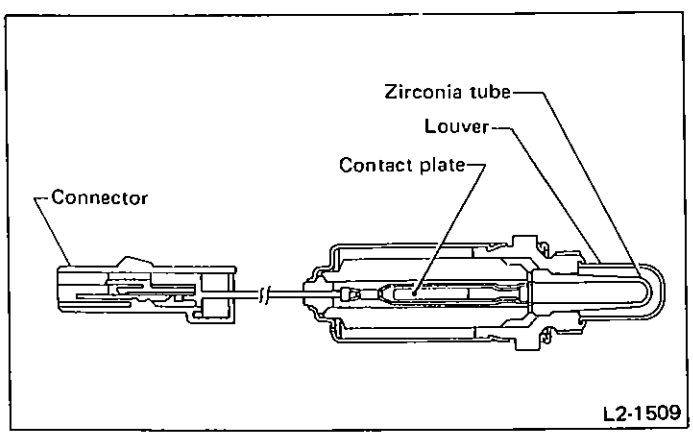


Fig. 82

When rich air-fuel mixture is burnt in the cylinder, the oxygen in the exhaust gases reacts almost completely through the catalytic action of the platinum coating on the surface of the zirconia tube. This results in very large difference in the oxygen concentration between the inside and outside, and the electromotive force generated is large.

When a lean air-fuel mixture is burnt in the cylinder, oxygen remains in the exhaust gases even after the catalytic action, and this results in small difference in the oxygen concentration. The electromotive force is very small.

The difference in oxygen concentration changes greatly in the vicinity of the optimum air-fuel ratio, and hence the change in the electromotive force is also large. By inputting this information into the MPFI control unit, the air-fuel ratio of the supplied mixture can be determined easily. The O_2 sensor does not generate much electromotive force when the temperature is low. The characteristics of the electromotive force stabilize at temperatures of approximately 300 to 400°C (572 to 752°F).

On California models, a ceramic heater is used to improve performance at low temperatures.

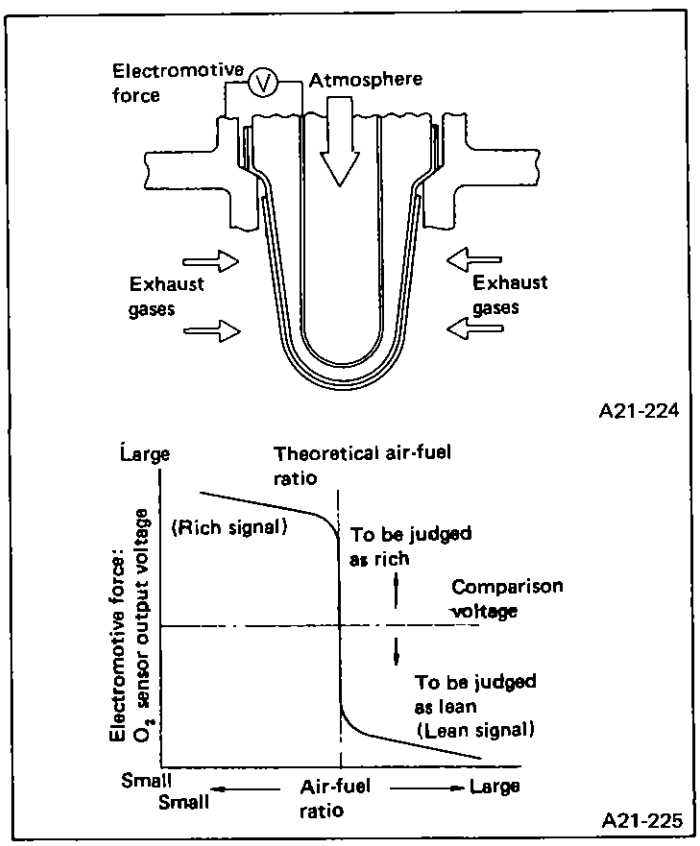


Fig. 83

Fuel Injector

The fuel injector injects fuel according to the valve open signal received from the MPFI control unit.
The nozzle is attached on the top of the fuel injector. The needle valve is lifted by the solenoid coil through the plunger on arrival of the valve open signal.
Since the injection opening, the lifted level of needle valve and the regulator-controlled fuel pressure are kept constant, the amount of fuel to be injected can be controlled only by the valve open signal from the MPFI control unit.

At the fuel inlet of the injector, the filter is mounted to prevent dust from entering.

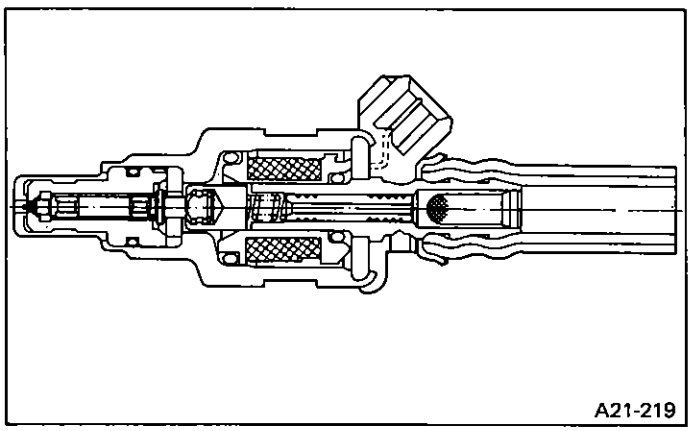


Fig. 84

Auxiliary Air Valve

The auxiliary air valve is used to increase air flow when the engine is started up at a low temperature and the following warmup is performed. It consists of the coiled bimetal, the bimetal-operated shutter valve, and the electric heater element for bimetal. The passing air flow (at start-up) is increased as the temperature becomes lower. After start-up of the engine, the heating is performed by the heater to which current is supplied from the fuel pump relay circuit. Thereby, the shutter valve turns gradually to decrease the air flow. After a certain elapsed time, the shutter valve is closed.

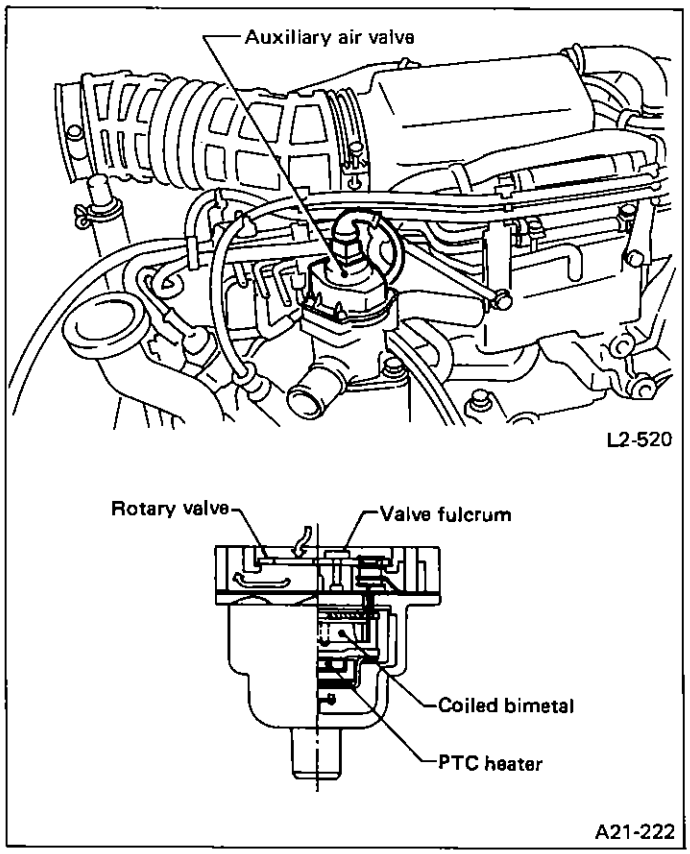


Fig. 85

Coolant Thermosensor

The coolant thermosensor is equipped on the waterpipe which is made of aluminum alloy. Its thermistor changes resistance with respect to temperature.
To the MPFI control unit, the thermosensor sends the coolant temperature signal which is decisive for the fuel volume to be injected.

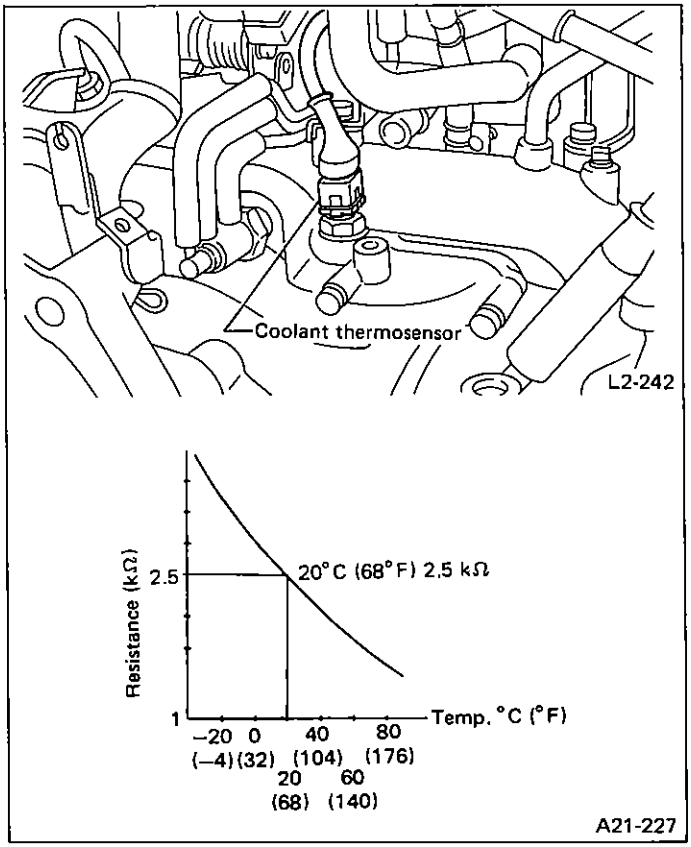


Fig. 86

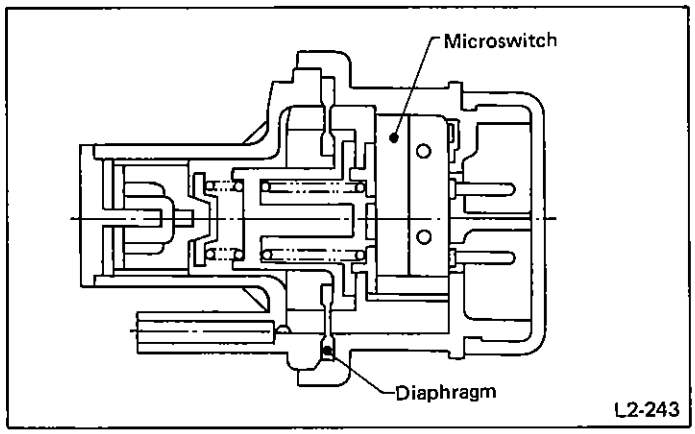


Fig. 87

Pressure Switch

Two positive pressure switches, which are combinations of a pressure withstanding diaphragm and microswitch, are mounted in front of the body strut mount. One switch operates when the intake manifold pressure reaches +6.7 kPa (+50 mmHg, +1.97 inHg) causing the TURBO indicator lamp to illuminate indicating that the turbocharger has begun its supercharging operation. At the same time, it also transmits the heavy load signal to the MPFI control box for cancelling the air-fuel ratio feedback control. The other switch operates at a pressure of +62.7 kPa (+470 mmHg, +18.50 inHg) for cutting off fuel when an abnormal rise in supercharging pressure occurs, due to a failed turbocharger waste gate or other fault, thereby preventing damage to the engine.

Pressure Regulator

The pressure regulator is divided into the fuel chamber and the spring chamber by the diaphragm as illustrated below. Fuel is fed to the fuel chamber through the fuel inlet connected with the injector. A difference in pressure between the fuel chamber and the spring chamber connected with the intake manifold causes the diaphragm to be pushed down, and fuel is fed back to the fuel tank through the return line.

By returning fuel so as to balance the above pressure difference and the spring force, the fuel pressure is kept at a constant level 250.1 kPa (2.55 kg/cm^2, 36.3 psi) against the intake manifold pressure.

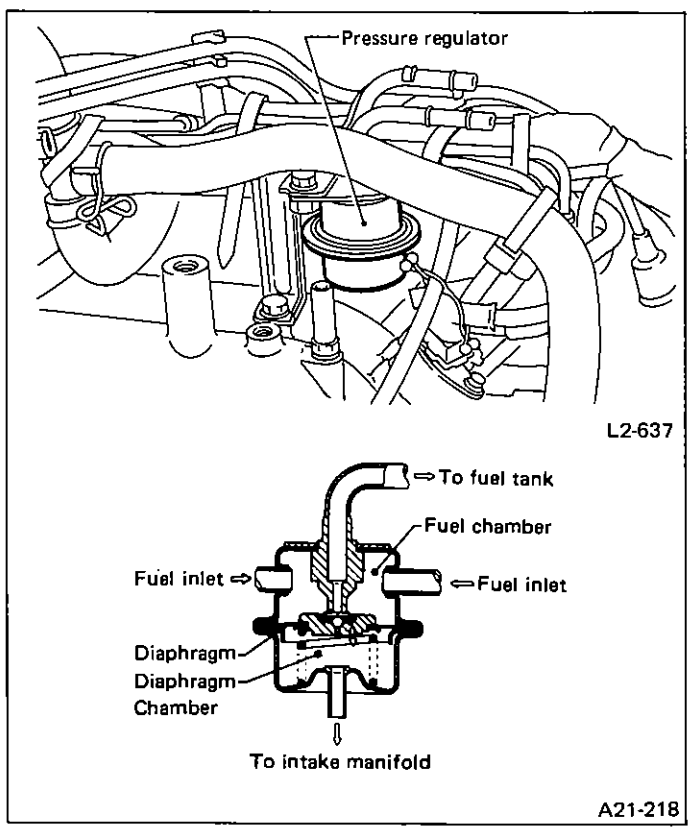


Fig. 88

Turbocharger System

General

The turbocharger performs supercharging with use of the wasted energy in the high temperature exhaust gas. It provides the following features:

- Less power loss with use of the exhaust gas energy.
- Light in weight and compact in size for better adaptability.
- Better matching with the engine load.
- Easy and efficient adjustment of the supercharge pressure by bypassing through the exhaust gas passage.

The turbocharger system for recent passenger cars places emphasis on low speed rather than high speed. More specifically, its supercharging performance is designed to be effective even at low engine speed with larger torque for enhancing both the fuel efficiency and power output. (In contrast, the conventional turbocharger is effective only at high engine speed.) The turbocharging effective at low engine speed minimizes a drawback of the conventional system which must take a certain time before the supercharging becomes effective through acceleration from low speed.

In the engineering of this turbocharger system, particular consideration has been given to the above performance. With the optimum turbocharger design and the suitable tuning of intake and exhaust systems, it is capable of providing powerful torque even at low speed, quick response and superb operability.

Regulation of Supercharging Pressure

BASIC FUNCTION OF THE WASTE GATE VALVE

As the engine speed increases with the opening of the throttle valve, the amount of exhaust gas increases. This leads to increase in the rotational speed of turbine (approx. 20,000 to 120,000 rpm), the supercharging pressure and the output.

However, excessive supercharging pressure may cause occurrence of the knocking and heavier thermal load on such a part as piston. In the worst case, the engine may be damaged or broken. To prevent this, the waste gate valve and its controller are equipped. By sensing the supercharging pressure, the waste gate valve restricts it below a predetermined level.

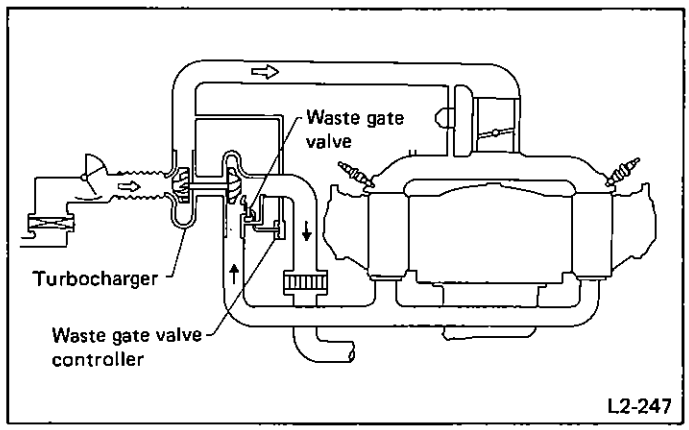


Fig. 89

While the supercharging pressure is lower than the predetermined level, the waste gate valve is closed so that all the exhaust gas is carried through the turbine.

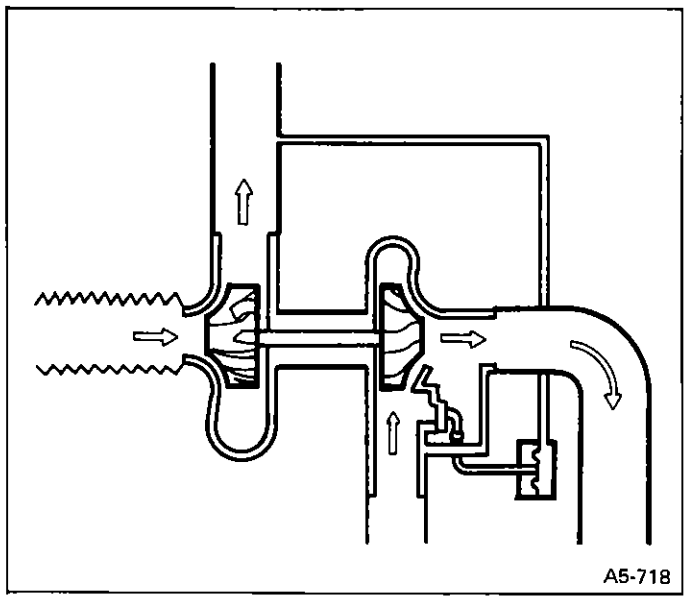


Fig. 90

When it reaches the predetermined level, the waste gate controller lets the supercharging pressure to press the diaphragm, causing the linked waste gate valve to open.

With the waste gate-valve opened, a part of the exhaust gas is allowed to flow into the exhaust gas pipe by bypassing the turbine.

This decreases the turbine rotating energy to keep the supercharging pressure constant.

It means $P_2 - P_1$ = constant

P_1 : Atmospheric pressure

P_2 : Supercharging pressure

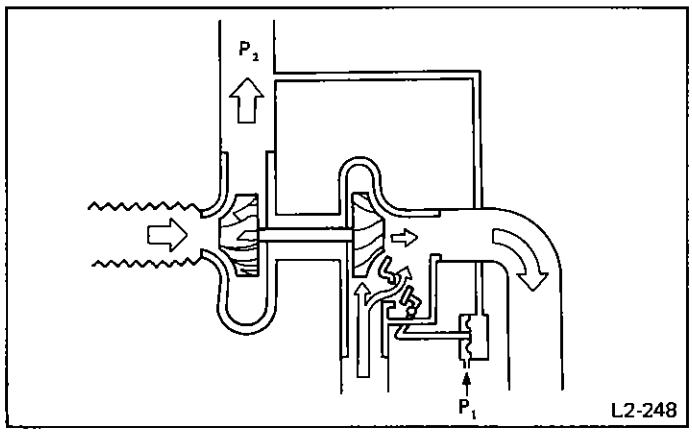


Fig. 91

Max P_2 = const (Absolute pressure 152.0 – 154.6 kPa (1,140 – 1,160 mmHg, 44.88 – 45.67 inHg)

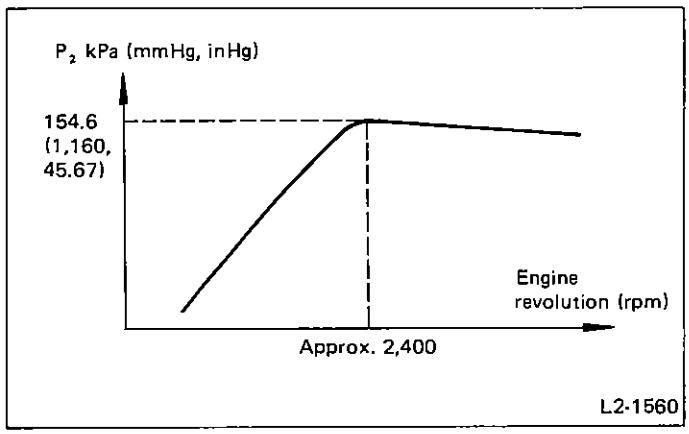


Fig. 93

CONCEPT OF THE WASTE GATE VALVE CONTROL

The higher the altitude, the lower the atmospheric pressure (P_1) and supercharging pressure (P_2). The duty solenoid valve acts as a control to maintain maximum supercharging pressure (P_2) under absolute pressure.

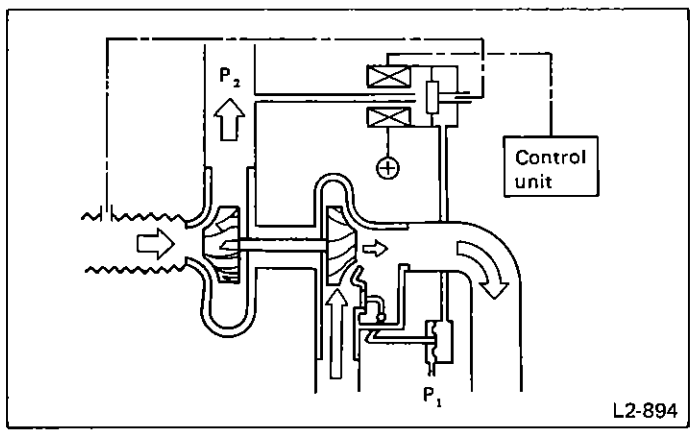


Fig. 92

Lubrication of Turbocharger

The turbocharger is lubricated by the engine oil branched out from the oil pump. Since the turbocharger turbine and the compressor shaft reach a maximum of several hundred thousand revolutions per minute, the full-floating type bearings are used to form desirable lubrication films on their inside and outside during running.

Further the oil supplied to the turbocharger also plays an important role of cooling the heat from exhaust gas in the turbine not to propagate to the bearings.

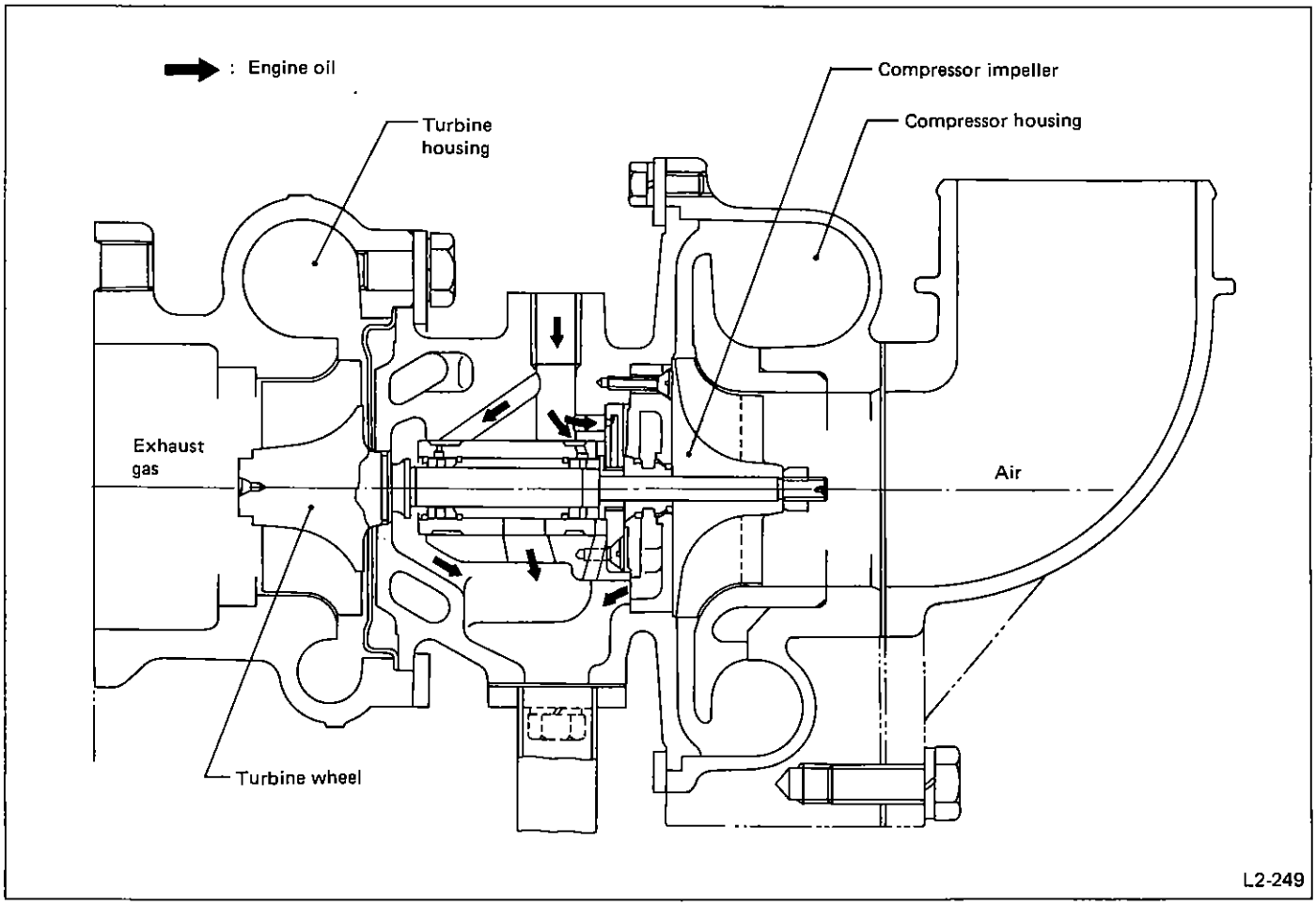


Fig. 94

Cooling of Turbocharger

The turbocharger is water cooled for higher reliability and durability. The coolant from the coolant drain hose under the engine cylinder head is led to the coolant passage, through a pipe, provided in the turbocharger bearing housing. After cooling the bearing housing, the coolant is led into the thermostat case in the intake manifold through a pipe.

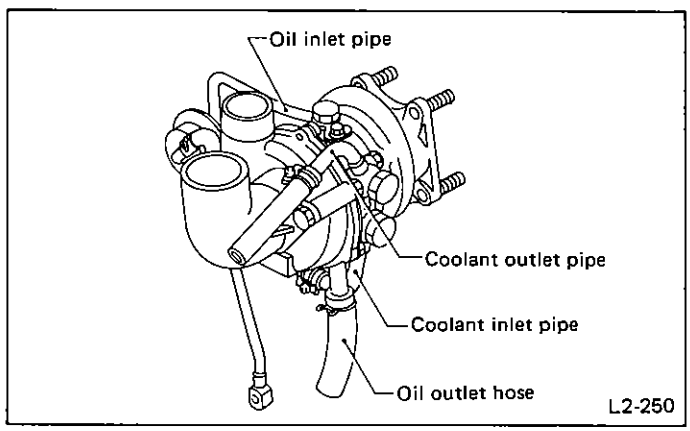


Fig. 95

Multi Point Fuel Injection System

SCHEMATIC DRAWING OF MPFI SYSTEM

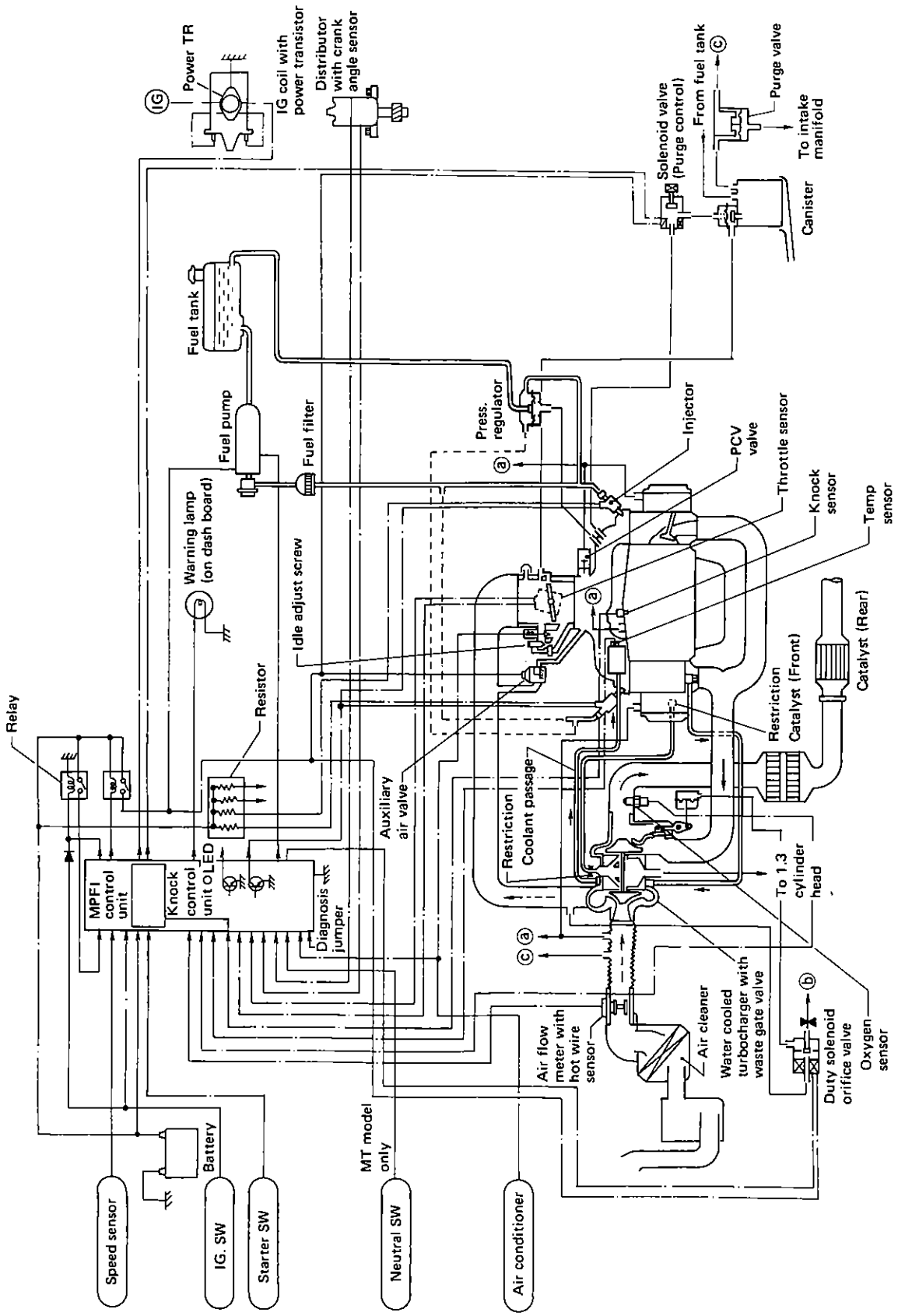
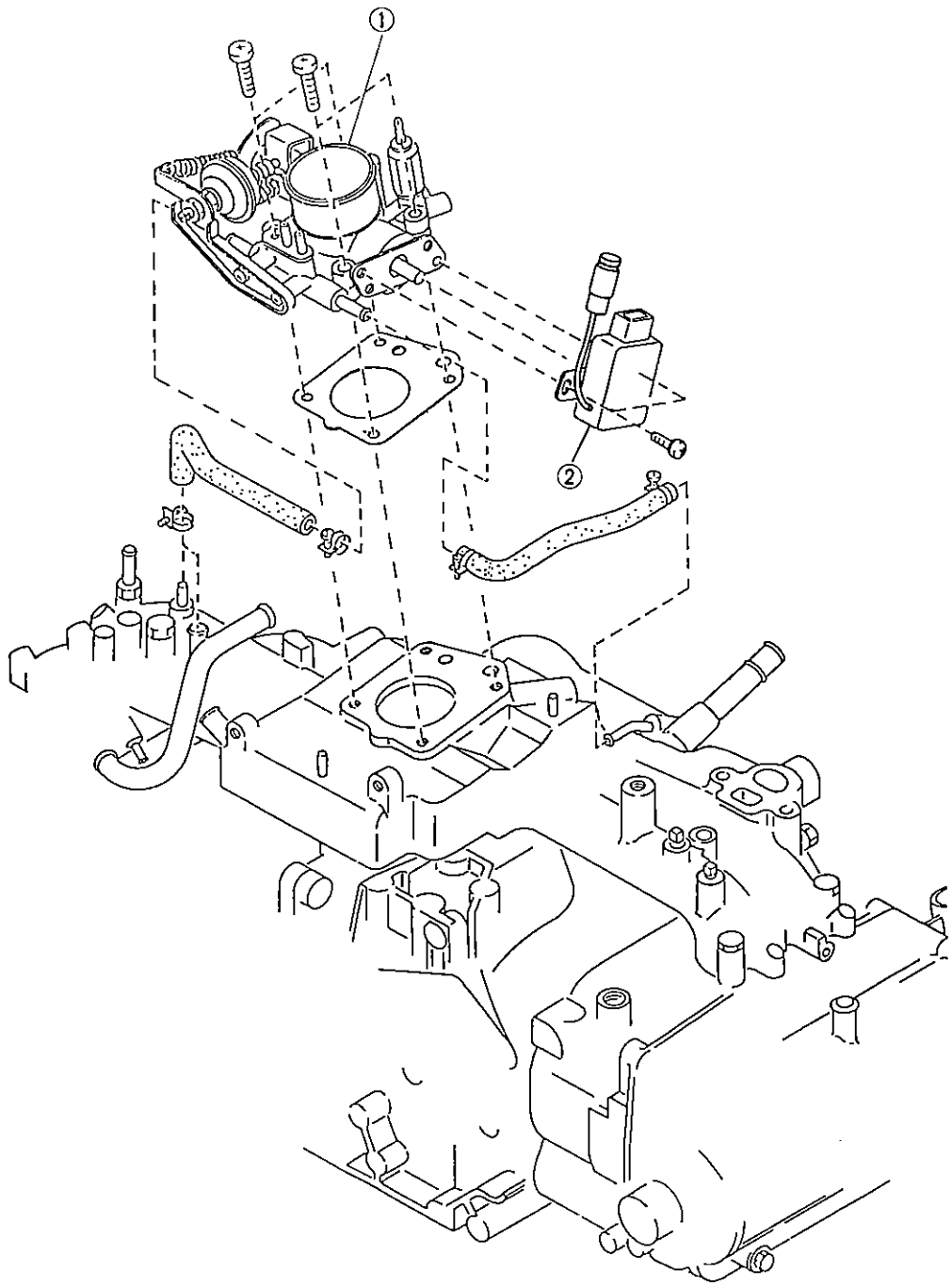


Fig. 4

L2-1680

COMPONENT PARTS

Throttle Body



1 Throttle body
2 Throttle switch

Fig. 5

L2-1685

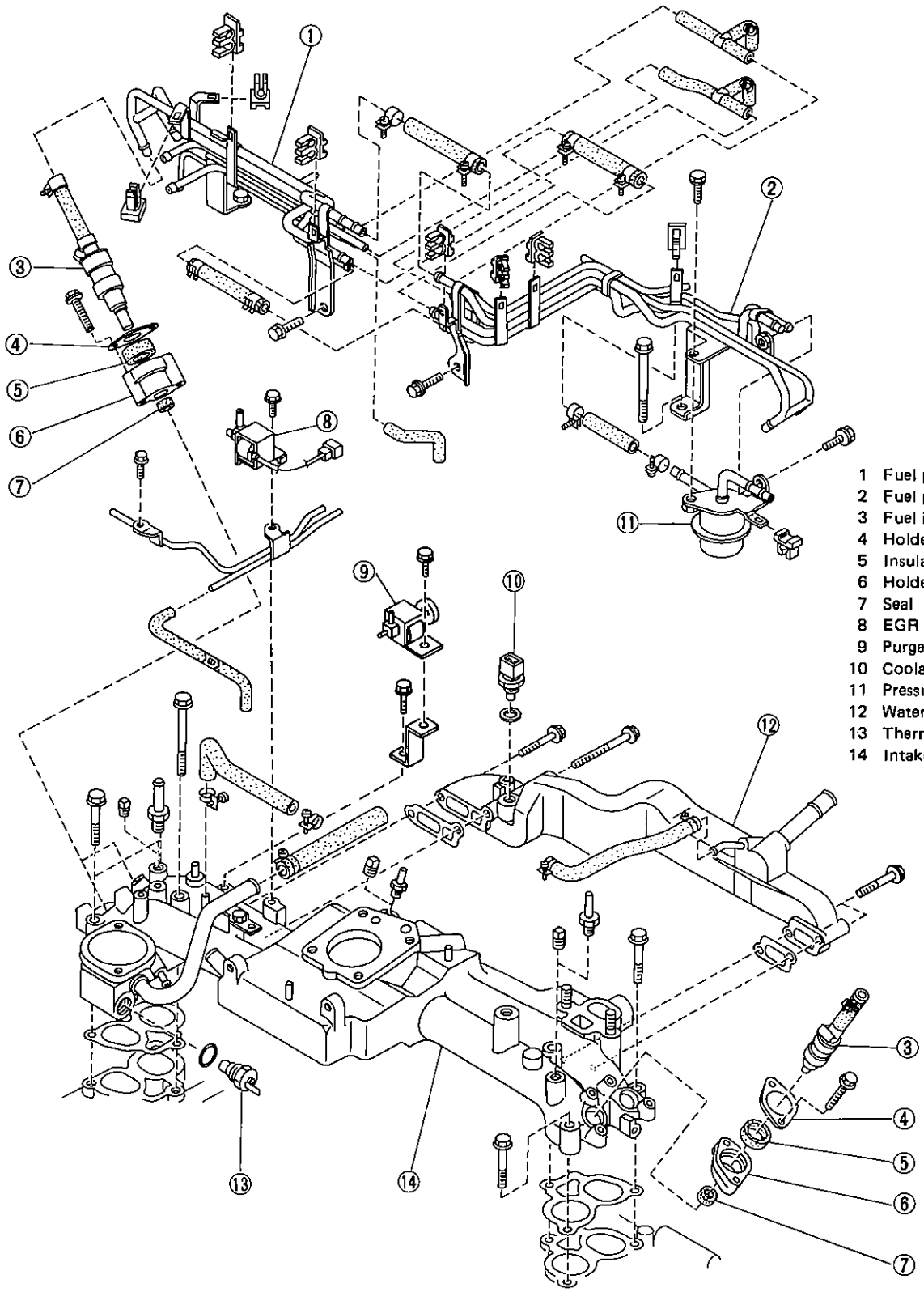
TROUBLESHOOTING

Self-diagnosis System

List of Trouble Codes

Trouble code	Item	See page
11	Crank angle sensor (No reference pulse)	p128
12	Starter switch (Continuously in ON position or continuously in OFF position while cranking)	p130
13	Crank angle sensor (No position pulse)	p131
14	Fuel injectors #1 and #2 (Abnormal injector output)	p133
15	Fuel injectors #3 and #4 (Abnormal injector output)	p134
21	Water temperature sensor (Open or shorted circuit)	p135
22	Knock sensor (Open or shorted circuit)	p136
23	Air flow meter (Open or shorted circuit)	p137
31	Throttle sensor (Open or shorted circuit)	p138
32	O_2 sensor (Abnormal sensor signal)	p139
33	Car-speed sensor (No signal is present during operation)	p141
35	Purge control solenoid valve (Solenoid switch continuously in ON or OFF position)	p143
41	System too lean	p144
42	Idle switch (Abnormal idle switch signal in relation to throttle sensor output)	p145
44	Duty solenoid valve (Waste gate control)	p147
51	Neutral switch (Continuously in ON position)	p146

Intake Manifold

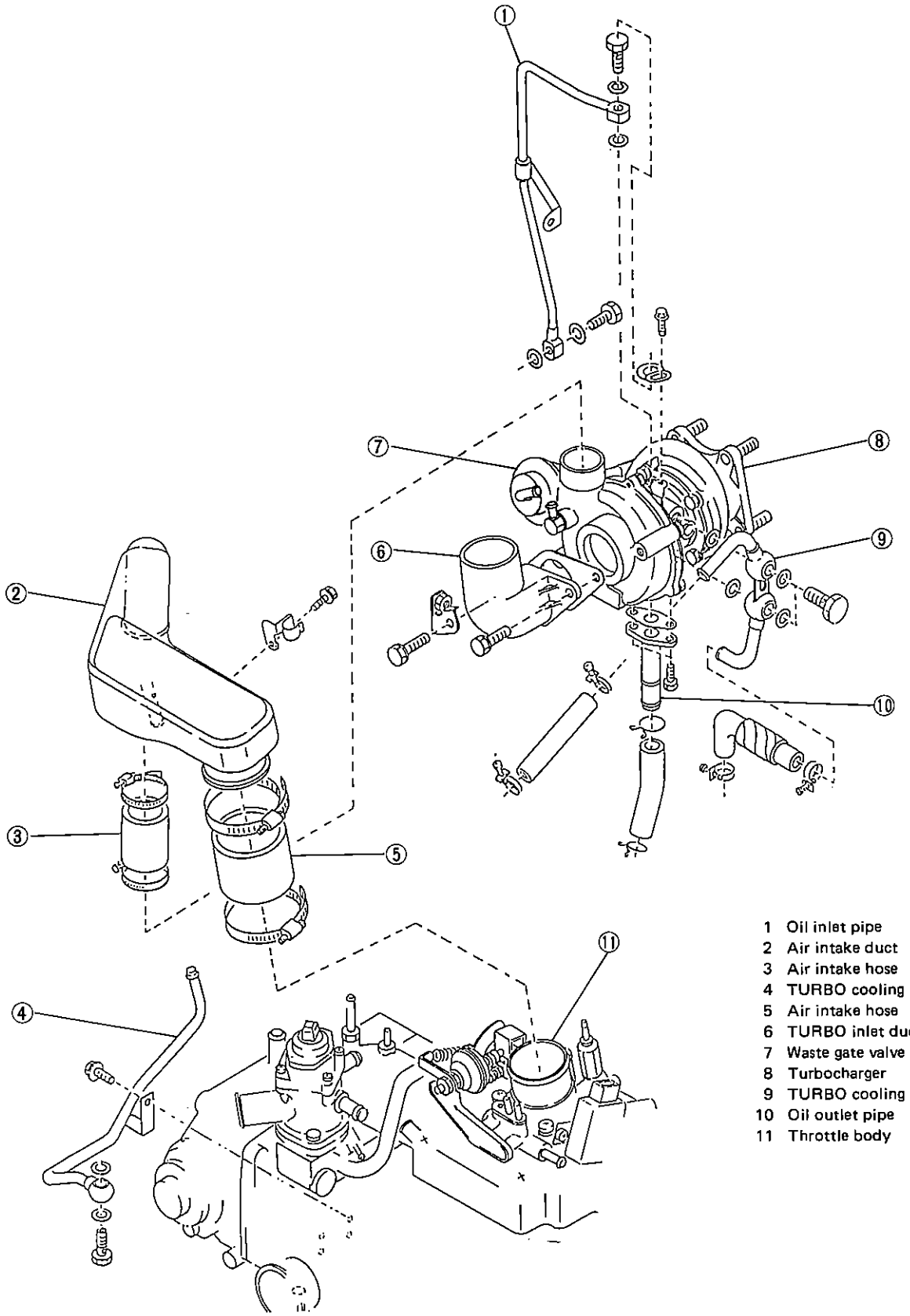


1 Fuel pipe ASSY RH
2 Fuel pipe ASSY LH
3 Fuel injector
4 Holder plate
5 Insulator
6 Holder
7 Seal
8 EGR solenoid valve
9 Purge control solenoid valve
10 Coolant thermosensor
11 Pressure regulator
12 Water pipe
13 Thermometer
14 Intake manifold

L2-898

Fig. 98

Turbocharger

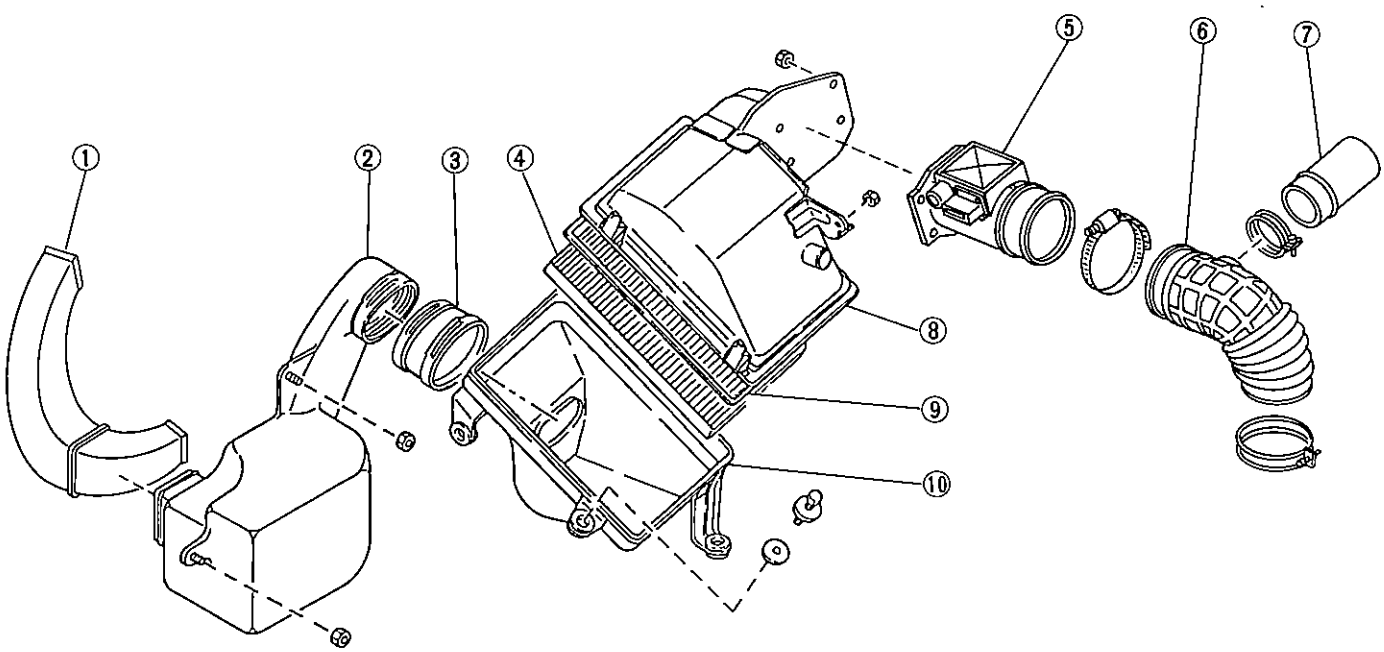


1 Oil inlet pipe
2 Air intake duct
3 Air intake hose
4 TURBO cooling inlet pipe
5 Air intake hose
6 TURBO inlet duct
7 Waste gate valve controller
8 Turbocharger
9 TURBO cooling pipe
10 Oil outlet pipe
11 Throttle body

Fig. 99

L2-899

Air Intake System



1 Chamber duct 1
2 Chamber
3 Chamber duct 2
4 Air cleaner element
5 Air flow meter ASSY
6 Air intake boot
7 Duct B
8 Upper case
9 Gasket
10 Lower case

L2-900

Fig. 100

SERVICE PROCEDURE

Precautions in Servicing

1) Never connect the battery in reverse polarity.
- The MPFI control unit will be destroyed instantly.
- The fuel injector and other part will be damaged in just a few minutes more.

2) Do not disconnect the battery terminals while the engine is running.
- A large counter electromotive force will be generated in the alternator, and this voltage may damage the electronic parts such as MPFI control unit, etc.

3) Before disconnecting the connectors of each sensor and the MPFI control unit, be sure to turn off the ignition switch.
- Otherwise, the MPFI control unit may be damaged.

4) The connectors to each sensor in the engine compartment and the harness connectors on the engine side and body side are all designed to be waterproof. However, it is still necessary to take care not to allow water to get into the connectors when washing the vehicle, or when servicing the vehicle on a rainy day.

5) Every MPFI-related part is a precision part. Do not drop them.

6) Observe the following cautions when installing a radio in MPFI equipped models.

a. The antenna must be kept as far apart as possible from the control unit.
(The MPFI control unit is located under the steering column, inside of the instrument panel lower trim panel.)
b. The antenna feeder must be placed as far apart as possible from the MPFI control unit and MPFI harness.
c. Carefully adjust the antenna for correct matching.
d. When mounting a large power type radio, pay special attention to items a. thru c. above.

- Incorrect installation of the radio may affect the operation of the MPFI control unit.

7) Before disconnecting the fuel hose, disconnect the fuel pump connector and crank the engine for more than five seconds to release pressure in the fuel system. If engine starts during this operation, run it until it stops.

4) Check for foreign matter, water, or oil in the air passages, especially in the by-pass. If any abnormality is noticed, replace the air flow sensor.

5) If no defect is found in the visual checks above, conduct the following inspections.

(1) Turn the ignition switch OFF (engine off).
(2) Attach the air flow meter to the air cleaner.
(3) Disconnect the air flow meter, and remove the rubber cover from the connector.
Conduct the following checks by attaching the tester check pins to the connector terminals on the side from which the rubber cover has been removed.

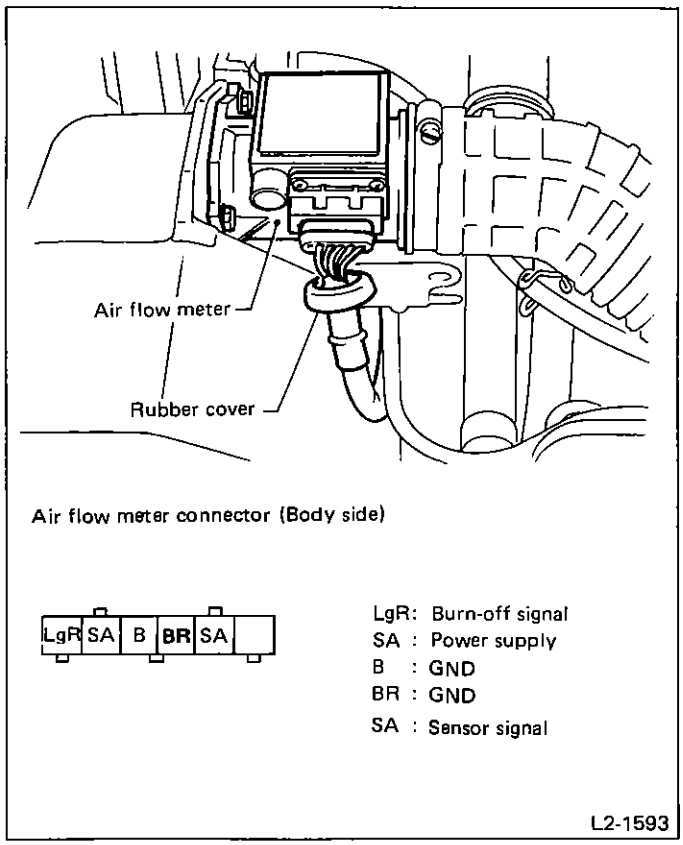


Fig. 101

Air Flow Meter

INSPECTION

1) Check for leaks or damage in the connection between the air intake boot and air flow meter. Repair any defect noted.

2) Remove the connectors from the air flow meter, the air intake boot, and the air flow meter for the air cleaner case in the order stated.

3) Check the exterior of the air flow meter for damage.

(4) Measure resistance between the body and ground terminals (B) and (BR).

Specified resistance:
10Ω, max.

If resistance is greater than 10Ω, check the harness and internal circuits of the control unit for discontinuity, and the ground terminal on the intake manifold for poor contact.

(5) Turn the ignition switch ON (engine off).

(6) Connect the air flow meter connector.
(7) Measure voltage across power terminal (SA) and the body.

Specified voltage:
10 V, min.

If voltage is outside specifications, check the condition of the parts (battery, fuse, control unit harness, connector, etc.) in the power line.
(8) Attach the positive lead of a tester to signal terminal (SA) and the negative lead to the ground terminal (BR). Measure the voltage across the two terminals.

Specified voltage:
1 – 2 V

If voltage is outside specifications, replace the air flow meter.

(9) Remove the air flow meter from the air cleaner. (The air intake boot need not be removed.)
(10) Blow air from the air cleaner side to check if voltage across terminals (SA) and (B) is greater than that measured in step (7) above. If not, replace the air flow meter.
(11) Install the air flow meter on the air cleaner.
(12) Start the engine.
(13) Warm up the engine until the coolant temperature reaches approximately 80°C (176°F).
(14) Drive at speed greater than 24 km/h (15 MPH) for at least one minute.
(15) Race engine above, 2,000 rpm.
(16) While idling the engine, monitor voltage across terminal (LgR) of the air flow meter connector and the body. (0 V under normal operating conditions is OK.)
(17) Turn the ignition switch OFF. Check if 12 volts are present across the terminal (LgR) and the body for one second shortly after the ignition switch has been turned OFF. If not, check the harness from the control unit to the air flow meter for discontinuity.

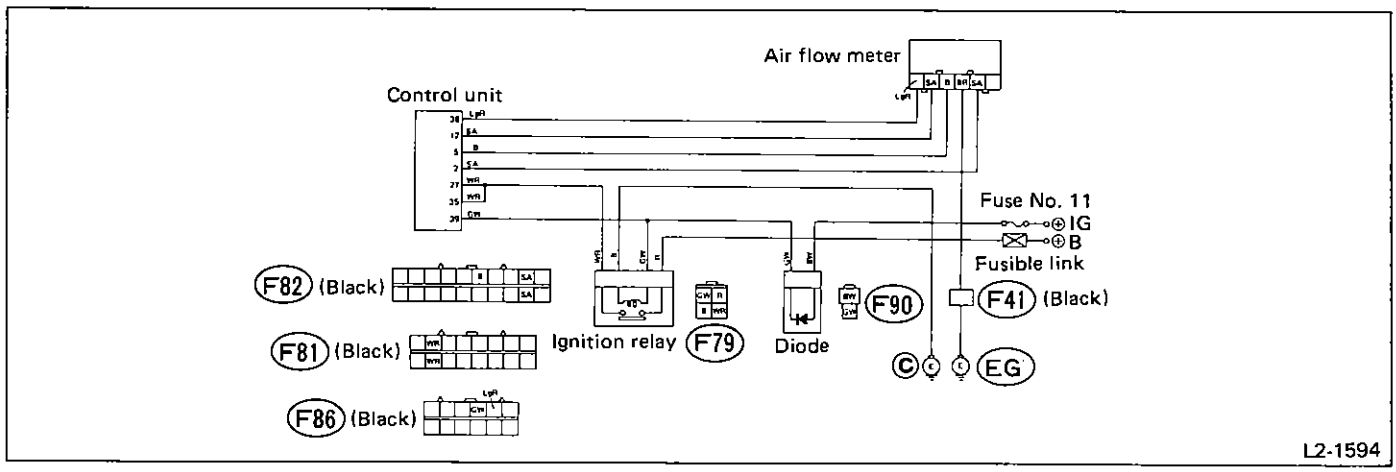


Fig. 102

Throttle Body

INSPECTION AND ADJUSTMENT

THROTTLE SENSOR

Idle contact

Insert a thickness gauge between the stopper screw of the throttle body and the stopper (portion Ⓖ), and check for continuity between (Ⓐ and Ⓒ).
1) Make sure that Ⓐ and Ⓒ are conducting when the throttle is closed fully.
2) Make sure that Ⓐ and Ⓒ are conducting when the thickness of gauge is 0.55 mm (0.0217 in) (this corresponds to throttle opening of 1.5°).
3) Make sure that Ⓐ and Ⓒ are not conducting when the thickness is 0.92 mm (0.0362 in) (this corresponds to a throttle opening of 2.5°).
4) If the above standards are not satisfied, loosen the screws (two) securing the throttle switch to the throttle body, and turn the throttle switch main body until the correct adjustment is obtained.

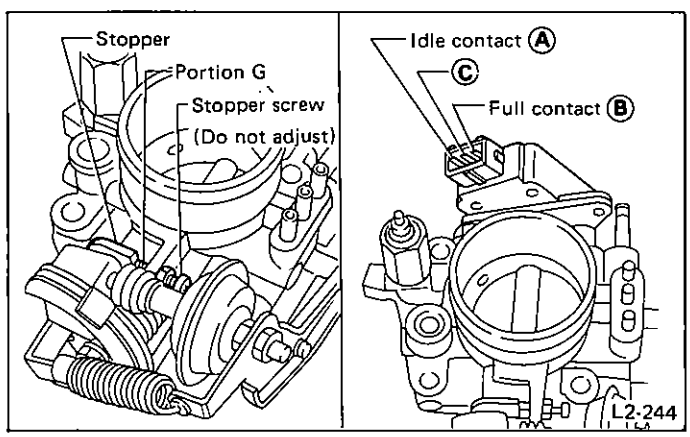


Fig. 103

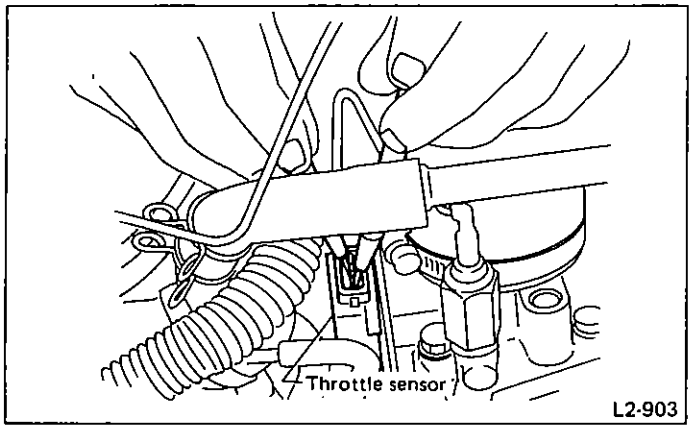


Fig. 104

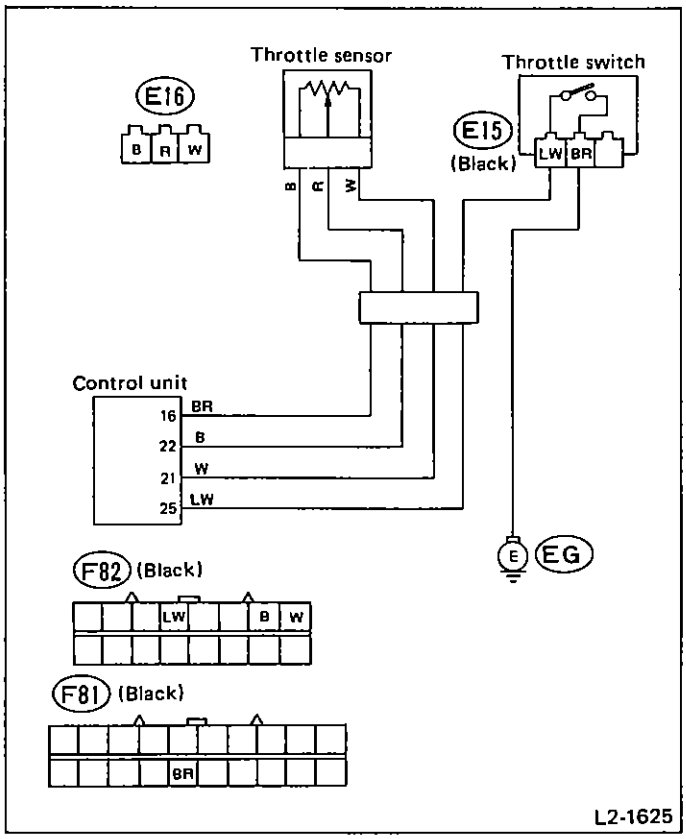


Fig. 105

Throttle opening signal

1) Measure resistance between terminals ① and ③.

Specified resistance:
6 – 18 kΩ

If resistance is outside specifications, replace the sensor.

2) Measure resistance between terminals ① and ②.

Specified resistance:
5.8 – 17.8 kΩ (Throttle closed)
1.5 – 5.1 kΩ (Throttle open)

Ensure that resistance changes smoothly between the fully-closed and fully-opened throttle positions. If resistance is outside specifications, replace the sensor.

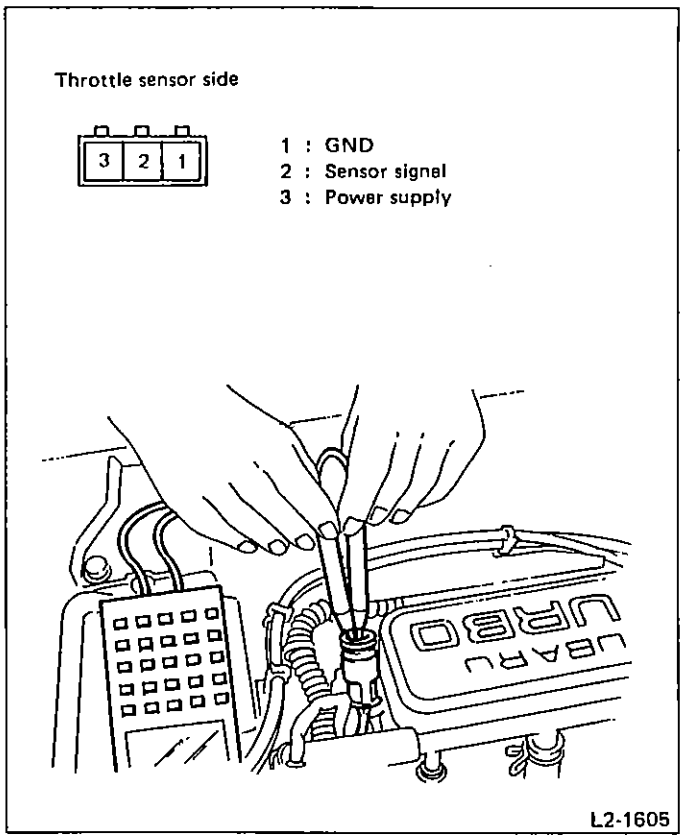


Fig. 106

DASH POT

1) Warm-up the engine sufficiently, and check that the idle speed is as specified.
2) Under the non-loaded state, turn the throttle lever by hand and increase engine speed until the end of the dash pot is off the throttle cam.
3) Gradually return the throttle lever, and read the engine rpm when the throttle cam contacts the end of the dash pot.

Engine rpm	2,800 – 3,400

4) If the engine rpm is not within this range, loosen the lock nut of the dash pot, and turn the dash pot until this specification is satisfied. After adjustment, tighten the lock nut securely.
5) After adjustment, race the engine and make sure the idle speed returns correctly to the idle speed as the throttle is released.

Fuel Injector and Resistor

INSPECTION

Using a stethoscope or a long-type screwdriver, make sure of operating noise (clicking sound) of each injector.
If this operating noise cannot be heard on any injector;
1) Disconnect the control unit connector (F80).
Measure voltage across the body and terminals 49 (W), 50 (W), 51 (WR) and 52 (WR) of control unit connector (body side), respectively.

Specified voltage:
12 V [Circuits ① through ⑦ in figure are all OK.]

If voltage is below 10 V in any line, the affected harness from the battery to the control unit through the resistor and injector is broken or shorted.
2) Disconnect each fuel injector connector.
Measure resistance between the terminals of each connector.

Specified resistance:
2 – 3Ω [Circuit ⑤ is OK.]

If resistance is greater than 1 MΩ, the affected harness is broken. If 0Ω, the harness is shorted. Replace the injector.
3) Measure voltage across power terminals RW, RB, R and RL (engine harness side) and the body.

Specified voltage:
12 V [Circuits ① through ④ are OK.]

If voltage is less than 10 V, the harness from the battery to the injector through the resistor is discontinued or shorted.
4) Disconnect the connector (F92) from the resistor.
Measure resistance between terminals W and B of the resistor.

Specified resistance:
5.8 – 6.5Ω [Circuit ② is OK.]

If resistance is outside specifications, replace the resistor.
5) Measure voltage across terminal 5 (R) of body harness connector and the body.

Specified voltage:
12 V [Circuit ① is OK.]

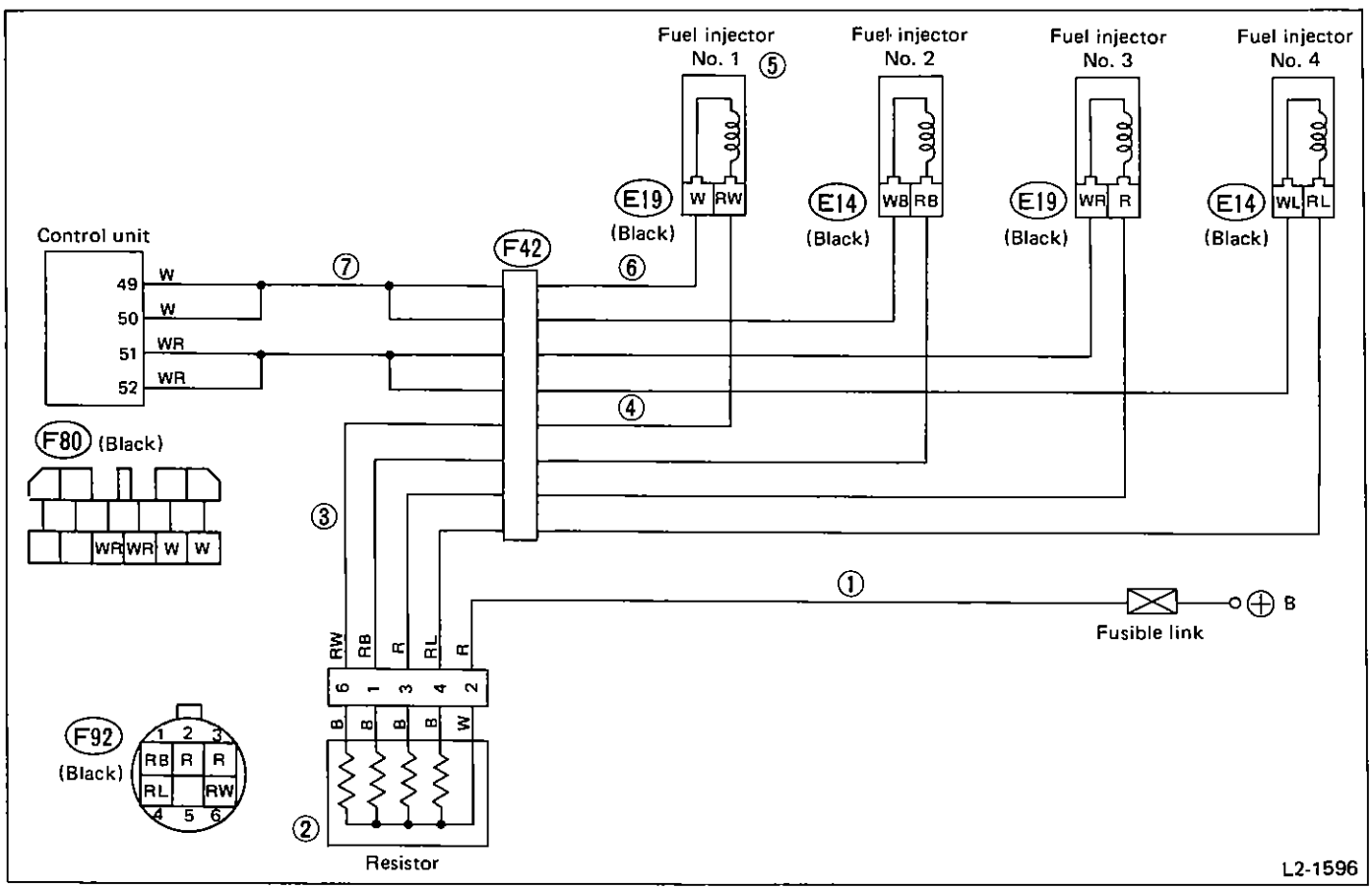


Fig. 107

Auxiliary Air Valve

INSPECTION

1) Pinch the hose connecting the air intake duct and auxiliary air valve and observe how the engine speed changes.

State of engine	Engine speed
When engine is cold	Engine idle speed drops as the hose is pinched.
When engine is hot	Reduction in engine speed is within 100 rpm.

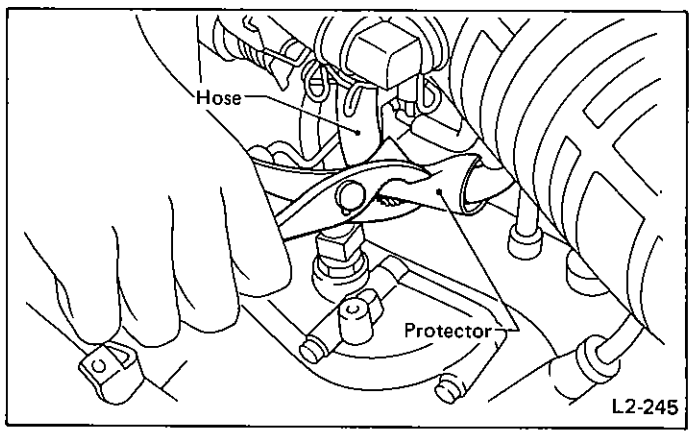


Fig. 108

When pinching the hose, cover it with a rubber plate or the like for protection.

2) As the engine is started, the auxiliary air valve is heated by the built-in heater and its shutter valve closes gradually. This causes the engine rpm to be lowered gradually until the specified idling rpm is reached.
If the engine speed will not drop to the idling rpm smoothly, the heater circuit or the heater power supply circuit may be faulty. In this case, perform the following checks;

(1) Check the resistance value of the auxiliary air valve.
Disconnect the connector of the auxiliary air valve and measure the resistance between the two terminals, using a circuit tester.

Resistance value must be other than zero (0) and infinity (∞).

If the resistance is zero (0) or infinity (∞), replace the auxiliary air valve with a new one.

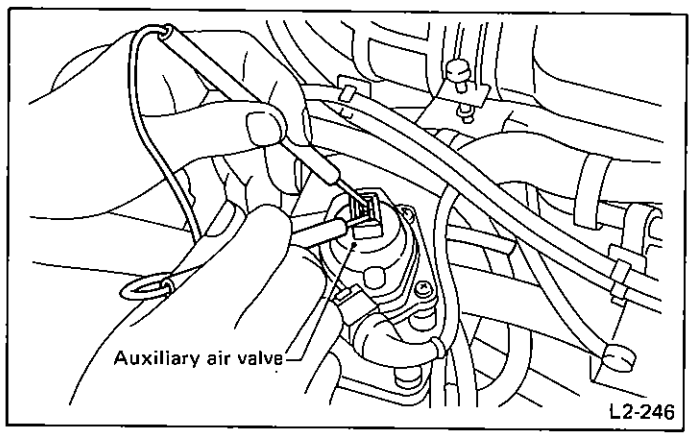


Fig. 109

(2) Check source voltage.
Disconnect the connector of the auxiliary air valve, and check voltage on the harness side.

Voltage (when engine is running):
Over 12V

If the voltage is 0V or lower than 12V, check the harness and connector for condition.

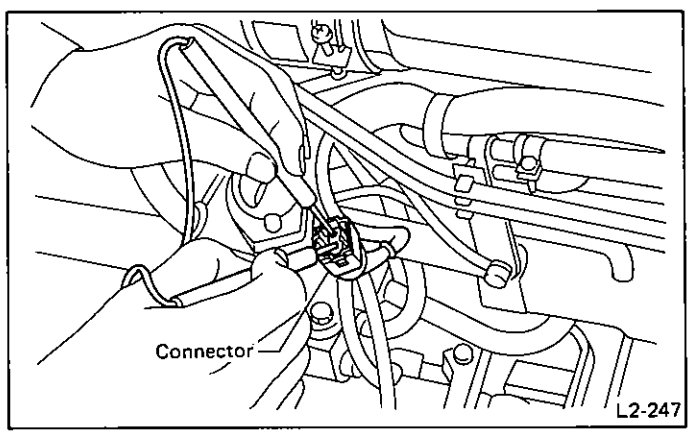


Fig. 110

3) If item 2) above is normal but only item 1) is faulty, the cause may be as follows:

	Cause of trouble	Symptom	Remedy
1	Sticking of shutter valve of auxiliary air valve. (Sticking in closed direction)	• Engine stalls easily when engine is cold.	Replace auxiliary air valve.
2	Sticking of shutter valve of auxiliary air valve. (Sticking in open direction)	• Engine rpm does not lower smoothly during warm-up operation. • Engine rpm remains high.	
3	Clogged air passage.	Same as ①	Check air passage, such as hose, etc. and clean.

Coolant Thermosensor

INSPECTION

Put the thermosensor in water of various temperatures and measure the resistance between terminals using a circuit tester.
If the resistance value is too much out of these ranges, replace the thermosensor with a new one.

Water temperature °C (°F)	Resistance value
−10 (14)	7 – 11.5 kΩ
20 (68)	2 – 3 kΩ
50 (122)	700 – 1,000Ω

Pressure Regulator

The pressure regulator adjusts the fuel pressure to 250.1 kPa (2.55 kg/cm^2, 36.3 psi) compared to the intake manifold pressure.

INSPECTION

Disconnect the fuel hose at the pressure regulator connecting portion and install a fuel gauge.

a. Before disconnecting the fuel hose, first disconnect the fuel pump connector and crank the engine (more than five seconds) to release the pressure in the fuel system. If the engine is started by this cranking, run it until it stops.
b. Be sure to clamp the hose at the connecting portion.

1) When checking with the engine running
(1) Measure the fuel pressure when the engine is at idle speed.

Standard:
177 – 206 kPa (1.8 - 2.1 kg/cm^2, 26 – 30 psi)

(2) Race the engine, and make sure the fuel pressure increases correspondingly.

2) When checking with the engine stopped
Set the diagnosis jumper for checking the MPFI system to ON, and then turn ON the key switch. This will cause the fuel pump to operate intermittently. Measure the fuel pressure in this state.

Standard:
Fuel pump ON
Approx. 255 kPa (2.6 kg/cm^2, 37 psi)
Fuel pump OFF
Approx. 226 kPa (2.3 kg/cm^2, 33 psi)

Turbocharger System

TROUBLE DIAGNOSIS

If the turbocharger system fails, any of the following phenomena can occur.

1) Excessively high supercharging pressure:
   - Engine knocking
2) Excessively low supercharging pressure:
   - Lack of engine power
   - Poor acceleration performance
   - Considerable fuel consumption
3) Oil leak from turbocharger:
   - Excessive oil consumption
   - White exhaust smoke

(However, the phenomena 2) can also result from other causes, such as air leakage from the intake system, exhaust system leakage or obstruction, incorrect ignition timing, malfunctioning knock control system, defects in the MPFI control system.)

Phenomenon	Judgement
Supercharging pressure is in the 49.3 to 57.3 kPa (370 to 430 mmHg, 14.57 to 16.93 inHg) range.	Normal
Supercharging pressure exceeds the 57.3 kPa (430 mmHg, 16.93 inHg) upper limit.	
(1) Cracked or disconnected waste gate valve control rubber hoses	Replace or connect rubber hose.
(2) Inoperative and closed waste gate valve	Replace turbocharger.
Supercharging pressure is below the 49.3 kPa (370 mmHg, 14.57 inHg) lower limit.	Faulty turbocharger. ↓ Replace turbocharger.

INSPECTION

WASTE GATE VALVE

1) Check connecting hose between waste gate valve, turbocharger and duty solenoid valve for looseness or disconnection, as well as cracks and damage.
2) Disconnect the waste gate valve control connecting hose from actuator, and connect checking rubber hose.
Plug the disconnected rubber hose.
3) Apply air pressure [59 to 69 kPa (0.6 to 0.7 kg/cm^2, 9 to 10 psi)] to the checking rubber hose, and see whether the waste gate valve link operates or not.

Excessive pressure may cause damage to the waste gate valve control diaphragm. Be sure to check that the pressure is 59 to 69 kPa (0.6 to 0.7 kg/cm^2, 9 to 10 psi) with a pressure gauge before applying.

SUPERCHARGING PRESSURE

1) Disconnect the duty solenoid connector.
2) Disconnect the rubber hose from the pressure switch, and attach a branch connector. Lead the rubber hose into the passenger compartment, and connect it to the positive pressure gauge.
3) After warming up the engine, make a test run. Read the supercharging pressure on the positive pressure gauge when the vehicle is running at approximately 2,400 rpm with a full-open throttle.

DUTY SOLENOID VALVE (WASTE GATE CONTROL)

1) Disconnect the duty solenoid connector.
2) Measure resistance between the terminals of connector (solenoid side).

Specified resistance:
17 – 21Ω [at 20°C (68°F)]

If resistance is outside specifications, replace the solenoid.
3) Measure resistance between each terminal of solenoid connector and the body.

Specified resistance:
1 MΩ, min.

If resistance is outside specifications, replace the solenoid.

TURBOCHARGER

Oil leakage from the exhaust gas side (turbine side)

Remove the center exhaust pipe and examine the turbocharger from the exhaust gas side.
If there are excessive carbon deposits on the turbine exhaust side, oil is leaking from the turbine.
(In this case, oil may also be leaking from between the turbine chamber and bearing chamber.)

Oil leakage from the inlet side (blower side)

1) The turbocharger is not necessarily leaking oil when oil is present on the blower side. The oil is likely to have come from oil mists contained in the blowby gases flow in the inlet system.
2) When oil is leaking from the inlet system, it is accompanied by a rattle from the turbocharger shaft when it moves in an axial or radial direction. Remove the turbocharger from the engine and determine if the shaft rattles.
(Limit of rattling: Measure with a dial gauge.)

a. Axial rattling:
0.09 mm (0.0035 in)

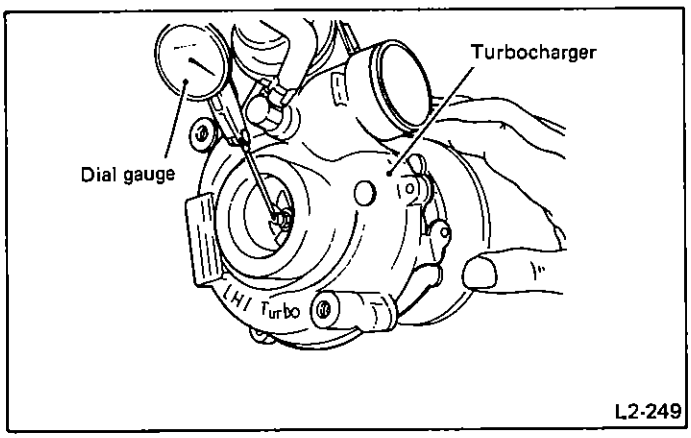


Fig. 111

b. Radial rattling:
0.17 mm (0.0067 in) when the turbine side and blower side of the shaft are moved circumferentialy at the same time.

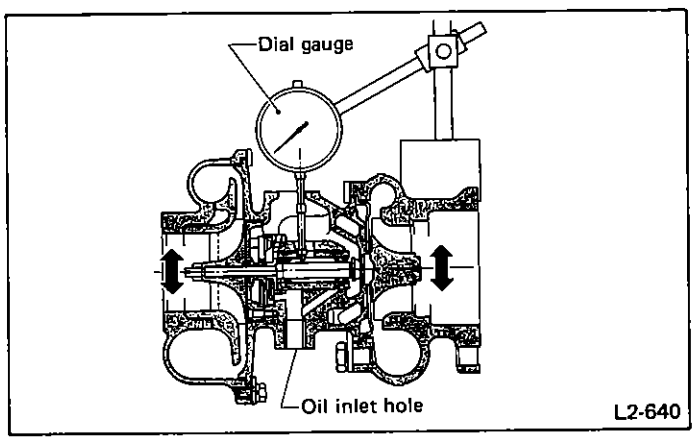


Fig. 112

If anything unusual is found, replace the turbocharger.

a. The turbocharger proper cannot be disassembled or adjusted.
b. When removing and installing the turbocharger, do not allow dirt and dust to enter the inlet and outlet openings of the turbine and blower. Any foreign matter allowed to enter, will undoubtedly damage the turbine and blower blades as soon as the turbocharger goes into operation again.
c. Likewise, cover the open end of the front exhaust pipe. If foreign matter is allowed to enter, the turbine blades will be instantaneously destroyed when the turbocharger is put into operation.

Oil leakage from the connection of the oil delivery pipe

Visually inspect the connections of the oil delivery pipe with the turbocharger and oil pump. If oil is leaking, replace the washer of the union screw and tighten it to the specified tightening torque.

Tightening torque:
14.7 – 17.7 N·m
(1.50 – 1.80 kg-m, 10.8 – 13.0 ft-lb)

Coolant leakage from connection of the cooling pipe

Visually check the connection between turbocharger and cooling pipe, between engine cylinder head and cooling pipe, and the hose clamped area for leakage of coolant. If leakage is detected, replace the washer at the union screw, and tighten the screw to the specified torque. Check the hose for cracks and damage at the clamped area before tightening the clamp. If the hose is faulty, replace with a new one.

Tightening torque:
22 – 25 N·m
(2.2 – 2.5 kg-m, 16 – 18 ft-lb)

Air Intake System

Air Cleaner Assembly

REMOVAL AND INSTALLATION

1) Disconnect connector from air flow meter.
2) Remove engine harness from clip.
3) Loosen hose clamps securing air intake boot, and remove air intake boot connecting with air flow meter.
4) Remove bolts, and detach the air cleaner ASSY from chamber.
5) Move air cleaner ASSY toward engine, and take it out from body.

Installation is in the reverse order of removal procedure.

Chamber Assembly

REMOVAL AND INSTALLATION

1) Remove mud guard.
2) Remove washer tank.
3) Remove nuts, and remove chamber ASSY from body.

Installation is in the reverse order of removal procedure.

TURBO Cover

REMOVAL AND INSTALLATION

1) Remove TURBO cover A.
2) Remove one bolt securing TURBO cover B to center exhaust pipe.
3) Remove turbocharger.
4) Remove TURBO cover B from front exhaust pipe.

Installation is in the reverse order of removal procedure.

TROUBLESHOOTING

General Troubleshooting Table

***: The CHECK ENGINE light blinks.**
***1: The CHECK ENGINE light blinks when contact is resumed during inspection (although poor contact is present in the D-check).**
***2: The CHECK ENGINE light lights when the mixture is leaner than that specified and does not light (U-check) or blink (D-check) when the mixture is richer.**
***3: The CHECK ENGINE light lights when abnormality is detected in the D-check mode if the idle switch persistently remains off with the accelerator pedal released.**

Symbols shown in the table refer to the degree of possibility of the reason for the trouble ("Very often" to "Rarely").
◎ : Very often
○ : Sometimes
△ : Rarely
☆ : Occurs only in extremely low temperatures

TROUBLE		
1	Engine will not start	No initial combustion
2		Initial combustion occurs.
3		Engine stalls after initial combustion.
4	Rough idle and engine stall	
5	Inability to drive at constant speed	
6	Inability to accelerate and decelerate	
7	Engine does not return to idle.	
8	Afterburning in exhaust system	
9	Knocking	
10	Excessive fuel consumption	
11		
U	CHECK ENGINE light operation	U-check mode & read memory mode
D		D-check mode

TROUBLE No.											CHECK ENGINE light		POSSIBLE CAUSE
1	2	3	4	5	6	7	8	9	10		U	D	
													AIR FLOW METER
		☆	◎				△	△	○		ON	ON	• Connector not connected
		△	◎	◎	◎		◎	○	△		ON	*1	• Poor contact of terminal
		☆	◎				△	○	△		ON	ON	• Short circuit
		☆	◎				△	△	○		ON	ON	• Discontinuity of wiring harness
		○	○	○	○		△	◎	○		*2	*2	• Performance characteristics unusual
													COOLANT THERMOSENSOR
	☆	○	☆		○		○	○	○		ON	ON	• Connector not connected
	△	△	◎	○	○		◎	△	○		ON	*1	• Poor contact of terminal
	☆	○	☆		○		○	○	○		ON	ON	• Short circuit
	☆	○	☆		○		○	○	○		ON	ON	• Discontinuity of wiring harness
	☆	○	☆		○		◎	◎	◎		*2	*2	• Performance characteristics unusual
													IDLE SWITCH OF THROTTLE SENSOR
				○	◎		◎				OFF	ON	• Connector not connected
				○			○				ON	*1	• Poor contact of terminal
				○	△		○				ON	ON	• Short circuit
					△		○				OFF	ON	• Discontinuity of wiring harness
							○				OFF	*3	• Improper adjustment
1	2	3	4	5	6	7	8	9	10		U	D	

TROUBLE No.										CHECK ENGINE light		POSSIBLE CAUSE
1	2	3	4	5	6	7	8	9	10	U	D	
												THROTTLE SENSOR
					◎		◎			ON	ON	● Connector not connected
				◎	◎		◎			ON	*1	● Poor contact of terminal
△					◎		◎			ON	ON	● Short circuit
					◎		◎			ON	ON	● Discontinuity of wiring harness
	○	○	△	○	◎		◎			OFF	*	● Performance characteristics unusual
												PRESSURE REGULATOR
	○	○	◎	◎	◎	○		△		*2	*2	● Sensing hose not connected
	△				○		○		◎	OFF	*	● Fuel pressure too high
○	○	○	◎	◎	◎		◎			*2	*2	● Fuel pressure too low
												FUEL INJECTOR
	◎	◎	○	○	○		○	○		ON	*1	● Connector not connected
	○	○	○	◎	◎		○			ON	ON	● Poor contact of terminal
	◎	◎	○	○	○		○			ON	ON	● Short circuit
	◎	◎	○	○	○		○	○		ON	ON	● Discontinuity of wiring harness
	△	○	○	△	○		○	△	○	*2	*2	● Performance characteristics unusual
	△	○	△	△	○		○	△		*2	*2	● Clogged filter
	△	○	○	○	○		○	△		*2	*2	● Clogged nozzle
○										OFF	*	● Stuck open
			○				○		○	OFF	*	● Slight leakage from seat
												CRANK ANGLE SENSOR
◎										ON	ON	● Connector disconnected
	○	○	◎	◎	◎		○	○		ON	*1	● Poor contact of terminal
◎										ON	ON	● Short circuit
◎										ON	ON	● Discontinuity of wiring harness
												POWER TRANSISTOR OF IGNITION COIL
◎										OFF	*	● Connector not connected
	○	○	◎	◎	◎		○			OFF	*	● Poor contact of terminal
◎										OFF	*	● Short circuit
◎										OFF	*	● Discontinuity of wiring harness
												AIR REGULATOR
						◎				OFF	*	● Connector not connected
	○	◎	○							OFF	*	● Short circuit
						◎				OFF	*	● Discontinuity of wiring harness
												KNOCK SENSOR
								◎		ON	ON	● Connector not connected
				○	○					ON	ON	● Short circuit
								◎		ON	ON	● Discontinuity of wiring harness
												DUTY SOLENOID
					△					OFF	*	● Connector disconnected
										OFF	*	● Poor contact of terminal
								○		OFF	*	● Short circuit
					△					OFF	*	● Discontinuity of wiring harness
			○	○	○	○	○	○		OFF	*	● Disconnected or cracked hose
1	2	3	4	5	6	7	8	9	10	U	D	

TROUBLE No.											CHECK ENGINE light		POSSIBLE CAUSE
1	2	3	4	5	6	7	8	9	10		U	D	
													ENGINE GROUNDING
○											ON		• Disconnected engine grounding terminal at intake manifold
◎	◎	○	◎	◎	◎						ON	*1	• Poor contact of engine grounding terminal
○											ON		• Discontinuity of wiring harness for engine grounding

Self-diagnosis System

General

The self-diagnosis system detects and indicates a fault in various inputs and outputs of the complex electronic control. The warning lamp (CHECK ENGINE light) on the instrument panel indicates occurrence of a fault or trouble, and also the light emitting diode (LED) in the control unit indicates a trouble code.

Further, against such a failure of sensors as may disable the drive, the fail-safe function is provided to ensure the minimal driveability.

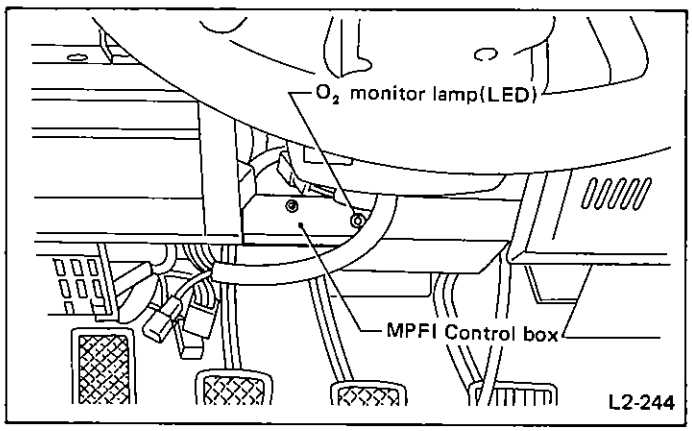


Fig. 113

SELF-DIAGNOSIS FUNCTION

The MPFI control unit executes the computational processing on the input information received from various sensors and produces the output information for driving the fuel injector, fuel pump, etc.

Along with this computational processing, it reads out all the input/output information to examine matching with the predetermined levels (proper values or ranges). If a predetermined level is not satisfied, i.e., a fault is found, the warning lamp is signaled to a driver. In this fashion, the self-diagnosis function is performed.

FAIL-SAFE FUNCTION

For the part which has been judged faulty in the self-diagnosis, the MPFI control unit generates the associated pseudo signal (only when convertible to electric signal) and carries out the computational processing. In this fashion, the fail-safe function is performed.

Function of Self-diagnosis

The self-diagnosis function has four modes: U-check mode, Read memory mode, D-check mode and Clear memory mode. Two connectors (Read memory and Test mode) and two lamps (CHECK ENGINE light and O_2 monitor) are used. The connectors are for mode selection and the lamps monitor the type of problem.

RELATIONSHIP BETWEEN MODES AND CONNECTORS

Mode	Engine	Read memory connector	Test mode connector
U-check	Ignition ON	DISCONNECT	DISCONNECT
Read memory	Ignition ON	CONNECT	DISCONNECT
D-check	Ignition ON	DISCONNECT	CONNECT
Clear memory	Ignition ON (engine on)	CONNECT	CONNECT

U-CHECK MODE

The U-check is a user-oriented mode in which only the MPFI components necessary for start-up and drive are diagnosed. On occurrence of a fault, the warning lamp (CHECK ENGINE light) is lighted to indicate to the user that the dealer's inspection is necessary. The diagnosis of other parts which do not give significant adverse effect to start-up and drive are excluded from this mode in order to avoid unnecessary uneasiness to be taken by the user.

READ MEMORY MODE

This mode is used by the dealer to read past problems (even when the vehicle's monitor lamps are off). It is most effective in detecting poor contact or loose connections of connectors, harnesses, etc.

D-CHECK MODE

This mode is used by the dealer to check the entire MPFI system and detect faulty parts.

CLEAR MEMORY MODE

This mode is used by the dealer to clear the trouble code from the memory after the affected part is repaired.

Basic Operation of Self-diagnosis System

NO TROUBLE

○ : CONNECT X : DISCONNECT

Engine	Read memory connector	Test mode connector	CHECK ENGINE light	O_2 monitor lamp	Remarks
ON	X	X	OFF	O_2 monitor	
ON	○	X	OFF	O_2 monitor	
*ON	X	○	** OFF → Blink	OFF	Vehicle specification code is outputted when CHECK ENGINE light is OFF.
*ON	○	○	OFF → Blink	OFF	All memory stored in control unit is cleared after CHECK ENGINE light blinks.
OFF (Ignition switch ON)	○	X	ON	Vehicle specification code	Before starting the engine, the self-diagnosis system assumes the engine to be in NO TROUBLE condition.
OFF (Ignition switch ON)	X	X	ON	Vehicle specification code	
OFF (Ignition switch ON)	X	○	ON	Vehicle specification code	
OFF (Ignition switch ON)	○	○	ON	Vehicle specification code	

TROUBLE

Engine	Read memory connector	Test mode connector	CHECK ENGINE light	O_2 monitor lamp	Remarks
ON	X	X	ON	Trouble code	
ON	○	X	ON	Trouble code (memory)	
*ON	X	○	** OFF → ON	Trouble code	Vehicle specification code is outputted when CHECK ENGINE light is OFF.
*ON	○	○	** OFF → ON	Trouble code	
OFF (Ignition switch ON)	○	X	ON	Trouble code (memory)	
STALL (Ignition switch ON)	X	X	ON	Trouble code	
STALL (Ignition switch ON)	X	○	ON	Trouble code	
STALL (Ignition switch ON)	○	○	ON	Trouble code	

***: Ignition timing is set to 20° BTDC (when the engine is on, test mode connector is connected, and idle switch is ON).**
****: CHECK ENGINE light remains off until engine is operated at speed greater than 2,000 rpm for at least 40 seconds.**

List of Trouble Codes

Trouble code	Item	See page
11	Crank angle sensor (No reference pulse)	p128
12	Starter switch (Continuously in ON position or continuously in OFF position while cranking)	p130
13	Crank angle sensor (No position pulse)	p131
14	Fuel injectors #1 and #2 (Abnormal injector output)	p133
15	Fuel injectors #3 and #4 (Abnormal injector output)	p134
21	Water temperature sensor (Open or shorted circuit)	p135
22	Knock sensor (Open or shorted circuit)	p136
23	Air flow meter (Open or shorted circuit)	p137
31	Throttle sensor (Open or shorted circuit)	p138
32	O_2 sensor (Abnormal sensor signal)	p139
33	Car-speed sensor (No signal is present during operation)	p141
*34	EGR solenoid valve (Solenoid switch continuously in ON or OFF position)	p142
35	Purge control solenoid valve (Solenoid switch continuously in ON or OFF position)	p143
41	System too lean	p144
42	Idle switch (Abnormal idle switch signal in relation to throttle sensor output)	p145
44	Duty solenoid valve (Waste gate control)	p147
51	Neutral switch (Continuously in ON position)	p146

*: **Except California model**

List of Specification Codes

Specification codes	Specification
01	MT, 49-state and Canada
02	MT, California
03	AT, 49-state and Canada
04	AT, California

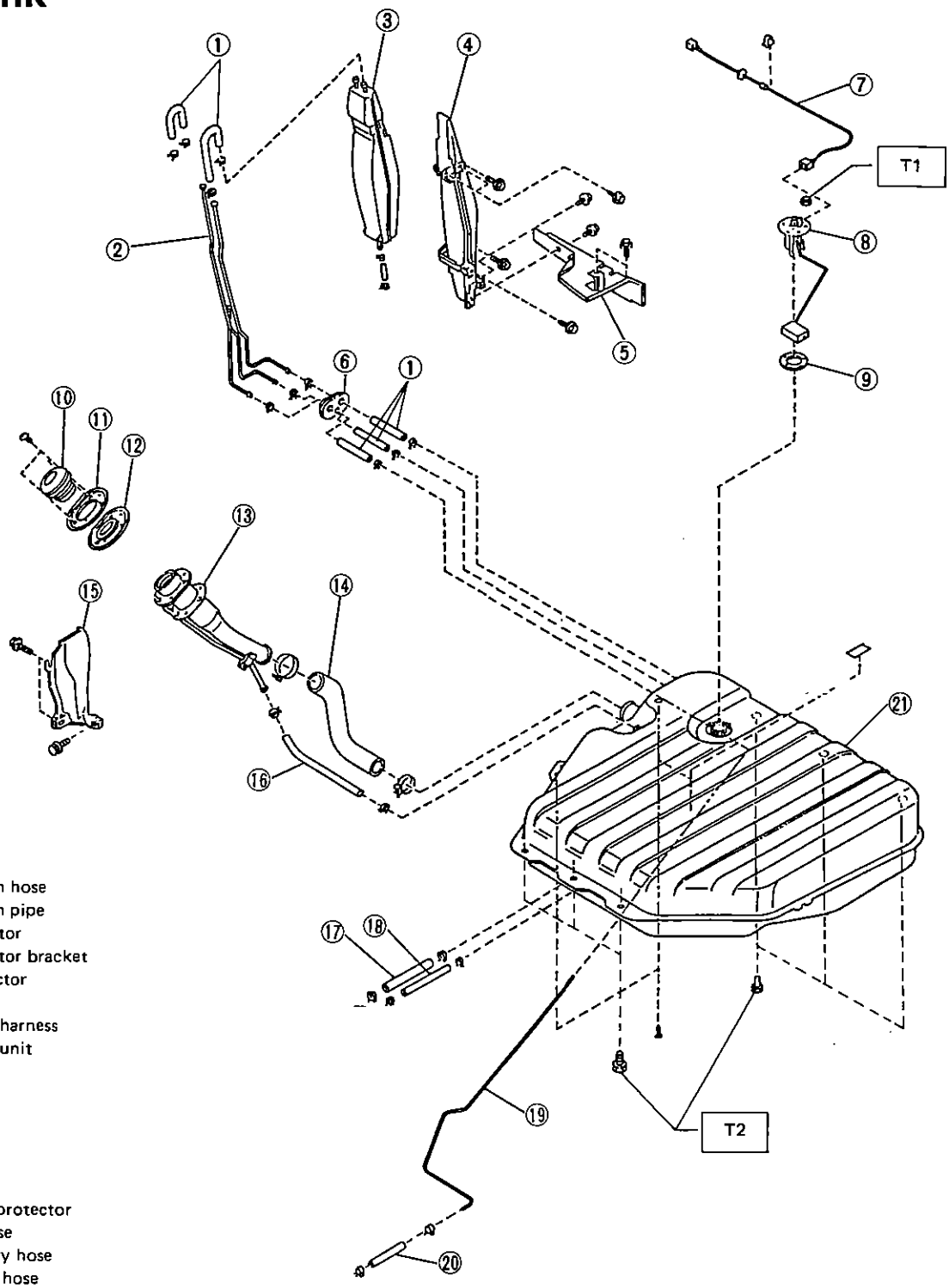
SPECIFICATIONS AND SERVICE DATA

SPECIFICATIONS

Item		MPFI model	SPFI model
Fuel tank	Capacity	60ℓ (15.9 US gal, 13.2 Imp gal)	
	Location	Under rear floor	
Fuel pump	Type	Electromagnetic pin roller	
	Discharge pressure	422 – 490 kPa (4.3 – 5.0 kg/cm^2, 61 – 71 psi)	245 – 343 kPa (2.5 – 3.5 kg/cm^2, 36 – 50 psi)
	Discharge flow	95ℓ (25.1 US gal, 20.9 Imp gal)/H min. [12 V at 299.1 kPa (3.05 kg/cm^2, 43.4 psi)]	80ℓ (21.1 US gal, 17.6 Imp gal)/H min. [12 V at 147 kPa (1.5 kg/cm^2, 21 psi)]
Fuel filter		Cartridge type	
Fuel separator	Capacity	1,250 mℓ (42.3 US fl oz, 44.0 Imp fl oz)	

COMPONENT PARTS

Fuel Tank



1 Evaporation hose
2 Evaporation pipe
3 Fuel separator
4 Fuel separator bracket
5 Hose protector
6 Grommet
7 Fuel meter harness
8 Fuel meter unit
9 Gasket
10 Filler cap
11 Ring
12 Packing
13 Filler pipe
14 Filler hose
15 Filler hose protector
16 Air-vent hose
17 Fuel delivery hose
18 Fuel return hose
19 Evaporation pipe
20 Evaporation hose
21 Fuel tank

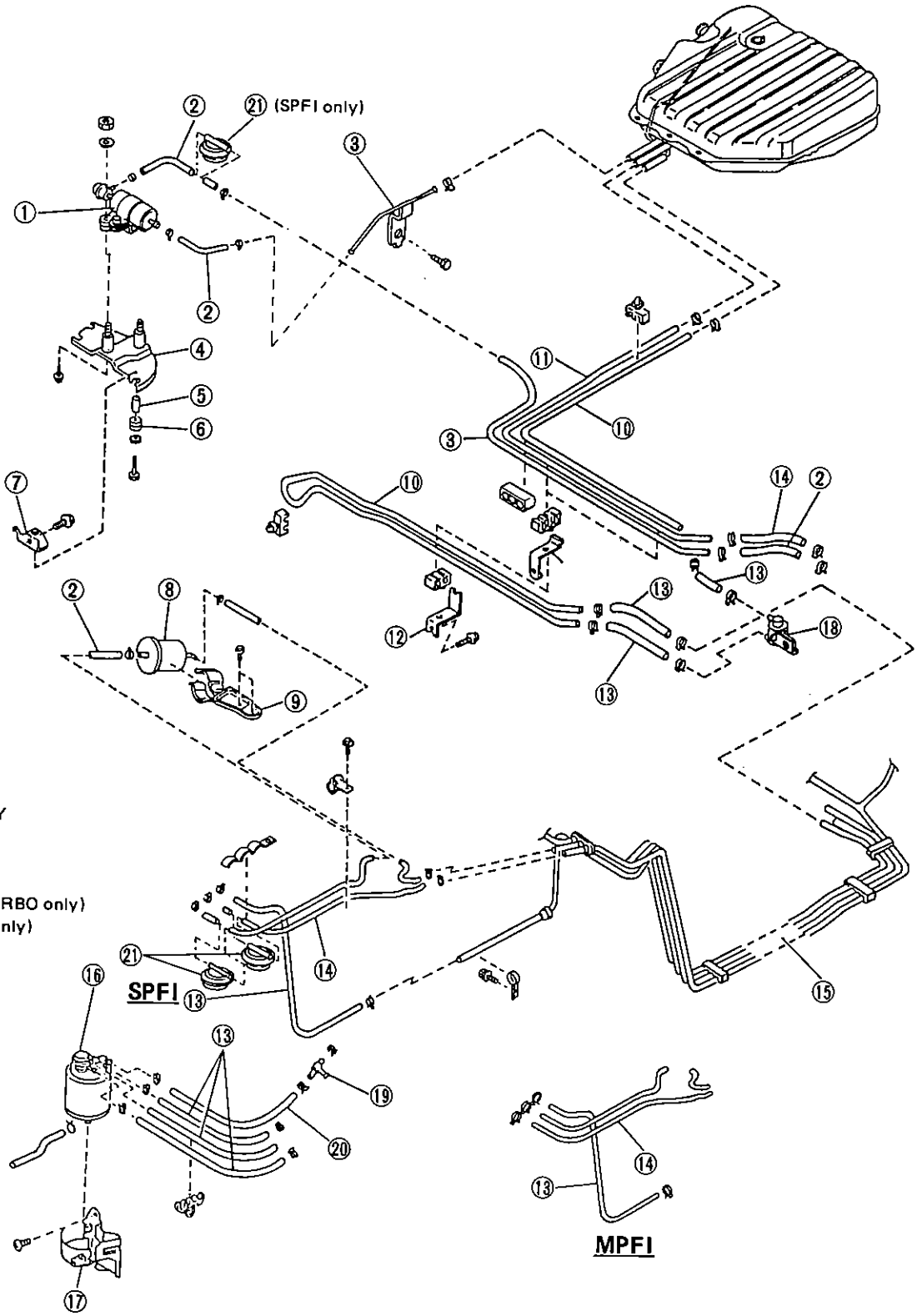
Tightening torque N·m (kg-m, ft-lb)
T1: 1.8 - 3.1 (0.18 - 0.32, 1.3 - 2.3)
T2: 13 - 23 (1.3 - 2.3, 9 - 17)

Fig. 3

L2-606

COMPONENT PARTS

Fuel Lines



1 Fuel pump
2 Fuel delivery hose
3 Fuel delivery pipe
4 Pump bracket
5 Spacer
6 Cushion
7 Pump bracket
8 Fuel filter
9 Filter bracket
10 Evaporation pipe
11 Fuel return pipe
12 Pipe stay
13 Evaporation tube
14 Fuel return hose
15 Fuel center pipe ASSY
16 Canister
17 Canister bracket
18 2-way valve
19 Evaporation tube (TURBO only)
20 Purge pipe (TURBO only)
21 Fuel damper

Fig. 3

L2-1691

SERVICE PROCEDURE

a. Before starting the job, be sure to carry out the following.
1) Place "No fire" signs near the working area.
2) Disconnect ground cable from battery.
b. Be careful not to spill fuel on the floor.

Fuel Tank

REMOVAL

1) Remove muffler and rear differential ASSY. (4WD model only)
2) Remove fuel filler cap and drain fuel from fuel tank.
3) Remove fuel filler pipe protector.

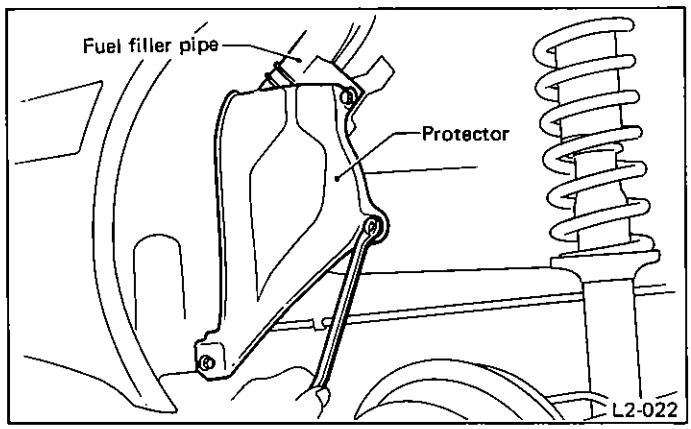


Fig. 5

4) Remove clamp and disconnect fuel filler hose from fuel filler pipe.
5) Remove clamp and disconnect air vent hose from fuel filler pipe.
6) Loosen clips and disconnect delivery hose, return hose and evaporation tube from fuel tank.
7) While holding fuel tank, remove six mounting bolts from fuel tank and dismount it.

a. Two men are required to perform step 7) above.
b. Have a helper support fuel tank, as shown in the figure, when disconnecting fuel meter harness or evaporation tube.

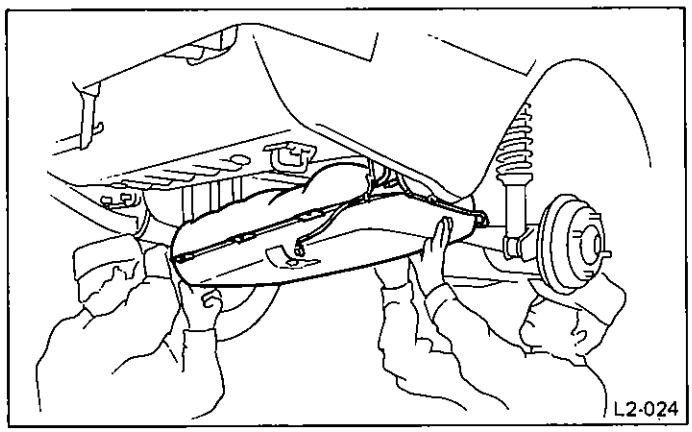


Fig. 6

8) Disconnect harness connector from fuel meter unit.
9) Loosen clips, disconnect evaporation tube, and dismount fuel tank.

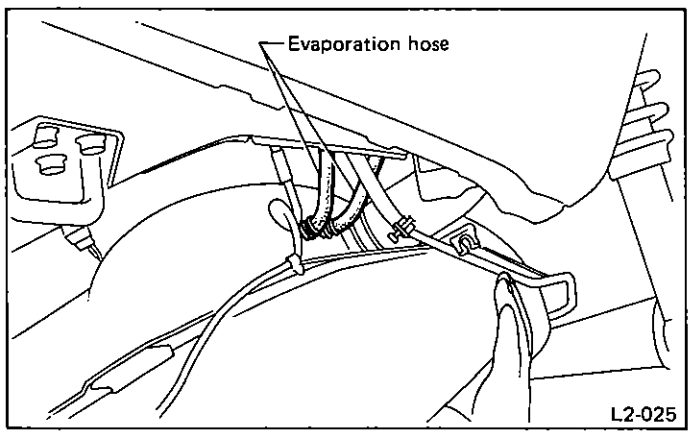


Fig. 7

INSTALLATION

Installation is in the reverse order of removal procedures. Observe the following:
1) When installing fuel tank, have a helper hold fuel tank while connecting hoses, tubes and harness connector.
2) Before tightening fuel tank mounting bolts, make sure hoses, harnesses, etc. are not caught between fuel tank and car body.

3) Install hose and tube holddown clips at positions indicated in the figure.

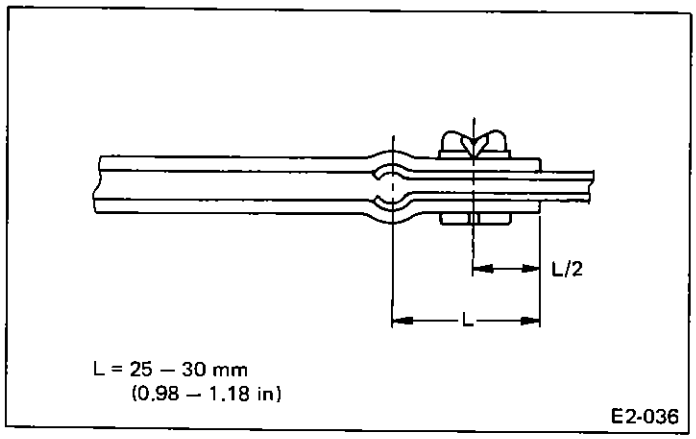


Fig. 8

Fuel Meter Unit

REMOVAL

1) Remove floor mat from luggage compartment.
2) Remove access hole lid.
3) Disconnect harness connector from fuel meter unit.

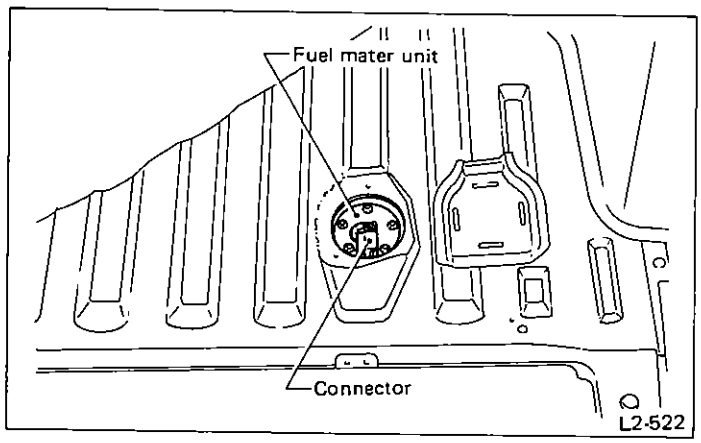


Fig. 9

4) Remove five nuts and detach fuel meter unit.

INSTALLATION

Installation is in the reverse order of removal procedures. Observe the following:

(1) Discard old packing (85025GA030) after removal. Replace with new packing.

(2) Ensure sealing portion is free from fuel or foreign particles before installation.
(Wipe tank mounting holes, packing, etc. clean with a cloth.)

(3) Tighten nuts in numerical sequence shown below, to specified torque.

Tightening torque:
1.8 – 3.1 N·m (18 – 32 kg-cm, 16 – 28 in-lb)

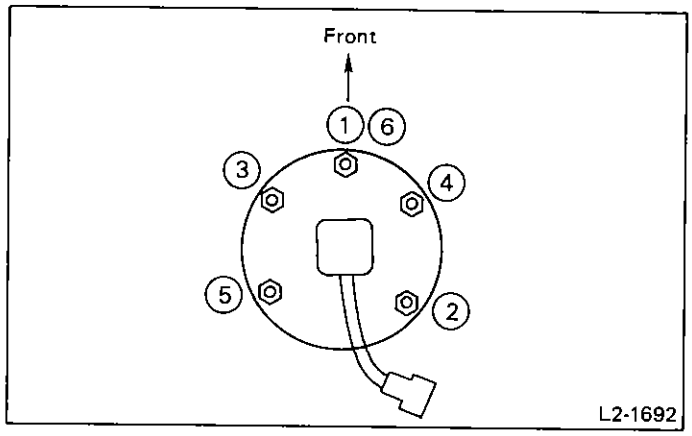


Fig. 5

(4) Apply a sealant to the edge of access hole lid before installation.

Fuel Filler Pipe

REMOVAL

1) Completely drain fuel from fuel tank.
2) Remove right rear tire.
3) Open fuel filler flap and remove filler cap.
4) Remove three screws holding packing in place.
5) Remove fuel filler pipe protector.
6) Remove clips and disconnect fuel filler hose and air vent hose from fuel filler pipe.

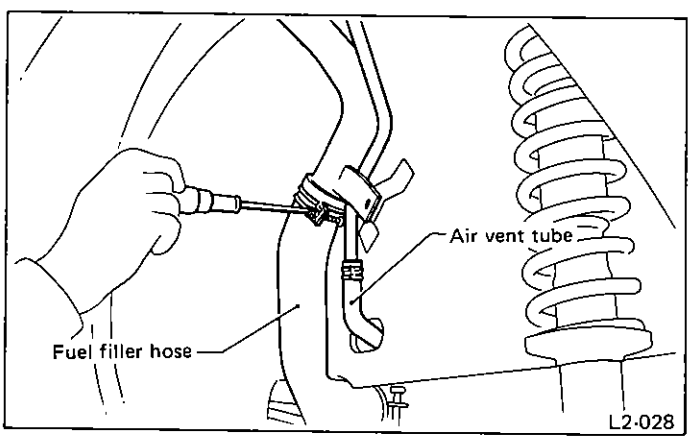


Fig. 10

SERVICE PROCEDURE

7) Disconnect fuel filler pipe from underside of car.

INSTALLATION

1) Hold fuel filler flap open.
2) Insert fuel filler pipe into hole in fuel saucer from the inner side of apron. Align holes in fuel filler pipe neck and packing and tighten screws.

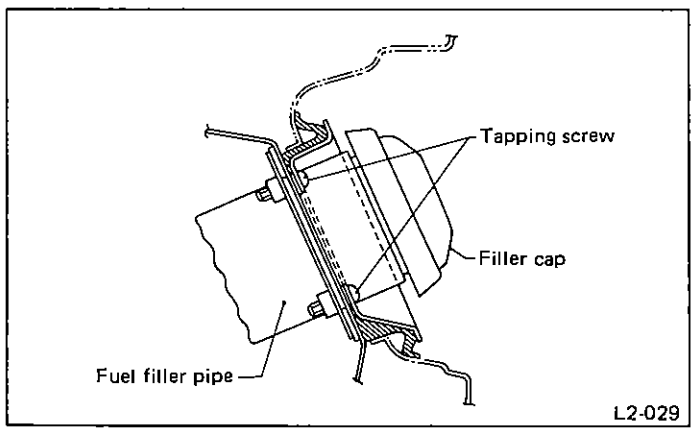


Fig. 11

3) If edges of rubber packing are folded toward the inside, straighten it with a standard screwdriver.
4) Insert fuel filler hose approximately 25 to 30 mm (0.98 to 1.18 in) over the lower end of fuel filler pipe and tighten clamps. Do not allow clips to touch protector and air vent pipe.
5) Insert air vent hose approximately 25 to 30 mm (0.98 to 1.18 in) into the lower end of air vent pipe and tighten with clips, as shown in figure.

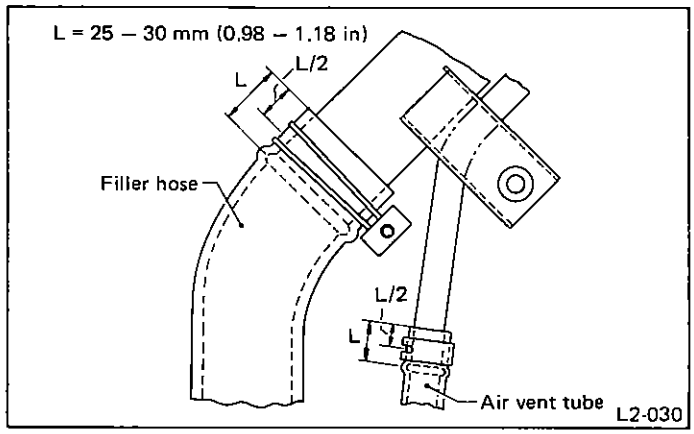


Fig. 12

6) Install protector together with fuel filler pipe. Check to be sure clamp for filler hose and clip for air vent hose do not touch apron.

Fuel Separator

REMOVAL

1) Remove right trim from luggage compartment.
2) Remove hose protector.
3) Remove fuel separator and bracket as a unit. Be sure not to scratch the inner side of car body.
4) Disconnect evaporation tube from pipe held to bracket.

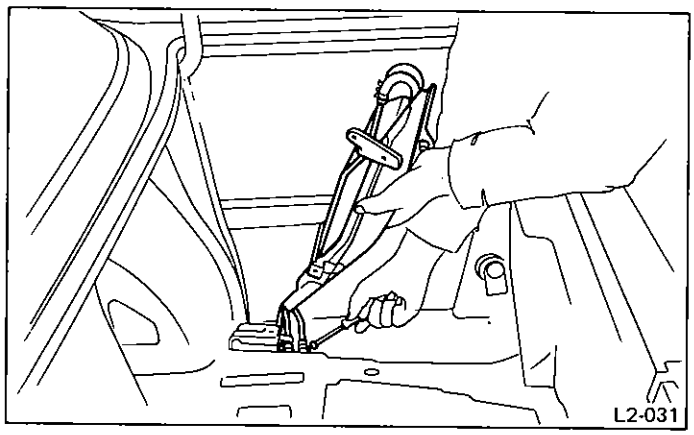


Fig. 13

5) Remove fuel separator from bracket.
6) Disconnect tube from fuel separator.

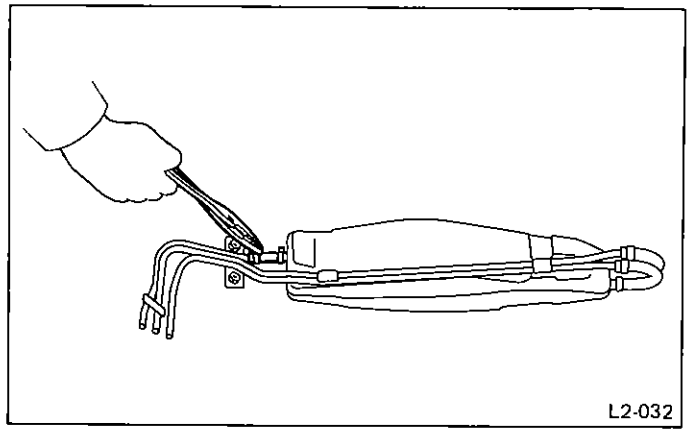


Fig. 14

INSTALLATION

Installation is in the reverse order of removal procedures. Observe the following:

1) When connecting tube between fuel separator and pipe, insert until it butts up against nipple on the separator side, and insert the other end up to the marked position on the pipe side.
2) Install fuel separator on bracket such that the pipe can run through the hollowed section of separator.

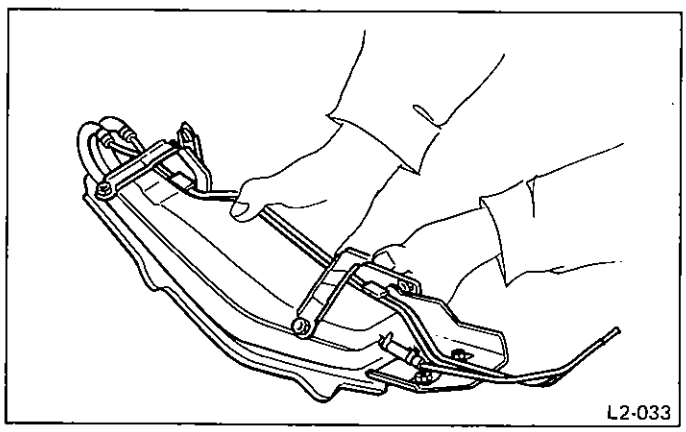


Fig. 15

3) Be sure to insert evaporation tube approximately 15 to 20 mm (0.59 to 0.79 in) into pipe on bracket. Install clips in a direction which does not touch other tubes.

Fuel Filter

REMOVAL

1) The fuel system is pressurized. Before removing the hose, filter, pump, etc., be sure to release the fuel pressure, as follows:
   (1) Disconnect the wiring connector of the fuel pump.
   (2) Crank the engine for more than five seconds.
   If the engine starts, let the engine run until it stops.
   (3) After turning IG switch to OFF, connect the wiring connector of the fuel pump.
2) Loosen the screw of the hose clamp and pull off the hose from the filter.
3) Remove the filter from the holder.

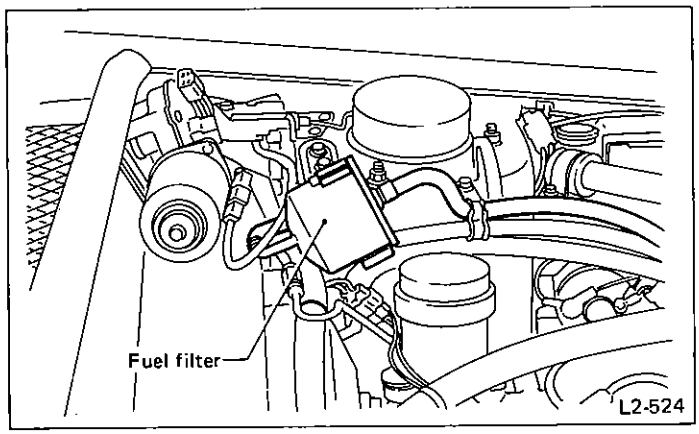


Fig. 16

INSTALLATION

1) Connect the hose as illustrated below:

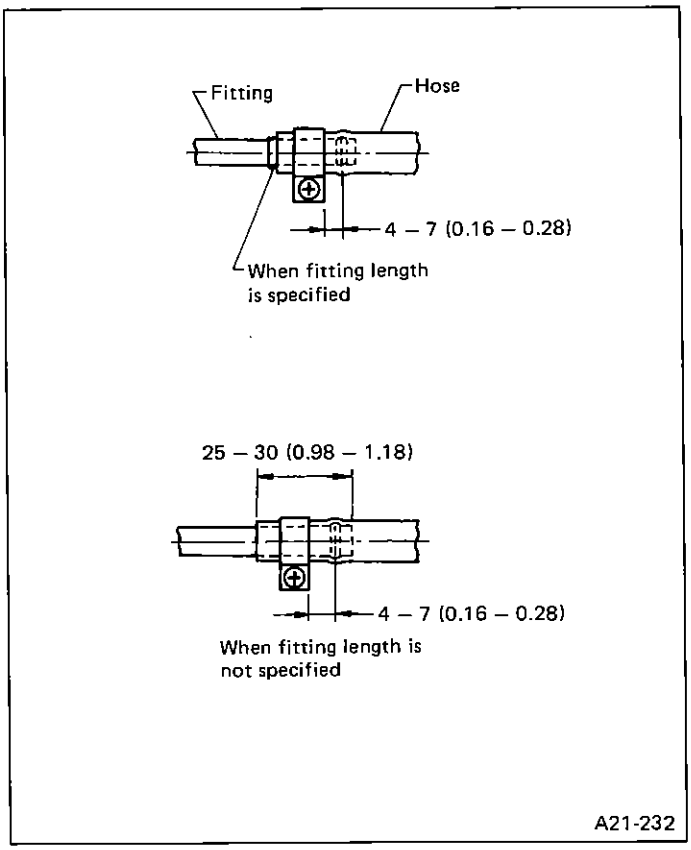


Fig. 17

2) Tighten the hose clamp screw to the specified torque.

Tightening torque:
1.0 - 1.5 N·m (0.1 - 0.15 kg-m, 0.7 - 1.1 ft-lb)

INSPECTION

1) Check the inside of the filter for dirt and water sediment.
2) If the filter is clogged or cracked, or if the replacement interval has been reached, replace the filter.
3) If water is found in the filter, shake the filter with its inlet port facing down, to expel the water.
3) If the hose is damaged at the clamping portion, replace the hose with a new one.
4) If the hose clamp is too deformed, replace with a new one.
5) Fit the hose to the filter, then install the filter to the holder. Correct the hose position by removing any twist so that it will not interfere with the filter body or washer tank, before tightening the screw of the hose clamp.

Fuel Pump

REMOVAL

1) Release the pressure of the fuel system.

Refer to "REMOVAL 1)" in Fuel Filter for MPFI & SPFI MODELS.

2) Keep the pump harness connector disconnected.
3) Jack up the vehicle.
4) Clamp the middle portion of the thick hose connecting the pipe (coupling) and pump. Prevent the fuel from flowing out of the fuel tank.

Do not bend the hose sharply; otherwise, it may be damaged.

5) Loosen the hose clamp, and disconnect the hose.
6) Remove three pump bracket mounting bolts, and remove the pump together with the pump damper.

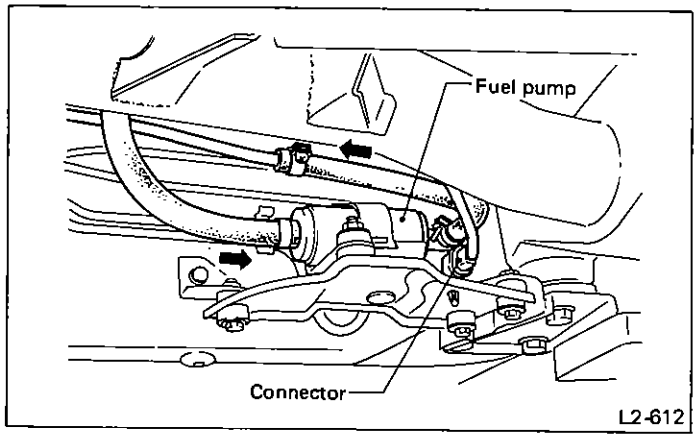


Fig. 18

INSPECTION

1) Connect the leads to the harness connector, and apply a 12-volt power supply to check whether the pump operates.

a. Keep the battery apart from the pump as far as possible.
b. Be sure to turn the 12 V supply ON and OFF on the battery side.
c. Do not run the pump for a long time under non-loaded condition.

INSTALLATION

1) If the pump and damper have been removed from the pump bracket, tighten the mounting bolts to the specified torque.
2) Install the hose using the same procedure as that explained in "Fuel Filter"
3) Install the pump bracket in position to the vehicle body, and secure it with bolts.

Use care not to drop the spacer of the cushion rubber.

4) Install the hose.
5) Connect the pump harness connector.
6) Run the pump and check for fuel leaks.

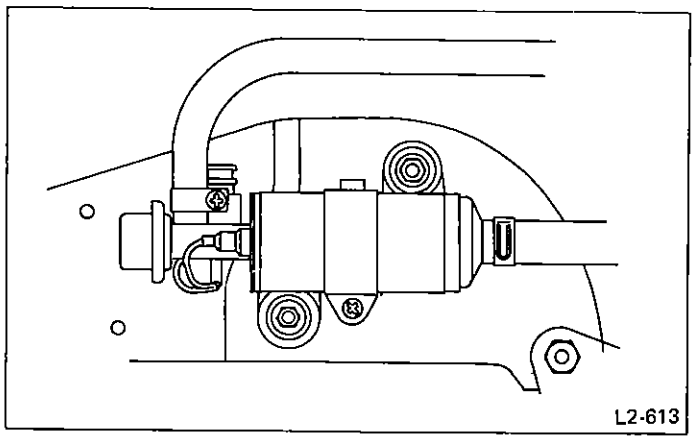


Fig. 19

Fuel Delivery, Return and Evaporation Lines

REMOVAL

1) Under body floor, detach fuel delivery hoses, return hoses, evaporation tubes and 2-way valve.

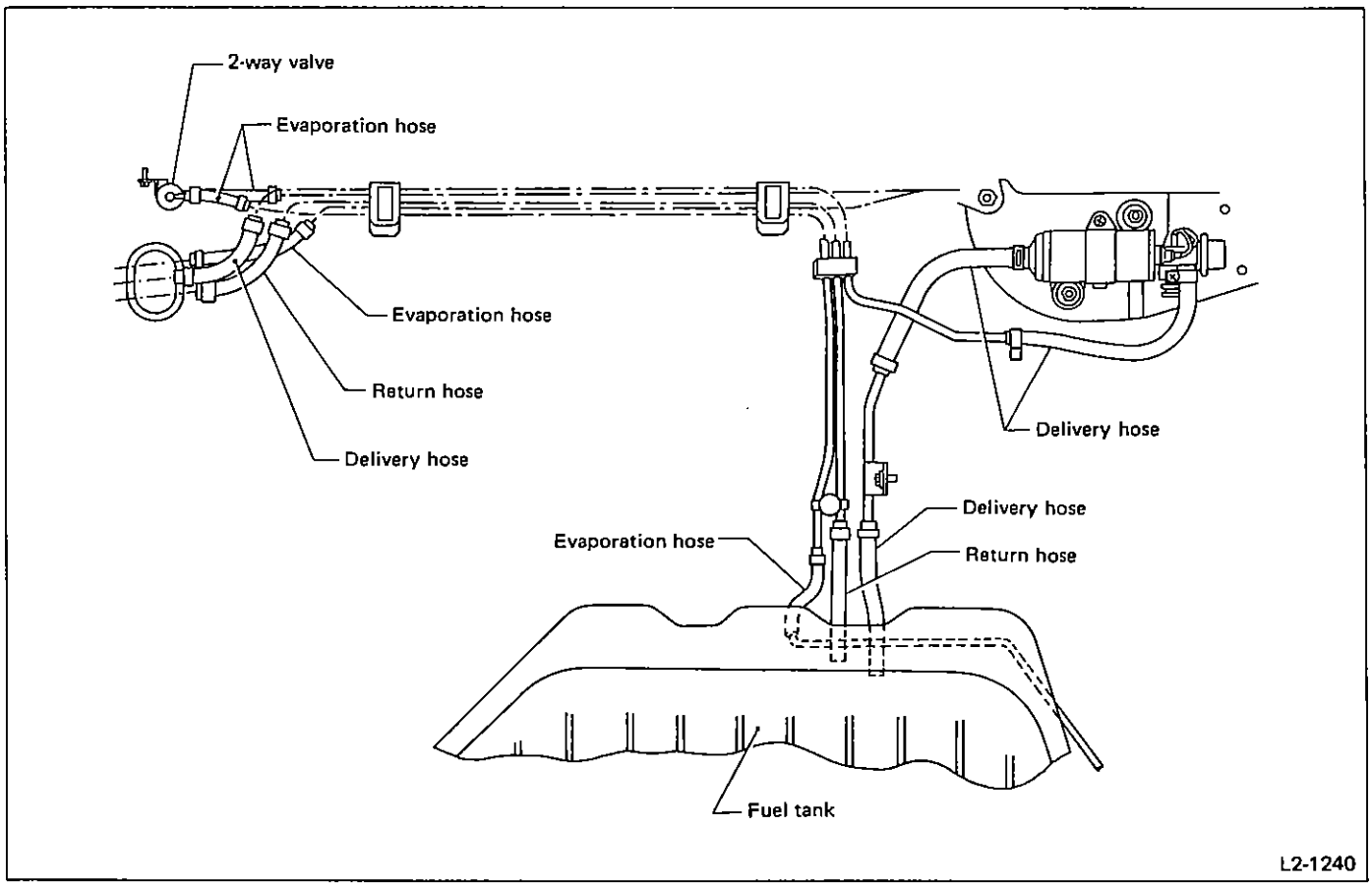


Fig. 20

2) In engine compartment, detach fuel delivery hoses, return hoses, evaporation tubes and canister.

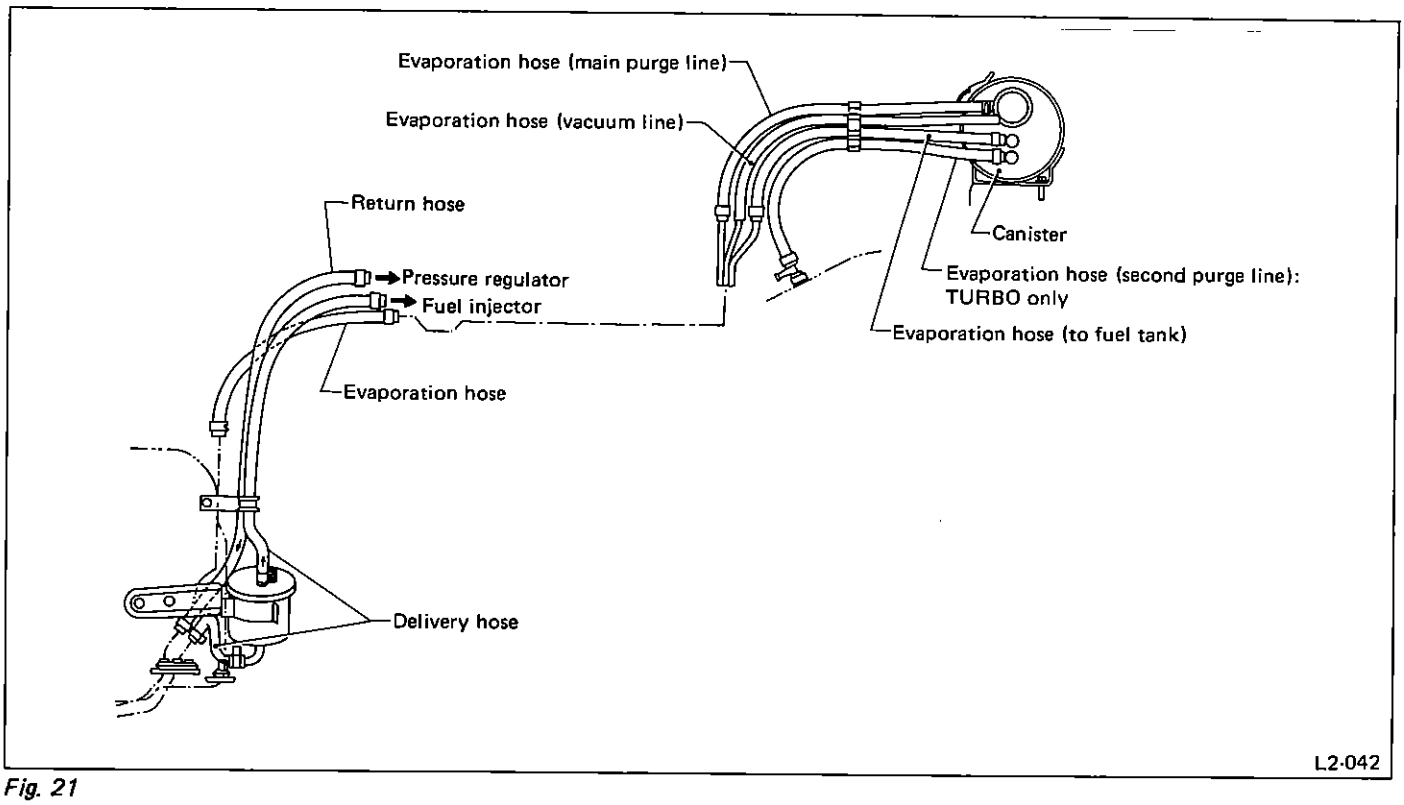


Fig. 21

INSTALLATION

Install in the reverse order of removal.

1) Connect delivery hose to delivery pipe with an overlap of 25 to 30 mm (0.98 to 1.18 in).

2) Connect delivery hoses and fuel return hose to fuel tank, fuel pump and fuel filter until they reach the base of each pipe.

3) Insert evaporation tube into evaporation pipe by approx. 15 mm (0.59 in) and position a clip with approx. 8 mm (0.31 in) from hose end.

4) When installing 2-way valve, install it with its "TO ENGINE" mark facing downward.

5) Be sure to inspect hoses and their connections for any leakage of fuel.

SUBARU

1989

SERVICE MANUAL

6 ELECTRICAL SECTION

ABBREVIATION LIST

A/C pulley	Air Conditioner Pulley
A/D converter	Analog/Digital converter
ALT	Alternator
A/S	Air Suspension
ASSY	Assembly
ASV	Air Suction Valve
AT	Automatic Transmission
ATF	Automatic Transmission Fluid
AVG speed	Engine Average speed
BAT	Battery
Cal	California
CP	Complete
C/P	Crankshaft Pulley
DIFF. LOCK	Differential Lock
ECC	Electronically Controlled Carburetor
ECM	Electronic Control Module
ECS	Electric Control System
ECU	Electronic Control Unit
E/G	Engine
EGR	Exhaust Gas Recirculation
ETR	Electronic Tuning Radio
FCV	Float Chamber Ventilation
FICD	Fast Idle Control Device
FLT	Fluorescent
GND	Ground
IC	Integrated Circuit
IGN	Ignition
INT	Intermittent
I/P	Idler Pulley
LCD	Liquide-Crystal Display
LED	Light Emitting Diode
LH	Left-Hand
LSI	Large Scale Integrated Circuit
MPFI	Multi Point Fuel Injection
MT	Manual Transmission
OD	Outer Diameter
P/S pulley	Power Steering Pulley
REV sensor	Revolution sensor
RH	Right-Hand
SPFI	Single Point Fuel Injection
S/r	Single-range
SW	Switch
VLC	Vacuum Line Control
W/P pulley	Water Pump Pulley

ENGINE ELECTRICAL SYSTEM

6-1

SUBARU

1989

SPECIFICATIONS AND SERVICE DATA

SPECIFICATIONS

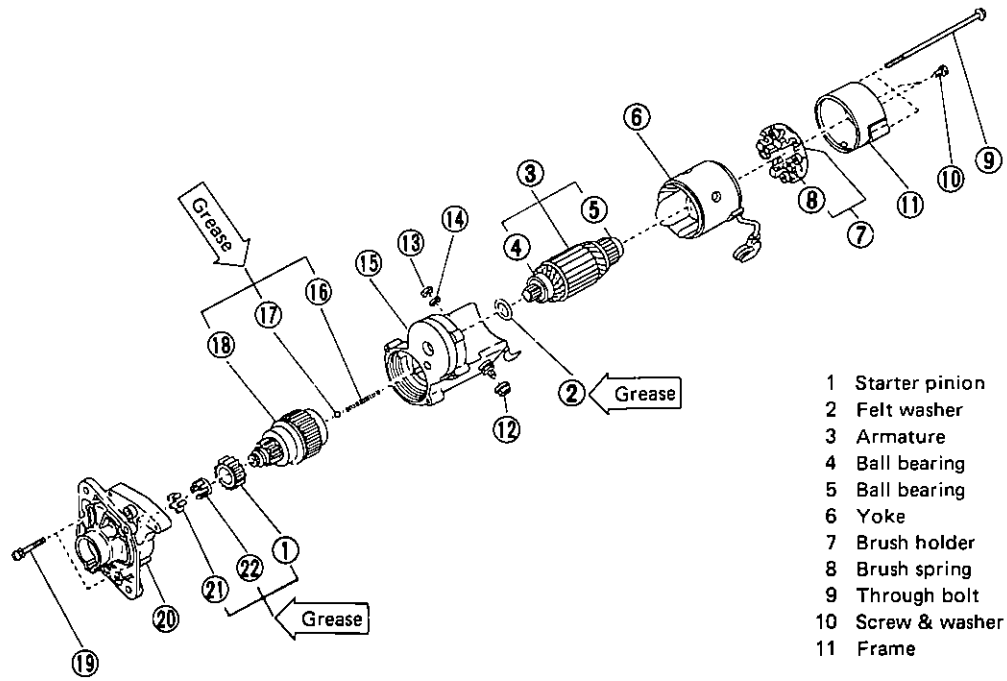
Item			Designation	
Starter	Type		Reduction type	
	Model		[MT] 028000-8581	[AT] 028000-9800
	Manufacturer		NIPPONDENSO	
	Voltage and Output		12V – 1.0 kW	12V – 1.4 kW
	Direction of rotation		Counterclockwise (when observed from pinion)	
	Number of pinion teeth		9	
	No-load characteristics	Voltage	11.5V	11V
		Current	90 A or less	
		Rotating speed	3,000 rpm or more	4,000 rpm or more
	Load characteristics	Voltage	8V	8V
		Current	230A or less	370A or less
		Torque	6.4 N·m (0.65 kg-m, 4.7 ft-lb)	14 N·m (1.4 kg-m, 10 ft-lb)
		Rotating speed	1,180 rpm or more	880 rpm or more
	Lock characteristics	Voltage	2.5V	5V
		Current	300A or less	735A or less
		Torque	7 N·m (0.7 kg-m, 5.1 ft-lb) or more	27 N·m (2.8 kg-m, 20 ft-lb) or more
Alternator	Type		Rotating-field three-phase type, Voltage regulator built-in type	
	Model		LR160-137 or LR160-138	
	Regulator type		TR1Z-56 (IC)	
	Manufacturer		HITACHI	
	Voltage and Output		12V – 60A	
	Polarity on ground side		Negative	
	Rotating direction		Clockwise (when observed from pulley side)	
	Armature connection		3-phase Y-type	
	Rectifying system		Full wave rectification by six self-contained silicone diodes	
	Revolution speed at 13.5 V 20°C (68°F)		1,000 rpm or less	
	Output current		1,250 rpm – 18A or more 2,500 rpm – 49A or more 5,000 rpm – 58A or more	
	Regulated voltage		14.1 – 14.8V [20°C (68°F)]	

Item		Designation
Distributor	Type	Breakerless type with control unit
	Model	D4P84-03
	Manufacturer	HITACHI
	Firing order	1-3-2-4
	Rotating direction	Counterclockwise
	Cap insulation resistance	More than 50 MΩ
	Rotor head insulation resistance	More than 50 MΩ
Ignition coil	Type	E12-113
	Manufacturer	HITACHI
	Primary coil resistance Ω	0.84 – 1.02
	Secondary coil resistance Ω	8,000 – 12,000
	Insulation resistance between primary terminal and case	More than 10 MΩ
Spark plug	Type and Manufacturer	BPR6ES-11 (or BPR5ES-11, BPR7ES-11) . . . . . NGK W20EPR-U11 (or W16EPR-U11, W22EPR-U11) . . . Nippondenso RN9YC-4 . . . . . Champion
	Thread size mm	14, P = 1.25
	Spark gap mm (in)	1.0 – 1.1 (0.039 – 0.043)

COMPONENT PARTS

Starter

MT: 028000-8581

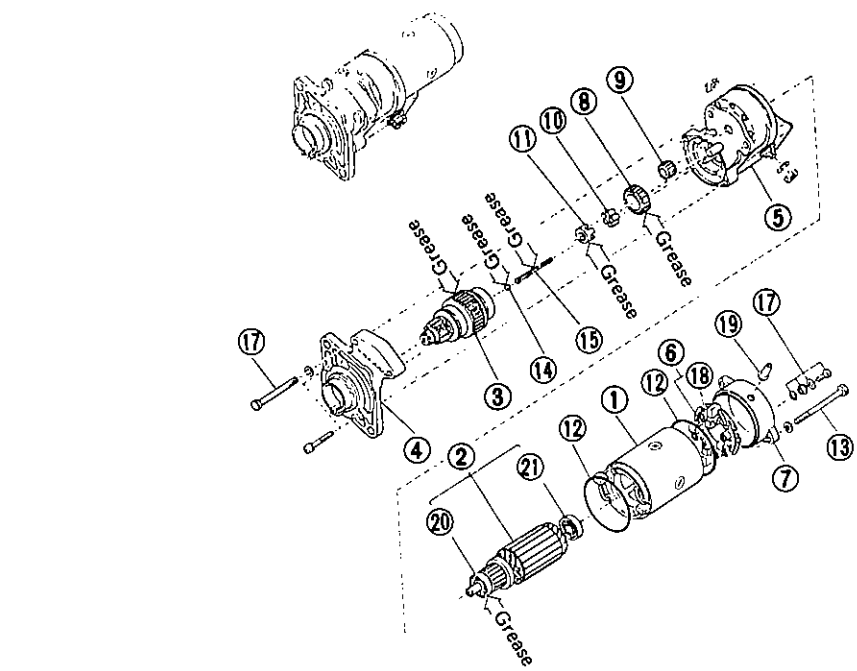


1	Starter pinion	12	Nut
2	Felt washer	13	Nut
3	Armature	14	Spring washer
4	Ball bearing	15	Magnet switch
5	Ball bearing	16	Spring
6	Yoke	17	Steel ball
7	Brush holder	18	Overrunning clutch
8	Brush spring	19	Screw & washer
9	Through bolt	20	Starter housing
10	Screw & washer	21	Clutch roller
11	Frame	22	Retainer

A25-761

Fig. 1

AT: 028000-9800



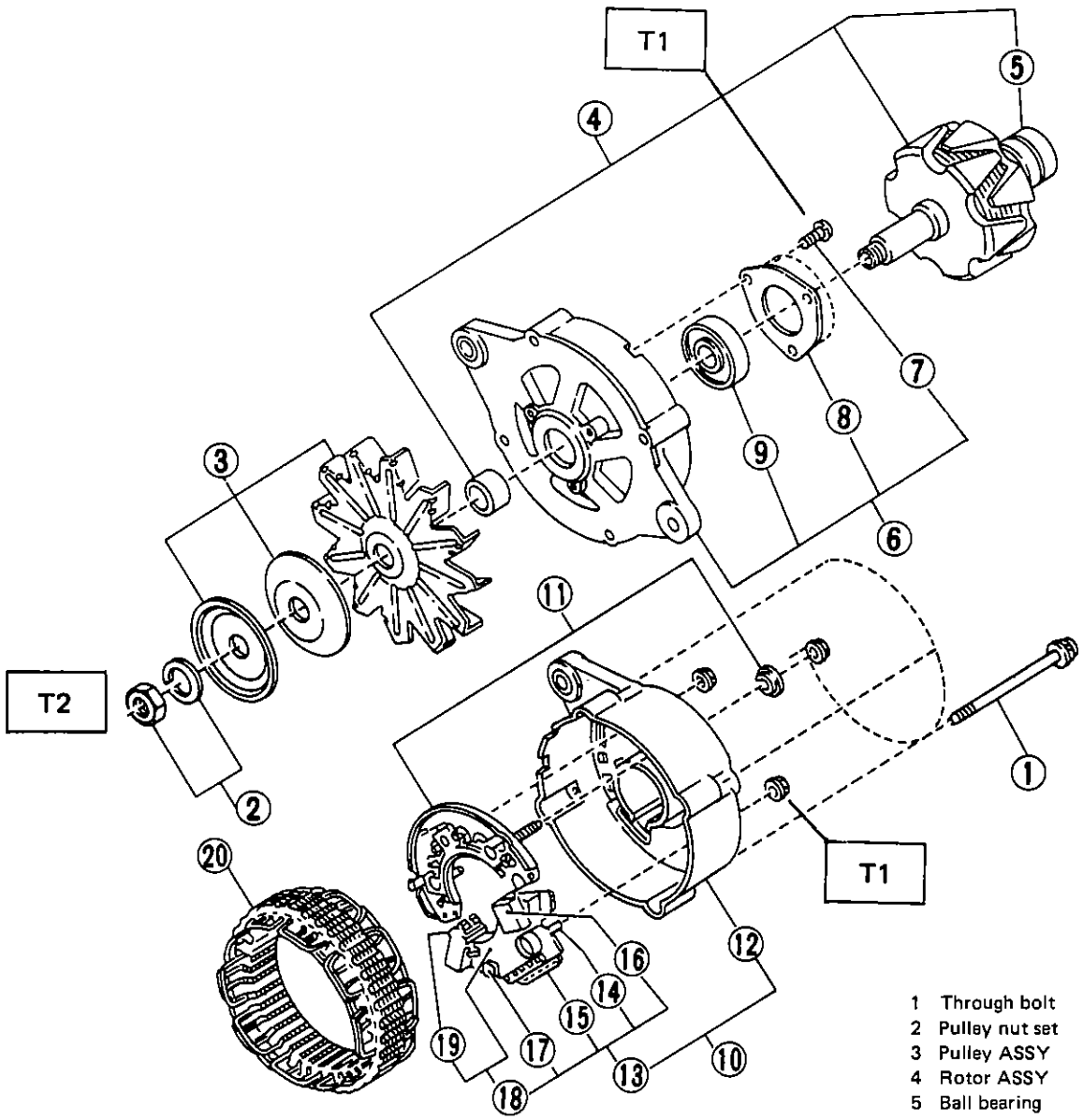
1	Yoke
2	Armature
3	Overrunning clutch
4	Starter housing
5	Magnet switch
6	Brush holder
7	End frame
8	Starter pinion
9	Idle pinion
10	Clutch roller
11	Retainer
12	O-ring
13	Through bolt
14	Steel ball
15	Spring
16	O-ring screw
17	Screw & washer
18	Brush spring
19	Cover
20	Ball bearing
21	Ball bearing

L6-004

Fig. 2

Alternator

LR160-137, LR160-138



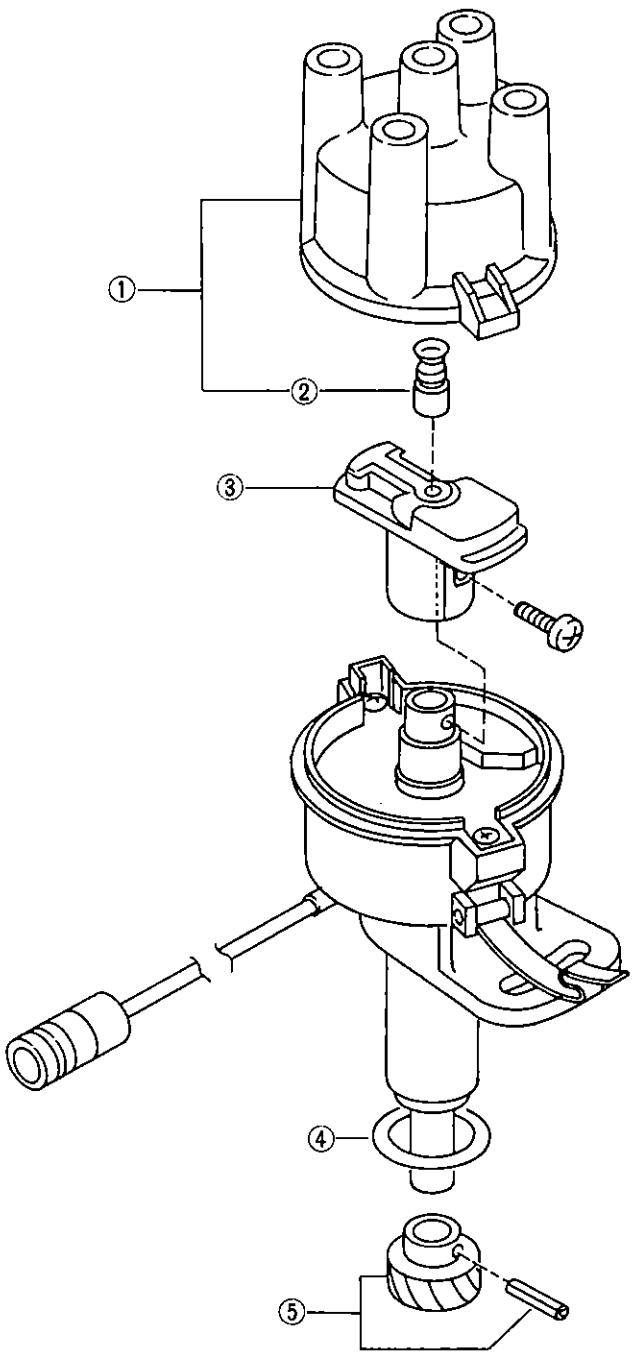
1 Through bolt
2 Pulley nut set
3 Pulley ASSY
4 Rotor ASSY
5 Ball bearing
6 Front cover ASSY
7 Bolt
8 Retainer
9 Ball bearing
10 Rear cover ASSY
11 Diode ASSY
12 Rear cover
13 Brush & IC regulator ASSY
14 Bolt
15 IC regulator
16 Condenser
17 Bolt
18 Brush ASSY
19 Brush
20 Stator

Tightening torque N·m (kg-m, ft-lb)
T1: 3.1 – 3.9 (0.32 – 0.40, 2.3 – 2.9)
T2: 39 – 59 (4.0 – 6.0, 29 – 43)

Fig. 3

A9-414

Distributor



1 Cap ASSY
2 Carbon point
3 Rotor head
4 O-ring
5 Pinion set

Fig. 4

L6-1673

SERVICE PROCEDURE

Starter

MT (028000-8581)

TEST

MAGNETIC SWITCH OPERATION

a. The following magnetic switch tests should be performed with specified voltage applied.
b. Each test should be conducted within 3 to 5 seconds. Power to be furnished should be one-half the rated voltage.

1) Checking pull-in coil
Connect a lead wire between negative (-) terminal of battery and terminal C of magnetic switch body. Then connect a lead wire between positive (+) terminal of battery and terminal 50. Pinion gear should spring out when the positive lead wire is connected.

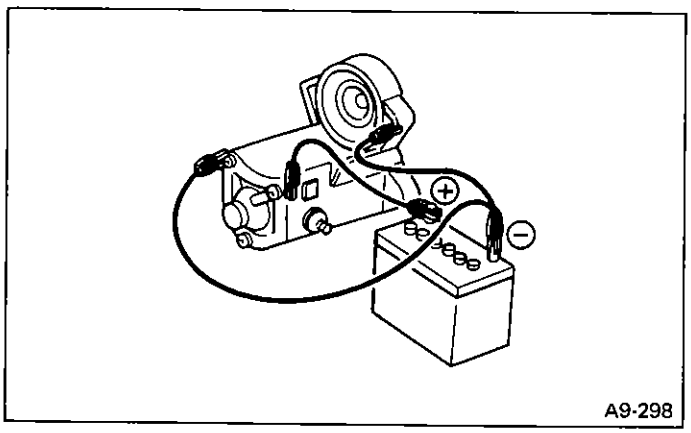


Fig. 5

2) Checking hold-in coil
In the same wiring connections as in 1) "Checking pull-in coil" above, disconnect the lead wire from terminal C to see if pinion gear remains sprung out. If not, hold-in coil is malfunctioning.

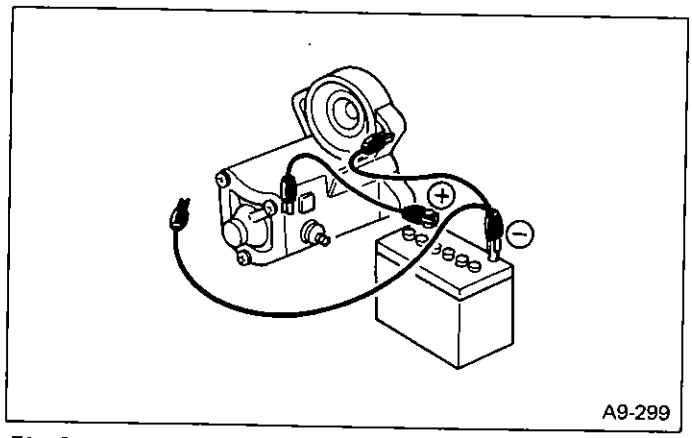


Fig. 6

PERFORMANCE TEST

The starter should be submitted to performance tests whenever it has been overhauled, to assure its satisfactory performance when installed on the engine.
Three performance tests, no-load test, load test, and lock test, are presented here; however, if the load test and lock test cannot be performed, carry out at least the no-load test.
For these performance tests, use the circuit shown in figure.
1) No-load test
With switch on, adjust the variable resistance to obtain 11.5 V (reduction type), take the ammeter reading and measure the starter speed. Compare these values with the specifications. values with the specifications. (See specifications.)
2) Load test
Apply the specified braking torque to starter. The condition is satisfactory if the current draw and starter speed are within specifications. (See specifications.)
3) Lock test
With starter stalled, or not rotating, measure the torque developed and current draw when the voltage is adjusted to the specified voltage. (See specifications.)

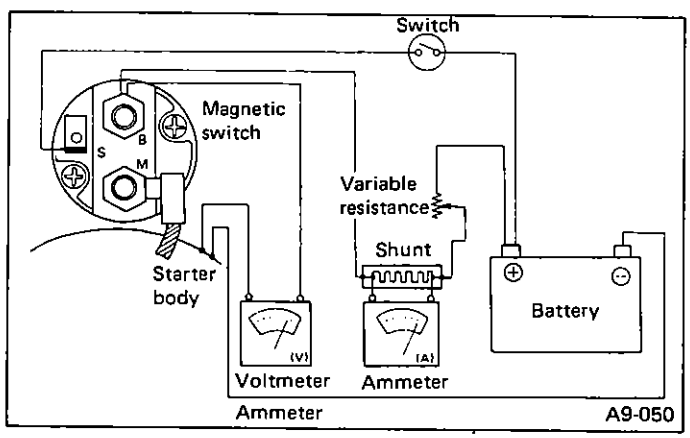


Fig. 7

DISASSEMBLY

1) Disconnect lead wiring from magnet switch.
2) Remove screws, bolts, etc.
- Two through bolts
- Two screws from starter housing
- Two screws and rear frame

3) Separate starter housing from magnet switch.
4) Separate yoke from magnet switch.
5) Using long-nose pliers, take off brushes, and pull out brush holder from armature.

Be careful not to scratch brushes, bearing and commutator.

6) Separate armature from yoke.

Be careful not to damage bearings.

7) Separate pinion and overrunning clutch.

a. Magnetic switch should be replaced as a subassembly.
b. Never loosen contact (terminal) bolt.

INSPECTION

ARMATURE

1) Check commutator for any sign of burns or rough surfaces or stepped wear. If wear is of a minor nature, correct it by using sandpaper.
2) Run-out test
Check the commutator run-out and replace if it exceeds the limit.

Commutator run-out:
Standard
0.02 mm (0.0008 in)
Service limit
Less than 0.05 mm (0.0020 in)

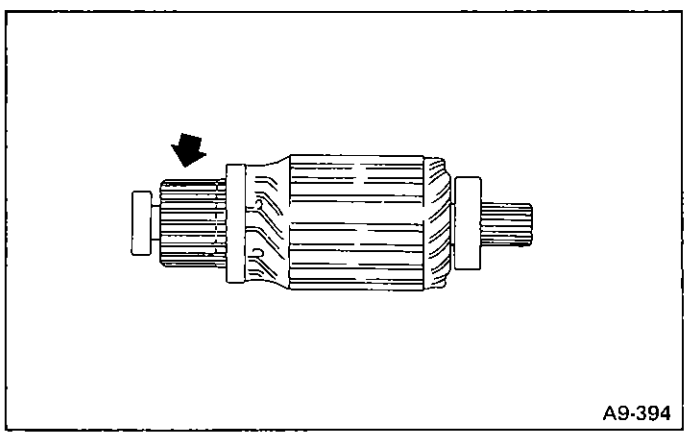


Fig. 8

3) Depth of segment mica
Check the depth of segment mica.

Depth of segment mica
Standard
0.5 – 0.8 mm (0.020 – 0.031 in)
Service limit
0.2 mm (0.008 in)

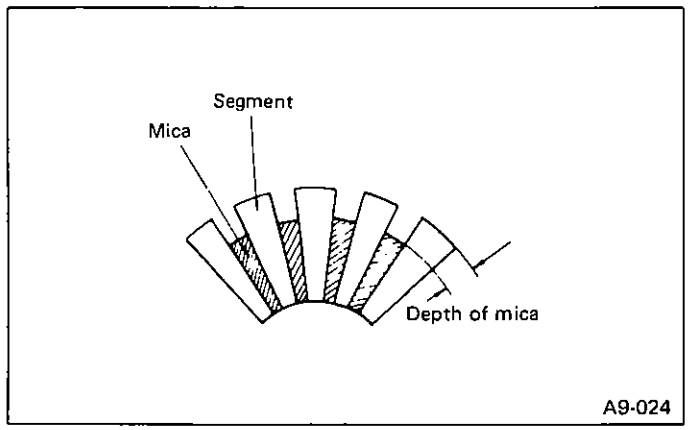


Fig. 9

4) Armature short circuit test
Check armature for short circuit by placing it on growler tester. Hold a hacksaw blade against armature core while slowly rotating armature. A short-circuited armature will cause the blade to vibrate and to be attracted to core. If the hacksaw blade is attracted or vibrates, the armature, which is short-circuited, must be replaced or repaired.

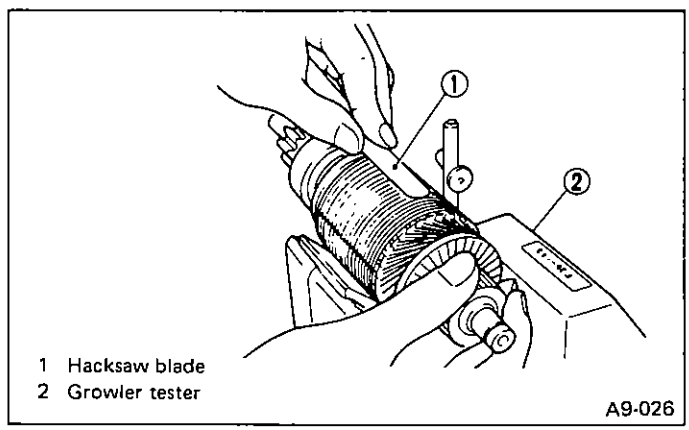


Fig. 10

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

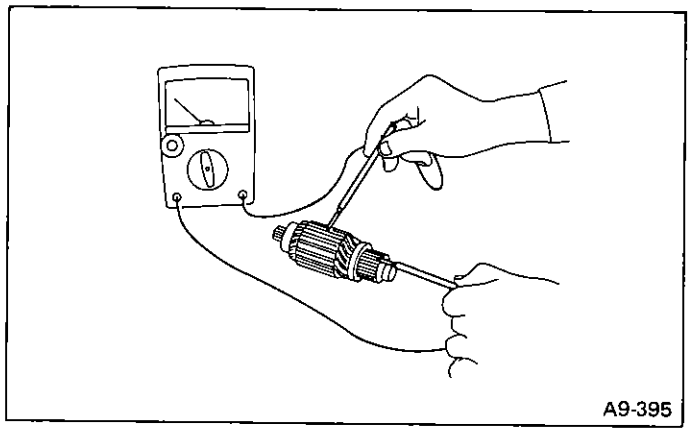


Fig. 11

6) Armature continuity test
Using circuit tester, touch two probes to segments. There should be continuity at any test points. Replace if it is open-circuited.

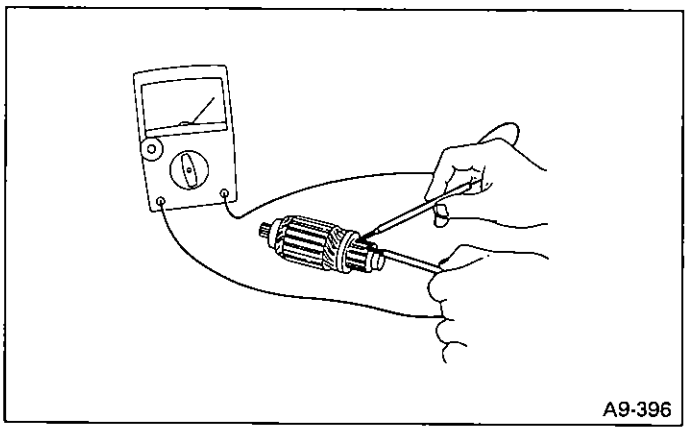


Fig. 12

YOKE

1) Field coil ground test
Using circuit tester, touch one probe to field coil end or brush and the other to the bare surface of yoke body. There should be no continuity. If there is continuity, field coil is grounded. Be sure to repair if it is grounded.

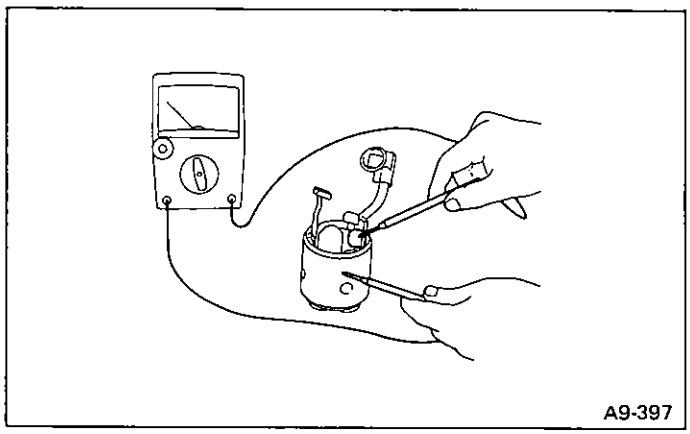


Fig. 13

2) Field coil continuity test
Using circuit tester, touch one probe to "C" terminal lead wire and the other to brush. There should be continuity. If there is no continuity, field coil is defective.

If field coil is defective, yoke ASSY must be replaced.

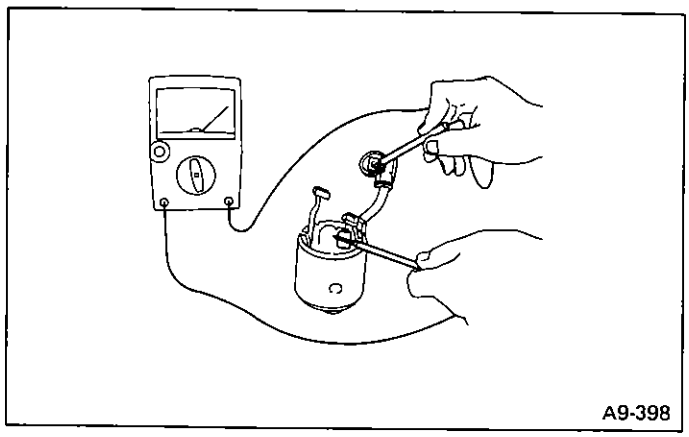


Fig. 14

BRUSH AND BRUSH HOLDER

1) Brush length
Measure the brush length and replace if it exceeds the service limit.

Brush length:
Standard
14 mm (0.55 in)
Service limit
9 mm (0.35 in)

a. If brushes are worn, replace them as entire yoke ASSY or entire brush holder ASSY.
b. Correct the contact surface of each brush after sandpaper (No. 300 or higher) has been wrapped around the commutator.

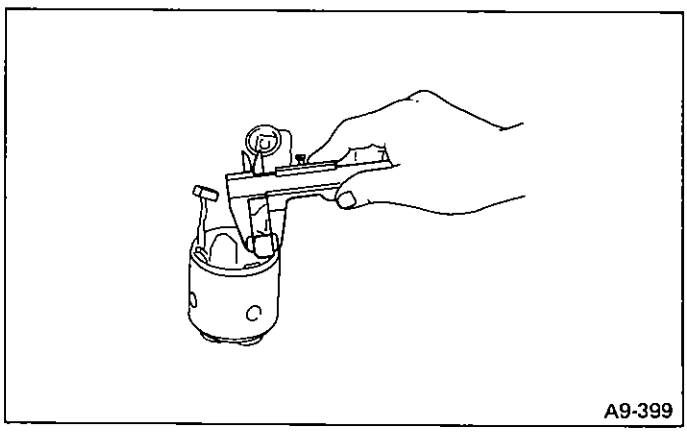


Fig. 15

2) Brush holder insulation test
Using circuit tester, check brush holder insulation. Touch one probe to holder plate and the other to positive brush holder. There should be no continuity.

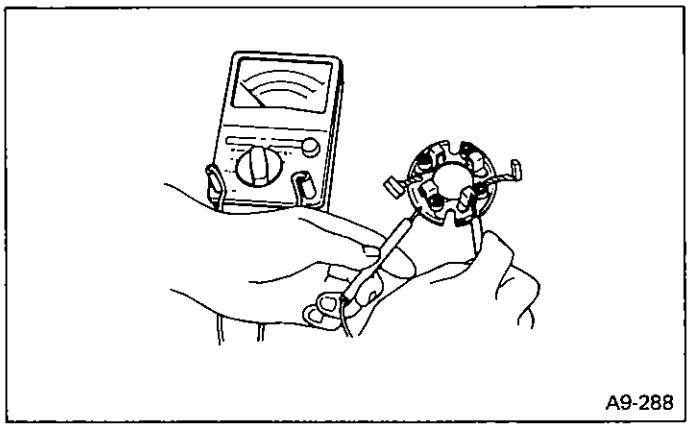


Fig. 16

OVERRUNNING CLUTCH

Inspect teeth of pinion for wear and damage. Replace it if damaged. Rotate pinion in direction of rotation (clockwise). It should rotate smoothly. But in opposite direction, it should be locked.

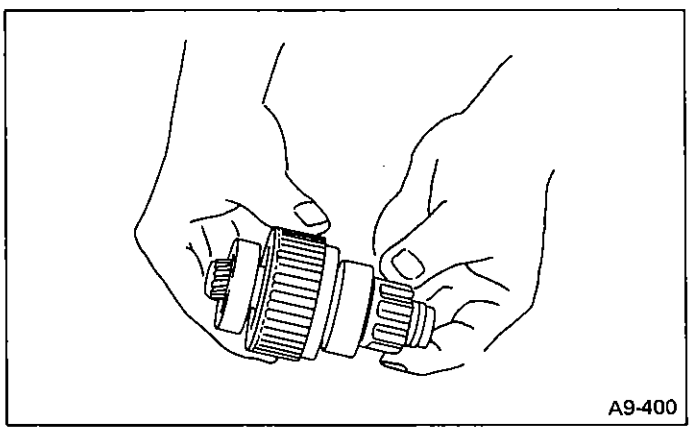


Fig. 17

BEARING

Check bearings for wear and damage. If bearings are noisy during operation, they should be replaced.

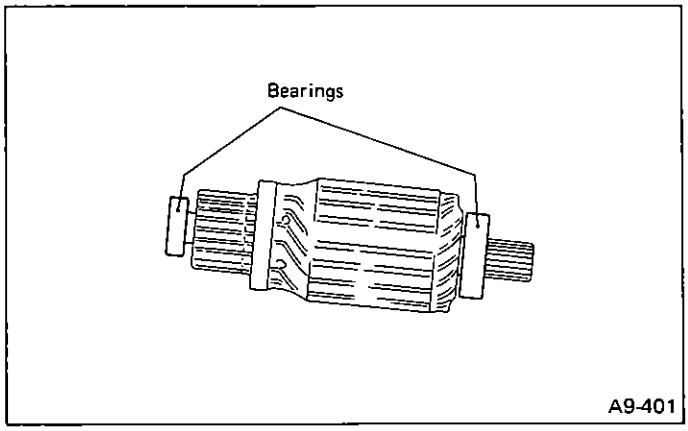


Fig. 18

ASSEMBLY

1) Before assembling, completely clean oil or dust off the surfaces of both commutator and brushes.
2) Apply a sufficient amount of grease to parts where necessary.
3) Assemble starter pinion and starter housing.
4) Assemble overrunning clutch and starter housing.

Do not forget to assemble steel ball and return spring.

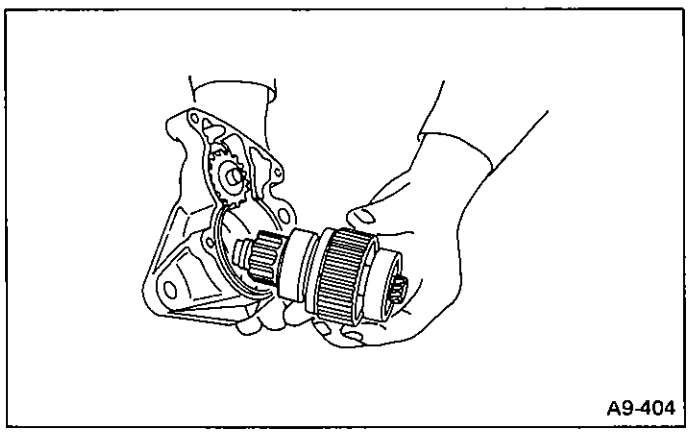


Fig. 19

5) Assemble brush holder and armature.

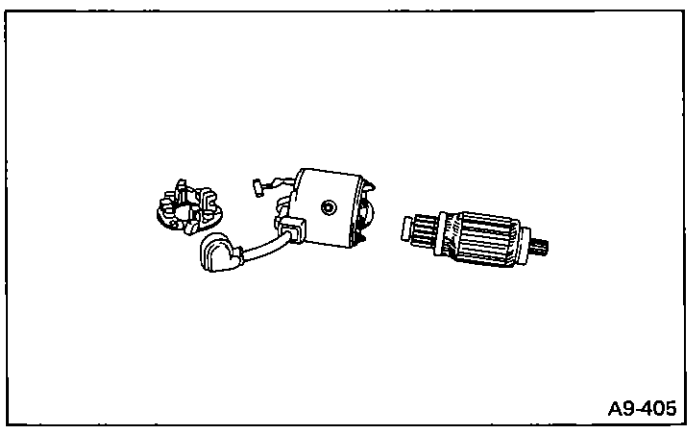


Fig. 20

6) Assemble brushes by using a long-nose pliers.

Take care not to damage nor to get oil on brushes.

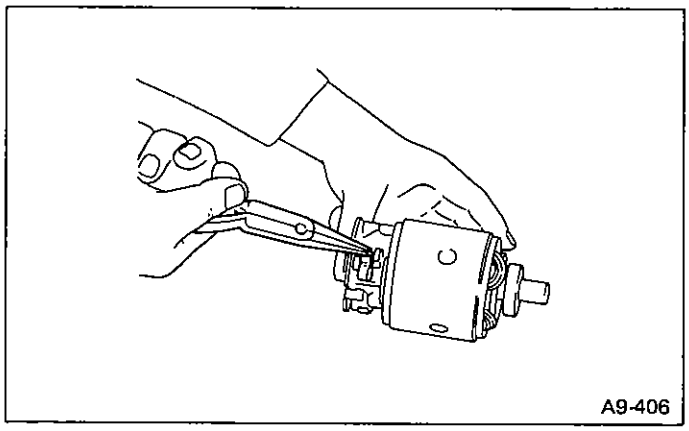


Fig. 21

7) Assemble rear frame and yoke.
8) Assemble yoke and magnet switch.
9) Assemble starter housing and magnet switch.

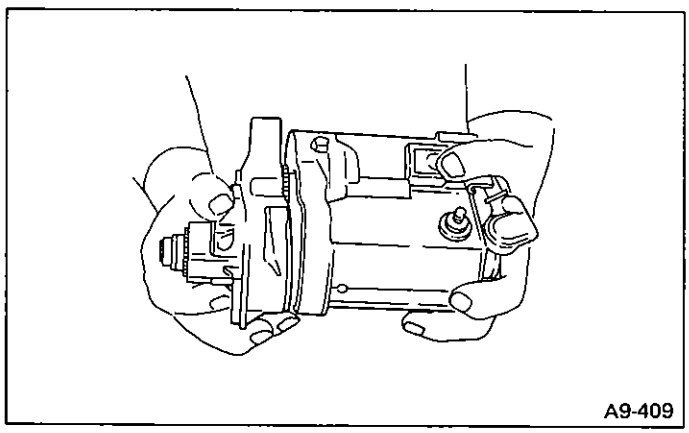


Fig. 22

10) Tighten two screws in rear frame.

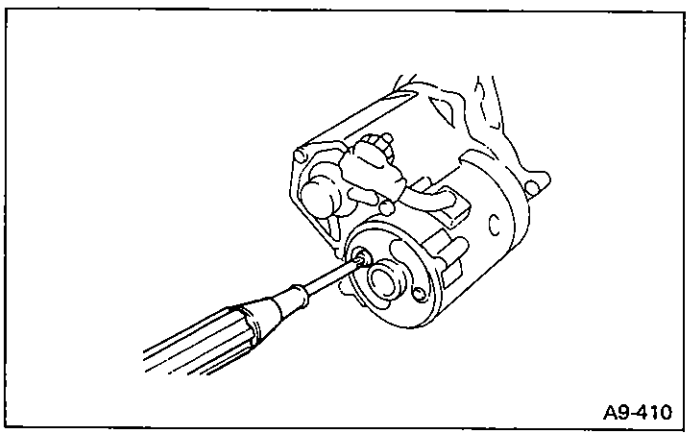


Fig. 23

11) Tighten two screws in starter housing.

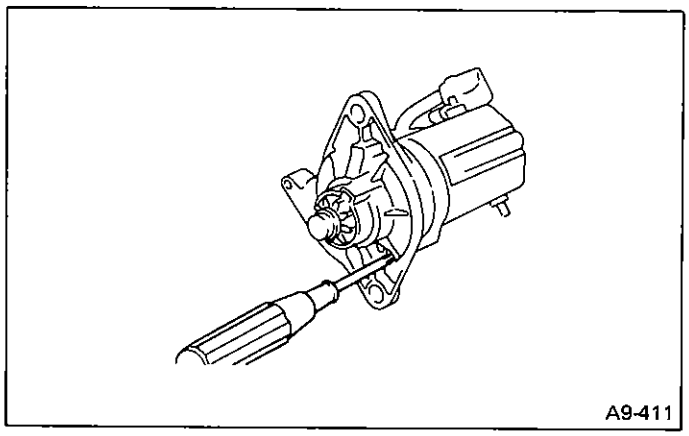


Fig. 24

12) Tighten two through bolts in yoke.

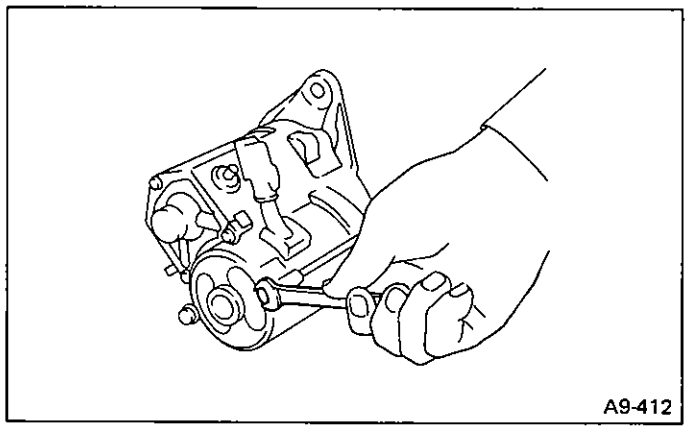


Fig. 25

13) Connect lead wire to magnet switch.

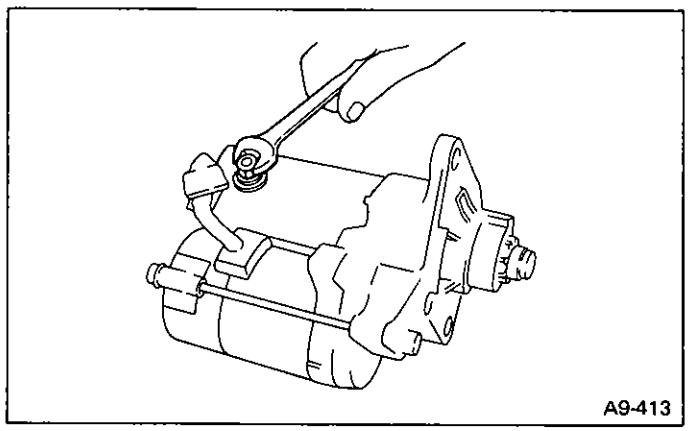


Fig. 26

AT (028000-9800)

TEST

MAGNETIC SWITCH

Be sure to complete each test within a few seconds.

1) Pull-in test
Connect two battery negative leads onto magnetic switch body and terminal C respectively. Then connect battery positive lead onto terminal 50. Pinion should extend when lead connections are made.

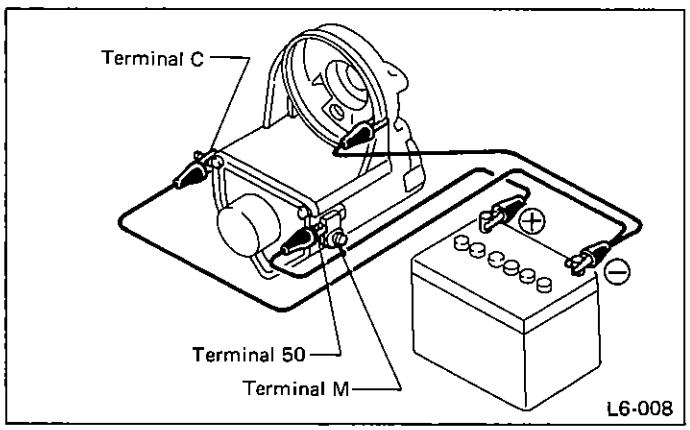


Fig. 27

2) Holding-in test
Disconnect lead from terminal C with pinion extended. Pinion should be held in the extended position.

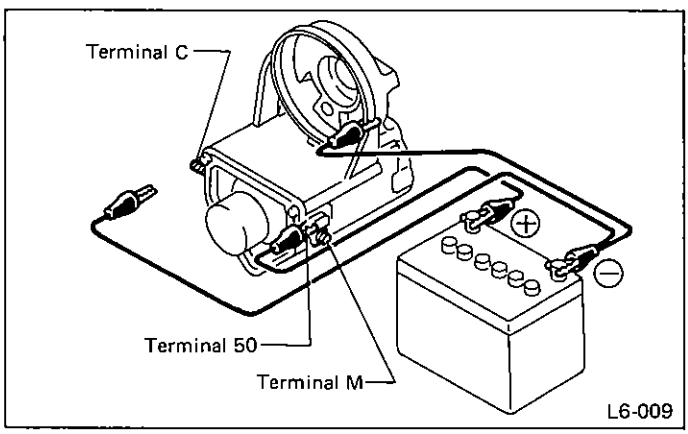


Fig. 28

3) Return test
Connect two battery negative leads onto terminal 50 and onto switch body respectively. Then connect battery positive lead onto terminal C. Next, disconnect lead from terminal 50. Pinion should return immediately.

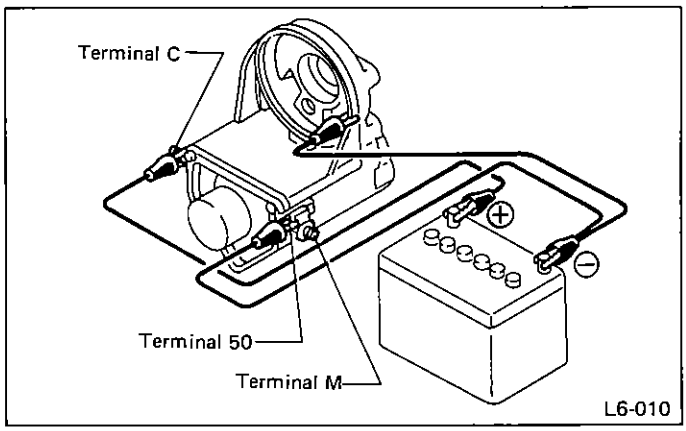


Fig. 29

PERFORMANCE TEST

The starter is required to produce a large torque and high rotating speed, but these starter characteristics vary with the capacity of the battery. It is therefore important to use a battery with the specified capacity whenever testing the starter.
The starter should be checked for the following three items.

1. No-load test: Measure the maximum rotating speed and current under a no-load state.
2. Load test: Measure the magnitude of current needed to generate the specified torque and rotating speed.
3. Stall test: Measure the torque and current when the armature is locked.

1) No-load test
Run single starter under no-load state, and measure its rotating speed, voltage, and current, using the specified battery. Measured values must meet the following standards:

No-load test (Standard):
Voltage/Current
11V/90A max.
Rotating speed
4,000 rpm min.

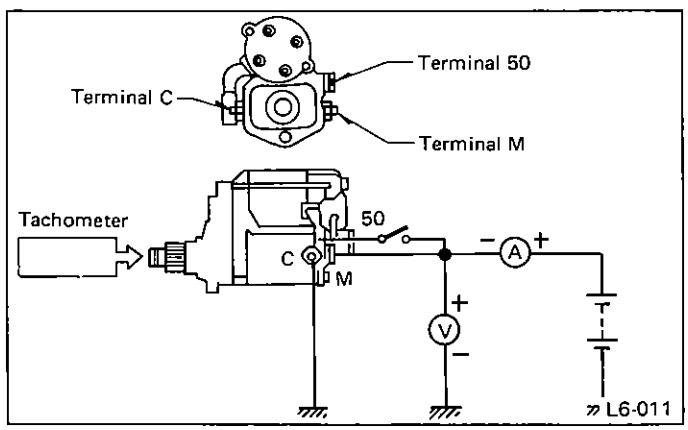


Fig. 30

2) Load test (For reference)
Perform this test to check maximum output of starter. Use test bench which is able to apply load (brake) to starter. Measure torque value and rotating speed under the specified voltage and current conditions while controlling braking force applied to starter.

Change engagement position of overrunning clutch and make sure it is not slipping.

Load test (Standard):
Voltage/Load
8V/14 N·m (1.4 kg-m, 10 ft-lb)
Current/Speed
370A max./880 rpm min.

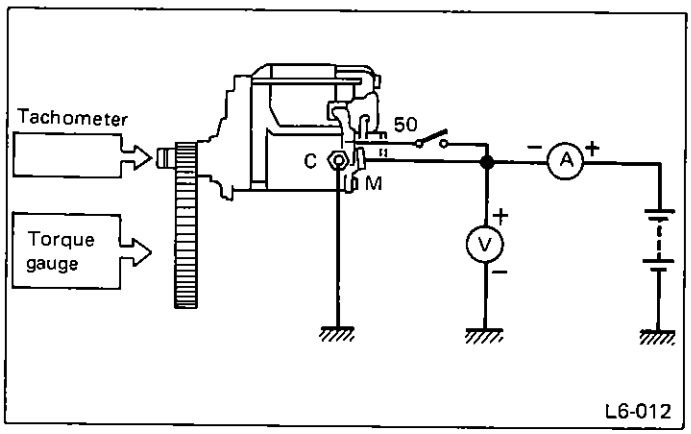


Fig. 31

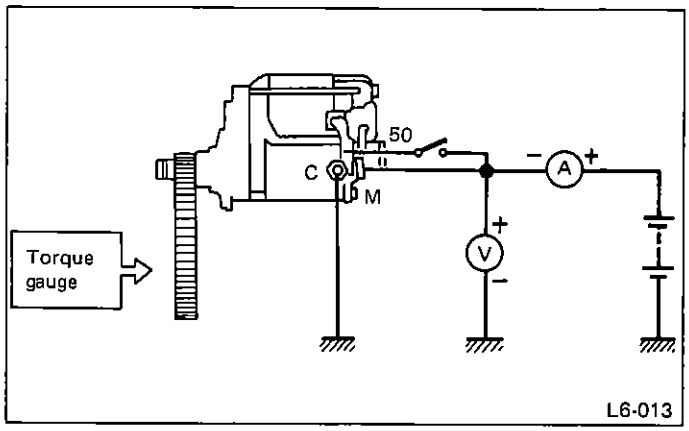


Fig. 32

Low rotating speed or excessive current during no-load test may be attributable to high rotating resistance of starter due to improper assembling.
Small current and no torque during stall test may be attributable to excessive contact resistance between brush and commutator; whereas, normal current and insufficient torque may be attributable to shorted commutator or poor insulation.
Starter can be considered normal if it passes no-load and stall tests; therefore, load test may be omitted.

3) Stall test
Using the same test equipment used for load test, apply brake to lock starter armature. Then measure voltage, current, and torque values.
Measured values must meet the following standard.

Stall test (Standard):
Voltage/Current
5V/735A max.
Torque
27 N·m (2.8 kg-m, 20 ft-lb) min.

DISASSEMBLY

1) Disconnect lead wire from magnetic switch.

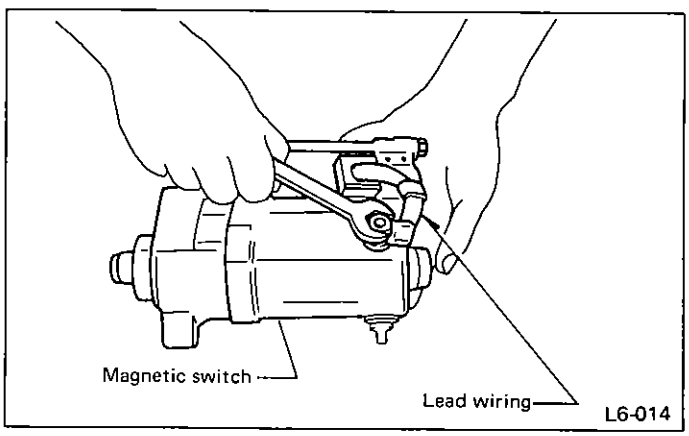


Fig. 33

2) Remove through-bolts from end frame.

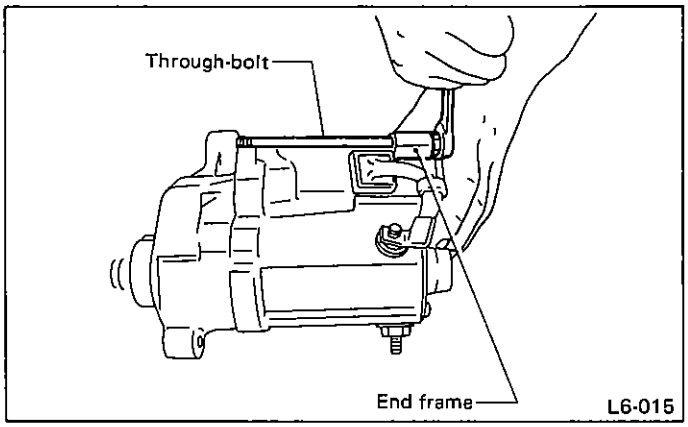


Fig. 34

3) Remove yoke from magnetic switch.

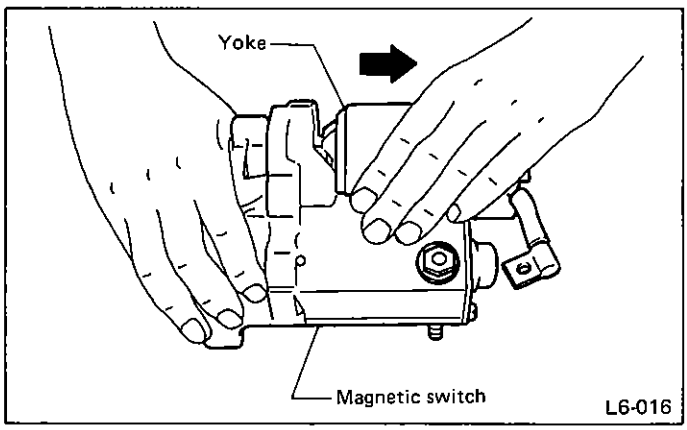


Fig. 35

4) Remove screws securing end frame to brush holder.

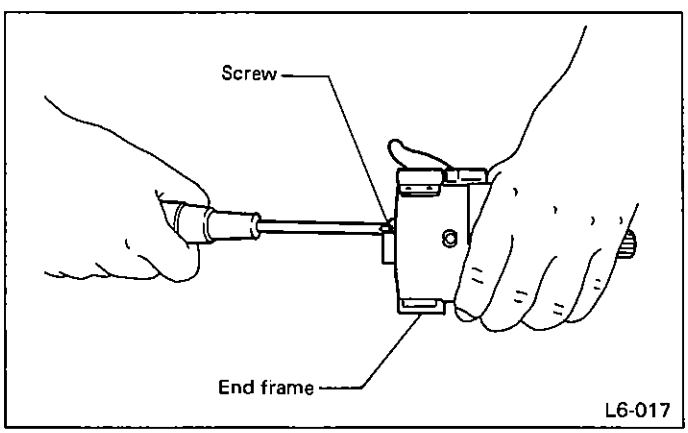


Fig. 36

5) Separate yoke from end frame.

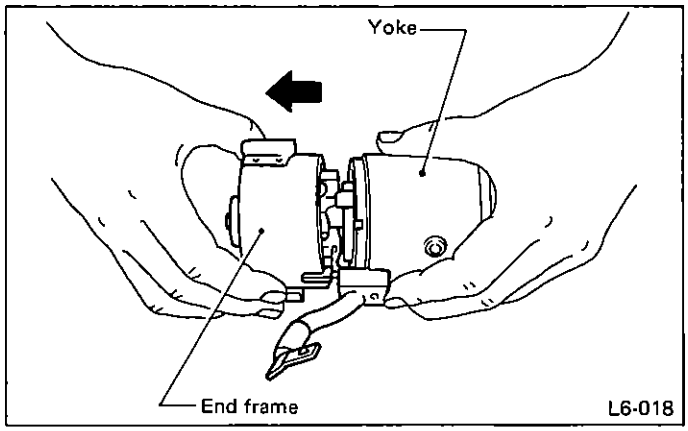


Fig. 37

6) Remove brush by lifting up positive (+) side brush spring using long-nose pliers.

Be careful not to damage brush and commutator.

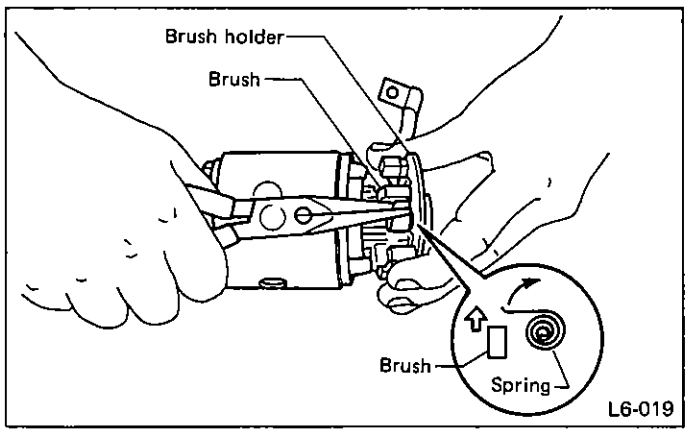


Fig. 38

7) Remove armature from yoke.

Be careful not to drop armature.

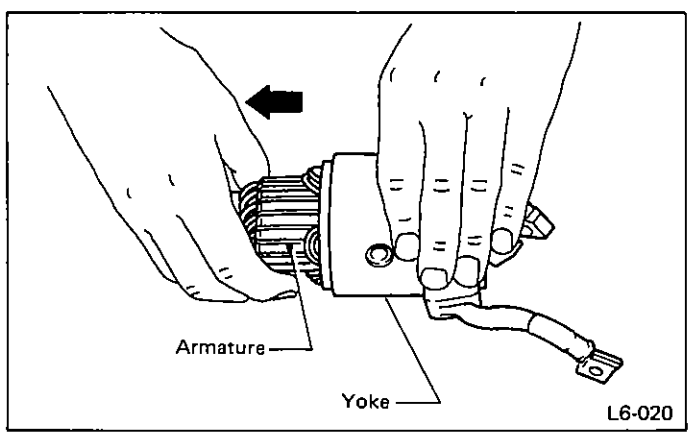


Fig. 39

8) Remove screws securing magnetic switch to housing.

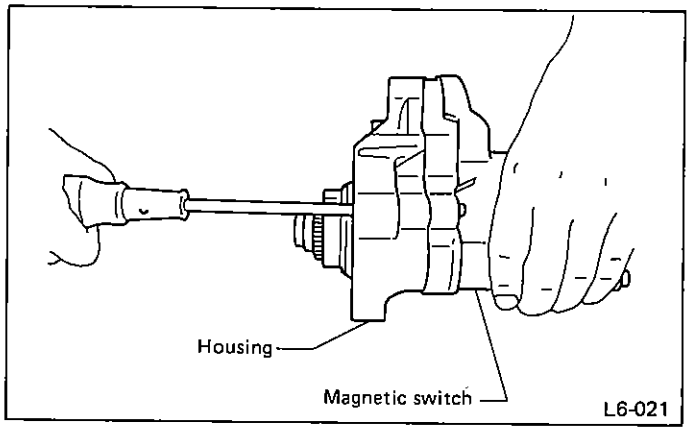


Fig. 40

Remove housing from magnetic switch.

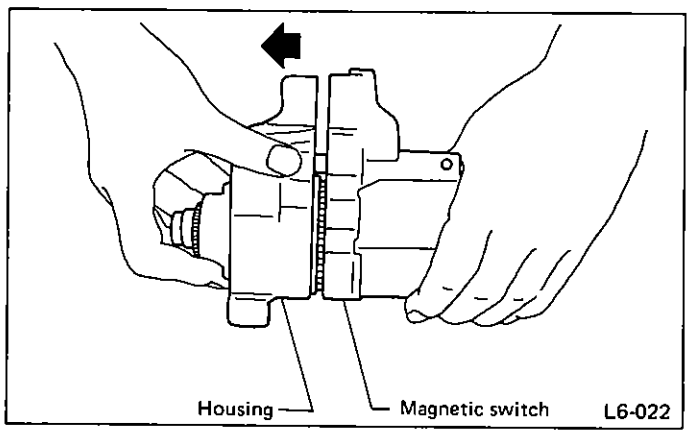


Fig. 41

9) Remove clutch from housing.

If pinion is placed on the outside of housing, first remove snap ring then take out clutch.
For removal of snap ring, see step 10).

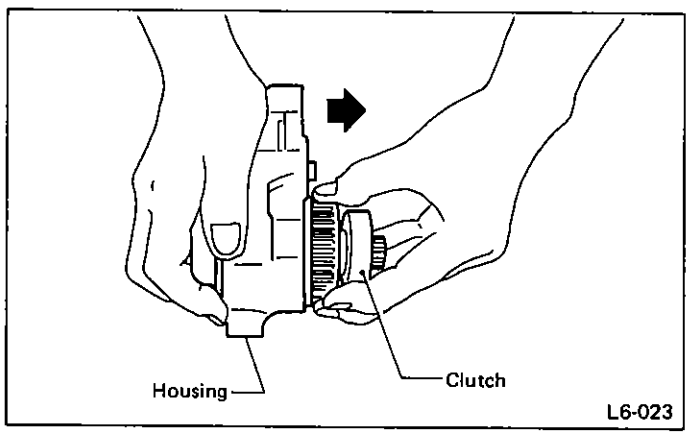


Fig. 42

10) Removal of snap ring (Models with pinion set on outside of housing).

(1) Press down housing to push out pinion.

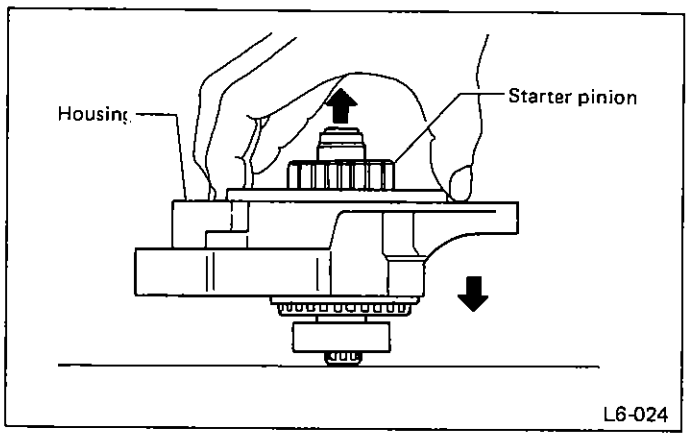


Fig. 43

(2) Press down pinion stop collar using jig as shown, until snap ring comes out.

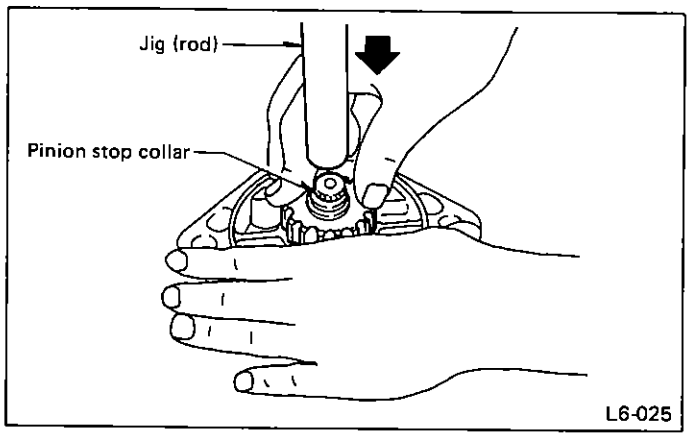


Fig. 44

(3) Remove snap ring using circlip pliers.
Remove pinion from clutch shaft, then take out clutch from housing.

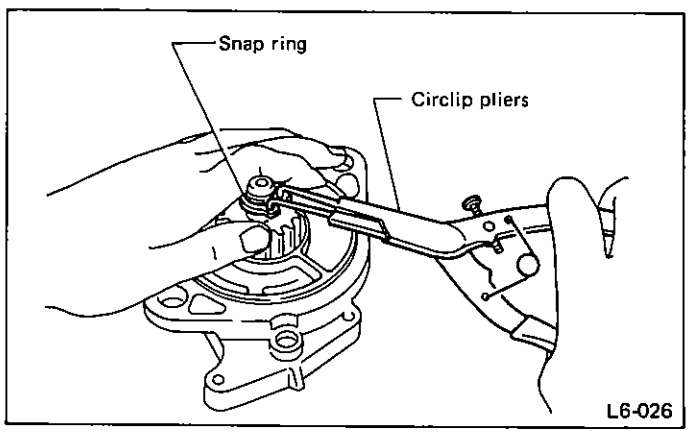


Fig. 45

11) Take out steel ball from clutch.

Be careful not to lose steel ball.

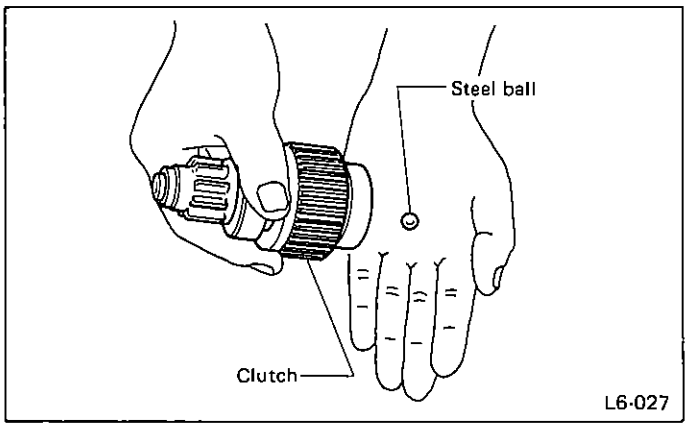


Fig. 46

12) Remove idle gear from housing.

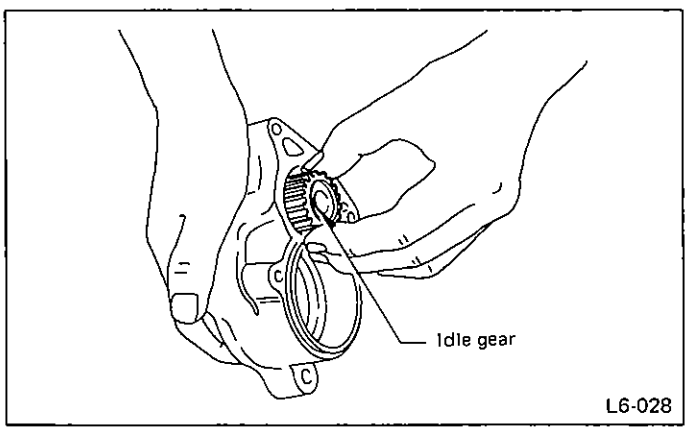


Fig. 47

13) Remove retainer and roller from housing.

Be careful not to drop retainer and roller.

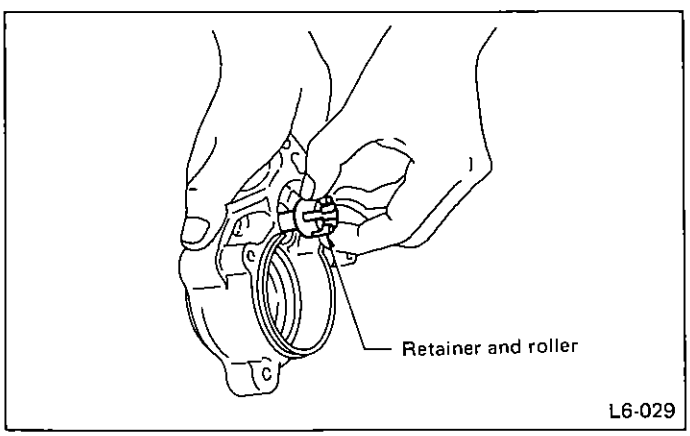


Fig. 48

14) Remove coil spring from magnetic switch.

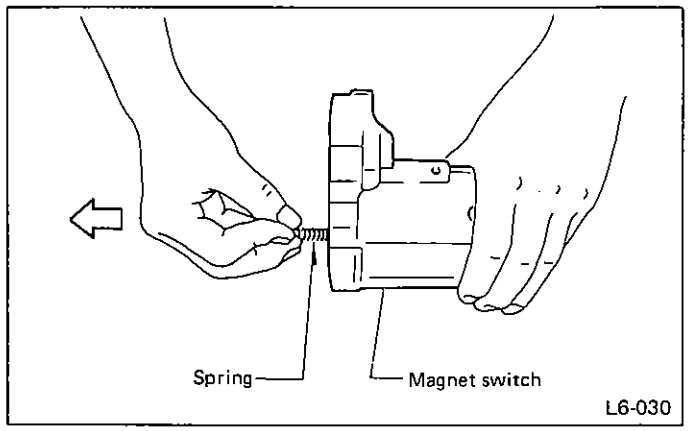


Fig. 49

INSPECTION AND REPAIR

ARMATURE

1) Layer test

Check armature coil for shortcircuit between layers by using armature tester.

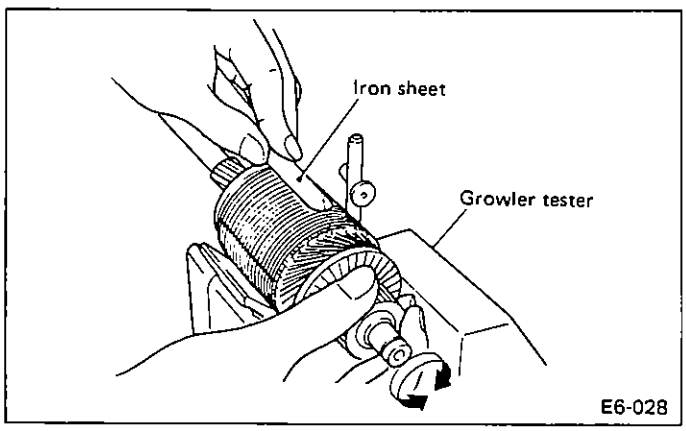


Fig. 50

If any shortcircuit exists in armature coil, circulating current is generated by alternating flux of armature tester, and the affected portion of the armature core is magnetized.
If an iron piece is brought close to that portion, it will vibrate, locating the shortcircuit.

Before performing the test, thoroughly remove carbon powder, etc. from around the commutator.

2) Insulation test

Check insulation between commutator and armature core using 500 V megger.
Insulation resistance should be 0.1 MΩ or larger.

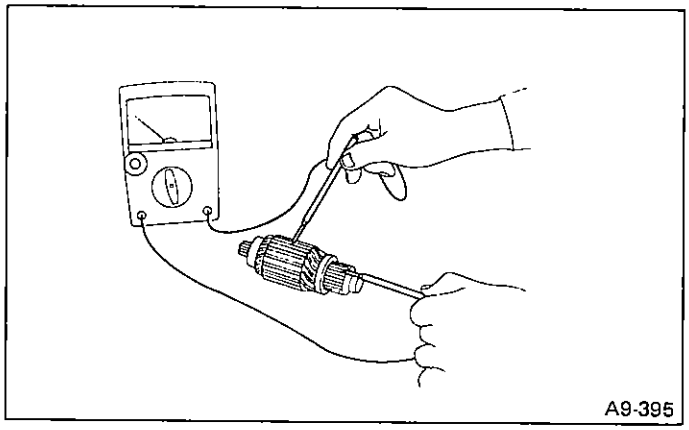


Fig. 51

3) Check commutator for out of roundness.
Use dial gauge to check that commutator is round. Repair commutator using lathe if uneven wear is found.
[If difference between maximum diameter and minimum diameter exceeds 0.05 mm (0.0020 in), repair commutator until the difference is less than 0.02 mm (0.0008 in).]

Be sure to perform this check after checking armature shaft for bend.

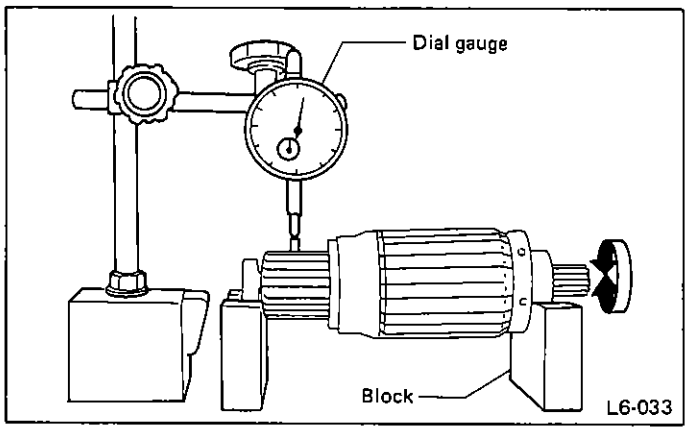


Fig. 52

If commutator surface is rough, polish with fine grain sand paper (#300); if burnt excessively, correct by cutting with a lathe.
In repairing commutator with lathe, do not reduce commutator O.D. by more than 1 mm (0.04 in) from its original (standard) value. Excessive cutting will hamper commutator durability.
After repairing, polish finished surface with sand paper.

Commutator O.D.:
Standard value
30 mm (1.18 in)
Service limit
29 mm (1.14 in)

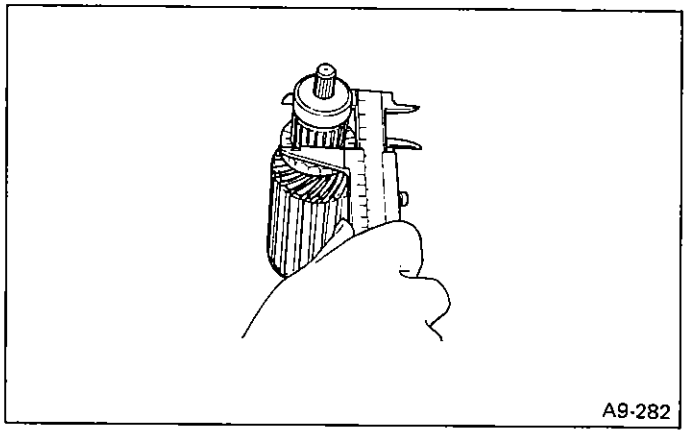


Fig. 53

4) Under-cutting of commutator
If commutator segments wear and mica insulation between segments stand higher than segment face, proper rectification is hampered. To avoid this, undercut insulator to a depth of 0.5 to 0.8 mm (0.020 to 0.031 in) if the depth below segment surface is reduced to less than 0.2 mm (0.008 in)

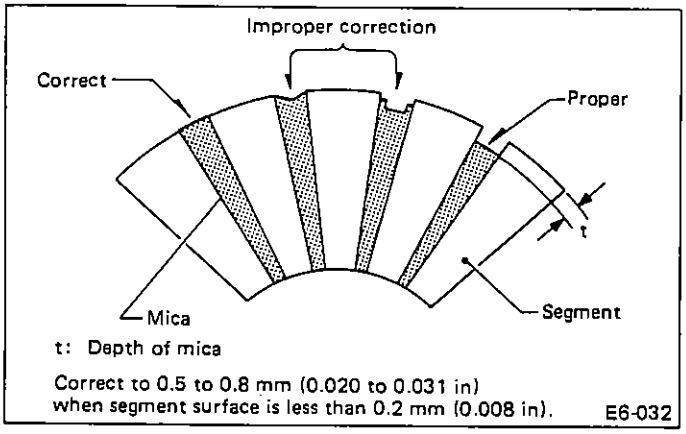


Fig. 54

YOKE

1) Testing field coil for open circuit
Check field coil for continuity using circuit tester. Continuity should exist.

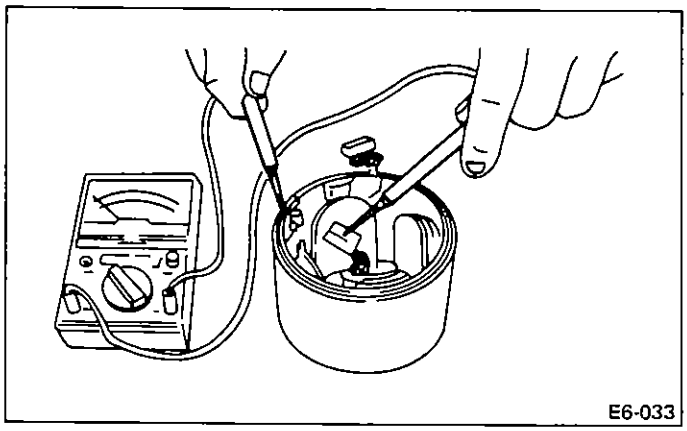


Fig. 55

2) Checking carbon brush
If carbon brush length has been reduced by more than 1/3 the original length, or if brush contact area has been reduced largely due to brush breakage, replace carbon brush.

Brush length:
Standard value
15 mm (0.59 in)
Service limit
10 mm (0.39 in)

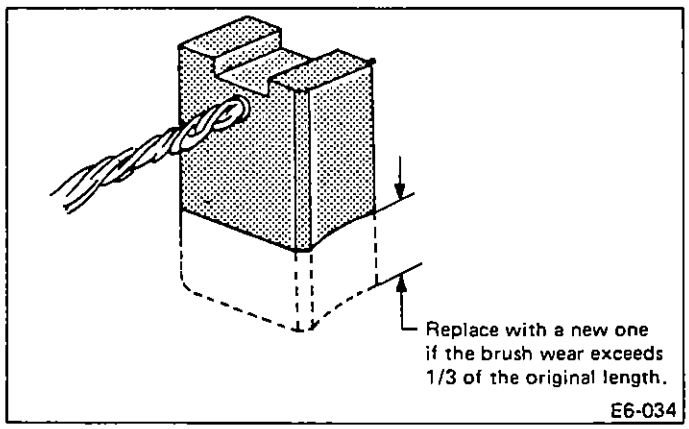


Fig. 56

BRUSH HOLDER

Measure insulation resistance of brush holder using Megger. Insulation resistance should be 0.1 MΩ or over.

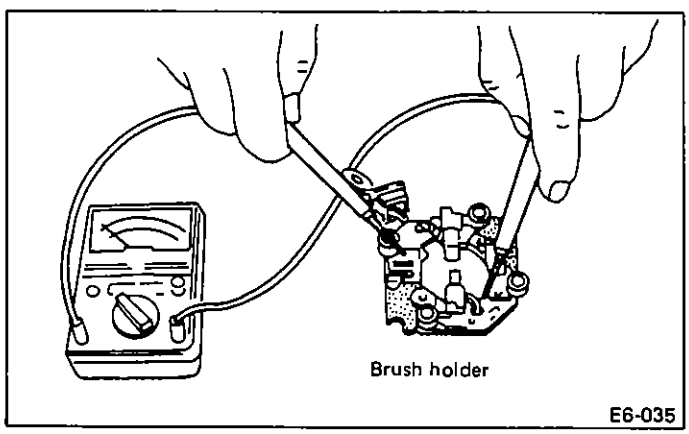


Fig. 57

CLUTCH

Check that pinion can be rotated in normal direction only.
Check pinion gear for wear, damage, rusting, or binding during rotation.

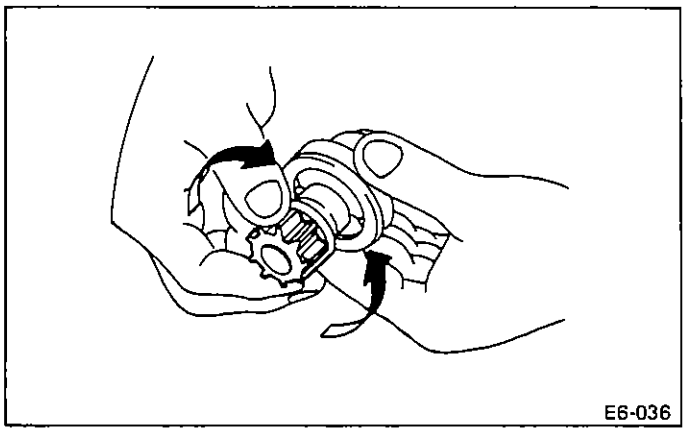


Fig. 58

Bearing

1) Inspection
(1) Rotate bearing by hand; no binding should exist.
(2) Rotate bearing rapidly; no abnormal noise should be heard.

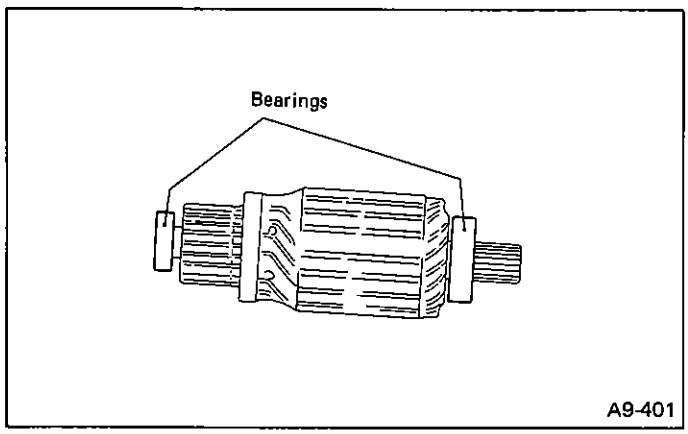


Fig. 59

2) Replacement
Pull out bearing using a jig as shown in Figure.

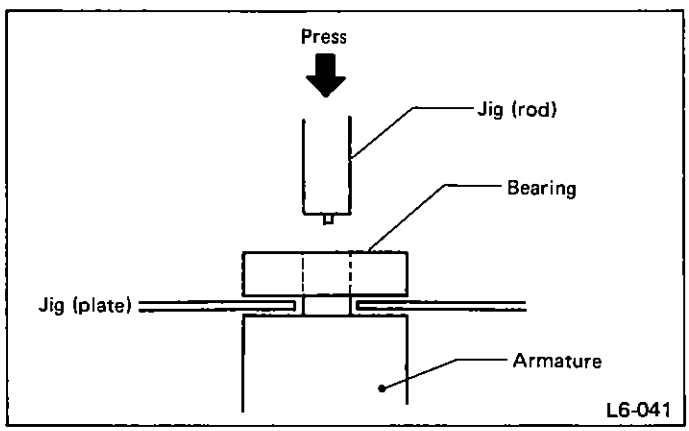


Fig. 60

ASSEMBLY

Assembly is in the reverse order of disassembly procedures. Observe the following:

1) Before assembling, lubricate disassembled parts at the points shown in the figure below.

Grease	
ESSO BEACON 325 SCHELL ALVANIA GREASE RA	or equivalent

2) Assembling magnetic switch, clutch, and housing

To assemble, first install clutch to magnetic switch, then install idle gear, and finally install clutch.

a. Do not forget to install steel ball and coil spring to clutch.
b. Attach bearing to idle gear beforehand.

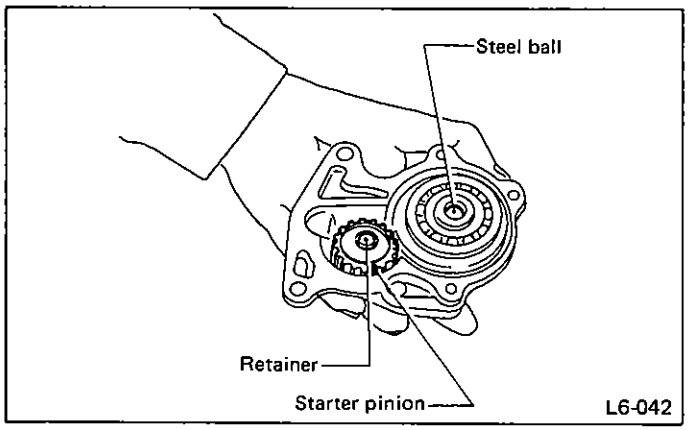


Fig. 61

3) Installing armature to yoke

Do not forget to put felt washer on armature shaft bearing.

4) Installing brushes

Assemble brush holder to yoke as shown, then assemble two yoke-side brushes to brush holder.

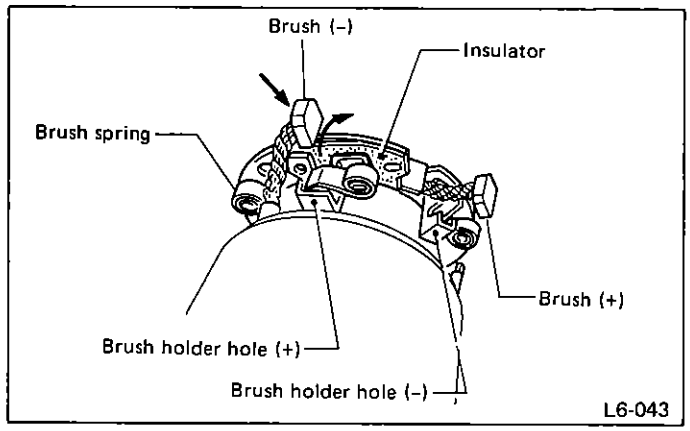


Fig. 62

5) Installing end frame

When assembling end frame to yoke, align notched portion of end frame with lead wire grommet.

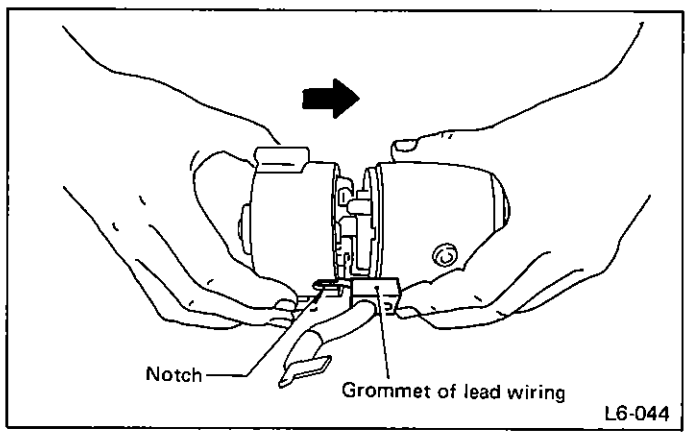


Fig. 63

6) Installing yoke

When installing yoke to magnetic switch, align notch of yoke with protrusion of magnetic switch.

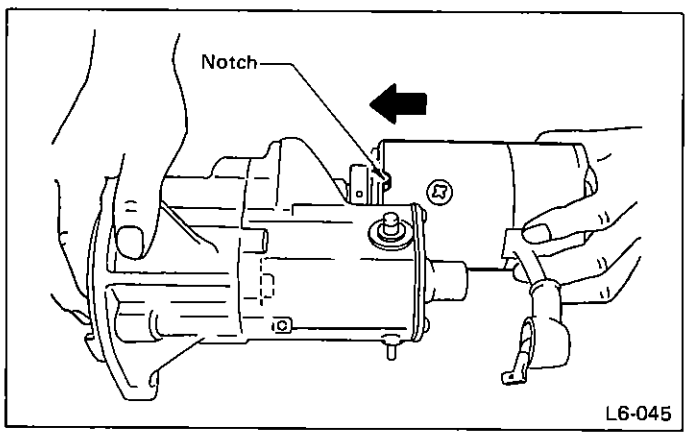


Fig. 64

Alternator

(LR160-137 and LR160-138)

TEST

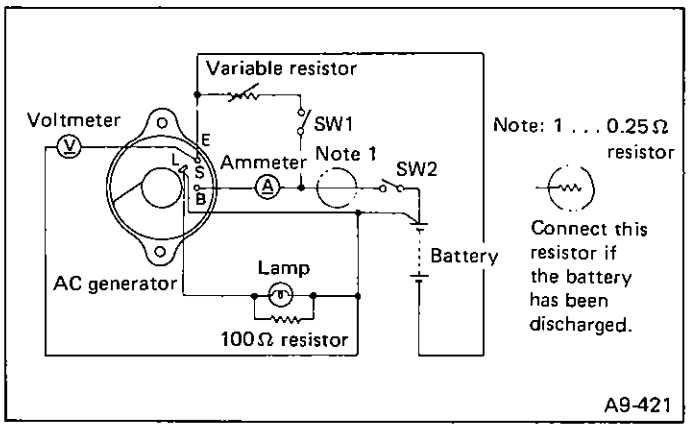


Fig. 65

GENERATOR SPEED AT 13.5V

1) Open switch SW_1, and close switch SW_2. Gradually raise generator speed, and read the speed when the voltage is 13.5V.
2) The generator is normal if it turns at 900 rpm when the voltage is 13.5V.

MEASUREMENT OF REGULATING VOLTAGE

Open switch SW_1 and close SW_2. Turn the generator at 5,000 rpm. The regulator is normal if the voltage is within 14.1 - 14.8 V with a fully charged battery.

MEASUREMENT OF OUTPUT CURRENT

1) With the variable resistor set to the minimum resistance position, close switches SW_1 and SW_2 in order to turn the generator.
2) Raise generator speed while keeping the voltage constant by adjusting the variable resistor. Measure the current at 1,250 rpm, 2,500 rpm and 5,000 rpm.

1,250 rpm	18A or more
2,500 rpm	49A or more
5,000 rpm	58A or more

DISASSEMBLY

1) Remove through bolts from alternator. Detach front cover with rotor from rear cover with stator by lightly tapping on front cover with a plastic hammer.
2) Hold rotor with a vise and remove pulley nut.

When holding rotor with vise, insert aluminum plates on the contact surfaces of the vise to prevent rotor from damage.

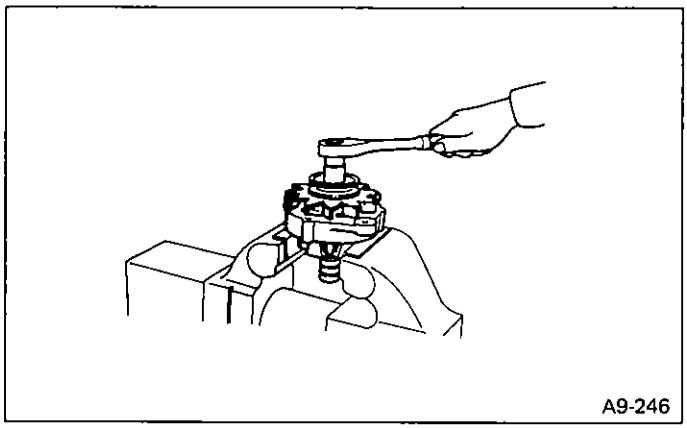


Fig. 66

3) Rotor from front cover.
4) Three screws from front cover and then retainer and ball bearing.
5) Separate stator with diode ASSY and brush ASSY from rear cover by removing nuts on rear cover.
6) Disconnect diode ASSY, brush ASSY and IC regulator all together from stator coil lead wires by using soldering iron.

Melting should be done quickly not to damage diodes and IC regulator.

7) Disconnect diode ASSY from brush and IC regulator by removing 3 mm (0.12 in) dia. rivet and by unsoldering L-terminal.
8) To replace IC regulator, first unsolder regulator terminals, and then remove two bolts.

Do not remove these bolts except when replacing IC regulator.

INSPECTION AND REPAIR

ROTOR

1) Inspect slip rings for contamination or any roughness of the sliding surface.
Clean or polish with #500 to #600 emery paper if defective.

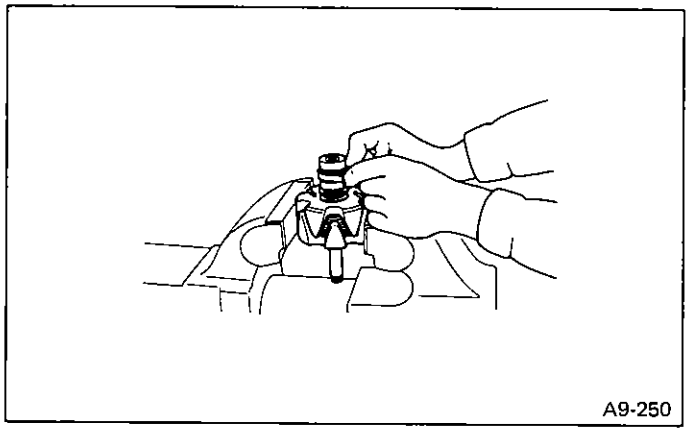


Fig. 67

2) Broken wire test
Inspect rotor coil for continuing between slip rings.
If there is no continuity, it is broken.
Replace rotor ASSY.

Resistance of rotor coil:
4 – 5Ω

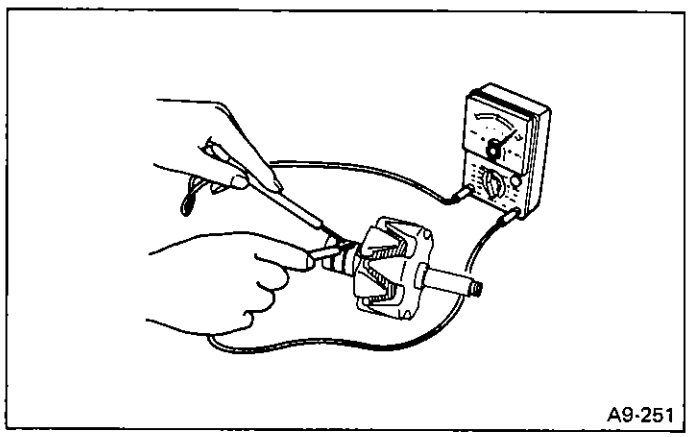


Fig. 68

3) Insulation test
Inspect continuity between slip ring and rotor core. If continuity exists, replace rotor ASSY because rotor coil or slip ring is broken.

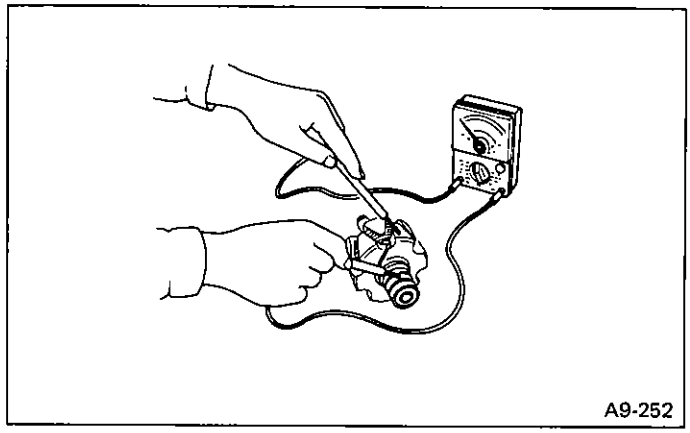


Fig. 69

4) Check ball bearing and replace if defective.

STATOR

1) Broken wire test
Inspect stator coil for continuity between its terminals.
When there is no continuity between individual terminals, cable is broken.
Replace stator ASSY.

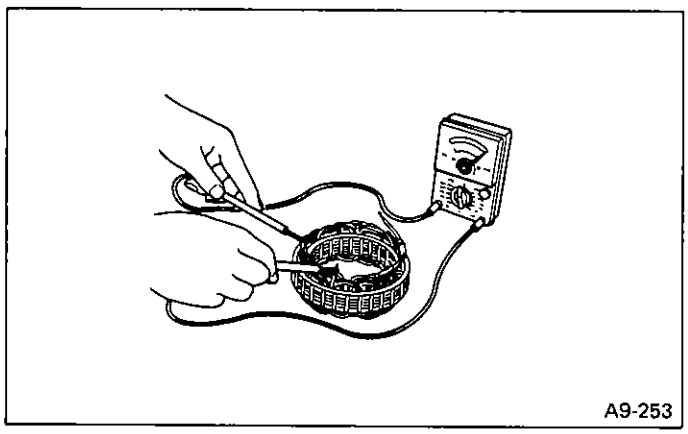


Fig. 70

2) Insulation test
Inspect stator coil for continuity between stator core and each terminal. If there is continuity, stator coil is grounded.

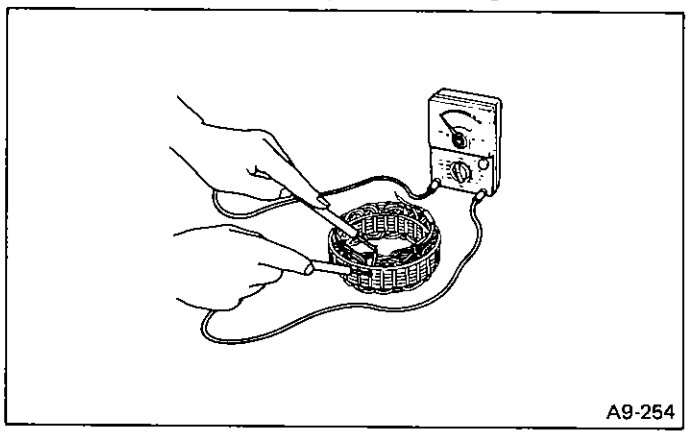


Fig. 71

BRUSH

1) Inspect the movement of brush and if the movement is not smooth, check brush holder and clean it.
Check brush for wear. If it is worn out to less than specified limit, replace brush ASSY.

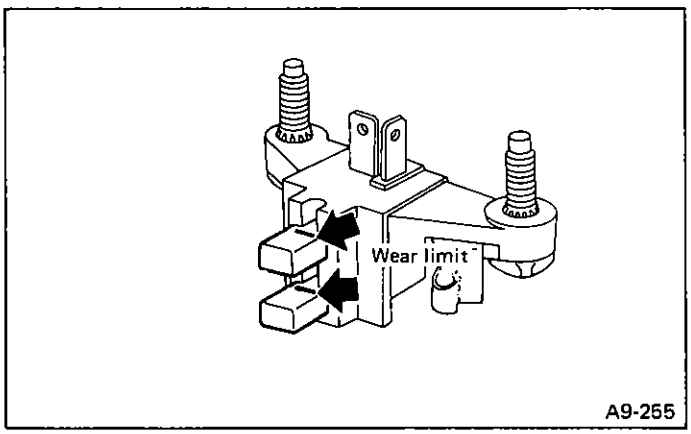


Fig. 72

2) With brush protruded approximately 2 mm (0.08 in) from brush holder, measure brush spring pressure with a spring balance.
Normally the pressure of a new brush spring is 2.501 to 3.383 N (255 to 345 g, 8.99 to 12.17 oz). When brush is worn, pressure decreases approximately 0.196 N (20 g, 0.71 oz) per 1 mm (0.04 in) wear.

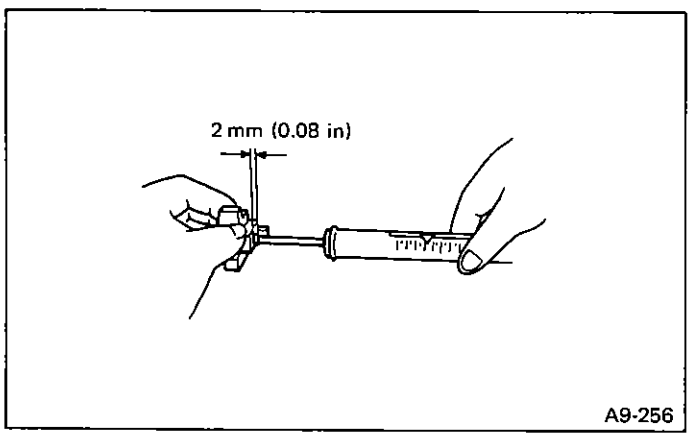


Fig. 73

DIODE ASSEMBLY

Perform the continuity test on diodes in both directions, using an ohmmeter.
A total of six diodes are used, there are mounted on the positive (+) plate, and other three are on the negative (-) plate. The continuity test should be performed on each diode between the terminal and plate.

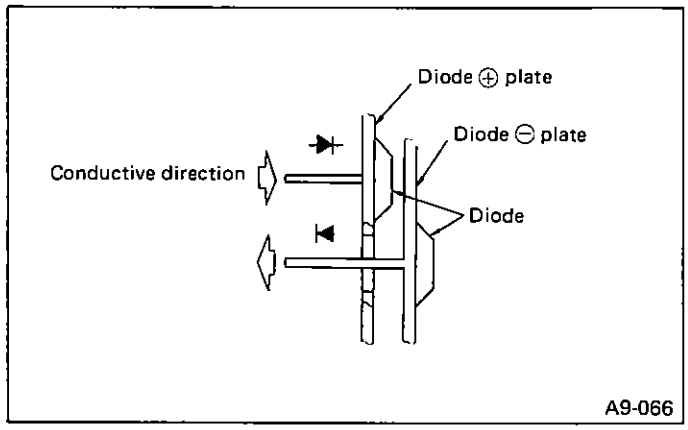


Fig. 74

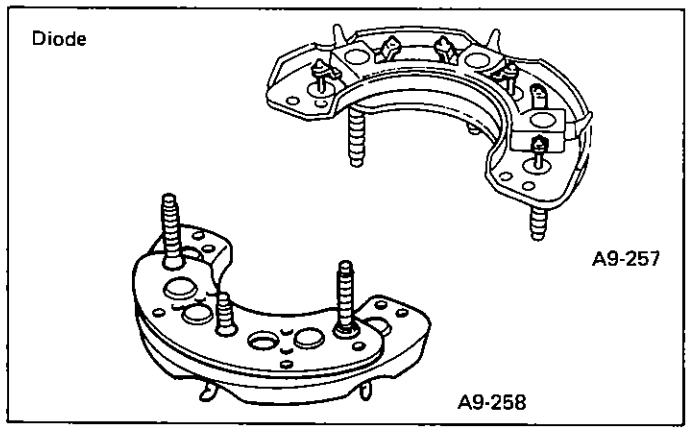


Fig. 75

Diodes installed on (+) plate are positive diodes which allow current flowing from terminal to (+) plate only.
Diodes installed on (-) plate are negative diodes which allow current flowing from (-) plate to terminal only. If each current flows in the same direction only, diode is in good condition.
If current flows toward both positive and negative directions, diode is short circuited. In this case, replace diode ASSY.

Never use a high tension insulation tester, such as a meggar as it will damage diodes with its high tension.

Normal conditions of continuity are shown in the following table.

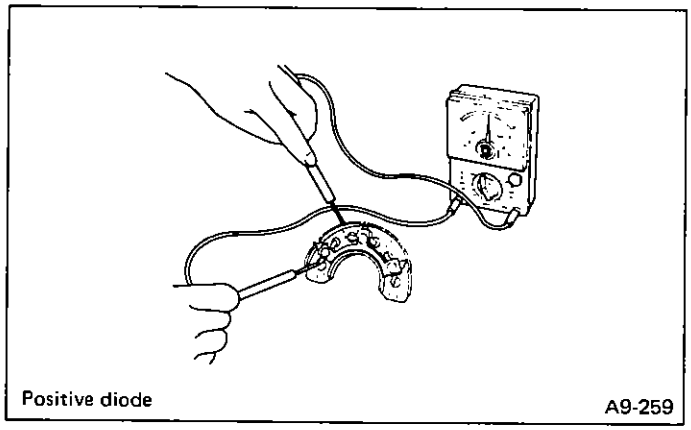

Positive diode A9-259

Fig. 76

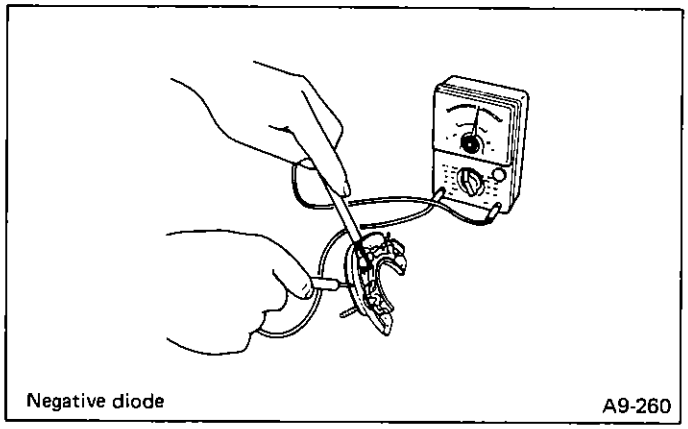

Negative diode A9-260

Fig. 77

		Connect (+) terminal of tester and ;		
		Diode (+) plate	Diode (-) plate	Diode (+) terminal
Connect (-) terminal of tester and ;	Diode (+) plate		Nonconduction	Nonconduction
	Diode (-) plate	Conduction		Conduction
	Diode (-) terminal	Conduction	Nonconduction	

IC REGULATOR

1) Prepare the following measuring apparatus:
   (1) Resistor (R_1)
   10 Ω, 3 W (one)
   (2) Variable resistor (R_V)
   0 to 300 Ω, 3 W (one)
   (3) Battery (BAT_1, BAT_2)
   12 V (two)
   (4) DC voltmeter (Ⓥ1, Ⓥ2, Ⓥ3, Ⓥ4)
   0 to 30 V (one)

2) Connect the above-listed apparatus as shown in figure below, and perform checks in the following sequence;

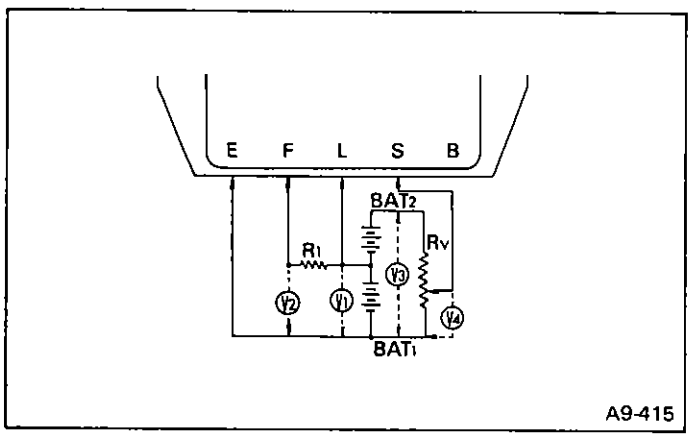


Fig. 78

(1) Check V_1 (voltage of battery 1).
Battery 1 is normal if 10 V to 13 V is indicated.
(2) Check V_2 (voltage between terminals F and E) with terminal S disconnected. IC regulator is normal if the voltage is below 2.0 V. If a voltage of 2.0 V or higher is indicated, the regulator is faulty and should be replaced.
(3) Check V_3 (total voltage of batteries 1 and 2). Both batteries are normal if 20 V to 26 V is measured.
(4) Measure V_2 (voltage between terminals F and E) while slowly increasing the resistance of variable resistor, starting from 0. Check whether the voltage of V_2 changes from below 2.0 V to 10 V – 13 V of V_3 (that is, the voltage of battery 1). If no change occurs, regulator is faulty and must be replaced.
(5) Measure V_4 (voltage between center tap of variable resistor and terminal E). With variable resistor Rv fixed, check V_4 to see whether it is within the specified range. If V_4 is in the specified range, regulator is normal. If not, regulator is faulty and must be replaced.

Specified voltage range:
14.1 - 14.8 V

(6) Connect measuring apparatus as shown in figure below, and measure V_4 (voltage between terminals B and E). Perform check in the same manner as in steps (4) and (5) above. If a voltage 0.5 V to 2.0 V higher than V_4 is measured, regulator is normal. In other cases, replace regulator.

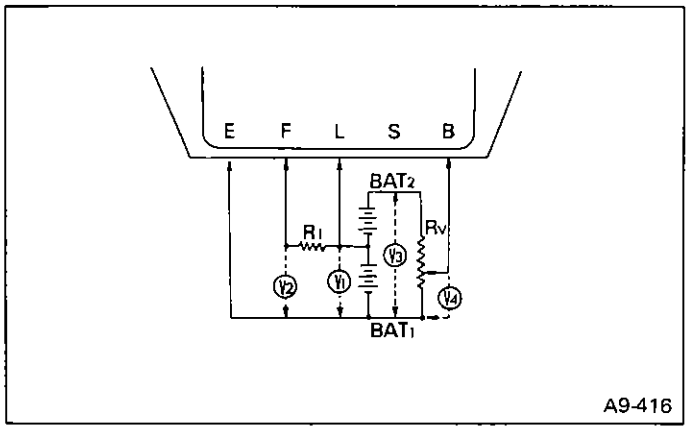


Fig. 79

ASSEMBLY

1) Assembling brush and IC regulator
   (1) Soldering brush
   Set brush in position and solder leads.

Use care not to allow melted solder to flow over lead wire.

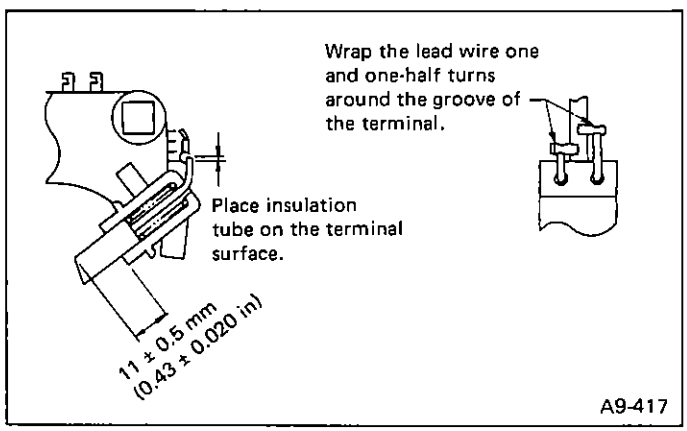


Fig. 80

   (2) Assembling IC regulator
   Place IC regulator on brush holder, and force-fit a 5 mm bolt. Be sure to set the bushing and connecting plate.

The output terminal is grounded and the battery will be short-circuited if the bushing is not installed.

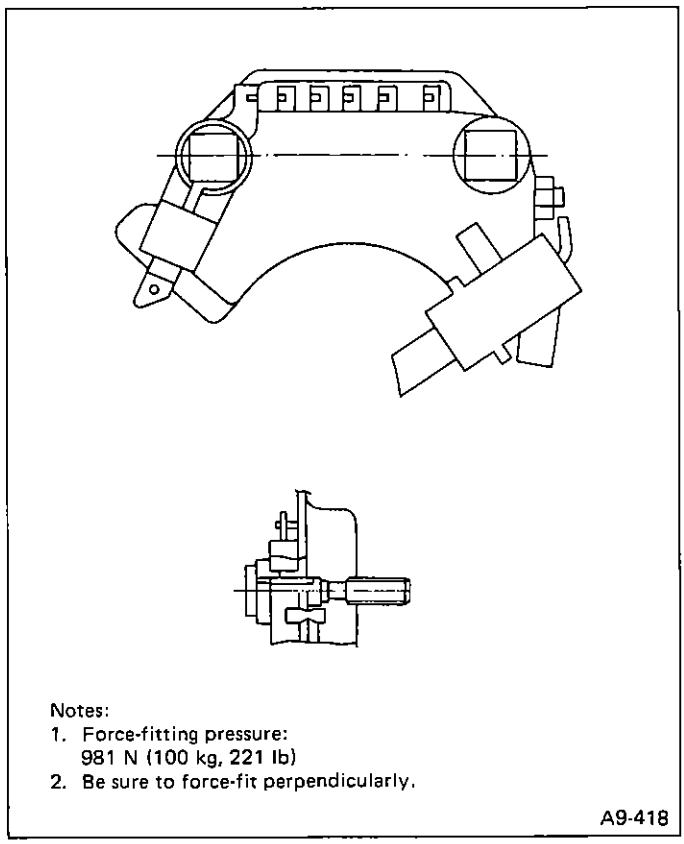


Fig. 81

2) Connecting brush & IC regulator ASSY and diode.
   (1) Joining by riveting
   Insert a 3 mm (0.12 in) dia. rivet, and caulk rivet using caulking tool.

Caulking pressure:
4,904 N (500 kg, 1,103 lb)

   (2) Connecting brush and diode
   Insert brush terminal into diode terminal which has been warmed by soldering iron, and caulk both terminals. Then solder these terminals.

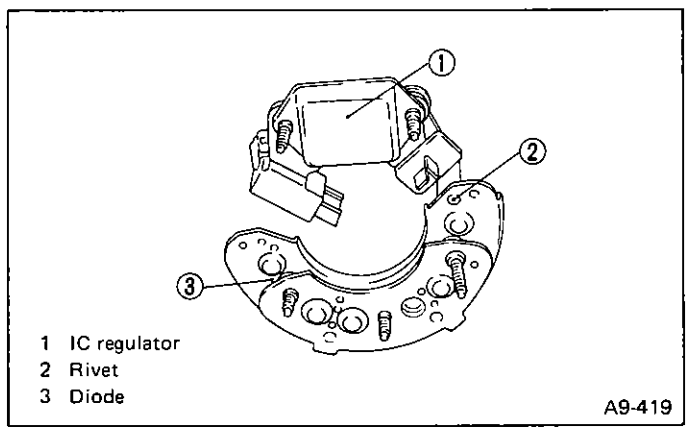


Fig. 82

3) Connect each stator coil lead wire to diode ASSY and brush terminals by soldering.

Soldering should be done quickly not to damage diodes.

4) Install and tighten diode ASSY and brush ASSY to rear cover by nuts.

Tightening torque:
3.1 – 3.9 N·m (0.32 – 0.40 kg-m, 2.3 – 2.9 ft-lb)

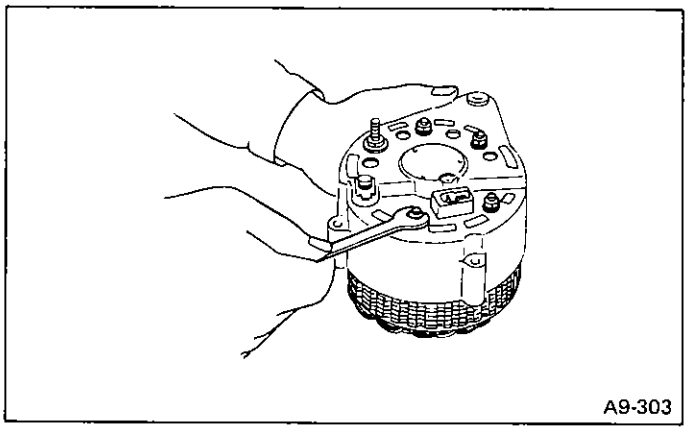


Fig. 83

5) After installing bearing into front cover, install bearing retainer on it by tightening screws.

Tightening torque:
3.1 – 3.9 N·m (0.32 – 0.40 kg-m, 2.3 – 2.9 ft-lb)

6) Install rotor ASSY into front cover.
7) Hold rotor with a vise and install spacer, fan, pulley, spring washer and pulley nut.
Tighten pulley nut to the specified torque.

Tightening torque:
39 – 59 N·m (4.0 – 6.0 kg-m, 29 – 43 ft-lb)

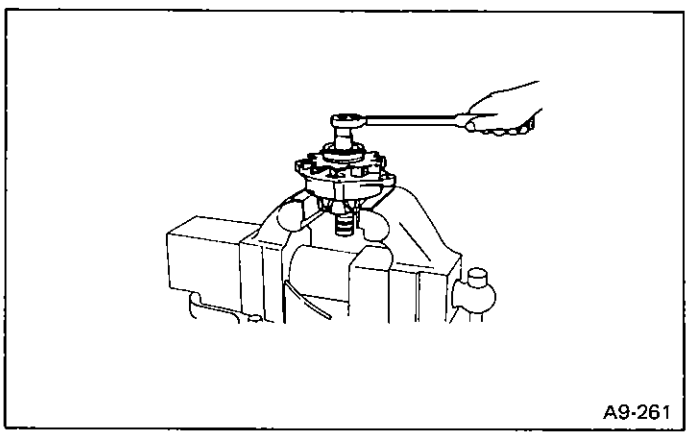


Fig. 84

When holding rotor with a vise, insert aluminum plates between the vise and rotor to prevent rotor from damage.
When pulley is tightened, make sure that deflection of V-groove is less than 0.3 mm (0.012 in).

8) Push brush up with finger and retain brush by inserting a pin, about 2 mm (0.08 in) dia, into brush lift hole from the outside of rear cover.

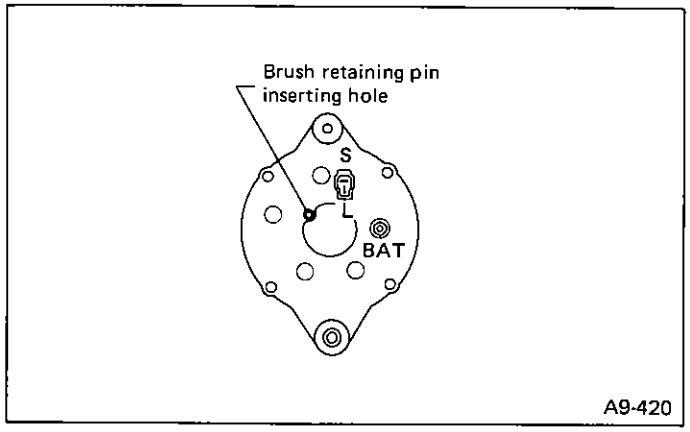


Fig. 85

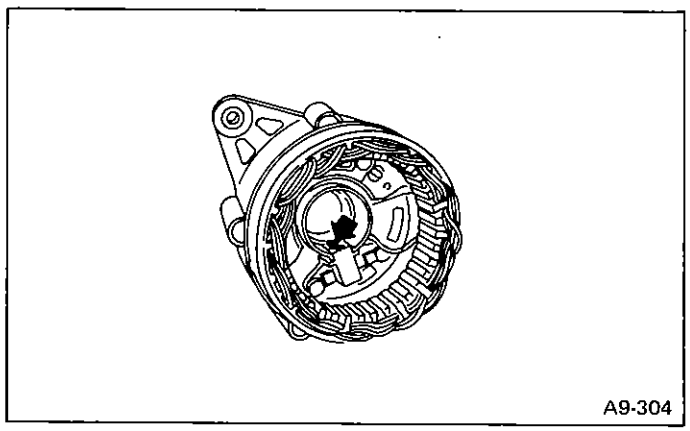


Fig. 86

9) Assemble front and rear parts of alternator and tighten through bolts.

Tightening torque:
3.1 – 5.4 N·m (0.32 – 0.55 kg-m, 2.3 – 4.0 ft-lb)

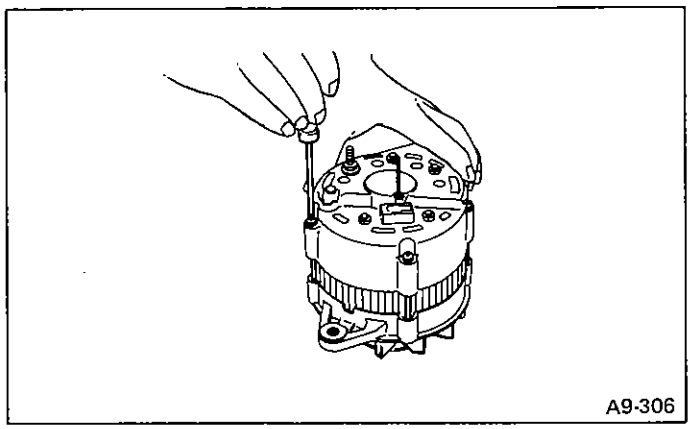


Fig. 87

10) After assembling alternator, pull up the brush holding pin by pushing toward center of hole.

Be careful not to damage the slip ring sliding surface by pulling pin.

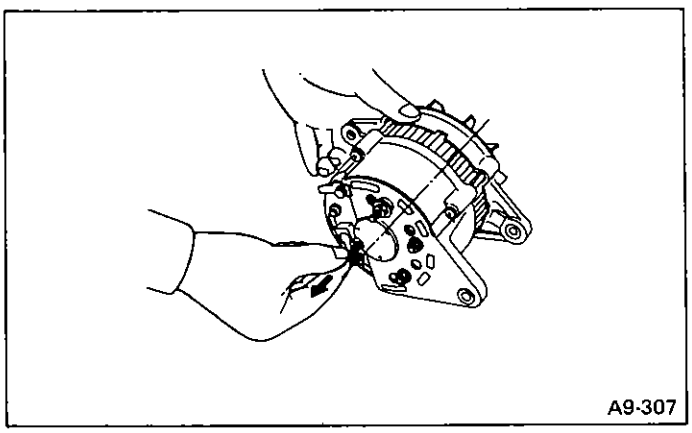


Fig. 88

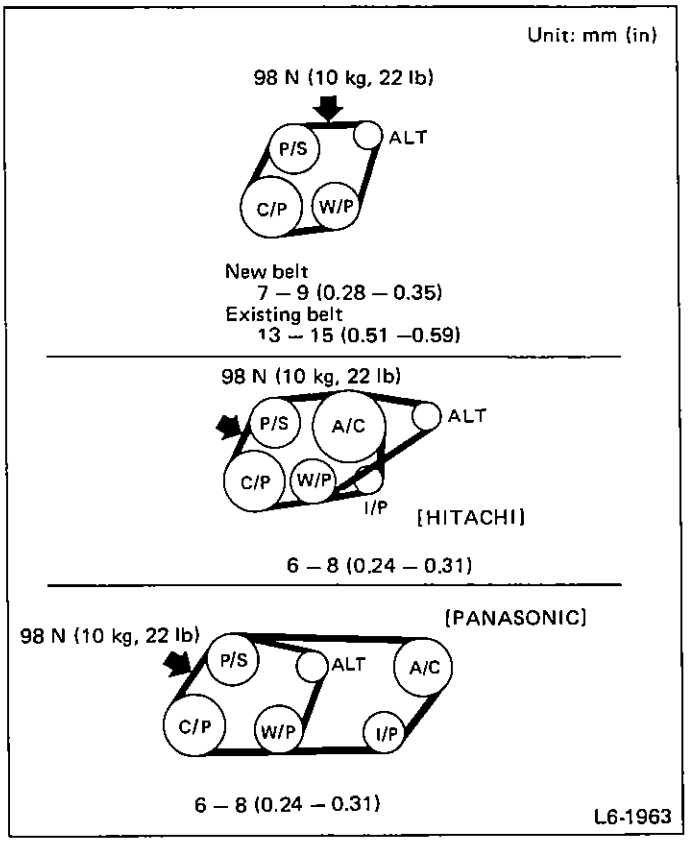


Fig. 89

4) Connect lead wires to alternator.

a. Be careful not to connect individual terminals erroneously.
b. Pay careful attention to battery polarity so that it may not be reversed by wrong connection. If polarities are reversed, battery will be shorted by diode, excessive current will flow, and diodes or wire harness may be damaged.

INSTALLATION

1) Install alternator to bracket on engine with bolts and tighten bolts lightly.
2) After installing drive belt, pull belt by moving alternator and tighten installing bolts.
3) Check belt tension as shown figure.

Distributor

DESCRIPTION

This distributor is equipped with a photoelectric crank-angle sensor which transmits a crank-angle signal and a cylinder-identification signal to the fuel injection control unit.

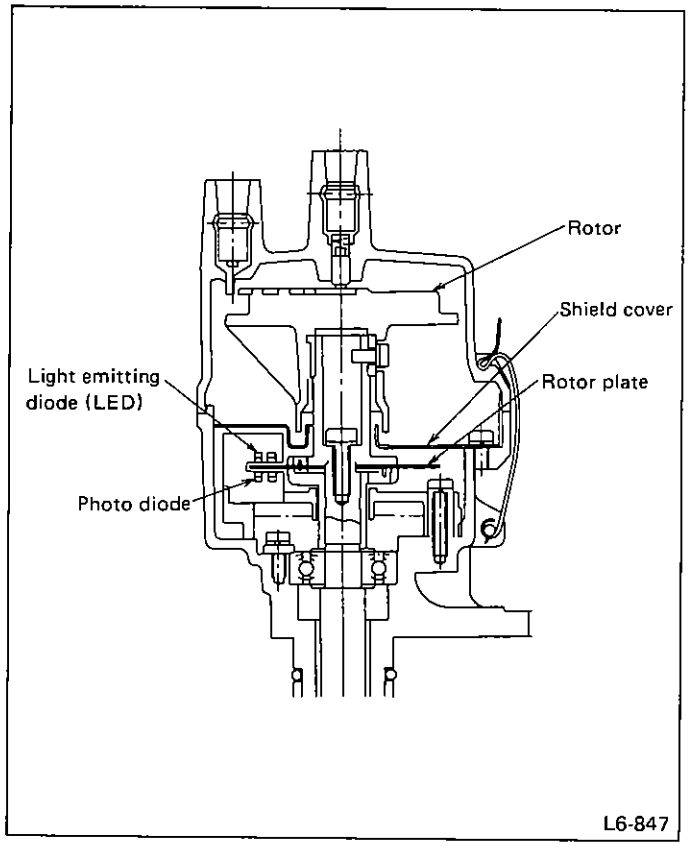


Fig. 90

A signal processing unit, which is built into the distributor housing, consists of LED and a photodiode. The rotor plate, located between the LED and the photodiode, is secured to the rotor shaft.

The rotor plate has four slits along its periphery through which 90° signals (in terms of distributor angle) are transmitted for cylinder detection. In addition, there are three hundred and sixty slits through which 1° signals (in terms of distributor angle) are transmitted for crank-angle detection. Directly above the rotor plate is the LED and below it is the photodiode.

When the ignition switch is turned "ON", the LED emits light to the photodiode. The rotor plate turns as the engine starts. The light emitted from the LED is then repeatedly interrupted and transmitted through the slits by rotation of the rotor plate. The "on-off" light signals (for cylinder detection and crank-angle detection) are then converted into output signals which are transmitted to the fuel injection control unit.

The fuel injection control unit determines optimum ignition timing in response to these output signals and engine operating conditions and transmits an ignition signal to the ignition coil. This type of distributor is not equipped with a centrifugal advance angle and a vacuum advance angle device.

DISASSEMBLY

1) Detach cap and dust cover as a unit.
2) Remove carbon point from cap.
3) Remove rotor head securing screw and detach rotor head from rotor shaft.
4) Remove O-ring from housing.
5) Drive roll pin out of shaft and pinion.
6) Remove pinion from shaft.

Further disassembly of parts is prohibited.

INSPECTION

1) Carbon point

Measure the length of carbon point in cap. Replace if it is less than service limit.

Standard length:
12 mm (0.47 in)
Service limit:
10 mm (0.39 in)

2) Cap and rotor head

Measure insulation resistance using a megger. Replace if it is less than the specified value.

Insulation resistance:
More than 50 MΩ

ASSEMBLY

ASSY is in the reverse order of disassembly. Observe the following:

1) Use new roll pin when installing pinion.
2) Install pinion so that its alignment mark is aligned with the mark on the housing when the cutout section of rotor shaft faces the 1st cylinder mark on the cap.

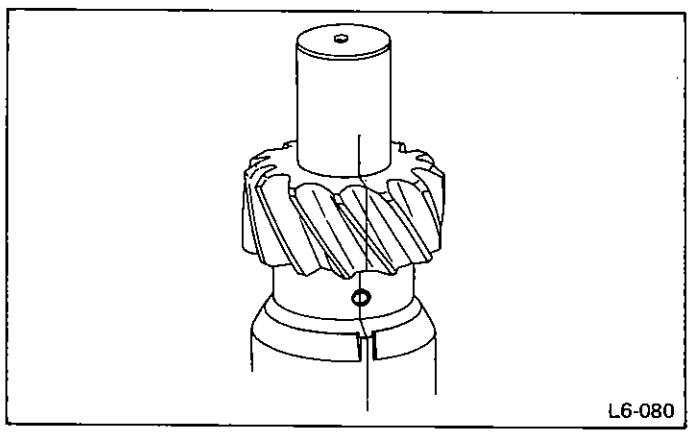


Fig. 91

Ignition Coil

DESCRIPTION

The E12-113 ignition coil is equipped with a power transistor igniter. The power transistor amplifies the ignition signal transmitted from the fuel injection control unit. The amplified signal is used to make and break the current flowing through the primary winding of the ignition coil.

REMOVAL AND INSTALLATION

1) Disconnect battery negative (–) terminals.
2) Disconnect wires from ignition coil.
3) Remove ignition coil.
4) To install, reverse the order of removal.

Be sure to connect wires to their proper positions. Failure to do so will damage unit.

INSPECTION

Using accurate tester, inspect the following items, and replace if defective.

1) Primary resistance
2) Secondary coil resistance

If the resistance is extremely low, this indicates the presence of a short-circuit.

3) Insulation between primary terminal and case: 10 MΩ or more.
4) If engine does not run due to faulty ignition system, check ignition system as follows:

Check for cracked distributor rotor or cap and corroded terminals.

Visually inspect high tension wire for condition. Check spark plugs and adjust gaps as necessary. Replace spark plug which is not suitable for further use.

If the above checks cannot correct the problem, check entire ignition system with oscilloscope or circuit tester in accordance with the troubleshooting charts. (See chapter 6-3)

Spark Plug

DESCRIPTION

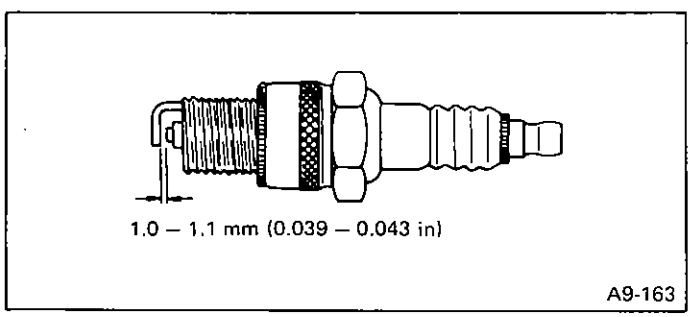


Fig. 92

The spark plugs are project type, having 14 mm (0.551 in) threads and 1.0 to 1.1 mm (0.039 to 0.043 in) gap.

All spark plugs installed on an engine, must be of the same heat range.

Applicable model	Spark plug
MPFI	NGK: BPR6ES-11 (or BPR5ES-11, BPR7ES-11) NIPPONDENSO: W20EPR-U11 (or W16EPR-U11, W22EPR-U11) CHAMPION: RN9YC-4
SPFI	NGK: BPR6ES-11 (or BPR5ES-11, BPR7ES-11) NIPPONDENSO: W20EPR-U11 (or W16EPR-U11, W22EPR-U11) CHAMPION: RN9YC-4

All spark plugs installed on an engine, must be of the same heat range.

Spark plug
NGK: BPR6ES-11 (or BPR5ES-11, BPR7ES-11) NIPPONDENSO: W20EPR-U11 (or W16EPR-U11, W22EPR-U11) CHAMPION: RN9YC-4

REMOVAL AND INSTALLATION

1) Remove spark plug cords by pulling boot, not cord itself.
2) Remove spark plugs.
3) When installing spark plugs on cylinder head, use spark plug wrench.

Tightening torque (Spark plug):
20 – 29 N·m (2 – 3 kg-m, 14 – 22 ft-lb)

The above torque should be only applied to new spark plugs without oil on their threads.
In case their threads are lubricated, the torque should be reduced by approximately 1/3 of the specified torque in order to avoid their over-stressing.

4) Connect spark plug cords.

INSPECTION

Check electrodes and inner and outer porcelain of plugs, noting the type of deposits and the degree of electrode erosion.

1) Normal

Brown to grayish-tan deposits and slight electrode wear indicate correct spark plug heat range.

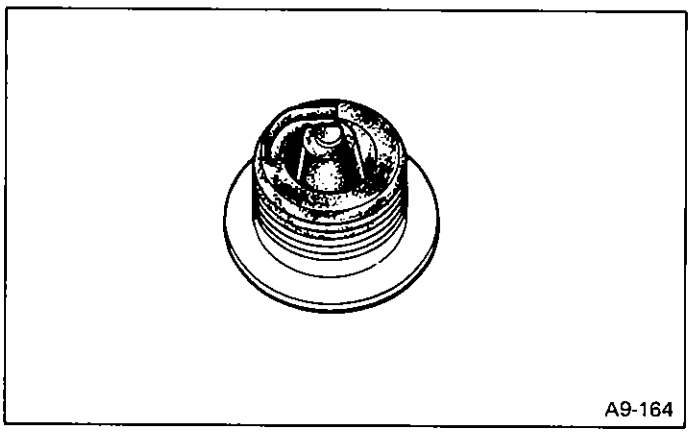


Fig. 93

2) Carbon fouled

Dry fluffy carbon deposits on insulator and electrode are mostly caused by slow speed driving in city, weak ignition, too rich fuel mixture, dirty air cleaner, etc.

It is advisable to replace with plugs having hotter heat range.

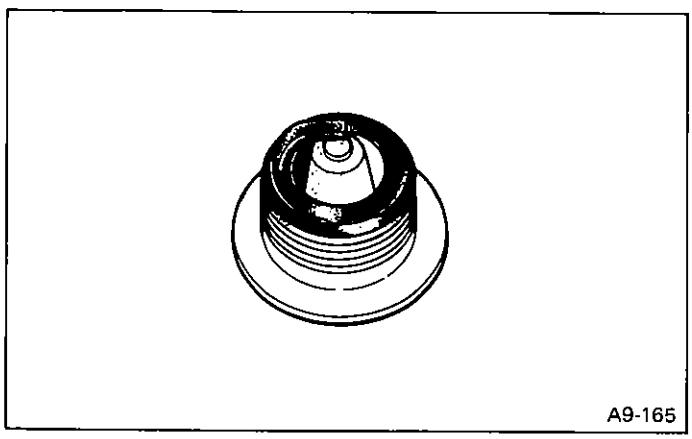


Fig. 94

3) Oil fouled

Wet black deposits show excessive oil entrance into combustion chamber through worn rings and pistons or excessive clearance between valve guides and stems. If same condition remains after repair, use a hotter plug.

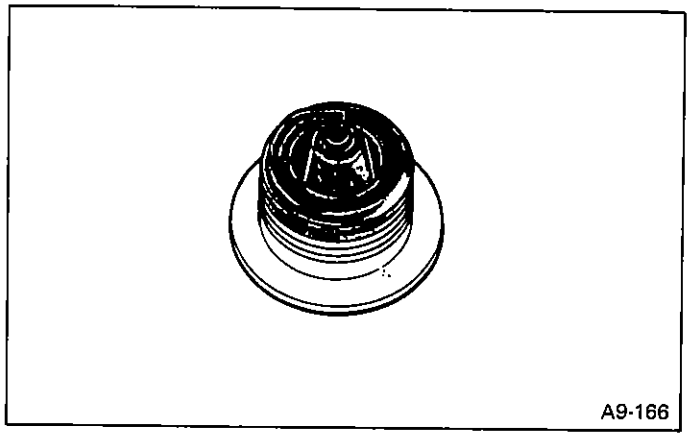


Fig. 95

4) Overheating

White or light gray insulator with black or gray brown spots and bluish burnt electrodes indicate engine overheating. Moreover, the appearance results from incorrect ignition timing, loose spark plugs, wrong selection of fuel, hotter range plug, etc. It is advisable to replace with plugs having colder heat range.

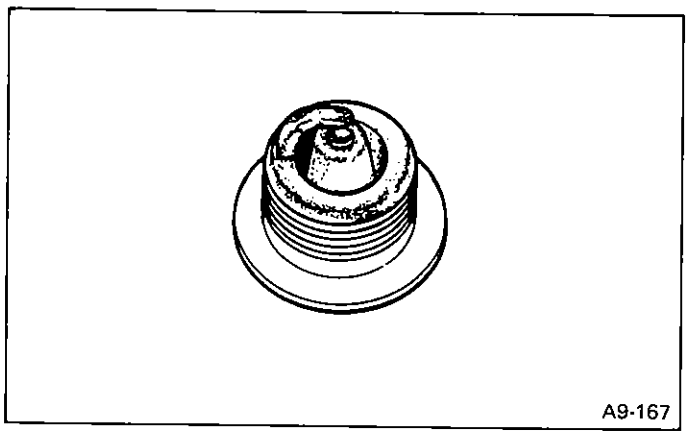


Fig. 96

CLEANING AND REGAPPING

Clean spark plugs in a sand blast type cleaner.

Avoid excessive blasting. Clean and remove carbon or oxide deposits, but do not wear away porcelain.

If deposits are too stubborn, discard plugs.

After cleaning spark plugs, recondition firing surface of electrodes with file. Then correct the spark plug gap to 1.0 to 1.1 mm (0.039 to 0.043 in) using a gap gauge.

Diagram of SPFI System

For 1 US model 4-Door FWD GL and GL-10
2 US model Station Wagon FWD GL and GL-10

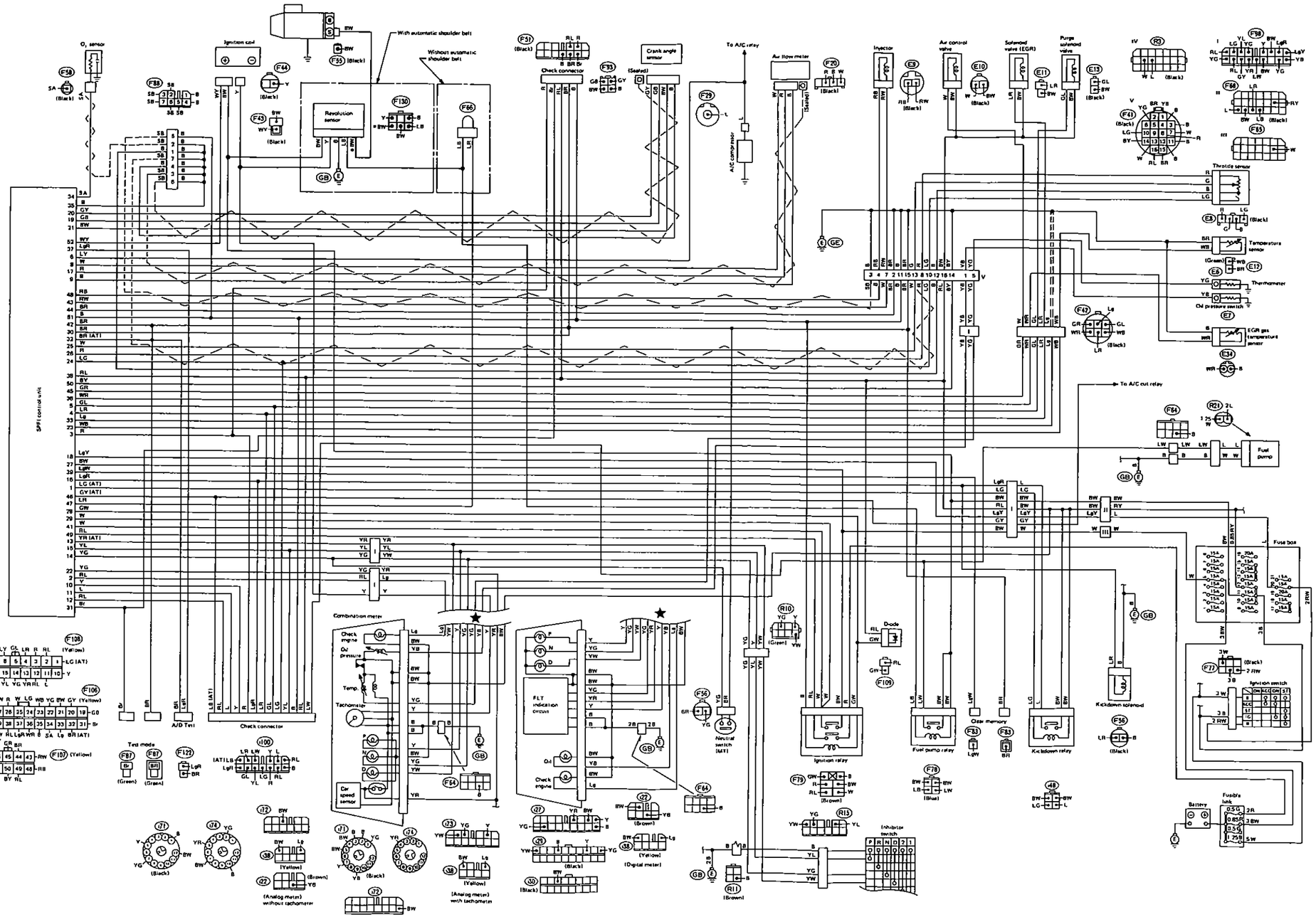


Fig. 2

L6-2029

Self-diagnosis System

Diagram of SPFI System

For 1 All CANADA model
2 US model 3-Door
3 US model 4-Door FWD DL and all 4WD
4 US model Station Wagon FWD DL and all 4WD

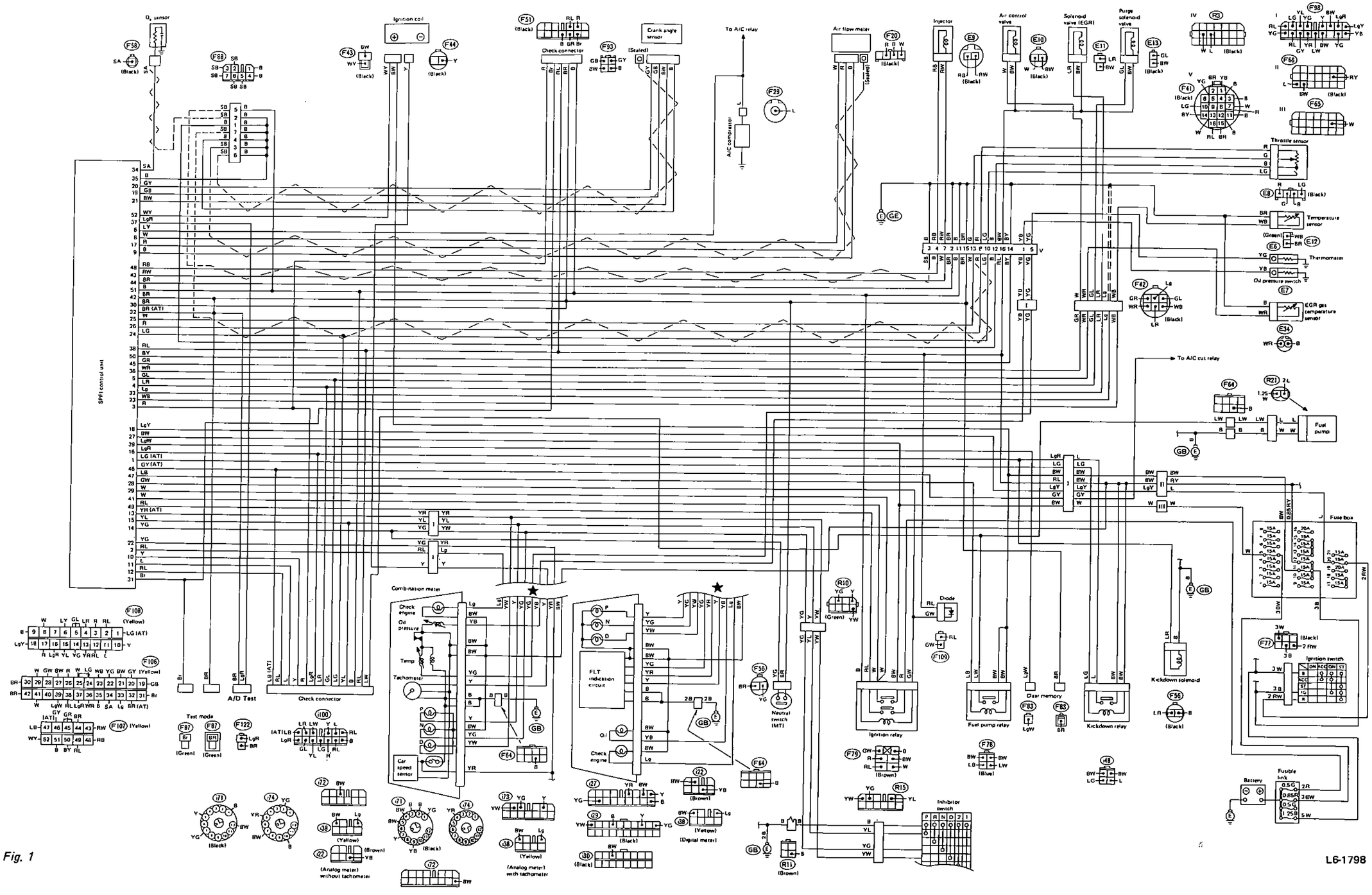


Fig. 1

L6-1798

Diagram of MPFI System (With automatic shoulder belt)

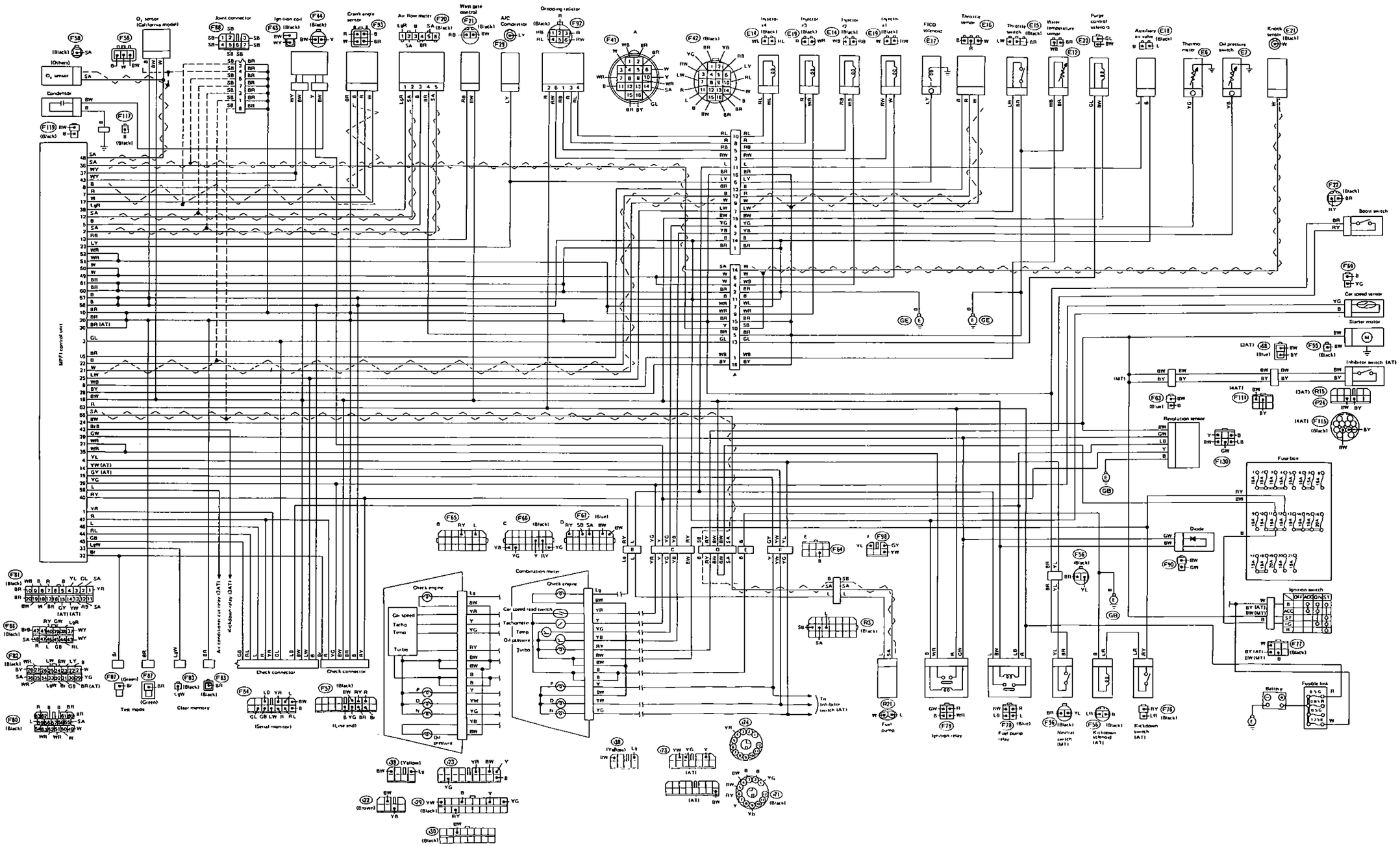
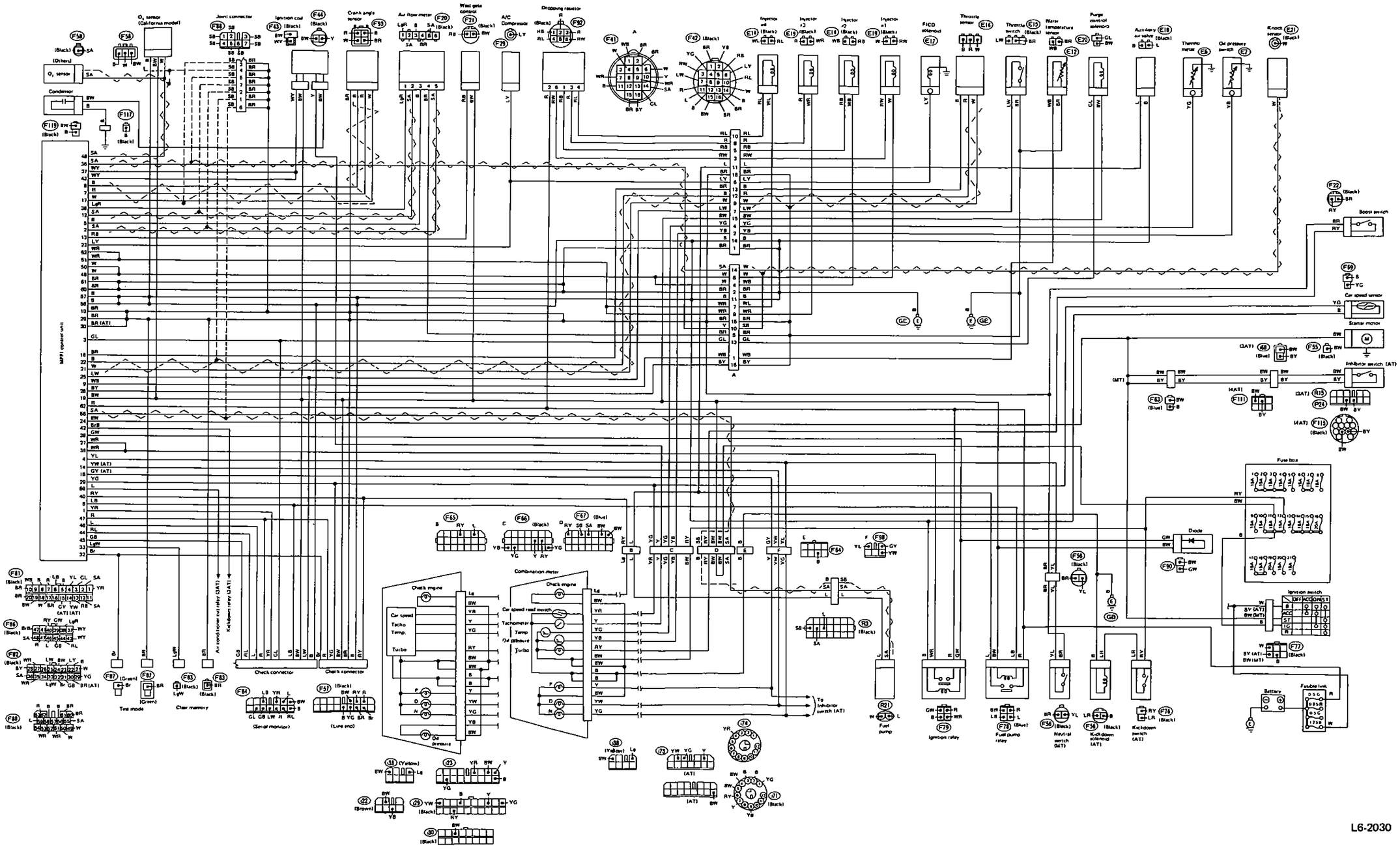


Fig. 7

Diagram of MPFI System (With automatic shoulder belt)



L6-2030

Fig. 6

Engine Electrical System

MPFI (Without Automatic Shoulder Belt)

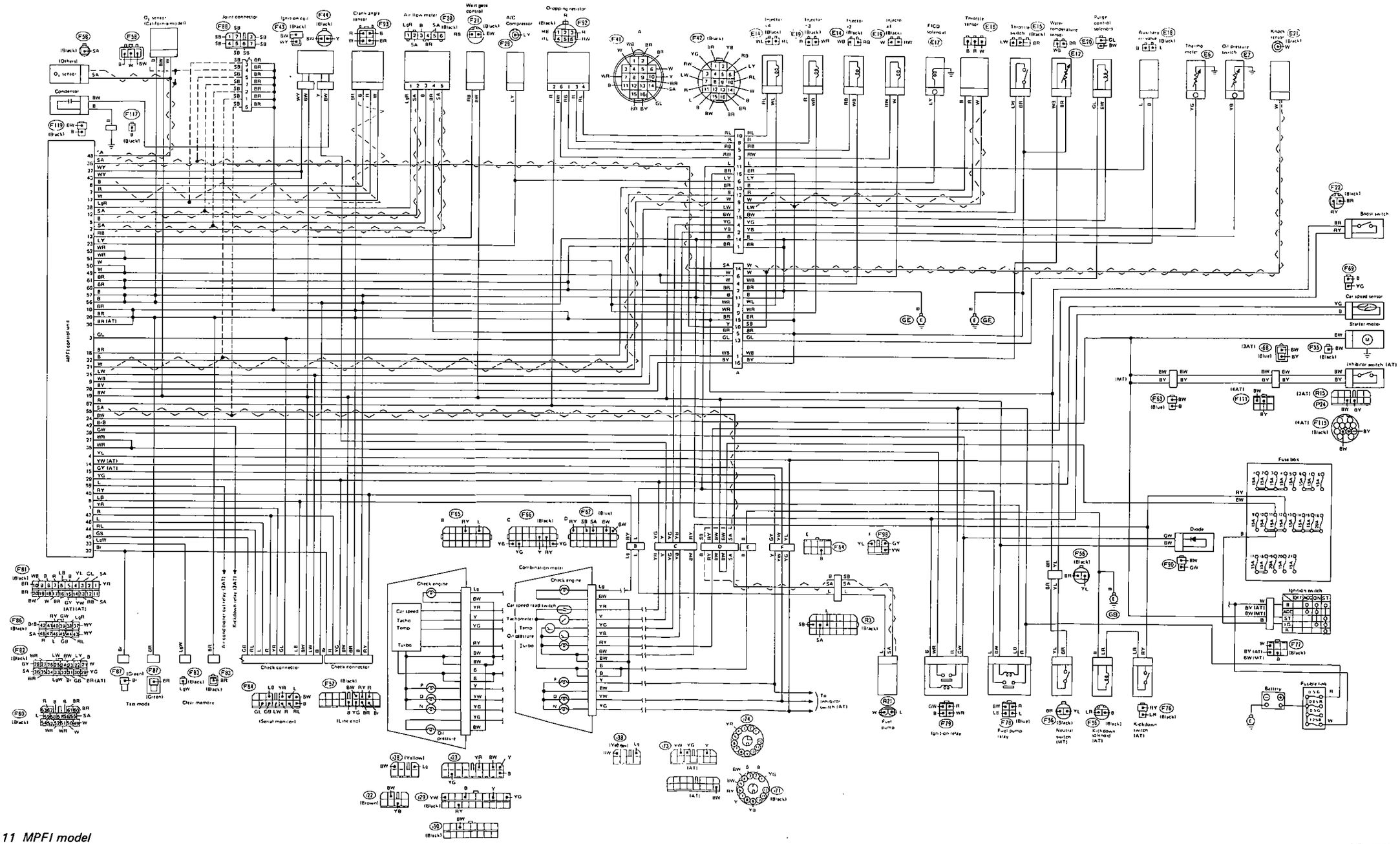


Fig. 11 MPFI model

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MPFI (With Automatic Shoulder Belt)

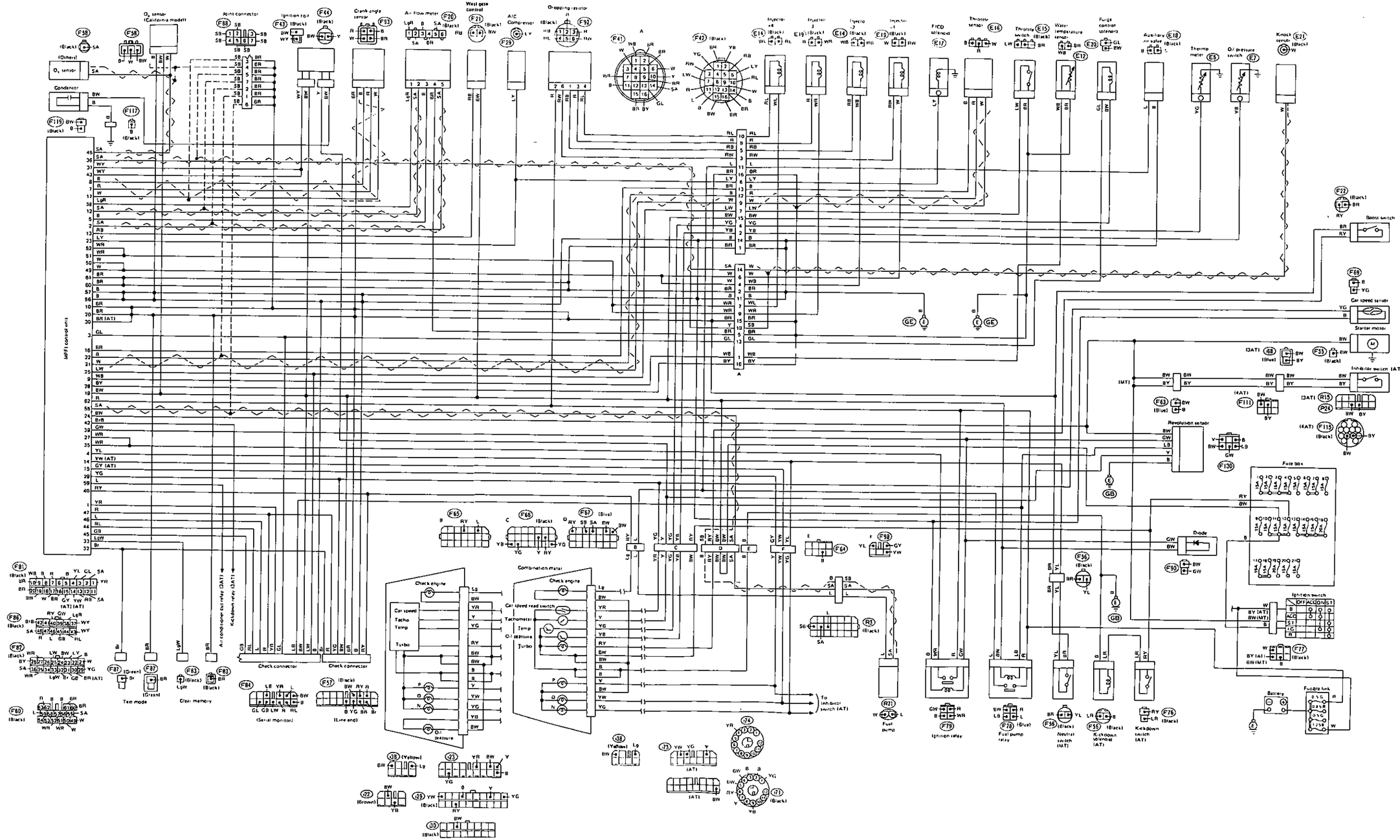

Fig. 12 MPFI model

SPFI

- ALL CANADA MODEL
- U.S. MODEL 3-DOOR
- U.S. MODEL 4-DOOR FWD DL & ALL 4WD
- U.S. MODEL STATION WAGON FWD DL & ALL 4WD

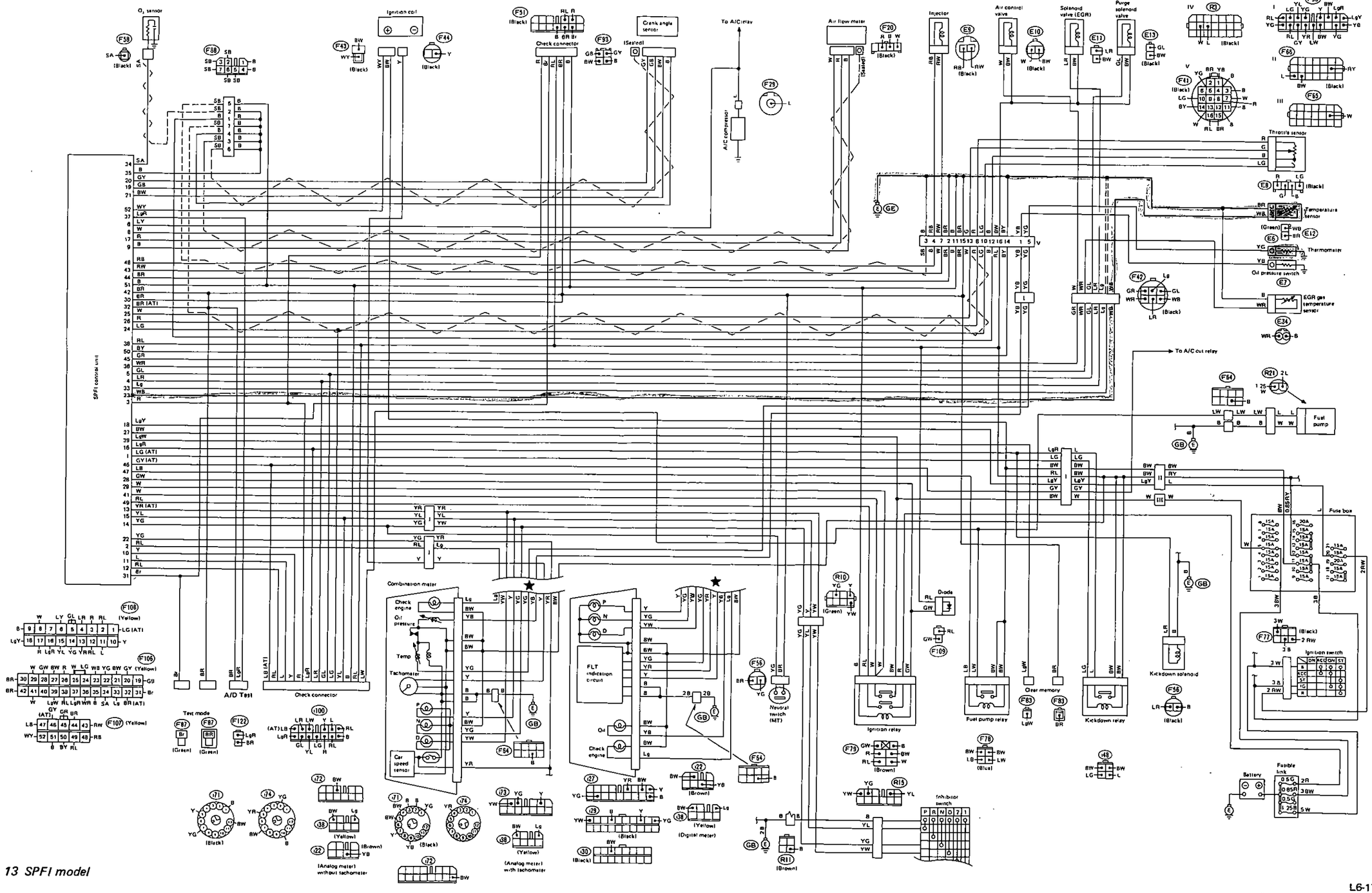

Fig. 13 SPFI model

L6-1798

SPFI
- U.S. MODEL 4-DOOR FWD GL & GL-10
- U.S. MODEL STATION WAGON FWD GL & GL-10

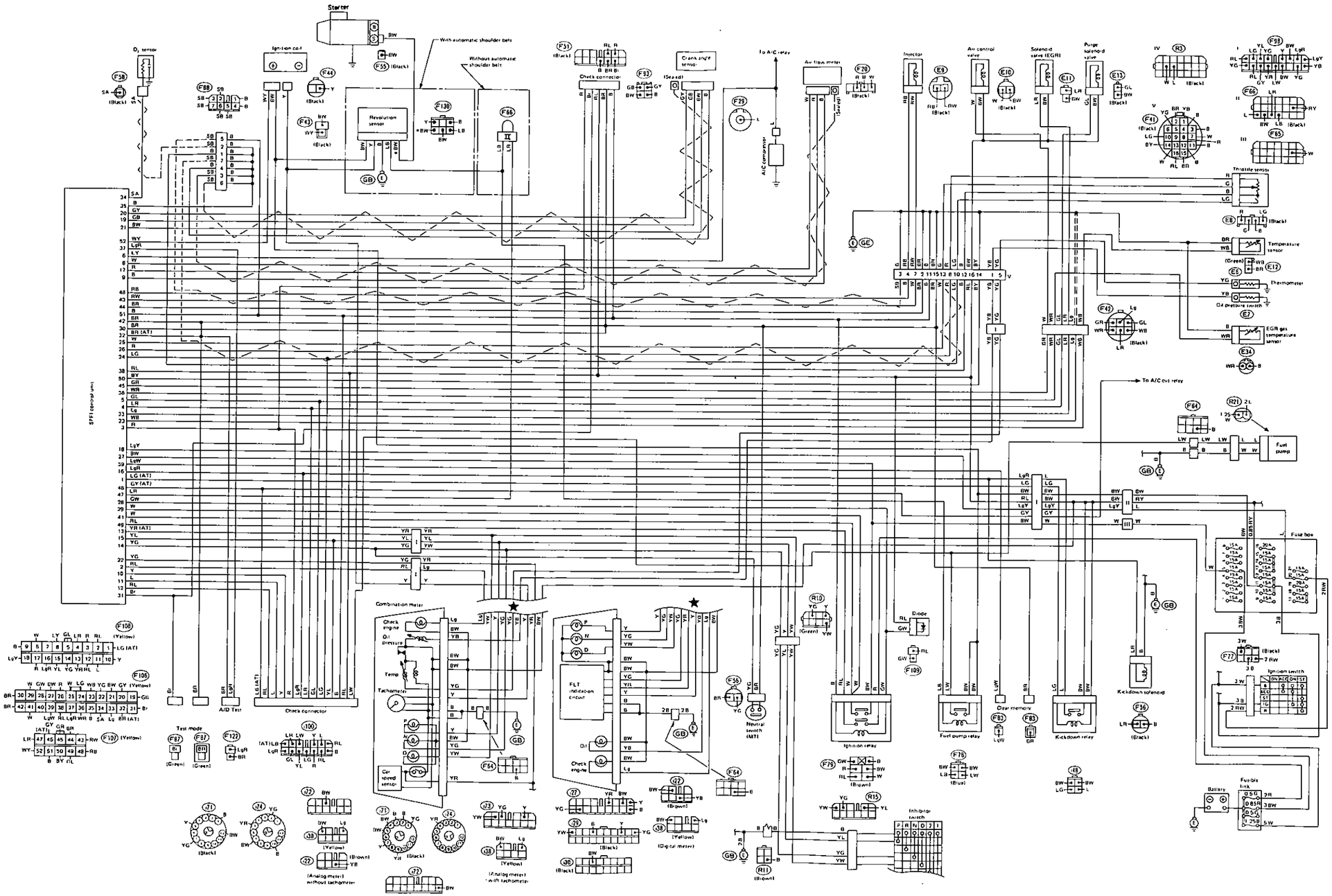

Fig. 14 SPFI model