FUEL AND EMISSION CONTROL SYSTEMS

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OUTLINE

OUTLINE OF CONSTRUCTION

Development concepts

The development concepts for the new model are as follows:

1. Improved performance
2. Improved fuel economy
3. Reduced CO, HC and NOx emission levels
4. Noise reduction
5. Sporty rotary sound
6. Improved idling stability

Improvements

The following points have been improved in order to achieve development concepts.

1. Air induction system

- **6PI system**
  The secondary side intake port is divided into two sections, and a valve which opens and closes according to engine conditions is installed in the secondary auxiliary port.
- **Dynamic supercharge system**
  The amount of air taken into the engine is increased by utilizing the compression wave generated by the opening and closing of the intake port.

2. Exhaust system

The size and capacity of components have been upgraded.
A multi-chamber port has been inserted into the exhaust port.

3. E.G.I. (Electronic Gasoline Injection) system

The fuel supply method is changed from a mechanical type (by carburetor) to an electrically controlled type (by control unit and injectors).

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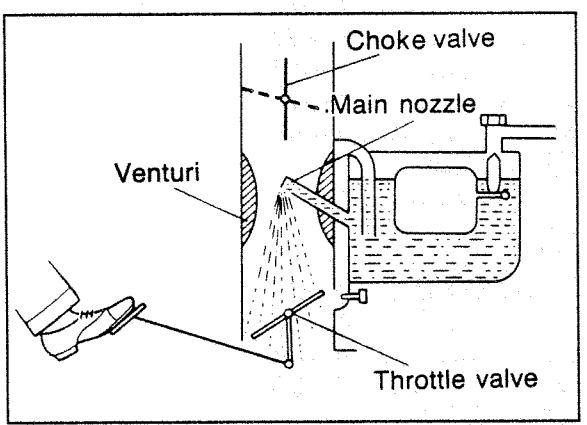

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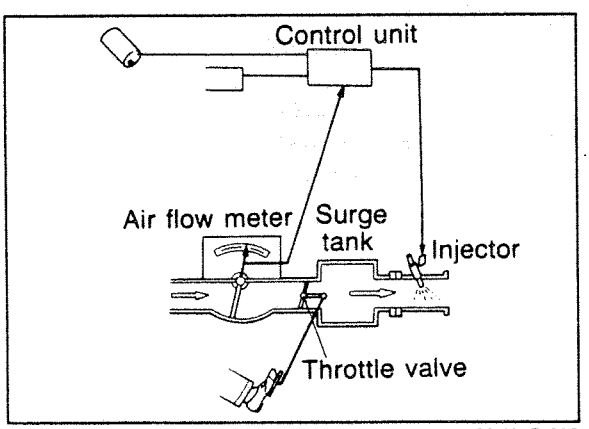
Carburetor System

The amount of fuel supplied to the engine is basically determined by the diameter of jets and the vacuum, which is generated in the venturi when intake air passes through the venturi.
Many other provisions eg. valves, air bleeds, pumps etc. have been devised so fuel increases may be mechanically controlled to provide the correct air-fuel ratio for all operating conditions.



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EGI System

The amount of fuel supplied to the engine is basically determined by the opening duration of the injectors which are controlled by signals, based on intake air flow and engine speed, etc., from the control unit.

The various sensors detect any changes in the operating conditions and send the signals to the control unit. This permits proper control over the opening duration of the injectors, thus providing optimum air-fuel ratios.

4. Ignition control system

- ESA (Electronic spark Advance) system (Australia)
  The spark advance control is changed from a mechanical type (by distributor) to an electrical type (by control unit).
- VCV (Vacuum Control Valve) system (Except for Australia)
  This system controls vacuum advance according to engine operating conditions.

5. BAC (Bypass Air Control) system

- This system controls the amount of air that bypasses the throttle valve, in order to prevent unstable engine idle. This system also functions as the idle-up system for the A/C and P/S.

6. Emission control system

- An EGR system, which introduces exhaust gas into the intake manifold according to engine operating conditions, is fitted.
- A system which reduces CO, HC and Nox emissions (by using pre-converters and a main converter combined with the EGI system) is equipped.

7. Back up (Fail safe) system

In order to prevent possibly dangerous, incorrect operation of the control unit if signals from a sensor did not reach it the signals for the sensors are fixed at a predetermined value within the control unit, and the systems (fuel and emissions) are activated according to those signals. This is the back up (fail safe) system.

Areas of Improvement

	Improved performance	**Improved fuel economy**	**Reduced CO, HC, and NOX emissions levels**	**Noise reduction**	**Sporty rotary sound**	**Improved idling stability**
Air induction system	○	X	X	X	X	X
Exhaust system	○	X	X		○	X
E.G.I. system	○	○	○	○	X	○
Ignition control system	○*1	○*1	○	X	X	○
BAC system	X	X	○	X	X	○
Emission control system	X	○	○	X	X	○

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○: related X: not related

*1 Australia only

			Australia	ECE (Sweden Switzerland)	MIDDLE EAST	OTHERS
E.G.I. SYSTEM	Intake Air System	Air flow meter	○ (5V)	○ (12V)	○ (12V)	○ (12V)
		Throttle chamber	○	○	○	○
	Fuel System	Intank fuel pump	○	○	○	○
		4 Injectors	○	○	○	○
	Control System	Crank angle sensor	○	X	X	X
		Boost sensor	○	X	X	X
		Oxygen (O_2) sensor	○	X	X	X
IGNITION CONTROL SYSTEM	ESA System	Coil with igniter	○	X	X	X
	Distributor		X	○	○	○
	Ignition coil		X	○	○	○
	VCV System		X	○	○	○
BAC SYSTEM	BAC Valve		○	○	○	○
	Air Bypass Solenoid Valve		○	X	X	X
EMISSION CONTROL SYSTEM	Secondary Air Injection System	Switching solenoid valve	○	X	X	X
		Relief solenoid valve	○	○	○	○
		Heat hazard sensor	○	X	X	X
	EGR System		○	X	X	X
	Pre. Converters		○	X	X	X
	Main Converter		○	X	X	X
	Thermal Reactor, Heat Exchanger		X	○	○	○
AIR INDUCTION SYSTEM	Dynamic Supercharge System		○	○	○	○
	6PI System	Auxiliary port valve	○	X	X	X
		Shutter valve	X	○	○	○
EXHAUST SYSTEM	Main Silencer	10,000 cc x 2	○	X	X	X
		12,000 cc x 2	X	○	○	○
	Multi Chamber Port Insert		○	○	○	○
EVAPORATIVE EMISSION CONTROL SYSTEM	Charcoal Canister		○	X	○	X
	Three Way Check Valve		○	X	○	X
	Two Way Check Valve		X	○	X	○

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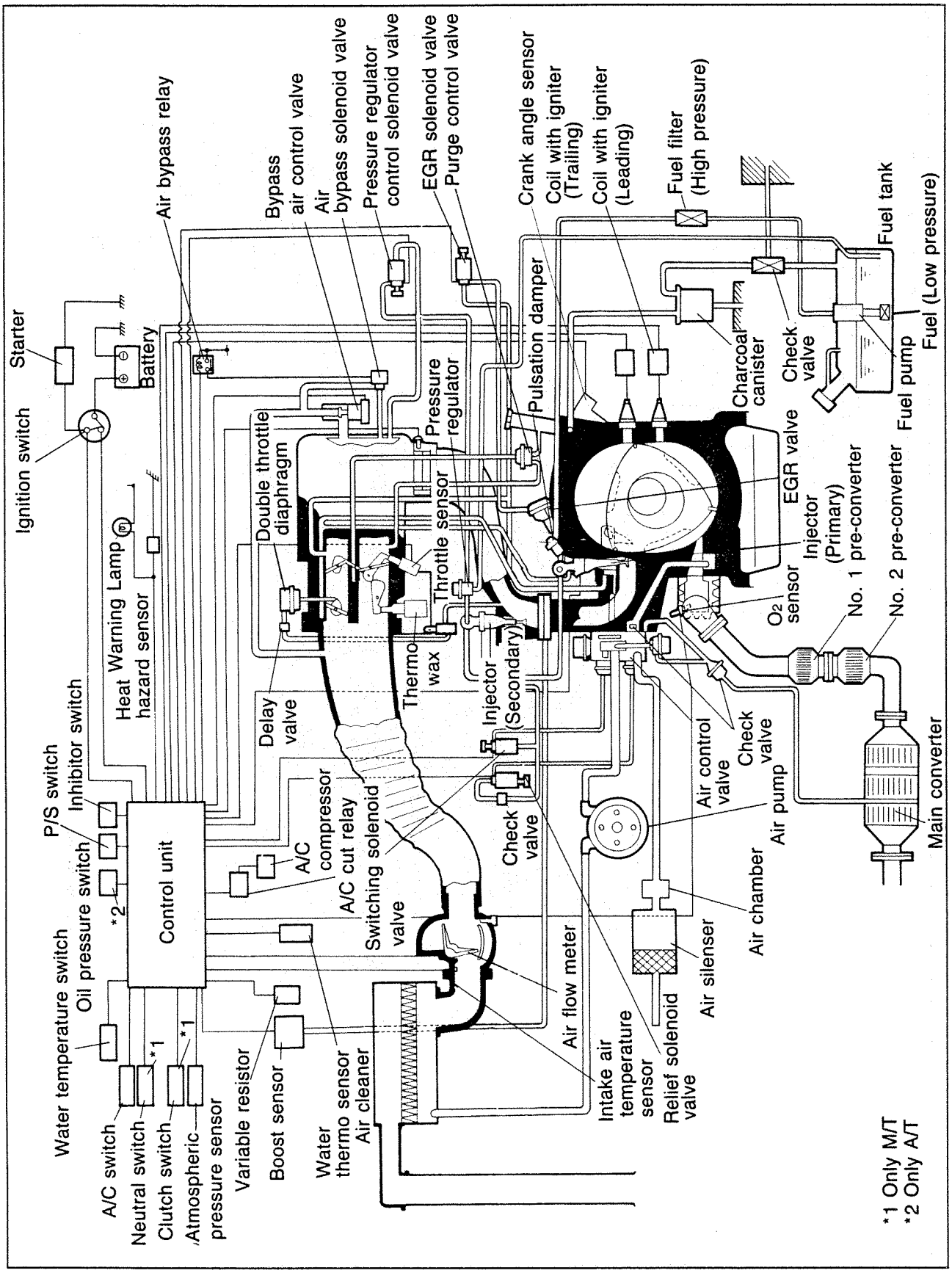
SYSTEM DIAGRAM
Australia



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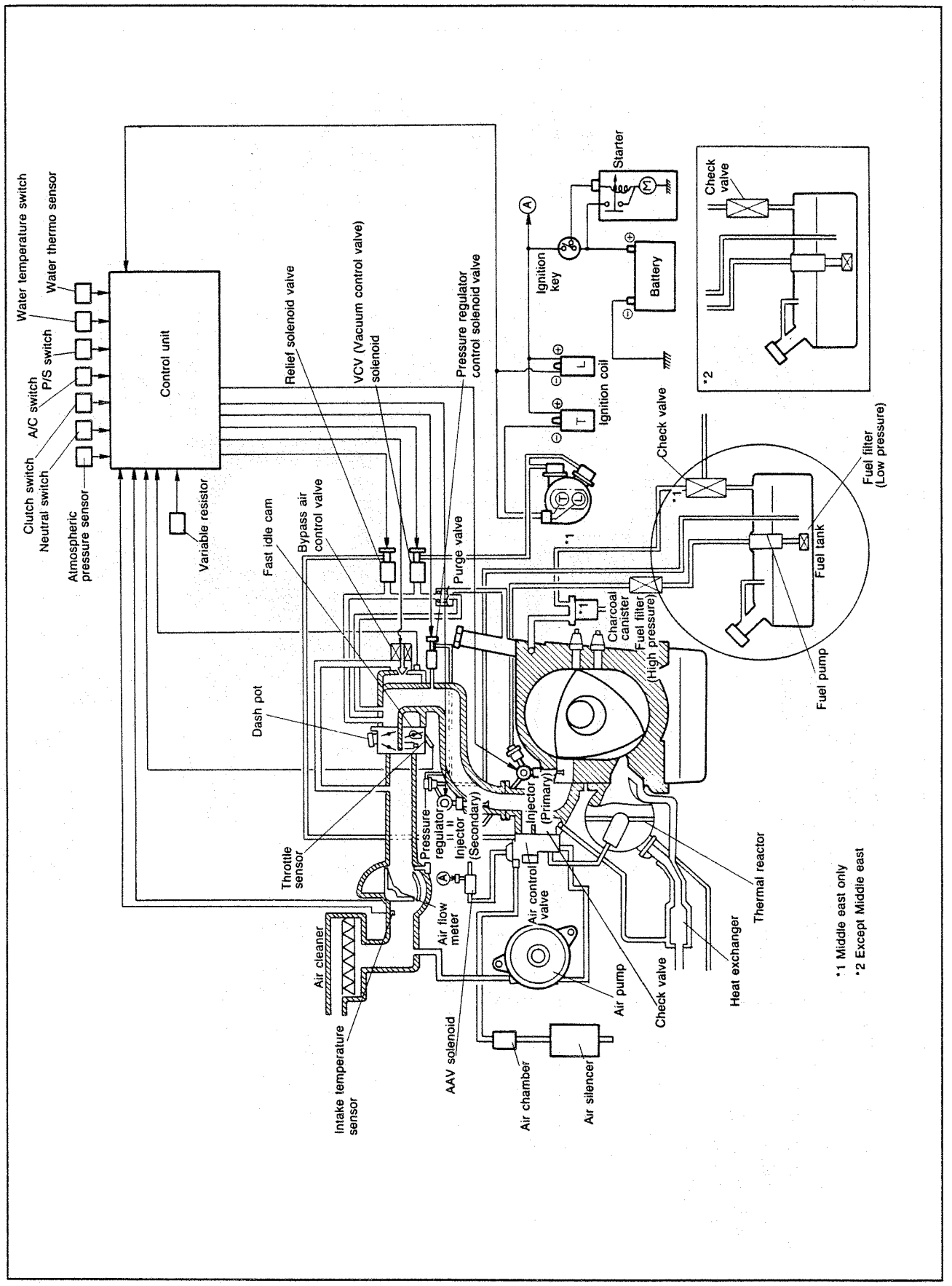
Except Australia



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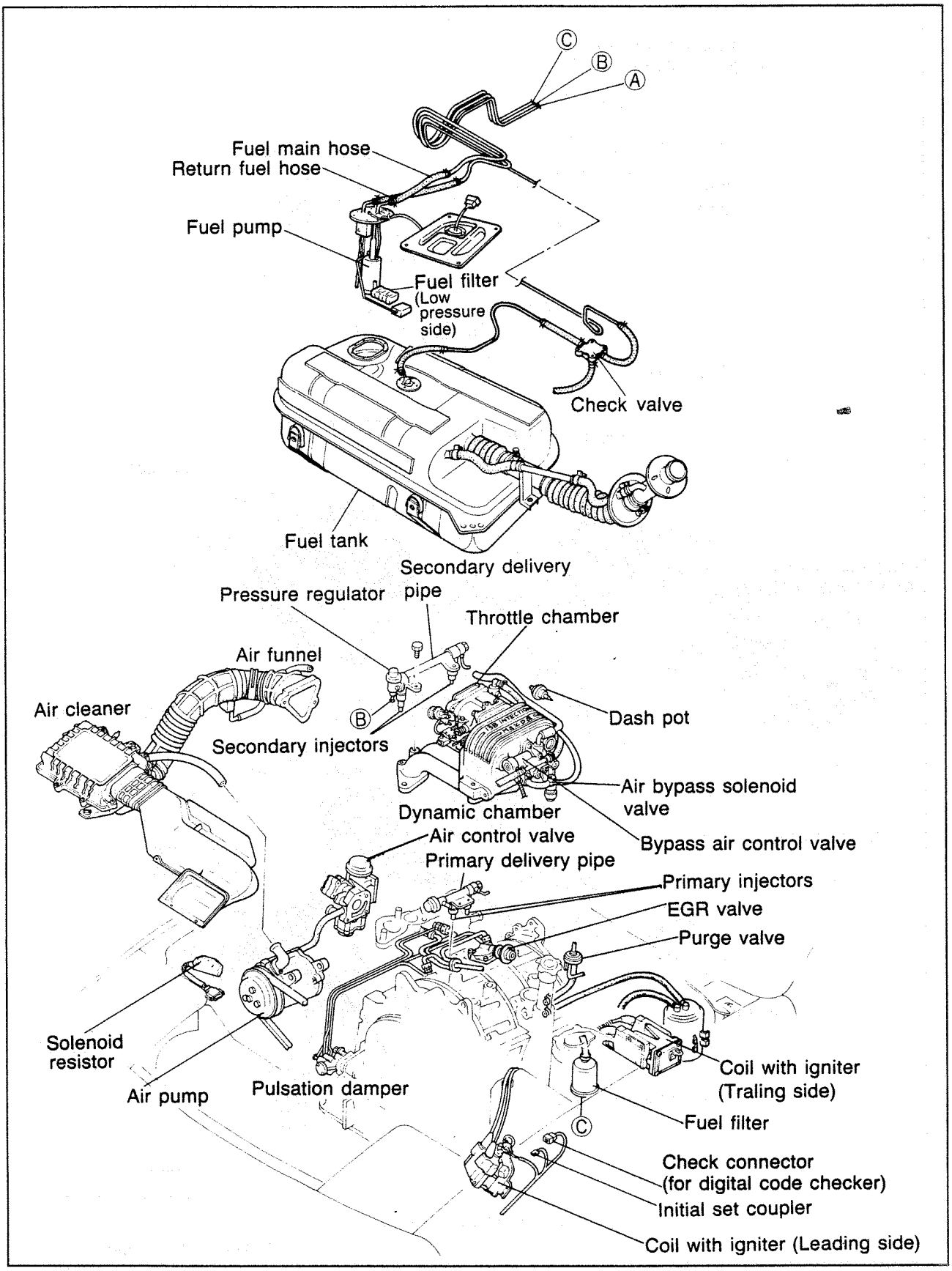
EMISSION CONTROL SYSTEM DIAGRAM
Fuel And Output Devices (Australia)



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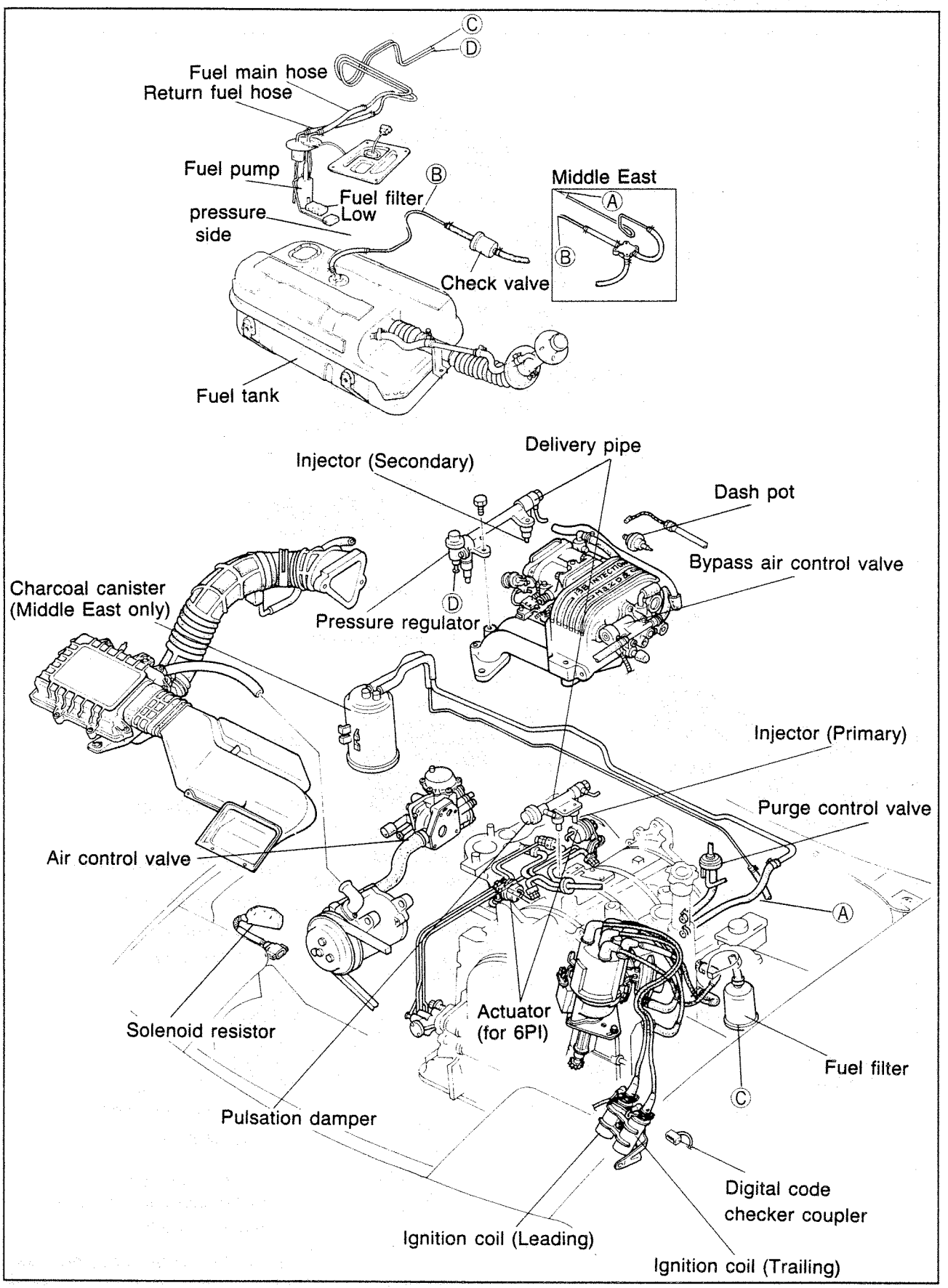

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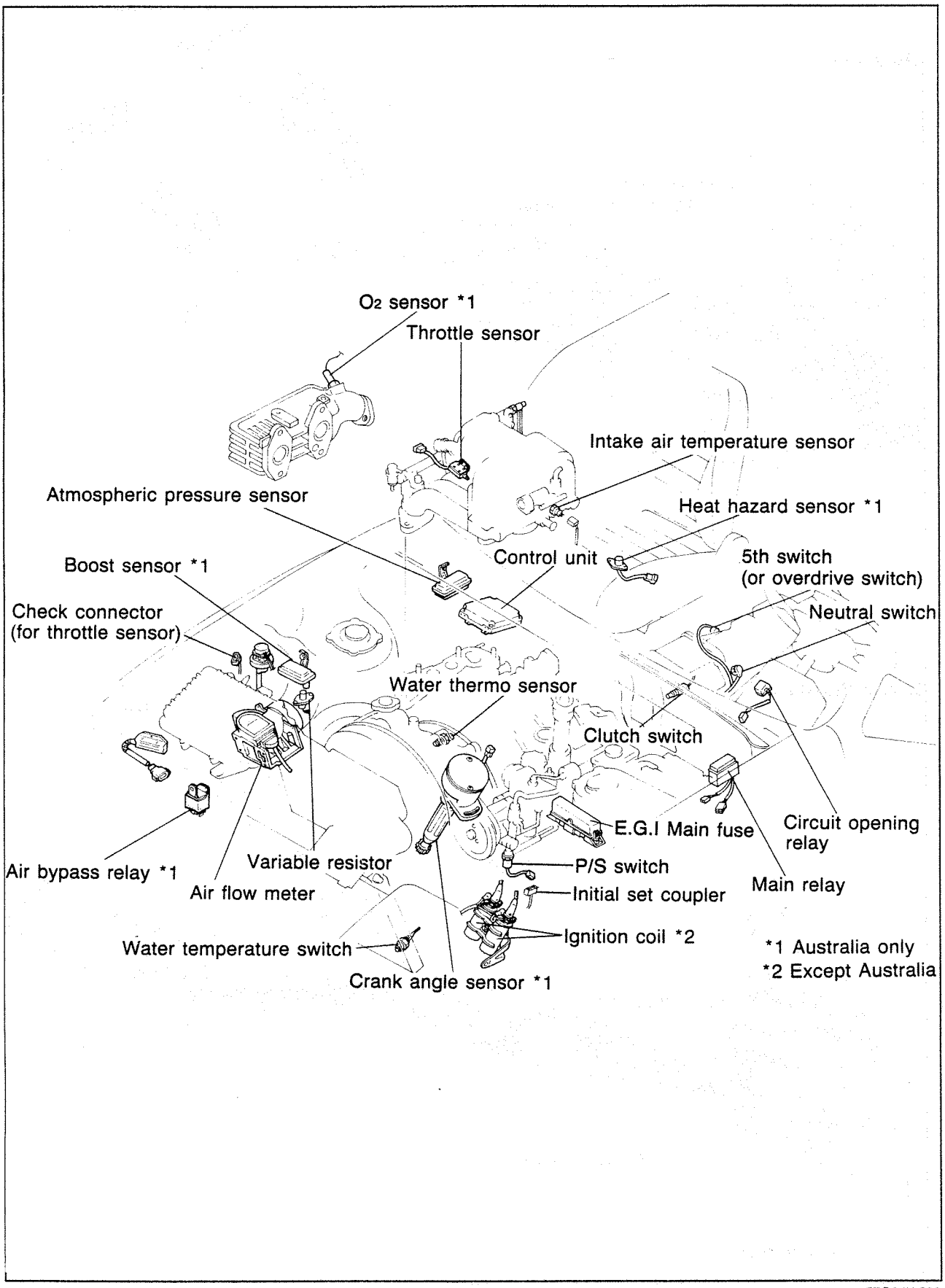
Input Devices



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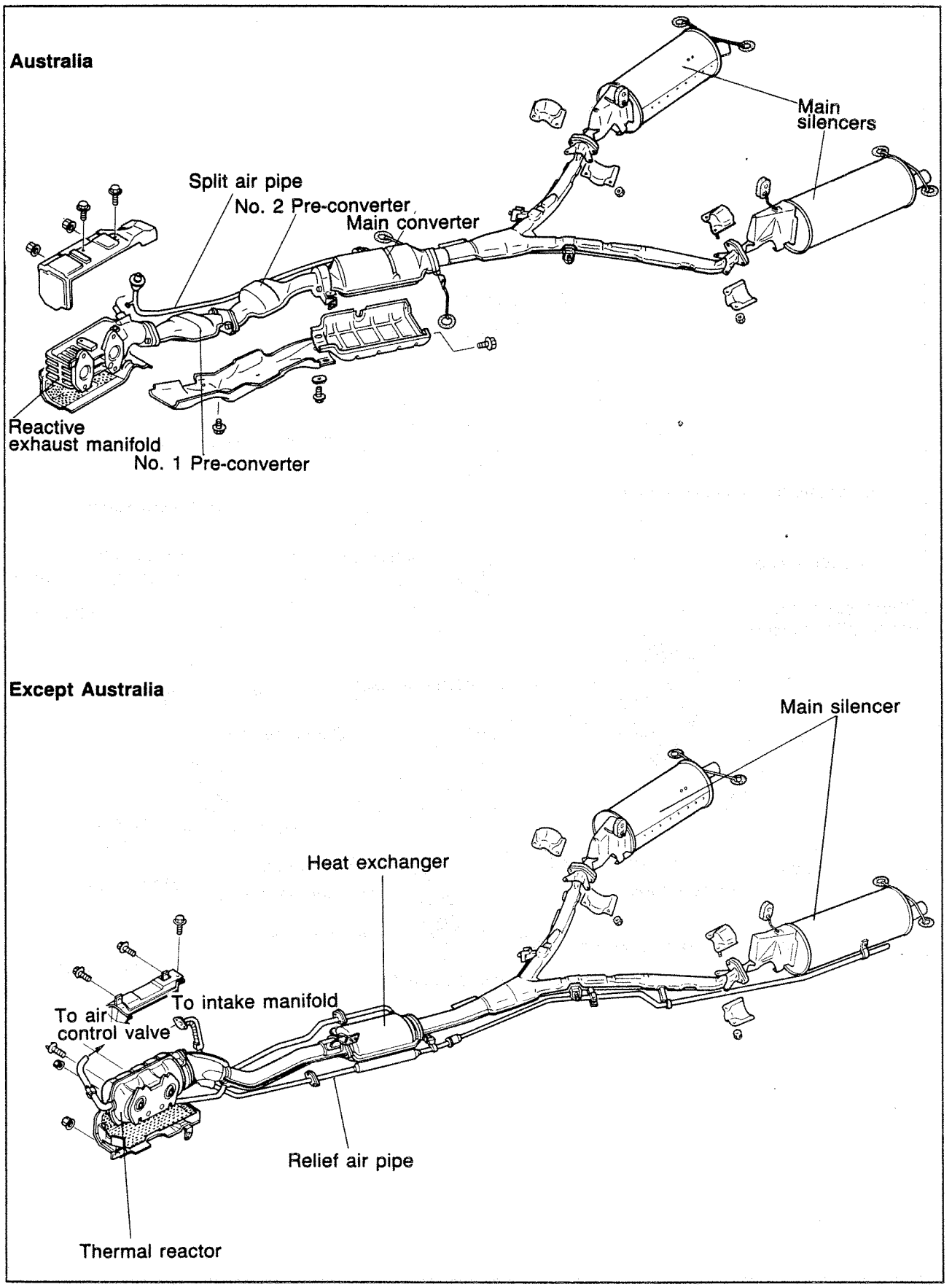
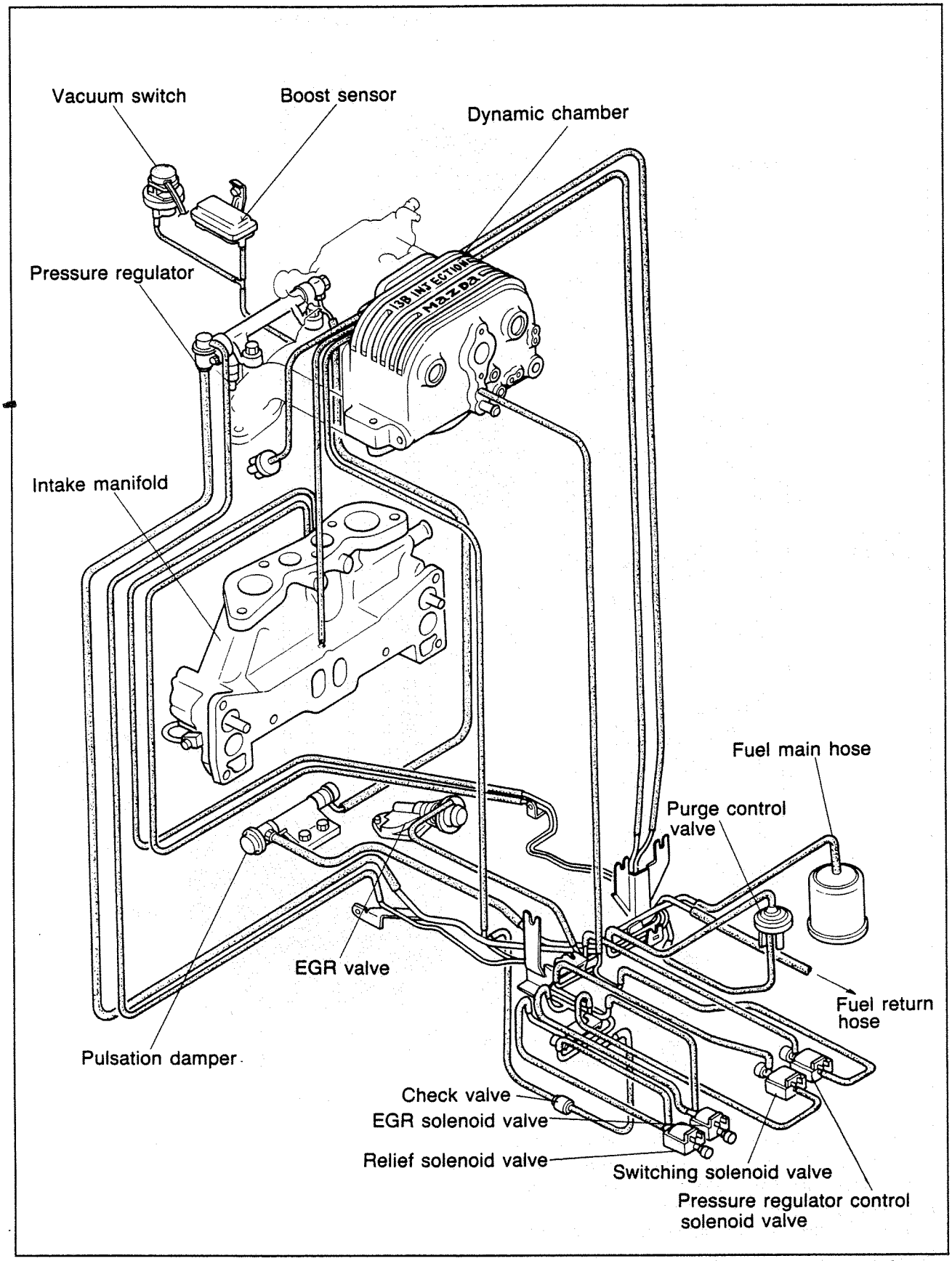
Exhaust System



57G04X-510

VACUUM HOSE ROUTING DIAGRAM
Australia



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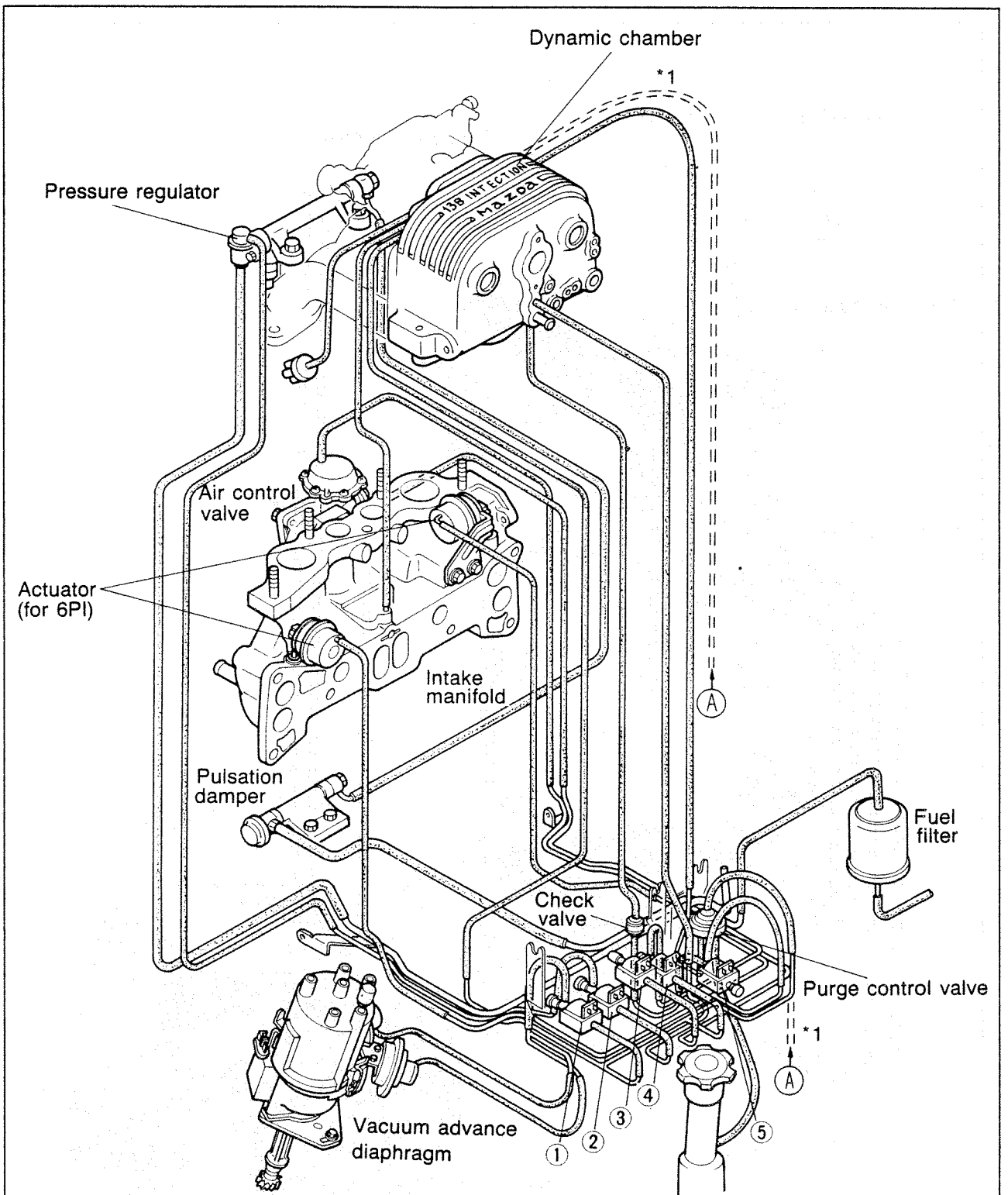
Except Australia



① Green: VCV (Vacuum control valve) solenoid
② Orange: Pressure regulator control solenoid valve
③ Yellow: AAV (Anti afterburn valve) solenoid
④ Blue: Relief solenoid valve
⑤ Brown: 6PI (6 Port induction) solenoid valve

*1 Middle East only

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SPECIFICATIONS

			Australia		Except for Australia
			M/T	A/T	M/T
Idle speed		[rpm]	725 ~ 775 rpm (with/BAC valve)		
Air cleaner	Element type		Long life dry		
Throttle chamber	Type		Horizontal-draft (2 stage-3 barrel)		
	Throttle diameter	Primary [mm (in)]	45 (1.772)		
		Secondary [mm (in)]	45 (1.772) x 2		
	Water thermo valve	Operation temp. [°C (°F)]	58 ~ 62 (136.4 ~ 143.6) or more	66 ~ 70 (150.8 ~ 158.0) or more	58 ~ 62 (136.4 ~ 143.6) or more
Dash pot	Adjustment speed	[rpm]	2,700 ~ 3,100		
Fuel tank	Capacity	[litters (US gal)]	63 (16.6)		
Fuel filter	Low pressure		Nylon 6 (164 & 45 mesh)		
	High pressure		Filter paper		
Pressure regulator	Type		Diaphragm		
	Regulated pressure	[kPa (kg/cm^2, psi)]	245. 2 ~ 255.0 (2.5 ~ 2.6, 35.6 ~ 37.0)		
Fuel pump	Type		Impeller (intank)		
	Outlet pressure	[kPa (kg/cm^2, psi)]	441 ~ 588 (4.5 ~ 6.0, 64.0 ~ 85.3)		
	Feeding capacity	[liters (US gal,/minute)]	at least 1.3 (0.35)		
Injector (Primary and Secondary)	Drive		Voltage drive + solenoid resistor		
	Injection amount	[cc (cu in)/min]	459 (28.0)		
Heat hazard sensor	Operation temperature	[°C (°F)]	105 ~ 115 (221 ~ 239)		—
Main silencer	Capacity	[cc (cu in)]	10,000 (610.3) x 2		12,000 (732.3) x 2
Ignition timing			Leading: 5° ATDC Trailing: 20° ATDC (at idle)		
Distribution			Control unit		Distributor
Spark Advance			Control unit		Vacuum, Centrifugal
Idle-up system	A/C	[rpm]	800		
	"D" range	[rpm]	750		—
Bypass air control system			Linier solenoid		
Anti-afterburn valve	Operation time	[sec]	1.60 ~ 2.20	0.52 ~ 0.92	1.8 ~ 2.4
Exhaust Gas Recirculation valve	Opening pressure	[mmHg (inHg)]	at least −50 (28.0)		—
CO concentration		[%]	Less than 0.1% (at idle)		
Fuel specification			Unleaded		leaded

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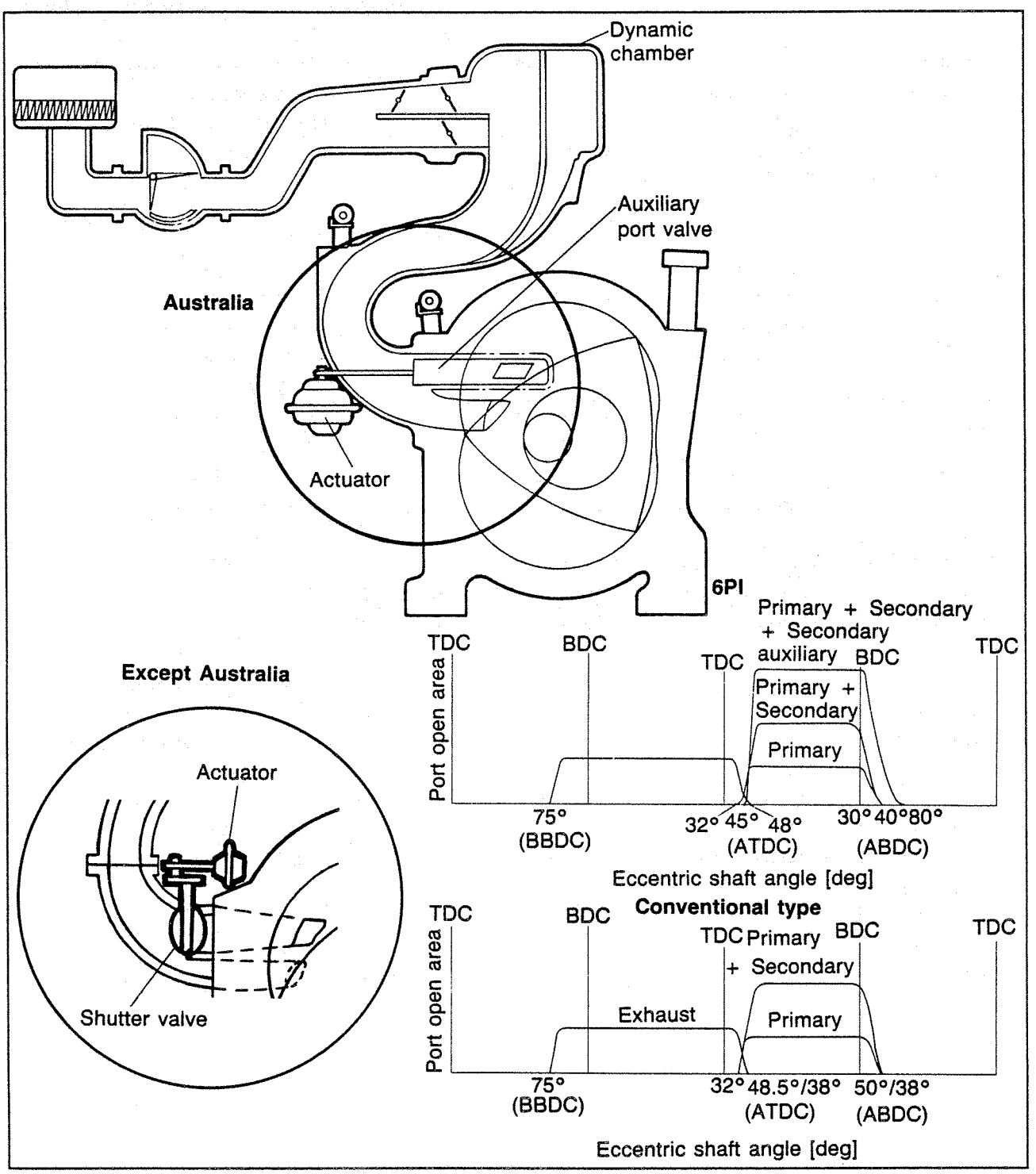
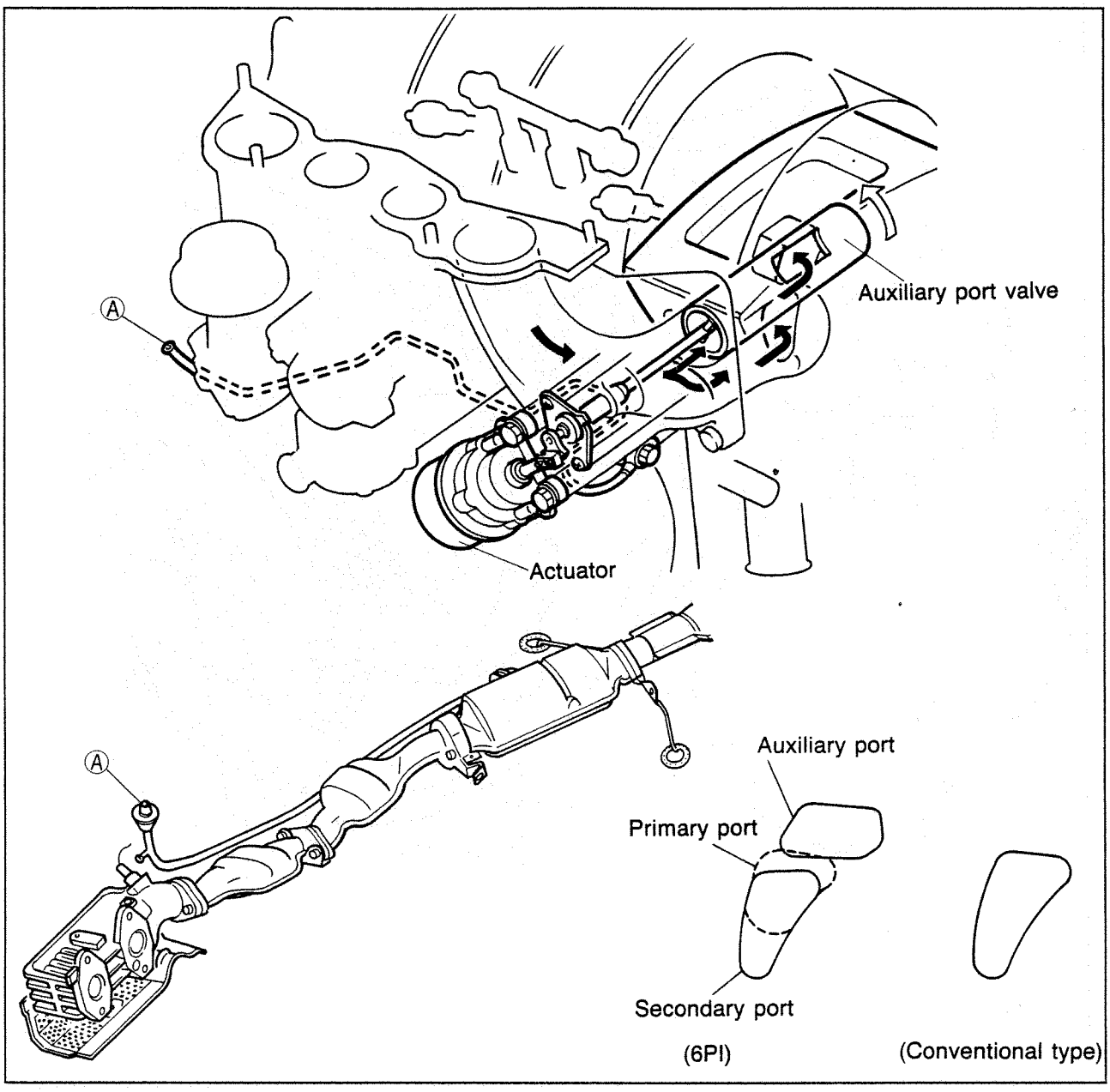
AIR INDUCTION SYSTEM



57G04X-514

For new models, the 6PI system and dynamic supercharge system are added to the air-induction system. For the 6PI system, the intake port arrangement for each rotor is divided into three sections (primary, secondary, and secondary-auxiliary), and a valve which opens and closes in accordance with engine operating conditions is mounted in the secondary-auxiliary port.
In conjunction with the 6PI system, the intake port opening/closing timing is changed. The dynamic supercharge system, by connecting the front and rear rotors by a dynamic chamber, activates a compression wave (which occurs in conjunction with the opening and closing of the intake port) during each air intake action.

6PI (6 Port Induction) System
Australia



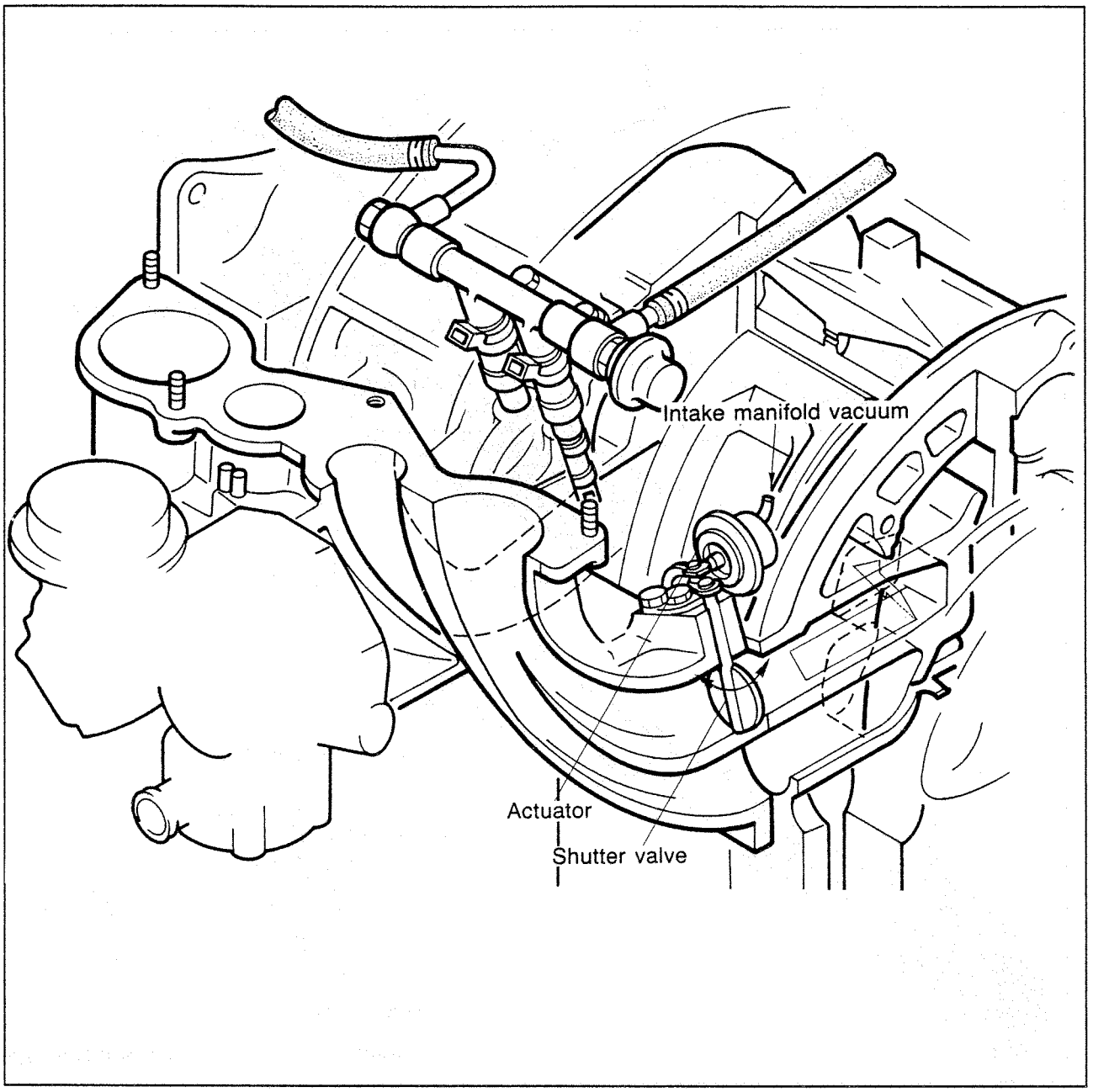
57G04X-515

The auxiliary port valve is installed at the secondary-auxiliary port, and is connected to the actuator which is activated by the exhaust pressure. Because the actuator is not activated below an exhaust pressure of 13 kPa (0.13 kg/cm^2, 1.8 psi), the valve is held closed by spring force at low and medium speeds. When the exhaust pressure exceeds 13 kPa (0.13 g/cm^2, 1.8 psi) (high speed), the actuator is activated, causing the valve to be opened.

Low and medium speed:
As a result of the constriction of the surface area of the intake port, the intake air-flow speed into the combustion chamber is increased for improved filling efficiency.

High speed:
As a result of the increase of the area of the intake port, intake air can easily enter the combustion chamber, thus increasing filling efficiency.

Except For Australia



57G04X-516

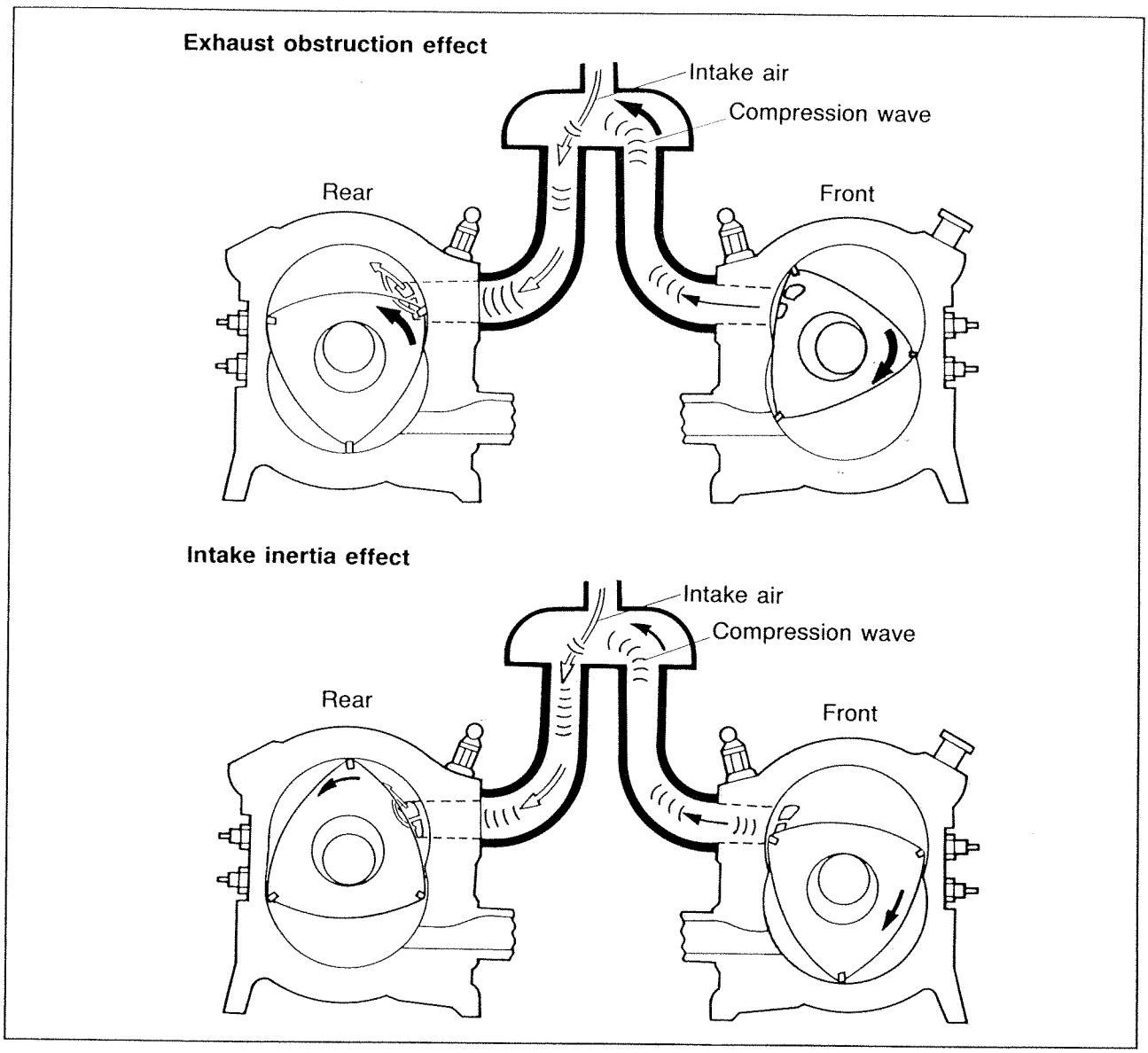
This system consists of shutter valve, actuator, 6PI solenoid valve and control unit.
The shutter valve is installed in secondary auxiliary port, and is connected to the actuator activated by the intake manifold vacuum.
The intake manifold vacuum which activates the actuator is controlled by the 6PI solenoid valve (three-way solenoid valve).
During low and medium speed, the 6PI solenoid is OFF, and the intake manifold vacuum is directed to the actuator, thus closing the shutter valve.
At high speed, the 6PI solenoid valve is ON, and the intake manifold vacuum is cut off, thus allowing the shutter valve to open.

Operation

Engine speed: above 4,500 rpm

The shutter valve is opened under the conditions described above.

DYNAMIC SUPERCHARGE SYSTEM



57G04X-517

The compression wave produced by the opening and closing of the intake port is put to use through the combination of the following two effects.

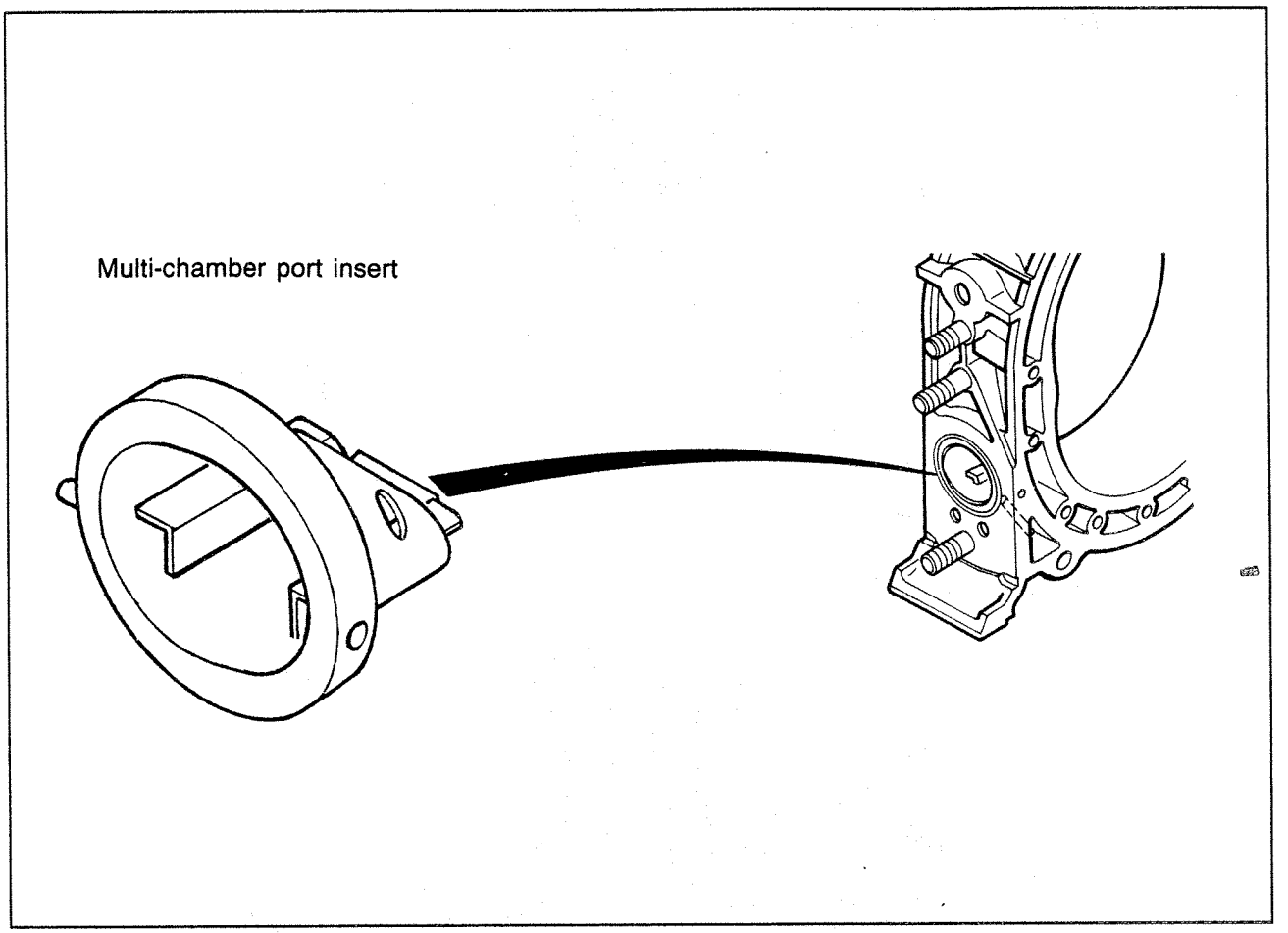
Exhaust Obstruction Effect

When the front side intake port has begun to open and the exhaust port is open, a compression wave rushes in to the intake port. This wave flows through the dynamic chamber and to the rear side where it pushes into and acts on the intake air.
When the compression wave flows through the dynamic chamber and to the rear side, the rear intake port is beginning to close and the volume of intake air that is being pulled is small but as a result of the this wave, intake air can be forced inside.

Intake Inertia Effect

When the front side intake port is closed, the intake air that was being pulled in collides with the side of rotor, and flows toward the rear side by the compression wave.
At the time this wave flows through the dynamic chamber and to the rear side, the rear side is in the process of air intake. At the time of the air intake operation the intake air is forced into the chamber by the compression wave.

EXHAUST SYSTEM



57G04X-518

This system consists of a multi-chamber port insert, main silencer, and exhaust pipe.
This system has been improved and changed as described below:

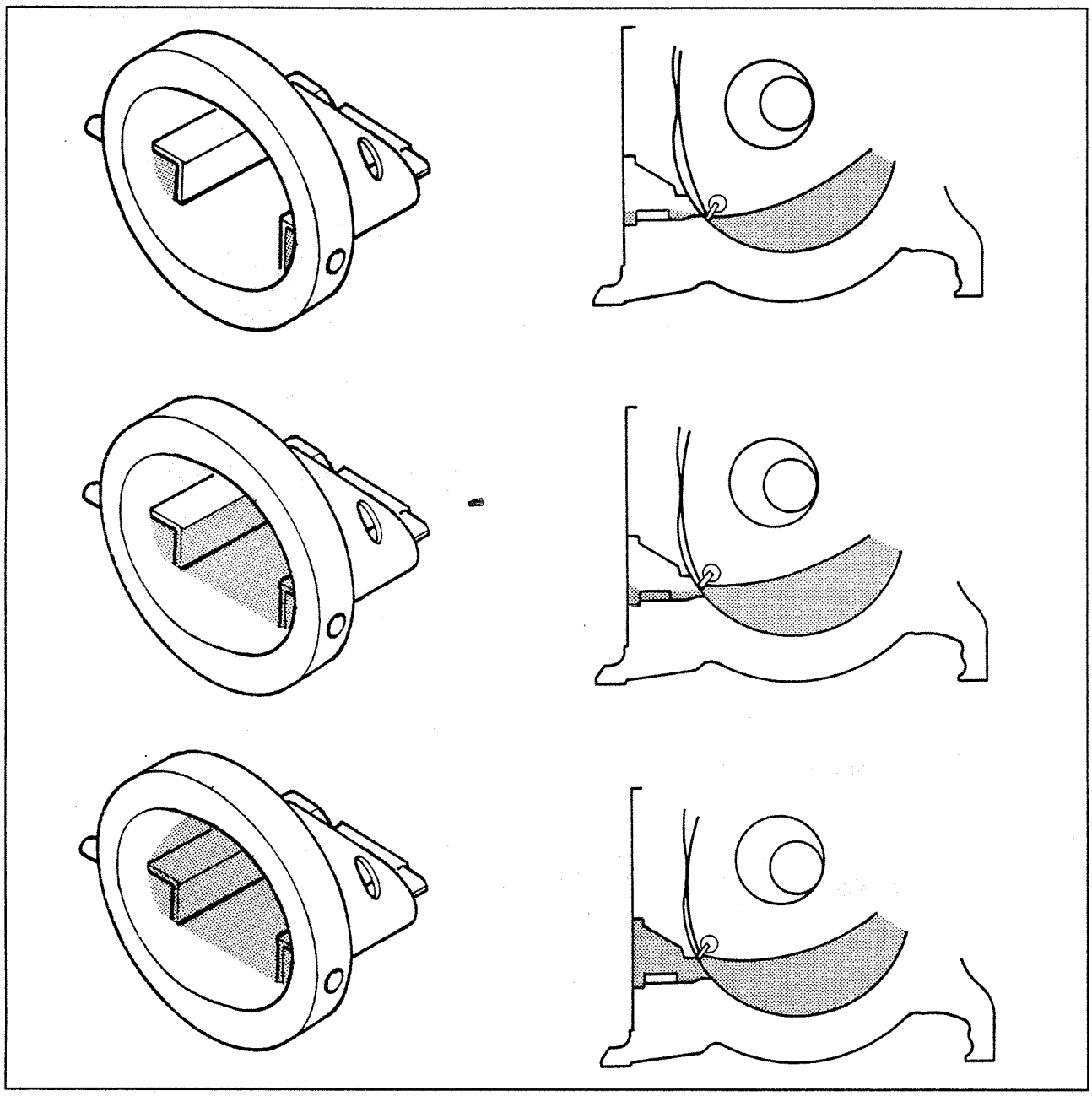
Main silencer

- The main silencer has been replaced by two individual silencers resulting in greater total capacity over the previous model.

Multi-chamber port insert

- A partition has been provided within the insert to create a two stage opening action of the exhaust port for smoother exhaust flow.

Operation



57G04X-519

Side view

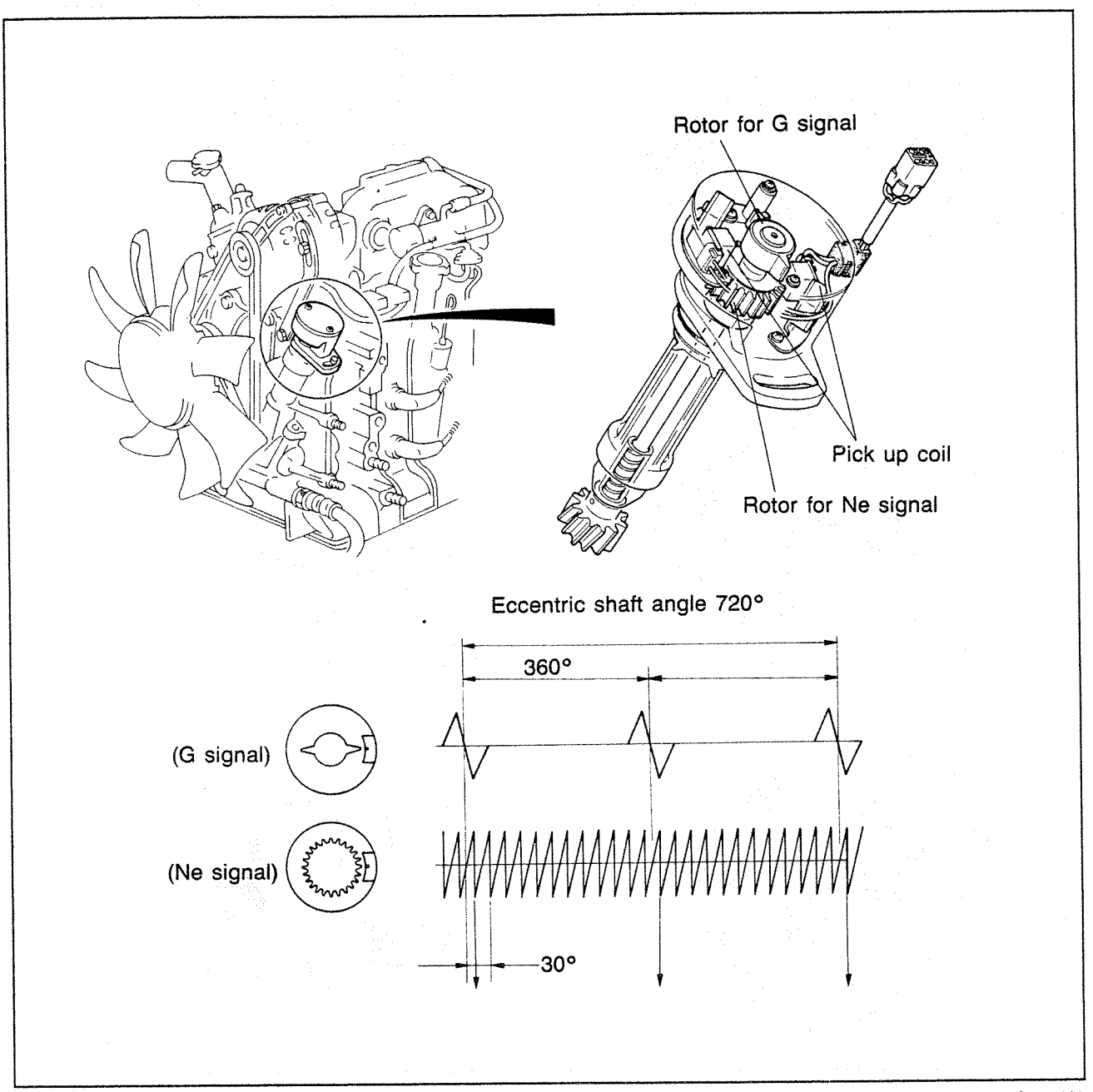
(1) Exhaust port opening start
Exhaust gases are only exhausted from the lower side *of the multi-chamber port.

(2) Exhaust port half open
Exhaust gases are exhausted from the lower side of the multi-chamber port and from the center area.

(3) Exhaust port fully open
Exhaust gases are exhaust from the entire multi-chamber port.

***Note**
Exhaust gases flow only from this area.

CRANK ANGLE SENSOR (AUSTRALIA ONLY)



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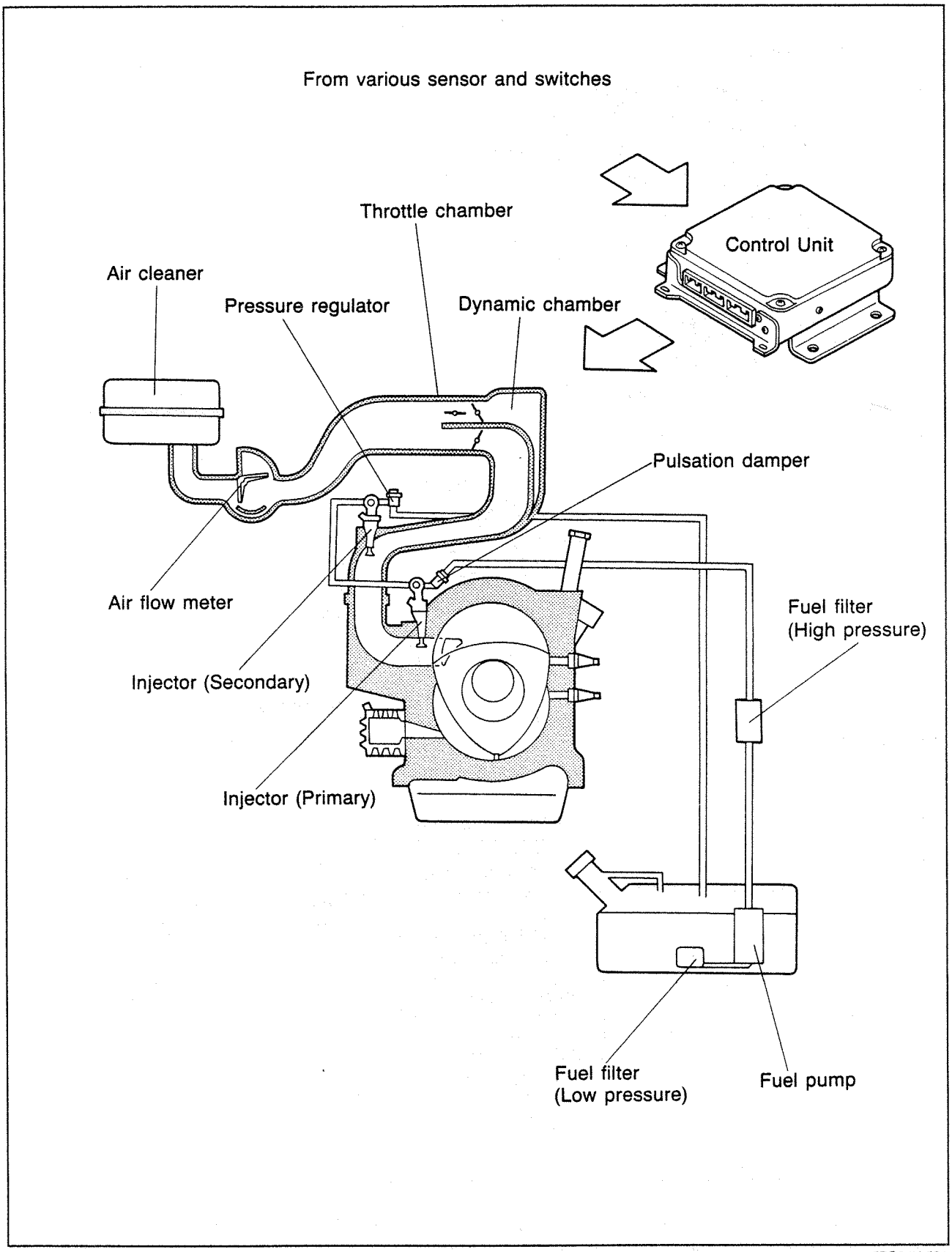
On the new model, the distributor has been replaced by a crank-angle sensor. The two output signals from the crank-angle sensor are sent to the control unit, where they are used to determine eccentric shaft angle and engine speed.

Signal	Purpose	Related system	Remarks
Ne	Fuel injection timing (Advancing)	E.G.I. system	Eccentric shaft angle detection
	Basic injection amount		
	Number of operating injectors		
	Distribution to front and rear, ignition timing	ESA system	
	Bypass air volume	BAC system	
	EGR operation	EGR system	
	Secondary air condition	SAI system	
G	Fuel injection timing (distribution)	E.G.I. system	Front side TDC detection

E.G.I. (ELECTRONIC GASOLINE INJECTION) SYSTEM



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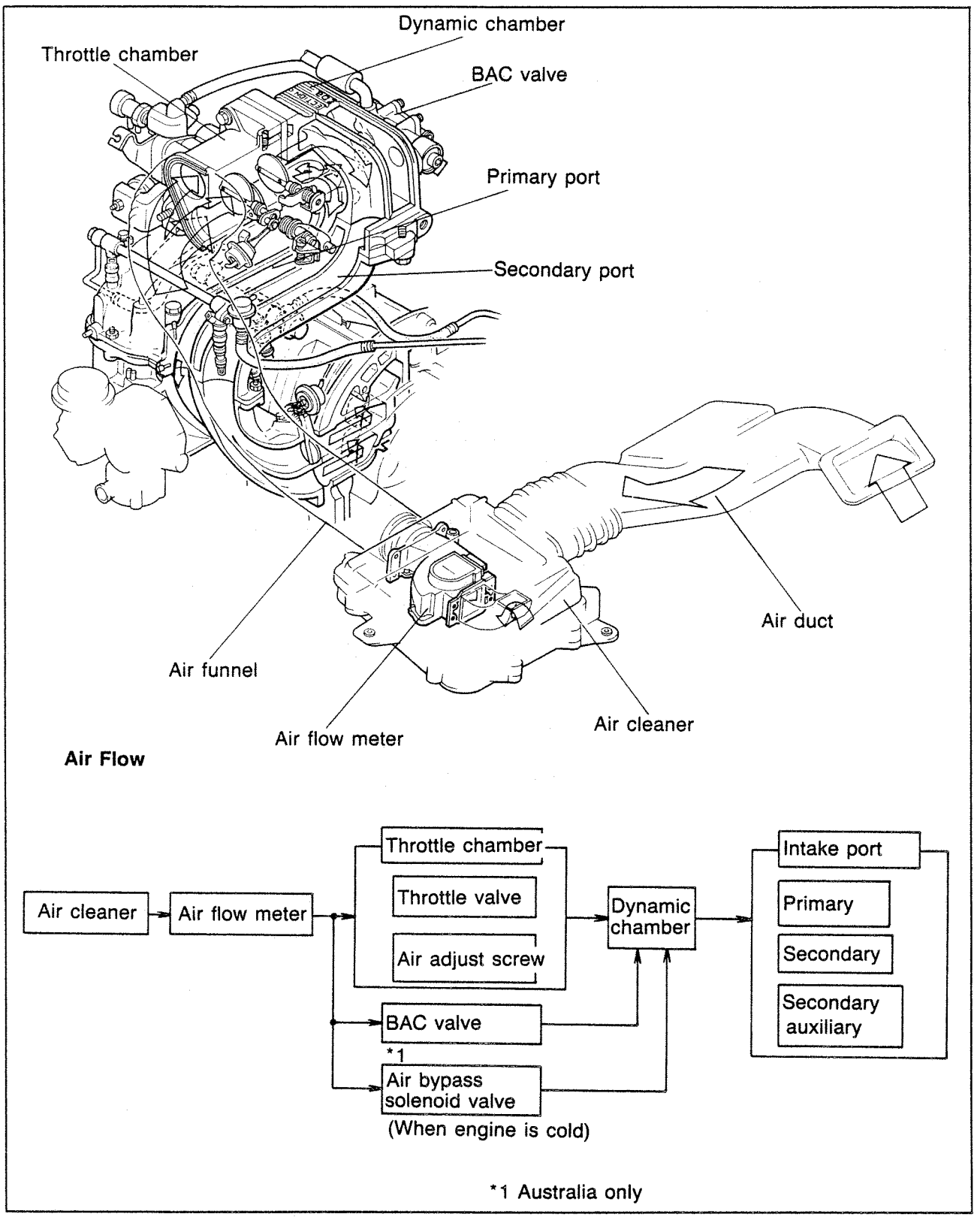
E.G.I. system consists of intake air system, fuel system and control system.

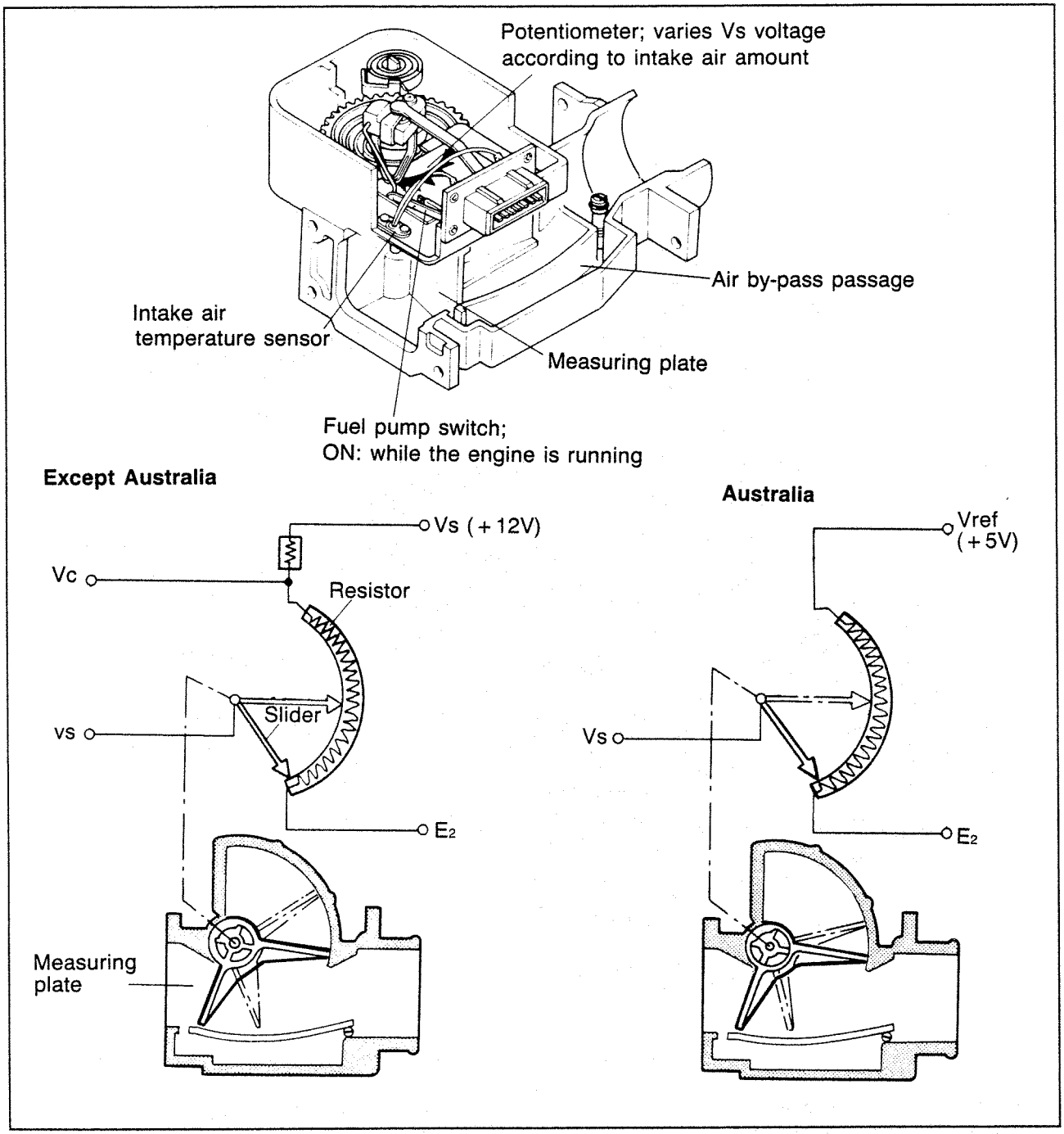
INTAKE AIR SYSTEM



57G04X-522

This system supplies and controls the amount of air required by the engine. If consists of the air cleaner, air flow meter, throttle chamber, dynamic chamber, air bypass solenoid valve and BAC valve. (For information regarding the BAC valve and air by-pass valve, refer to the BAC system.)

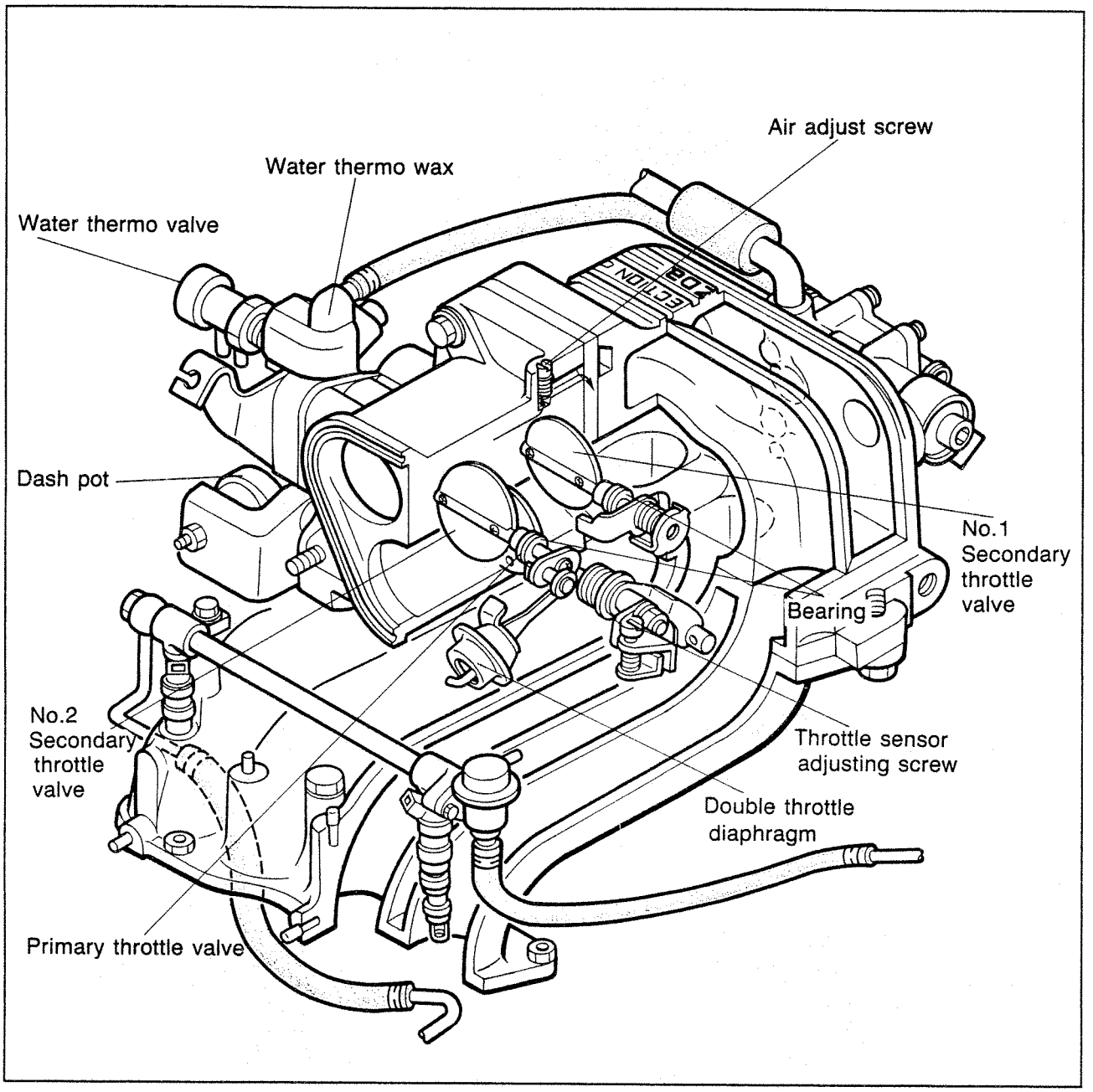
Air Flow Meter



57G04X-523

The air flow meter detects the air quantity and convert the flow of air measurement to a voltage reading by means of the potentiometer. The voltage signals are sent to the control unit, which, in turn, determines fundamental injection quantities based on the signals and the engine speed etc.
The voltage detecting a change in opening of the measuring plate is called Vs voltage; it goes up as the opening gets greater, and lowers as the opening becomes smaller.
The meter also incorporates a sensor to detect intake air temperature; a by-pass system to adjust fuel mixture when idling; and a fuel pump switch to control the fuel pump.
The intake air temperature sensor is mounted in the air flow meter to detect intake air temperature. Any change in intake air temperature is detected as a change in resistance by the thermistor in the intake air temperature sensor, converted to voltage and sent as a signal to the control unit, which controls fuel injection quantities according to intake air temperature.

Throttle Chamber



57G04X-524

The throttle chamber which controls the amount of intake air consists of the throttle valve (connected to the accelerator pedal), and a bypass system to supply small quantities of air when engine is idling. The throttle chamber is provided with a throttle sensor for detecting the primary throttle valve opening, a dash pot to control throttle valve closing, fast idle mechanism to stabilize the idle and double throttle system to prevent hesitation during acceleration.

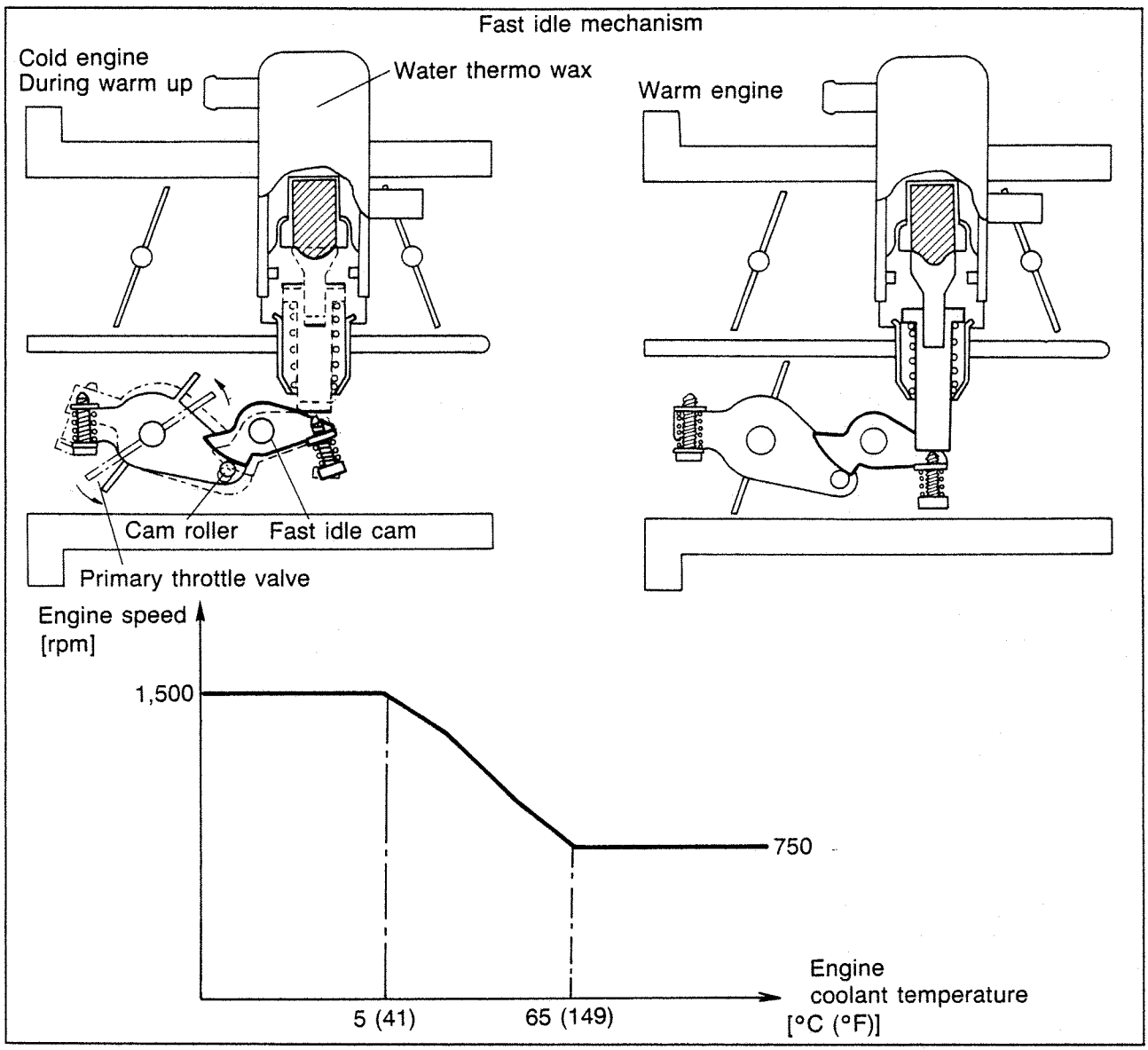
Molybdenum disulfide and Bearing

The throttle valve and bore and coated with molybdenum disulfide to eliminate air leakage past the valve at idle.

A small hole is provided in the primary throttle valve to allow a small controlled amount of air leakage to maintain a smooth idle.

Bearings have been added to the throttle shaft.

Fast Idle Mechanism



57G04X-525

With a function equivalent to the choke of a carburetor, it performs this function by the degree of opening, by thermo wax, of the throttle valve, and by the amount of fuel increase. The water thermo wax is located on the throttle chamber.
Engine coolant is led into the water thermo wax, the wax rod extends at the coolant temperature becomes higher, this turns the fast-idle cam, and the throttle valve is thus gradually closed.

Operation

Cold engine

The fast-idle cam moves to a position on top of the cam roller, and the cam roller is pushed downward. As a result, the primary throttle valve is forced open.

During warm up

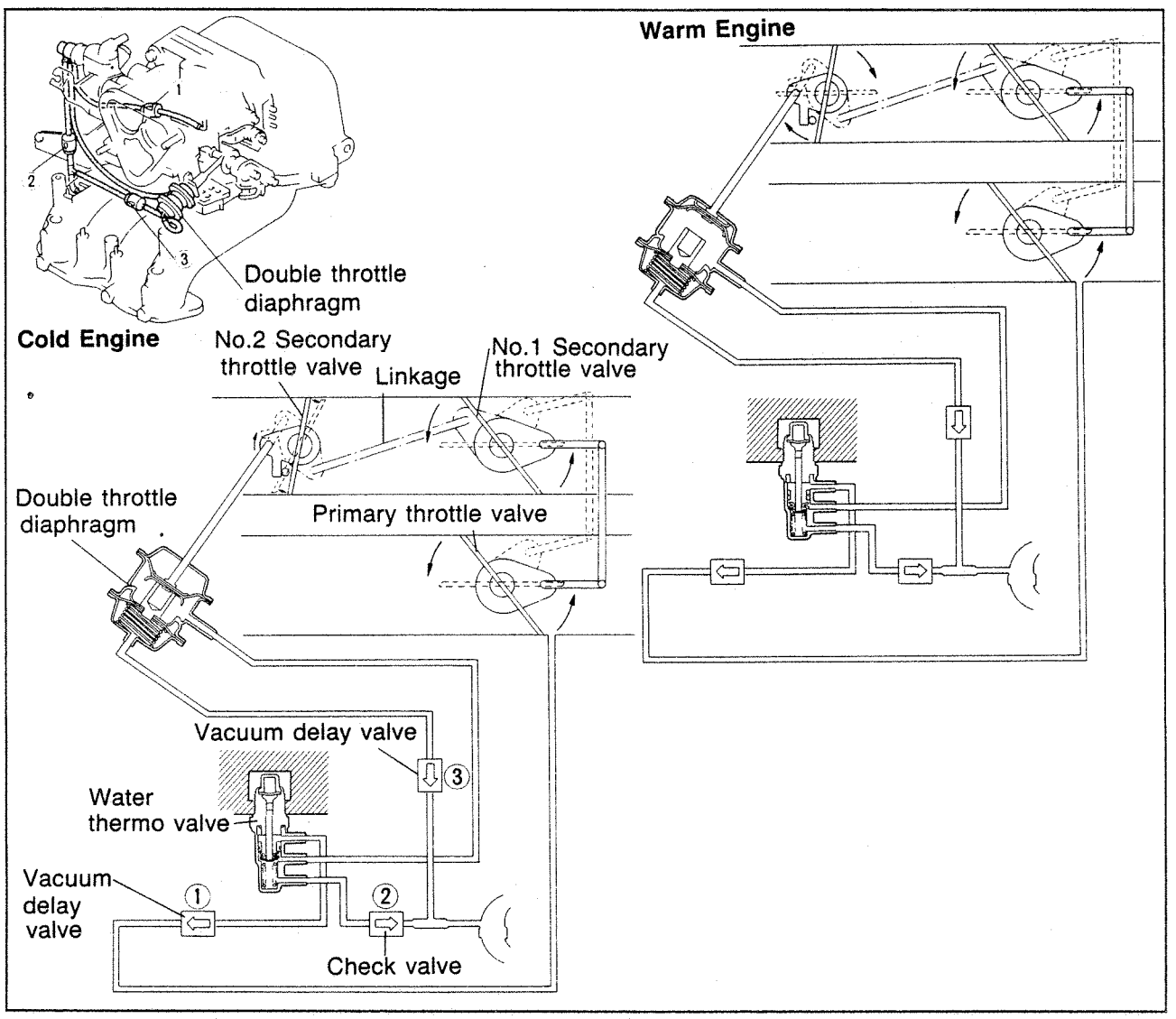
The water thermo wax swells as a result of the increase of the coolant temperature, thus extending the thermo wax rod. As a result, the fast-idle cam gradually rotates and frees the primary throttle valve.

After warming up

Because the fast-idle cam has completely moved away from the cam roller, the movement of the primary throttle valve is free, and the valve closes to the normal idling position.

Double throttle system
This system consists of No. 1 secondary throttle valve, No. 2 secondary throttle valve, double throttle diaphragm, vacuum delay valve, check valve and water thermo valve.

Operation
A/T Vehicle

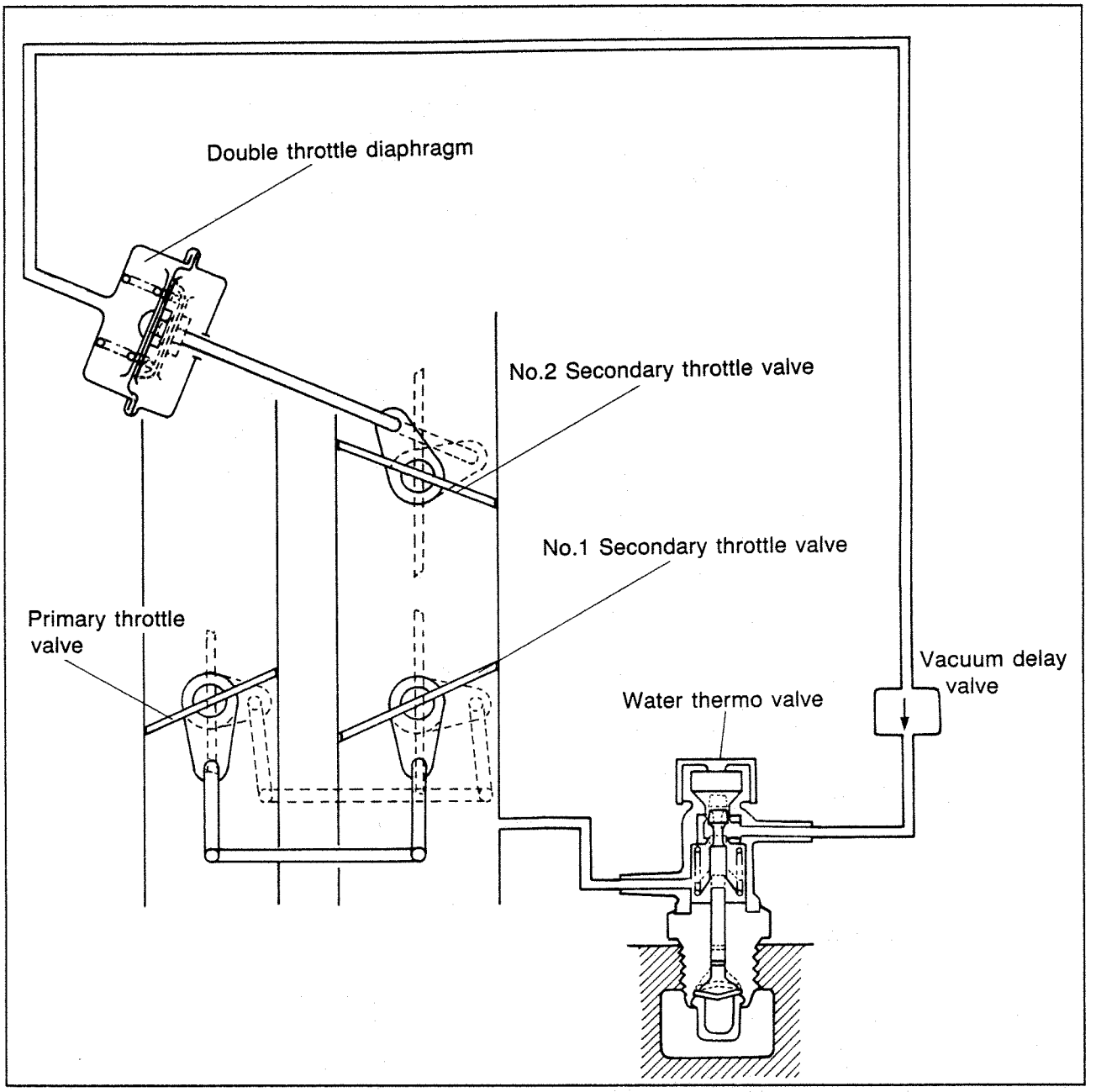


57G04X-526

Cold engine (engine coolant temperature: 68°C (154.4°F) or below)
As a result of the constant application of the intake manifold vacuum to the double throttle diaphragm, the No. 2 secondary throttle valve is held closed at idle.
When the No. 1 secondary throttle valve begins to open, the No. 2 secondary throttle valve (which is linked to the No. 1 secondary throttle valve) opens, controlled by the double throttle diaphragm and the linkage.
The No. 2 secondary throttle valve is opened gradually even if the No. 1 secondary throttle valve is fully opened suddenly. The opening secondary throttle valve does not exceed 13.5°.

Warm engine (engine coolant temperature: 68°C (154.4°F) or more)
When the No. 1 secondary throttle valve begins to open, the intake manifold vacuum gradually disappears from within the double throttle diaphragm, and the movement of the No. 2 secondary throttle valve gradually becomes free.
The No. 2 secondary throttle valve is opened gradually even if the No. 1 secondary throttle valve is fully opened suddenly. This is done to prevent a lean mixture during rapid acceleration.

M/T Vehicle

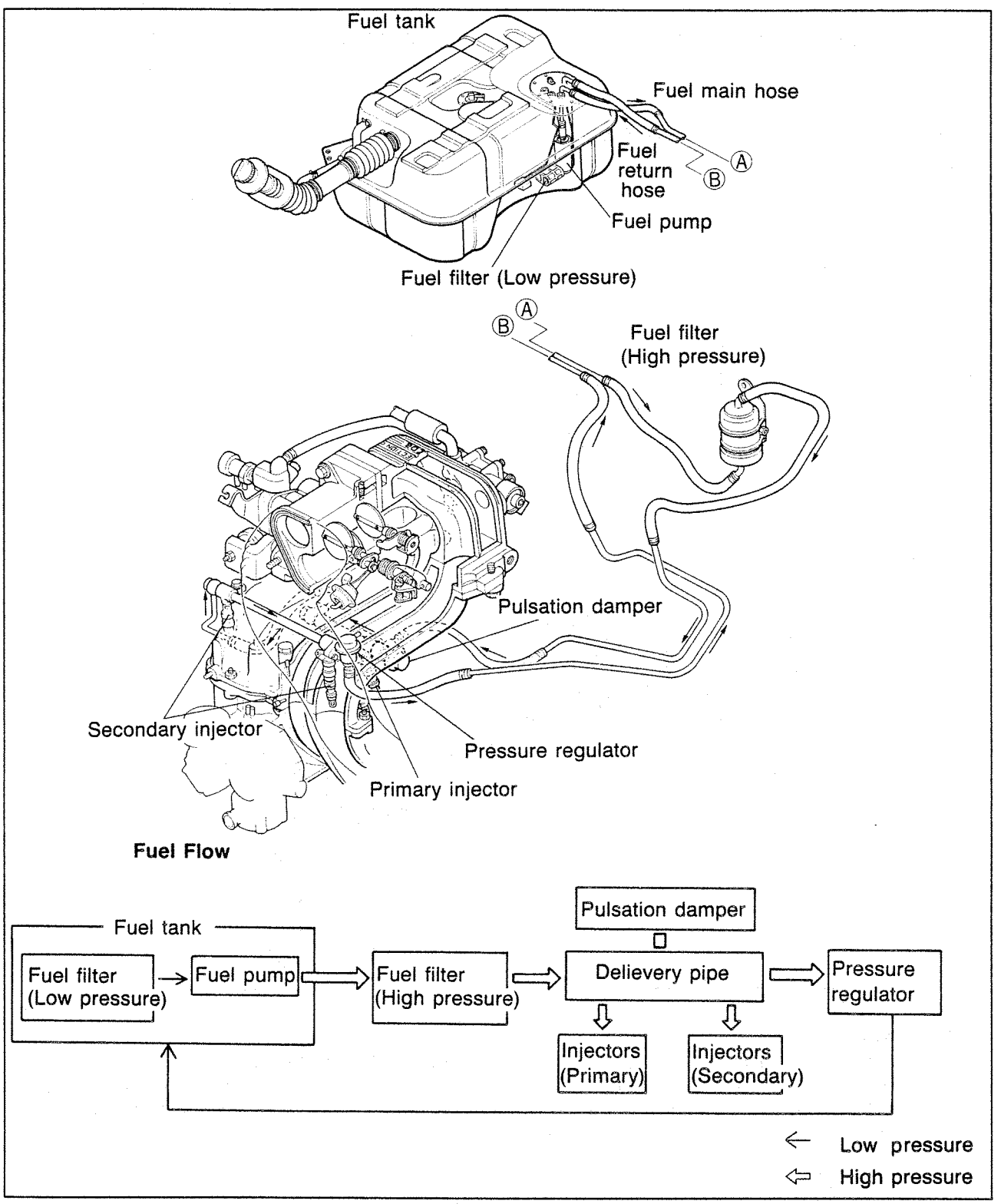


57G04X-527

Cold engine
The intake manifold vacuum is applied to the double throttle diaphragm, and the No. 2 secondary throttle valve is held closed. When the No. 1 secondary throttle valve starts to open, the intake manifold vacuum acting upon the throttle diaphragm gradually decreases, and the movement of the No. 2 secondary throttle valve gradually becomes free.

Warm engine
Because the intake manifold vacuum is not applied to the double throttle diaphragm, the movement of the No. 2 secondary throttle valve is free.

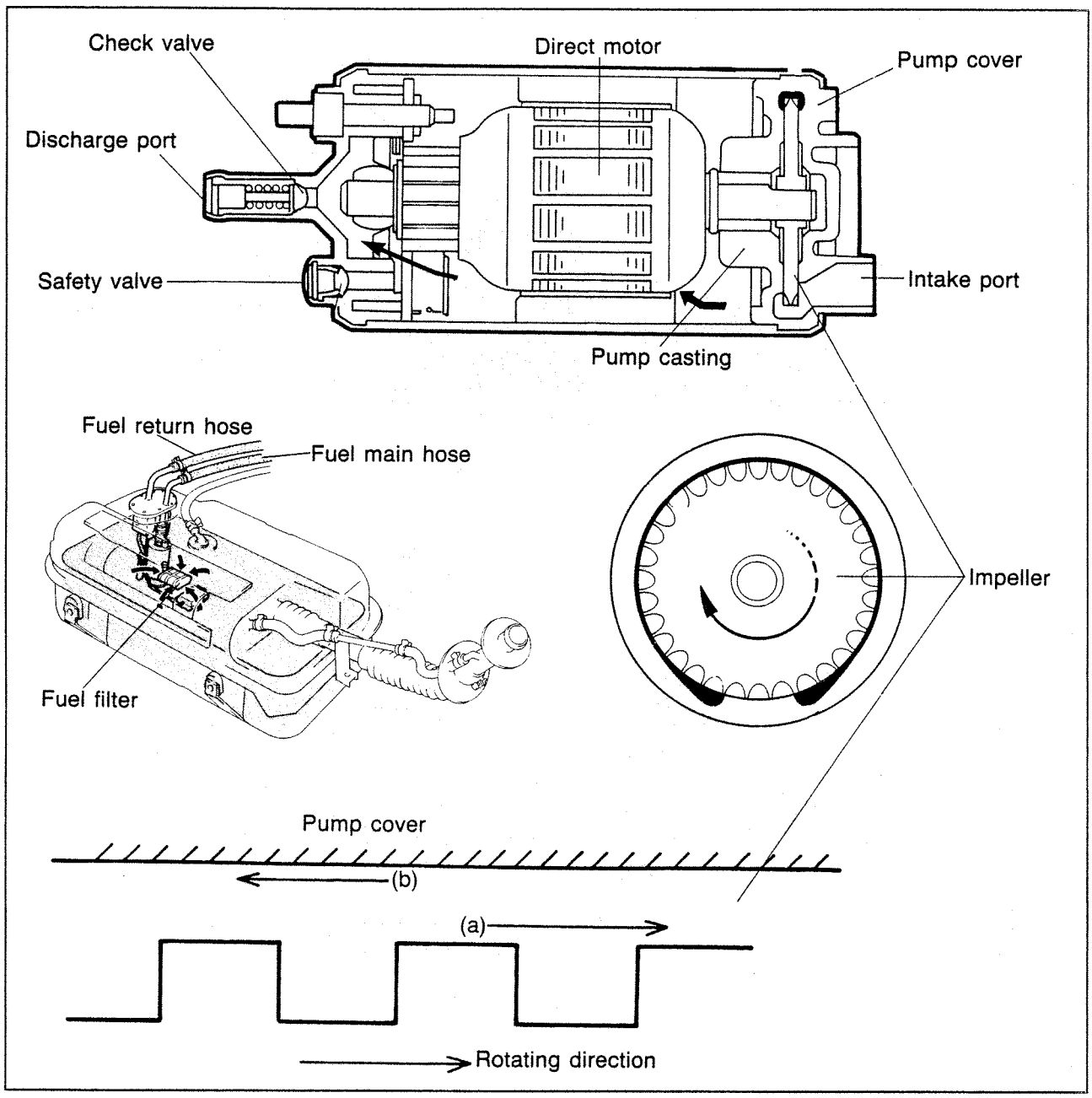
FUEL SYSTEM



57G04X-528

This system supplies the injectors with fuel necessary for combustion at a constant pressure. Fuel is metered and injected into the secondary intake manifold (Secondary injector) or intermediate housing (Primary injector) according to the injection control signals from the control unit.
It consists of the fuel pump, fuel filters, distribution pipes, pulsation damper, pressure regulator and injectors.

Fuel Pump



57G04X-529

The intank type fuel pump consists of an impeller, direct current motor, safety valve and check valve.

Operation

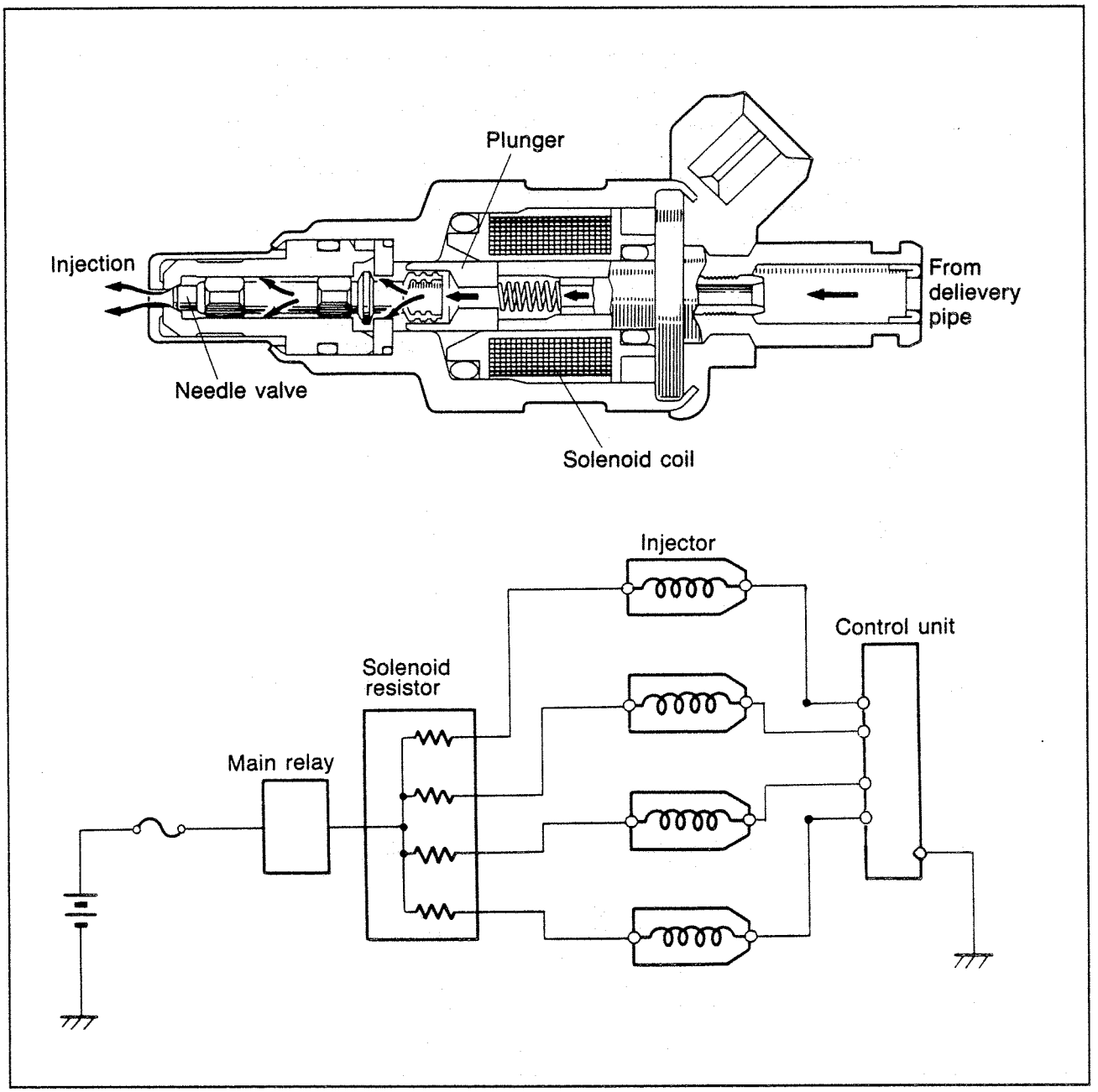
Intake and pressure action

- When the impeller turns, negative pressure is created at the intake port and fuel is carried by the impeller rotating in the sealed pump chamber.
- The rotating impeller creates pressure by utilizing the difference between the frictional force (a) of the rotating impeller which is pumping the fuel, and force (b) which is the opposing force of the pump chamber wall.

Discharge

- The overall final pressure causes fuel to be discharged from the outlet port in the pump chamber. Fuel then passes via the internal portion of the pump past the check valve and out the discharge port. The safety valve will relieve excess pressure directly back within the fuel tank.

Injector



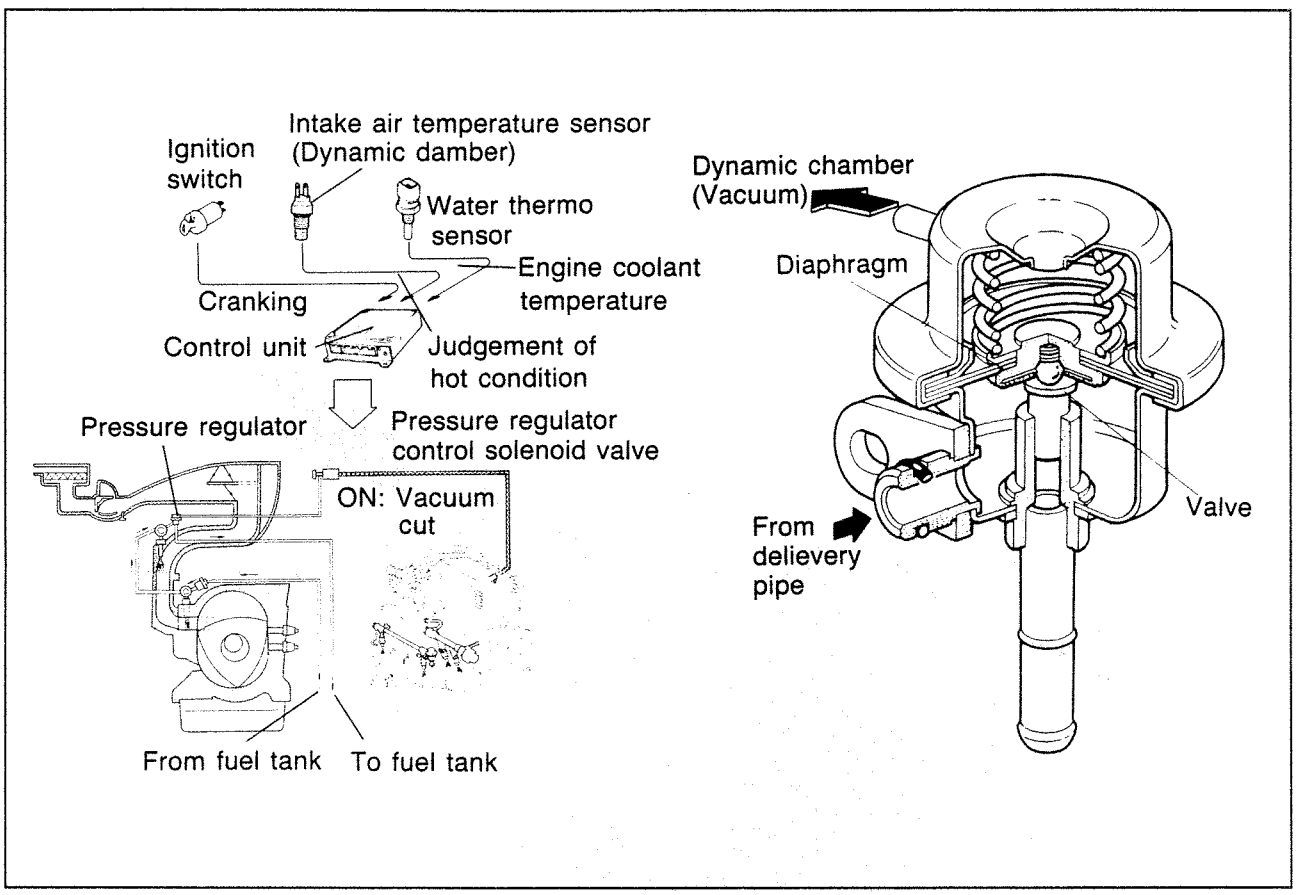
57G04X-530

The injector injects fuel based upon the injection signals calculated by the control unit.
When these injection signals are applied to the solenoid coil:
1. The plunger is attracted to the coil.
2. The needle valve is pulled off its seat.
3. The fuel is injected into the secondary intake port or intermediate housing.

For maximumy efficiency, and for calibration accuracy the injector must have very little mechanical working lag of the needle valve and hence good response to the solenoid coil. The solenoid coil has very few windings and low inductance. Such a solenoid coil can, however, be burnt out due to excessive current flow when energized.

For this reason a solenoid resistor is connected in series with the injector to prevent excess current flow. **Therefore, in checking the injector never apply battery voltage (12V) directly to the solenoid coil.**

Pressure Regulator



57G04X-531

The pressure regulator adjusts the fuel pressure supplied to the injectors to always keep it **250 kPa (2.55 kg/cm^2, 36.3 lb/in^2)** higher than the pressure in the intake manifold.

Operation
When intake manifold vacuum is low:
Due to low manifold vacuum acting upon the diaphragm the internal spring of the valve is not compressed, thereby not allowing fuel to by-pass back to the fuel tank and resulting in high fuel pressure in the fuel piping.

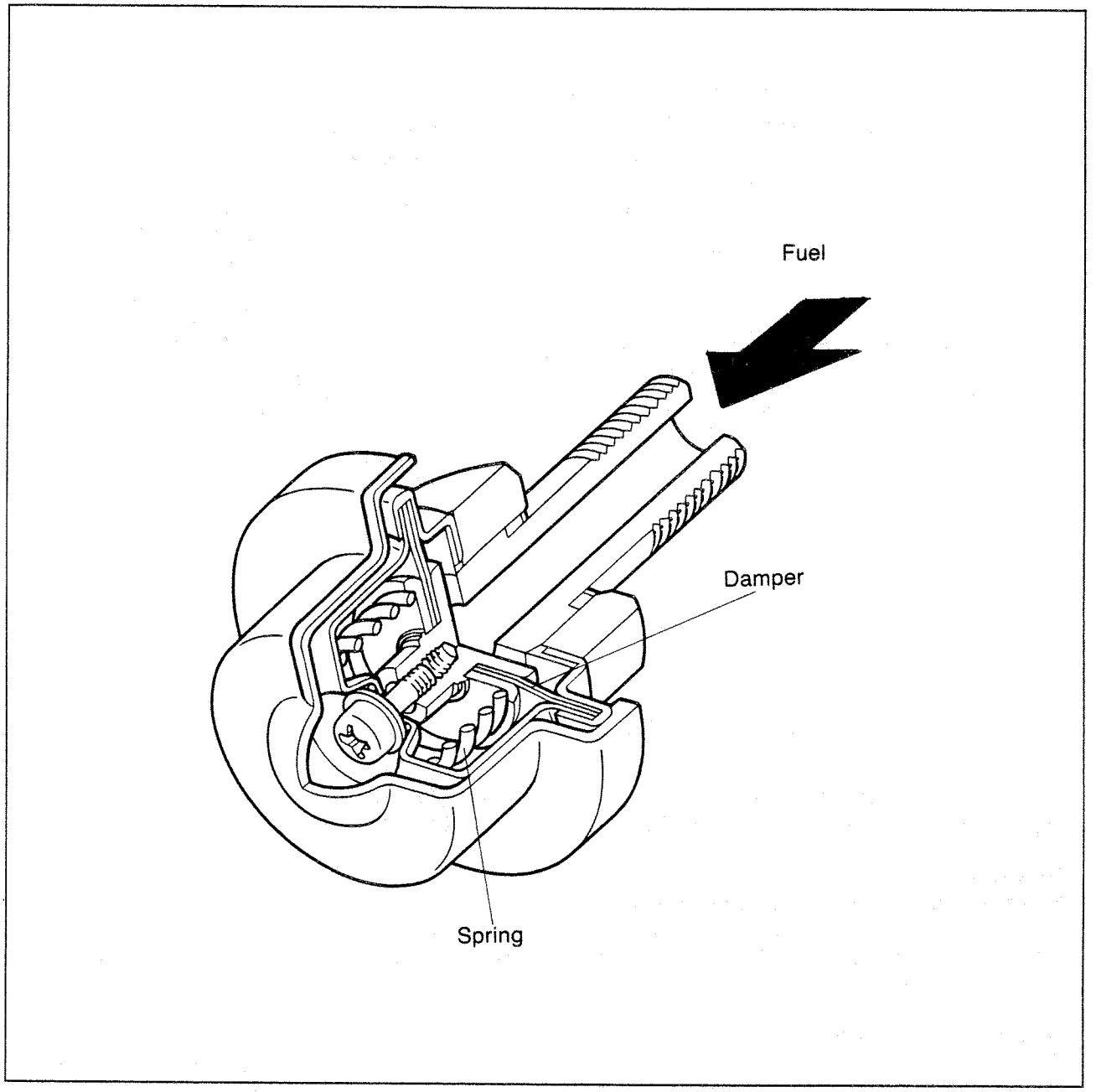
When intake manifold vacuum is high:
Due to high manifold vacuum acting upon the diaphragm the internal spring is compressed thereby allowing fuel to be by-passed back to the fuel tank, resulting in low fuel pressure in the fuel piping.

Pressure regulator control
To prevent percolation of the fuel during idling for specified time after the engine is re-started, vacuum is cut to the pressure regulator and the fuel pressure is increased.

Specified time:
Australia: 90 sec
Except for Australia: 120 sec

Note:
Australia
Only when intake air temp. is above 78°C (172.4°F) and coolant temp. is above 65°C (149°F).
Except for Australia
Only when intake air temp. is above 50°C (122°F) and coolant temp. is above 65°C (149°F).

Pulsation Damper

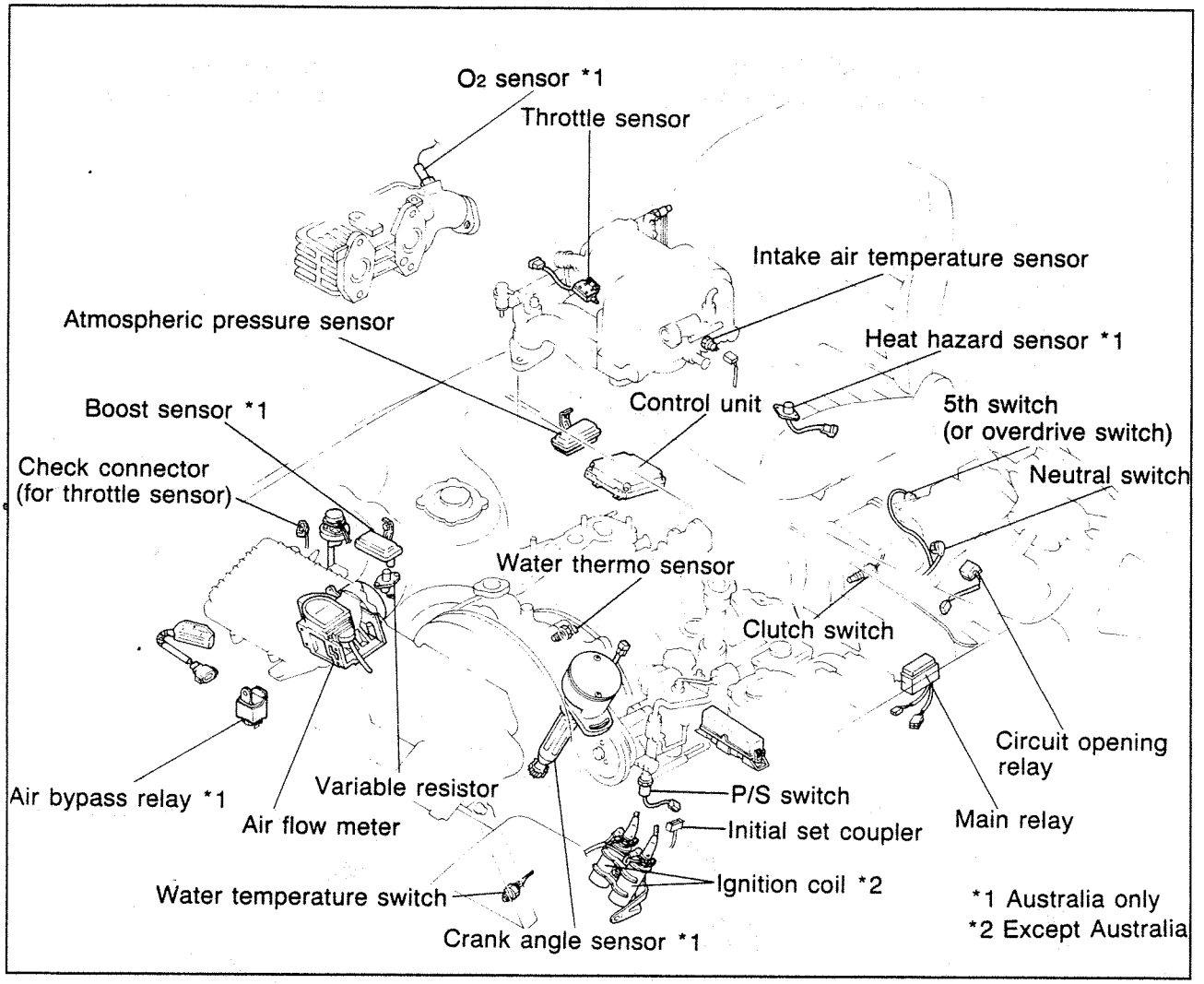


57G04X-532

The pulsation damper absorbs pulsation sounds caused by operation of the injectors and sounds of the operation of the injectors themselves.

INJECTION CONTROL SYSTEM

This system consists of input sensor, switches and control unit.



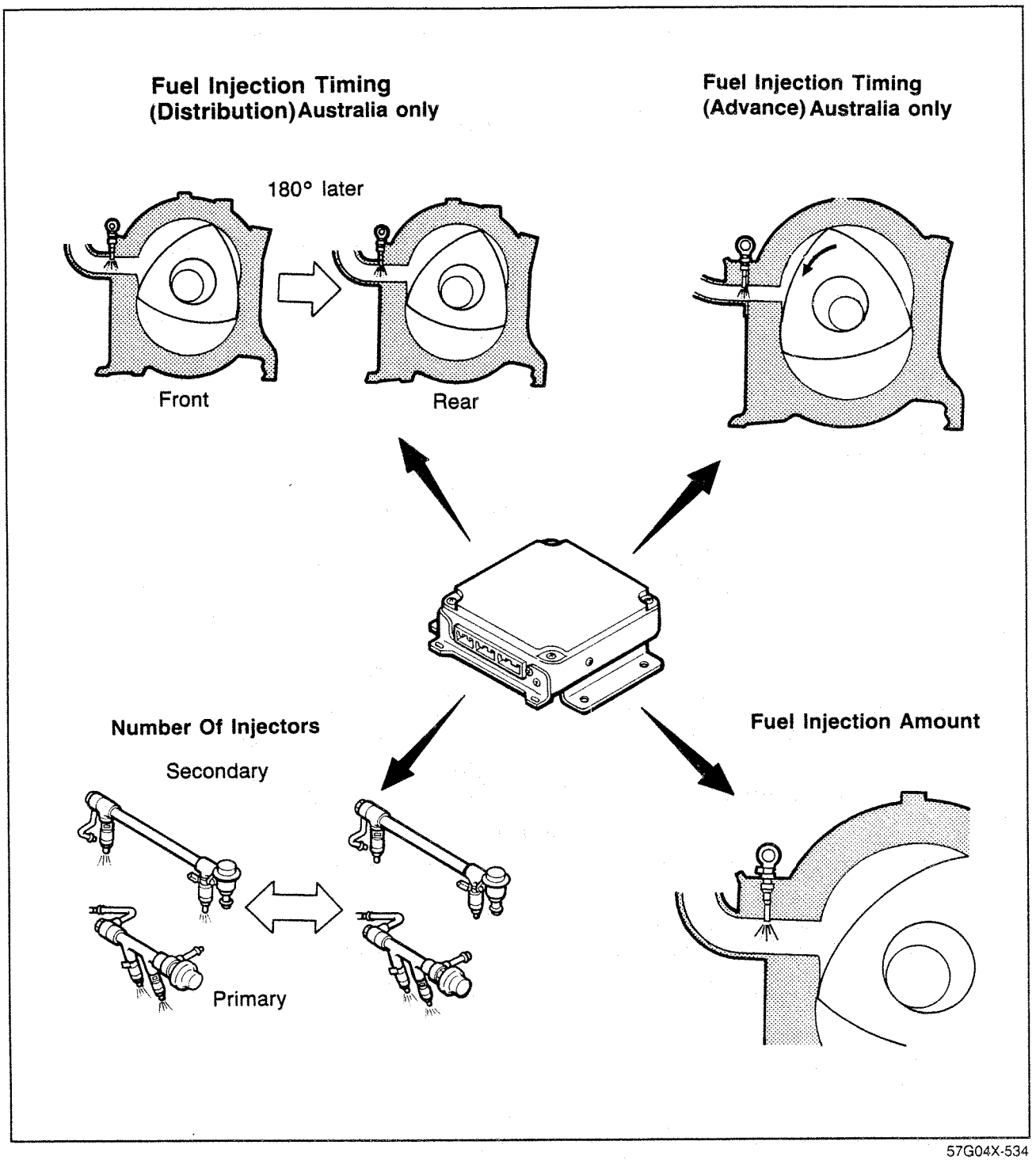
57G04X-533

Input Sensors and Input Switches

The input sensor and input switches perform the following functions:

Sensors and Switches	Detection	Remarks
Air flow meter	Intake air amount	
Water thermo sensor	Engine coolant temperature	Thermistor
Intake air temperature sensor	Intake air temperature	Thermistor
Atmospheric pressure sensor	Atmospheric pressure	
Boost sensor (Australia only)	Intake manifold vacuum	
Water temperature switch	Radiator coolant temperature	15°C (59°F) and more: ON
Clutch switch	In-gear condition	When clutch pedal is depressed: ON
Neutral switch	In-gear condition	Neutral position: ON
Throttle sensor	Throttle valve opening angle	Primary throttle valve
O_2 sensor (Australia only)	Exhaust gas O_2 concentration	
Starter switch	Engine start condition	Engine start: ON
A/C switch	A/C load condition	When air conditioner ON
Inhibitor switch	D range load condition	N or P Range: ON

Control Unit



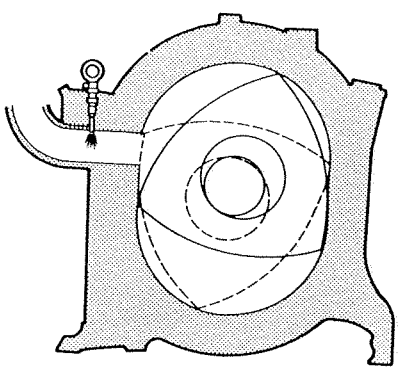
57G04X-534

The control function for the E.G.I. system performed within the control unit are described below:

1. **Fuel injection distribution (Australia only)**
   Fuel is injected separately to the front and the rear rotors.
2. **Fuel injection timing (Australia only)**
   Fuel injection timing advances according to engine speed.
3. **Number of injectors**
   Either two or four injectors are in operation, depending on engine operating conditions.
4. **Fuel injection amount**
   The most suitable fuel injection amount is determined based on engine operating conditions.

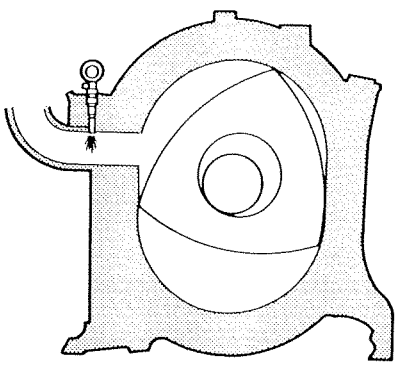
Fuel injection timing (Distribution)

Except Australia

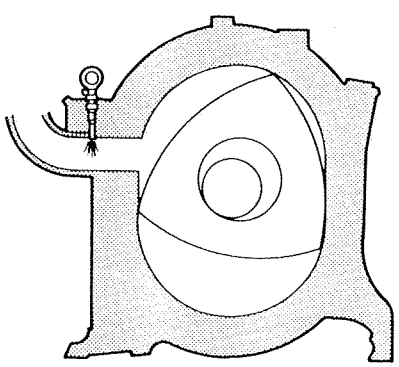


Simultaneous front/rear injection

Australia



Front



Rear

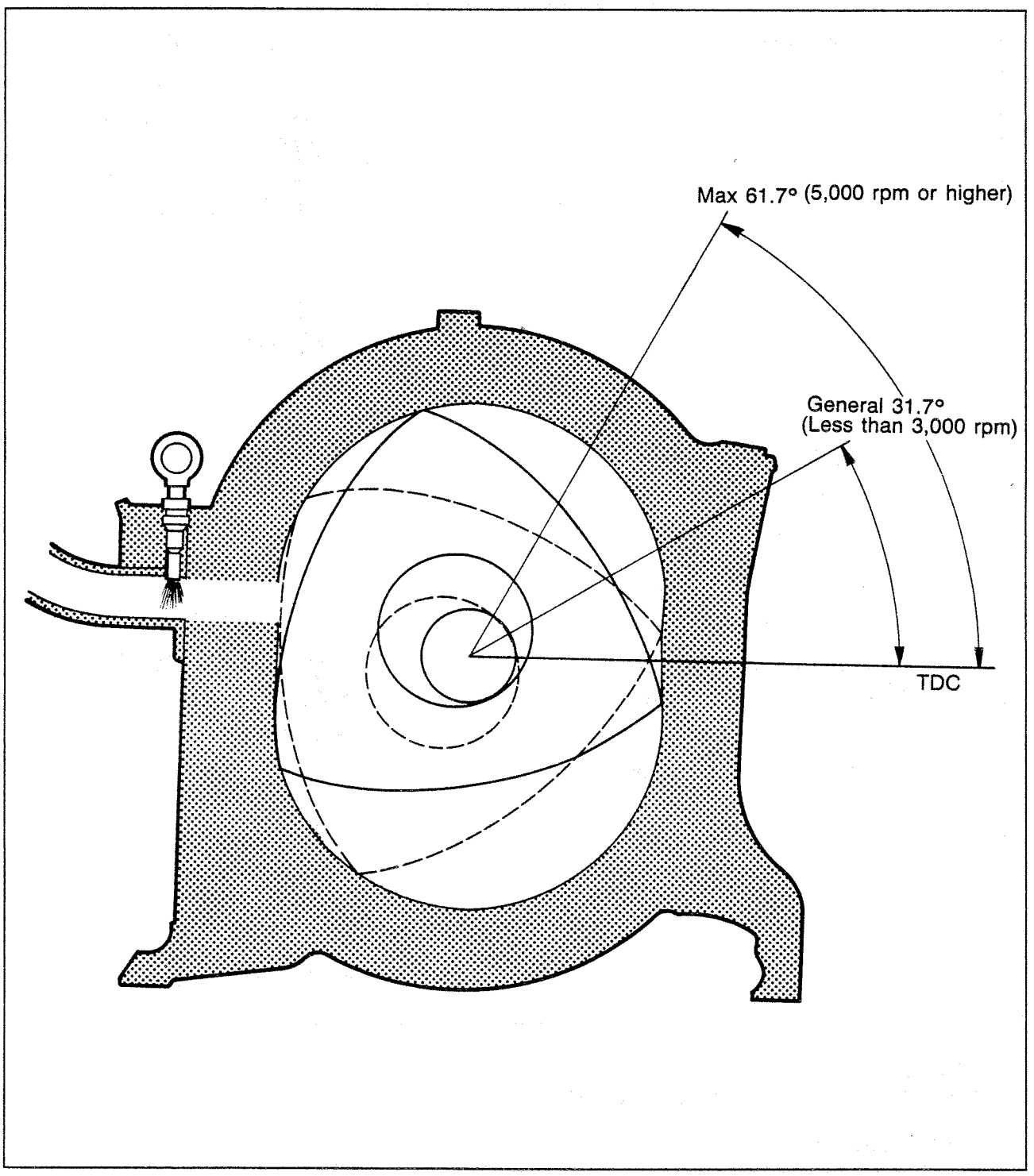
Non-simultaneous front/rear injection

57G04X-535

Australia:
The fuel and rear injectors inject separately.

Except Australia:
The front and rear injectors inject at the same time.

Fuel injection timing (Advance) —Australia only—

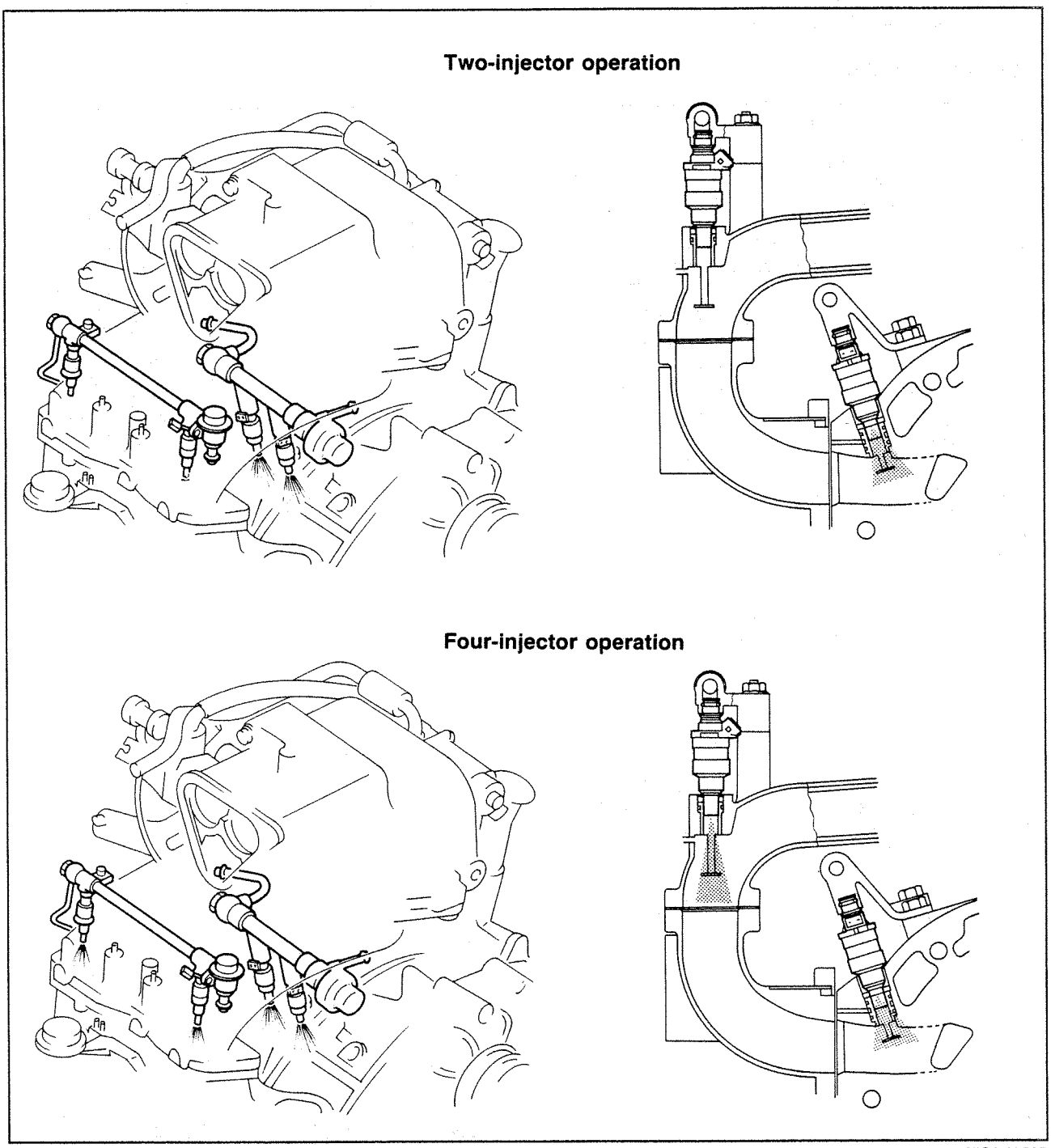


57G04X-536

The fuel injection timing is varied according to the engine speed.

- At an engine speed of **less than 3,000 rpm,** fuel injection occurs at **95°BTDC (rotor angle: 31.7°).**
- At **5,000 rpm or higher,** fuel injection occurs at **185°BTDC (rotor angle: 61.7°)**.
- At **3,000 rpm to 5,000 rpm,** fuel injection occurs within a range of **95°BTDC (rotor angle: 31.7°) and 185°BTDC (rotor angle: 61.7°)**.

Multiple injector operation



57G04X-537

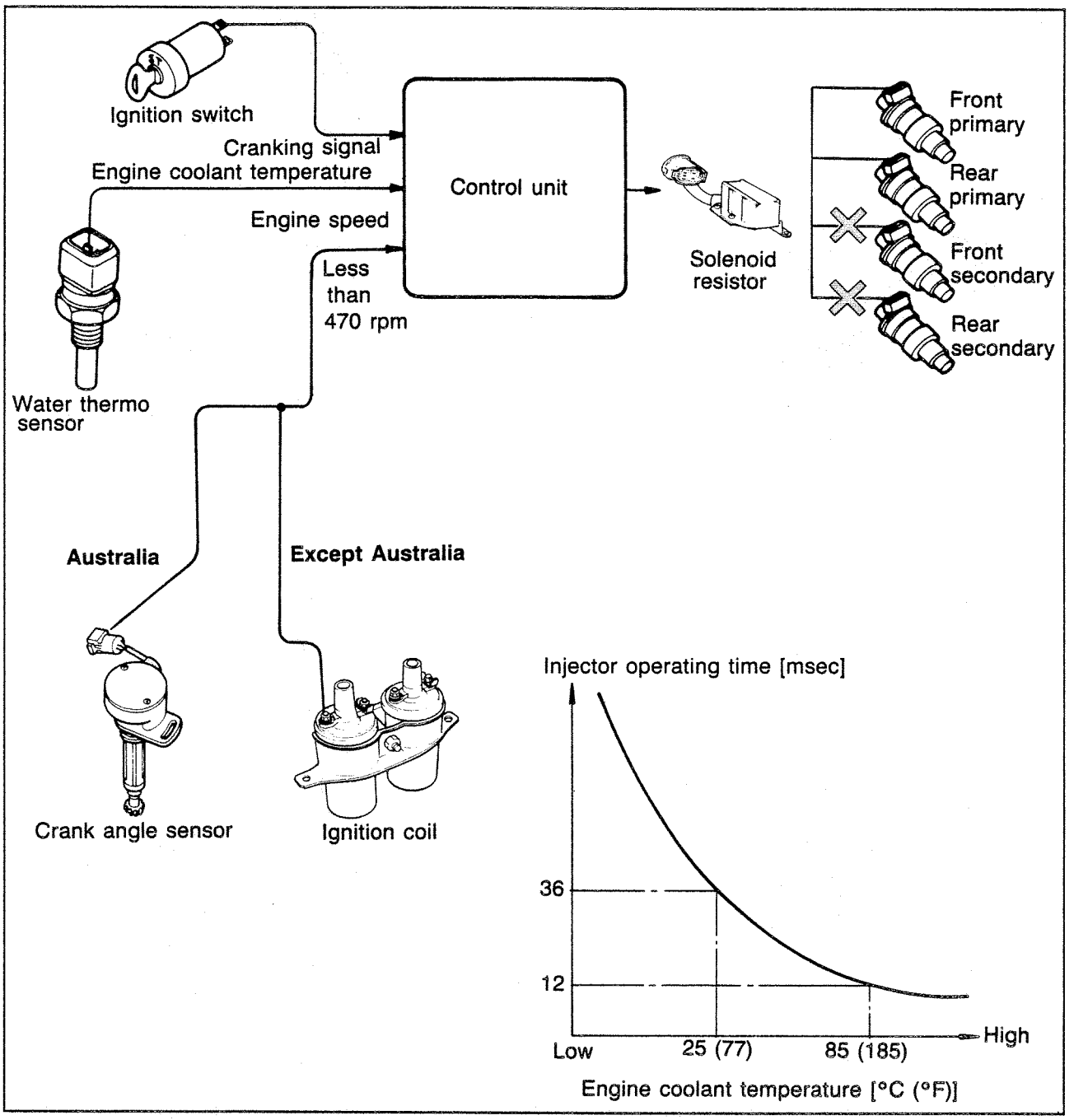
The number of injectors used is controlled according to the engine operating conditions. During 4-injector operation, there is injection at the secondary side in addition to primary injection.

Operation

Injectors	Operation condition	Remarks
4	Engine Speed: 3,688 — 8,000 rpm Intake manifold vacuum: 0~90 mmHg (0~3.5 inHg)	Primary & Secondary Injection
2	Other than as above	Primary Injection

Fuel injection amount
Injection characteristics are basically classified into two groups, one is "cranking", and the other is "running" including at idling.

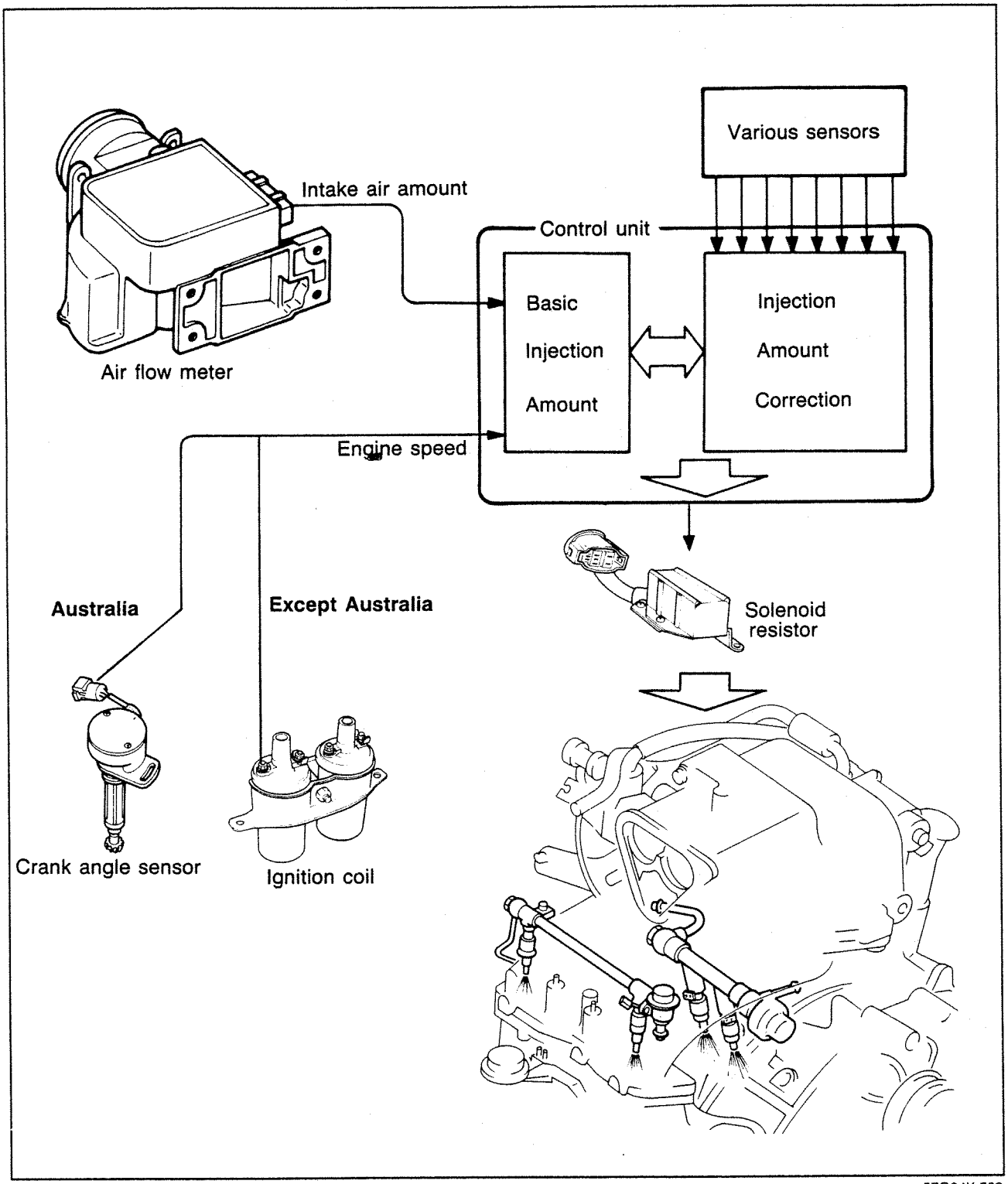
During cranking



57G04X-538

The control unit regulates fuel injection by the cranking signals, the engine coolant temperature signal and the engine-speed signal.
When the ignition key is at the ST position and the engine speed is approx. 500 rpm or less, the EGI control unit judges that the engine is in the cranking condition, and fuel is continuously injected at the preset injection amount according to the engine coolant temperature.

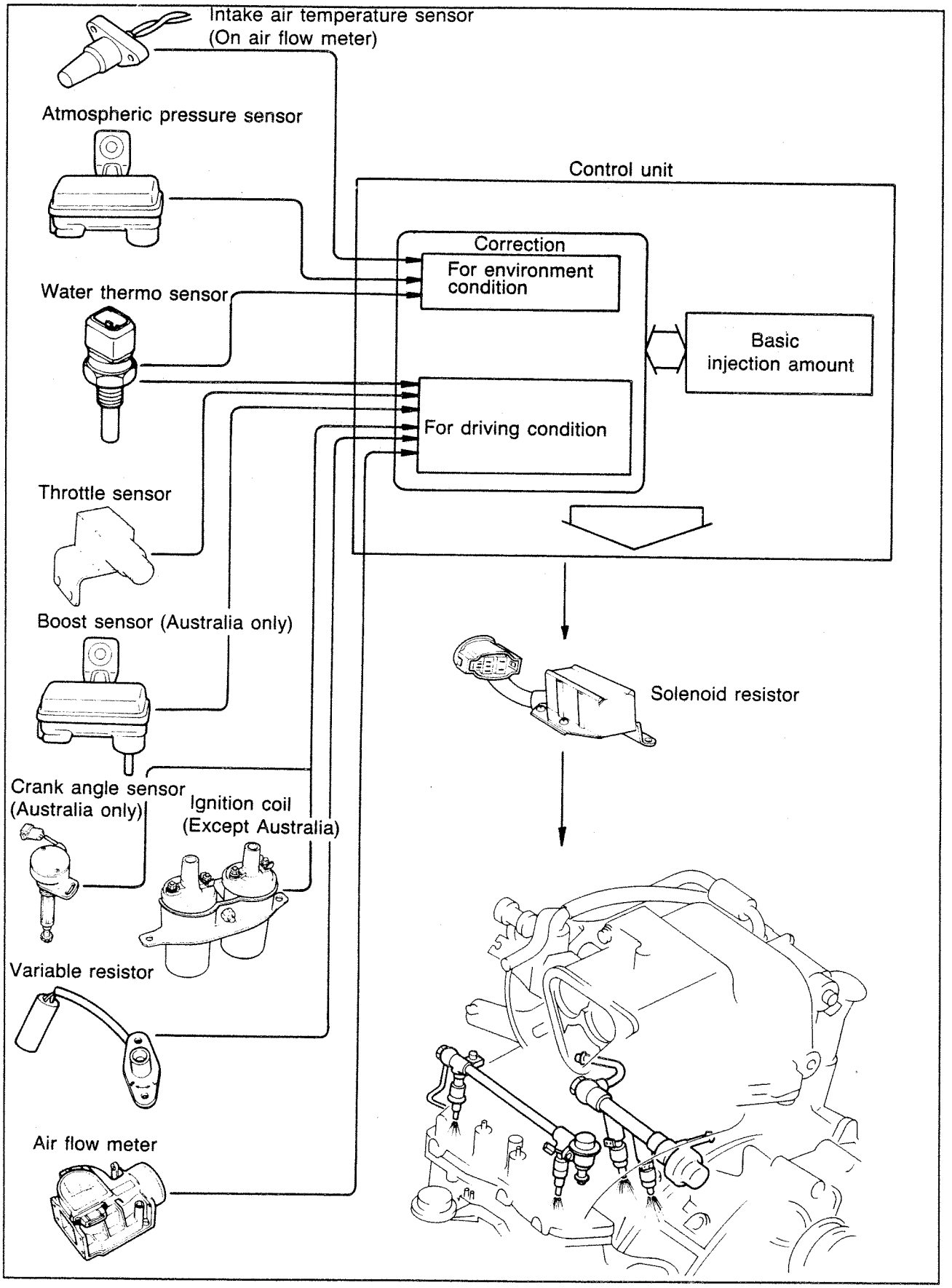
During running



57G04X-539

The control unit receives electrical signals from the air flow meter (intake air amount) and crank angle sensor/ignition coil (engine speed), and calculates how much fuel is required.
The control unit then sends an electrical signal to the injectors of the proper amount of time to supply the correct amount of fuel.

Injection amount correction



57G04X-540

Corrections for environment conditions

Correction	Purpose	Function	Sensors
Air concentration correction	To correct variations of the A/F mixture (A/F = 14.7) caused by changes in air density.	The reference standard intake air temperature is specified to be 20°C (68°F). At higher than 20°C (68°F): reduced amount At lower than 20°C (68°F): increased amount	Intake air temperature sensor (Air flow meter)
High altitude correction	To prevent over-rich A/F mixture (A/F-14.7) at high altitudes	At higher than 760 mmHg (29.9 inHg): increased amount At lower than 760 mmHg (29.9 inHg): reduced amount	Atmospheric pressure sensor
Battery voltage correction	To prevent injector operation delay by voltage changes	Unavailable injection time as battery voltage increase in shortened.	Battery
Warm up amount increase	To maintain driving stability during cold weather	To engine coolant temperature if engine coolant temperature is 65°C (149°F) or below.	Water thermo sensor

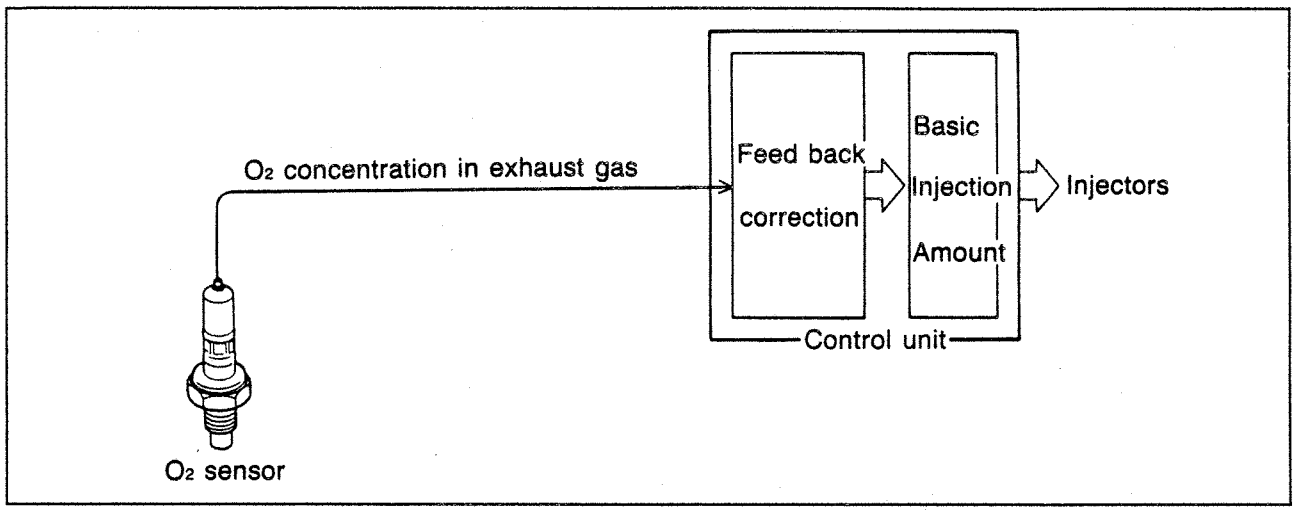
57G04X-541

Corrections for driving conditions

Correction	Purpose	function	Sensors
Acceleration amount increase	To improve response during acceleration	Amount increased during acceleration	Throttle sensor Air flow meter
Air/fuel ratio amount increase	To maintain idling stability and combustion increase	Amount increased/decreased according to changes of resistance of variable resistor. Amount increase according	Variable resistor
Amount increase immediately after starting	To prevent engine stall after starting, and to maintain idling stability. Fast warm-up of converter. (Australia only)	During start: increased amount also increased amount after starting (cold and hot conditions only)	Water thermo sensor
Feedback correction*1 (Australia only)	To reduce CO and HC emissions (Feedback system)	Increased/decreased amount repeated so as to obtain A/F = 14.7	O_2 sensor
Deceleration decrease	To prevent vehicle "bucking" during deceleration. To prevent abnormal temperature increase inside converter (Australia only) (deceleration control system)	Fuel cut at front and rear, or front only	Throttle sensor Crank angle sensor (Australia only) Boost sensor (Australia only) Ignition coil (Except Australia)
Idling increase	To maintain idling stability	Amount increase during idling	
Light load increase	To improve driveability	Amount increase	
Low speed increase	To improve driveability		
High speed increase	To improve driveability To prevent abnormal temperature increase inside converter (Australia only)		
Output increase	To increase output		
General increase	To improve driveability (when feedback correction is stopped)		
A/T model correction (Only A/T)	To prevent engine stall caused by D load (cold condition)	Amount increase	Water thermo sensor Inhibitor switch

57G04X-542

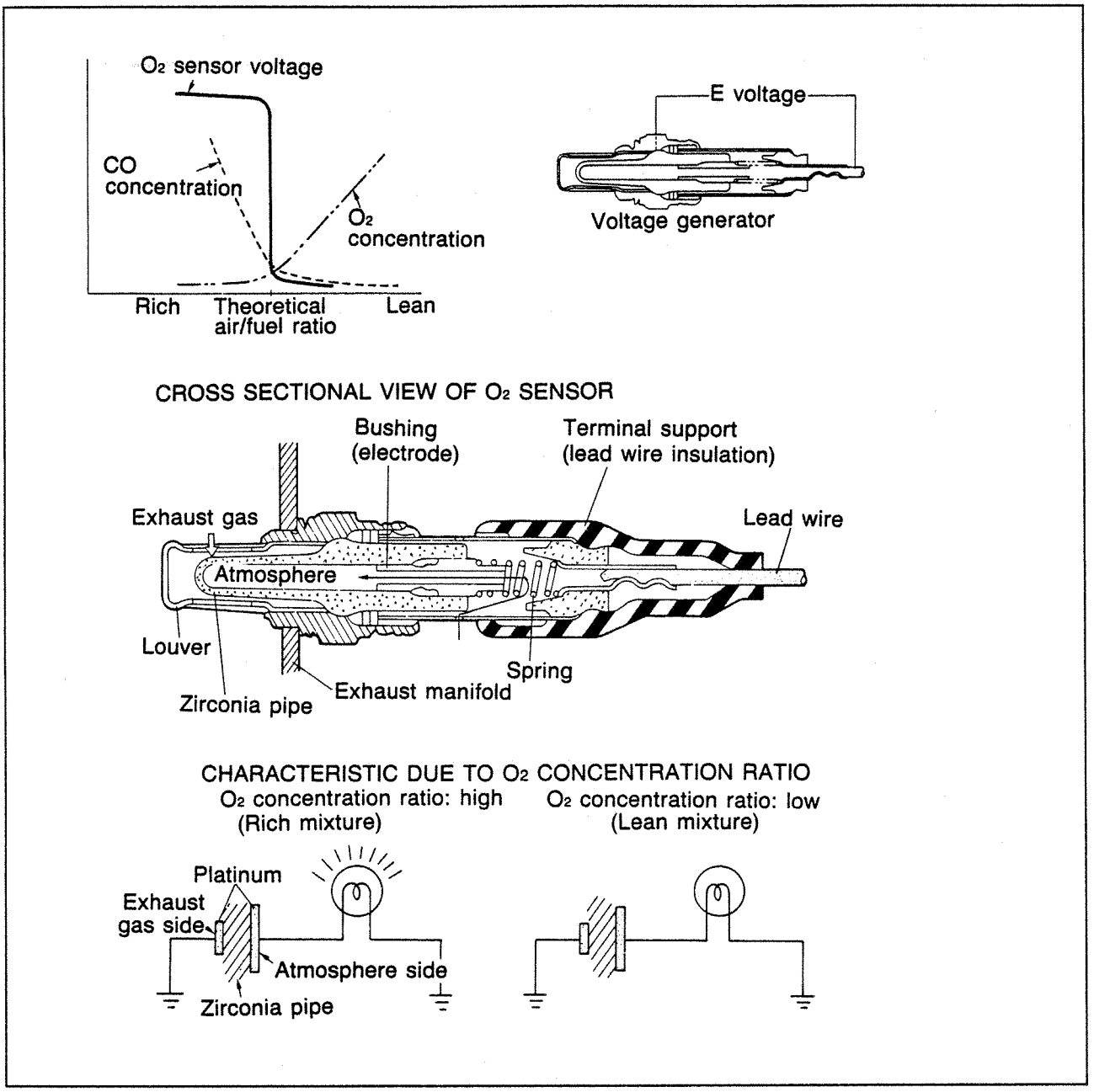
***1 Feedback correction (Austraiia only)**



57G04X-543

The feedback correction is made independently of the other corrections mentioned on the previous pages. The O2 sensor, installed at the lower part of the reactive exhaust manifold, functions to detect the O2 concentration in the exhaust gas, and sends signals to the control unit.
The control unit determines, from these signals, whether the air/fuel mixture is rich or lean, and whether to increase or decrease the injection amount, and performs overall control based on the theoretical air/fuel ratio of **14.7.** The objective is to use the catalytic converter at the highest level of efficiency to reduce CO, HC and NOx emissions.

O2 sensor (Australia only)

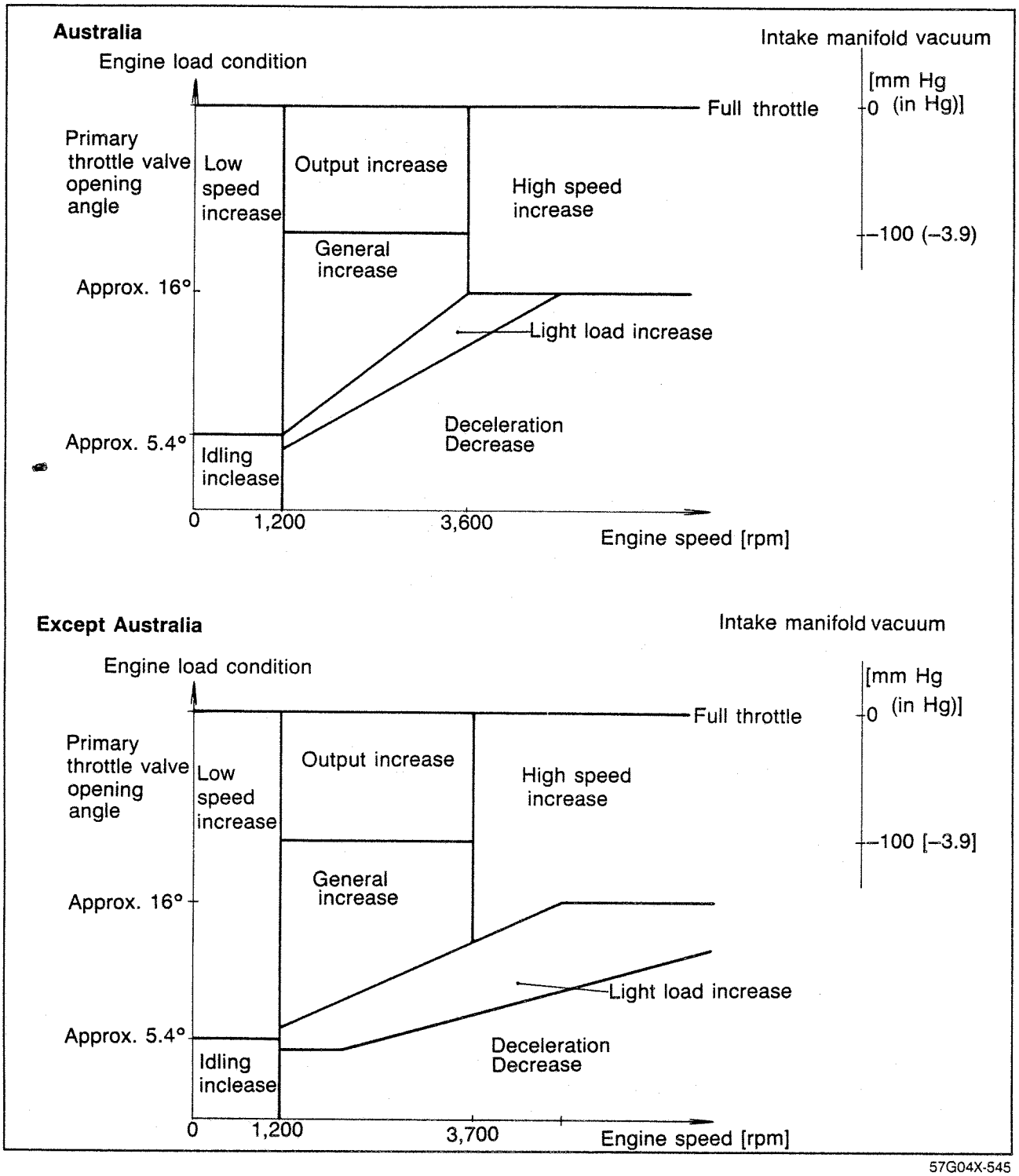


57G04X-544

The O2 sensor is a type of battery cell which generates a small voltage according to the radio of the O2 concentration in the atmosphere to that in the exhaust gas. When the mixed gases are burned at the theoretical air/fuel ratio, the O2 concentration in the exhaust gas causes the voltage of the O2 sensor to change suddenly. At the rich side, the voltage characteristic becomes high, and at the lean side it becomes low.

Consequently when the characteristic of the O2 sensor is a voltage, the control unit judges that the mixture is rich and therefore makes a correction to reduce the injection amount, and, conversely, when the characteristic of the O2 sensor is a low voltage, the control unit judges that the mixture is lean, and therefore makes a correction to increase the injection amount.

REFERENCE NOTE

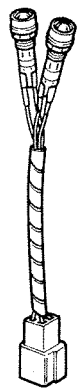


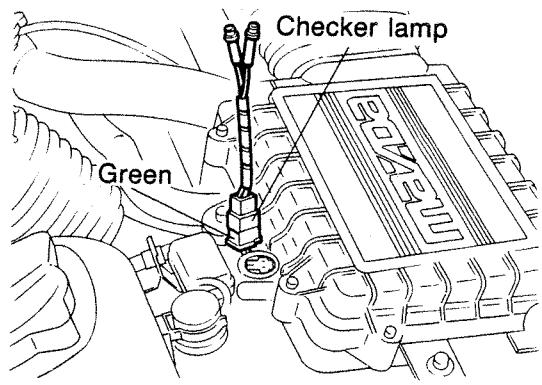
57G04X-545

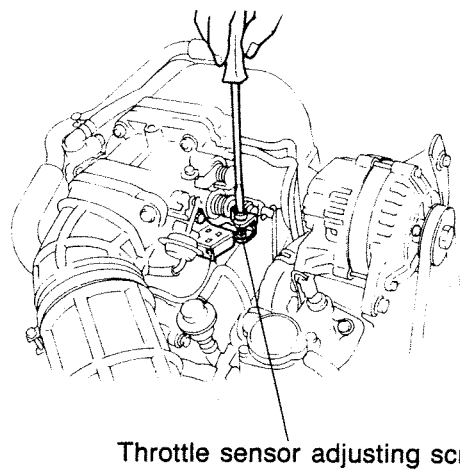
Seven engine operation patterns are programmed in to the memory of the control unit. These patterns are set according to the combinations of signals from the throttle sensor, crank angle sensor (or the ignition coil), the boost sensor, and the air flow meter.
Correction amounts are also determined for these patterns.
During actual driving, the engine operation pattern at constantly monitored by the control unit according to the signals from the various sensors and switches, and in that way a correction which corresponds to the driving pattern is applied to the basic injection amount. These corrections made according to the driving pattern are called "zone corrections".

SERVICE POINT
Adjustment of Throttle Sensor

checker lamp (49 F018 001)







57G04X-546

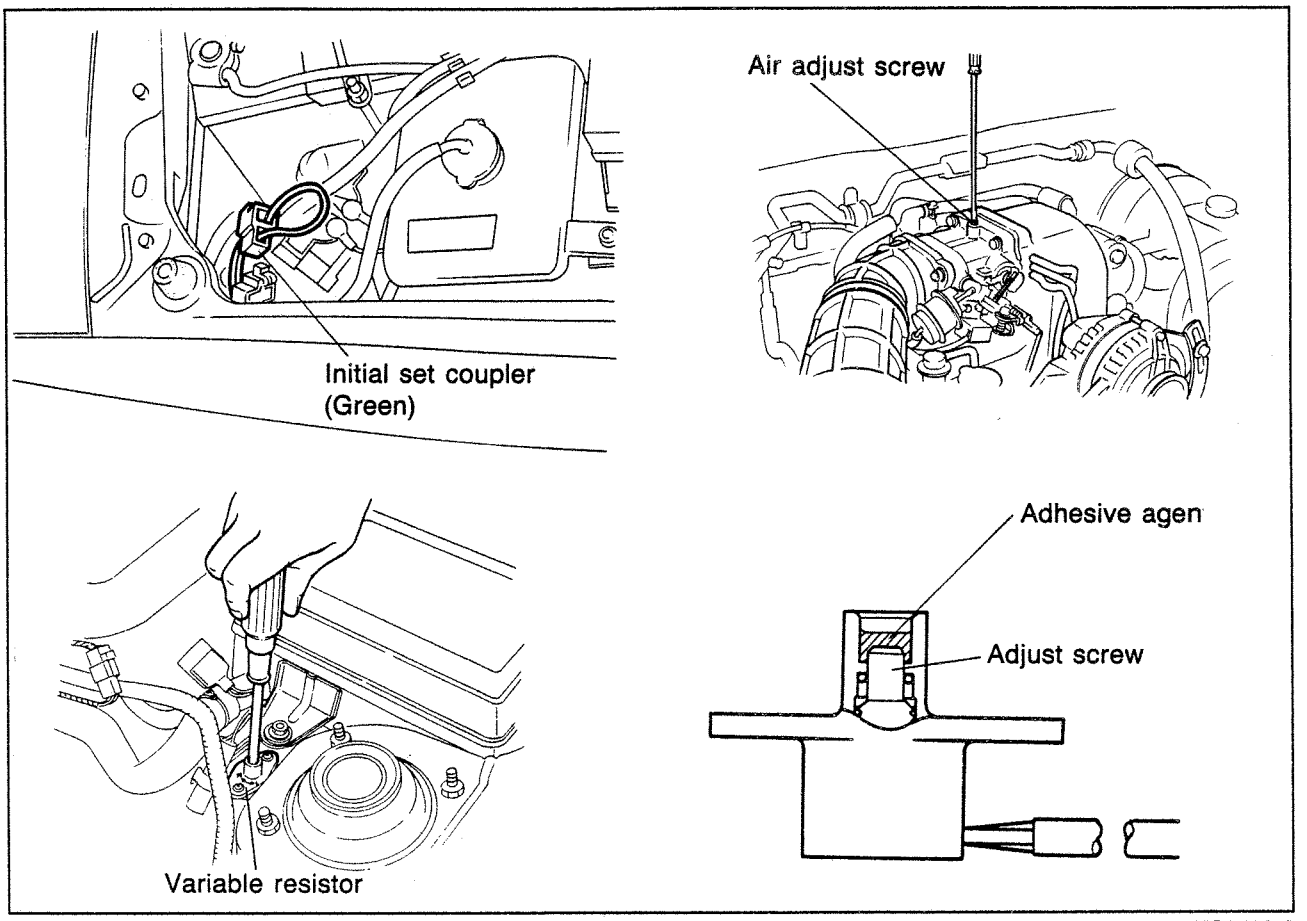
1. Warm up the engine, then stop it.
2. Connect the **checker lamp** (49 F018 001) to the checker connector (Green).
3. Turn the ignition switch "ON" and check whether one of the lamps illuminates.
4. If both lamps illuminate or if neither does, turn the throttle sensor adjusting screw until one of the lamps illuminates.

Condition	Adjustment
both lamps illuminate	Turn the adjusting screw counter-clockwise.
both lamps do not illuminate	Turn the adjusting screw clockwise.

5. Reinstall the cap on the adjusting screw after adjusting.

Note
Do not use excessive pressure on the screw; this may cause incorrect adjustment.

Idle Speed And Idle Mixture
AUSTRALIA



57G04X-547

Before adjustment of the idle speed and idle mixture, warm-up the engine competely. Then, after checking to be sure that the throttle sensor is correctly adjusted, adjust the idle speed and idle mixture.

Note: All electrical loads should be switched OFF.

Idle speed.....

1. Connect a jumper wire to the initial set coupler terminal.
2. Turn the air adjust screw to set the idle speed.
   Idle speed: 725 — 775 rpm
3. 0Disconnect the jumper wire from the initial set coupler terminal.

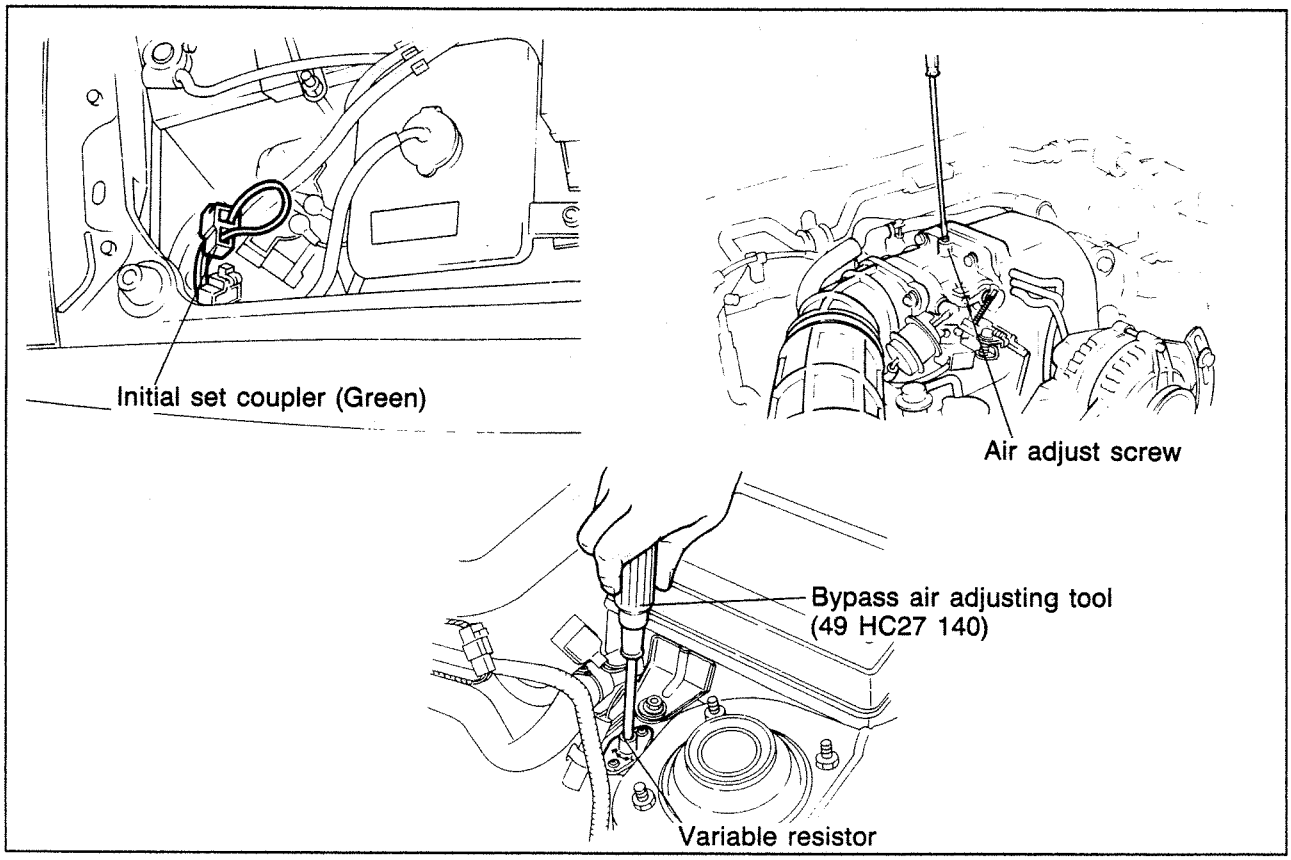
Idle mixture.....

Adjustment of the idle mixture is unnecessary unless the variable resistor has been replaced.

1. Connect a jumper wire to the initial set coupler terminal.
2. Turn the air adjusting screw to set the idle speed to **750 rpm**.
3. Turn the variable resistor and stop at the position where engine speed is the highest.
4. turn the air adjusting screw to set the idle speed back to **750 rpm** once again.
5. Turn the variable resistor screw to the left to reduce the engine speed to **730 rpm**. Then turn the variable resistor screw to the right and stop at the position where the engine speed becomes **750 rpm**.
6. Apply adhesive agent (P/N. N304 23 795) to the variable resistor, and disconnect the jumper wire from the initial set coupler.

CAUTION:
When making the adjustments, do not forget to connect the jumper wire to the initial set coupler terminal.

EXCEPT FOR AUSTRALIA



57G04X-548

Before adjustment of the idle speed and idle mixture, warm-up the engine competely. Then, after checking to be sure that the throttle sensor is correctly adjusted, adjust the idle speed and idle mixture.

Note: All electrical loads should be switched OFF.

Idle speed.....

1. Connect a jumper wire to the initial set coupler terminal.
2. Turn the air adjust screw to set the idle speed.
   Idle speed: 725 — 775 rpm
3. Disconnect the jumper wire from the initial set coupler terminal.

Idle mixture.....

1. Connect a jumper wire to the initial set coupler terminal.
2. Turn the air adjust screw to set the idle speed to **750 rpm**.
3. Turn the variable resistor counter-chockwise and stop at the position where engine speed drops.
4. Turn the variable resistor clockwise gradually until co decreases to **0.1%**.
5. From the position, turn the variable resistor clockwise **45°**.

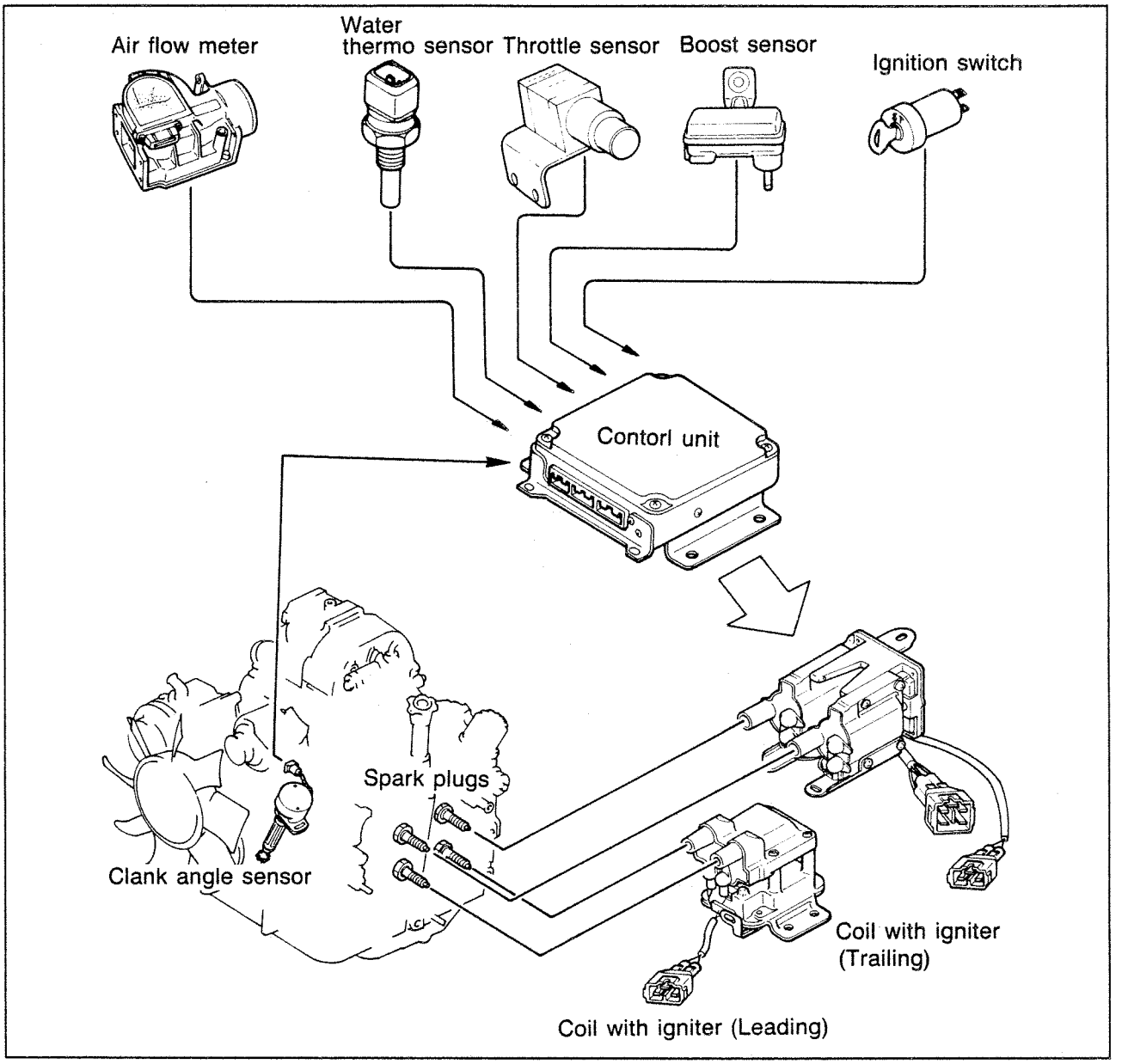
Note:
Use a bypass air adjusting tool.
(49 HC27 140)

6. Reset the idle speed to **750 rpm** by turning air adjust screw.
7. Install the blind cap and disconnect the jumper wire.

CAUTION:
When making the adjustments, don't forget to connect the jumper wire to the initial set coupler terminal.

IGNITION CONTROL SYSTEM

ESA (ELECTRONIC SPARK ADVANCE) SYSTEM (AUSTRALIA)



57G04X-549

- The ESA system consists of the control unit and the coil with igniter.
- Ignition timing is determined within the control unit by signals from the input sensors and the input switches.

NOTE:
The differences between the mechanical-ignition system and the electronic-ignition system are described below:

Item	Mechanical Ignition System	Electronic Ignition System
Distribution	Distributor	Control Unit
Ignition timing (including spark advance)	Vacuum, Centrifugal	Control Unit

Control System
This system consists of input sensors, input switches and a control unit.
Almost all input sensors and input switches are also used with the EGI system.

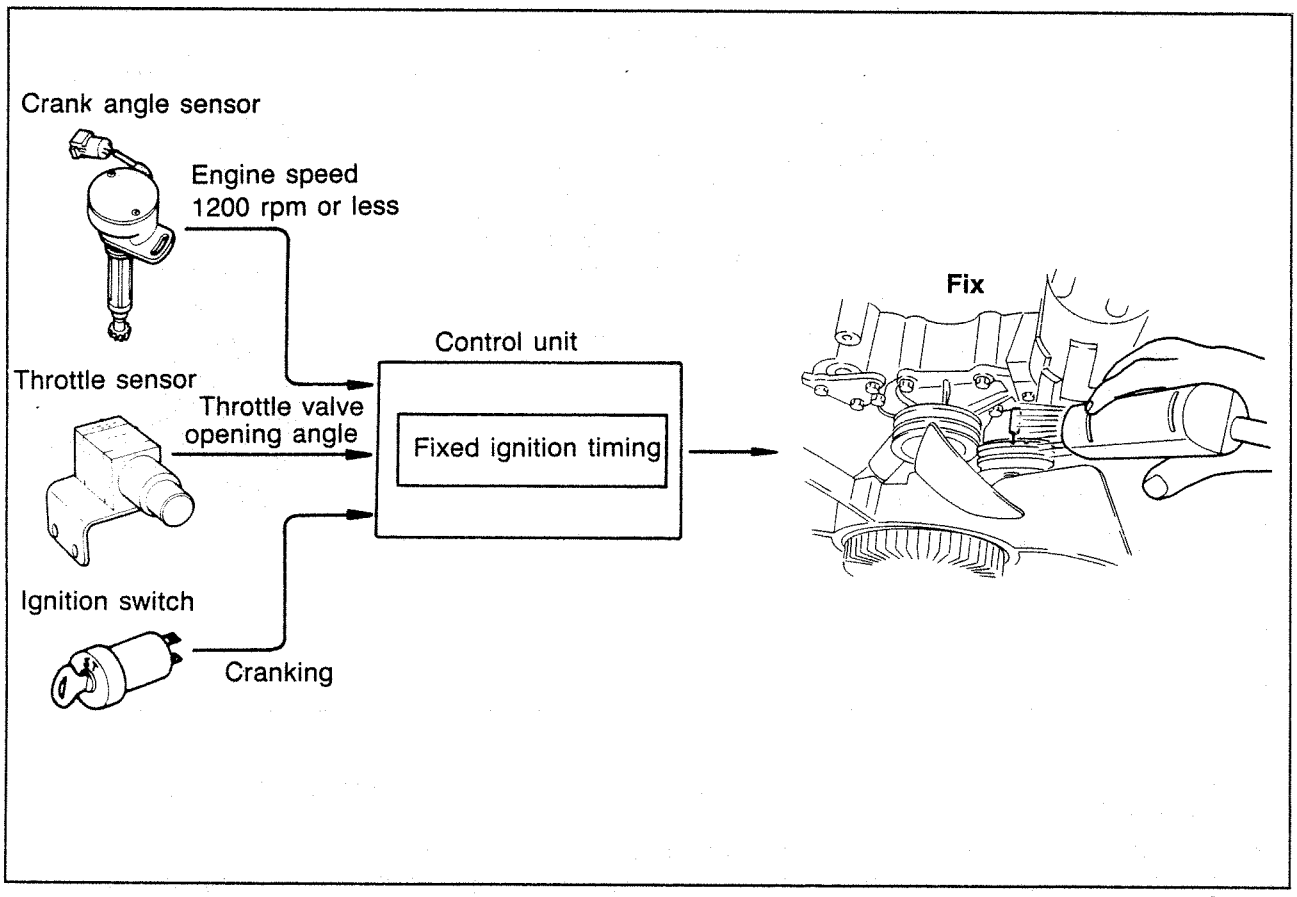
Control unit.....
The control functions of the ESA system which are performed within the control unit are as follows:

1. Ignition timing
The ignition timing which is most suitable according to the engine conditions is determined.

2. Distribution
Distribution occurs on the trailing side only front and rear. The leading coil ignites both front and rear simultaneously.

Ignition timing
There are two types of ignition timing: fixed ignition timing and total spark advance.

(1) Fixed ignition timing

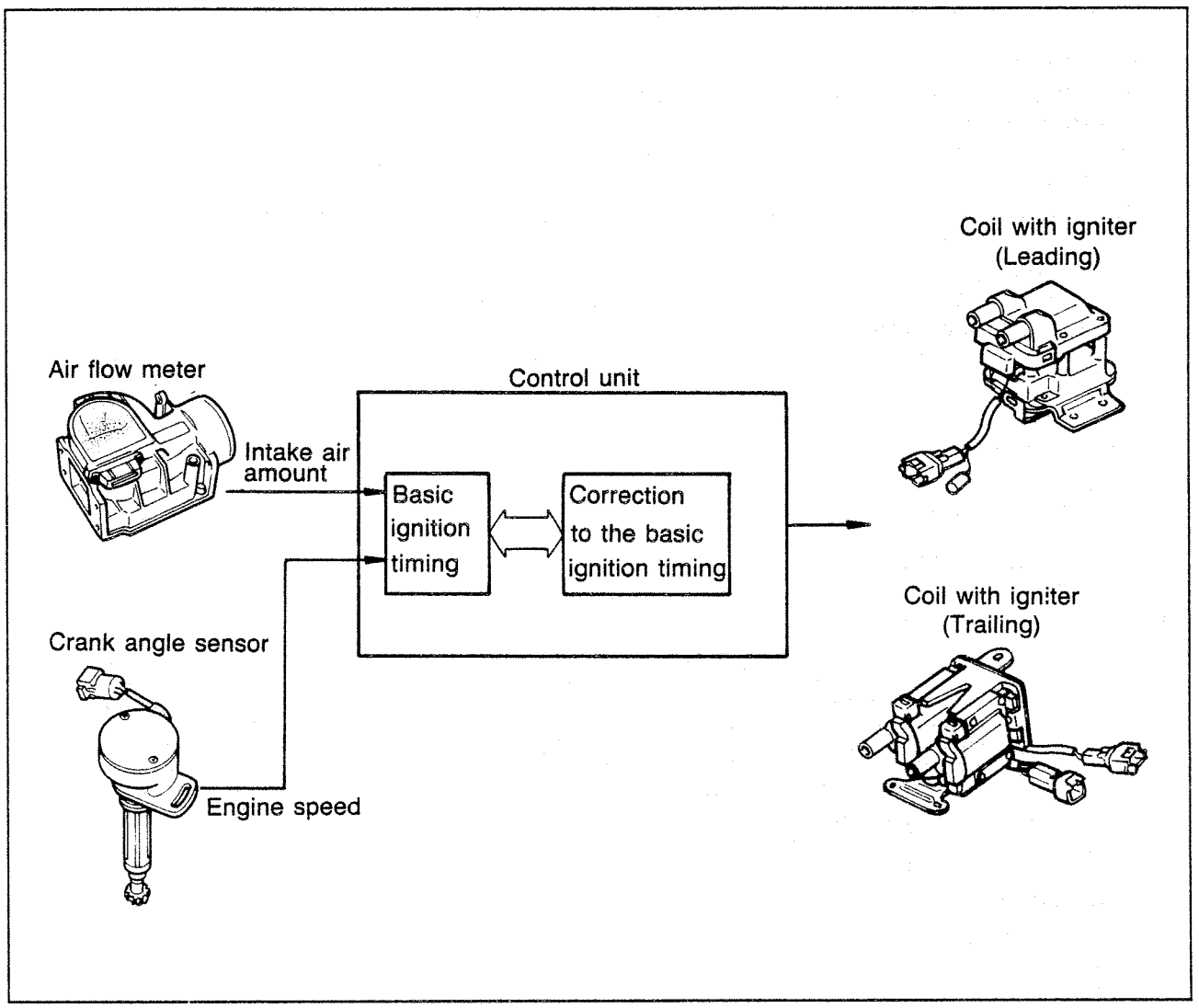


57G04X-550

- This is when the ignition timing is not changed even if there are changes in engine speed and/or load conditions.
- Fixed ignition timing occurs under the following engine conditions:

Engine condition		Ignition timing		Remarks
		Leading (BTDC)	Trailing (BTDC)	
Engine cranking		5°	5°	Crank angle sensor G signal synchronized
Idle	—	–5°	–20°	
	A/C	10°	10°	
	Immediately after N...D	2.5°	–5°	A/T only
	D range	10°	10°	A/T only
	P/S	2.5°	–5°	
Low speed		–5°	–20°	

(2) Total spark advance



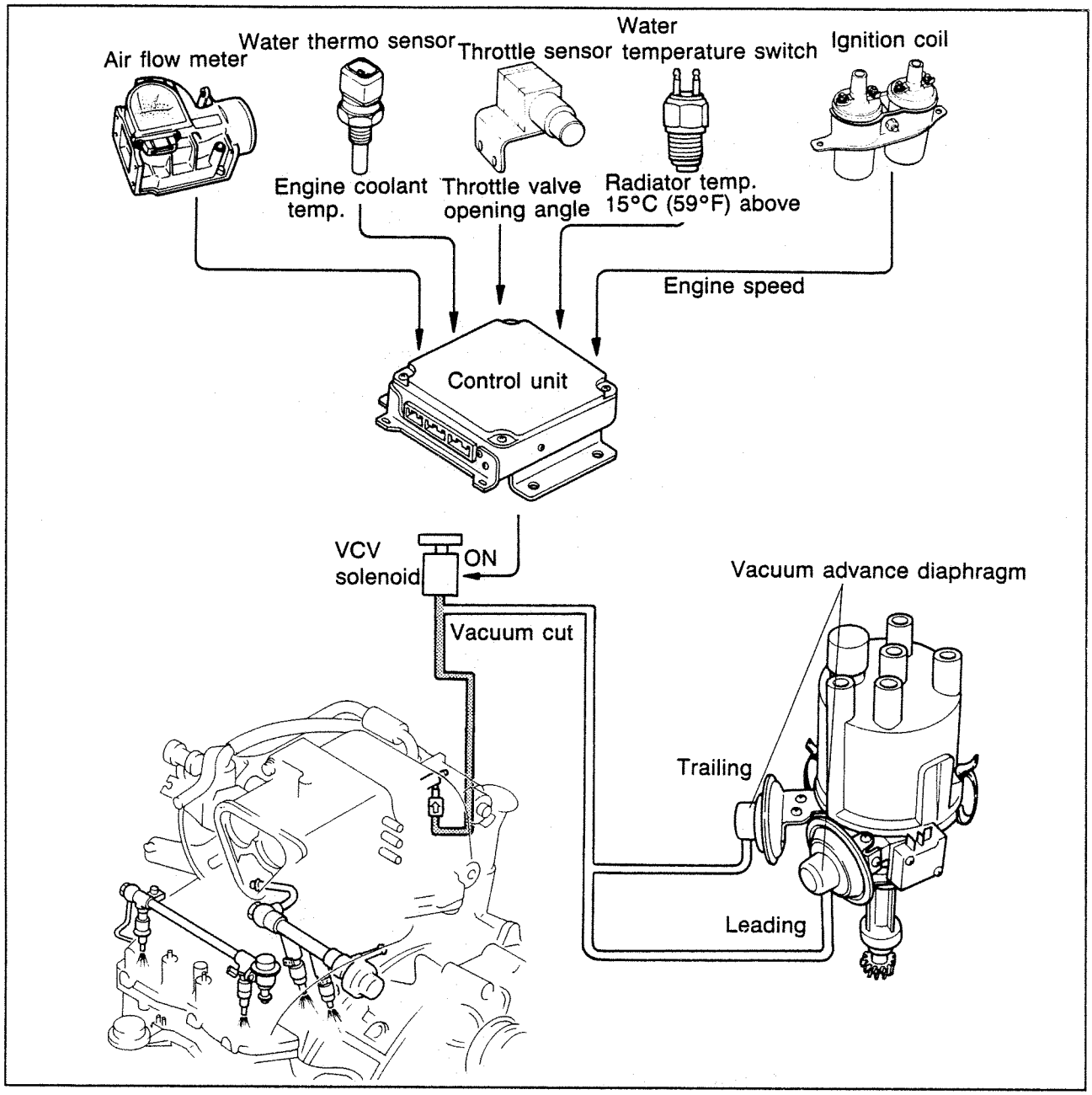
57G04X-551

- This is when the ignition timing is changed to correspond with changes in the engine speed and load conditions.
- Total spark advance is basic ignition timing plus corrections to the basic ignition timing.
- The basic ignition timing is determined by the signals from the crank angle sensor and the air flow meter.
- Correction of basic ignition timing occurs under the following conditions:

Correction	Purpose	Function	Sensors
Spark retard correction immediately after starting (cold condition)	To maintain initial warm-up of the converter	For 120 seconds after cold starting: Spark retard	Water thermo sensor
Spark retard correction during fuel cut	To prevent "bucking" during deceleration	During fuel cut: Spark retard	Throttle sensor Crank angle sensor

Distribution
The front and rear distribution signals are determined based upon the ignition timing signal.

VCV (VACUUM CONTROL VALVE) SYSTEM (EXCEPT AUSTRALIA)



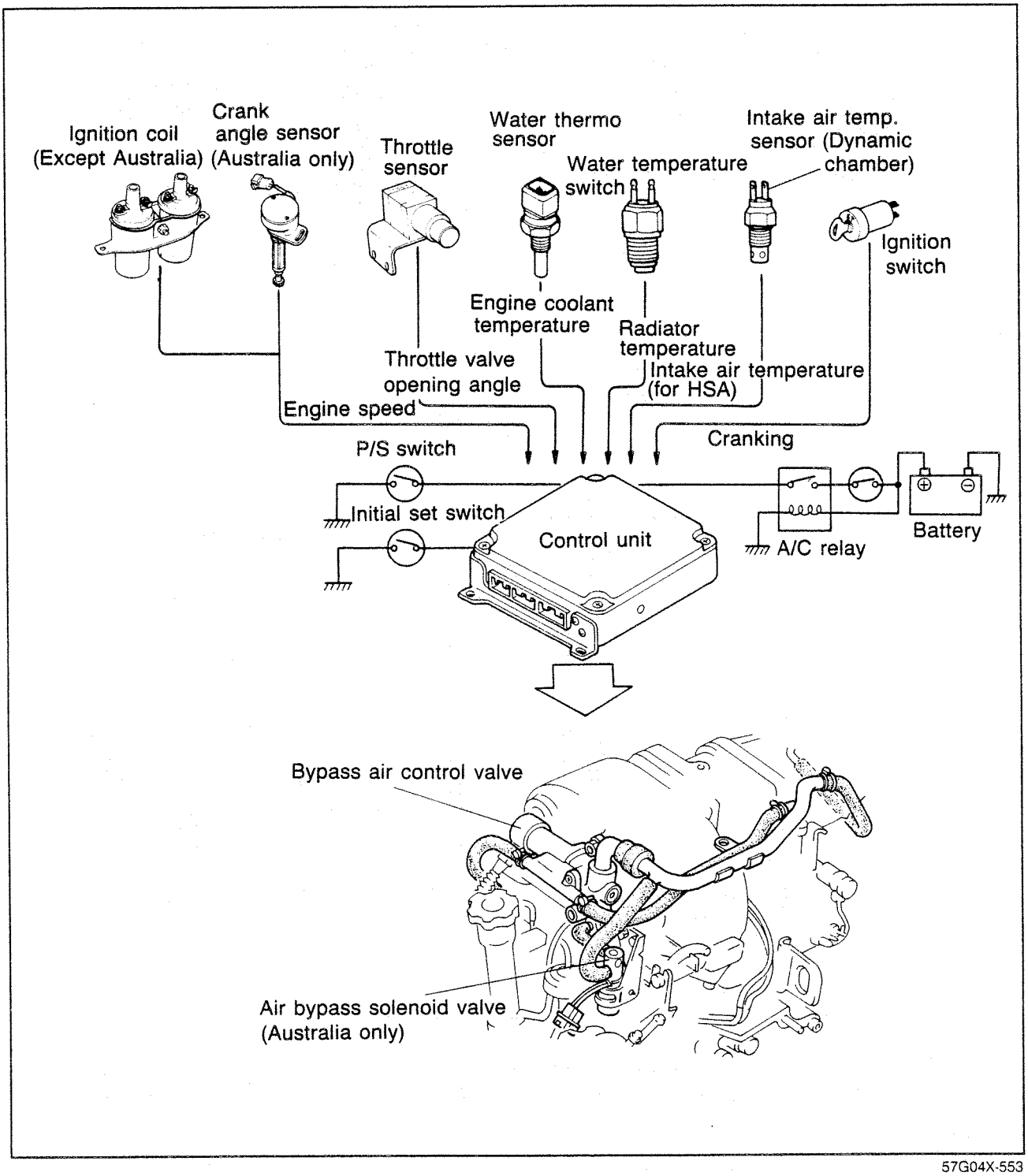
57G04X-552

When the engine is operating in any of the conditions as described below, the intake manifold vacuum applied to the leading/trailing vacuum advance diaphragm is cut off, leaving only the centrifugal advance.

Operation

1. During 0.5 sec from start of acceleration	To prevent knocking
2. During deceleration	To prevent backing
3. Engine speed less than 1,200 rpm	To prevent surging
4. 130 sec after starting engine; Engine coolant temperature: 15 ~ 37°C (59 ~ 98°F) Radiator temperature: above 15°C (59°F) Engine speed: less than 5,000 rpm	To reduce CO and HC emissions (exhaust gas temp. increase)
5. During warming up (No load)	To reduce CO and HC emissions (exhaust gas temp. increase)

BAC (BYPASS AIR CONTROL) SYSTEM



57G04X-553

The BAC system consists of the control system, bypass air control valve and air bypass solenoid valve. The following improvements and changes have been made:

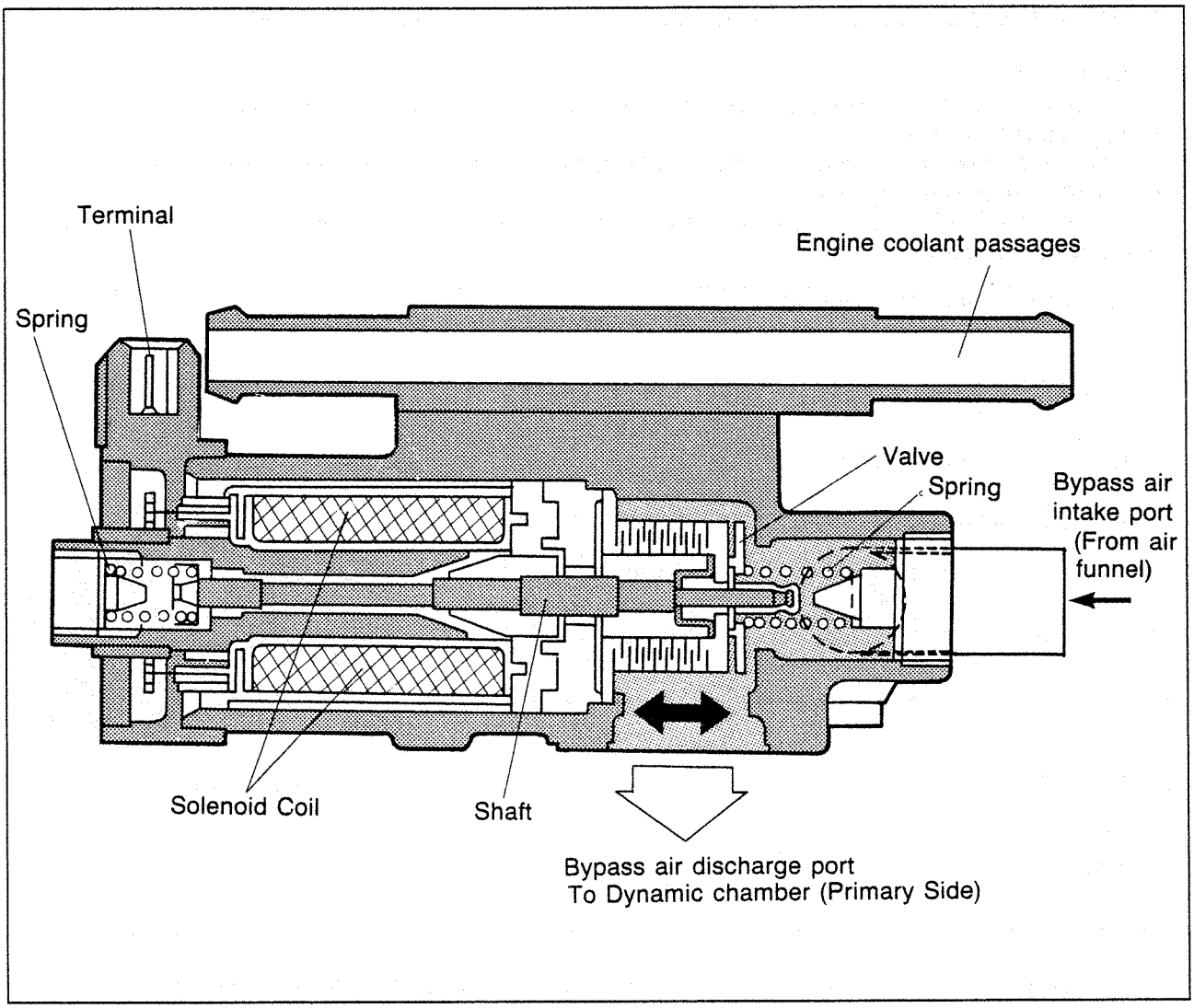
Bypass air control valve

Bypass air is controlled electrically by a single linear-type solenoid and the control unit.

Air bypass solenoid valve

Supplies additional bypass air during cold starting.
Also BAC system operates for idle up.

BAC VALVE



57G04X-554

The bypass air control valve is controlled by duty signal from control unit.

"Duty" is $\frac{\text{Valve opening time (ON)}}{\text{Valve closing time (OFF)} + \text{Valve opening time (ON)}} \times 100(\%)$;

The amount of bypass air amount increases as the duty value becomes greater.

Operation

- When no signal is sent to the valve from the control unit, the valve is closed by spring force. As a result, no bypass air is sent to the dynamic chamber.
- When the ON signal is sent to the valve from the control unit, the shaft is pulled by an electromagnetic force generated around the solenoid coil, and the valve is opened. As a result, bypass air is then sent to the dynamic chamber.

NOTE:
An engine coolant passage is provided in the bypass air control valve for the following reasons:
(1) To prevent valve icing
(2) To maintain a constant fixed solenoid coil temperature

BAC CONTROL SYSTEM

- This system consists of the input sensors, input switches and control unit.
- Almost all of the input sensors and input switches are also used in the EGI system.

Control Unit

The control functions of the BAC system performed in the control unit are as follows:

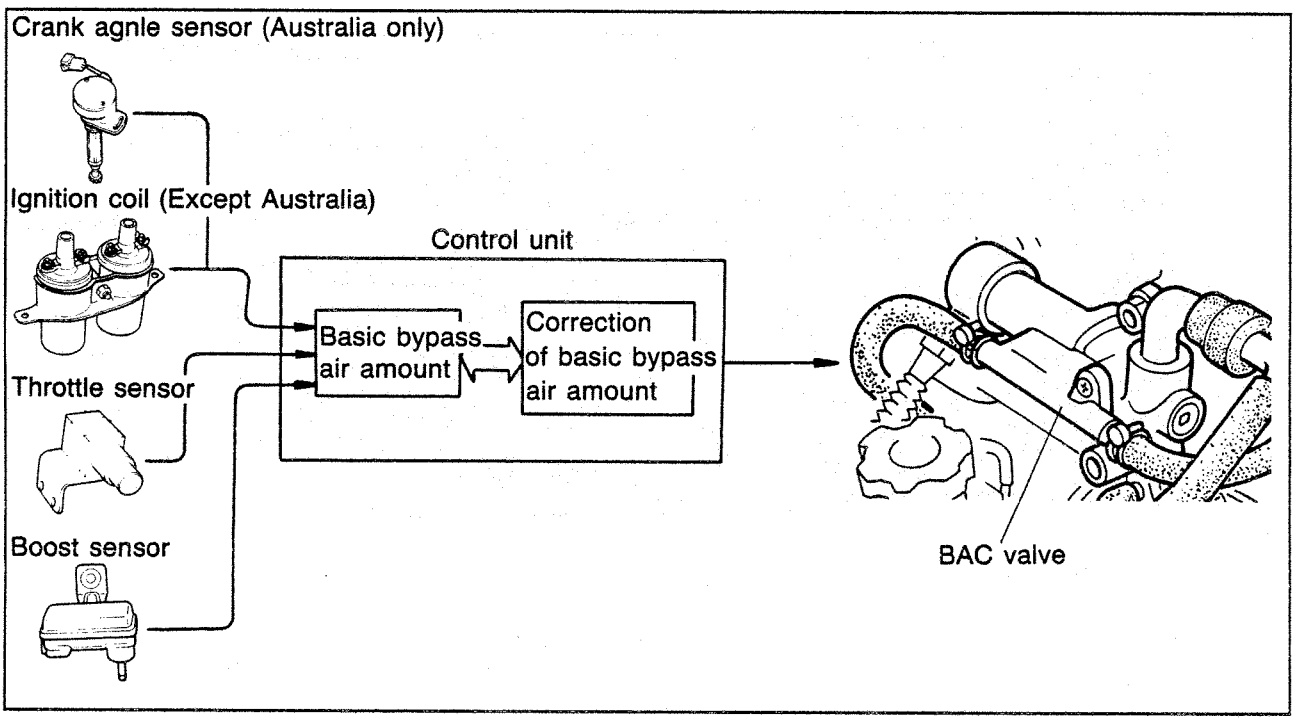
1. Bypass air amount

Determines the most suitable amount of bypass air in accordance with engine conditions.

2. Control of engine speed

The engine RPM is maintained at a constant speed for a smooth, stabilized idle.

Bypass air amount

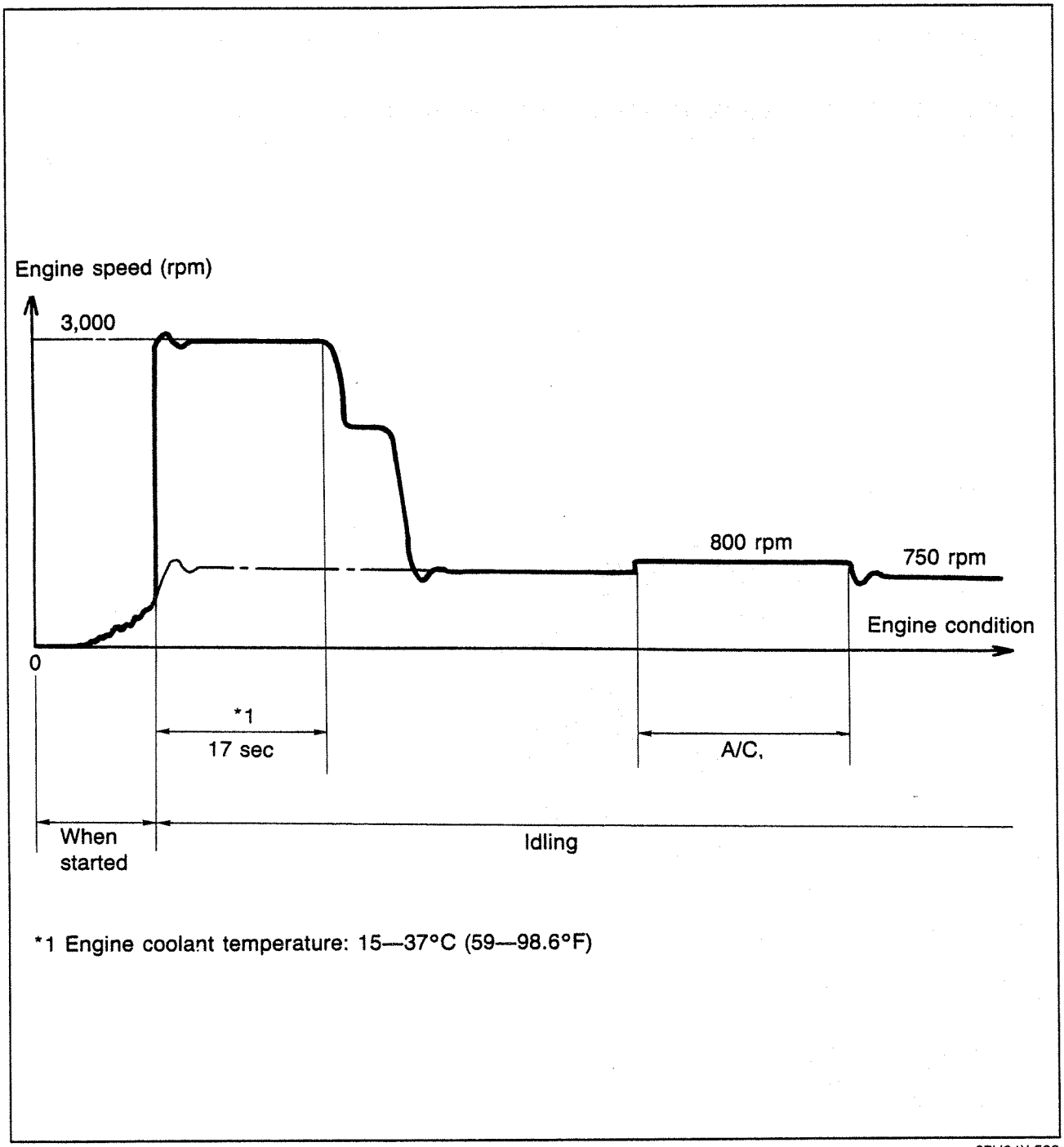


57G04X-555

- The bypass air amount consists of the basic bypass air amount and the correction of the bypass air amount.
- The basic bypass air amount is determined by signals from the crank angle sensor (or ignition coil), throttle sensor and boost sensor.
- The correction to the basic bypass air amount is determined by the following:

Correction	Purpose	Function	Sensor
Intake air temperature correction	Corrects reduction of bypass air volume by air density changes.	Dynamic chamber internal temperature 70°C (158°F) or higher: increased amount	Intake air temperature sensor (Dynamic chamber)
Coolant temperature correction	Corrects changes of bypass air amount relative to changes of solenoid coil resistance value.	Engine coolant temperature: Less than 85°C (185°F): reduced amount 85°C (185°F) or higher: increased amount	Water thermo sensor
Battery voltage correction	To correct the changes of the bypass air amount relative to changes of battery voltage	Less than 14V: increased amount 14V or higher: reduced amount	Battery
A/C, P/S, A/T correction	To correct the bypass air amount for increased idling speed	When A/C, P/S in D range: volume increase	A/C switch P/S switch Inhibitor switch

ENGINE SPEED CONTROL



*1 Engine coolant temperature: 15—37°C (59—98.6°F)

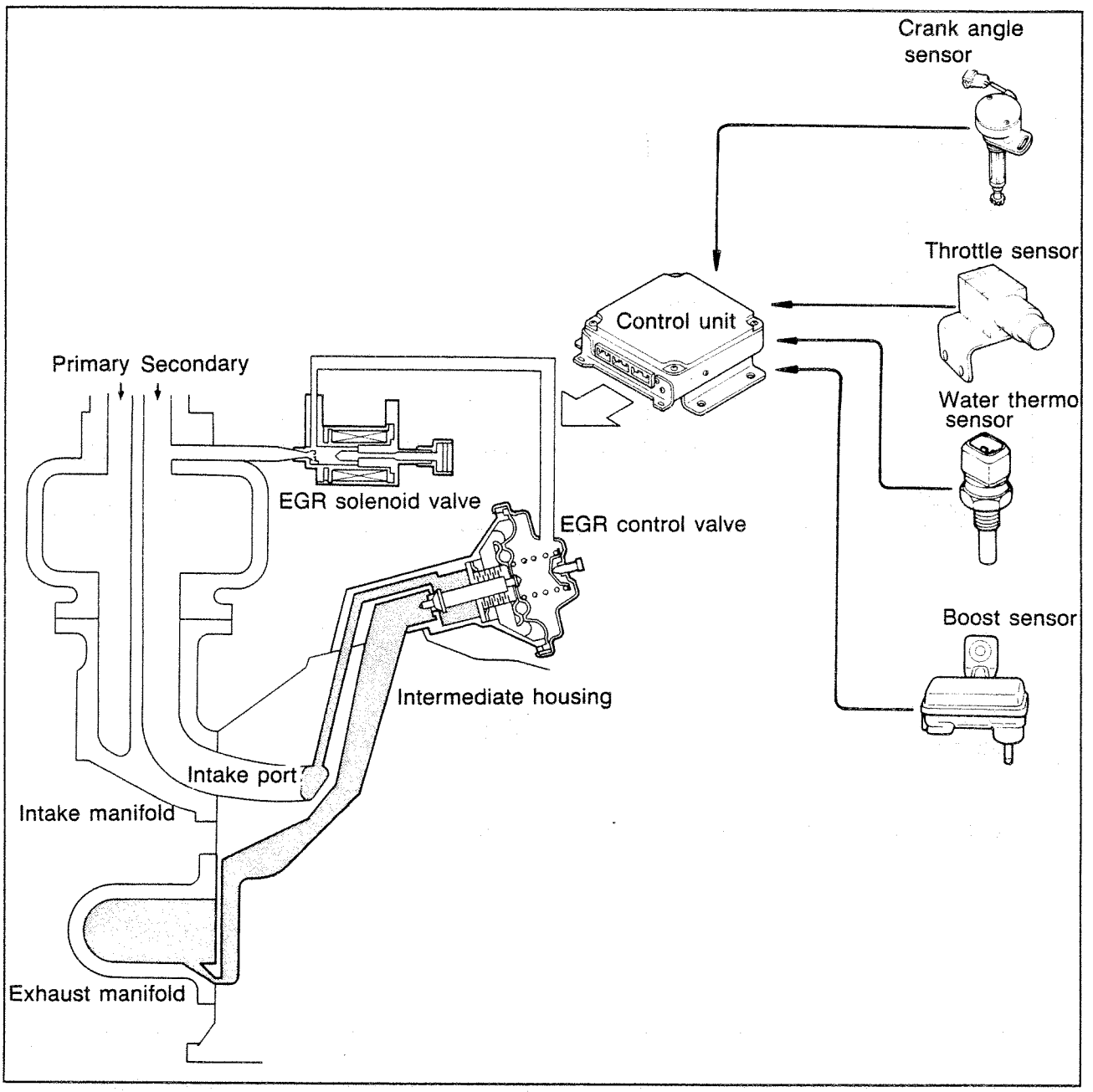
67U04X-532

The amount of bypass air is increased for 17 seconds after a cold start as shown above.

EMISSION CONTROL SYSTEM

This system consists of EGR (Exhaust Gas Recirculation) system, Main converter and secondary air injection system.

EGR (EXHAUST GAS RECIRCULATION) SYSTEM (AUSTRALIA ONLY)



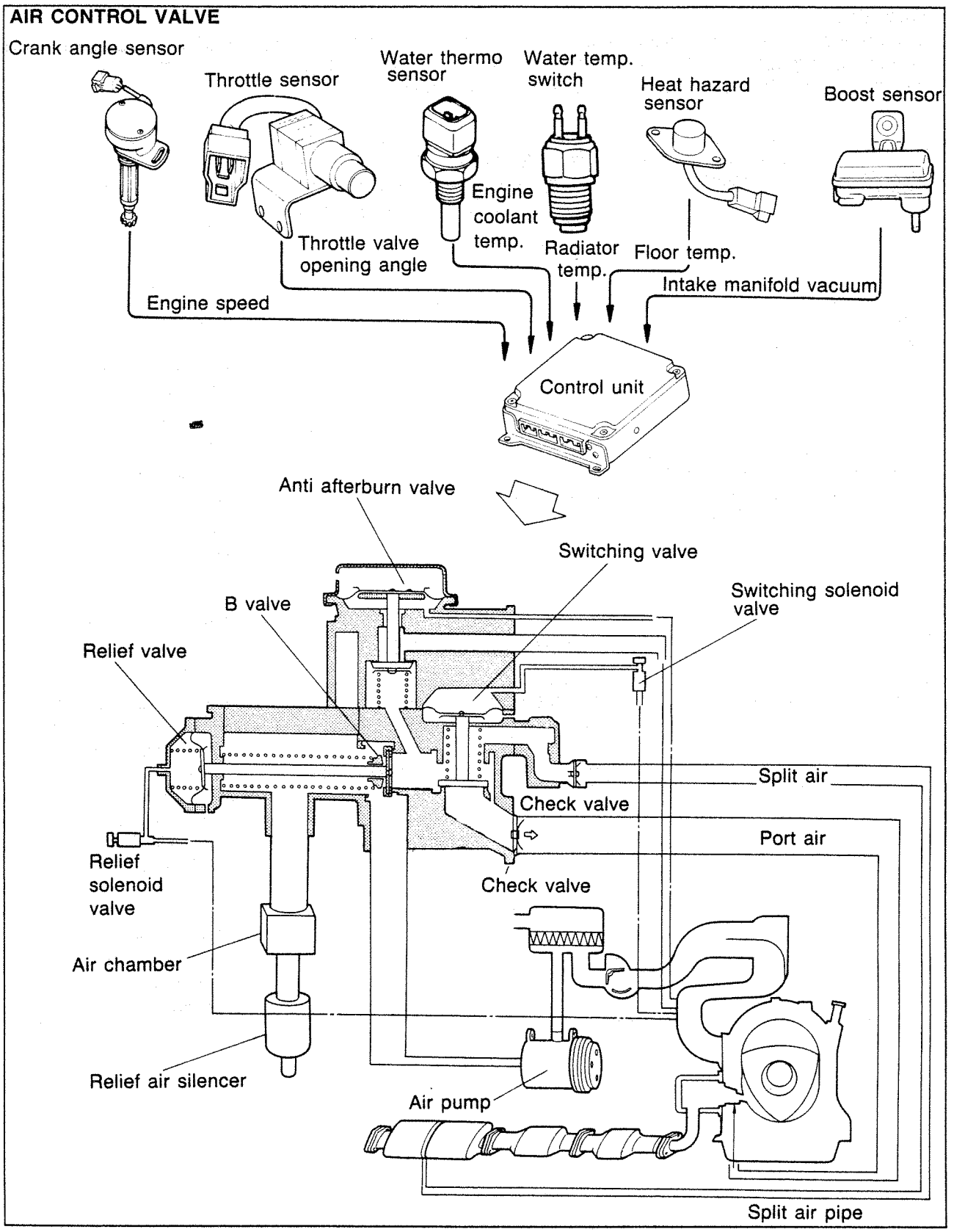
57G04X-556

This system consists of the EGR valve, three-way solenoid valve, and the control unit.
The exhaust gas recirculation (EGR) system lowers the combustion temperature and thereby reduces NOx emissions.

Operation

The EGR system operates under the following engine conditions:
- Engine Coolant temperature: **above 65°C (149°F)**
- Engine Speed: **1700 - 3600 rpm**
- Intake manifold vacuum **below 659 mmHg (25.9 inHg)** (Except during deceleration)

SECONDARY AIR INJECTION CONTROL SYSTEM (AUSTRALIA ONLY)



57G04X-557

This system consists of an air control valve (ACV), three-way solenoid valve, air pump, air chamber, air silencer and control unit.

Air Control Valve

Operation

The engine operating conditions and environmental conditions are monitored by the control unit according to signals from the various sensors and switches. A signal for the supply of secondary air which matches these conditions is sent to the air control valve.

<table>
<tr><th rowspan="3">Engine condition</th><th rowspan="3">Water temperature 15°C (59°F) or lower</th><th colspan="2">Water temperature 15C° (59C°) or higher</th><th rowspan="3">Remark</th></tr>
<tr><th colspan="2">Engine coolant temperature:</th></tr>
<tr><th>50°C or lower</th><th>50°C or higher</th></tr>
<tr><td>Idle</td><td colspan="3">Port air</td><td>• Reduces CO and HC emissions.
• Maintains idling stability</td></tr>
<tr><td>Deceler-ation</td><td colspan="3">Port air</td><td>• Reduces CO and HC emissions.
• Prevents bucking.
• Prevents abnormal increase of temperature within con-verter</td></tr>
<tr><td>Low speed</td><td colspan="3">For 8 seconds after low speed: port air, 8 seconds later: air relief
Intake manifold vacuum: less than 673 mmHg (26.5 inHg)</td><td>• Reduces CO and HC emissions.</td></tr>
<tr><td>Light load</td><td>Air Relief</td><td colspan="2">Port air
(Engine speed: less than 3,700 rpm)</td><td>(Extremely cold engine)
• Prevents abnormal increase of temperature within con-verter.
(Cold engine, Warm engine)
• Reduces CO and HC emissions.</td></tr>
<tr><td>General</td><td>Air Relief</td><td>For 120 seconds after general: port air
120 seconds later: air relief</td><td>For 120 seconds after general: split air*1
120 seconds later: air relief
(Engine speed: 1,200 - 3,600 rpm)</td><td>(Extremely cold engine)
• Prevents abnormal increase of temperature within con-verter.
(Cold engine)
• Prevents drop of tempera-ture within converter.
• Reduces CO and HC emissions.
(Warm engine)
• Prevents drop of tempera-ture within converter.
• Reduces CO, HC and NOX emissions.</td></tr>
</table>

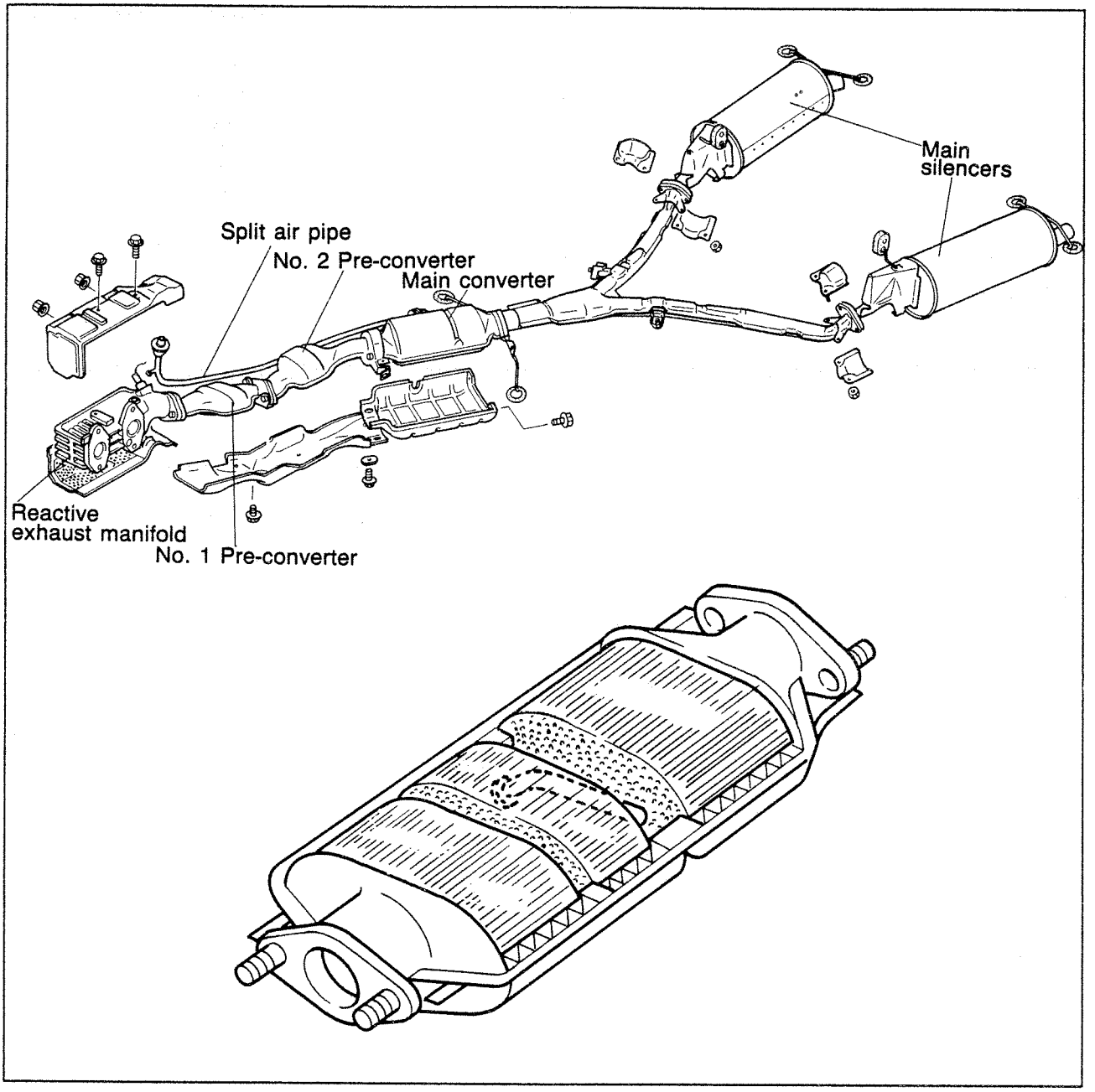
57G04X-558

Output increase	Air Relief	For 120 seconds after heavy level: split air 120 seconds later: air relief	(Extremely cold engine) • Prevents abnormal increase of temperature within converter. (Cold engine, Warm engine) • Prevents drop of within converter.
	(Intake manifold vacuum: 673 - 732 mmHg (26.5 - 28.8 inHg))		
Others	Air relief		Prevents abnormal increase of temperature within converter.

*1: port air, however, at throttle opening of 10.2° or less.

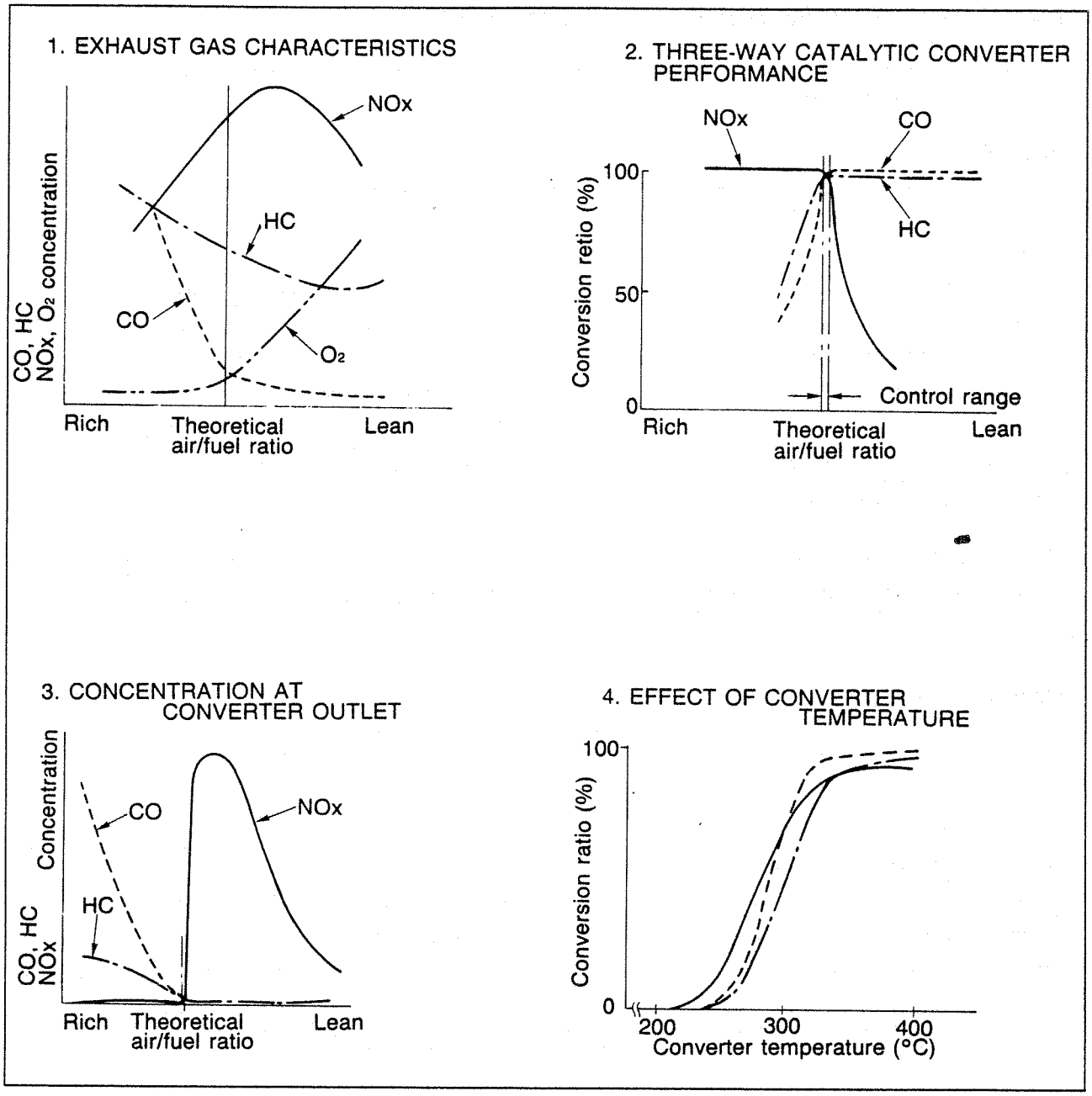
Note
If heat hazard sensor is ON (floor temperature: more than 110°C (230°F)): air relief under all operating conditions.

CATALYTIC CONVERTER (AUSTRALIA ONLY)



57G04X-559

A catalytic converter has been installed toward the rear of the exhaust pipe in order to reduce CO, HC and NOx exhaust emissions.
Catalytic converters can be broadly classified into one of two types: the oxidizing converter and the reduction converter. In the oxidizing converter, platinum (Pt) and palladium (Pd) are used to oxidize the CO and HC. In the reduction converter, Ru (ruthenium) and Rh (rhodium) are used to reduce NOx. The three-way catalytic converter, which combines the characteristics of both types described above, has been adopted for this model.
The main component material of the catalytic converter, alumina, is impregnated with small amounts of the precious metals platinum (Pt), palladium (Pd) and rhodium (Rh).
When CO, HC and NOx pass through this converter, they come in contact with the Pt, Pd and Rh, and are then changed to harmless CO_2, H_2O, N_2 and O_2.



53G04B-515

There is a close relationship between the scavenging performance of the 3-way catalytic converter and the air/fuel ratio during fuel combustion within the engine.

1. Figure 1 shows the ordinary exhaust gas characteristics of a gasoline engine.
2. Figure 2 shows the scavenging performance of the 3-way catalytic converter.
   The scavenging ratio for NOx is high on the "rich" side of the theoratical air/fuel ratio, and, conversely, the scavenging ratio for CO and HC is on the "lean" side.
3. Figure 3 shows the relationship between air/fuel mixture differences and the exhaust gas concentration at the 3-way catalytic converter outlet.
4. Figure 4 shows the differences of scavenging performance resulting from differences of the exhaust gas temperature.
   When **300°C (572°F)** is exceeded, scavenging performance becomes close to 100%.

BACK UP SYSTEM (FAIL-SAFE SYSTEM)

The ensure driving is still possible when there are no signals from the sensors, the control unit incorporates back up functions.

Australia

Location of problem	Fail safe
Crank angle sensor	—
Air flow meter	Maintains the basic signal at a preset value.
Water thermo sensor	Maintains a constant 80°C (176°F) command.
Intake air temperature sensor (inside air flow meter)	Maintains a constant 20°C (68°F) command.
Oxygen (O_2) sensor	Stop the feedback correction
Throttle sensor	Maintains a constant 100% (approx. 18.2°) command.
Boost sensor (for detection of high load)	Maintains a constant-96 mmHg (–3.78 inHg) command.
Atmospheric pressure sensor	Maintains a constant commands of the sea-level pressure.
Coil with igniter (Trailing side)	Stop operation of ignition system (only trailing side).
Intake air temperature sensor (inside dynamic chamber)	Maintains a constant 20°C (68°F) command.

57G04X-560

Except for Australia

Location of problem	Fail safe function
IG pulse	—
Air flow meter	Maintains the basic signal at a preset value.
Water thermo sensor	Maintains constant 20°C (68°F) command.
Intake air temperature sensor (inside air flow meter)	Maintains constant 20°C (68°F) command.
Throttle sensor	Maintains constant 80% (14.2°) command.
Atmospheric pressure sensor	Maintains a constant commands of the sea level pressure.
Intake air temperature sensor (inside dynamic chamber)	Maintains constant 20°C (68°F) command.

57G04X-561