INDEX CONTINUED

1. GENERAL INFORMATION

The 3.0E 6 cylinder engine, fitted to VL Series Models, is equipped with an engine management system called Electronic Combustion Control System (ECCS).

The ECCS employs a microcomputer based control unit for centralized control of six main control functions.

1. Fuel Injection
2. Ignition Timing
3. Idle Speed Control
4. Fuel Pressure Control
5. Fuel Pump Control
6. Self Diagnostics

1.1 LAYOUT OF COMPONENTS

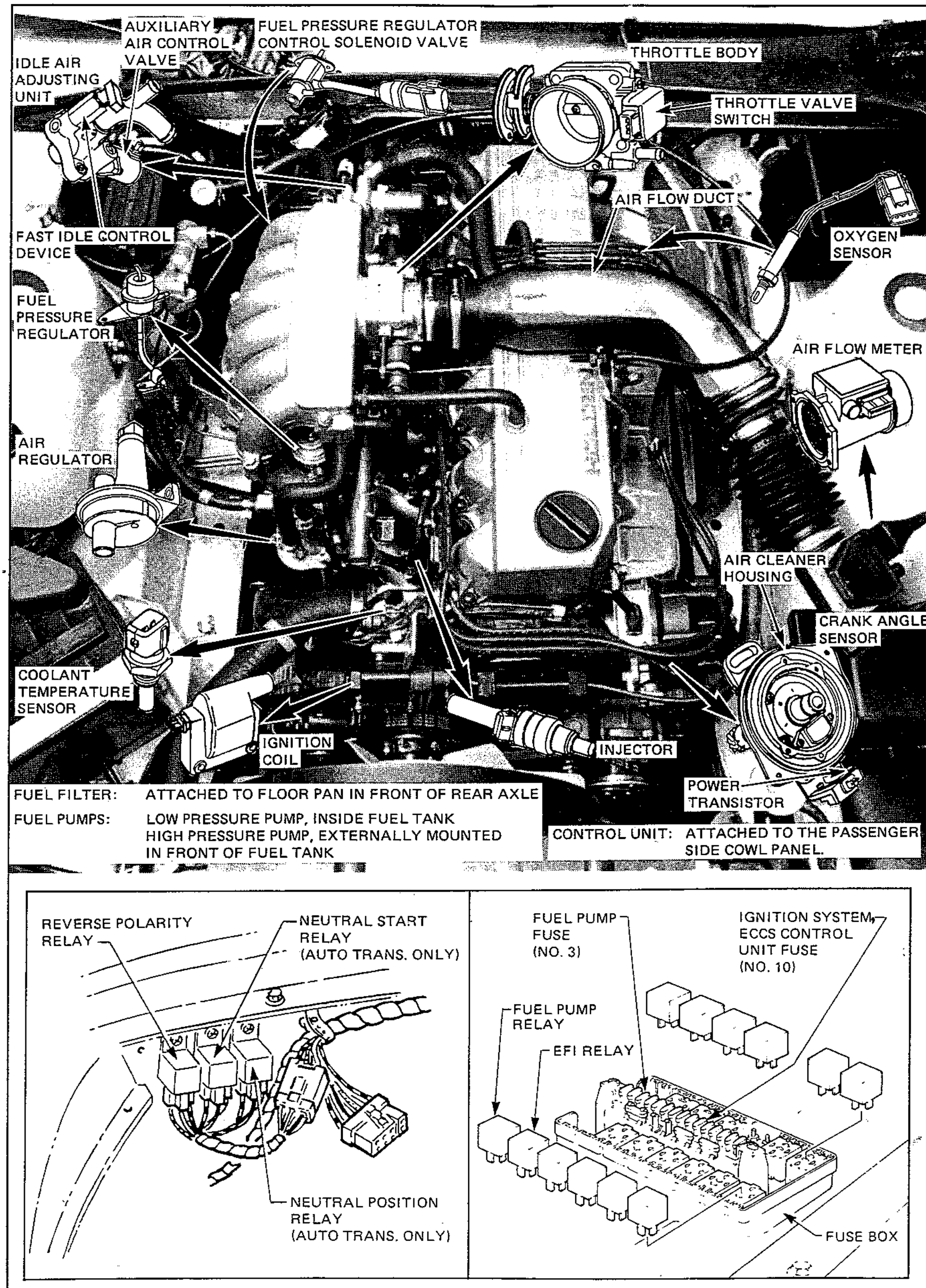


Figure 6C-1

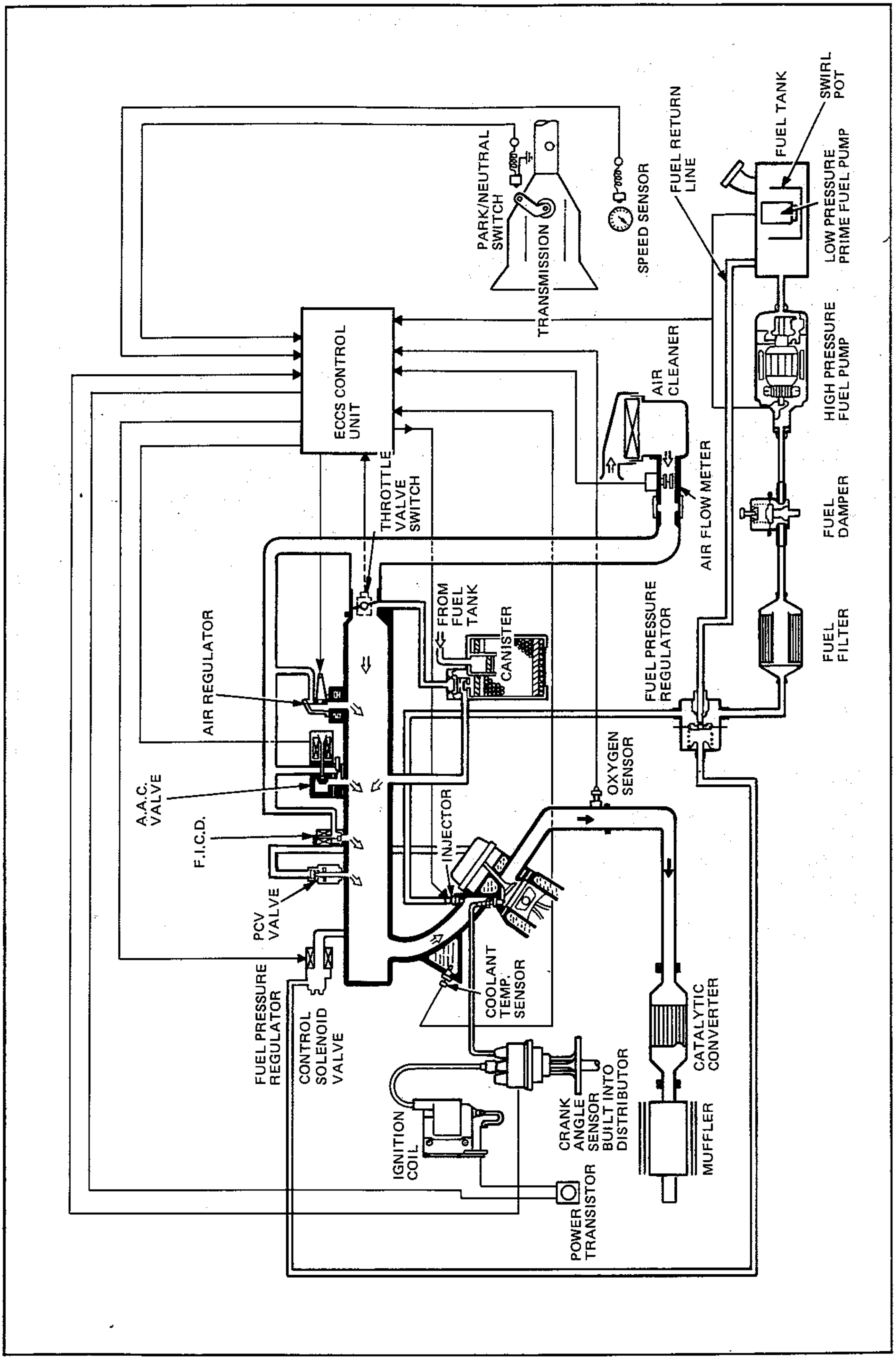

PARK/NEUTRAL SWITCH
TRANSMISSION
SPEED SENSOR
FUEL RETURN LINE
FUEL TANK
SWIRL POT
LOW PRESSURE PRIME FUEL PUMP
HIGH PRESSURE FUEL PUMP
FUEL DAMPER
FUEL FILTER
FUEL PRESSURE REGULATOR
AIR CLEANER
AIR FLOW METER
ECCS CONTROL UNIT
THROTTLE VALVE SWITCH
FROM FUEL TANK
CANISTER
AIR REGULATOR
A.A.C. VALVE
F.I.C.D.
PCV VALVE
INJECTOR
OXYGEN SENSOR
COOLANT TEMP. SENSOR
FUEL PRESSURE REGULATOR
CONTROL SOLENOID VALVE
IGNITION COIL
POWER TRANSISTOR
CRANK ANGLE SENSOR BUILT INTO DISTRIBUTOR
CATALYTIC CONVERTER
MUFFLER

Figure 6C-2

2. PRINCIPLES OF OPERATION

2.1 FUEL INJECTION TIMING

With many early fuel injection systems, fuel was injected into the inlet port just prior to the beginning of the intake stroke. This is not the case with the Electronic Combustion Control System. (ECCS)

All fuel injectors are electrically connected to the control unit so they all inject simultaneously. Therefore fuel injection is made independently of the engine stroke cycle.

With the ECCS, injection is made once every engine crankshaft revolution, after the control unit receives information regarding crankshaft position from the crank angle sensor (in the distributor).

One injection of fuel provides only half the required quantity necessary for the operation of the 4-stroke cycle of the engine, therefore injection is made twice during one 4-stroke cycle, i.e. once every engine revolution. (Refer Fig. 6C-3).

Fuel in this system is not injected directly into the cylinder, but is injected into the intake ports of the cylinder head. Therefore, the air-fuel mixture is drawn into the cylinder when the intake valve opens. During strokes, other than the intake stroke, the air-fuel mixture is kept outside the intake valve.

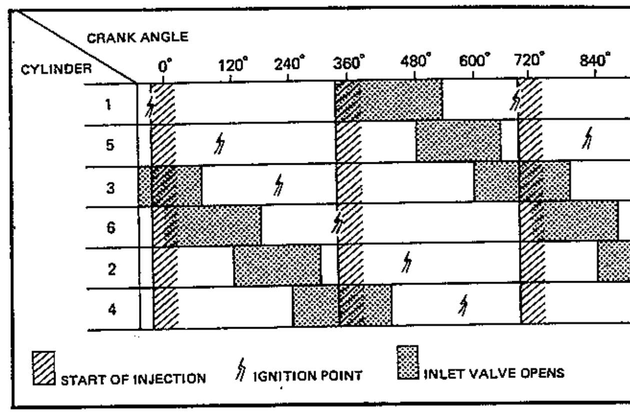


Figure 6C-3

2.2 FUEL INJECTION QUANTITY CONTROL

BASIC FUEL INJECTION QUANTITY CONTROL

Vehicle engine speed and load are the two requirements needed to calculate the basic fuel requirements for any engine operating condition.

With the ECCS, the speed of the engine is signalled from the crank angle sensor in the distributor and engine load is monitored by the air flow meter. The signals from these two sensors provide the control unit with data to calculate the basic fuel injection quantity.

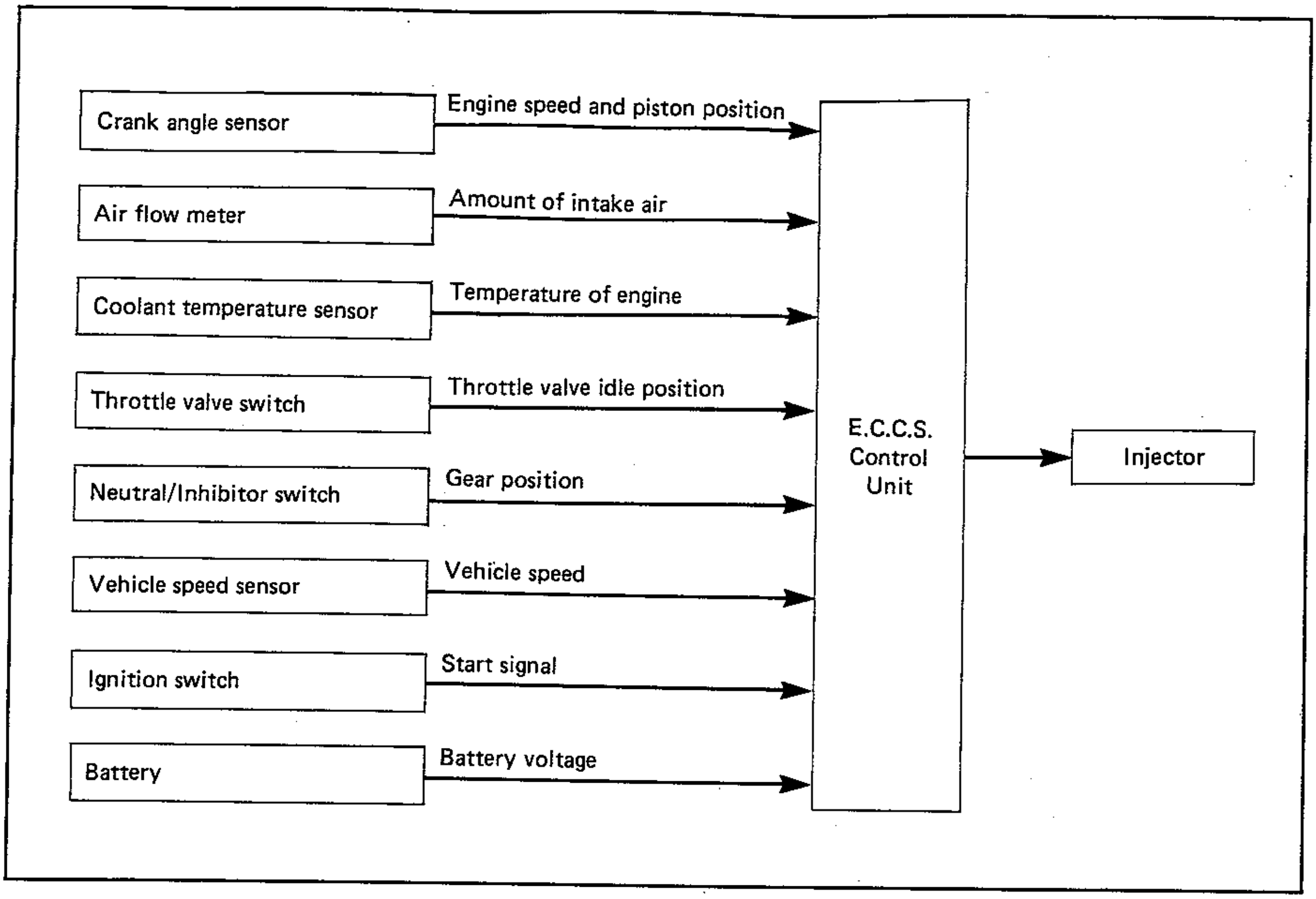


Figure 6C-4

NORMAL INJECTION QUANTITY CONTROL

During normal engine running conditions, other than at starting, the fuel injection quantity can be determined by the following equation:

Normal fuel injection quantity ≒

> Basic fuel injection quantity x various enrichment correction factors x oxygen sensor control connection coefficient + quantity corresponding to voltage correction function.

INJECTION QUANTITY

The fuel injection quantity control is basically calculated for two different conditions (in normal operation).

1. Engine starting
2. All other conditions

Fuel Injection Quantity - Engine Starting

Fuel injection at starting can be divided into two phases.

1. The first time injection occurs is at the moment the ignition switch is turned to the 'START' position.
2. Subsequent injection with the ignition switch in the 'START' position and the engine cranking.

First Time Injection Quantity

When the ignition switch is turned to the 'START' position, no engine speed or load signal is available for input to the control unit. So the first time fuel injection quantity from the data stored in the control unit's memory, corresponding to the engine coolant temperature, is directly injected (refer Fig. 6C-5.)

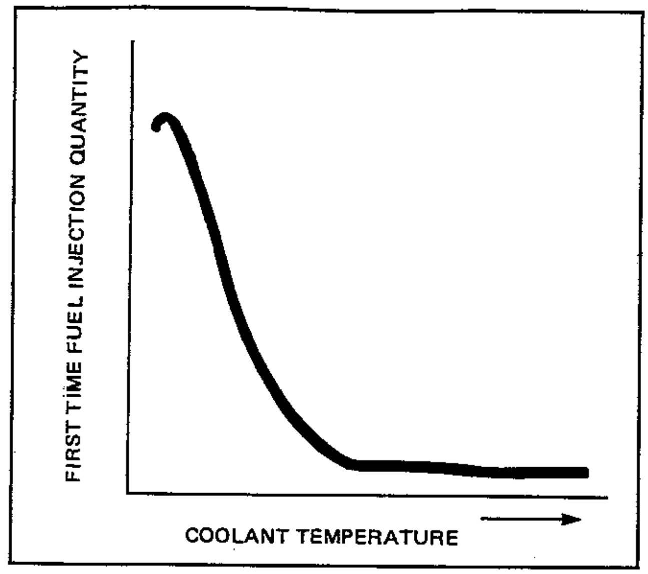


Figure 6C-5

Injection Quantity - Engine Cranking

The ECCS control unit has two fuel injection quantity equations from which to choose when the ignition switch is in the 'START' position and the engine is cranking.

1. Fuel injection quantity = (Normal injection quantity x correction coefficient x 1.3) + quantity corresponding to voltage correction.
2. Fuel injection quantity = First time injection quantity x rotational speed correction coefficient x time correction coefficient.

Rotational Speed Coefficient

This corrects the 'First Time Injection Quantity'. The correction coefficient varies with engine cranking speed (refer Fig. 6C-6).

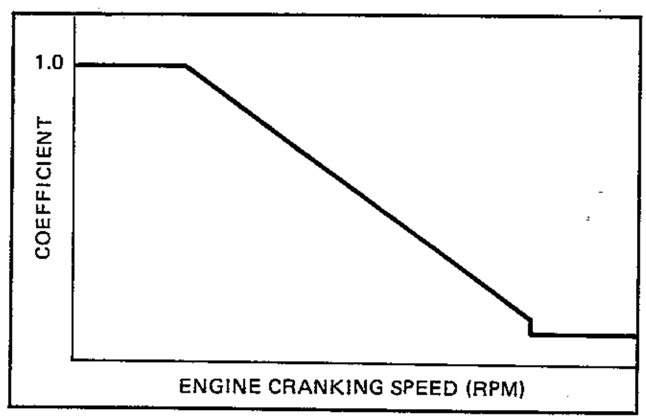


Figure 6C-6

Time Correction Coefficient

This also corrects the 'First Time Injection Quantity'. The correction coefficient varies with the length of cranking time beginning with the moment the ignition switch has been turned to the 'START' position, (refer Fig. 6C-7).

The equation with the largest fuel quantity is the one adopted by the control unit as the fuel injection quantity at that time.

For example, equation 2 excludes the intake air quantity signal. The reason is that, during cranking, the intake air quantity cannot be measured correctly because of the very low air flow. However, it is considered as roughly constant, hence it is not adopted as one of the variable input signals. Equation 2 represents the 'before ignition state', while Equation 1 represents the 'after ignition state' of the engine.

As the mixture is ignited, engine speed increases, and the intake air quantity increases. At this stage, the fuel injection quantity calculated by Equation 1 is larger than that calculated by Equation 2. Therefore the value obtained by Equation 1 is adopted.

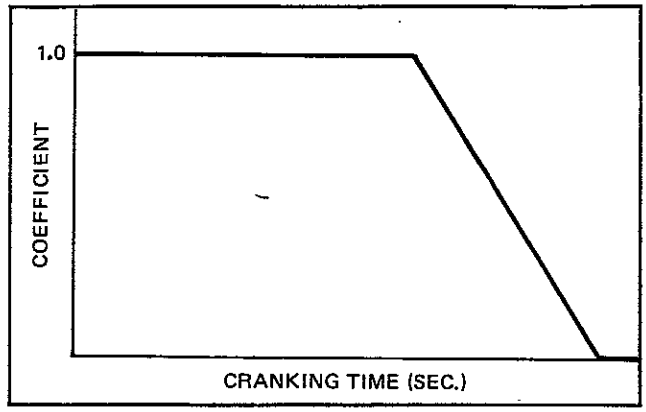


Figure 6C-7

MIXTURE CORRECTION FACTORS

As previously stated, Normal Injection Quantity is determined by the Basic Fuel Injection Quantity multiplied by various mixture correction factors. The following paragraphs cover these factors.

After Start Enrichment Correction

This enrichment begins just after the ignition switch has been turned from 'START' to 'ON' position for stabilized engine operating after starting.

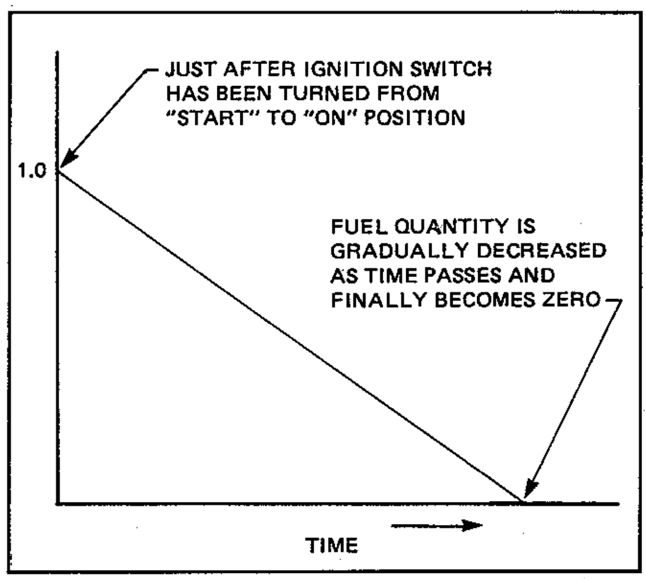


Figure 6C-8

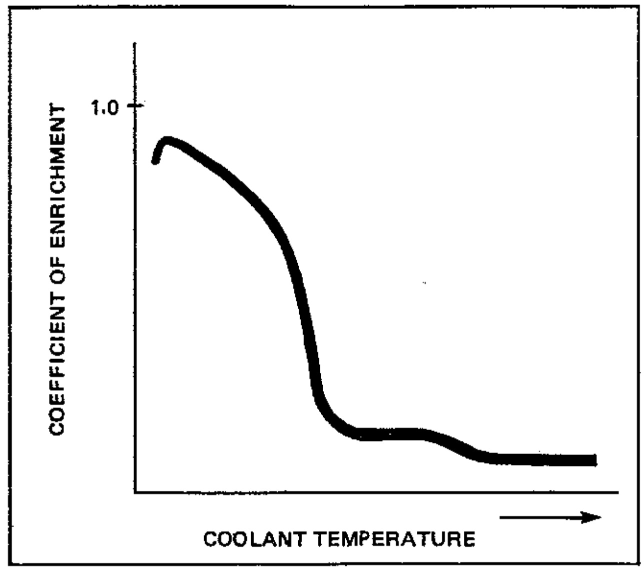


Figure 6C-9

After Idling Enrichment Correction

When the throttle valve switch idle contact is set to OFF (that is, when the throttle is 'OFF IDLE'), fuel is enriched according to the coolant temperature to enable smooth initial operation of the vehicle.

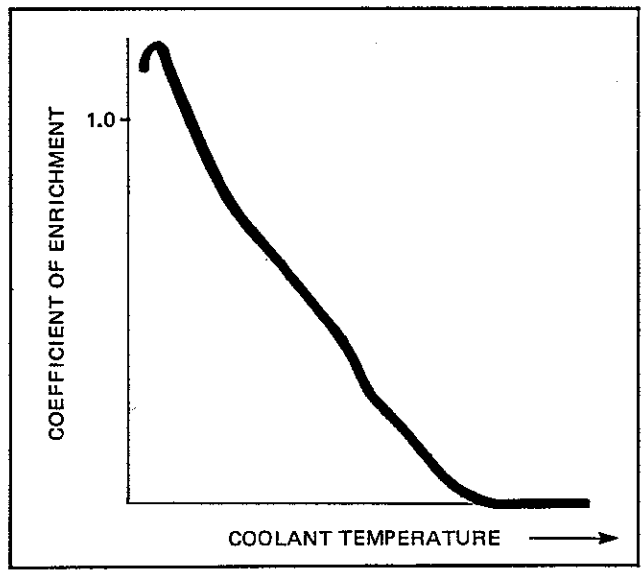


Figure 6C-10

Immediately after the vehicle starts off, the after idling enrichment correction is gradually decreased as time passes as shown in Fig. 6C-11, and finally brought to zero.

If the idle contact is turned back to 'ON' (closed contacts), this enrichment is stopped immediately.

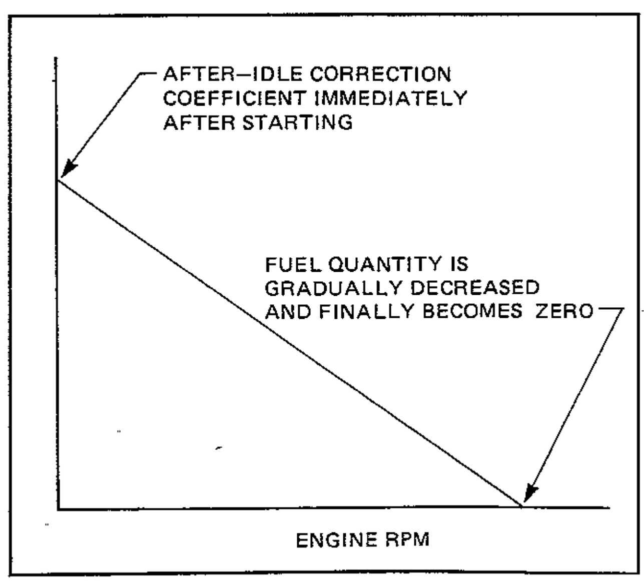


Figure 6C-11

Mixture Ratio Correction

The mixture ratio correction coefficient corresponding to engine speed and basic injection quantity is stored in the control unit memory beforehand, and is used to increase fuel quantity in high speed or heavily loaded operation.

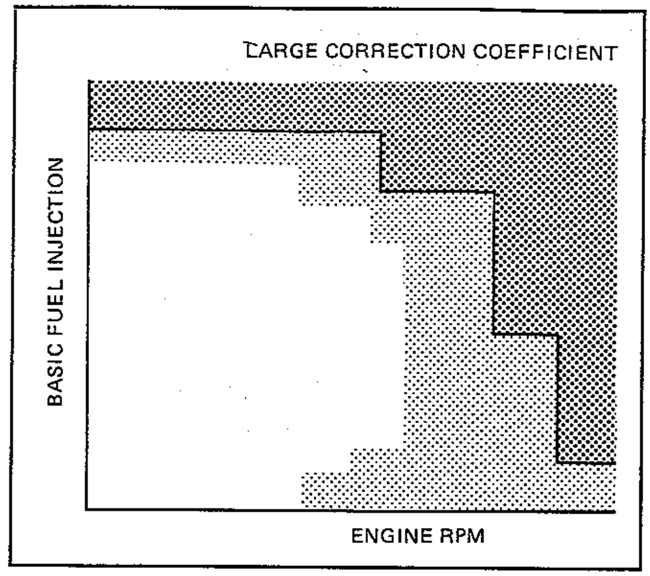


Figure 6C-12

Acceleration Decremental Correction

During sudden acceleration (idle contact ON ⟶ OFF), the air flow voltage signal generated in the air flow meter has some 'overshoot', and this correction is provided to reduce fuel by that extra amount.

If the engine speed is higher than 3,200 rpm, or the idle contact is turned 'ON' (closed contacts), this correction stops immediately.

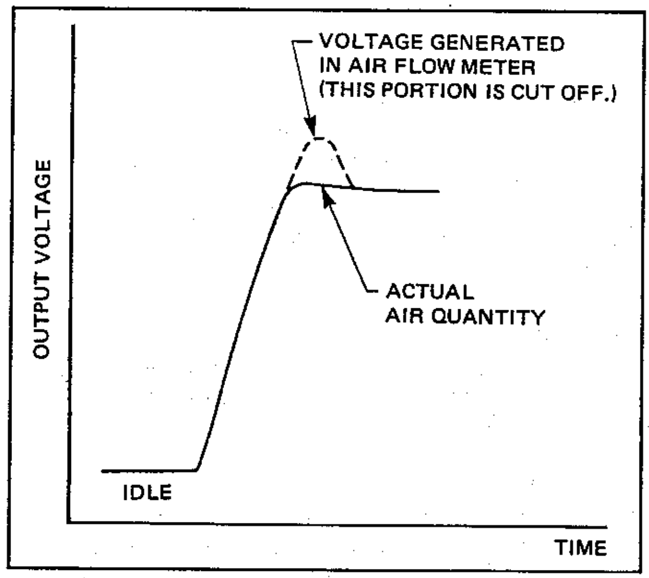


Figure 6C-13

Coolant Temperature Enrichment Correction

This correction is used to obtain the optimum air-fuel mixture ratio corresponding to the engine coolant temperature. This temperature is detected by the ECCS coolant temperature sensor.

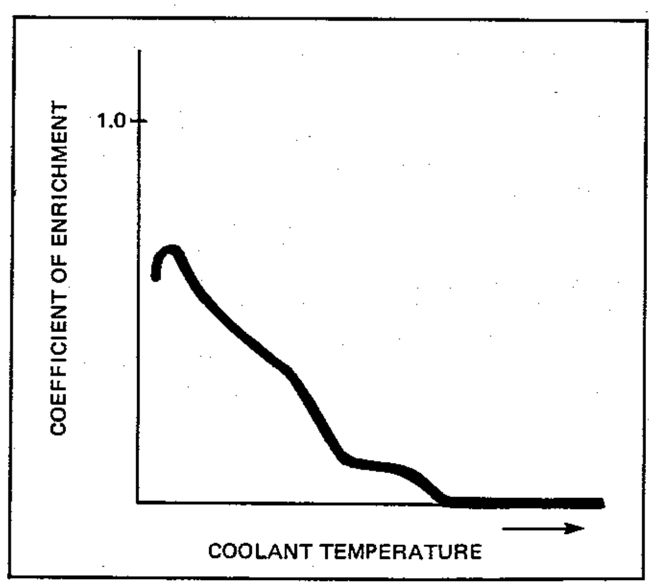


Figure 6C-14

High Coolant Temperature Correction

If the coolant temperature is more than 95°C when the idle contact is turned 'OFF' (open contacts), this correction is used to reduce the possibility of detonation by increasing the fuel injected by 10% over the basic fuel injection quantity.

Acceleration Enrichment Correction

This correction is incorporated to improve acceleration performance. Immediately after the idle contact of the throttle valve switch has been turned 'OFF' from 'ON', additional fuel is injected only once for a certain pulse width injector valve opening simultaneously to each cylinder. After this ordinary injection begins again with the injection timing set at the pre-acceleration state.

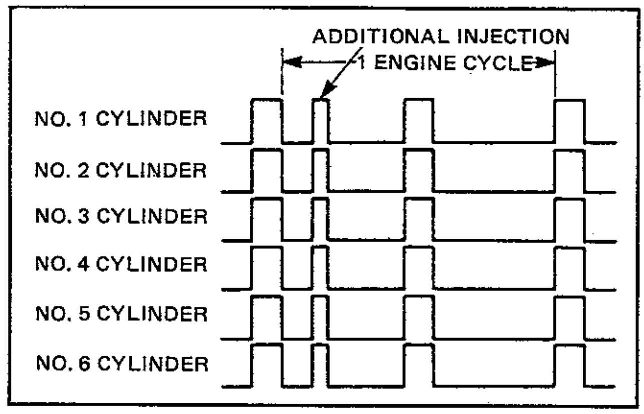


Figure 6C-14A

Voltage Correction Function

Under conditions of low system voltage, such as would occur with a battery in a low state of charge, the injectors are slightly slower to open. Under these conditions, the injector valve opening time (pulse width) is automatically extended to ensure the full quantity of fuel is injected.

Fuel Shut-Off

A fuel shut-off feature is also incorporated with the ECCS. With this feature, the injector pulse width is reduced to a minimum value when decelerating in order to:

1. Improve fuel economy.
2. Prevent harmful emissions while decelerating.

When the accelerator pedal is lifted so the vehicle is decelerating, fuel injection is reduced, depending on the engine speed, vehicle speed, throttle position and coolant temperature, until the engine reaches the fuel recovery zone. Refer Fig. 6C-15.

For vehicles with automatic transmission, the control unit reduces the fuel injected into the engine after a 0.6 second delay.

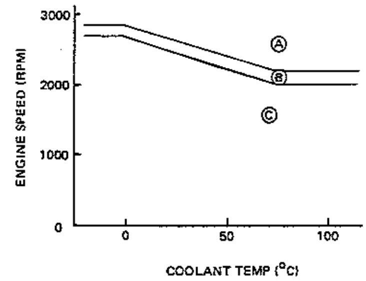
For vehicles with manual transmission, fuel injection on cylinders 1, 2 and 3, reduces after a 0.3 second delay. Then cylinders 4, 5 and 6 fuel injection reduces after a further 0.3 second delay.

The injection restarts on all cylinders when the engine speed reaches the fuel recovery zone.

The reason for the delay in fuel injection reductions is to avoid simultaneous application of shocks caused by changes in engine torque. The injector pulse width is also reached when the engine speed reaches 6200 rpm as a means of engine over speed control.

VEHICLES WITH MANUAL TRANSMISSION

Gear Position	Throttle Position Switch Idle Contact	Fuel Shut-off Operation Condition	Fuel Shut-off Zone	Fuel Recovery Zone
ANY GEAR	ON	ENGINE SPEED Ⓐ	Ⓐ & Ⓑ	Ⓒ
	OFF→ON	CAR SPEED; OVER 8 km/h		



VEHICLES WITH AUTOMATIC TRANSMISSION

Gear Position	Throttle Position Switch Idle Contact	Fuel Shut-off Operation Condition	Fuel Shut-off Zone	Fuel Recovery Zone
ANY GEAR	ON	ENGINE SPEED Ⓐ CAR SPEED; OVER 8 km/h	Ⓐ & Ⓑ	Below Ⓒ
	OFF→ON	ENGINE SPEED: Over Ⓒ CAR SPEED; OVER 8 km/h	Over Ⓒ & Ⓓ	Ⓔ

* When air conditioner switch is "ON" ONLY Idle switch OFF ON' FUEL RECOVERY will OCCUR below "R"

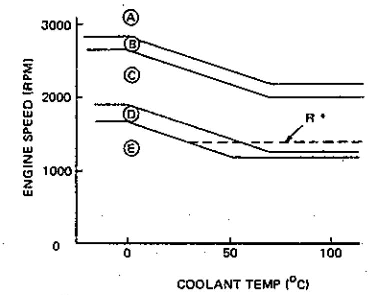


Figure 6C-15

Mixture Ratio Feedback Control

The ECCS is a closed loop mixture control system (refer Fig. 6C-16) via a mixture ratio feedback control, utilizing an oxygen sensor to monitor the exhaust gases.

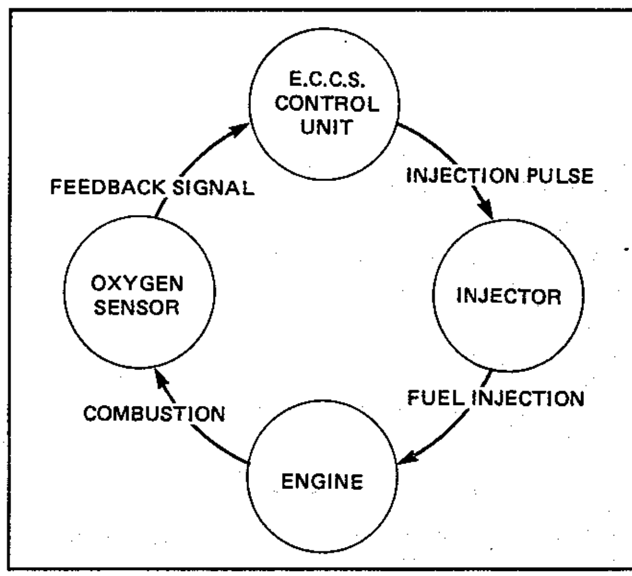


Figure 6C-16

The mixture ratio feedback system is designed to control the mixture ratio precisely to the stoichiometric point (combustion without excess of oxygen or fuel) so that the catalytic converter can minimise CO, HC and NO_X emissions simultaneously.

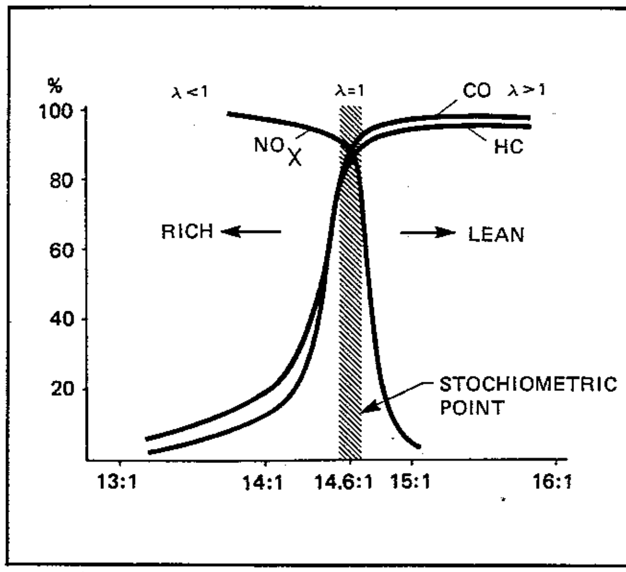


Figure 6C-17

The system uses an oxygen sensor located in the exhaust manifold to indicate to the ECCS control unit the level of oxygen in the exhaust gas, which is also a measure of whether the air fuel ratio is richer or leaner than the stoichiometric point. The control unit adjusts the injection pulse width according to the signal from the oxygen sensor so that the mixture ratio will be held within the narrow band around the stoichiometric air-fuel ratio of $\lambda = 1$. This allows the three way catalytic converter to minimise CO, HC and NO_X emissions.

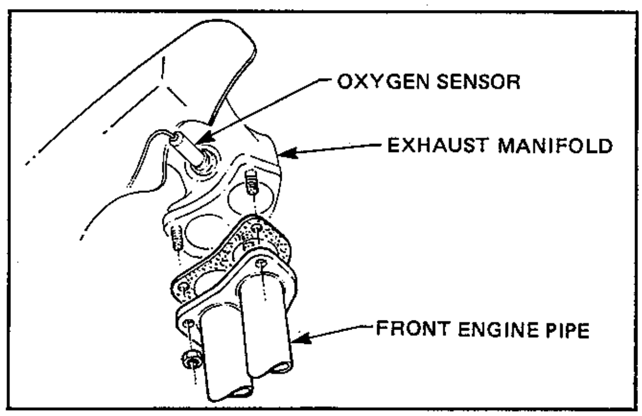


Figure 6C-18

However, the closed loop feature is not used (i.e. system runs open loop) under the following conditions:

1. When starting the engine.
2. When the engine and oxygen sensor are cold.
3. When driving at high speeds or under heavy load.
4. At idle.
5. When the oxygen sensor detects a too lean condition for more than 10 seconds (i.e. fault condition).
6. When fuel shut-off function is in operation.

2.3 IGNITION TIMING CONTROL

The distributor used in the ECCS has no vacuum or centrifugal advance mechanism, as used in a conventional distributor. Instead, the ECCS selects an optimum advance value, corresponding to the engine conditions, from among a number of ignition timing values stored in the control unit's memory. With the ignition timing value calculated and the reference signal from the crank angle sensor, the control unit knows when to trigger the ignition coil via the power transistor. Thus controlling the spark advance for the engine. The secondary voltage is generated by the ignition coil which is turned 'ON' and to 'OFF' by the power transistor, connected in series with the coil primary winding.

The control unit also regulates the energizing time (dwell control) of the ignition coil, according to battery voltage.

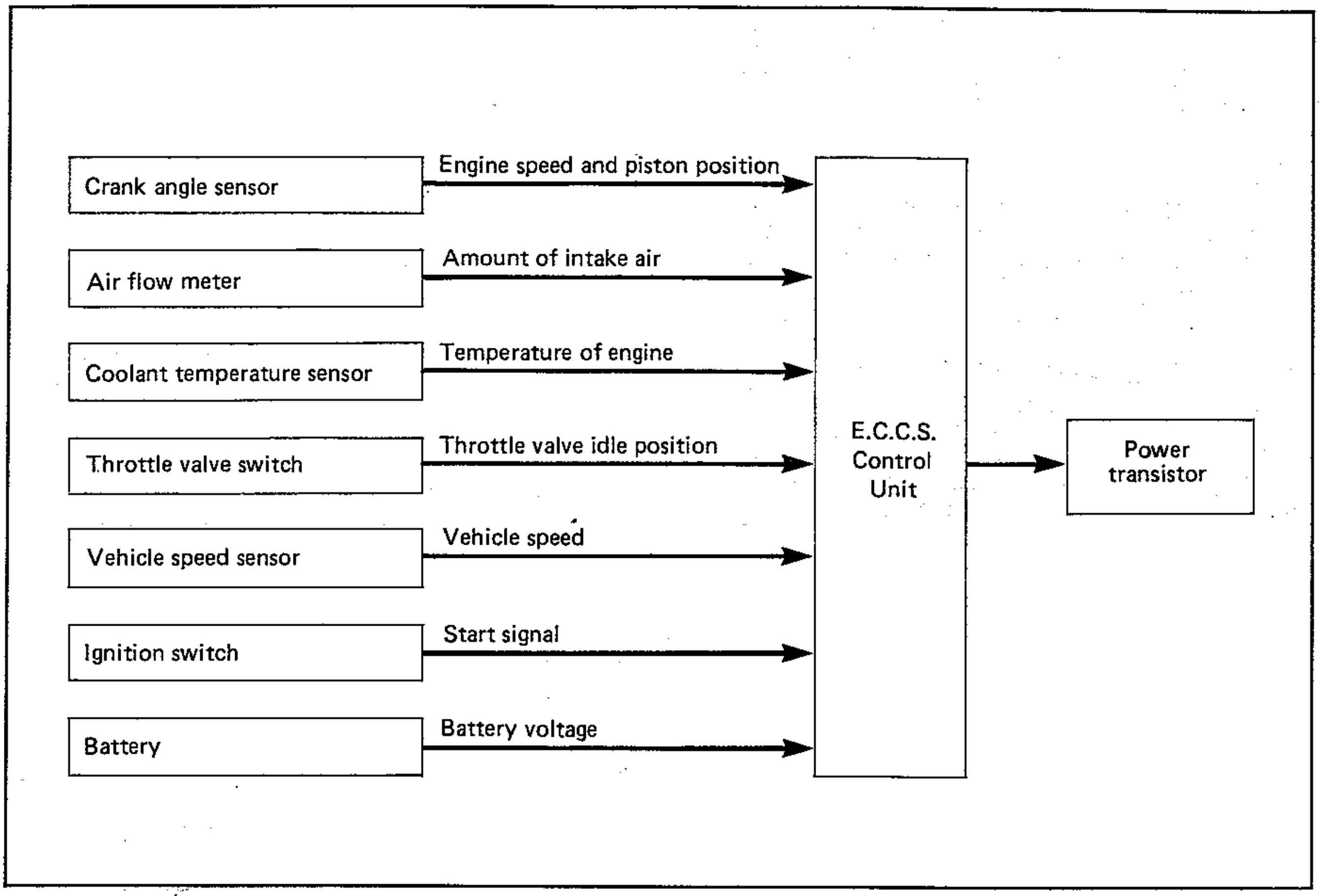


Figure 6C-19

OPERATION

The ignition timing control is performed in three different phases:

1. Ordinary operation.
2. Cranking.
3. Idling and decelerating.

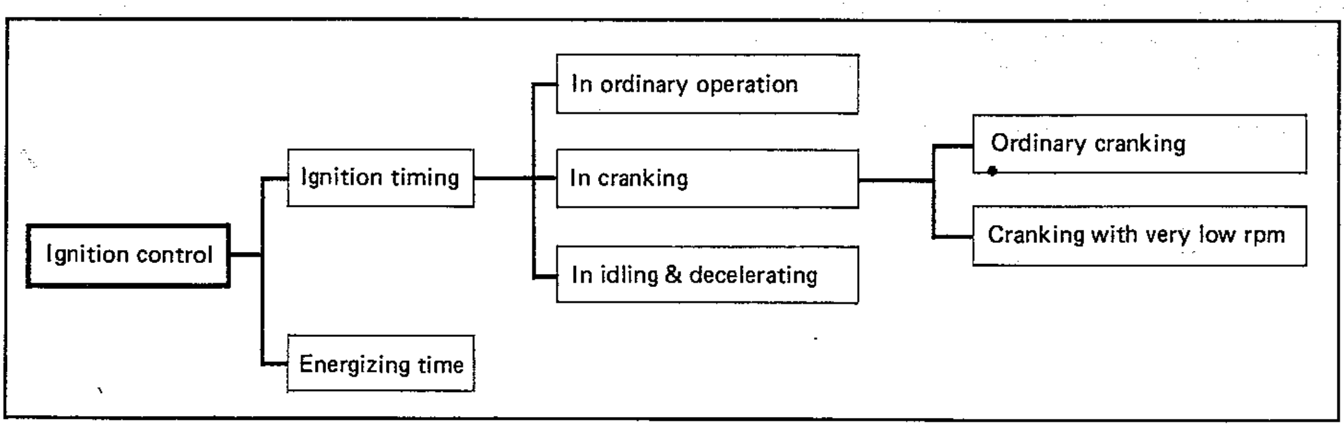


Figure 6C-20

Ordinary Operation (Off Idle Position)

The condition in which the idle contact of the throttle valve switch is 'OFF' is referred to as ordinary operation (or off idle position). Ignition timing is controlled by selecting the optimum ignition timing value determined by the basic injection quantity and engine speed from the data stored in the control unit's memory.

Cranking

In the cranking operation, again the optimum timing valve is selected from the data stored in the control unit's memory, and a corresponding control signal is sent to the power transistor. During cranking the following two conditions are considered in improving engine starting.

Ordinary Cranking (Engine rpm over 100)

The ignition timing is determined by the coolant temperature. If the temperature is below 0°C, the combustion chamber is cold, and more time is needed after ignition to generate the maximum combustion pressure. Therefore, the ignition timing is advanced.

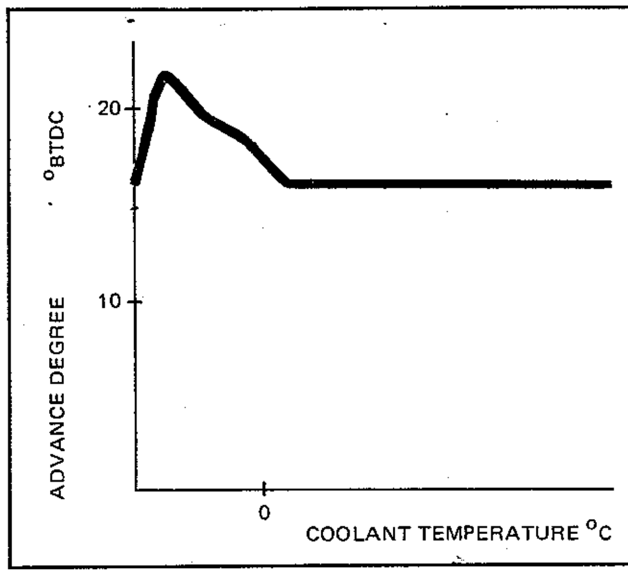


Figure 6C-21

Cranking With Low Engine Speed (Engine rpm below 100)

If the engine cranking speed is very low, combustion will proceed before the piston reaches T.D.C. position, and this condition can cause reverse rotation of the crankshaft. To prevent this happening, the ignition timing is delayed by the control unit according to the engine cranking speed, as expressed by the following equation.

$$\text{Ignition timing value} = \text{Timing value for ordinary cranking} \times \frac{\text{cranking speed}}{100}$$

Idling and Decelerating

When the idle contact of the throttle valve switch is 'ON', the optimum ignition timing value is selected from data stored in the control unit's memory. This data is different to the data used in ordinary operation.

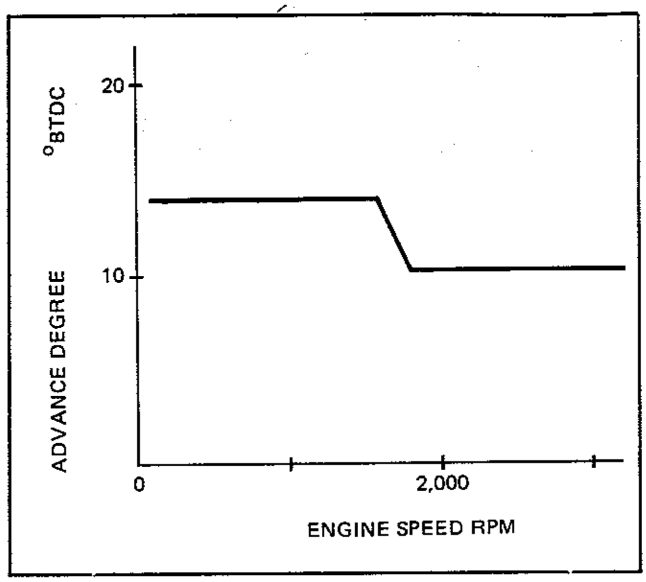


Figure 6C-22

Ignition Coil Energizing Time Control (Dwell Control)

Energizing time means a time period during which the primary current of the ignition coil is kept 'ON'. As shown in Fig. 6C-23 the energizing time must be extended as the battery voltage drops.

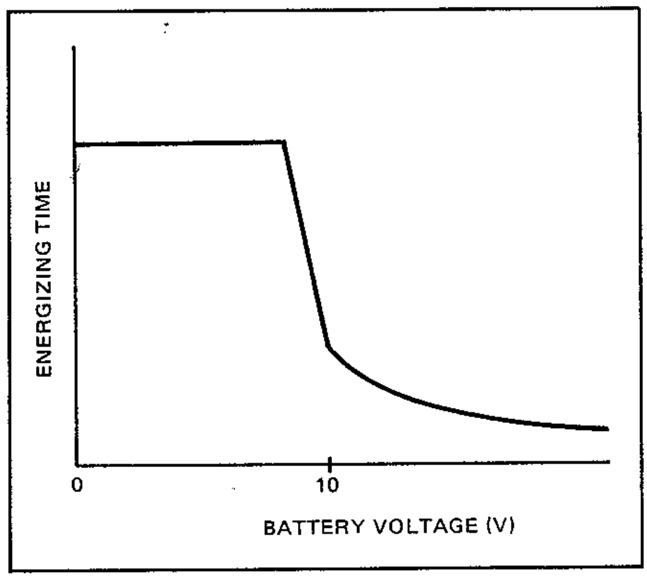


Figure 6C-23

Since the ignition coil has inductance, the currect flowing through the coil (primary current) cannot be increased rapidly even when the power transistor is turned 'ON'. The secondary voltage is proportional to this primary current. Hence, it is necessary to keep the power transistor in the 'ON' state for some time.

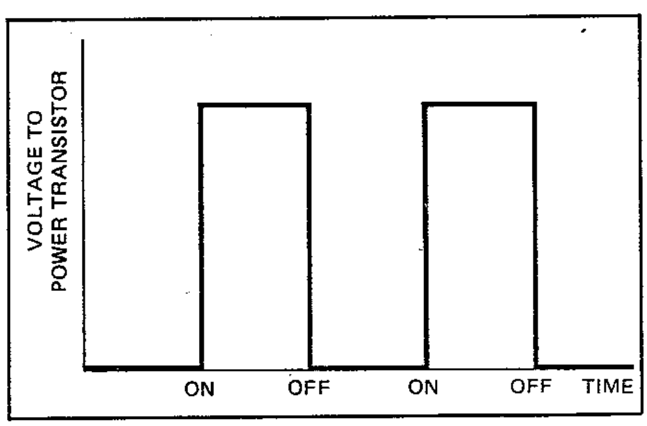


Figure 6C-24

The current flowing in the ignition coil is shown in Fig. 6C-25. When the battery voltage is low (dotted line), the energizing time is extended so that equal primary current can be obtained between high battery voltage and low battery voltage when the power transistor is turned 'OFF'.

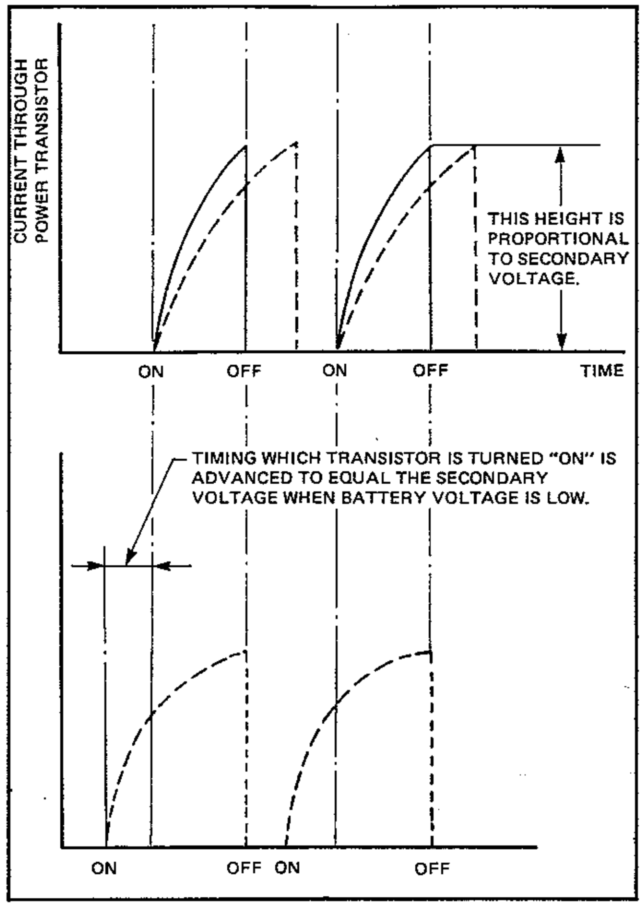


Figure 6C-25

2.4 IDLE SPEED CONTROL

The idle speed is controlled by the auxiliary air control (AAC) valve via the ECCS control unit, corresponding to the engine operating conditions.

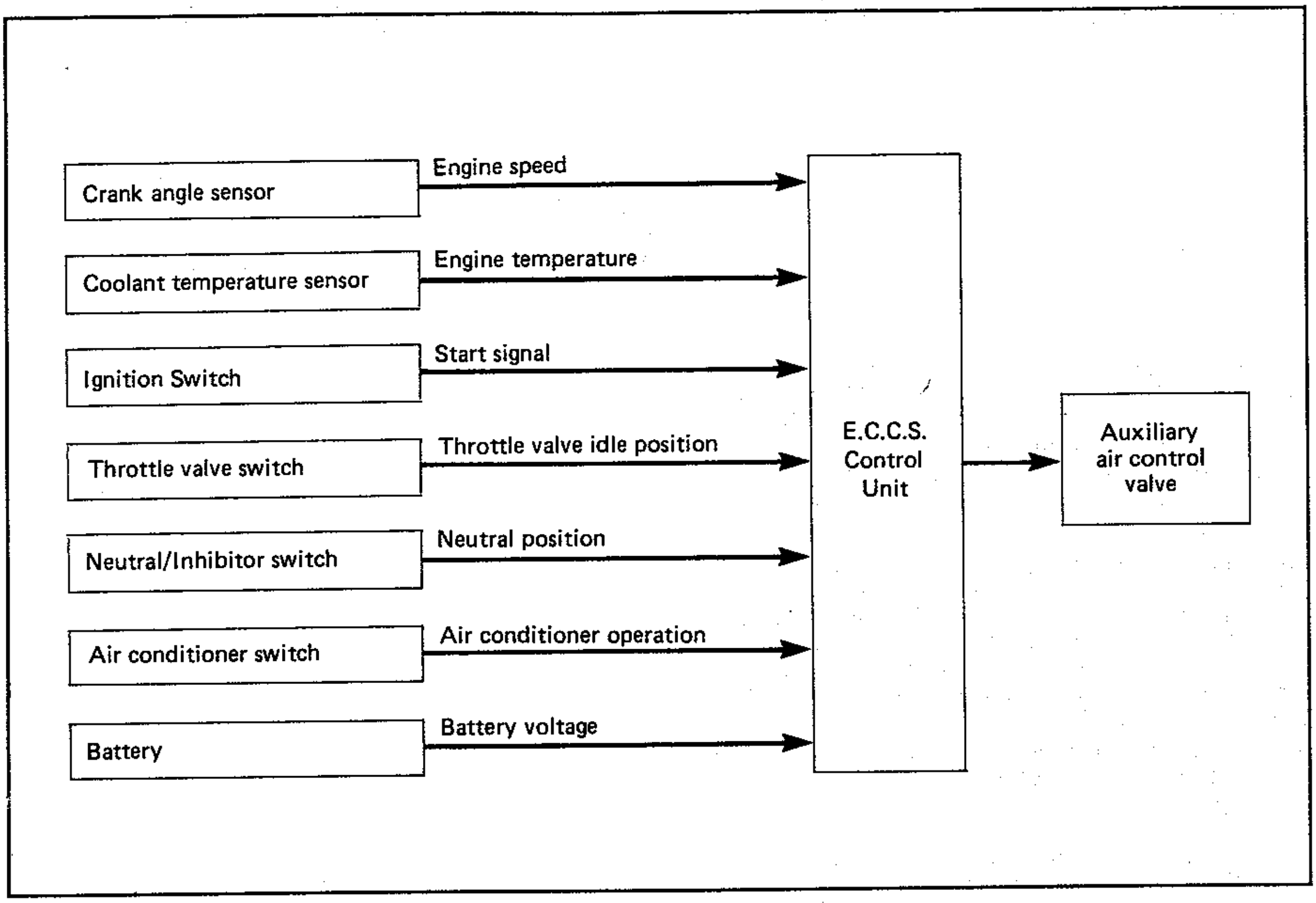


Figure 6C-26

The ECCS control unit senses the various engine operating parameters and detemines the best idle speed at each engine coolant temperature conditon and gear position, refer Fig. 6C-27.

The control unit then sends an electrical control signal, corresponding to the difference between the required idle speed and the actual idle speed to the Auxiliary Air Control (A.A.C.) valve.

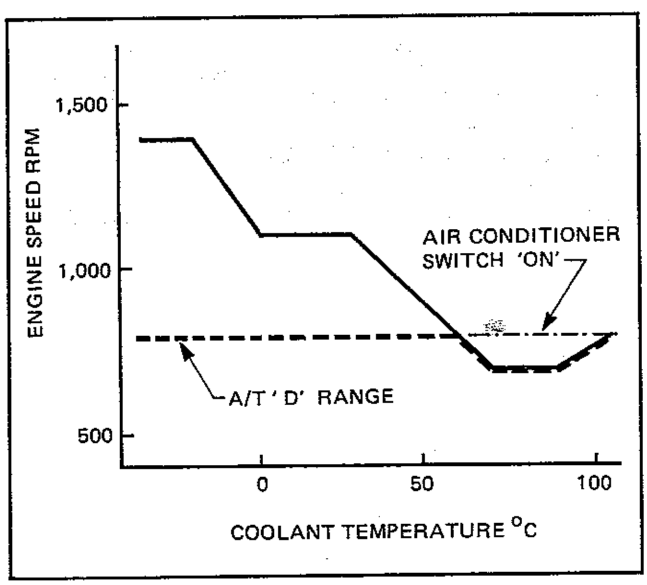


Figure 6C-27

Based on the idle speed control value, determined by the basic characteristic value plus the various correction values, the ECCS control unit sends an optimum signal to the solenoid valve in the AAC valve.

The signal frequency is kept constant (160 Hz), and the air quantity is controlled by changing the duration ratio of 'ON' and 'OFF'.

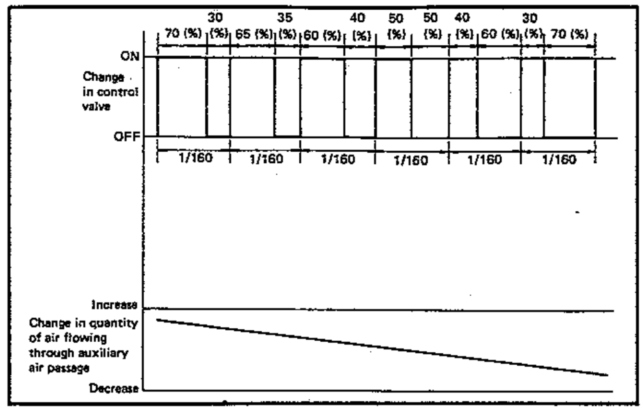


Figure 6C-28

At stabilized engine temperatures, the A.A.C. valve is used to maintain constant engine idle speed, compensating for varying engine loads (i.e. Power Steering, Automatic Transmission, Headlamps, etc.).

The idle speed is determined by the following equation:

Idle speed control value = basic characteristic value + various correction values.

When starting the vehicle (ignition switch in the 'START' position) the idle speed is determined by the basic characteristic value only. If the engine is started when the coolant temperature is high, the AAC valve opens up to its maximum value for the first 10 seconds after the ignition switch has been returned to the 'ON' position from the 'START' position.

The meaning of terms and available corrections are explained in the following paragraph.

1. BASIC CHARACTERISTIC VALUE

   The fundamental control value, of the AAC valve 'ON DUTY', is 80% constant, i.e. during one duration ratio of 'ON, OFF' of the valve, 80% is 'ON'. This characteristic value alone is used when starting the engine.

2. GEAR POSITION CORRECTION

   Idle speed correction is provided on vehicles fitted with automatic transmission to compensate for varying loads imposed on the engine in Neutral/Park, D, 1, 2, R ranges.

3. DECELERATION CORRECTION

   The objective of this correction is to prevent the engine stalling when decelerating, refer Fig. 6C-29.

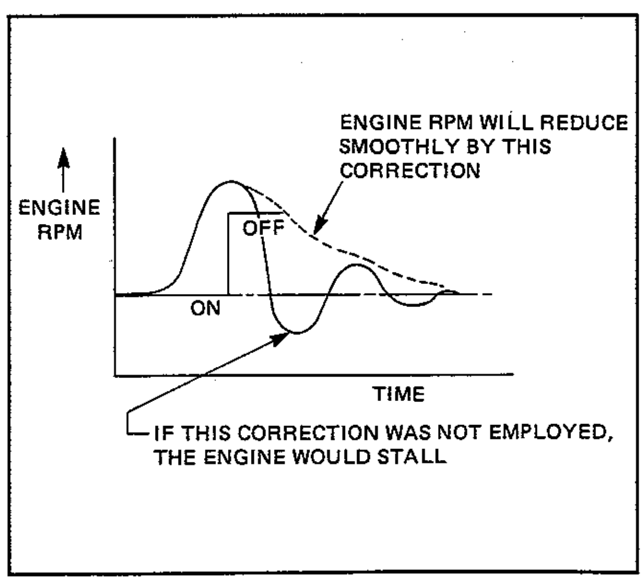


Figure 6C-29

4. FEEDBACK CORRECTION
   If there is a difference of more than 25 rpm between the objective speed and actual engine speed after control is performed by the combination of basic characteristic value and gear position correction, the feedback correction is activated. The feedback correction brings the actual speed to within the required range.

NOTE: When the engine is cold, the engine speed differs from the objective engine speed caused by the action of the air regulator.

For example, if the transmission is set in D range (with the air conditioner turned 'OFF'), the objective speed will be approximately 600 rpm. However, since the air regulator is operating, the actual engine speed may be over 1000 rpm.

Based on the control value determined by the equations and corrections, the control unit sends an optimum signal to the solenoid valve in the A.A.C. valve.

5. LOW VOLTAGE CORRECTION
   If battery voltage remains below 12 volts for approximately 1.3 seconds, the idle speed control causes the engine speed to increase by approx. 100 rpm, to increase the generator output.

Control Unit Diagnosis Mode Selector Correction

If the mode selector is rotated from the fully counter clockwise position, clockwise gradually, the lower limit of the engine idle speed is raised corresponding to the position of the mode selector. However, if the screw is rotated fully (i.e. to the self diagnosis postion), the lower limit is raised only 25 rpm.

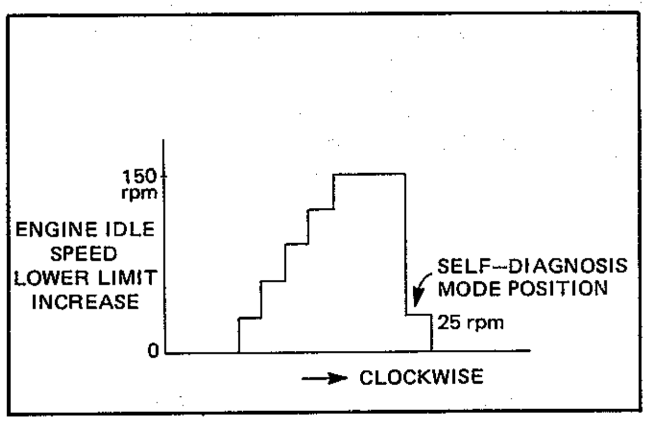


Figure 6C-29a

3. COMPONENTS

3.1 AIR FLOW METER

The air flow meter is a hot wire type and has no moving parts. The air flow meter is mounted directly onto the air cleaner assembly, which is located behing the left hand headlamp assembly.

The function of the air flow meter is to generate an electrical signal to the ECCS control unit, proportional to the amount of air flow into the engine. This signal is the base engine load signal to determine the correct amount of fuel to be injected.

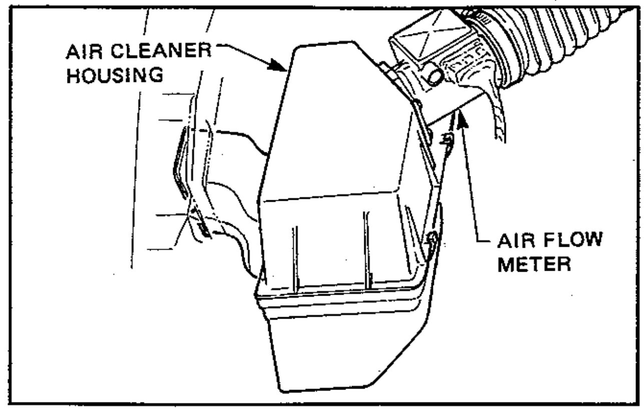


Figure 6C-30

Measurement of air flow is made in such a manner that the air flow meter control circuits generate an electrical output signal in relation to the amount of heat dissipated from the hot wire, which is placed in the air stream of the incoming air flow.

The air flowing past the hot wire removes heat from the hot wire. The temperature of the hot wire is very sensitive to the air flow rate.

The amount of current passing through the wire is controlled so that the wire temperature is kept constant, regardless of the change in air flow rate.

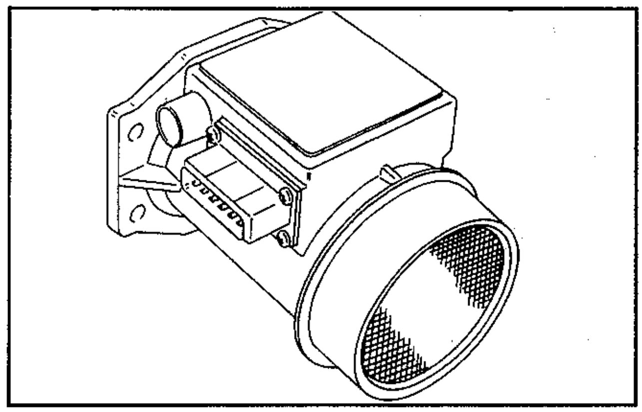


Figure 6C-31

After the engine is switched 'OFF', the ECCS control unit heats up the hot wire to approximately 1,000°C to burn off dust which has adhered to the hot wire.

This is an important self maintenance operation of the system to prevent any dust/dirt build up on the hot wire.

CONDITION	OPERATION
After running engine at above 1,500 rpm After driving vehicle at above 20 km/h Coolant temperature less than 115°C	Operates
Except Above	Does not operate

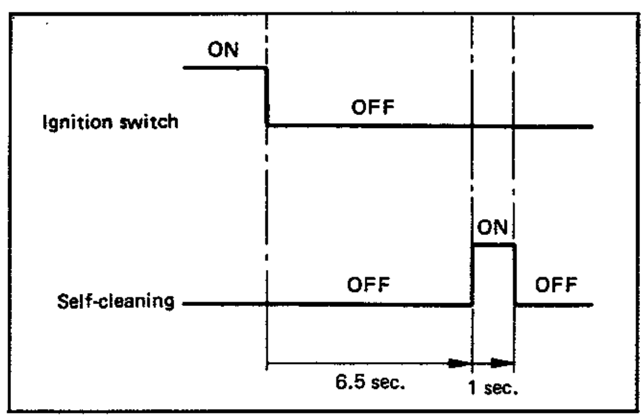


Figure 6C-32

If the output voltage from the air flow meter is less than 1.6 volts during engine operation, the control unit judges that the air flow meter circuit is open circuited. The control unit will go into a 'BACK UP MODE' and immediately control the injector pulse width according to the following chart.

	Throttle Valve Switch Idle Contact	Base Fuel Injector Pulse Width
Less than 2000 rpm	OFF	Approx 4 m sec.
Less than 2000 rpm	ON	Approx 2 m sec.
More than 2000 rpm	OFF	0

Also, the control unit changes the duration ratio of 'ON' and 'OFF' of the auxiliary air control valve to 90% 'ON' duty.

3.2 IDLE AIR ADJUSTING UNIT

The Idle Air Adjusting (IAA) unit, located on the rear of the intake manifold (refer Fig. 6C-33), is used to control engine idle speed to a preset level determined when various load switches are 'ON',i.e. air conditioning or when battery voltage is low.

The IAA unit has an Auxiliary Air Control (AAC) valve, idle speed adjusting screw and a Fast Idle Control Device (FICD) solenoid valve, (refer Fig. 6C-33). The FICD is used to compensate for air conditioning compressor loads.

NOTE: The IAA unit, as fitted to 3.0E engines, will include the FICD, even if the vehicle is not fitted with air conditioning. This is to provide for after sales fitment of air conditioning.

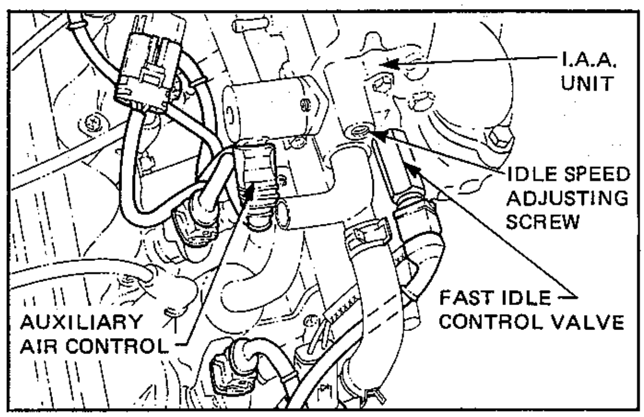


Figure 6C-33

The ECCS control unit determines the required optimum idle speed, then sends a signal to the AAC valve to control the amount of air which passes through it to maintain the required idle speed.

The ECCS control unit actuates the AAC valve by an 'ON-OFF' pulse at a rate of 160 pulses per second.

The additional air supplied by the AAC valve bypasses the throttle body, via a hose connected between the air flow duct and the AAC valve and enters directly into the intake manifold. Additional air entering the induction system is measured by the air flow meter and signals the control unit that more fuel is required, thereby maintaining the correct air fuel ratio.

When the air conditioner is turned 'ON', the FICD solenoid valve is activated. This increases the engine speed to a fast idle level to compensate for the air conditioning load on the engine. When the FICD is activated, this also allows additional air to bypass the throttle body. The control unit increases the pulse width signal to the injectors because of the greater air flow past the air flow meter and the engine idle speed is increased.

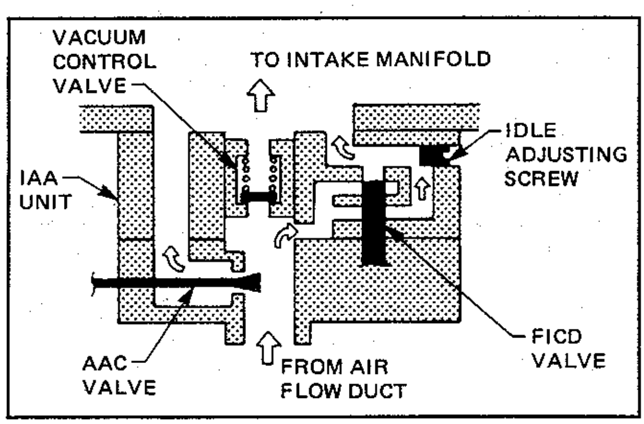


Figure 6C-34

3.3 AIR REGULATOR

The air regulator, situated near the front of the intake manifold (Fig. 6C-35), provides an air bypass when the engine is cold to increase the idle speed during engine warm up.

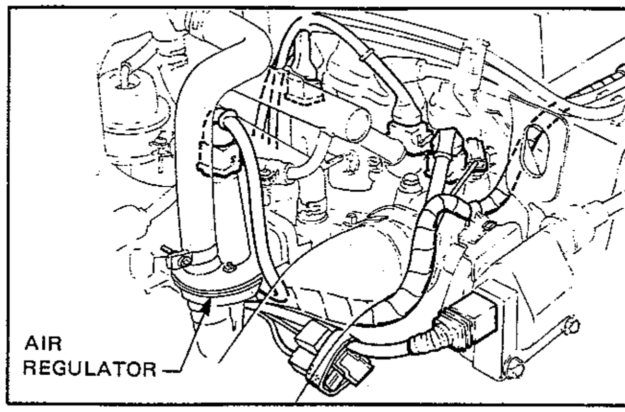


Figure 6C-35

The air regulator contains a slotted shutter that rotates to open, close or partially close an air passage in the valve, (refer Fig. 6C-36). Current flow through a heater coil, controls the operation of a bimetal strip which rotates the slotted shutter.

The current flow to the valve begins when the ignition is switched to the 'ON' position for approximately 5 seconds and continues whenever the engine is cranking or running (i.e. operates whenever the fuel pump is operating).

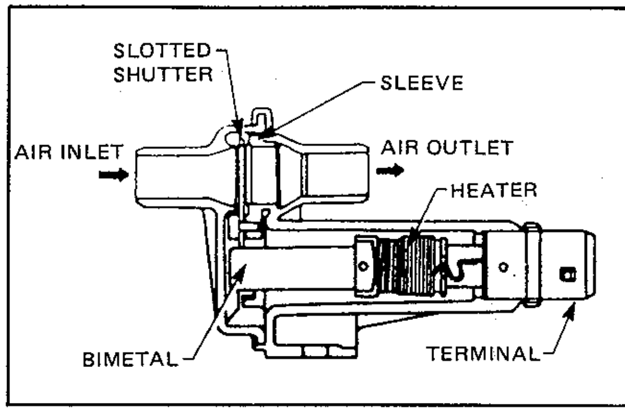


Figure 6C-36

With a cold engine, the bimetal strip keeps the shutter positioned so as to open the air passage, permitting air from the air flow duct to bypass the throttle body. As the heater coil warms up, the bimetal strip deflects, gradually closing the air passage in the regulator until at a predetermined temperature, the shutter has completely closed the passage and idle compensation via the air regulator ceases.

The additional air entering the induction system is measured by the air flow meter and signals the control unit that more fuel is required, thereby maintaining the correct air fuel ratio.

The wiring harness connector for the air regulator is coloured light blue, to distinguish if from the injector and coolant temperature sensor wiring harness connectors.

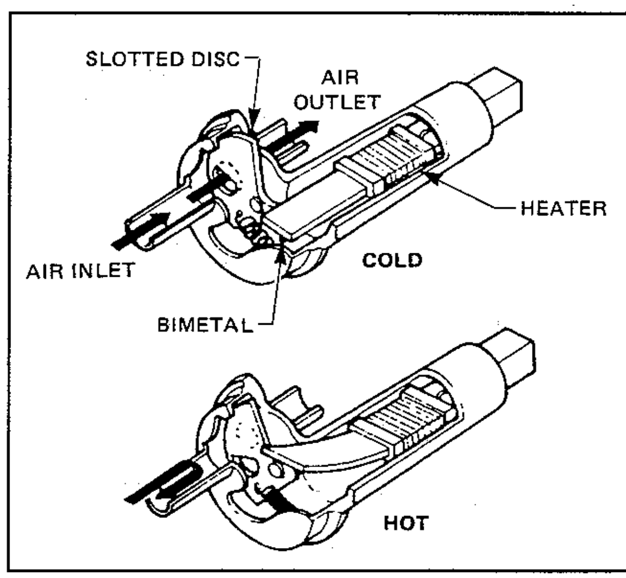


Figure 6C-37

3.4 ECCS CONTROL UNIT

The ECCS control unit is a microprocessor based control unit with inbuilt diagnostic capabilities.

The control unit is mounted behind the passenger side front cowl panel trim, (refer Fig. 6C-38).

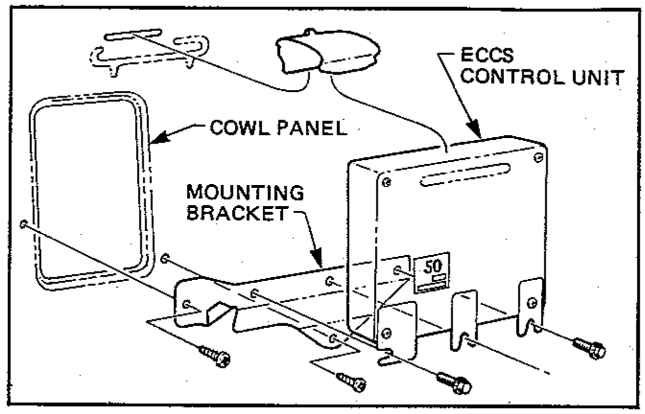


Figure 6C-38

The control unit receives signals from various sensors and switches (refer Fig. 6C-39) performs computations, and compares the results with the data stored in the memory. It then outputs signals for the control of ignition timing, idle speed, fuel pump operation, fuel pressure and fuel injection.

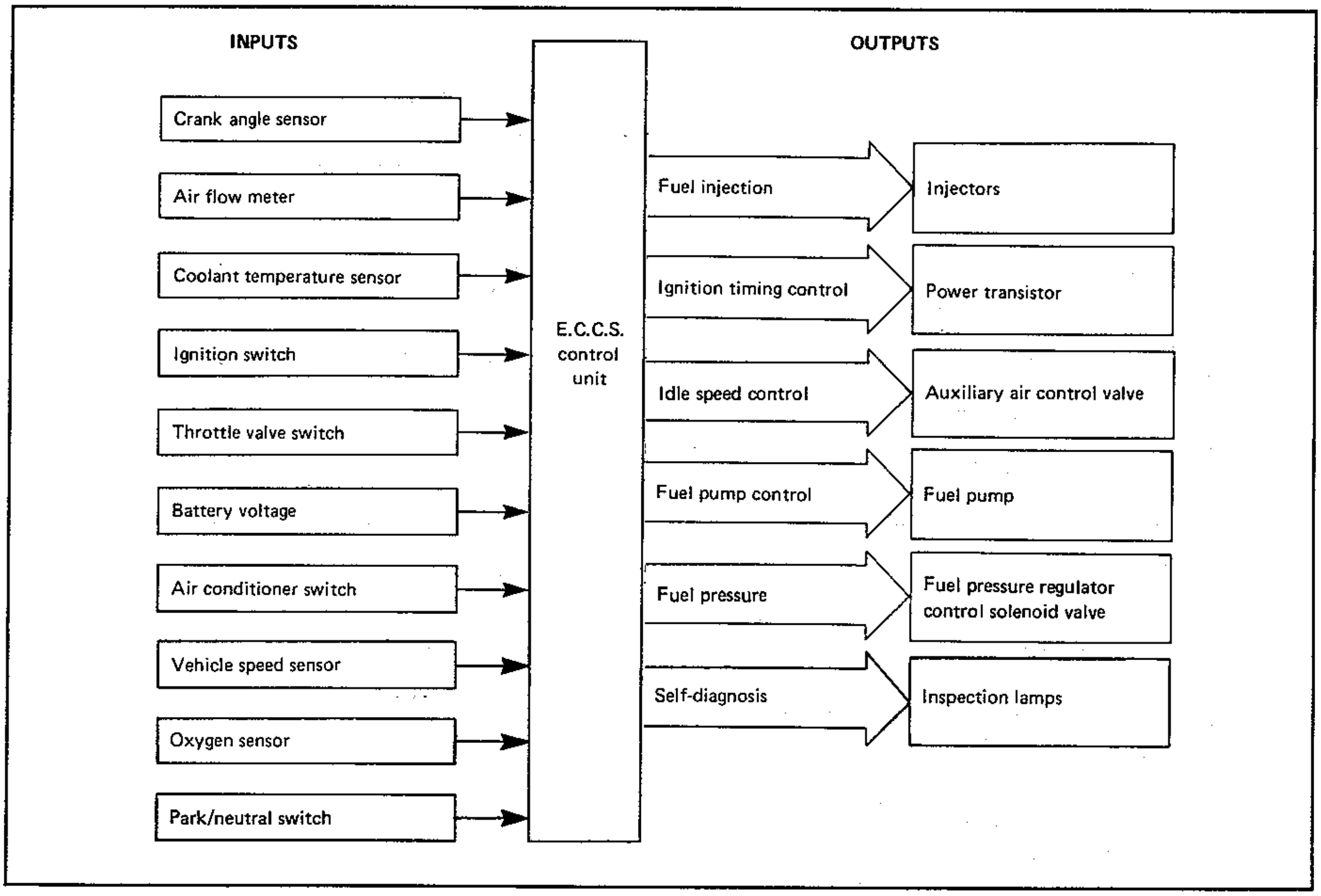


Figure 6C-39

If the control unit receives a signal from one of the sensors, which is outside the sensor operating parameters (i.e. the sensor is faulty), the control unit will substitute its own value for that sensor (referred to as 'BACK UP MODE' for that particular sensor). This enables the vehicle to be driven until the fault is repaired.

The crank angle sensor input is the only sensor input that the control unit cannot substitute, if it becomes faulty.

The ECCS control unit is a microcomputer, and can be divided into three major functional parts:

Input - Output (I/O) port.

Memory - Read Only Memory (ROM) and Random Access Memory (RAM).

Central Processing Unit (CPU).

The Input port is where the microcomputer converts signals from various sensors into numerical values which it can understand. The Output port converts the numerical values the microprocessor has calculated for the operation, into signals for operating the injectors and the power transistor (ignition timing) etc.

ROM and RAM are the memory of the microcomputer. The ROM stores the programmes to run the engine system and also the calibration data for fuel enrichment, ignition timing, etc, and the computer can only read this data from this memory. The RAM permits the results of calculations of information sent from various sensors and sent to various control devices to be stored temporarily.

The Central Processing Unit is the brain of the entire microcomputer system, and controls various functions of the computer. It processes the signals sent from the input port while controlling the ROM and RAM, and transmits the computed results from the output port which controls the injectors, power transistor etc.

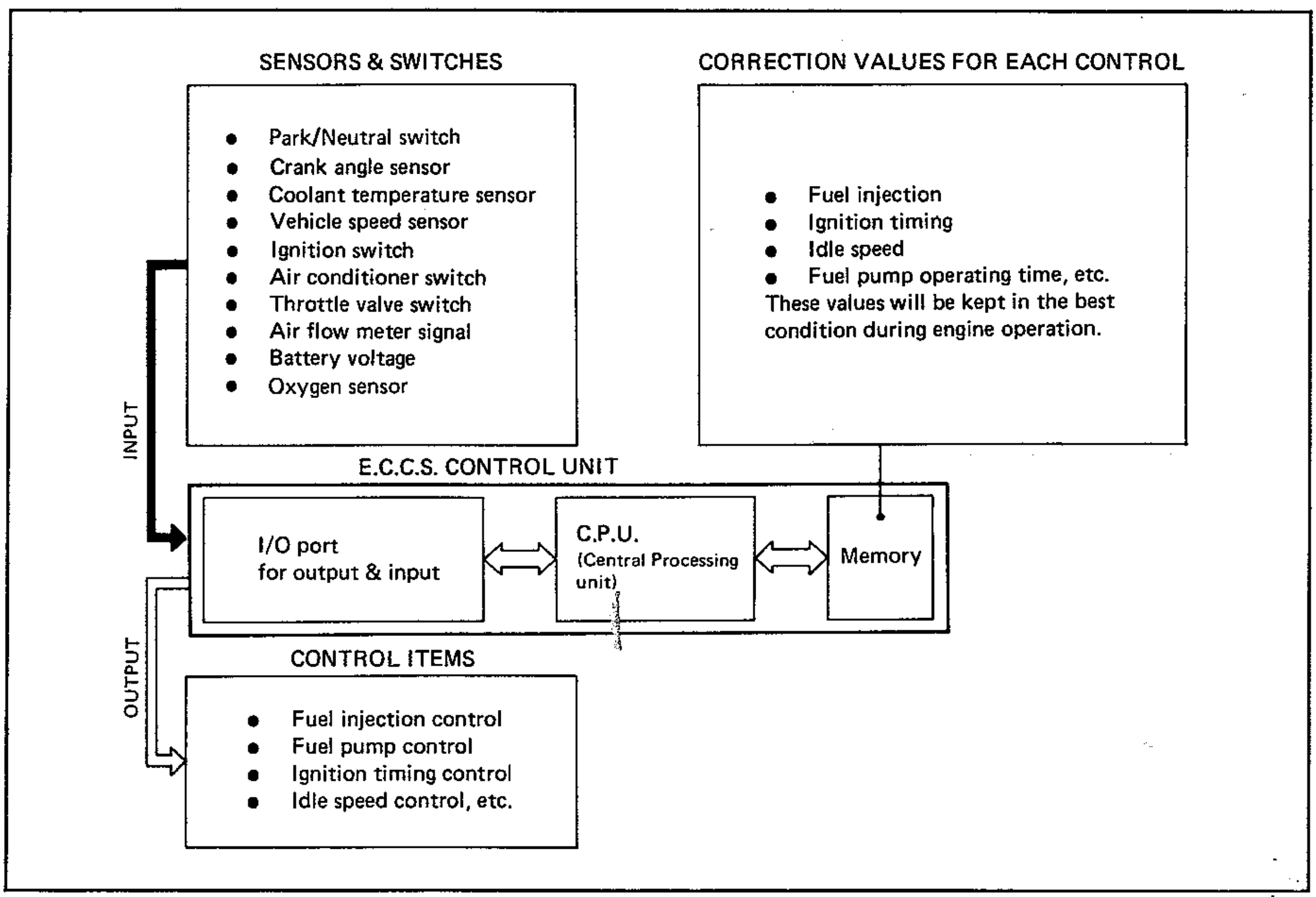


Figure 6C-40

The control unit has a self diagnostic system which displays and records system malfunctions.

A malfunctioning area is determined by a code which is displayed on two LIGHT EMITTING DIODES (LEDs), red and green coloured, located on the side of the control unit (refer Fig. 6C-41). Refer to '5. DIAGNOSIS' for details.

When the control unit diagnostic mode selector is in its normal position, and the ECCS is in closed loop operation, the diagnostic lamps may blink to indicate excessive or lack of oxygen in the exhaust gas.

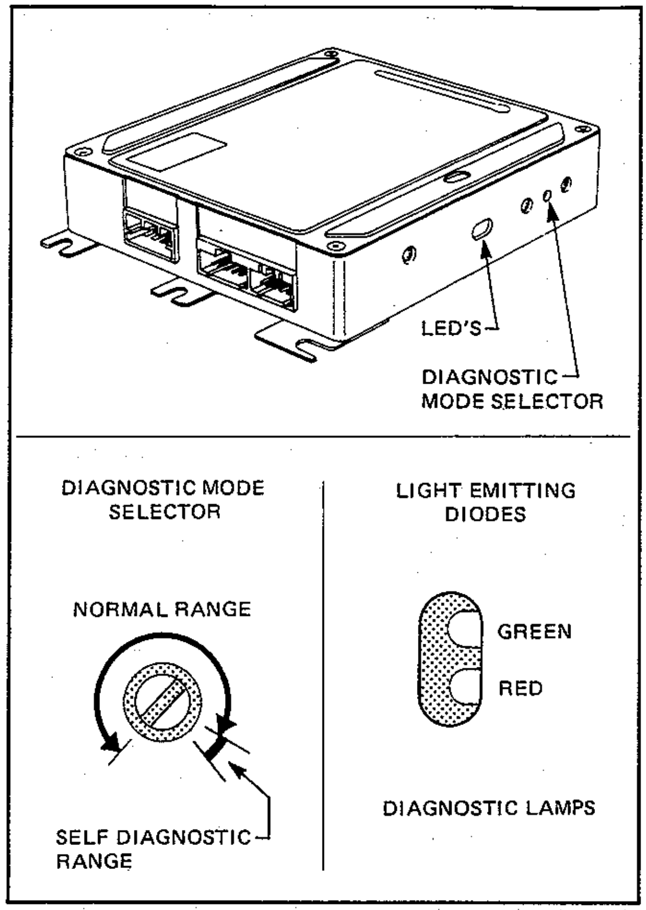


Figure 6C-41

The following chart interprets the coded flashing of the diagnostic lamps with the mode selector in normal position.

NOTE: The following conditions must be checked before interpreting the closed loop operation of the diagnostic lamps.

1. Engine at operating temperature, preferably achieved by driving.
2. Throttle valve switch connected.
3. Engine at 2000 ± 200 rpm.
4. Diagnostic mode selector turned counter clockwise (normal position).

MIXTURE CODE SEQUENCE CHART

DIAGNOSTIC LAMPS		NO.	DECODING LAMP FUNCTIONS	CAUSE OR STATUS
GREEN	RED			
OFF	OFF	1	Closed Loop Not Functioning	1. Oxygen Sensor and Harness Malfunction 2. Fully Rich 3. Fully Lean
Flashing 5 times per 10 secs.	ON	2	Oxygen Sensor Functioning OK Base Mixture Ratio Lean	Air Flow Meter requires Adjusting
	OFF	3	Oxygen Sensor Functioning OK Base Mixture Ratio Rich	Air Flow Meter requires Adjusting
	Flashing staying 'ON' longer than 'OFF'	4	Oxygen Sensor Functioning OK Base Mixture Slightly Lean	Operation within tolerance (Note 1)
	Flashing staying 'OFF' longer than 'ON'	5	Oxygen Sensor Functioning OK Base Mixture Slightly Rich	Operation within tolerance (Note 1)
	Flashing in time with green	6	Oxygen Sensor Functioning OK Base Mixture Ratio Correct ($\lambda = 1$)	Optimum Operation
Refer Fig. 6C–42				

NOTE 1: If adjustment is necessary, the mixture ratio should be adjusted to the No. 6 "Optimum Operation" (Red lamp should flash in-time with the green lamp).

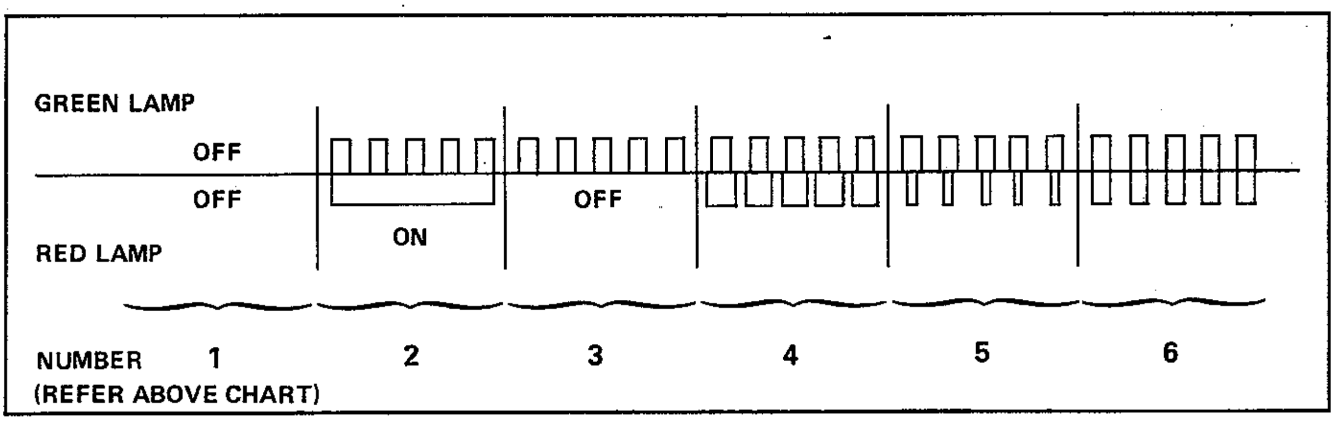


Figure 6C-42

3.5 CRANK ANGLE SENSOR

The crank angle sensor is one of the basic ECCS sensors and is built into the distributor. The sensor function is to provide the control unit with two types of input signals:

1. Engine speed.
2. Crank angle or piston position.

The crank angle sensor consists of three sections:

a. Sensor section with two Light Emitting Diodes (LEDS) and two photo diodes.
b. Rotor plate section with a number of slits. The rotor plate is driven by the distributor shaft.
c. Wave-forming circuit, which shapes the signal wave form sent from the photo diodes.

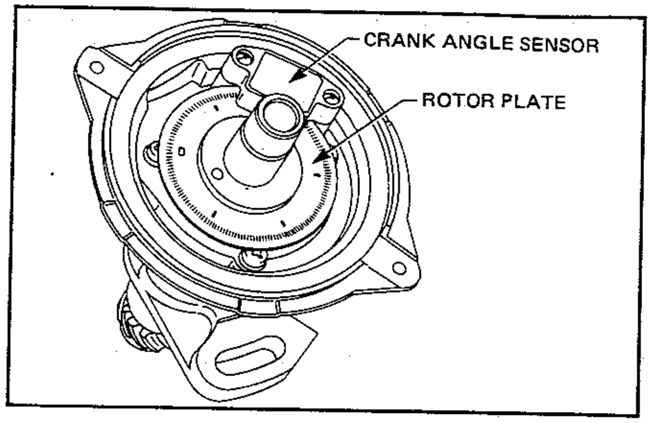


Figure 6C-43

The rotor plate is a circular disc which has 360 slits at 1 degree intervals on the outside circumference for detecting engine speed, (refer Fig. 6C-44). It also has 6 slits at 60 degree intervals (to represent 120 degrees of crankshaft travel), with the slit for No. 1 cylinder being the largest. These 120 (engine) degree slits are used for detecting crank angle or piston position.

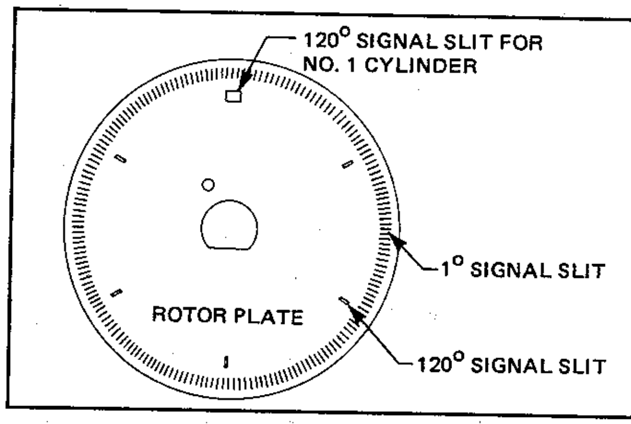


Figure 6C-44

One LED and photo diode pair is used to detect engine speed, the other pair is used to detect crank angle or piston position. An 'ON-OFF' signal is generated when the light beam emitted from the LED is allowed to reach the opposing photo diode through a slit in the rotor plate and then cut off as the slit moves away. This generates a signal in the photo diode which is shaped by the wave forming circuit into a square wave and then transferred to the ECCS control unit.

NOTE: The crank angle sensor is not to be dismantled.

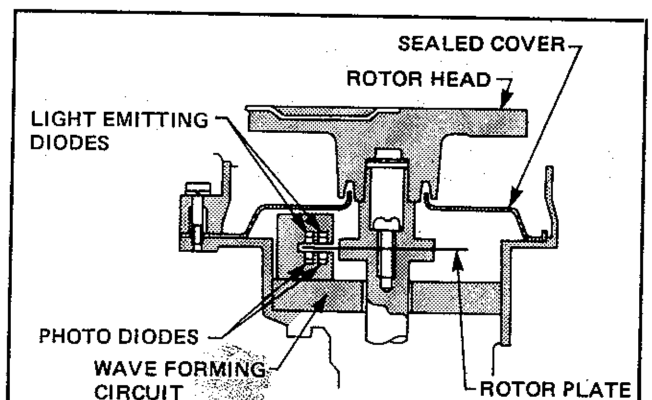


Figure 6C-45

OPERATION

If, for example, the engine speed is 2000 rpm with ignition timing at 40°BTDC, the 120° reference signal of the crank angle sensor is generated at 70°BTDC. If the timing is to be generated at ignition timing of 40°BTDC, one degree signal pulses (slits) must be counted starting with the arrival of the 70° signal, and after counting thirty 1° signal pulses (because 70-30=40) the power transistor must be turned off for ignition to take place.

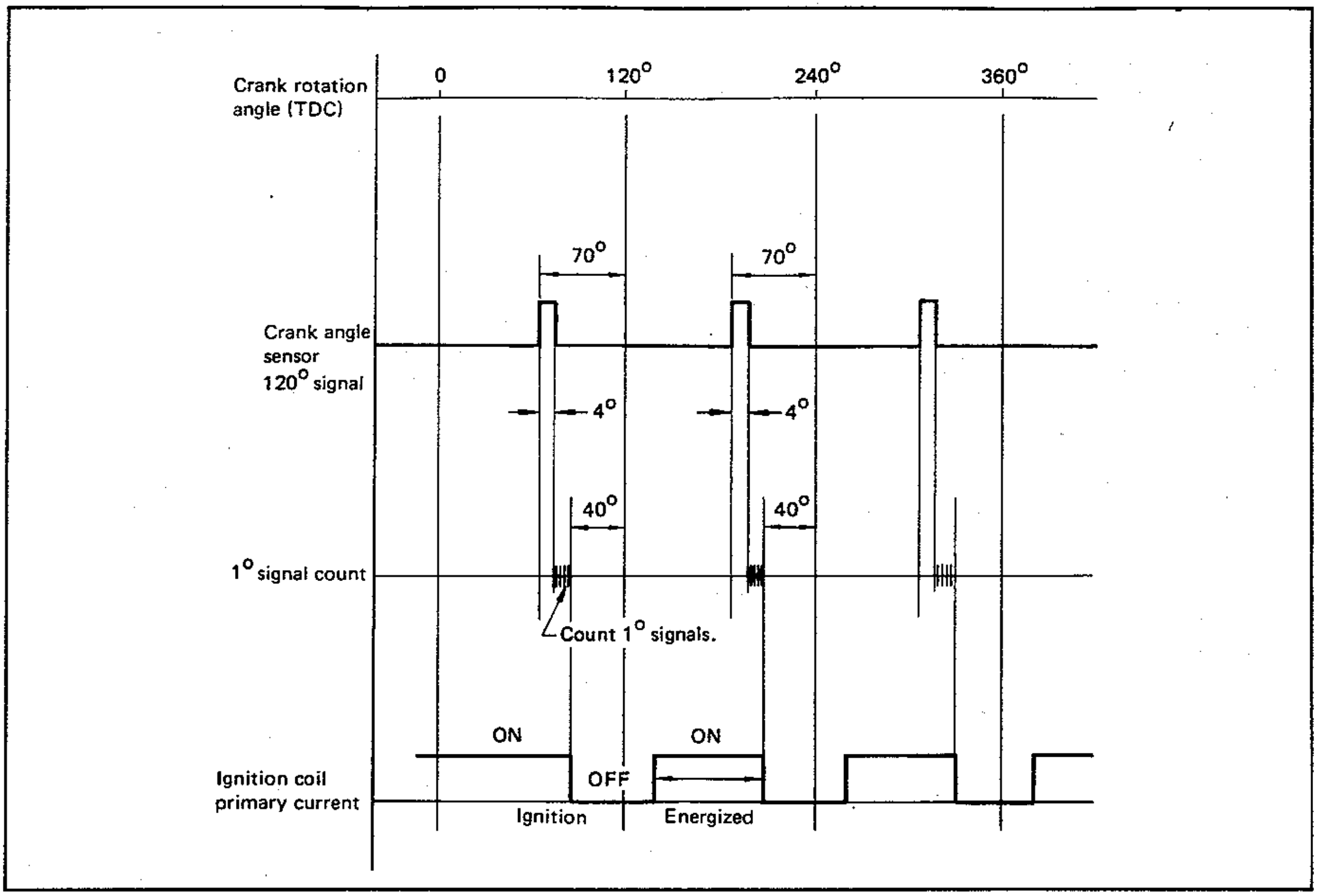


Figure 6C-46

3.6 POWER TRANSISTOR

The power transistor is mounted on the distributor, (refer Fig. 6C-47). Its function is to turn the primary current flowing through the ignition coil ON and OFF according to the signal sent from the control unit.

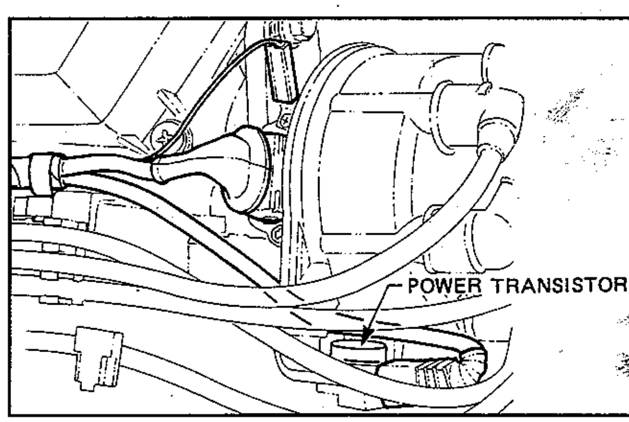


Figure 6C-47