

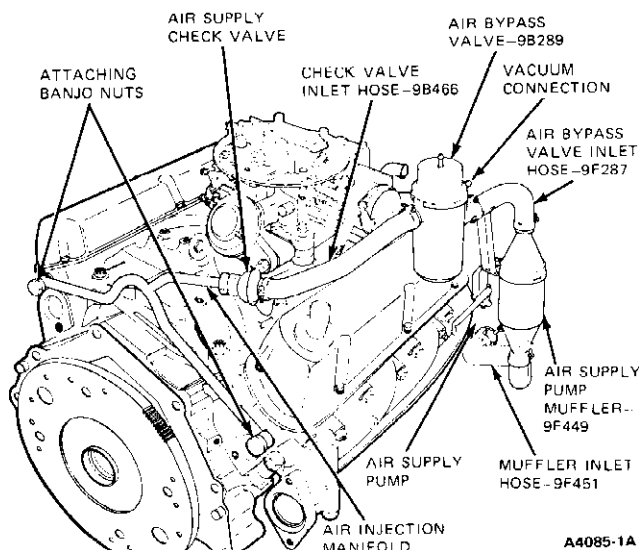


FIG. 2 Mustang II 302 CID V-8 Thermactor System

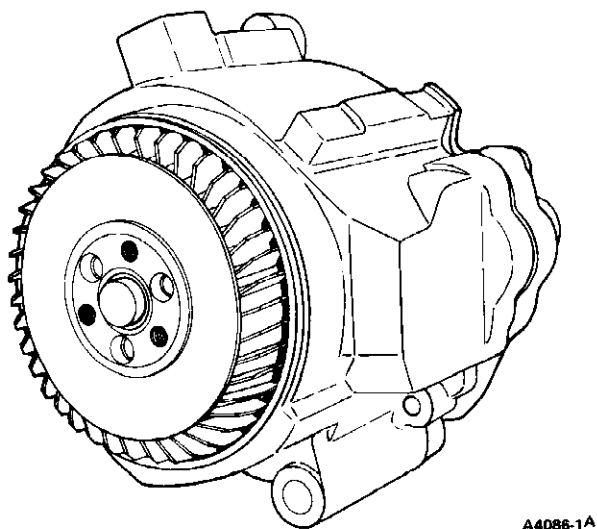


FIG. 3 Thermactor Air Supply Pump—Typical

again on both sides of the diaphragm through a small orifice in the diaphragm.

The normally-closed, timed bypass valve used with catalytic systems operates as follows: During normal operation, engine intake manifold vacuum applied through the VDV holds the normally-closed valve upward, allowing thermactor air to flow to the cylinder head(s) and blocking the vent port (Fig. 5). When engine intake manifold rises or drops sharply (such as during acceleration or deceleration, or system blockage or failure), the VDV operates and momentarily cuts off the vacuum to the bypass valve. The spring pulls the stem down, seating the valve to cut off pump air to the exhaust manifold, and opening the dump valve at the lower end of the bypass valve to momentarily divert the pump air to the atmosphere. In the case of excess pump volume or a downstream restriction, the excess pressure will unseat the valve in the lower portion of the bypass valve and allow a partial flow of pump air to the atmosphere. At the same time, the valve in the upper

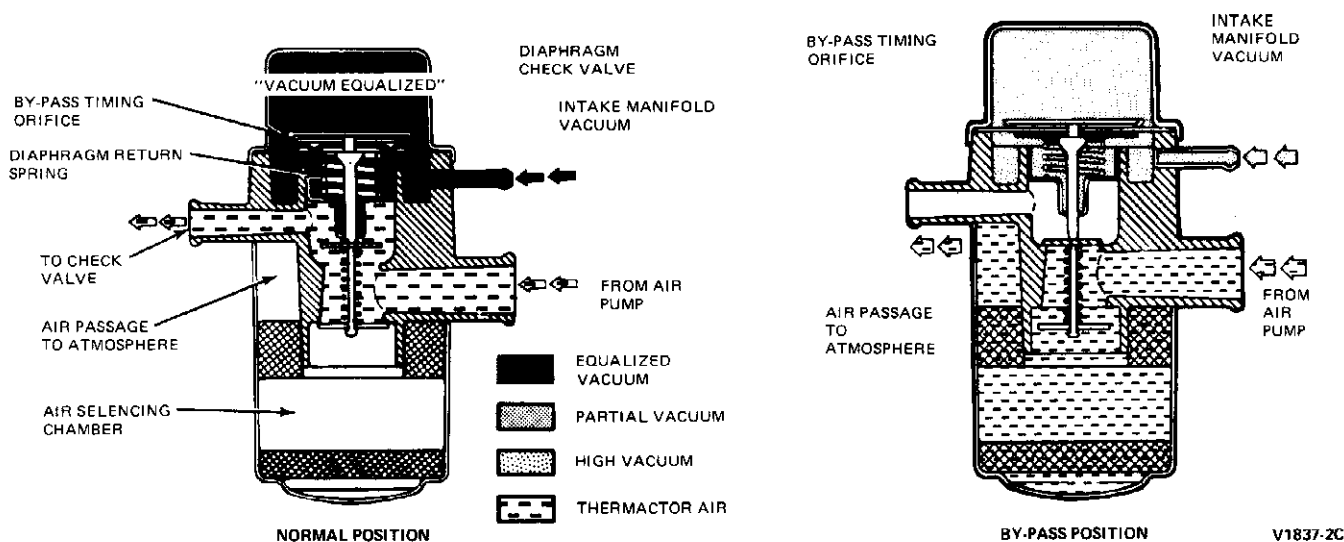


FIG. 4 Timed Bypass Valve

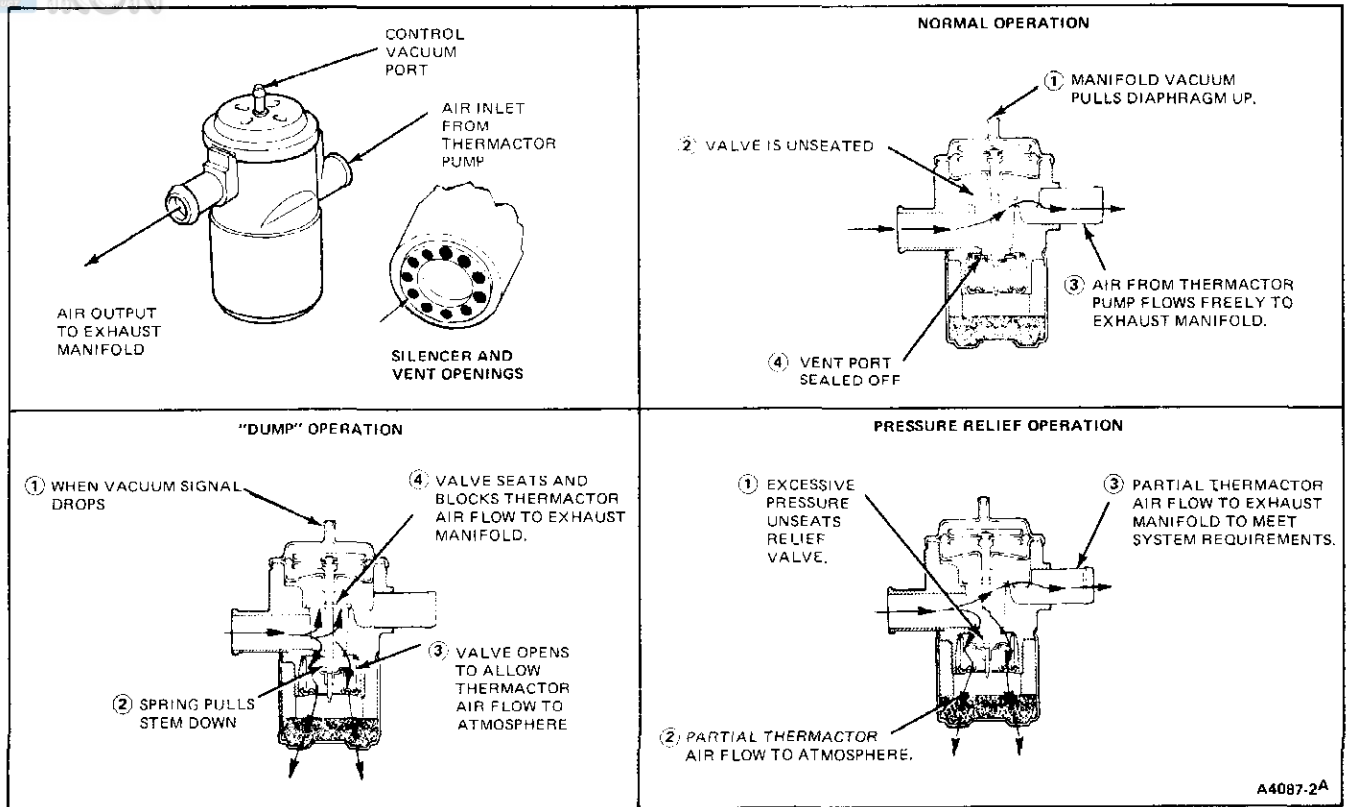


FIG. 5 Bypass Valve—Normally Closed

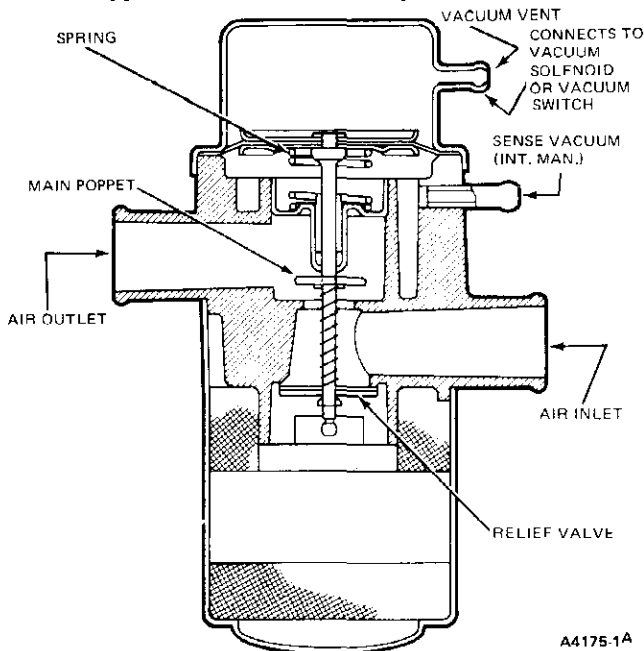


FIG. 6 Timed Air By-Pass Valve With Integral Vacuum Differential Function

part of the bypass is still unseated, allowing a partial flow of pump air to the exhaust manifold to meet system requirements.

A timed air by-pass valve is used with some thermactor systems (Fig. 6).

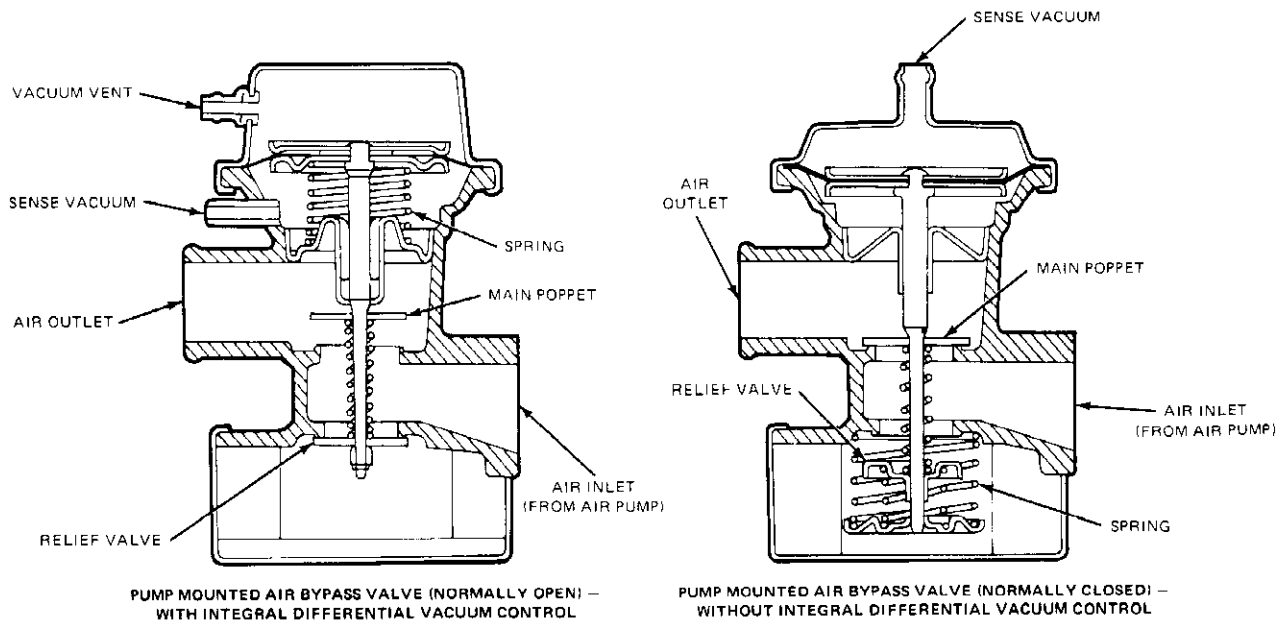
This by-pass valve contains an integral vacuum differential function and a vacuum vent. A separate VDV is not required with this valve. When the vent is

blocked, the valve functions as a timed by-pass valve just as was used in past years with a VDV. When the vent is open to atmospheric pressure, however, and a vacuum of 4" Hg or more is applied to the source port, the valve goes immediately to the "dump" mode. Thermactor air pump mounted bypass valves are shown in Fig. 7. Operation for these valves is the same as similar types of in-line valves.

VACUUM DIFFERENTIAL VALVE (VDV)—CATALYST SYSTEMS

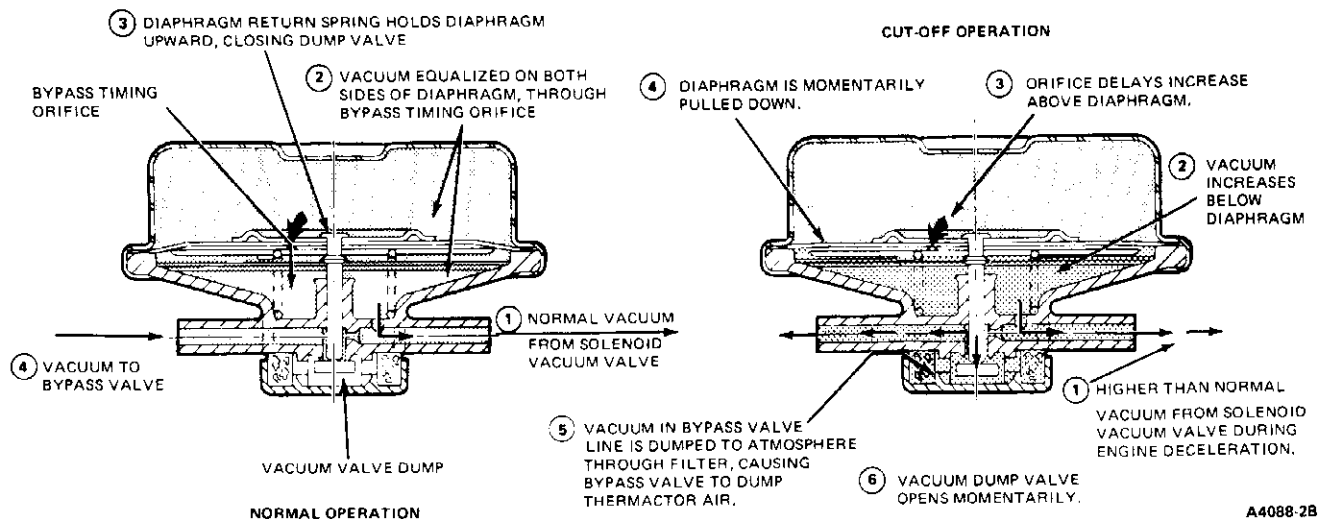
The vacuum differential valve (VDV) controls the operation of the bypass valve that doesn't have an integral differential valve (Fig. 8).

The VDV is inserted in the vacuum control line to the bypass valve and serves to cut off the vacuum and de-energize the bypass valve. The differential valve consists of a diaphragm connected to a dump valve that controls the vacuum to the bypass valve. During normal operation, vacuum is equalized on both sides of the diaphragm and the spring holds the dump valve closed. When sudden higher than normal vacuum is encountered, such as under deceleration conditions, vacuum is higher on the dump valve side of the diaphragm and the diaphragm operates the dump valve. As the dump valve operates, the vacuum signal to the bypass valve is diverted through the built-in filter system to atmosphere. When the vacuum bleeding through the bypass timing orifice in the VDV has equalized on both sides of the diaphragm, the diaphragm return spring once again closes the dump valve and applies vacuum to the bypass valve, which again directs pump air to the exhaust ports.



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FIG. 7 Air Pump Mounted Bypass Valves



A4088-2B

FIG. 8 Vacuum Differential Valve (VDV)—Catalyst Systems Only

DIFFERENTIAL VALVE DELAY VALVE (DVDV)

This delay valve is used to delay air bypass during periods of low engine manifold vacuum. The DVDV is installed in series with the VDV (Fig. 9).

This installation of a delay valve in the sense vacuum line delays operation of the vacuum differential valve during sudden drops in manifold vacuum such as during hard acceleration. During sudden deceleration, however, the sudden rise in intake manifold vacuum opens the check in the delay valve, passing the signal along instantly.

VACUUM VENT VALVE

Some engines which use the 2700 variable venturi carburetor require vacuum vent valves (Fig. 10).

The thermactor vacuum vent valve provides the makeup air for the thermactor retard delay valve and air bypass valve during idle modes to deactivate the thermactor system after a controlled period of time.

Application of vacuum from the carburetor to both parts of the thermactor vacuum vent causes the diaphragm to initially move left (Fig. 10) and the dump valve to seat. With the dump valve seated, the vacuum is applied to the rest of the system.

The removal of vacuum during idle modes results in the diaphragm moving right (Fig. 10). The dump valve leaves the seat, opening the vent and allowing air to enter the system to reduce the vacuum previously applied to the retard delay valve.

EXHAUST CHECK VALVE (FIG. 12)

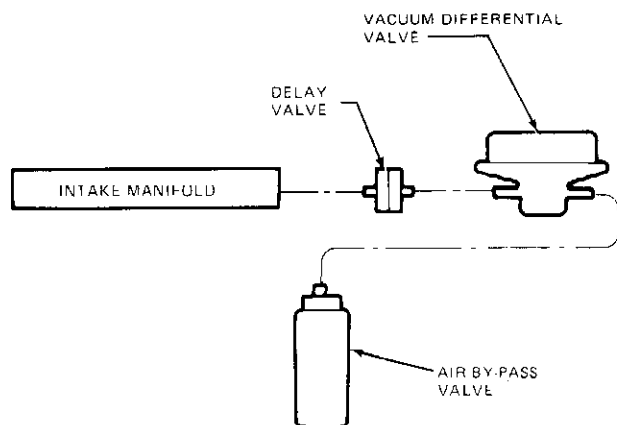
The exhaust gas check valve allows thermactor air to enter the exhaust port drillings, but prevents the reverse flow of exhaust gases in the event of improper operation of system components. The valve is located between the bypass valve and the exhaust port drillings, either mounted on the external air manifold or directly on the engine.

THERMACTOR II SYSTEM (Pulsed Air Type)

The 3.3L (200 CID) I-6 used in Fairmont and Zephyr with automatic transmission (49 States) is equipped with a new exhaust air injection system called "Thermactor II". (California, altitude, and manual transmission applications use Thermactor I system). The new system differs from the Thermactor system used on other applications in that it has no air pump. In operation, the system uses the natural pulses present in the exhaust system to "pull" air into the exhaust manifold.

An air inlet valve (Fig. 13) and a flame arrestor are connected to the exhaust manifold and air cleaner with hoses. The air inlet valve looks like a conventional Thermactor check valve, but they are not interchangeable.

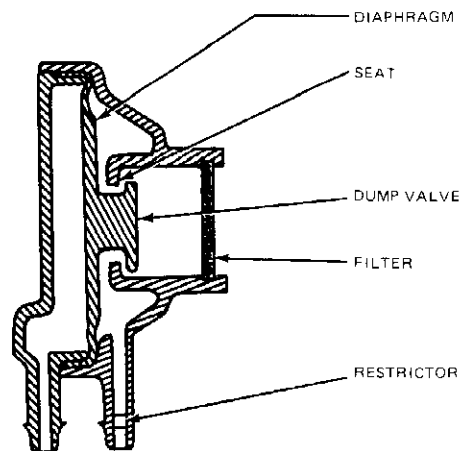
When the pressure in the exhaust manifold is **more** than the pressure in the air cleaner (Fig. 14), the reed valve closes. When the pressure in the exhaust manifold is **less** than the pressure in the air cleaner, the reed valve opens and air is drawn into the exhaust manifold. The incoming oxygen reduces the hydrocarbon and carbon monoxide content of the exhaust gases by



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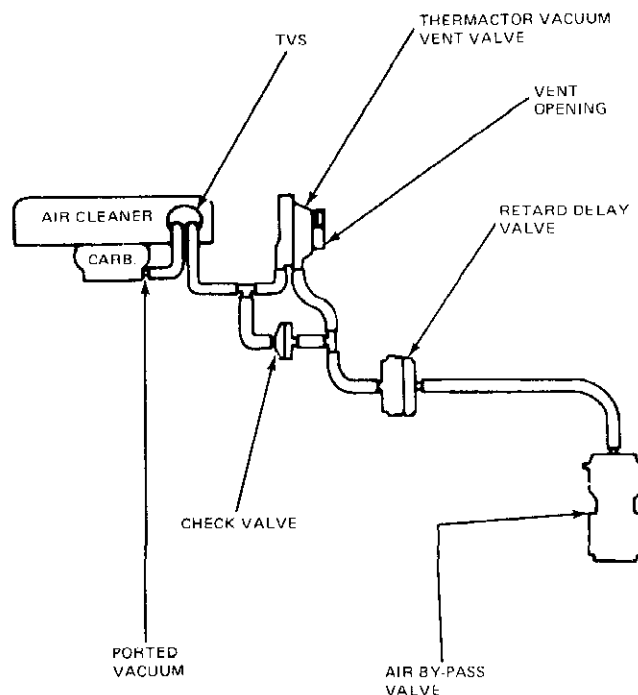
Fig. 9 Differential Valve Delay Valve

continuing the combustion of unburned gases in the same manner as the conventional air pump type Thermactor system.



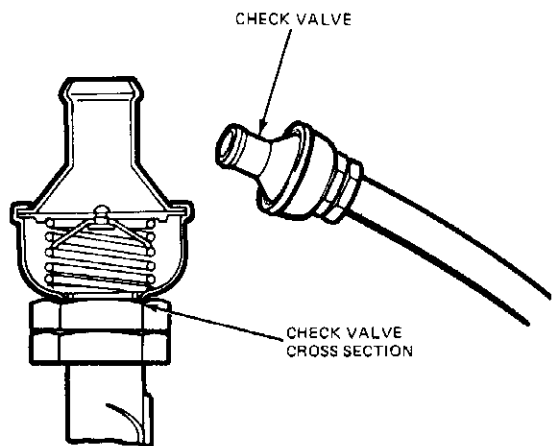
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FIG. 10 Thermactor Vacuum Vent Valve



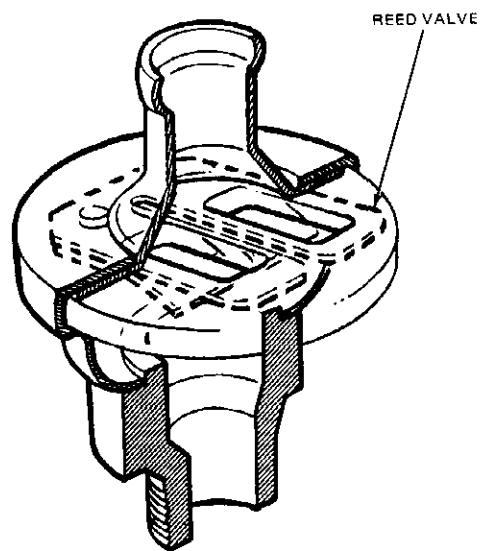
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FIG. 11 Typical Vent Valve Installation



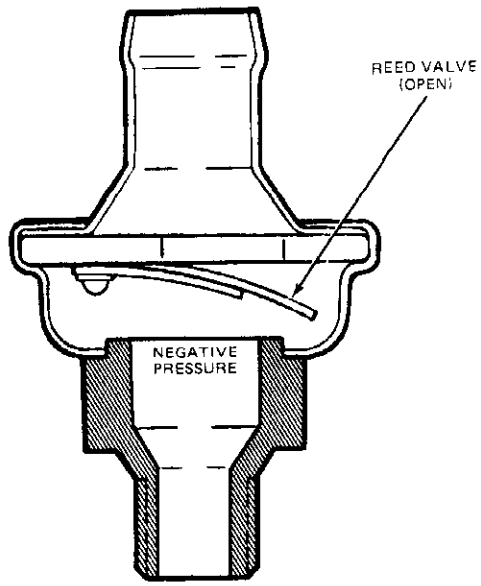
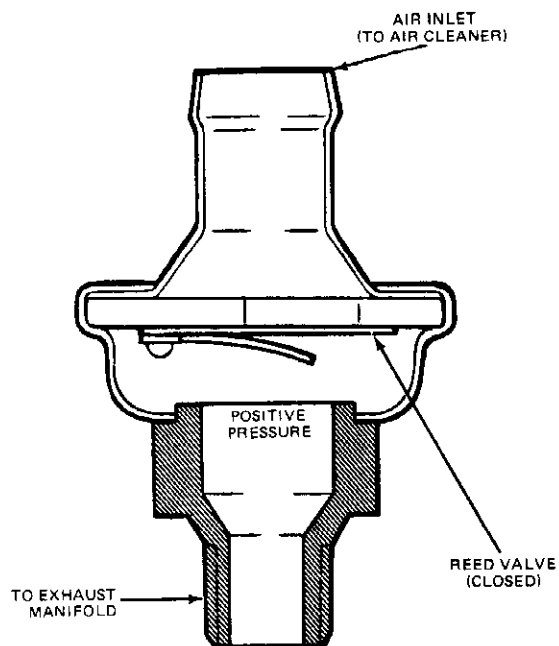
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FIG. 12 Exhaust Check Valve



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FIG. 13 Thermactor II Air Inlet Valve



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FIG. 14 Air Inlet Valve Operation

Electronic Engine Control (EEC) System

PART
29-06

Lincoln Versailles W/5.0L (302 CID) Only

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CA4531-2A

DESCRIPTION

GENERAL

The Lincoln Versailles for 50 states and Canada is equipped with an integrated electronic engine control system designed to more precisely control ignition timing, EGR flow rate and Thermactor System air flow. The new system is called the Electronic Engine Control (EEC) System, and consists of an Electronic Control Assembly (ECA) and seven sensors, a Dura-Spark II ignition module and coil, a unique distributor assembly and an air pressure operated EGR System (Fig. 1).

To monitor ambient conditions and the function of the vehicle and engine, two pressure sensors, two temperature sensors and three position sensors are required. The sensors monitor:

- Manifold Absolute Pressure
- Barometric Pressure
- Engine Coolant Temperature
- Inlet Air Temperature
- Crankshaft Position
- Throttle Position
- EGR Valve Position

The sensors monitor these various engine and ambient conditions and send electrical signals to the ECA for processing. The ECA computes the correct ignition timing, EGR flow rate and Thermactor air flow for the best performance and emission control and sends command to the ignition module, the EGR Control Solenoids and the Thermactor Air Control Solenoid.

If for some reason the ECA should not function properly, it goes into what is called the Limited Operation Strategy (LOS) Mode. In the LOS mode,

spark advance is held constant at 10 degrees BTDC; EGR and Thermactor systems are deactivated. This allows operation of the vehicle, although with reduced performance, until repairs can be made.

EEC SYSTEM COMPONENTS

Electronic Control Assembly (ECA)

The Electronic Control Assembly (ECA) is the "brain" of the EEC System, and is a solid-state, micro-computer consisting of a Processor Assembly and a Calibration Assembly (Fig. 2). This assembly is located in the passenger compartment under the instrument panel, just to the right of the steering column.

PROCESSOR ASSEMBLY

The processor assembly is housed in an aluminum case and contains circuits designed to:

- Continuously sample the seven sensor input signals.
- Convert the sampled signal to a form usable by the computer section in calculations
- Perform ignition timing, thermactor and EGR flow calculations
- Send electrical output control signals to the ignition module and control solenoids to adjust timing, EGR flow rate and Thermactor air flow.

The processor assembly also provides a continuous reference voltage (about 9 volts) to the sensors.

CALIBRATION ASSEMBLY

The Calibration Assembly (Fig. 2) is attached to the top of the Processor Assembly with two screws, and



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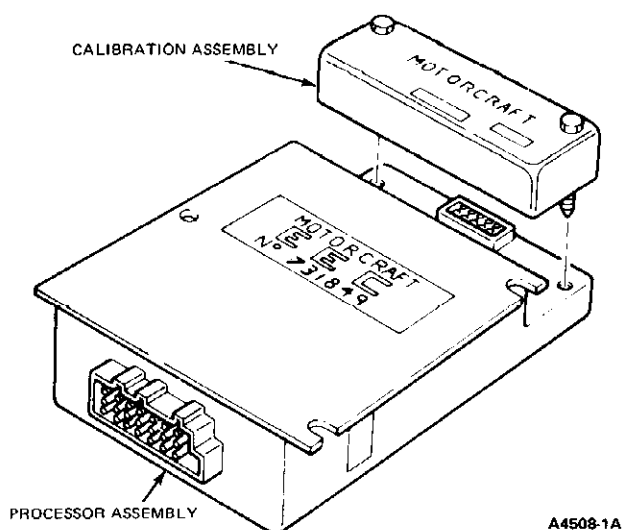


FIG. 2 Electronic Control Assembly (ECA)

contains the "memory" and programming for the processor assembly. It is capable of:

- Providing calibration information for that particular vehicle, for use by the processor assembly.
- Storing calculations for the processor assembly.
- Recalling information from its memory when asked.

Power Relay

A power relay attached to the lower right hand side of the ECA mounting bracket (Fig. 3) supplies battery voltage to the EEC system. It also protects the ECA from damage possible due to reversed voltage polarity.

EEC Crankshaft

To provide the EEC system with an accurate "reference timing" (indication when pistons reach top dead center (TDC) the rear of the crankshaft is fitted with a four-lobe "pulse ring" (Fig. 4).

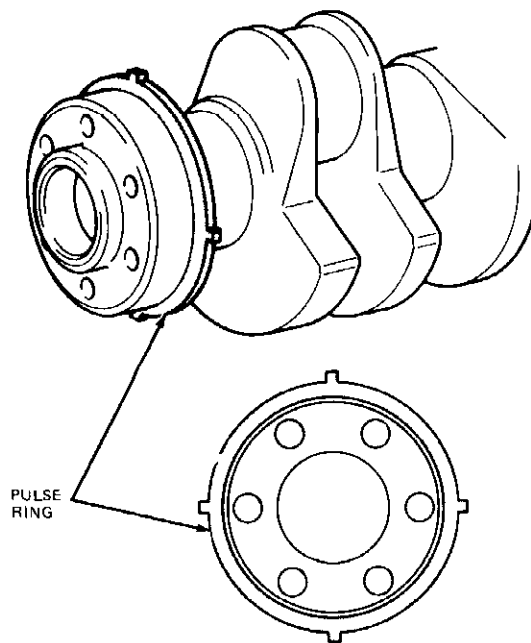


FIG. 4 Crankshaft Pulse Ring

The pulse ring is a thin (1/4") powdered metal ring carefully positioned on the crankshaft during manufacturing. It has four equally-spaced lobes which represent when pistons are at TDC. (The ring is actually positioned 10 degrees **before** top dead center (BTDC) to establish the engine reference timing at 10 degrees BTDC). Since four cylinders fire during each crankshaft revolution, only four lobes are needed.

Crankshaft Position Sensor

As the crankshaft rotates, the lobes on the pulse ring pass by the tip of the Crankshaft Position (CP) sensor (Fig. 5).

In operation, the crankshaft position sensor works somewhat like the breakerless distributor pickup coil; that is, the pulse ring interrupts the magnetic field generated by the tip of the sensor. When the field is interrupted, an output signal is generated and sent to the Electronic Control Assembly (ECA). As the crankshaft turns, the ECA interprets the electrical impulses to determine the exact position of the crankshaft at any given time. From the frequency of the pulses, the ECA can determine the engine rpm. By knowing these two factors, the ECA will determine the appropriate ignition timing advance required for best engine operation.

The crankshaft position sensor is held in place by a retaining clip and screw. An "O" ring near the top of the sensor seals the lower opening in the rear of the engine block. Once the sensor is locked in place, no field adjustment is necessary.

A broken sensor or open wiring will prevent the ECA from receiving a position signal, and the ECA will not

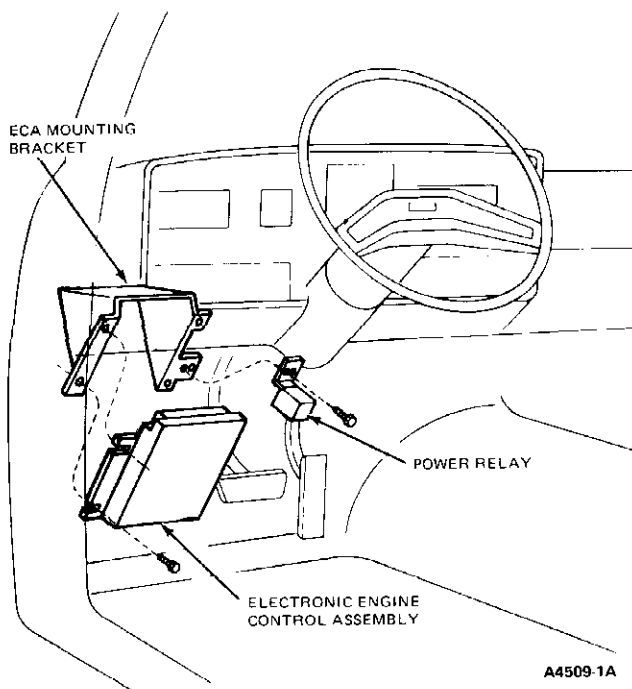


FIG. 3 Power Relay and ECA Attachment

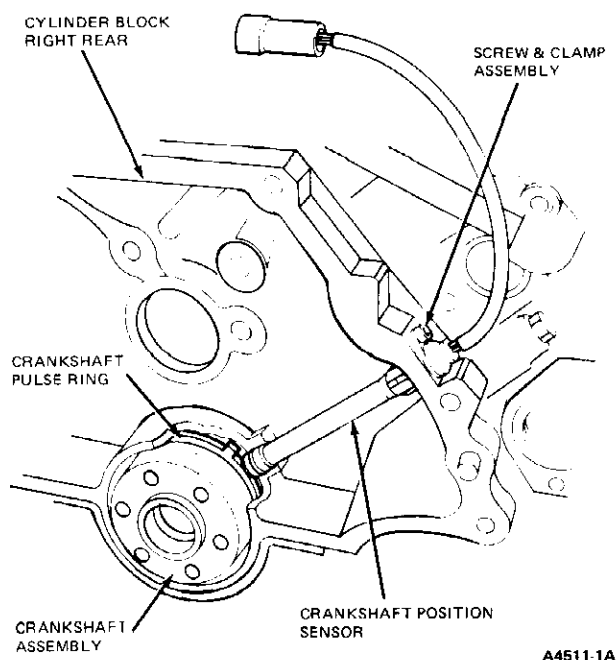


FIG. 5 Crankshaft Position (CP) Sensor

send a firing signal to the ignition module, thus disabling the ignition system and preventing the engine from starting.

Throttle Position (TP) Sensor

The Throttle Positioner (TP) Sensor is a potentiometer (rheostat) switch that responds to changes in throttle angle (Fig. 6).

With a reference voltage applied, the TP sensor output is interpreted as one of the following modes:

- Closed Throttle (idle or deceleration)

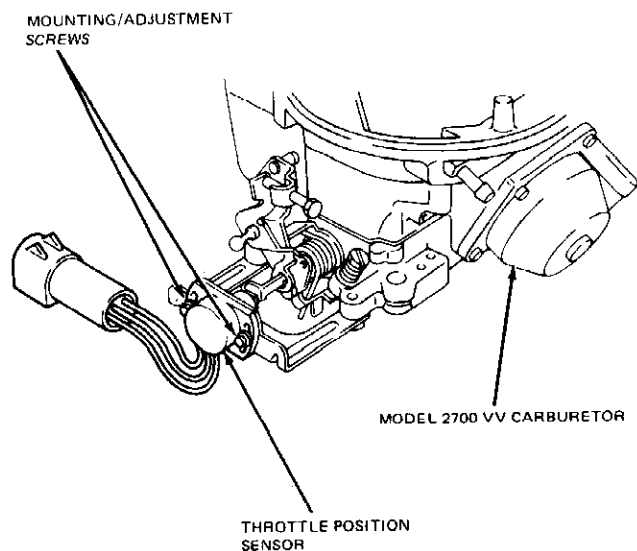


FIG. 6 Throttle Position (TP) Sensor

- Part Throttle (cruise)
- Wide Open Throttle (maximum acceleration)

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

The EGR system used with Versailles consists of three major components (Fig. 7):

1. EGR valve/sensor assembly
2. EGR Control Solenoids (2)
3. EGR Cooler Assembly

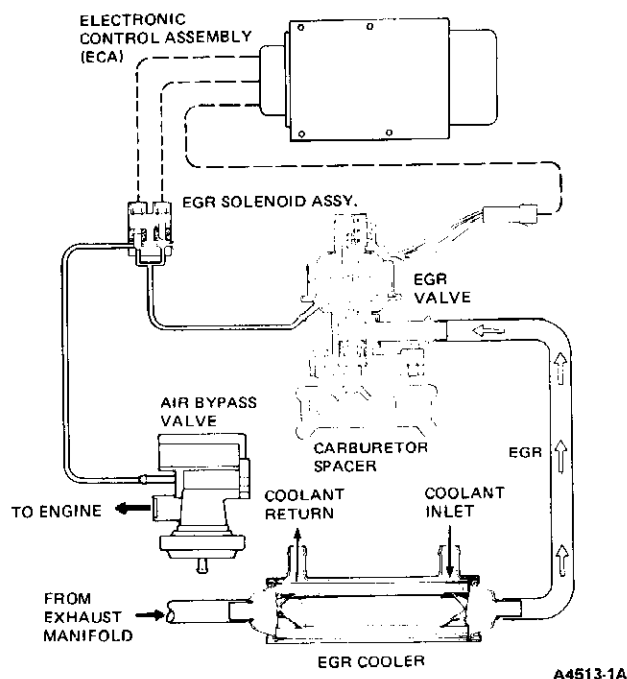


FIG. 7 Typical EGR System Used With EEC System

The EGR gas flow is controlled by the ECA, which utilizes air pressure from the Thermactor system bypass valve to operate the EGR valve. When the valve is open, exhaust gas from the exhaust manifold is allowed to flow into the intake manifold, becoming part of the combustion cycle and reducing NOx emissions.

EGR Valve and Sensor Assembly

The EGR valve used with the EEC system resembles the valve used with non-EEC system applications, but is air pressure operated rather than vacuum operated (Fig. 8).

The EGR valve attaches to a spacer (Fig. 9) that mounts under the carburetor on the intake manifold. The valve controls the flow of gases through a tapered pintle valve and seat. A position sensor built into the valve provides an electrical signal to the ECA that indicates EGR valve position.

Unlike non-EEC system EGR valves, the EEC system EGR valve is completely sealed, and no pintle valve movement can be seen when the valve is installed on the spacer. The valve and position sensor are serviced as a unit.

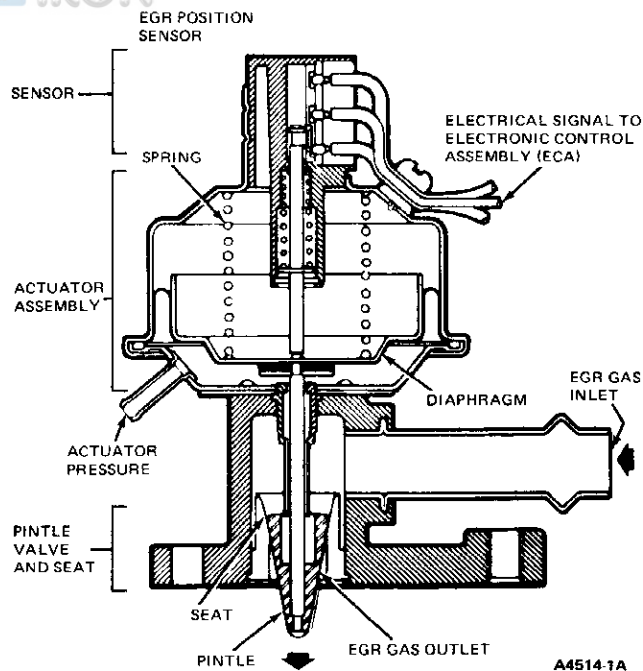


FIG. 8 EGR Valve Used With EEC System

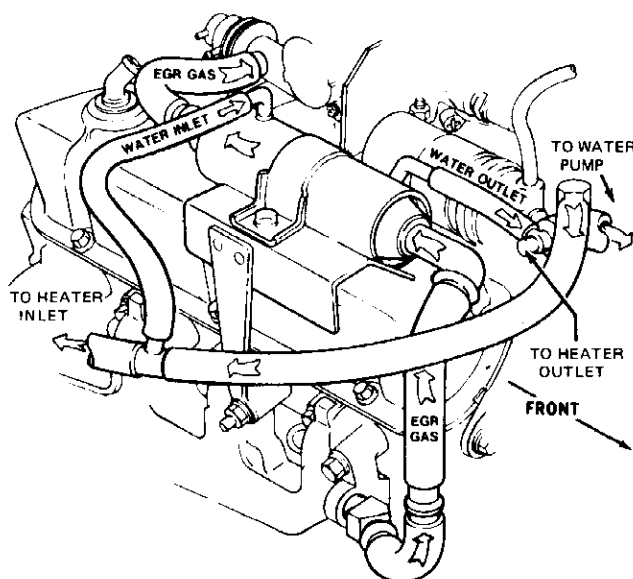


FIG. 10 EGR Gas Cooler

To properly control the air pressure used to operate the EGR valve, and to allow for application, hold and release of the air pressure, requires two types of solenoid valve:

1. A "vent" valve, which is normally open—that is, the outlet port is normally connected to the inlet port (Fig. 12) when the solenoid is **not** operated.
2. A "pressure" valve, which is normally closed—that is, the outlet port is normally blocked when the solenoid is **not** operated (Fig. 12).

EGR SYSTEM OPERATION

The EGR Valve is operated by air pressure supplied from the thermactor bypass valve. The pressure and vent solenoid valves work together under the direction of the ECA to:

- **INCREASE EGR FLOW** by applying air pressure to the EGR valve
- **MAINTAIN EGR FLOW** by trapping air pressure in the system
- **DECREASE EGR FLOW** by venting system pressure to atmosphere

With data received from the various sensors, the ECA determines the correct amount of EGR flow required, checks the position of the EGR valve pintle, and decides if a change in position is required. In response to these calculations, the ECA puts the EGR system into one of the modes shown in Fig. 13. The ECA samples and calculates these changes about 10 times each second, for improved economy and driveability under all conditions.

Fig. 14 is an overall view of the EGR system, showing the relationship of the thermactor bypass valve and control solenoid as it applies to the EGR system.

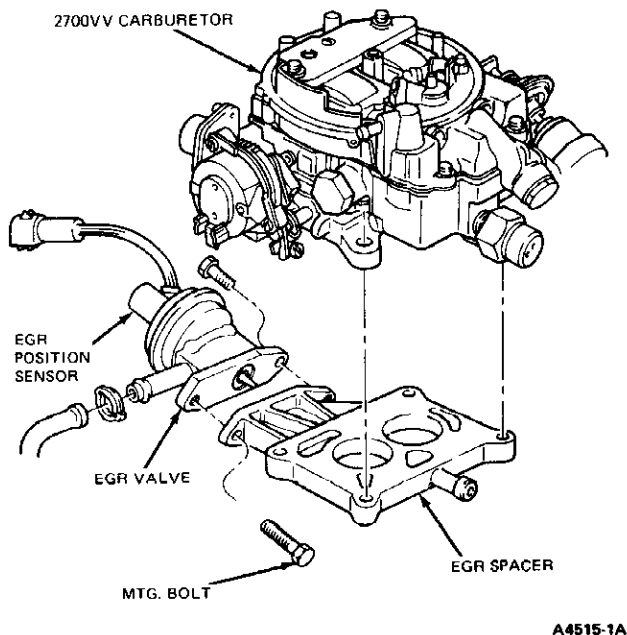


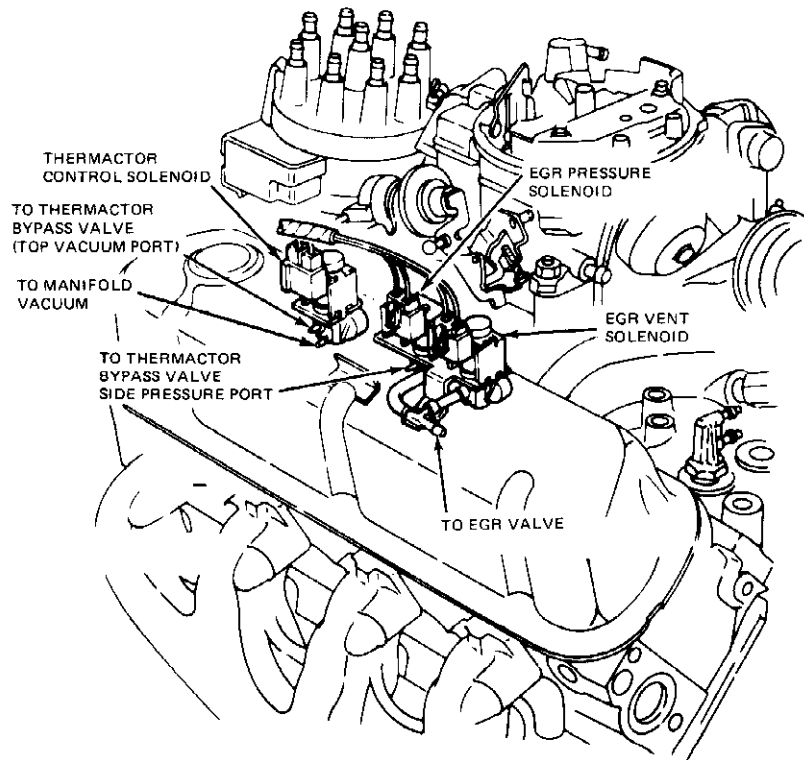
FIG. 9 EGR Valve And Spacer

EGR Cooler Assembly

In order to provide improved flow characteristics, better engine operation and EGR valve durability, an external EGR gas cooler is used to reduce EGR gas temperature (Fig. 10). The cooler assembly is mounted over the right valve cover and uses engine coolant to reduce the temperature of exhaust gases routed from the exhaust manifold to the EGR valve.

Dual EGR Control Solenoids

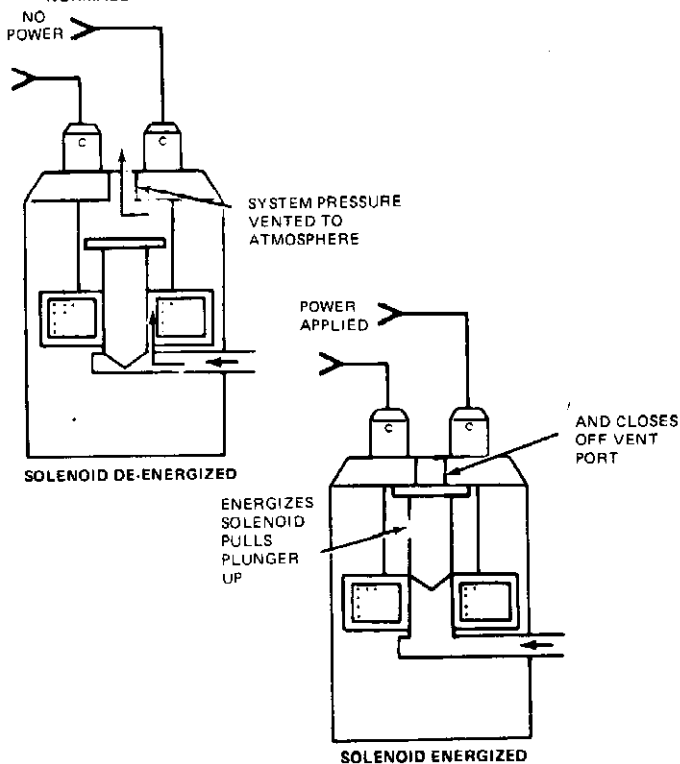
EGR valve movement is controlled by two solenoid valves mounted on a bracket above the left hand valve cover (Fig. 11).



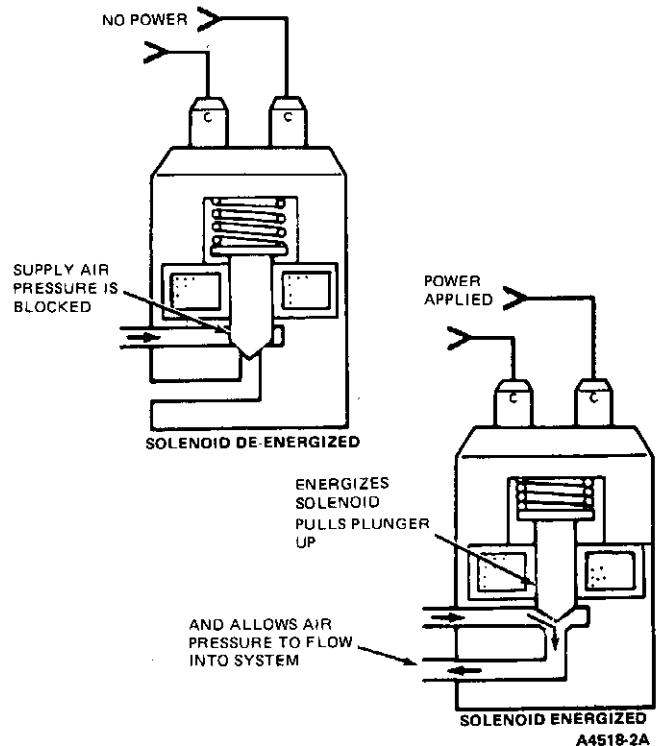
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FIG. 11 Dual EGR Control Solenoids

"NORMALLY OPEN" E.G.R. SOLENOID "VENT VALVE" OPERATION



"NORMALLY CLOSED" E.G.R. SOLENOID "PRESSURE VALVE" OPERATION



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FIG. 12 Vent and Pressure Solenoid

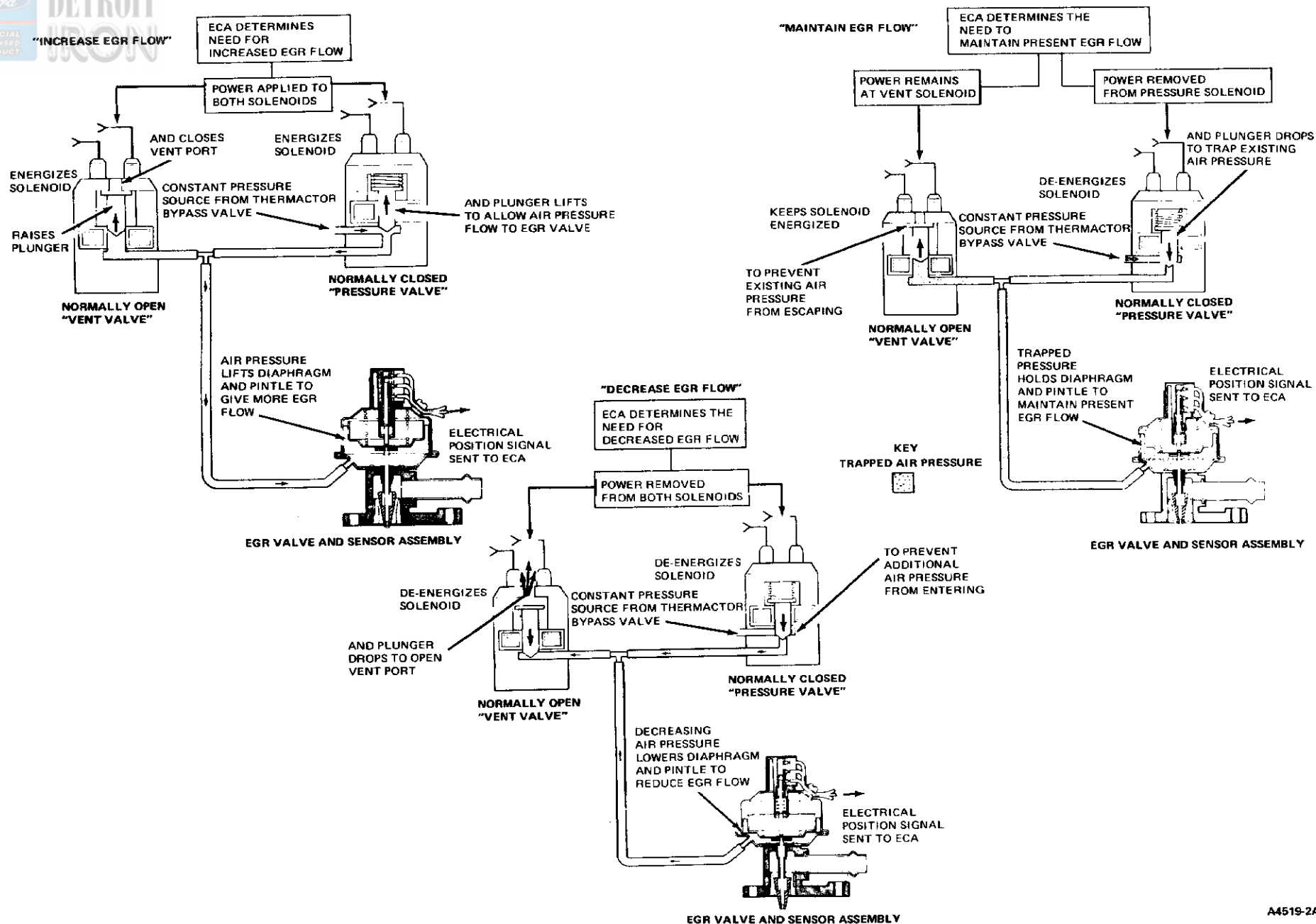
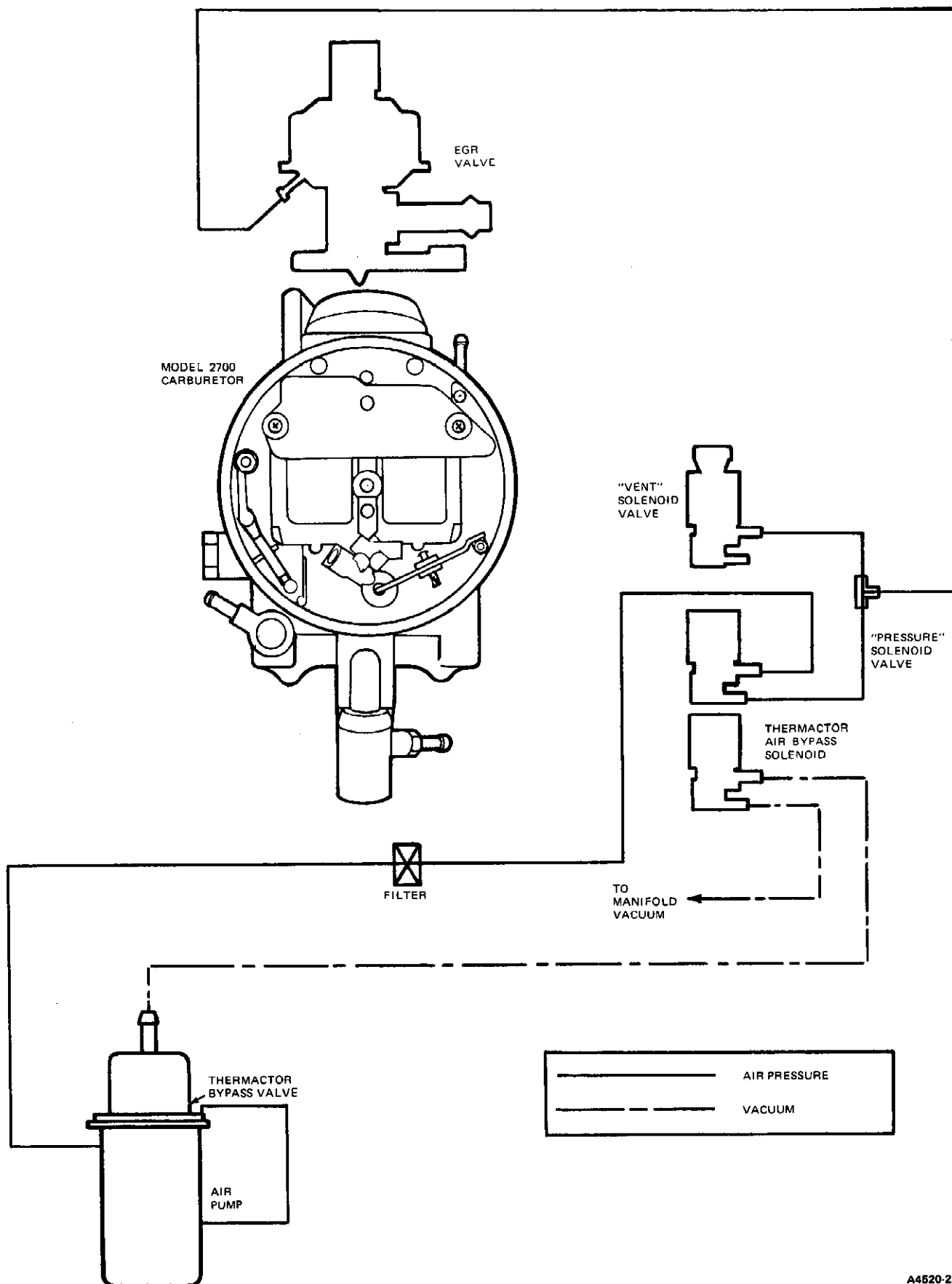


FIG. 13 EGR System Operation

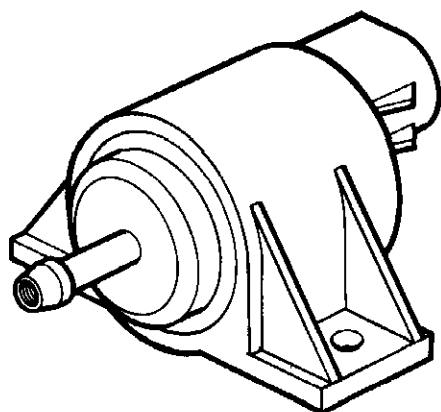


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FIG. 14 EGR System Vacuum/Pressure Line Schematic

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The Manifold Absolute Pressure (MAP) sensor (Fig. 15) monitors the changes in intake manifold pressure which result from changes in engine load, speed and atmospheric pressure. (Manifold Absolute Pressure is defined as barometric pressure minus manifold vacuum). The MAP sensor contains a pressure-sensing element and electronic circuits that convert pressure sensed by the unit into an electric signal for the ECA. This signal is used by the ECA to determine part throttle spark advance and EGR flow rate.

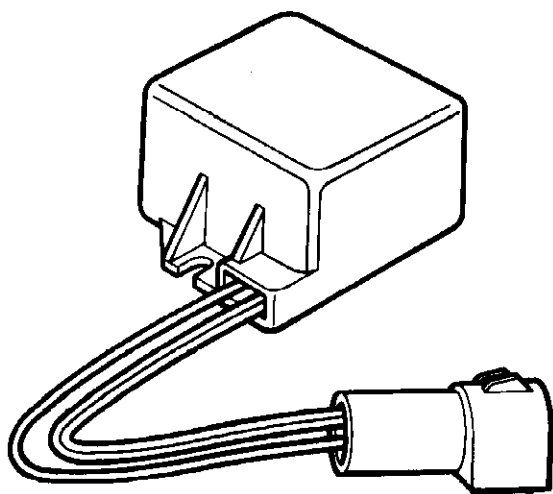


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FIG. 15 Manifold Absolute Pressure (MAP) Sensor

BAROMETRIC PRESSURE (BP) SENSOR

The BP sensor is mounted on the engine compartment side of the dash panel (Fig. 16) and senses barometric pressure. The pressure is then converted into an electrical signal and fed to the ECA for computations. From this input, the ECA is able to determine EGR flow requirements depending on the altitude at which the vehicle is being driven.

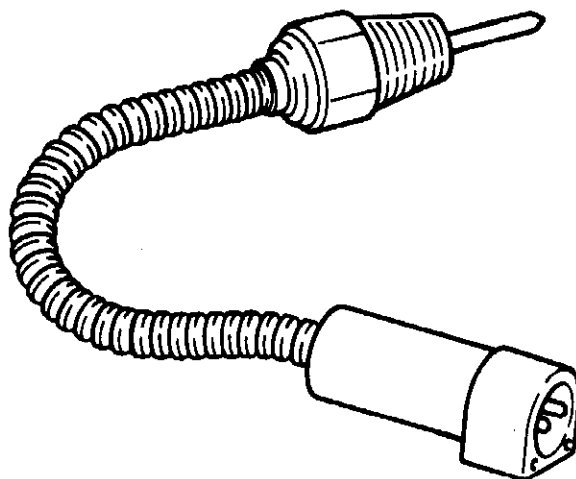


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FIG. 16 Barometric Pressure (BP) Sensor

COOLANT TEMPERATURE SENSOR (ECT)

The engine coolant temperature sensor (Fig. 17) is installed in the rear of the intake manifold and converts engine coolant temperature into an electrical signal for the ECA to process. The sensor consists of a brass housing which contains a thermistor (variable resistor in which the resistance decreases as the temperature rises) that measures engine temperature. When the reference voltage is applied to the sensor, the resistance can be measured by the resulting voltage drop, telling the ECA the coolant temperature.



A4523-1A

FIG. 17 Coolant Temperature Sensor (ECT)

The coolant temperature sensor takes the place of the cooling PVS and EGR PVS used in the conventional system. When the engine coolant temperature reaches a predetermined value stored in the system's memory, the ECA will cut off all EGR flow. In addition, if the engine coolant overheats from prolonged idle, the ECA will advance the engine initial ignition timing for increased engine idle speed and improved cooling system efficiency.

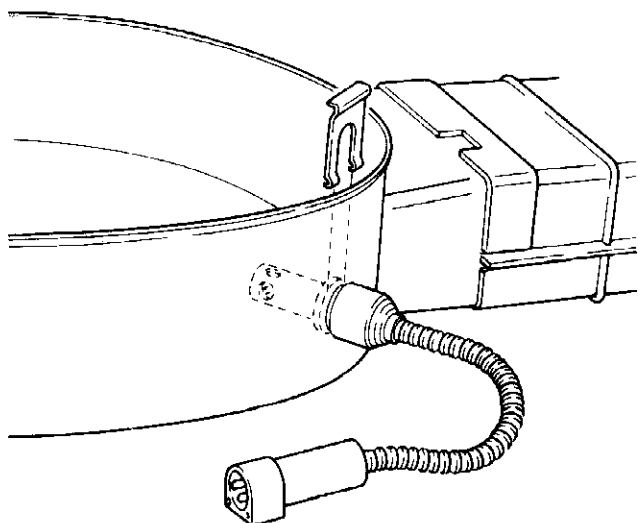
INLET AIR TEMPERATURE (IAT) SENSOR

The inlet air temperature sensor is similar in construction and function to the coolant temperature sensor, except for the addition of a protective shield near the tip (Fig. 18).

The sensor is mounted in the air cleaner body near the duct and valve assembly and is sensitive to changes in inlet air temperature. As inlet air temperature rises, the resistance of the sensing thermistor decreases, allowing the ECA to keep constant check on the temperature. With this information, the ECA can determine the proper spark advance and Thermactor system air flow. At high inlet air temperatures (above 32°C (90°F)) the ECA will modify ignition timing advance as necessary to prevent spark "knock".

THERMACTOR AIR BYPASS SOLENOID

The thermactor control solenoid is a normally closed valve that functions the same as the EGR pressure solenoid valve (Fig. 12). The upper port is connected to



A4524-1A

FIG. 18 Inlet Air Temperature (IAT) Sensor

the Thermactor bypass valve top (actuator) port and the lower port is connected to manifold vacuum. When the ECA energizes the Thermactor air bypass solenoid, manifold vacuum is applied to the bypass valve and Thermactor air is injected into the cylinder head exhaust ports. When the ECA de-energizes the Thermactor air bypass solenoid, the valve closes and the bypass valve "dumps" Thermactor air to the atmosphere. The ECA uses information from the inlet air temperature sensor and the throttle position sensor to determine when to inject air and when to dump air to the atmosphere.

IGNITION SYSTEM

The ignition system used with the EEC system uses a Dura Spark II ignition module and ignition coil (see Part 23-01) to generate the required high voltage spark. Routing the secondary voltage to the appropriate spark plugs is accomplished with an all-new distributor designed exclusively for the new EEC system.

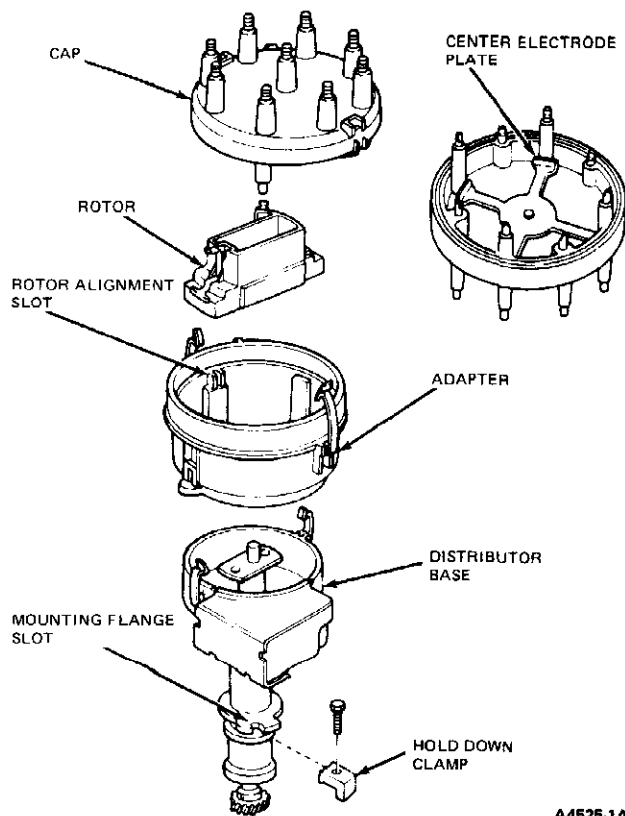
Distributor

The EEC distributor does not have conventional mechanical or vacuum advance mechanisms as do other Ford distributors. Instead, all ignition timing is controlled by the Electronic Control Assembly (ECA), which is capable of firing the spark plug at any point from top dead center (TDC) to 60 degrees before top dead center (BTDC). This increased spark advance capability requires greater separation of adjacent distributor cap electrodes to prevent cross-fire.

BI-LEVEL ROTOR AND DISTRIBUTOR CAP

The distributor rotor and cap electrodes have been designed to handle the additional advance capability, by using a two-level design (Fig. 19).

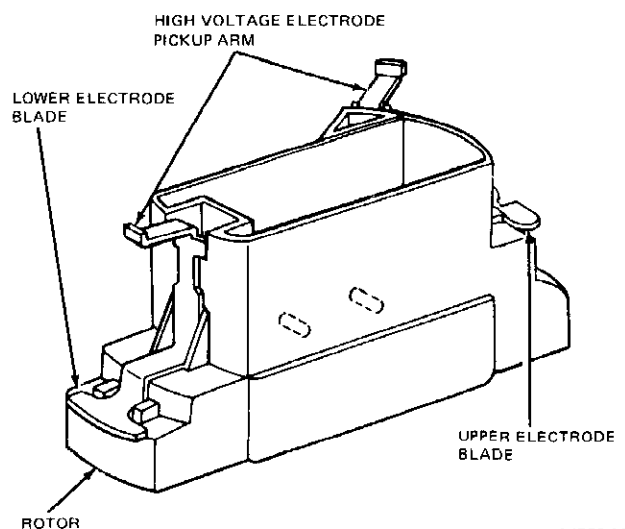
Both the rotor and cap have upper and lower electrode levels. As the rotor turns, one of the high-voltage electrode pickup arms (Fig. 20) aligns with one



A4525-1A

FIG. 19 EEC Distributor, Cap and Rotor

spoke of the distributor cap center electrode plate, allowing high voltage to pass from the plate, through the rotor to a terminal on the distributor cap and out to the spark plug.



A4526-1A

FIG. 20 Distributor Rotor

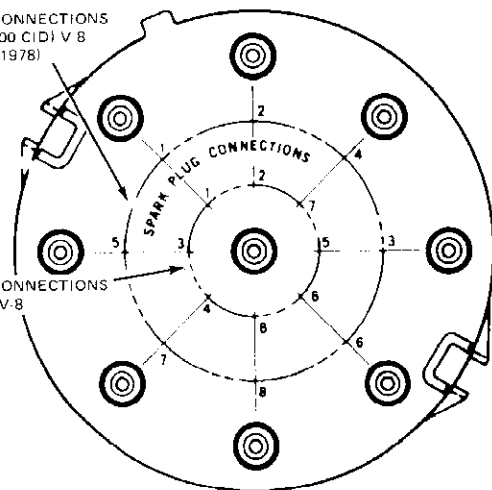
The numbers molded into the top of the cap are spark plug wire identification numbers (Fig. 21). Due to the unique construction of the distributor cap and rotor, however, the wires are not arranged in the cap in firing order. The inner ring of numbers (Fig. 21) is for the Versailles 5.0L (302 CID) V-8. The outer ring of numbers is for future use in 5.8L/6.6L (351/400 CID) V-8

applications. The actual firing order for the 5.0L (302 CID) V-8 is 1-5-4-2-6-3-7-8, as noted on the intake manifold.

NOTE: Do not attempt to remove any silicone coating from the rotor lower electrode blades or from the distributor cap electrodes, including the center plate electrodes. As this silicone compound ages, it has the appearance of being a contaminant of the cap and electrodes. This condition is normal and causes no performance loss.

SPARK PLUG CONNECTIONS
5.8/6.6L (351/400 CID) V-8
(NOT USED IN 1978)

SPARK PLUG CONNECTIONS
5.0L (302 CID) V-8



A4527-1A

FIG. 21 Spark Plug Wire Connections

REMOVAL AND INSTALLATION

ELECTRONIC CONTROL ASSEMBLY (ECA)

The Electronic Control Assembly (ECA) is mounted behind the instrument panel on the driver's side near the brake pedal support. The ECA is attached to its mounting bracket with three screws. If the ECA requires replacement, loosen only the two left hand screws and remove the one right hand screw. There are slots which allow the unit to slide out and away from the left hand mounting screws. The bottom side of the ECA has 3 wiring harness connectors which are easily removed for diagnostic work and test equipment connection. The harness connector bodies are polarized (keyed) to prevent improper connection. Each connector body is color coded (Black=7-pin, Blue=10-pin, Red=9-pin) and each has pin identification letters on the side of the connector. Also, corresponding colored dots are located on the bottom side of the ECA to aid in reconnection of the three wiring harness connectors. Refer to the wiring diagram (Fig. 24) for further information.

DISTRIBUTOR ROTOR

In order to obtain maximum timing advance without crossfire to adjacent distributor cap electrodes, it is important that proper distributor rotor alignment be established, using the special rotor alignment tool designed for this purpose. Since there is no mechanical advance mechanism or adjustments under the rotor, there is no need to remove the rotor except to replace it.

Removal

1. Remove the distributor cap by loosening the two spring clips holding the cap to the distributor adaptor (Fig. 19).
2. Rotate the crankshaft sufficiently to align the distributor rotor upper blade (with slot) with the

locating slot in the distributor adaptor (Fig. 22), so the distributor rotor alignment Tool T78P-12200-A will drop into place. **If the rotor or adaptor is damaged and alignment is not possible, position the crankshaft with number 1 piston at compression TDC by aligning the zero mark on the damper with the timing pointer on the front cover.**

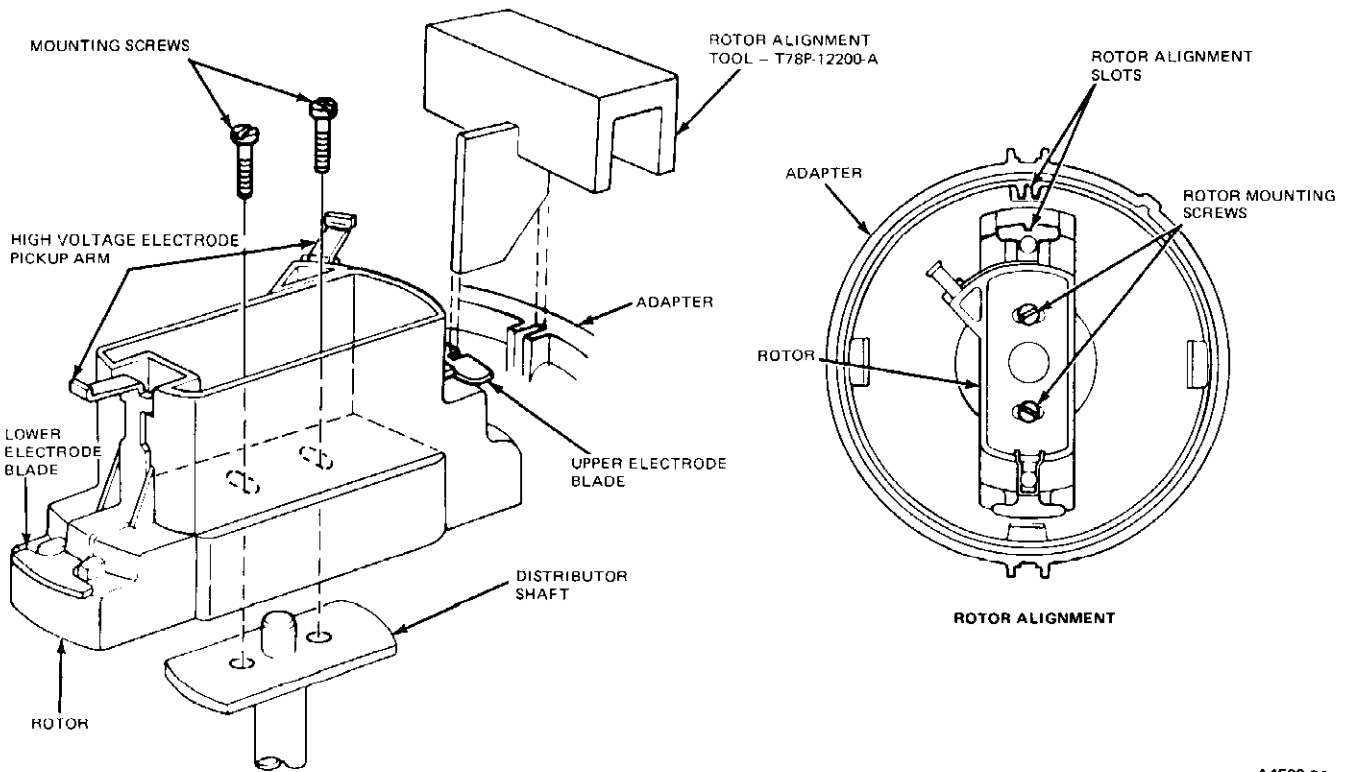
3. Remove the rotor alignment tool and remove the two screws attaching the rotor to the distributor shaft. Remove the rotor.

CAUTION: DO NOT ROTATE THE CRANKSHAFT AFTER THE ROTOR HAS BEEN REMOVED.

Installation

NOTE: When replacing the rotor, coat the lower electrode blades approximately 1/16" thick on all sides (outboard of the plastic) with D7AZ-19A331-AA silicon grease or equivalent (Dow 111 or G.E. G-627 compound).

1. Place the new rotor on the distributor shaft with the slot in the upper blade pointing to the locating notch in the distributor adaptor. Install, but do not tighten both rotor attaching screws.
2. Position the rotor alignment Tool T78P-12200-A in the distributor adaptor so that the tang on the underside of the tool engages the locating notch in the distributor adaptor and the slot in the rotor at the same time.
3. Tighten both rotor attaching screws to 15-20 in-lb.
4. Remove the rotor alignment tool and reinstall the distributor cap. Seat both cap-to-adaptor spring clips.



A4528-2A

FIG. 22 Rotor Alignment

DISTRIBUTOR

The EEC distributor is locked in place during engine assembly and no rotational adjustment is possible. A slot in the distributor base mounting flange fits around the distributor clamp hold-down bolt, preventing movement (Fig. 19). Adjustment is not required, since all timing is controlled by the ECA.

Removal

1. Remove the distributor cap and insert the rotor alignment Tool T78P-12200-A by following Steps 1 and 2 under Rotor Removal.
2. With the rotor alignment tool inserted, loosen the distributor hold-down bolt and clamp. Remove alignment tool.
3. Slowly remove the distributor assembly from the engine block, noting the position of the rotor blade with respect to the distributor base when the cam and distributor drive gear are felt to disengage.

CAUTION: DO NOT ROTATE THE CRANKSHAFT AFTER THE DISTRIBUTOR HAS BEEN REMOVED FROM THE ENGINE.

Installation

1. Position the distributor in the block so that when fully seated the following conditions are met:

- a. The slot on the distributor base hold-down flange is aligned with the clamp bolt hole in the block, and
- b. the slot in the upper blade of the rotor is approximately aligned with the slot in the adapter.

If alignment is not possible when the distributor is fully seated, raise the distributor out of the block enough to disengage the cam gear and rotate the distributor shaft slightly to allow the next tooth on the distributor drive gear to engage the cam gear. Repeat this procedure until conditions outlined in (a) and (b) are satisfied.

2. Install the distributor-to-block clamp and bolt and torque to specifications.
3. Align the rotor and install the distributor cap following procedures outlined under Rotor Installation (Steps 1-4).

NOTE: When installing a new distributor cap, coat the brass center electrode plate tip surfaces shown in Fig. 23 with D7AZ-19A331-AA silicon grease or equivalent (Dow 111 or G.E. G-627 compound).

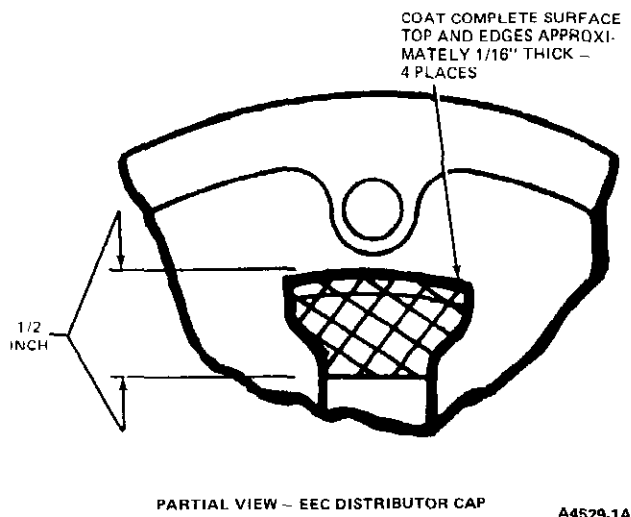


FIG. 23 Coating New Distributor Cap

DIAGNOSIS

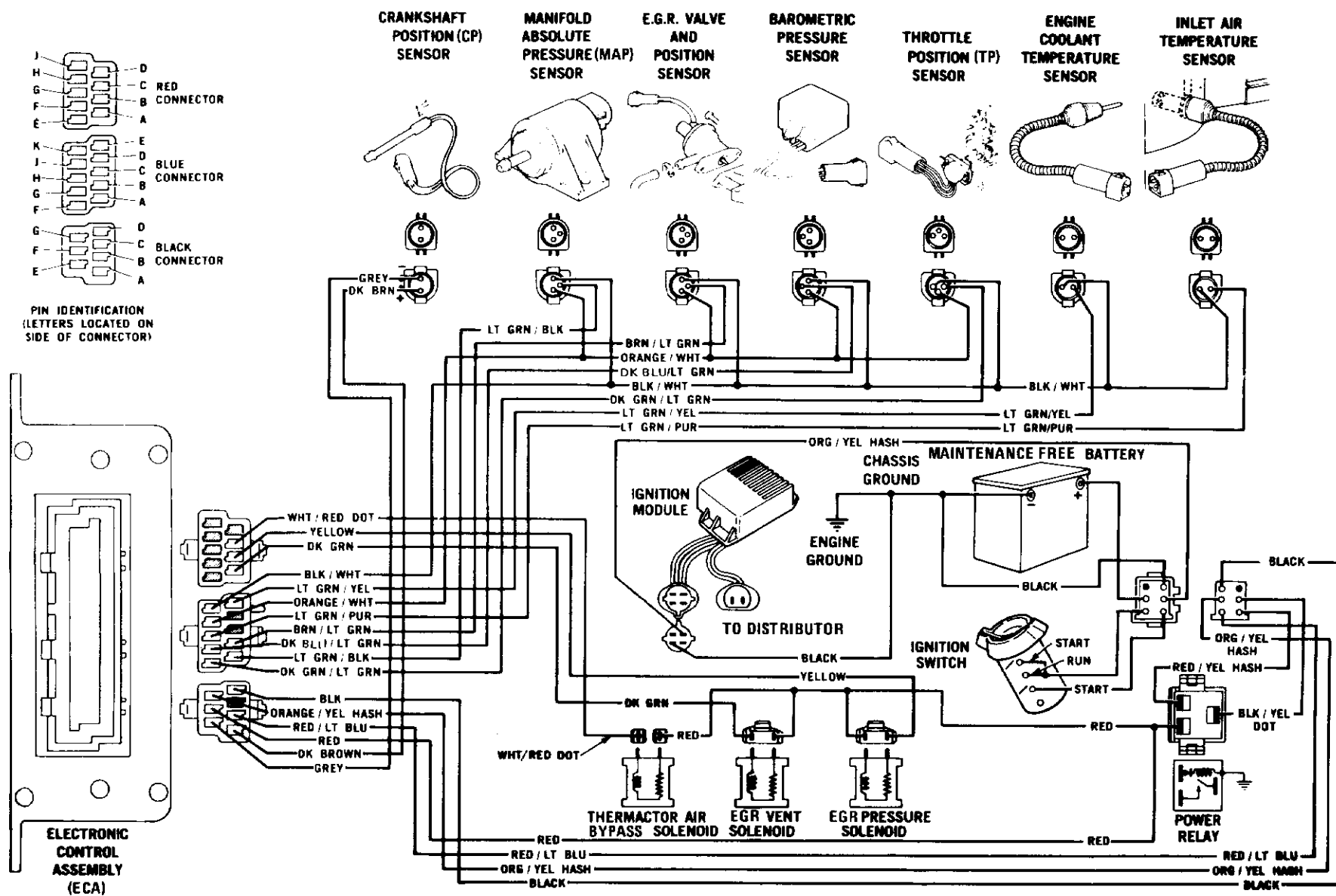
Due to the complexity of the EEC system, two special diagnosis aids are required:

1. **EEC Diagnostic Tester T78L-50-EEC-1** —Plugs in between ECA and vehicle wiring harness to monitor EEC signals. Refer to Part 29-02 and the Tester Operator's Manual for required diagnostic procedures and test specifications. Diagnostic limits for spark advance and EGR valve position sensor are located on the vehicle emission control information decal located on the engine valve cover. These specifications will vary for various calibrations.
2. **Digital Volt/Ohmmeter (DVOM) T78L-50-DVOM-1** —Accurate, high input impedance unit developed for gathering EEC system data. Digital readout minimizes errors, giving technician

necessary accuracy for EEC diagnosis. Can also be used for other electrical system diagnosis in addition to EEC system.

An advance timing light such as Rotunda 27-0002 (or equivalent), compatible with the Dura Spark II ignition system, a pressure/vacuum gauge and a tachometer are also required for diagnosis of the EEC system. Refer to Part 29-01 and 50-29 for diagnosis and service of the applicable EEC system components. Refer to Fig. 24 for the EEC system wiring diagram.

NOTE: The EEC Diagnostic Tester (T78L-50-EEC-1) and Digital Volt/Ohmmeter (DVOM) (T78L-50-DVOM) are available from: Owatonna Tool Company, Owatonna, Minnesota, Attention Ford Order Desk.



A4530-2A

FIG. 24 EEC System Wiring Diagram

Exhaust Gas Recirculation (EGR) System

**PART
29-07**

All Models Except Versailles W/ EEC System

SUBJECT	PAGE	SUBJECT	PAGE
GENERAL INFORMATION		GENERAL INFORMATION (Cont.'d)	
EGR Backpressure Transducer	07-1	Poppet Type	07-1
EGR/CSC System	07-4	Tapered Stem Type — Internal	07-1
EGR System WOT (Wide Open Throttle)		Spacer Entry EGR System	07-1
Load Control Valve	07-4	Venturi Vacuum Amplifier (VVA)	07-1
EGR Valve	07-1		
Integral Transducer Backpressure			
EGR Valve	07-1		

CA4258-28

GENERAL INFORMATION

The Exhaust Gas Recirculation System (EGR) is designed to re-introduce small amounts of exhaust gas into the combustion cycle, thus reducing the generation of nitrous oxides (NOX). The amount of exhaust gas re-introduced and the timing of the cycle are controlled by various factors such as engine vacuum, exhaust system backpressure and temperature. Typical systems are shown in Figs. 1 and 2.

EGR VALVE

The EGR valve (Figs. 3, 4 and 5) is a vacuum-operated unit that attaches to a spacer that fits under the carburetor. When the valve is open, exhaust gas is permitted to enter the intake manifold passages. When the valve is closed, internal or external sealing takes place, preventing the flow of exhaust gases into the intake passages.

Ford EGR valves are operated by a vacuum motor. There are four different types of valves to provide various degrees of flow rate as follows:

POPPET TYPE

The poppet valve (Fig. 3) is a rapid opening valve—the poppet disc is retracted from the seat providing the initial flow curve shape. The flow is limited by the valve seat diameter in valves above approximately 10 CFM. Below approximately 10 CFM the flow is limited by various orifice plates inserted in the mounting pad.

TAPERED STEM TYPE—INTERNAL

The tapered stem valve (Fig. 3) utilizes a pintle protruding through the valve seat to provide greater slope ratios of the flow curve than that obtained with a simple poppet. The flow rate is controlled by the relationship of the pintle OD to the seat ID.

INTEGRAL TRANSDUCER BACK PRESSURE EGR VALVE

The integral transducer EGR valve (Fig. 4) combines the exhaust backpressure transducer within the

diaphragm housing of a typical EGR valve. This device modulates EGR flow by venting the EGR valve vacuum available to open the valve dependent upon exhaust backpressure. The exhaust backpressure is sensed in the cavity between the orifice and the poppet/tapered stem. The EGR flow is dependent upon source vacuum, exhaust pressure, control setting and the orifice.

EGR BACKPRESSURE TRANSDUCER

Some EGR systems employ a Backpressure Transducer connected to an adapter between the EGR valve and the intake manifold. The transducer modulates EGR flow by varying the EGR valve vacuum signal according to exhaust backpressure. The exhaust pressure is sensed in the pressure cavity of the transducer spacer (Fig. 5).

SPACER ENTRY EGR SYSTEM

On this type of system, exhaust gases are routed to the EGR valve, which is attached to a spacer mounted between the carburetor and the intake manifold (Fig. 6).

VENTURI VACUUM AMPLIFIER (VVA)

The EGR Venturi Vacuum Amplifier (Fig. 7) uses a relatively weak venturi vacuum signal in the throat of the carburetor to shape a strong intake manifold vacuum signal to operate the EGR valve. This makes it possible to achieve an accurate, repeatable and almost exact proportion between venturi air flow and EGR flow. Thus, it assists in controlling oxides of nitrogen emissions with minimal sacrifice in vehicle driveability.

The amplifier connects to a vacuum reservoir and contains a check valve to maintain adequate vacuum supply regardless of variations in engine manifold vacuum (Fig. 8).

A relief valve is also used to "dump" or cancel the output EGR signal whenever the venturi vacuum signal

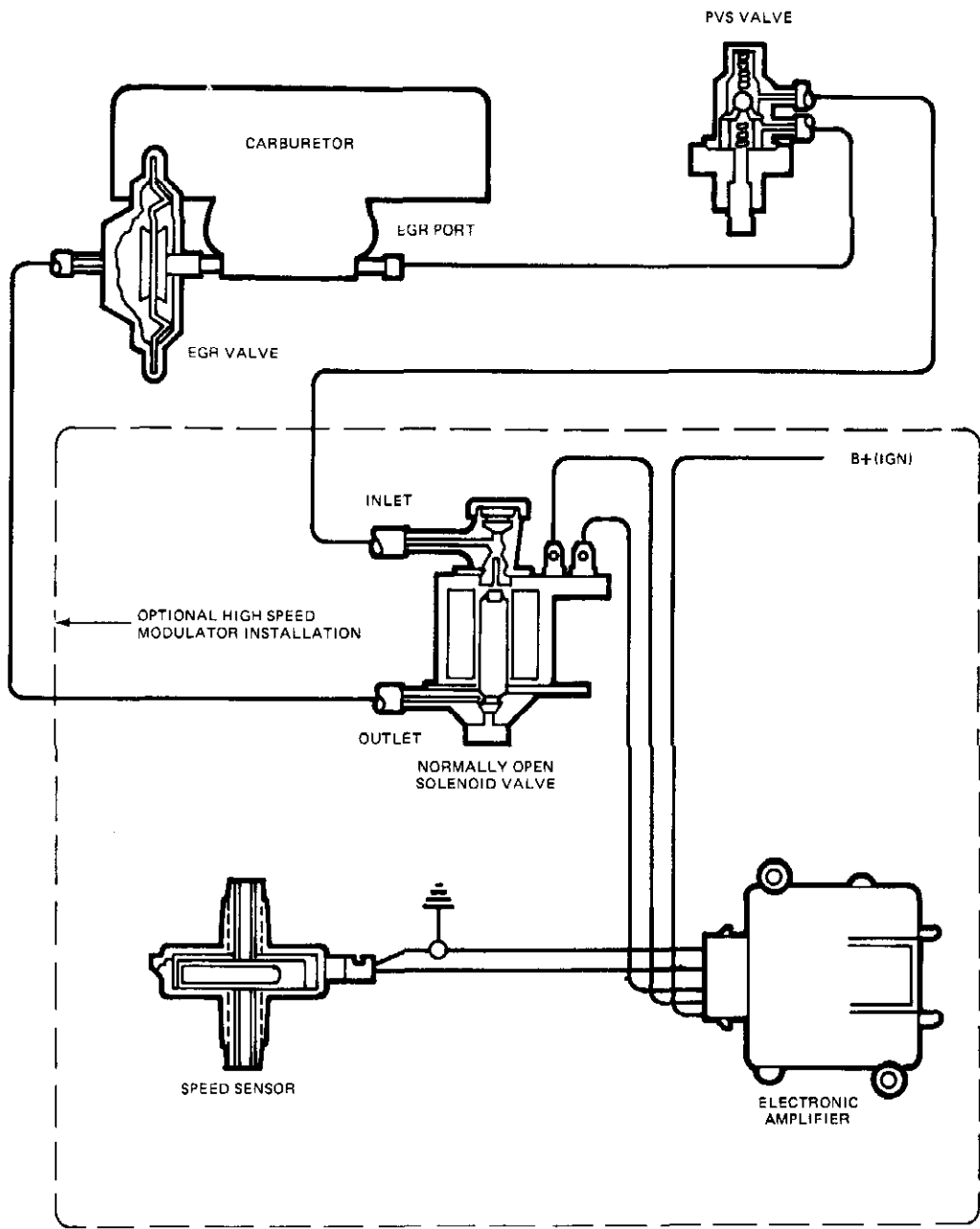


FIG. 1 Typical EGR System Installation

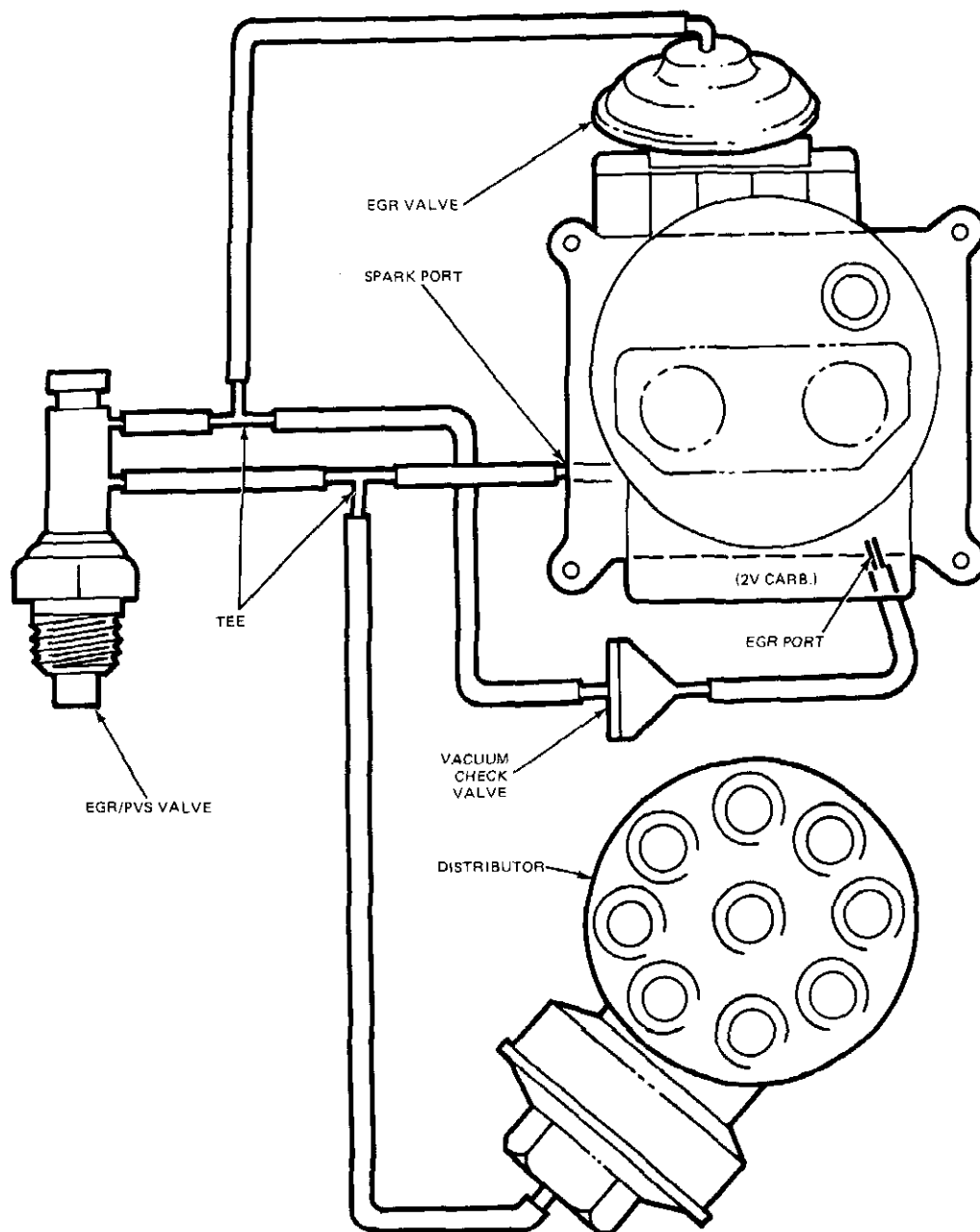
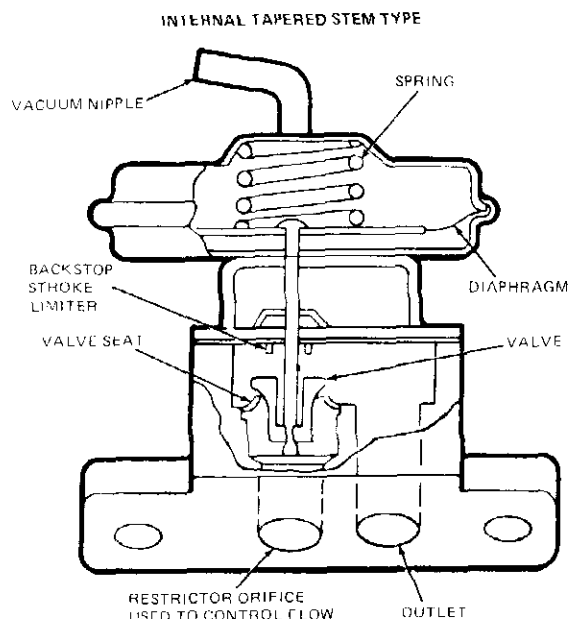
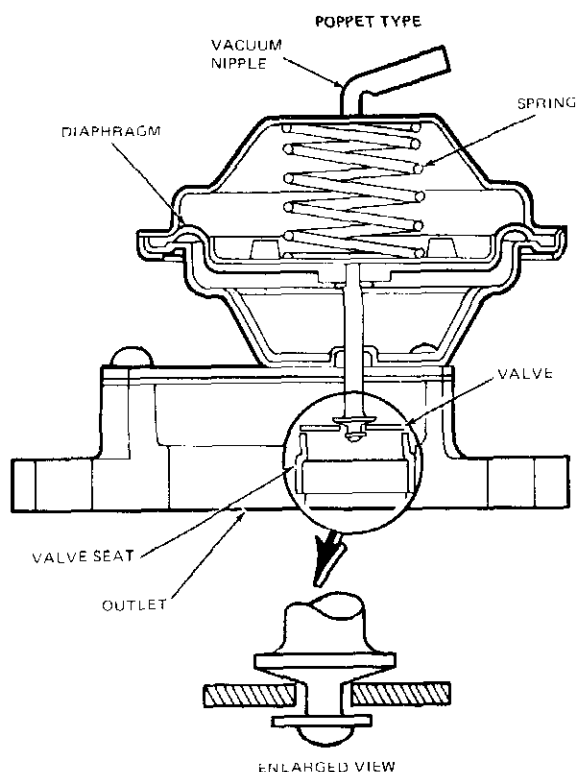


FIG. 2 Typical Modified Combined Vacuum (Modified COVAC) Installation



V1875-2D

FIG. 3 Typical EGR Valves

is equal to, or greater than, the intake manifold vacuum. This allows the EGR valve to close at or near wide-open throttle acceleration, when maximum power is required from the engine.

EGR/CSC SYSTEM

This vacuum installation (Fig. 9) operates to control the spark advance and EGR flow as follows:

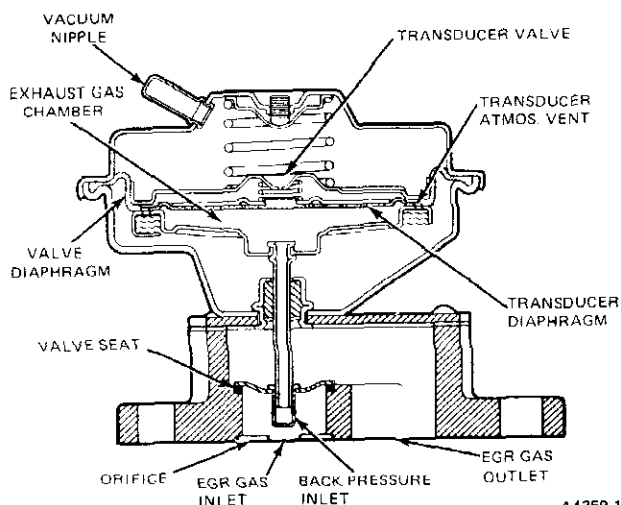
At cold start (coolant temperatures below EGR PVS opening temperature) the EGR PVS connects carburetor EGR port vacuum to the distributor through the check valve and by-passing the spark delay valve. As the engine temperature increases and coolant temperature reaches EGR PVS opening temperature, the EGR PVS switches EGR port vacuum from the distributor to the EGR valve. At coolant temperatures above EGR PVS opening temperature the EGR vacuum port on the carburetor controls the EGR valve and the spark vacuum port controls spark advance through the cooling PVS and the spark delay valve.

EGR SYSTEM WOT (WIDE OPEN THROTTLE) LOAD CONTROL VALVE

Some EGR systems feature a load control valve that closes the EGR valve when the engine requires maximum power at or near wide open throttle (Fig. 10).

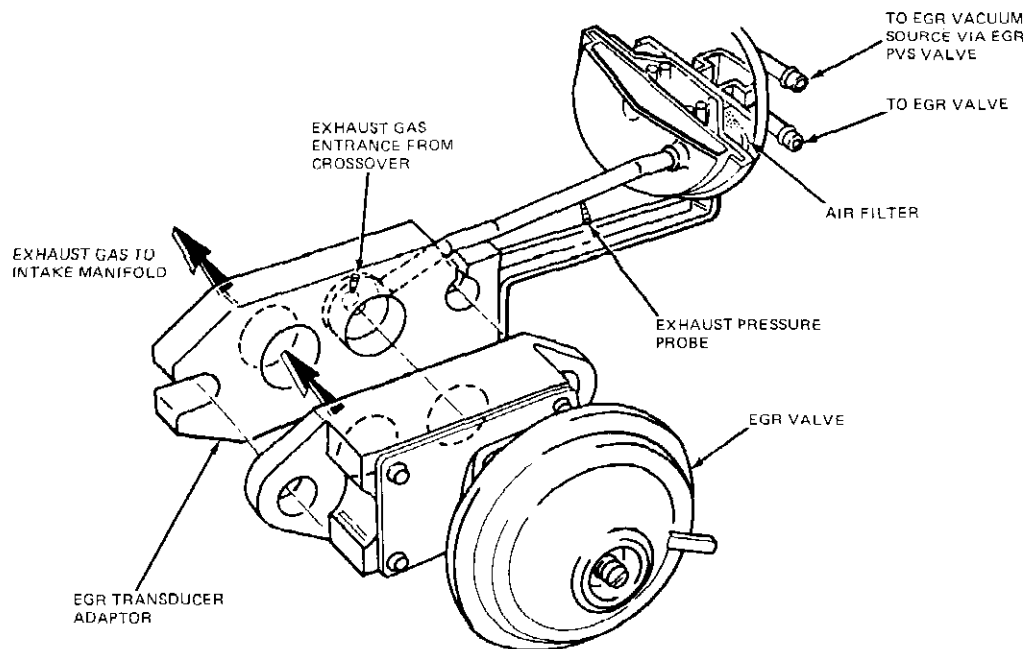
The WOT valve is installed in the vacuum line between the ported vacuum connection on the carburetor and the EGR valve. A vacuum line from the

carburetor venturi vacuum tap is connected to the top port on the WOT valve and provides control for the valve. When the venturi vacuum signal is at a predetermined level near wide open throttle, it is strong enough to overcome the calibration spring pressure and unseat the diaphragm valve, diverting EGR source vacuum to the atmosphere and causing the EGR valve to close. Normal EGR flow is resumed when there is a reduction in engine load from the wide open throttle condition.



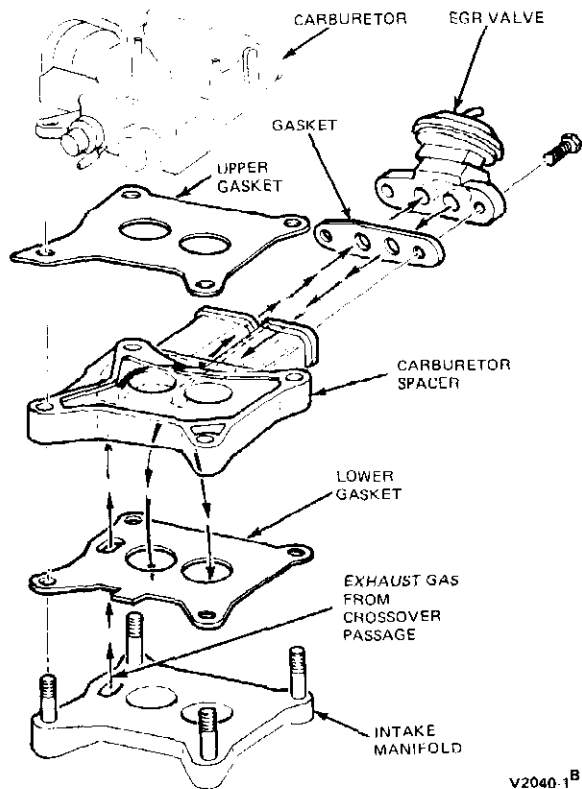
A4259-1A

FIG. 4 Typical Integral Backpressure Transducer/EGR Valve



A4178-2B

FIG. 5 EGR Valve Exhaust Backpressure Transducer

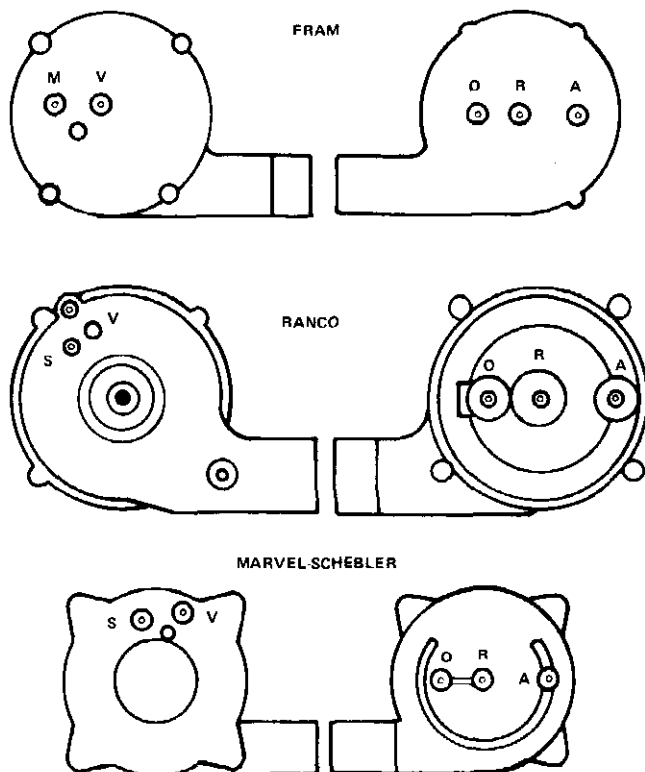


V2040-1^B

FIG. 6 Spacer Entry EGR System—Typical

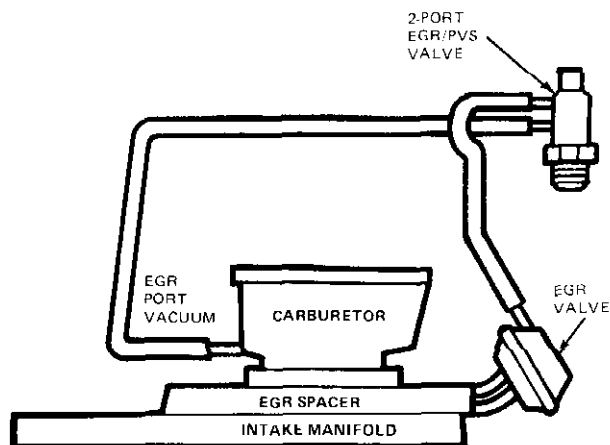
AMPLIFIER CODED FOR PORT CONNECTIONS:

O — OUTPUT TO EGR VALVE
 R — FROM RESERVOIR
 S — VACUUM SOURCE
 (SPARK OR EGR PORT)
 V — VENTURI VACUUM
 A — ATMOSPHERE (VENT)



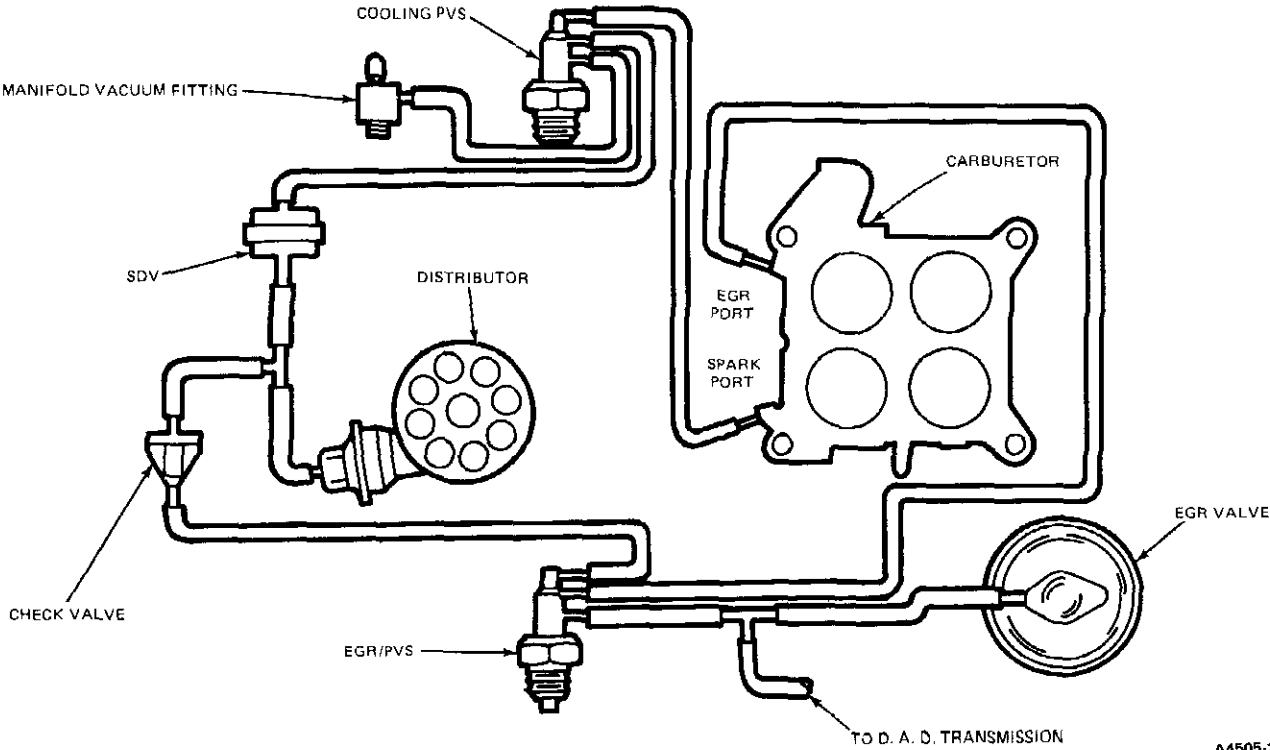
V2041-1A

FIG. 7 Venturi Vacuum Amplifier—Dual Connector Type



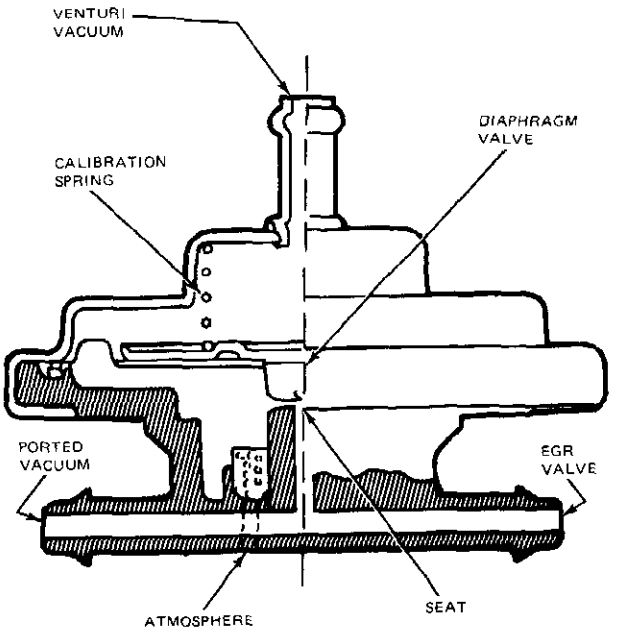
V1846-1C

FIG. 8 Typical EGR System With Venturi Vacuum Amplifier



A4505-2A

FIG. 9 Exhaust Gas Recirculation and Coolant Spark Control (EGR/CSC) System



A4056-1A

FIG. 10 EGR Load Control (WOT) Valve

2.3L Feedback Carburetor Electronic Engine Control System

PART
29-08

Pinto and Bobcat with 2.3L I-4 (California Only)

SUBJECT	PAGE	SUBJECT	PAGE
DESCRIPTION		DESCRIPTION (Cont'd.)	
Cold Temperature Vacuum Switch	08-8	Model 6500 Feedback Carburetor	08-3
Electronic Control Unit	08-7	Throttle Angle Vacuum Switch	08-8
Electronically Controlled Feedback		Vacuum Solenoid/Regulator	08-6
Carburetion	08-3	Vacuum Switches	08-7
Exhaust Gas Oxygen (EGO) Sensor	08-6		
General	08-1	DIAGNOSIS	08-8

CA4490-2A

DESCRIPTION

General

Pinto and Bobcat vehicles manufactured for sale in California and equipped with the 2.3L I-4 engine are also equipped with a Feedback electronic engine control system. This system consists of three subsystems:

1. Dual Catalytic Converter
2. Thermactor Air Control
3. Electronic Feedback Carburetion

These three subsystems work together to provide improved fuel economy, engine performance and lower exhaust emissions. A detailed explanation of each subsystem is provided here.

Generally, the engine control system works as follows: The Electronic Control Unit (ECU) monitors the composition of the exhaust gases via the Exhaust Gas Oxygen (EGO) and commands modification of carburetor main metering mixture for best exhaust emissions.

Dual Catalytic Converter

The Dual Catalytic Converter consists of two catalytic converters in one shell, with a mixing chamber between the two (Fig. 1).

The cutaway view shows the two separate catalytic converters, each composed of a ceramic "honeycomb" coated with catalytic material. The front converter is coated with a rhodium/platinum catalyst designed to control oxides of nitrogen (NOx), unburned hydrocarbons (HC) and carbon monoxide (CO), and this is therefore called a "Three-Way Catalyst" (TWC). The rear converter is coated with platinum catalyst and is called a "Conventional Oxidation Catalyst" (COC) converter. The platinum catalyst is also sometimes called a "Two Way Catalyst" because it only acts on two of the major pollutants: HC and CO.

The TWC converter operates on the exhaust gases as they arrive from the engine. As the gases flow from the TWC to the COC converter, they mix with air from the Thermactor pump injected into the mixing chamber

or "mid bed". This air is required for proper oxidation of HC and CO in the COC converter.

Thermactor Air Control

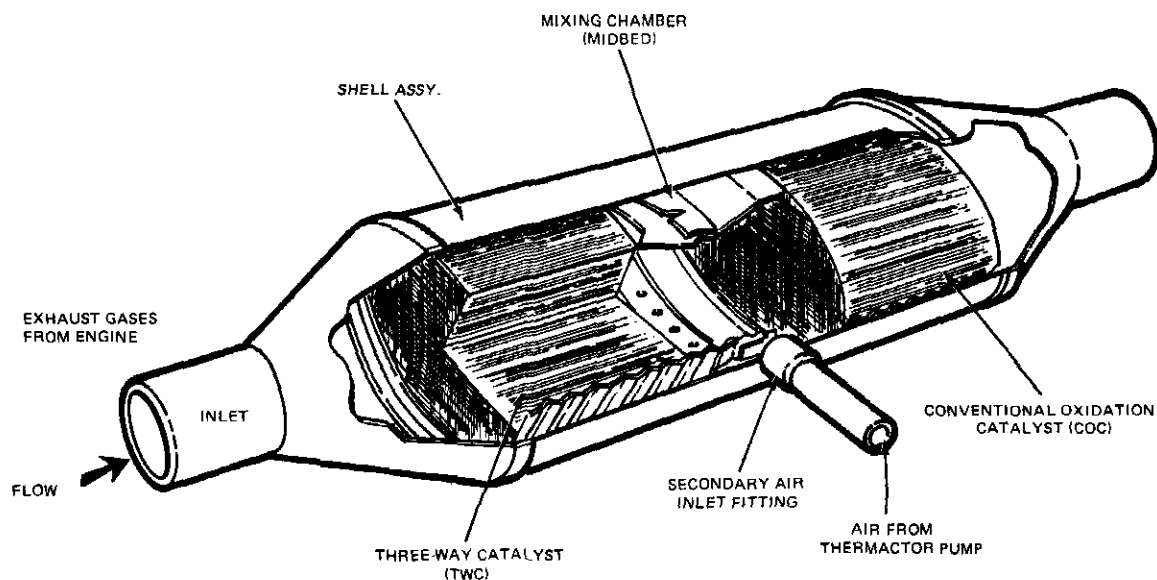
The efficiency of the dual catalytic converter is heavily dependent upon temperature and the chemical composition of the exhaust gases. To help satisfy these requirements, an air supply system called Thermactor Air Control is provided (Fig. 2). The Thermactor system used with ECU-A is similar in design and operation to the conventional Thermactor system, with the addition of a second air control valve (besides the air bypass valve), and a second exhaust check valve. The Thermactor system used with the 2.3L engine consists of:

- Thermactor Air Pump
- Air Bypass Valve
- Air Control Valve
- Ported Vacuum Switch (PVS)
- Temperature Vacuum Switch (TVS)
- Two Exhaust Check Valves

With the air bypass valve in normal (non-dump) position, Thermactor air passes to the air control valve. If the Thermactor PVS is operated (coolant temperature above 52°C (125°F), vacuum is cut off from the actuator port on the air control valve and Thermactor air is routed to the dual catalytic converter midbed to assist in operation of the converter (Fig. 2).

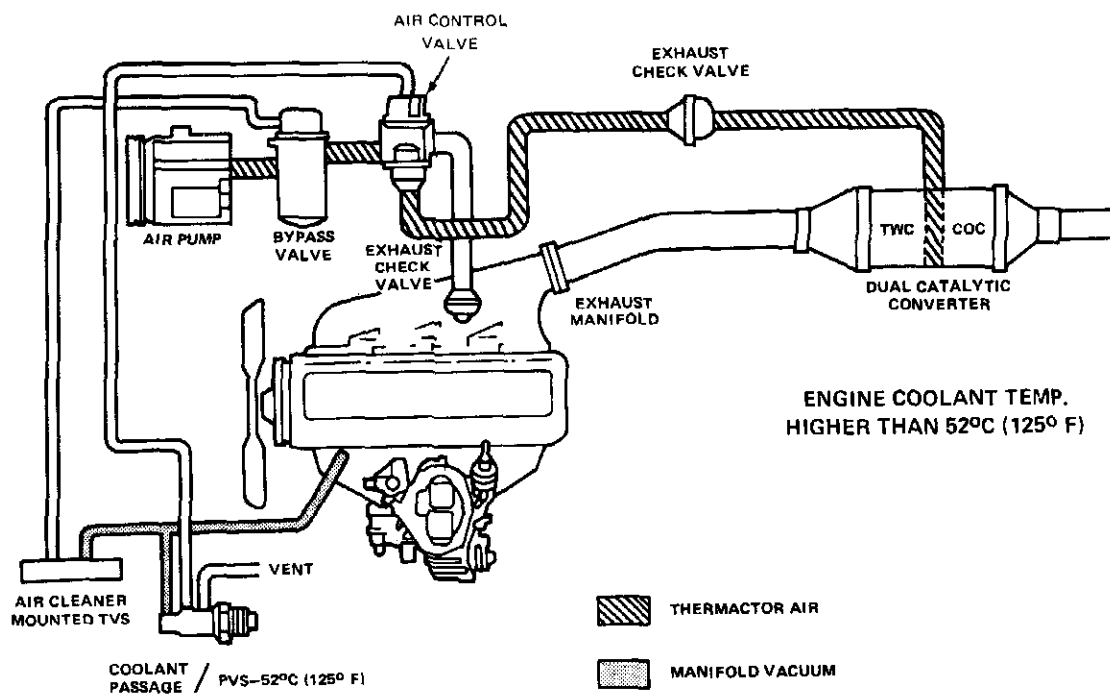
During engine warm-up, when the coolant temperature is below 52°C (125°F), the PVS applies vacuum to the actuator port on the air control valve, causing it to operate. Thermactor air is then diverted through the operated air control valve to the engine exhaust manifold, to aid in the removal of excessive amounts of HC and CO produced during warmup (Fig. 3).

The Thermactor system includes a catalyst protection feature that applies vacuum to the actuator port on the



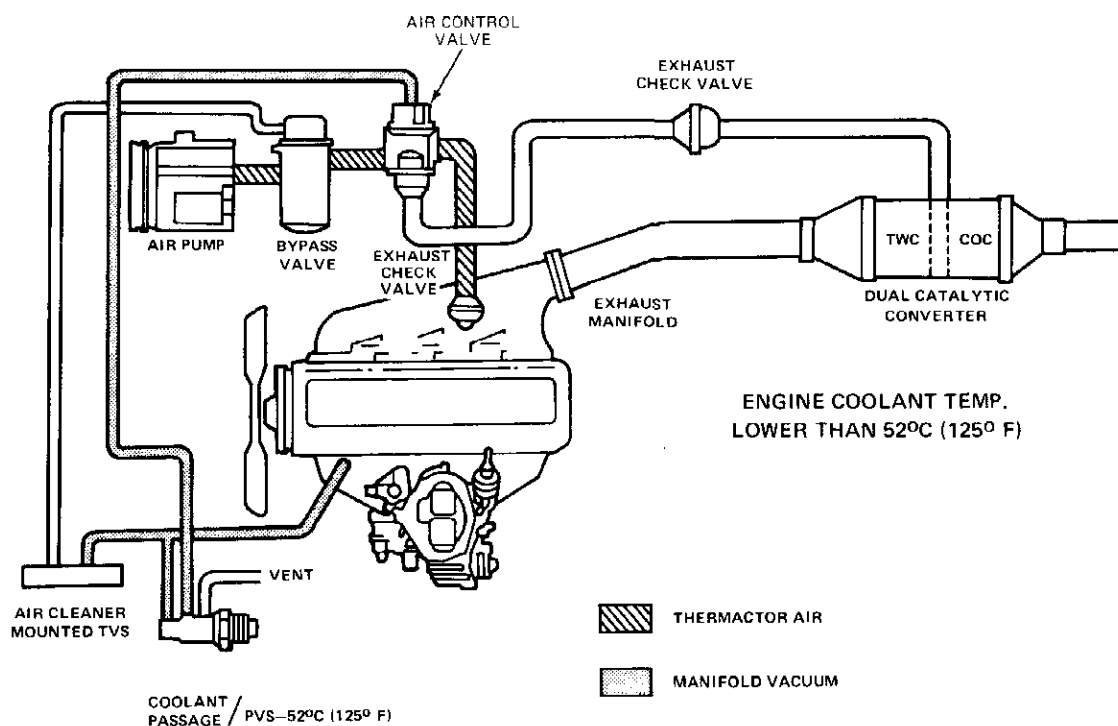
A4491-2A

FIG. 1 Dual Catalytic Converter



A4492-2A

FIG. 2 Thermactor System—Coolant Temperature Above 52 degrees C (125 degrees F)



A4493-2A

FIG. 3 Thermactor System—Coolant Temperature Below 52 degrees C (125 degrees F)

air bypass valve if the air cleaner mounted TVS is operated by inlet air cooler than 9°C (49°F). This causes the bypass valve to immediately dump thermactor air to the atmosphere rather than to the catalytic converter or exhaust manifold.

Electronically Controlled Feedback Carburetion

The use of a three-way catalyst requires more precise fuel metering for efficient operation than is possible with a conventional carburetor. To provide this metering, the new Model 6500 carburetor is used. This carburetor features external air/fuel ratio control and is an integral part of the feedback system. The electronic engine control system consists of:

- Model 6500 Feedback Carburetor
- Exhaust Gas Oxygen (EGO) Sensor
- Electronic Control Unit (ECU)
- Vacuum Solenoid/Regulator
- Throttle Angle Vacuum Switch
- Cold Temperature Vacuum Switch

In operation, the electronically controlled system has two "modes" of operation that are determined by conditions monitored by the various sensors:

Closed Loop Control - where each component in the system is sensitive to the other components. This means that the carburetor is being controlled by the Vacuum Regulator/Solenoid, which is being controlled by the ECU in relation to a signal from the EGO in the exhaust manifold, which is being influenced by the mixture from the carburetor, and so on. When all the components are thus functioning together, the system is said to be under closed loop control.

Open Loop Control - where the air/fuel mixture is set to a predetermined, nonvarying setting by the ECU, and is not influenced by EGO sensor signals. In this case, such as when coolant temperature is below normal operating range and the catalytic converter is not up to efficient operating temperature, or when the throttle is closed (idle or deceleration), the fuel mixture is under the control of the ECU.

Model 6500 Feedback Carburetor

The Model 6500 Feedback carburetor is basically a Model 5200 carburetor with an externally-variable auxiliary fuel metering system in place of the enrichment valve used on the Model 5200 (Fig. 5). The auxiliary system is operated by vacuum from the vacuum regulator/solenoid under control of the ECU. The Model 6500 also has a switching bowl vent that allows venting of fuel bowl vapors to the vapor canister and fresh air pickup for the vacuum regulator/Solenoid.

In the Model 6500, the fuel enrichment valve found in the model 5200 is replaced by a metering valve assembly and a metering valve, operating piston and diaphragm assembly (Fig. 6).

The feedback metering valve supplements fuel entering the main well through the conventional main metering jet and channel. The amount of fuel entering the main well through the metering valve depends on the position of the tapered metering rod in its orifice. The position of the metering rod depends on the metering rod operating piston assembly.

Control vacuum from the vacuum regulator solenoid is channeled to the cavity above the metering rod diaphragm (Fig. 6). With no vacuum present, the valve

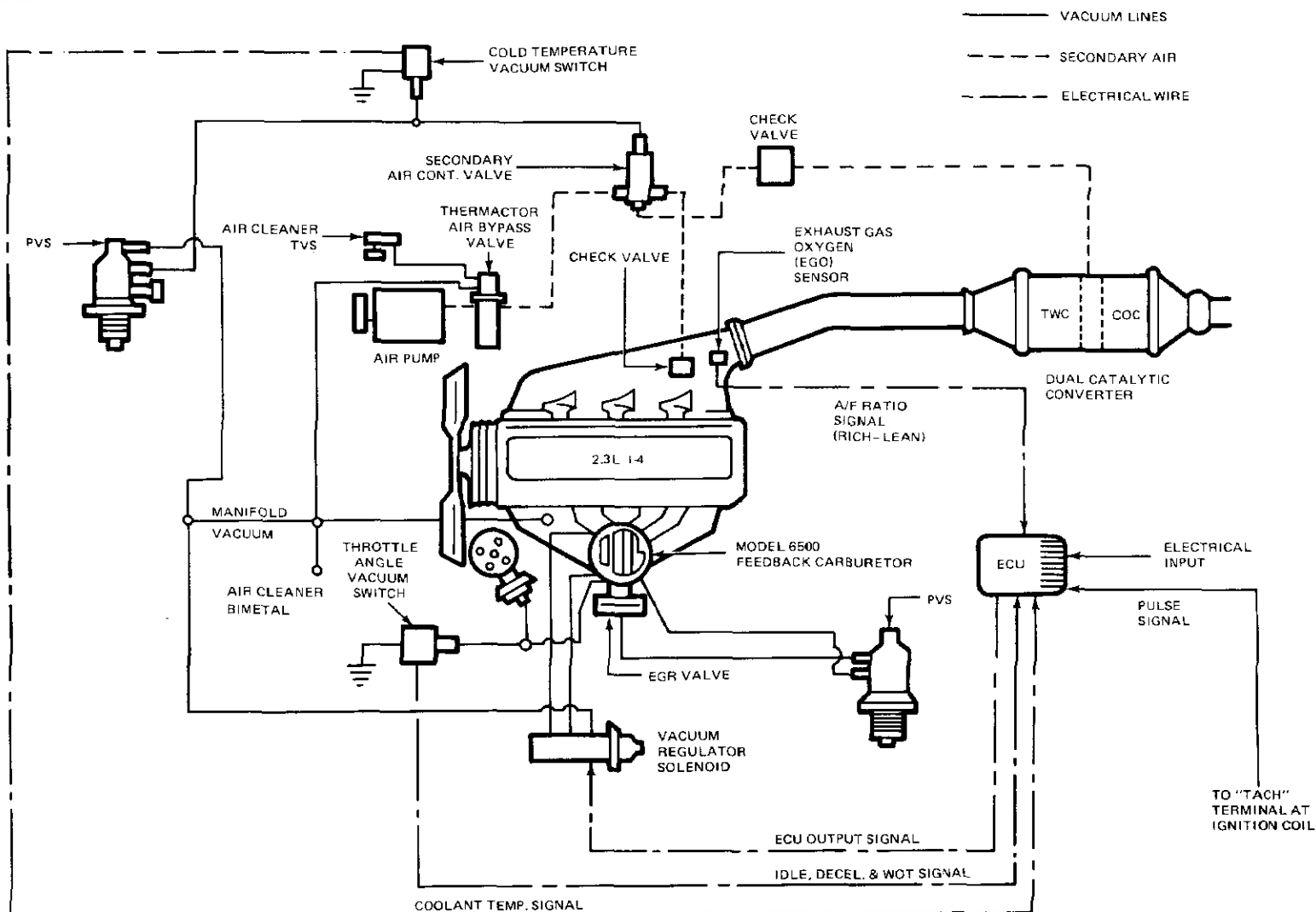
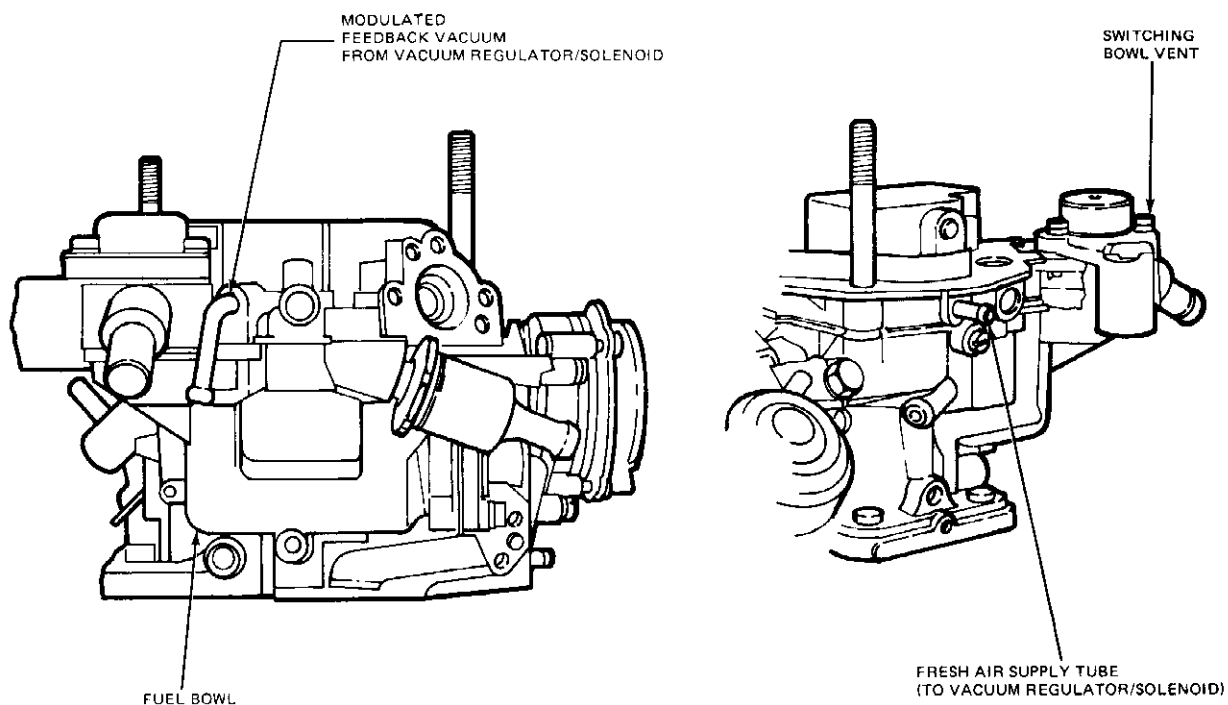
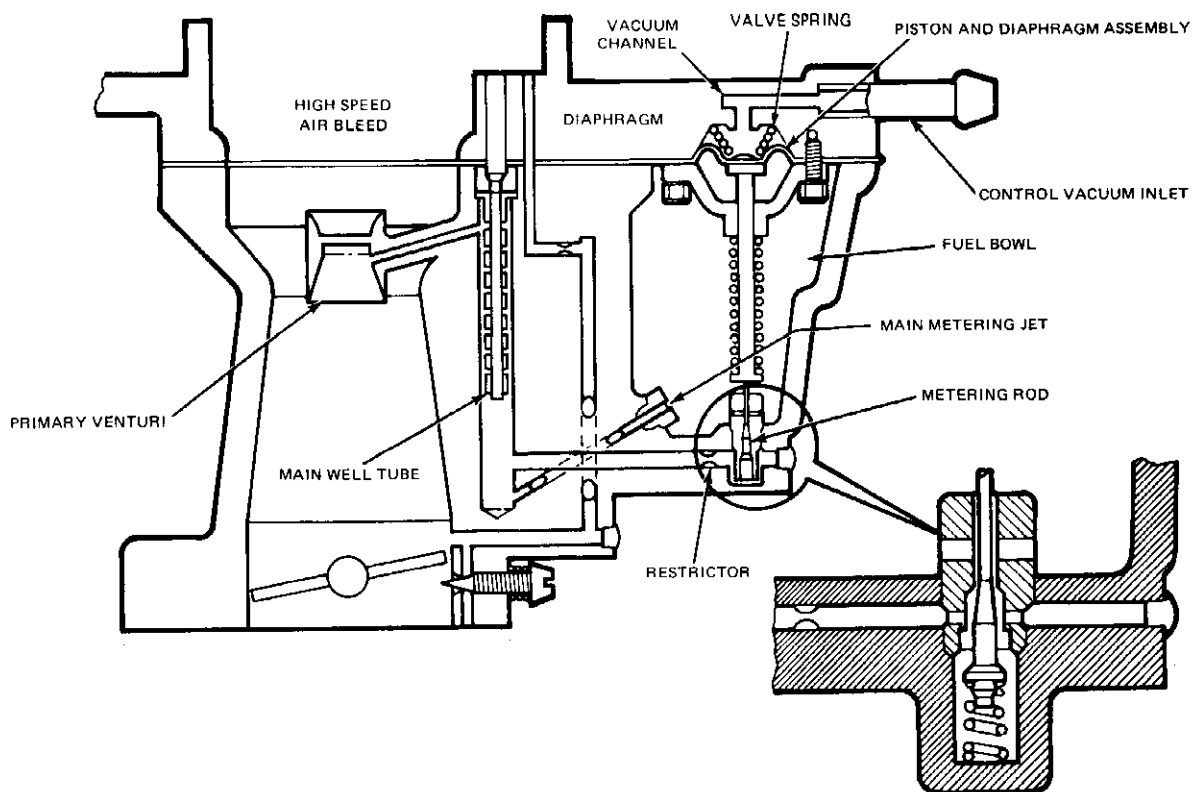


FIG. 4 2.3L Feedback Carburetor Electronic Engine Control System Schematic



A4495-2A

FIG. 5 Model 6500 Carburetor—External



A4496-2A

FIG. 6 Fuel Metering

spring causes the valve to move to its lowest (richest) position, where maximum fuel can pass through the orifice. As vacuum is applied to the diaphragm, spring pressure is overcome and the metering rod rises, reducing the orifice area and permitting less fuel to pass. The metering valve is calibrated so that the maximum vacuum signal supplied by the vacuum regulator/solenoid (5 inches Hg) raises the rod to its highest (leanest) position.

In the open loop mode, a constant vacuum of 2-1/2" Hg is applied to the feedback valve diaphragm, holding the metering rod at its mid-position. In closed loop operation, the vacuum signal varies from 0 to 5" Hg, producing a richer or leaner mixture in response to commands from the ECU.

During wide open throttle (WOT) acceleration, manifold vacuum drops, resulting in little or no output vacuum signal. The feedback metering valve moves to its lowest (richest) position, providing a richer air/fuel mixture in conjunction with the main metering system and thus the correct mixture for good engine performance.

The Model 6500 Feedback Carburetor differs from the Model 5200 in one other major feature: it has an internal choke pulldown diaphragm vacuum supply rather than the new external vacuum connection used on the Model 5200. Adjustment of choke pulldown is thus similar to that used on the 1977 Model 5200 carburetor.

Vacuum Solenoid/Regulator

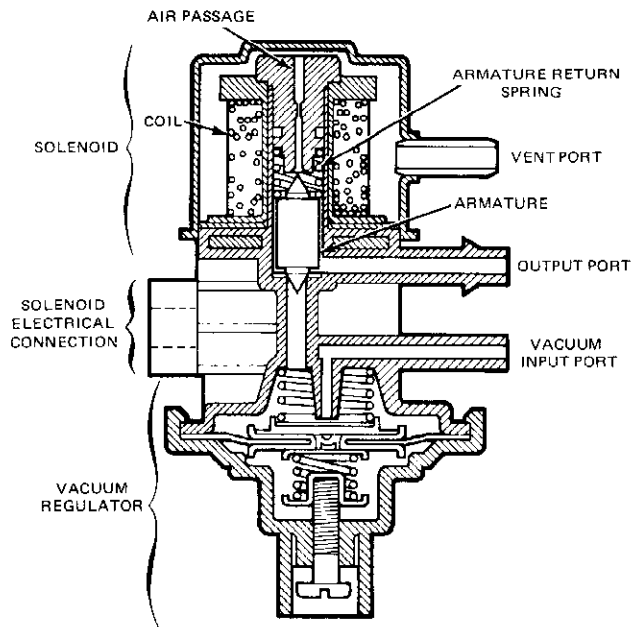
The component that supplies the vacuum signal to the carburetor feedback valve is the vacuum solenoid/regulator (Fig. 7).

The vacuum solenoid and regulator are enclosed in a single housing, with two input ports, one output port and an electrical connection for the solenoid. In operation, the solenoid turns the assembly on and off, while the vacuum regulator controls the amount of vacuum applied to the lower chamber at a constant 5" Hg. The vent input port is open to the atmosphere, so the upper chamber is always at atmospheric pressure.

The solenoid is shown in Fig. 7 in the de-energized position, with the armature held in the lower seat by the armature return spring. In this position, the vacuum in the lower chamber is cut off from the output port and atmospheric pressure from the vent port is connected to the output through the passage shown near the top of the armature.

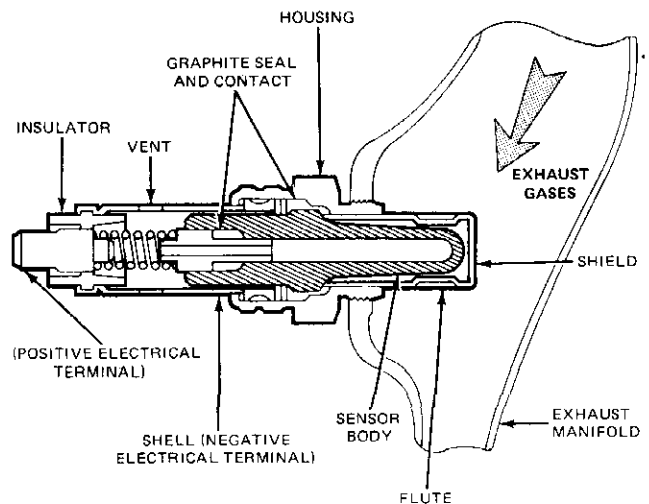
When current is applied to the solenoid coil, the armature moves upward until it rests on its upper seat (Fig. 7). This blocks the atmospheric pressure passage and opens the vacuum passage to the output port. The output vacuum will now reach a constant 5" Hg. When current is removed from the coil, the armature moves downward until it seats against its lower seat. This opens the atmospheric pressure passage and closes the vacuum passage, causing the output vacuum to drop to zero.

In operation, the armatures actually cycles up and down at a rate of 10 times each second, according to the signal received from the ECU. The output vacuum is an average value, related to the length of time the armature spends in each position. (If the solenoid is



A4497-1A

FIG. 7 Vacuum Solenoid/Regulator



A4498-1A

FIG. 8 Exhaust Gas Oxygen (EGO) Sensor

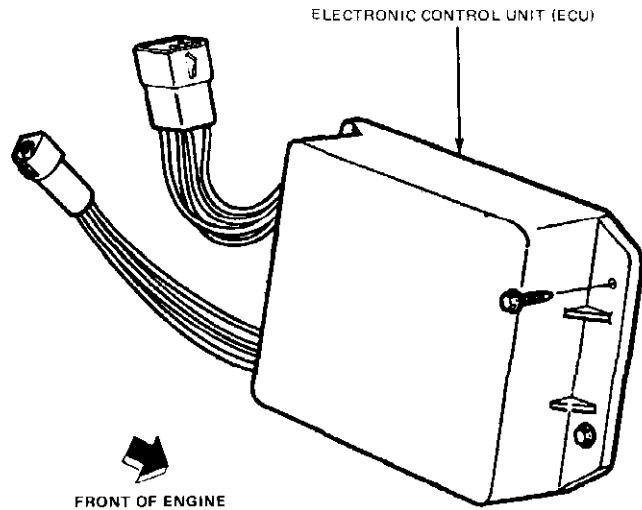
energized half the time, the average reading would be 1/2 of 5" Hg, or 2-1/2" Hg.)

Exhaust Gas Oxygen (EGO) Sensor

The Exhaust Gas Oxygen (EGO) sensor is threaded into the exhaust manifold, and provides information to the ECU regarding the oxygen content of the exhaust gas (Fig. 8).

The outer surface of the sensor is composed of a threaded steel housing and shell, and the sensor body is protected by a shield pressed into the housing where it projects into the exhaust manifold (Fig. 8). Exhaust gases contact the sensor body by entering through

flutes in the sensor shield. A vent is provided in the shell to allow atmospheric air to enter the inner portion of the sensor body. The sensor connects to the vehicle wiring harness with a connector that contacts the inner (positive) terminal. The shell is the (negative) terminal of the sensor, and provides the signal return path via the engine block.



A449B-1A

FIG. 9 Electronic Control Unit (ECU)

The EGO sensor monitors the air/fuel ratio and generates an output of 0.6 to 1.0 volts when surrounded by a rich exhaust gas mixture (absence of oxygen) and less than 0.2 volts when surrounded by a lean mixture (presence of oxygen). This constantly changing voltage signal is sent to the ECU for analysis.

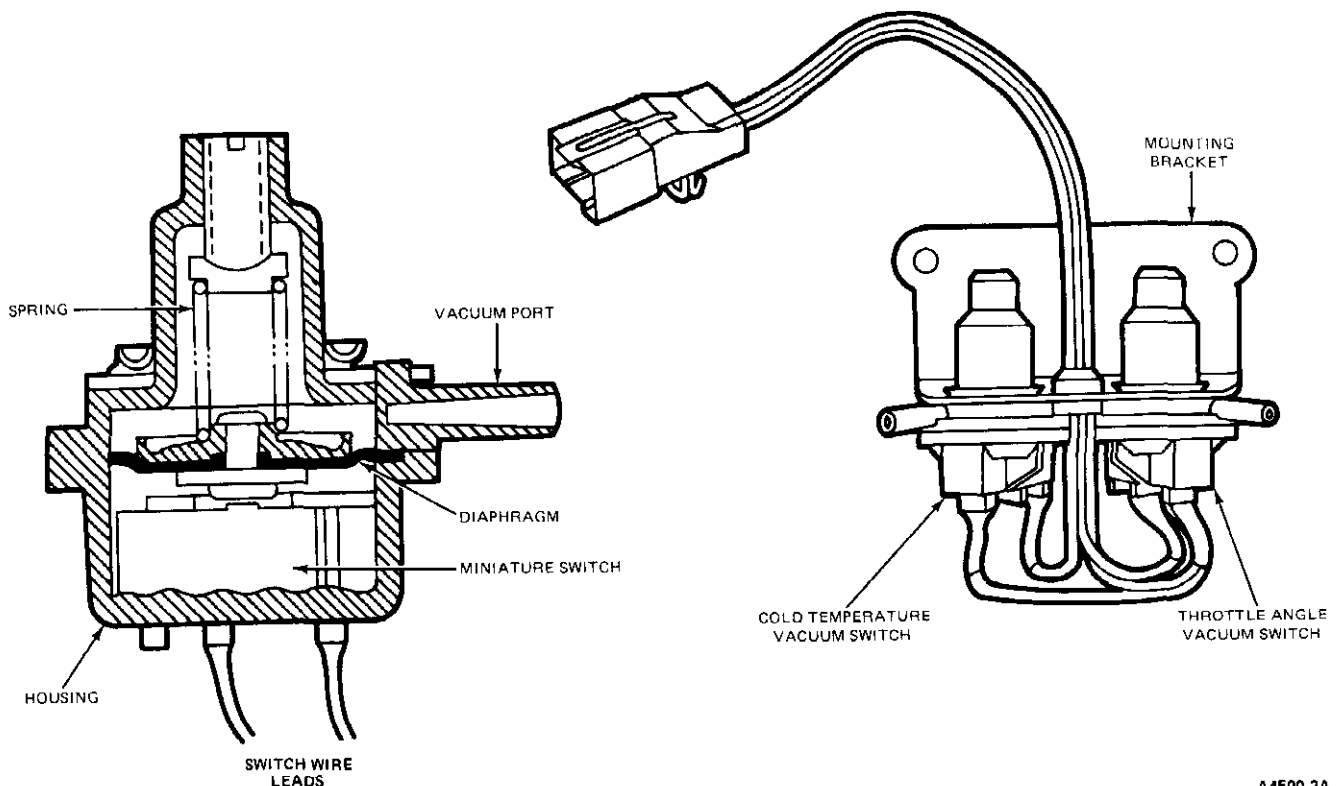
Electronic Control Unit

The Electronic Control Unit (ECU) used in this system is similar to the ignition module in appearance and size, but has noticeably different connectors to prevent wrong connections (Fig. 9).

The ECU is the "brain" of the system, and is the central component of the control "loop". The ECU continuously monitors the signals from the exhaust gas oxygen sensor, throttle angle vacuum switch and cold temperature vacuum switch, analyzes them, and sends out commands to the vacuum solenoid/regulator, which in turn supplies the vacuum signal to adjust the fuel metering rod in the carburetor to obtain the proper air/fuel ratio required for optimum operation of the catalytic converter. The ECU also contains circuitry that—based on engine rpm—varies the time required for the carburetor to adjust from rich to lean or lean to rich. The engine rpm signal is taken from the TACH terminal of the ignition coil connector (See Part 23-01).

Vacuum Switches

The throttle angle and cold temperature vacuum switches share a mounting bracket on the left fender apron (Fig. 10). Depending on engine load (throttle angle vacuum switch) or coolant temperature (cold temperature vacuum switch), these switches signal the



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FIG. 10 Vacuum Switches

ECU when to change from "open loop" to "closed loop" operation.

Throttle Angle Vacuum Switch

The throttle angle vacuum switch is a vacuum actuated electrical switch with normally closed contacts (Fig. 10). This vacuum switch is connected to vacuum at the carburetor spark port. When a vacuum of 3" Hg or more is applied to the vacuum port, the electrical contacts open.

During closed throttle operation (idle and deceleration), no spark port vacuum is available and the switch contacts are closed, sending a signal to the ECU to operate in "open loop" mode. In this mode, the ECU ignores the EGO sensor signal and commands the feedback fuel metering rod to mid-position. During part throttle operation (acceleration or cruise), spark port

vacuum causes the switch contacts to open, signalling the ECU to operate in "closed loop" mode. In this mode, there is full feedback control, and the ECU adjusts the air/fuel ratio in response to EGO sensor signals.

Cold Temperature Vacuum Switch

The cold temperature vacuum switch is a normally open contact vacuum switch, mounted on the same bracket with the throttle angle vacuum switch (Fig. 10). The vacuum switch is connected to the 3-way PVS, which supplies vacuum to the switch when engine coolant is below 52°C (125°F), operating the switch and closing the contacts. This signals the ECU to operate in the "open loop" mode. As the temperature rises above 52°C (125°F), the coolant PVS switches, cutting off vacuum from the cold temperature vacuum switch and signalling the ECU to go into the "closed loop" mode.

DIAGNOSIS

Complete diagnosis and testing of the ECU-A system is contained in Part 29-02 of this Manual. Because of the sophisticated nature of the ECU-A system, two special diagnostic aids are required for diagnosis:

1. **Feedback Control Tester T78L-50-FBC** - Connects into the electronic control unit (ECU) and the system harness, which provides access to the ECU input and output signals. The tester also contains plugs for continuity test and Digital Volt/Ohmmeter connection.
2. **Digital Volt/Ohmmeter (DVOM) T78L-50-DVOM** - Plugs into the Feedback Control Tester

and provides technician with precision data necessary to diagnose ECU-A system. Unit may also be used for other electrical system diagnosis.

In addition to these two special testers, a tachometer, vacuum gauge, throttle rpm tool and hand vacuum pump/tester are required for proper diagnosis.

NOTE: The Feedback Control Tester (T78L-50-FBC) and Digital Volt/Ohmmeter (DVOM) (T78L-50-DVOM) are available from Owatonna Tool Company; Owatonna, Minnesota; Attention Ford Order Desk.