

1975-79 EXHAUST EMISSION SYSTEMS

Ford Motor Co. Thermactor I System

DESCRIPTION

NOTE: Some Federal models equipped with the 200" 6-cylinder engine and automatic transmission are equipped with a pulse air type air injection system. See FORD MOTOR CO. THERMACTOR II PULSE AIR SYSTEM article in this section.

NOTE: For complete Thermactor I information on 1975-77 Ford models without Catalytic Converter, see the Air Injection Systems - Exc. Ford W/Cat. Converter article at beginning of this section.

The Thermactor I exhaust control system reduces carbon monoxide and hydrocarbon content of exhaust gases, by injecting fresh air into the exhaust gas stream as it leaves the combustion chamber. System consists of the following components: Air supply pump, air by-pass valve, vacuum differential valve (not used on all models), air supply system (external or internal), cylinder heads with air passages to exhaust ports, exhaust check valve(s), vacuum reservoir (some models), cold engine lockout/overheat protection system (1975-77 only), air pump muffler (some models with 302"), and a vacuum vent valve (2700 VV carburetor only).

NOTE: Thermactor air may also be injected into the catalytic converter on systems equipped with the Three-Way Catalyst (TWC). See Ford Motor Co. Feedback Carburetor Electronic Engine Control System and Electronic Engine Control (EEC I or EEC II) system articles in COMPUTERIZED ENGINE CONTROLS section for additional information.

OPERATION

Inlet air to the air pump is drawn through a centrifugal air filter fan. The pump then supplies air under pressure to the exhaust port near the exhaust valve, by either an external air manifold, or through internal drilled passages in the cylinder head or exhaust manifold. The oxygen in the fresh air, plus the heat of the exhaust gases, causes further oxidation (burning), which converts the exhaust gases into carbon dioxide and water.

AIR PUMP

Pump is belt driven from crankshaft pulley or from alternator. Pump takes air in through an impeller type centrifugal air filter fan, thus eliminating the need for a separate air filter. Dust and dirt particles cannot enter the pump because these heavier-than-air contaminants are thrown from the air intake by centrifugal force. The air pump does not have a pressure relief valve, this function being controlled by the air by-pass valve.

AIR BY-PASS VALVE

NOTE: Several types of air by-pass valves are used by Ford Motor Co. In addition, these valves may be mounted in-line with the air pump or mounted directly on the pump.

Air By-Pass Valve (Normally Closed Type) - During normal operation, engine intake manifold vacuum applied through the Vacuum Differential Valve (VDV) holds the normally closed valve upwards, allowing thermactor air to flow to the cylinder head(s) and blocking the vent port.

When intake manifold vacuum 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 by-pass valve. The spring pulls stem down, seating the valve to cut off pump air to exhaust manifold, and opening the dump valve at lower end of by-pass valve to momentarily divert pump air to the atmosphere. In the case of excess air pump volume or a downstream restriction,

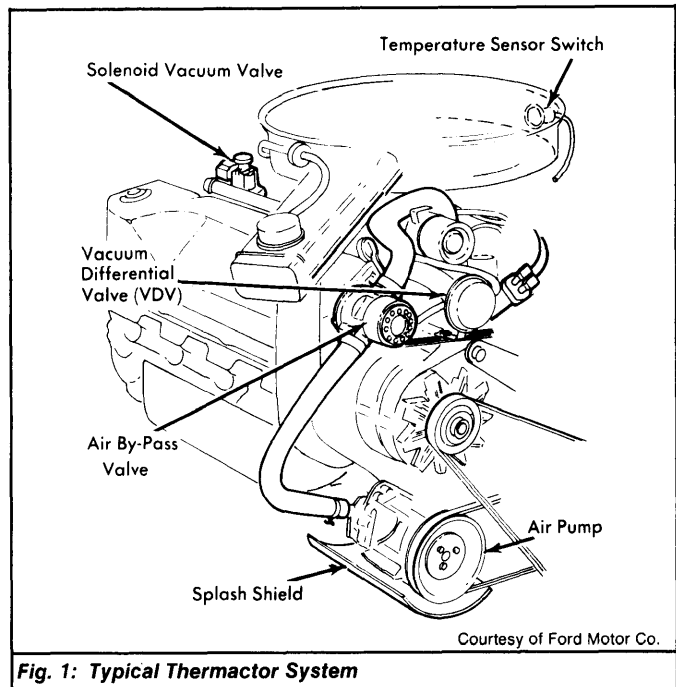


Fig. 1: Typical Thermactor System

the excess pressure will unseat the relief valve in lower portion of by-pass valve and allow a partial flow of pump air to the atmosphere. At the same time, the valve in upper portion of the by-pass valve is still unseated, allowing a partial flow of pump air to the exhaust manifold to meet system requirements.

NOTE: Some 1978-79 models are equipped with a Thermactor Air By-Pass (TAB) solenoid. This solenoid is controlled by a computer and is used to direct air injection from exhaust manifold (upstream) to catalytic converter (downstream). This system normally uses a closed type air by-pass valve with an EGR tap to control exhaust gas recirculation. See appropriate FORD MOTOR CO. ELECTRONIC ENGINE CONTROL article in the COMPUTERIZED ENGINE CONTROLS section for additional information.

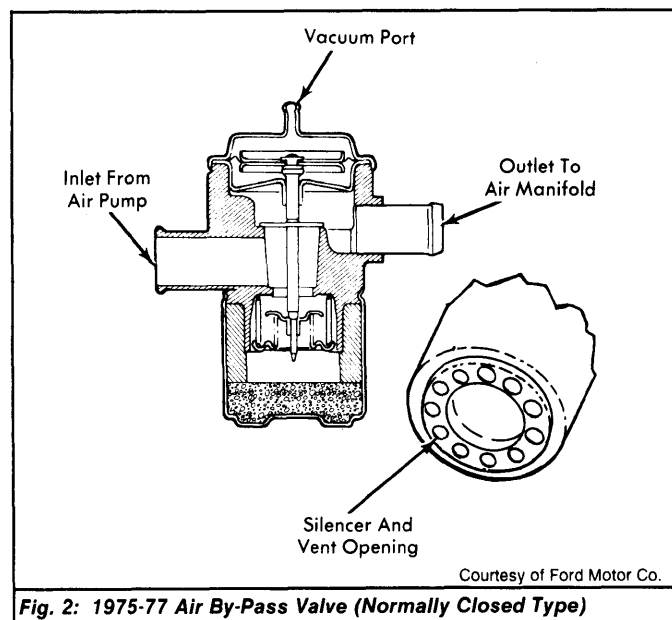


Fig. 2: 1975-77 Air By-Pass Valve (Normally Closed Type)

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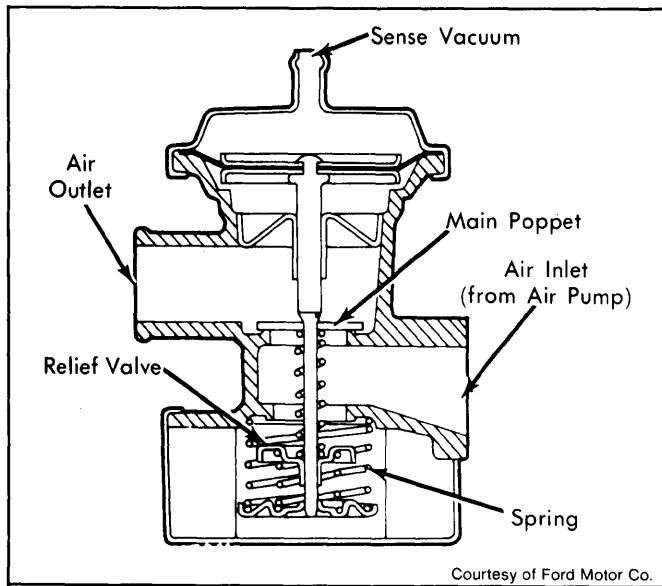


Fig. 3: 1978-79 Air By-Pass Valve (Normally Closed Type)

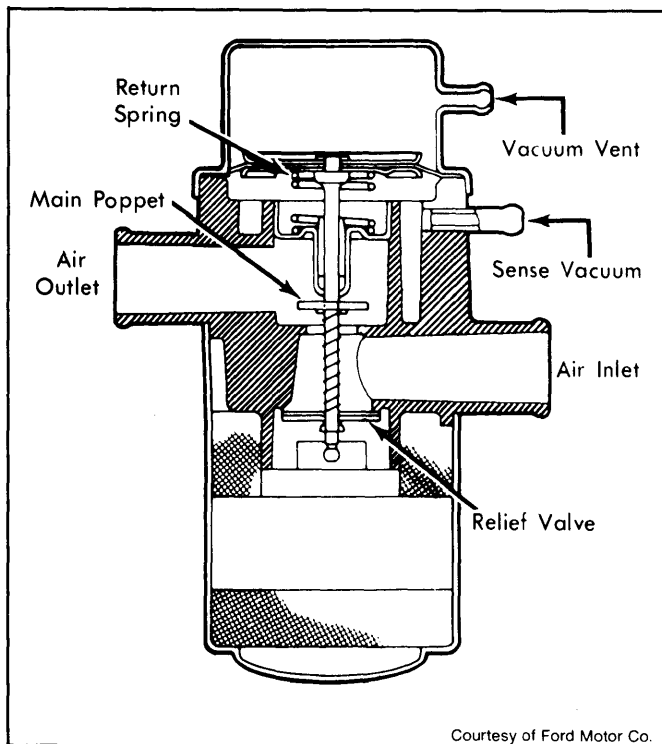


Fig. 4: 1977-79 Air By-Pass Valve (Normally Open Type)

Air By-Pass Valve (Normally Open Type) - This by-pass valve contains an integral VDV and a vacuum vent. During normal operation, the vent is blocked and vacuum is equalized on both sides of the diaphragm. The diaphragm return spring holds the valve closed, allowing thermactor pump air to the exhaust ports. When the vent is open to atmospheric pressure, and a vacuum of 4 in. Hg or more is applied to the sense port, intake manifold vacuum under the diaphragm overcomes the return spring pressure and pulls the valve downward. Thermactor air is then diverted to the atmosphere momentarily.

Air By-Pass/Diverter Valve - This type of by-pass valve is used on models equipped with Electronic Engine Control I or II (EEC I and EEC II) system only. It differs from the standard type by-pass valve in that it can route thermactor pump air to 3 different locations:

- Downstream (air is injected into the three-way catalyst).
- Upstream (air is injected into the exhaust manifold).
- By-pass (air is by-passed to the atmosphere).

The proper routing of the thermactor air is determined by the EEC I or EEC II Electronic Control Assembly (ECA) based on engine coolant temperature and other sensor data. For additional information, see appropriate FORD MOTOR CO. ELECTRONIC ENGINE CONTROL article in the COMPUTERIZED ENGINE CONTROLS section.

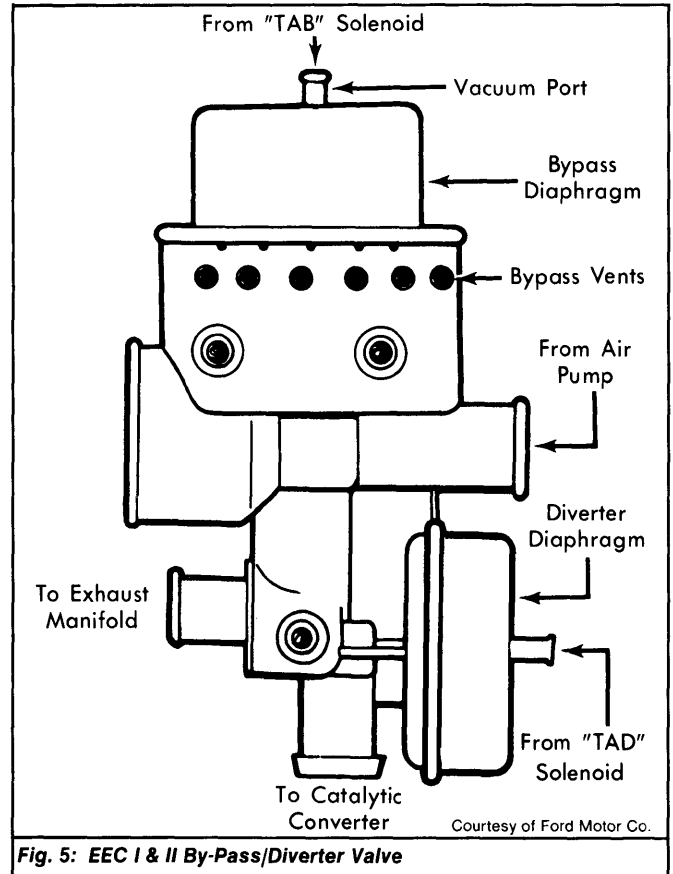


Fig. 5: EEC I & II By-Pass/Diverter Valve

VACUUM DIFFERENTIAL VALVE (VDV)

This valve controls the operation of the by-pass valve that doesn't have an integral vacuum differential valve. The VDV is inserted in the control vacuum line to the by-pass valve and serves to cut off vacuum and de-energize the by-pass valve.

The VDV consists of a diaphragm connected to a dump valve that controls vacuum to by-pass valve. During normal operation, vacuum is equalized on both sides of diaphragm and the spring holds dump valve closed. When sudden higher than normal vacuum is encountered, such as under deceleration conditions, vacuum is higher on dump valve side of diaphragm and the diaphragm operates the dump valve.

As the dump valve operates, the vacuum signal to by-pass valve is diverted through the built-in filter system to atmosphere. When the vacuum bleeding through by-pass timing orifice in the VDV has equalized on both sides of diaphragm, the diaphragm return spring once again closes the dump valve and applies vacuum to the by-pass valve, which again directs pump air to the exhaust ports.

DIFFERENTIAL VACUUM DELAY VALVE (DVDV)

This delay valve is used to delay air by-pass during periods of low engine manifold vacuum. The DVDV is installed in series with the VDV.

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This delay valve, in the sense vacuum line, delays operation of the VDV during sudden drops in manifold vacuum such as during hard acceleration. During sudden deceleration, the sudden rise in intake manifold vacuum opens the check valve 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.

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

Application of vacuum from the carburetor to both ports of the thermactor vent valve causes the diaphragm to initially move left 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. 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.

COLD ENGINE LOCK-OUT/OVERHEAT PROTECTION (1975-76 MODELS)

This system provides protection for catalytic converter when engine is cold or overheated. Two types of systems are used. System 1 uses normally closed switches while system 2 uses normally open switches.

System 1: Normally Closed - 1) When engine is operating at normal temperature, battery current goes through air cleaner mounted temperature sensor to solenoid vacuum valve. Some models also include a floor mounted overheat sensor.

2) If normally closed switch(s) open (due to cold air temperature or overheated floor pan), solenoid vacuum valve will operate. This causes by-pass valve to dump thermactor air to atmosphere.

System 2: Normally Closed - 1) When engine is operating at normal temperature, solenoid vacuum valve does not operate. This will allow vacuum through the VDV and thermactor will direct air to exhaust system.

2) If normally open switch(s) closes (due to cold air temperature or overheated floor pan), solenoid vacuum valve will operate. When solenoid vacuum valve operates on this system, this causes VDV to operate by-pass valve and dump thermactor air to atmosphere.

EXHAUST CHECK VALVE

The exhaust check valve(s) allows thermactor air to enter the exhaust manifold port drillings (and converter on models with three-way catalyst), but prevents the reverse flow of exhaust gases in the event of improper operation of system components. The valve is located between by-pass valve and exhaust port drillings. Models equipped with a by-pass/diverter type valve also have a check valve located between the valve and the catalytic converter.

TROUBLESHOOTING

Exhaust Backfire - This is usually caused by excess fuel entering exhaust system on deceleration. Check for incorrect engine tune-up, misfire, leaking exhaust manifold, defective by-pass valve or check valve. VDV valve defective, or electrical circuit inoperative.

TESTING

AIR PUMP

- 1) Check all hoses for leaks and correct as necessary. Check air pump drive belt tension and adjust if necessary.
- 2) Disconnect air pump hose at by-pass valve. Connect a pressure gauge to hose. Connect a tachometer to engine.
- 3) With transmission in Neutral or Park and parking brake set, start engine and allow to reach normal operating temperature.

4) Slowly increase engine speed to 1000 RPM. The air pressure must be 2¼ psi minimum. If pressure gauge is not available, run engine at 1500 RPM and place hand over open end of hose. Air flow should be felt and heard.

5) If air flow does not meet specifications, replace air pump assembly and repeat test.

AIR BY-PASS VALVE

Normally Closed Type By-Pass Valve - 1) Warm engine to normal operating temperature. Place transmission in Park or Neutral and set parking brake. Disconnect by-pass valve-to-air manifold check valve hoses at the by-pass valve.

NOTE: For a "tee" system, remove both hoses connecting by-pass valve to check valves.

2) Connect a tachometer to engine. Start engine and accelerate to 1500 RPM. Verify that air is flowing from by-pass valve hose connection(s) by placing hand over valve connection. Air flow should be heard or felt.

3) Remove and plug vacuum signal hose from by-pass valve. With engine at 1500 RPM and hand held over by-pass valve connection, there should be virtually no air flow. Air flow will be discharged through the exhaust ports in end of valve silencer cover. If air flow is felt or heard through the by-pass valve connection, the valve should be replaced.

Normally Open Type By-Pass Valve - 1) Warm engine to normal operating temperature. Place transmission in Park or Neutral and set parking brake. Disconnect by-pass valve-to-check valve hose at by-pass valve.

NOTE: For a "tee" type system, disconnect both hoses connecting by-pass valve to check valves.

2) Cap by-pass valve vacuum vent nipple. Remove, or route around, any restricting or delaying device in the sense vacuum hose. Connect a tachometer to engine.

3) Accelerate engine to 1500 RPM. Verify that air is flowing from by-pass valve hose outlet connection(s) by placing hand over valve connection. Air flow should be felt or heard. If no air flow is detectable, the valve must be replaced.

4) With engine still at 1500 RPM and hand placed over valve outlet, momentarily (5-8 seconds) pinch off sense vacuum hose to by-pass valve to simulate the by-pass valve cycle.

5) Release pinched hose. Air flow through by-pass valve should diminish or stop for a short period of time, then return to normal. Air will be discharged through the exhaust ports in valve silencer cover. If this cycle does not occur, by-pass valve must be replaced.

NOTE: The length of time required to resume normal air flow is dependent on engine vacuum, and length of time vacuum line is pinched off.

6) Stop engine and remove cap from vacuum vent nipple, and leave nipple open. Start engine and accelerate to 1500 RPM. Virtually no air flow should be detectable from by-pass valve outlet(s). Air will be discharged from exhaust ports in silencer housing. If air flow can be detected at outlet(s), the valve must be replaced.

NOTE: The following test apply to vehicles with a computer-controlled air by-pass/diverter valve. This system is used on 1978-79 Fords with EEC I and EEC II only. The test will check operation of the vacuum from the solenoid(s) to by-pass/diverter valve and if the computer is able to control the solenoid(s). The EEC I uses one Thermactor Air Solenoid. EEC II uses 2 solenoids. TAB is used to divert air from exhaust to atmosphere. TAD is used to direct air from exhaust manifold (upstream) to catalytic converter (downstream).

Air By-Pass/Diverter Valve - 1) Using a Digital Volt/Ohmmeter (DVOM), backprobe White/Red Dot wire of solenoid (Thermactor Air Solenoid on EEC I or TAB on EEC II). On EEC II, you will also need

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to backprobe Light Green/Black Dot wire of TAD solenoid. This may be done with another DVOM or by switching DVOM test lead from TAB solenoid and touching DVOM test lead to TAD solenoid.

2) Using 0-25 in. Hg gauge(s) and vacuum "T", tee into vacuum line between air by-pass/diverter and Thermactor Air Solenoid on EEC I or by-pass valve-to-solenoid (TAB) line and diverter valve-to-solenoid (TAD) line on EEC II. See Fig. 5.

3) Remove air cleaner and plug vacuum lines. Start engine and idle until normal operating temperature is reached and throttle is off fast idle. Turn engine off. Turn ignition on, but do not start engine.

4) Ensure 12 volts are indicated on DVOM(s). If not, check and correct for loss of battery power on Red wire from EEC power relay. Disconnect terminals from solenoid(s). Ensure resistance of solenoid(s) is 30-50 ohms. If not, replace solenoid(s).

5) Restart engine. Verify that vacuum gauge(s) on Thermactor Air Solenoid for EEC I or TAB and TAD for EEC II read a minimum of 10 in. Hg vacuum and that the DVOM(s) reads near zero volts:

- If gauge(s) do not read 10 in. Hg vacuum, and the DVOM(s) read low voltage, check vacuum signal to solenoids. Repair and replace as required. If vacuum signal to solenoids is okay, replace solenoid(s) assembly.
- If the DVOM(s) do not show a voltage drop, check thermactor air solenoid for EEC I or TAB and TAD for EEC II solenoid operation by grounding solenoid-to-computer circuit wire with a non-self powered test light. If solenoid works, go to step 8).

6) Within 60 seconds of engine start-up, the diverter valve vacuum gauge reading should drop to zero and the DVOM on TAD solenoid should return to about 12 volts:

- If gauge does not drop to zero, but the DVOM on TAD returns to about 12 volts, replace TAD solenoid assembly.
- If the DVOM stays near zero volts, check TAD solenoid circuit to computer for short to ground. If no problem found, go to step 8).

7) Within 95 seconds of engine start-up, the by-pass valve vacuum gauge reading should drop to zero and the DVOM Thermactor Air Solenoid for EEC I or TAB for EEC II should go back to about 12 volts:

- If gauge does not drop to zero, but the DVOM on the Thermactor Air Solenoid for EEC I or TAB for EEC II returns to about 12 volts, replace Thermactor Air Solenoid for EEC I or TAB assembly for EEC II.
- If the DVOM stays near zero volts, check Thermactor Air Solenoid for EEC I or TAB for EEC II solenoid to computer circuit for short to ground. If no problem found, go to next step.

8) If problem is still present, the EEC I/EEC II circuits, sensor(s) or computer may be defective. See appropriate ECC article in the COMPUTERIZED ENGINE CONTROLS section. Remove all test equipment and reconnect all system components.

VACUUM DIFFERENTIAL VALVE (VDV)

1) With engine at normal operating temperature, transmission in Park or Neutral and parking brake set, disconnect by-pass valve-to-exhaust check valve hose at by-pass valve. Connect a tachometer to engine.

NOTE: For a "tee" system, disconnect hoses connecting both check valves to bypass valve.

2) Start engine, place a hand over by-pass valve outlet connection and accelerate engine to 2500 RPM. Release throttle and allow engine to return to normal idle speed.

3) During the deceleration period, air flow at by-pass valve outlet should be felt and/or heard to momentarily diminish or stop and then return to normal. Air flow will be discharged through exhaust ports in end of by-pass valve silencer cover.

NOTE: The length of time required to resume normal air flow is dependent on engine vacuum, and length of time vacuum line is pinched off.

4) If by-pass valve is functioning properly, but does not operate as described in step 3), check to ensure that VDV is receiving vacuum. If vacuum is present, VDV is defective and should be replaced.

DIFFERENTIAL VACUUM DELAY VALVE (DVDV)

NOTE: For testing of this valve see Air Cleaner Delay Valve testing in Ford Motor Co. Vacuum Delay Valves article in this section.

COLD ENGINE LOCK-OUT/OVERHEAT PROTECTION (1975-76 Models)

Normally Closed System One – 1) Warm engine to normal operating temperature. Ambient temperature should be about 65°F. Disconnect vacuum hose at air by-pass valve.

2) Air by-pass valve should dump air to atmosphere. If it does not, vacuum supply is not operating correctly. Reconnect hose. Disconnect vacuum source line at solenoid and check for adequate engine manifold vacuum. Reconnect vacuum line.

NOTE: Vacuum supply always goes to bottom fitting on solenoid valve.

3) Disconnect wires from solenoid and then reconnect hot wire only. If by-pass valve dumps air, when other exposed terminal is grounded, solenoid valve is defective. If by-pass valve dumps air when wires are reconnected, check temperature switch in air cleaner.

Normally Open System Two – 1) Warm engine to normal operating temperature. Ambient temperature should be about 65°F. Disconnect vacuum hose at air by-pass valve.

2) Air by-pass valve should dump air to atmosphere. If it does not, vacuum supply is not operating correctly. Reconnect hose.

NOTE: Vacuum supply always goes to Black fitting on solenoid valve.

3) Disconnect wires from solenoid and then reconnect hot wire only. If by-pass valve DOES NOT dump air, when other exposed terminal is grounded, solenoid valve is defective. If by-pass valve dumps air when wires are reconnected, check temperature switch in air cleaner.

CHECK VALVE

1) Disconnect hose to check valve at by-pass valve. Connect a squeeze bulb tester to hose.

2) Squeeze bulb to force as much air from bulb as possible. Quickly release bulb and start timing. The bulb should remain collapsed (not returning to its original shape) for at least 15 seconds.

3) If bulb returns to its original shape within 15 seconds, check by-pass hose to ensure that it is free of leaks. If hose is in good shape, replace check valve.