# FORD MOTOR CO. THERMACTOR SYSTEMS

## DESCRIPTION

The Thermactor 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 bypass 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), air pump muffler (some models with 302"), and a vacuum vent valve (2700 carburetor only).

The Managed Thermactor Air (MTA) System uses the same basic components but "manages" thermactor air according to operating conditions. Air is by-passed to atmosphere, directed upstream to the catalytic converter near the exhaust manifold, or directed downstream to the underbody catalytic converter.

The Thermactor II System is a pulsed air system which uses a reed valve to control fresh air to the exhaust manifold. It is used only on Federal 2.3 Liter engines with automatic transmissions. It has no air pump.

## 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 bypass valve.

### AIR BYPASS VALVE

NOTE – *Several types of air bypass 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 Bypass 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 bypass 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 bypass valve to momentarily divert pump air to the atmosphere.

In the case of excess air pump volume or a downstream restriction, the excess pressure will unseat the relief valve in lower portion of bypass valve and allow a partial flow of pump air to the atmosphere. At the same time, the valve in upper portion of the bypass valve is still unseated, allowing a partial flow of pump air to the exhaust manifold to meet system requirements.

**Air Bypass Valve (Normally Open Type)** – This bypass valve contains an integral vacuum differential valve and a vacuum vent. A separate vacuum differential valve (VDV) is not required with this valve.

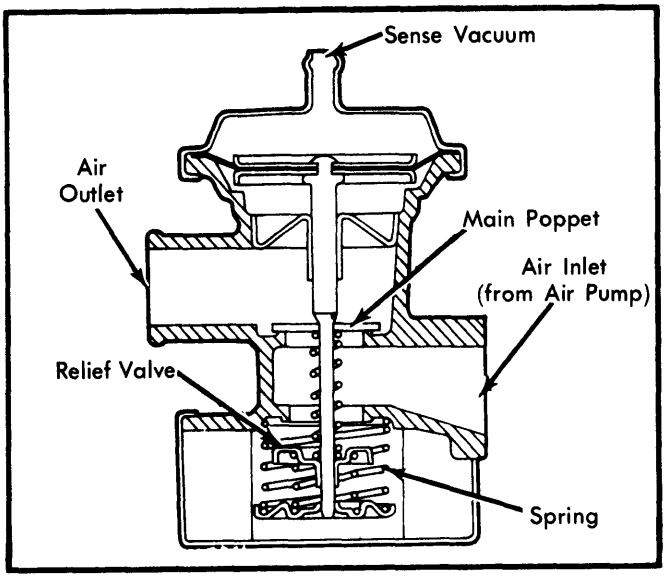


***Fig. 1 Cutaway View of Air Bypass Valve (Normally Closed Type)***

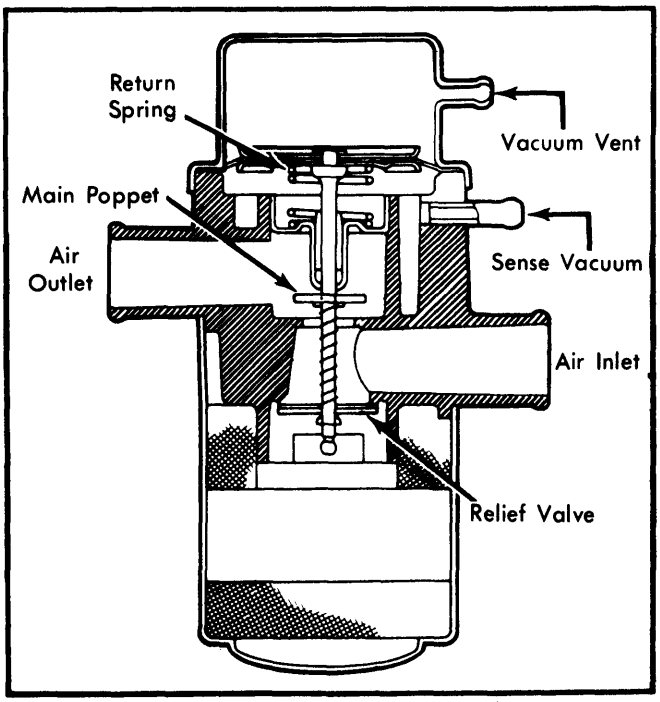


***Fig. 2 Cutaway View of Air Bypass Valve (Normally Open Type)***

## FORD MOTOR CO. THERMACTOR SYSTEMS (Cont.)

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.

**Thermactor Bypass/Diverter Valve** – Used only on models equipped with Electronic Engine Control III (EEC III). Differs from standard type bypass 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).
- Bypass (air is bypassed to the atmosphere).

Proper routing of thermactor air is determined by the Electronic Control Assembly (ECA) based on engine coolant temperature and other sensor data. *For additional information, see Ford Motor Co. Electronic Engine Control III (EEC III) article in this section.*

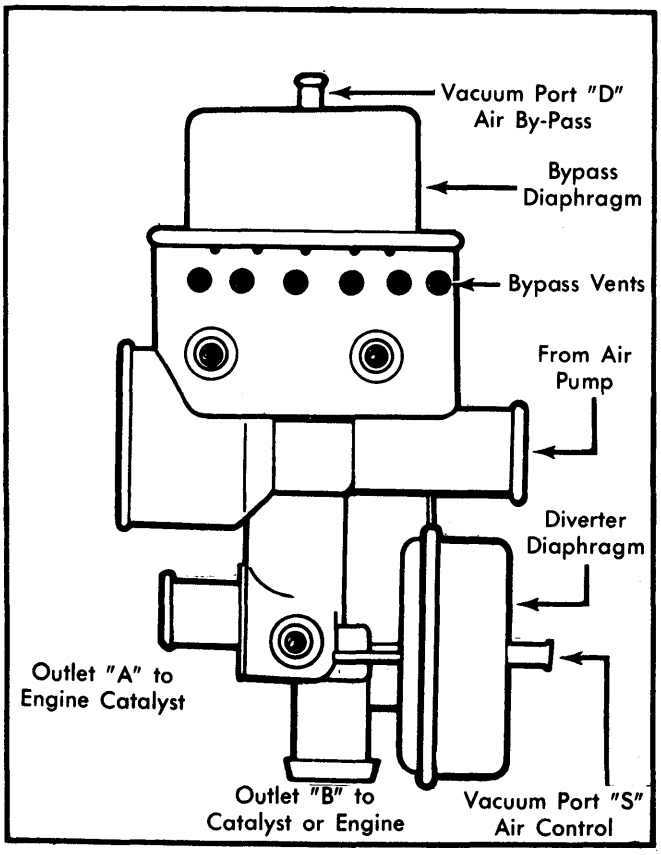


***Fig. 3 Thermactor Bypass/Diverter Type Valve***

### SOLENOID VACUUM VALVE

Controlled by the Electronic Control Assembly (ECA) or Microprocessor Control Unit (MCU) to direct vacuum and operate thermactor valves more precisely.

### VACUUM DIFFERENTIAL VALVE (VDV)

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

The differential valve consists of a diaphragm connected to a dump valve that controls vacuum to bypass 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 bypass valve is diverted through the built-in filter system to atmosphere. When the vacuum bleeding through bypass 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 bypass valve, which again directs pump air to the exhaust ports.

### 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 vacuum differential valve (VDV).

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, 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 bypass 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.

### THERMACTOR AIR (REED) CHECK VALVE (THERMACTOR II ONLY)

When pressure in the exhaust manifold is more than the pressure in the air cleaner (positive pressure), the air inlet valve closes. When pressure is less in the exhaust manifold than in the air cleaner (negative pressure), the valve opens. At this point, air is drawn into the exhaust manifold where it reduces hydrocarbon and carbon monoxide emissions by continuing the combustion of unburned gases in the same manner as an

## FORD MOTOR CO. THERMACTOR SYSTEMS (Cont.)

air pump system. This opening and closing is a normal pattern established by exhaust gas pulses created by the combustion process.

NOTE – *Although the Thermactor Air Check Valve may look like the Exhaust Check Valve, the two are NOT interchangeable.*

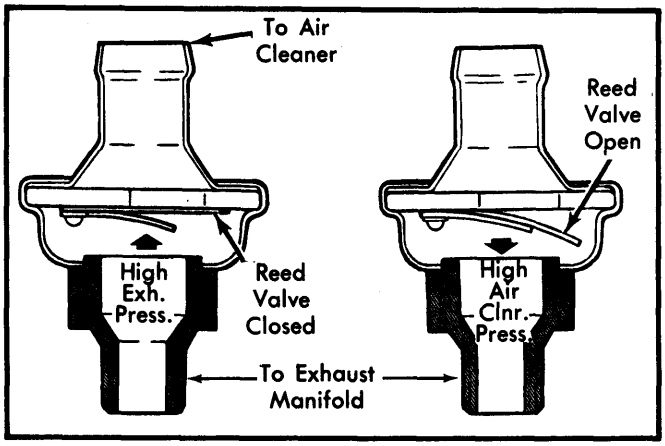


***Fig. 4 Thermactor Pulsed Air (Reed) Check Valve***

### EXHAUST CHECK VALVE

The exhaust check valve(s) allows thermactor air to enter the exhaust manifold port drillings (and converter on models with 3-way catalyst), but prevents the reverse flow of exhaust gases in the event of improper operation of system components. The valve is located between bypass valve and exhaust port drillings. Models equipped with a bypass/diverter type valve also have a check valve located between the valve and the catalytic converter.

## TESTING

### AIR PUMP

1) Check all hoses for leaks and make sure leaks are corrected if any are found. Check air pump drive belt tension and adjust if necessary.

2) Disconnect air pump hose at bypass valve. Connect a suitable 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.

CAUTION – *Position the pressure gauge so that the air blast emitted will be harmlessly dissipated.*

4) Slowly increase engine speed to 1000 RPM and observe pressure produced at pressure gauge. The air pressure must be 2¼ psi minimum.

5) 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.

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

### AIR BYPASS VALVE

**Normally Closed Type Bypass Valve** – 1) With engine at normal operating temperature, transmission in park or neutral and parking brake set, disconnect bypass valve-to-air manifold check valve hoses at the bypass valve.

NOTE – *For a tee system, remove both hoses connecting bypass valve to check valves.*

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

3) Remove vacuum hose from bypass valve and plug off the hose. With engine at 1500 RPM and hand held over bypass 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 bypass valve connection, the valve should be replaced.

**Normally Open Type Bypass Valve** – 1) With engine at normal operating temperature, transmission in park or neutral and parking brake set, disconnect bypass valve-to-check valve hose at bypass valve.

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

2) Cap bypass valve vacuum vent nipple. Remove, or short circuit, 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 bypass 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 bypass valve to simulate the bypass valve cycle.

5) Release pinched hose. Air flow through bypass 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, bypass valve must be replaced.

NOTE – *The length of time required to resume normal air flow cannot be specified since the time interval 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 bypass 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.

## FORD MOTOR CO. THERMACTOR SYSTEMS (Cont.)

### SOLENOID VACUUM VALVE

**Normally Closed Valve** – 1) With engine idling at normal operating temperature and ambient air above 65°F (18°C), disconnect vacuum hose to thermactor air by-pass valve. If air dumps to atmosphere through exhaust ports in silencer cover, hose connections are correct. Reconnect vacuum hose.

2) Disconnect vacuum supply hose from bottom fitting of solenoid valve and check for manifold vacuum. If no vacuum, check and/or replace vacuum source hose as required. Reconnect vacuum hose. (Vacuum supply ALWAYS goes to bottom fitting on solenoid vacuum valve.)

3) Disconnect wires to solenoid vacuum valve and determine which wire has B+ voltage with ignition switch in RUN position. Connect B+ wire to solenoid vacuum valve. With engine idling, ground other exposed terminal on valve. Air should NOT dump to atmosphere.

4) Connect wires as originally installed and note that thermactor air is NOT being dumped to atmosphere. Replace solenoid valve if air dumps in either solenoid test.

**Normally Opened Valve** – Perform same test as for Normally Closed Valve EXCEPT that thermactor air SHOULD be dumped to atmosphere when solenoid terminal is grounded.

### VACUUM DIFFERENTIAL VALVE (VDV)

1) With engine at normal operating temperature, transmission in park or neutral and parking brake set, disconnect bypass valve-to-exhaust check valve hose at bypass 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 bypass 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 bypass 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 bypass valve silencer cover.

NOTE – *The length of time required to resume normal air flow cannot be specified since the time interval is dependent on engine vacuum, and length of time vacuum line is pinched off.*

4) If bypass valve is functioning properly, but does not operate as described in step **3)**, check to ensure that vacuum differential valve (VDV) is recieving vacuum. If vacuum is present, VDV is defective and should be replaced.

### DIFFERENTIAL VALVE 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.*

### THERMACTOR AIR (REED) CHECK VALVE

1) With engine off, inspect hoses and clamps from pulse air valve to air cleaner for cracks, splits, etc. Tighten or replace a necessary.

2) Disconnect hose from air inlet valve to air cleaner at valve. Connect Thermactor air valve tester (T75L-9487 or equivalvent) to open end of air valve. Position hose clamp and tighten.

3) Squeeze test bulb to force as much air from bulb as possible. Quickly release bulb and note time it takes to return to normal shape. Bulb should remain collapsed for at least 15 seconds. If bulb returns to normal shape in less than 15 seconds, valve is defective and should be replaced.

### CHECK VALVE

1) Disconnect hose to check valve at bypass valve. Connect a suitable 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 bypass hose to ensure that it is free of leaks. If hose is in good shape, replace check valve.