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Positive Backpressure EGR Valves

In Tech Tip #25, we looked at ported EGR valves and their operation principles. This issue we are going to discuss positive backpressure EGR valves.

The EGR's main function is to help in the reduction of NOx. The ported EGR valve simply opens and closes as vacuum is applied. The positive style operates on a slightly different principle. Lets take a look at the mechanics and function of the positive backpressure valve.

The positive backpressure EGR valve contains two diaphragms inside the canister (Fig.1). This may be one large diaphragm sandwiched between two plates to make two diaphragms, or two separate diaphragms. We will call the top diaphragm the "upper diaphragm" and the bottom one the "lower diaphragm". These two diaphragms are separated by a spring. There is also a heavier spring located on top of the upper diaphragm.

There is a hole in the center of the upper diaphragm. There is also a hole in the lower diaphragm to the atmosphere. If vacuum is applied to the vacuum port of this valve, the air will be drawn in from the hole of the lower diaphragm, through the center hole of the upper diaphragm (Fig. 2). This means the EGR valve will not open. So how does this valve open? To find this out we have to look at the lower half of the valve.

The lower half of the valve contains a pintle and a shaft that is connected to the plate below the lower diaphragm (Fig. 3). The pintle has two

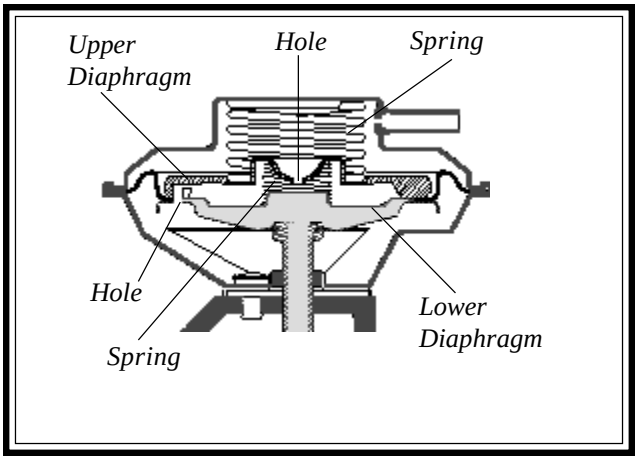

Figure 1

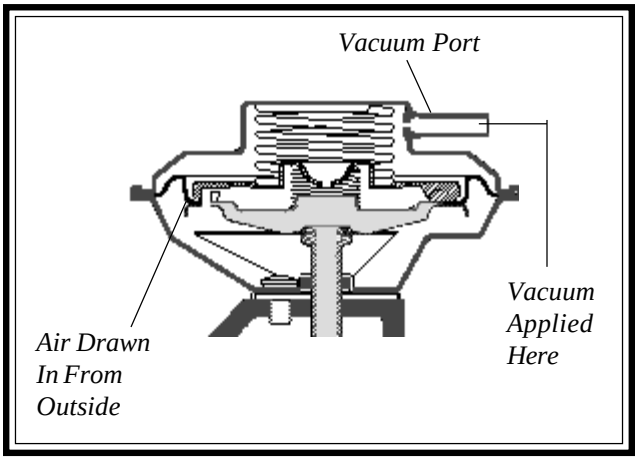

Figure 2

holes drilled in its tip. The pintle shaft is hollow up to the lower diaphragm.

When exhaust backpressure builds due to increased engine load, it travels into the holes at the pintle shaft. It then travels up the hollow pintle shaft to the lower diaphragm. This exhaust backpressure causes the lower diaphragm to move upward. If the exhaust backpressure is great enough, it will overcome the tension of the spring

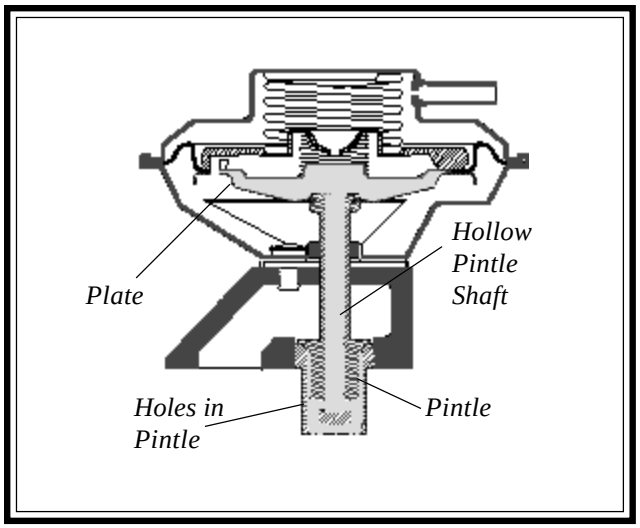

Figure 3

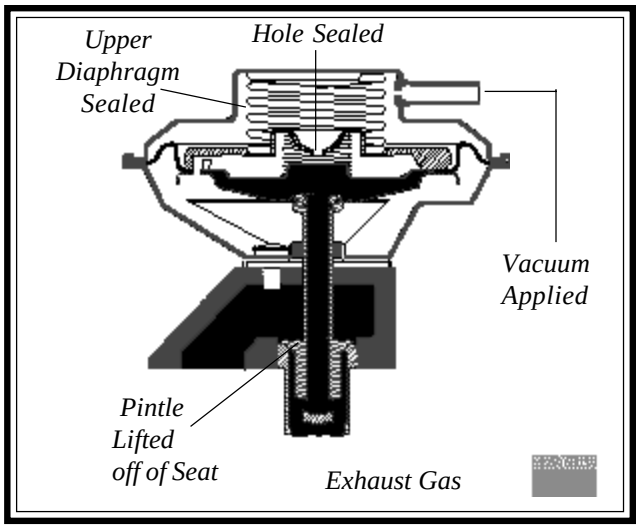

Figure 4

between the upper and lower diaphragm. The lower diaphragm will move upward and seal the hole in the upper diaphragm (Fig. 4). This completes the seal of the upper diaphragm. Now when vacuum is applied to the vacuum port, the upper diaphragm will lift and cause the EGR pintle to be moved off its seat. This allows exhaust gas to enter into the intake manifold to reduce combustion temperatures and the production of NOx.

Now once the pintle is lifted the positive backpressure of the exhaust is affected by the negative pressure of the intake manifold. This decreases the positive pressure on the lower diaphragm. The spring tension overcomes the backpressure and pushes the lower diaphragm down, once again opening up the hole in the upper diaphragm. The vacuum that is being applied to the vacuum port is again drawing atmospheric air. Since there is no longer a sealed chamber the upper diaphragm falls, causing the pintle to lower on its seat, thus shutting off EGR flow.

The cycle is repeated over and over as exhaust backpressure increases and decreases. This up and down movement of the EGR valve is know as *dithering.*

Why use this method to operate the EGR? As you may remember from last issue we controlled the early EGR valves simply with a ported vacuum switch and ported vacuum. This was not a real effective way of correlating EGR operation with engine load. By using exhaust backpressure as a control we have better correlation and therefore a more precise control of the EGR valve.

EGR PROBLEMS

One problem that can occur with these valves is carbon clogging. The small holes in the pintle tip can become clogged very easily. Once the pintle is clogged, the lower diaphragm can no longer operate. This results in total EGR failure.

The spring between the two diaphragms can also become weak. This may allow the lower diaphragm to seal the upper diaphragm too quickly. This will cause the EGR to open too soon, causing hesitation or surging. Replacing the valve is the only solution to this problem.

Another problem which may exist is an exhaust system that has developed too much backpressure. This results in the EGR valve opening too early. A simple back pressure check taken at the O_2 port will tell you if the exhaust is clogged. The rule of thumb is: anything over 3 PSI at 2500 rpm is excessive.

On the opposite side, replacing the exhaust with a performance system might decrease the backpressure. This may not allow the EGR valve

See "EGR Problems", page 4

Electronics 101: Transistors in Applications

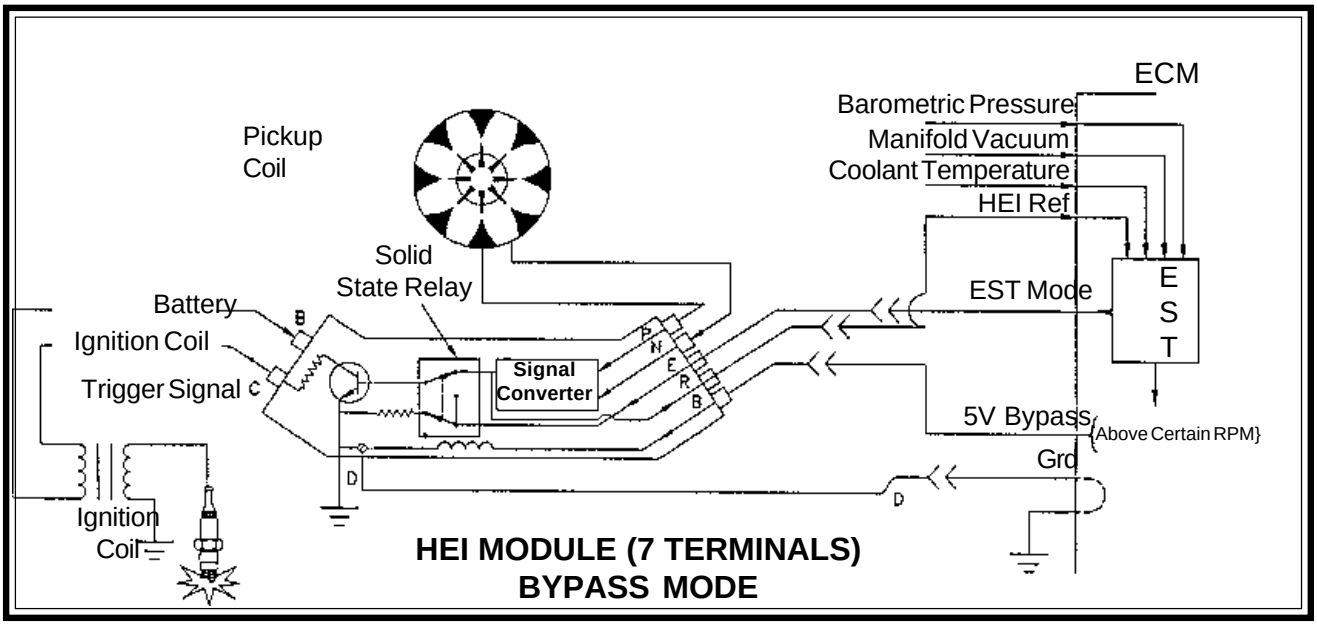

Figure 5

Lets take a look at a transistor's function in a GM High Energy Ignition (HEI) module with Electronic Spark Timing (EST).

In figure 5 we have a typical seven pin GM HEI module. Our main concentration will be on the transistor that fires the coil. But first lets give some background.

As you can see, terminal B on the left side of the module is connected to the battery and the positive side of the coil. This supplies power to the module. Terminal C is connected to the negative side of the coil. Terminal D is the ground for the module.

On the right side of the module terminals P and N are connected to the pickup coil. The pickup coil in this case produces an AC signal (Figure 6). This AC signal is sent to the signal converter in the module and is changed to a DC signal. This DC signal is sent to the computer via terminal R as a reference pulse. The computer uses this signal to trigger the firing of the injector pulses and as an rpm signal.

This DC signal is also attached to the base of the transistor during engine cranking (Fig. 5). This means that during cranking mode this DC signal is being used to control the firing of the ignition coil. So timing during cranking is being controlled by the module itself. This is called module or bypass mode.

Terminal B on the right side of the module is connected to the computer. When the computer sees above a certain RPM (usually between 400 to 600 rpm depending on the vehicle) it sends five volts on that line to the module. This five volt signal energizes the solid state relay inside the module. This disconnects the reference signal from the base of the transistor. At the same time it also connects terminal E to the base of the transistor (Fig. 7).

Terminal E comes from the computer. This is the Electronic Spark Timing (EST) signal. This signal is a five volt high/low toggle. This signal triggers the base of the transistor which controls the firing of the coil. The computer monitors the last pulse from the pickup coil and delays the output pulse. The output pulse is thus shifted from the reference which advances the timing above base timing. The computer uses the MAP

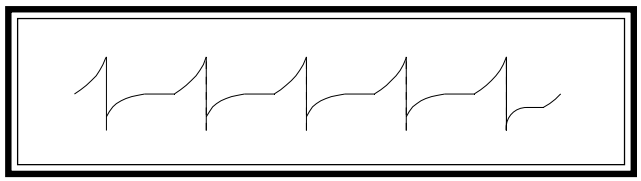

Figure 6

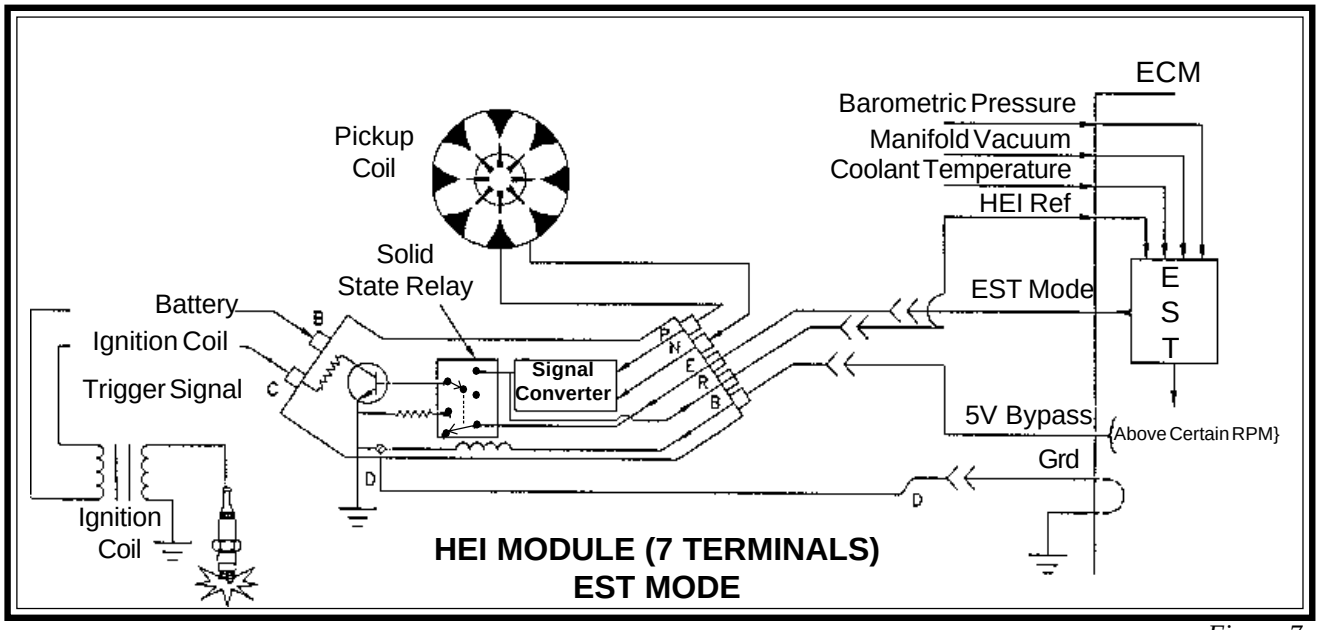

Figure 7

or MAF sensor, Coolant Temperature sensor, Barometric Pressure sensor and rpm to calculate spark timing. This is called EST mode.

In this application the transistor is being turned on or off by the bypass or the EST signal. In both cases the signal energizes the base of the transistor, which allows current to flow from the collector to the emitter. This completes the ground path for the coil. Then at the calculated time the EST or bypass signal goes low, which shuts the transistor off and fires the coil.

EGR Problems (continued from page 2)

to open when it was needed.

Remember that the positive backpres-sure EGR valve will not open when vacuum is applied to the vacuum port. Therefore when checking this valve just applying vacuum will not be an effective test. You must create enough backpressure to move the lower diaphragm enough to seal the upper diaphragm. Just revving the engine may not produce enough backpressure to accomplish this.

An easy way to check these valves is to stick a socket in the exhaust and clamp it to the exhaust with a pair of vise grips. This will increase the exhaust backpres-sure. Start the engine and rev it up while checking to see if the diaphragm moves up and down. As we all know the EGR valve area is extremely hot. Make sure you use proper precautions to avoid burns or injury.

With the new emissions testing coming, NOx is being measured in many states. Proper understanding of EGR principles and diagnostics is essential to repair NOx failures.