Driveability Clinic

Charcoal Canisters

The last time we got involved with charcoal canisters was in a Tools and Techniques article on slack tube testing back in September 1990. In that earlier article, we referred to the evaporative emission control system as a charter member of the Ignored Auto Parts Club. As long as the system is doing its job, there is rarely a reason to give it a second thought. In this article, we'll discuss what the evaporative emission control system does and how it works. A better understanding of this system's operation should make diagnosis easier when the system it stops doing its job.

We buy gasoline as a liquid fuel by the gallon. But under the right conditions, a certain percentage of that liquid fuel can easily change to a vapor. Before vehicles were equipped with evaporative emission control systems, fuel evaporation from the fuel tank and carburetor could account for as much as 15 to 20 percent of a vehicle's total hydrocarbon emissions. Those old cars did a good job of polluting the air even when they weren't running.

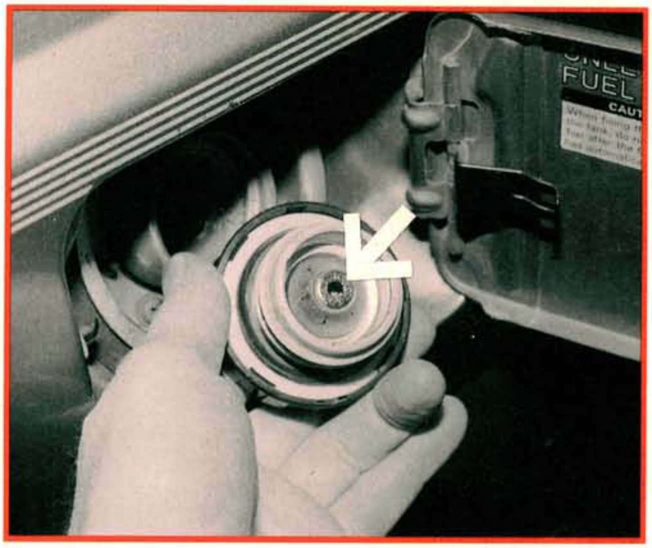
Government antipollution legislation changed all that. By the early 1970's, laws had been passed that required all gasoline powered passenger cars to be equipped with a variety of pollution control devices, including evaporative emission control systems.

The early evaporative emission systems were simple. They collected the fuel vapors from the fuel tank and carburetor. A charcoal canister stored the vapors until the vapors could be drawn into the engine and burned as fuel. These systems lowered vehicle evaporative emissions as the new laws required, but they did very little to improve the performance quality of the cars of that era. Engine surging and hesitation were common problems.

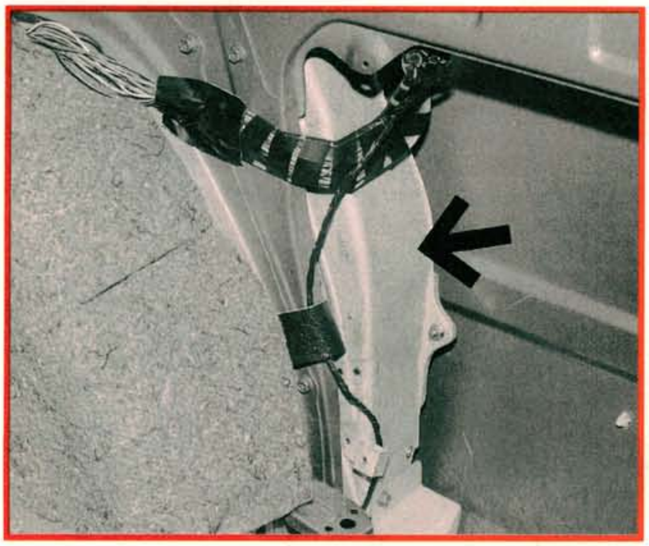
It's gotten better since then. Today's evaporative emission control systems are just one part of integrated engine management systems. When they are working properly, these systems do a much better job than their patchwork quilt predecessors. We'll look at 12 representative examples of evaporative emission system components, explain what these components do, and explain what happens when they don't.

—By Karl Seyfert

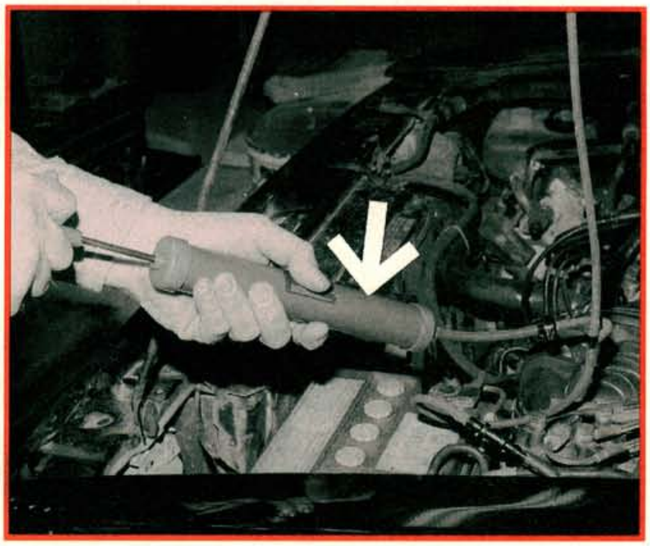
1 Heat causes fuel in the tank to expand and evaporate. The system is sealed to prevent venting to the atmosphere, so most tanks are designed to allow for this normal expansion and increase in tank pressure. Hot, unused fuel entering the tank through the fuel return line may also cause an increase in fuel tank pressure. A check valve is used to control tank pressure. A small amount of tank pressure is maintained to reduce fuel pump cavitation caused by fuel vaporization.



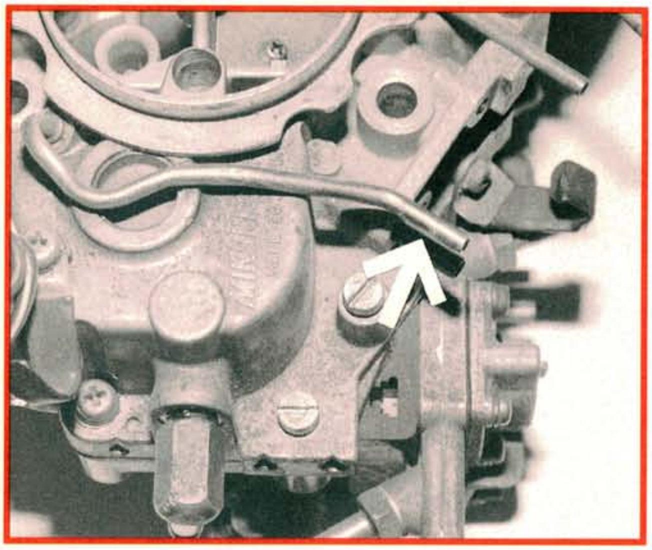
2 Try pouring liquid out of a bottle by turning the bottle upside down. The liquid comes out slowly because a vacuum has been created. Very little air can enter the bottle to replace the escaping liquid. The same thing happens as fuel is drawn from the tank. With no source of outside air, a vacuum strong enough to collapse the fuel tank could be created. A one-way vent valve in the gas cap lets outside air into the gas tank as it empties, while maintaining pressure to prevent any fuel vapors from escaping.



3 Some evaporative systems use a liquid/vapor separator to keep liquid fuel out of the vent line leading to the charcoal canister. Have you ever tried to squeeze the last drop of fuel into the tank before a trip? This leaves very little room for the fuel to expand. On a hot day, fuel in the tank may expand more than the liquid/vapor separator can handle. Liquid fuel may bypass the separator and overload the charcoal canister. Under normal conditions, a fuel soaked canister may mean separator problems.

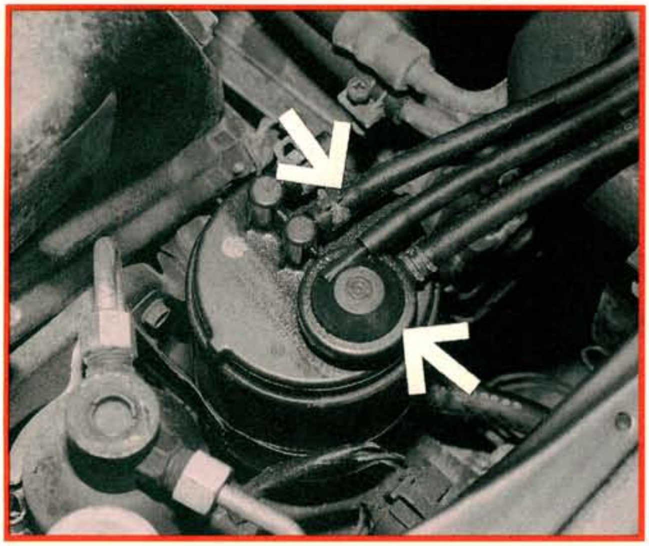


4 The fuel vapors have a long way to go from the fuel tank or fuel/vapor separator to the charcoal canister. Fuel vapor may condense to liquid fuel along the way. On some cars, the vent lines and fittings may be exposed to damage on the underside of the car. Leaks will let dirt and water into the system and may create a fire risk. A hand pump and manometer can be used to check the lines and fittings between the tank and canister for fuel or vapor leaks.

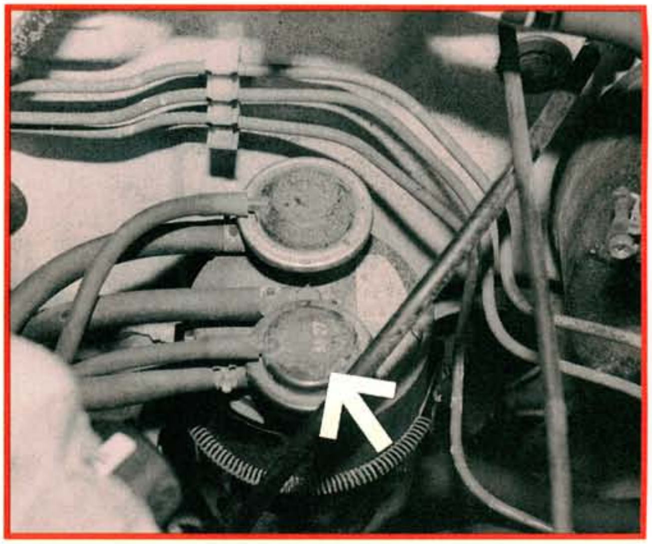


5 Another spot where heat and fuel expansion produce evaporative emissions is the carburetor float bowl. A vent hose sends these vapors to the canister. A vent switching valve at the canister may be used to close the bowl vent when the engine is running and open it when the engine is off. The carburetor vent hose must run downward in a direct path from the carburetor to the canister. Liquid fuel may accumulate in any bends or rises, keeping it from reaching the canister and possibly creating a fire hazard.

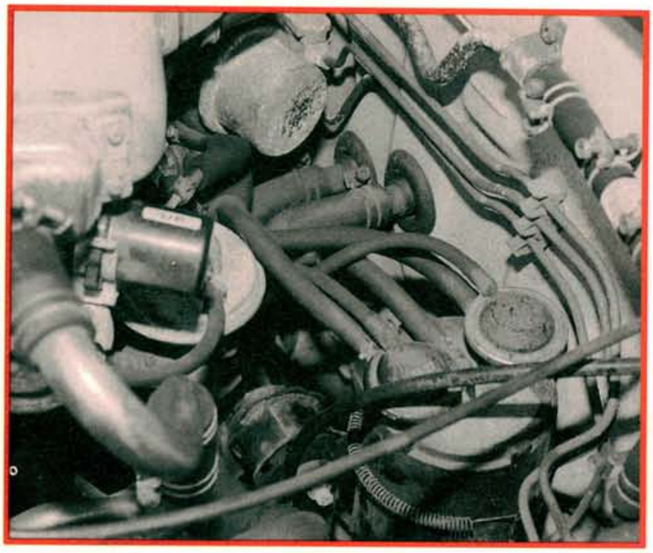
6 The canister is filled with activated carbon or charcoal. The carbon holds the fuel vapors until they can be drawn into the intake manifold and burned as fuel. The opening at one end allows fresh air to circulate over the charcoal during canister purging. Some canisters also have a replaceable air filter to filter the incoming air. A clogged canister air filter will prevent proper canister purge operation. Check the maintenance schedule for recommended filter replacement intervals.



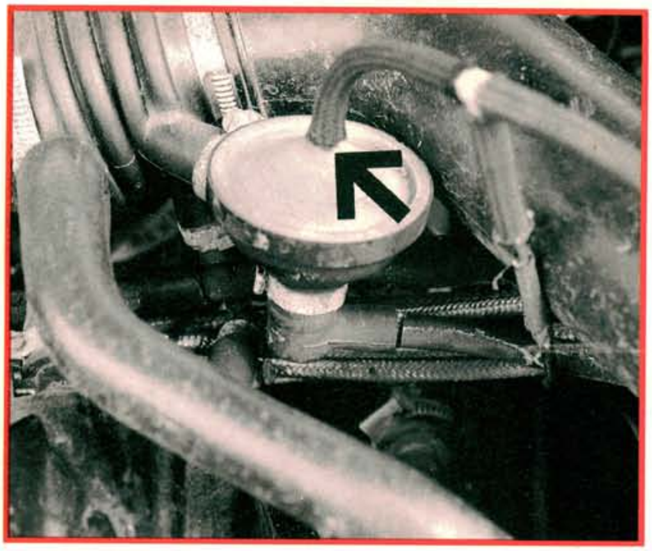
7 Depending on the manufacturer, you'll find an assortment of control valves and vacuum ports on top of the charcoal canister. These valves control when fuel vapor may flow in and out of the canister. On this fuel injected Subaru, the fuel tank vent line is the only inlet to the canister. Tank vapors are not restricted and may enter the canister at any time. The single purge control valve uses a ported vacuum signal to prevent canister purging unless the engine is running above idle speed.



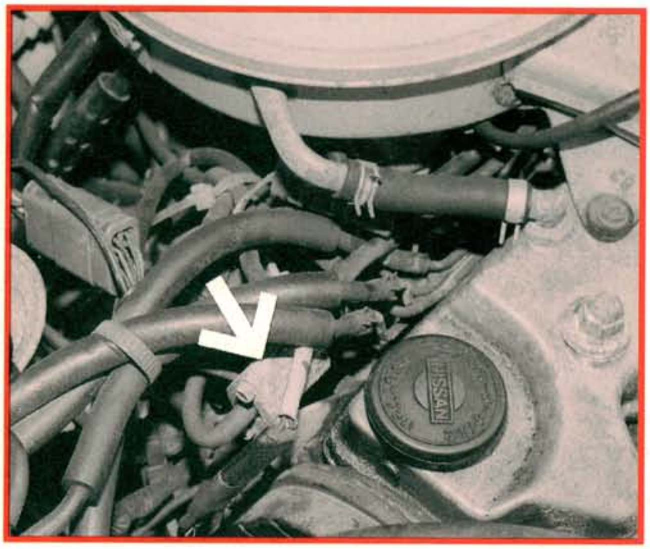
8 On carbureted models, a second control valve controls the flow of vapors from the carburetor bowl to the canister. The valve normally uses a ported vacuum signal to control when the bowl vent is opened. On early systems, the bowl vent remained closed whenever the engine was running. This setup caused driveability problems under hot conditions, especially at slower engine speeds. Fuel vapors escaped into the carburetor air inlet, richened the air/fuel ratio, and caused surging or flooding.



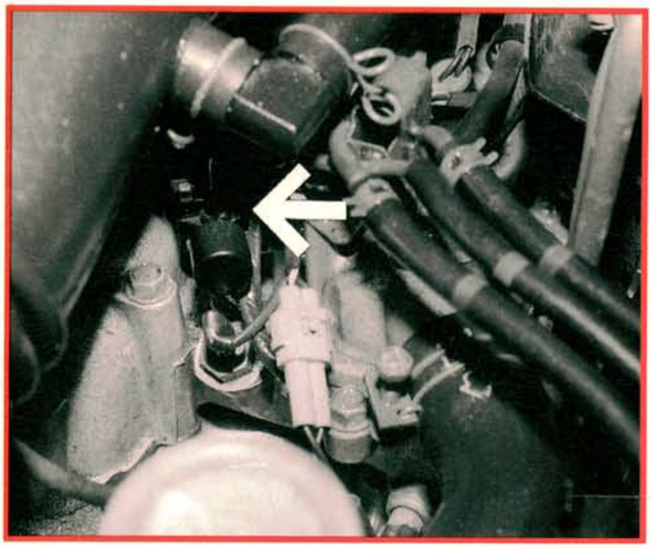
9 Some early systems also used a canister purge line that ran straight from the canister purge control valve to the throttle housing or intake manifold. Canister purging could occur as soon as the engine produced a vacuum signal that was strong enough to open the canister purge control valve. A ported vacuum signal was used to prevent canister purging until the engine was operating above idle. However, canister purge could occur at any engine temperature. This caused many cold driveability problems.



10 This Volkswagen system's canister purge control valve is located closer to the engine. But like other systems, a ported vacuum signal from the throttle housing opens the control valve to purge the canister only when the throttle opens. A throttle housing restrictor orifice limits the amount of vapor flow. Test the control valve's operation by applying and releasing vacuum at the control vacuum port. The valve should be completely closed when no vacuum is applied to the control port.



11 Dumping extra fuel vapors into the system at the wrong time can cause more problems than it solves. More advanced evaporative systems use a thermal vacuum valve (TVV) to control canister purge operation. The TVV prevents canister purge until the engine reaches operating temperature. The TVV may also control EGR operation. Sluggish performance or a loss of power when cold may be caused by a stuck or inaccurate TVV that is allowing both systems to operate before the engine warms up.



12 The purge control solenoid on this engine management system controls the vapor flow between the canister and the throttle chamber. The ECU only allows canister purge under certain conditions to improve driveability characteristics. Canister purge is stopped during cranking, when the engine is cold, under heavy engine loads, when engine RPM is high, or when the engine temperature is high. Purge operation and driveability may be affected by ECU input sensor problems.