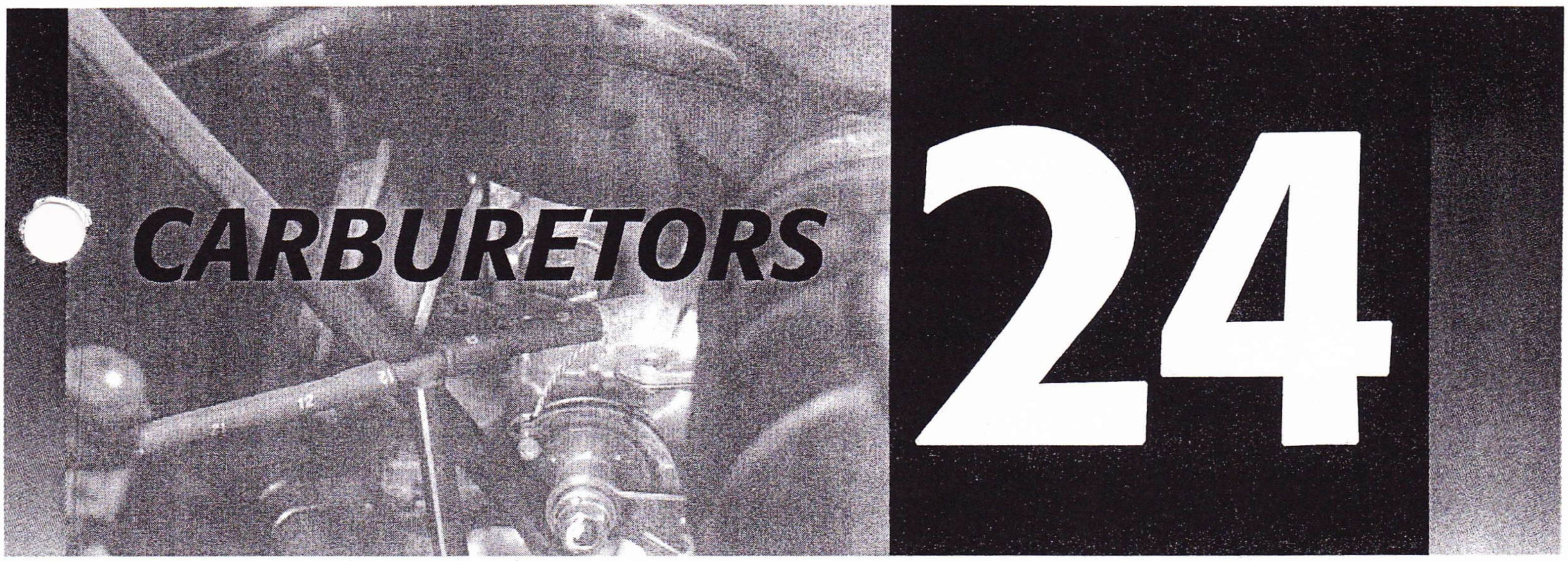
Carburetors

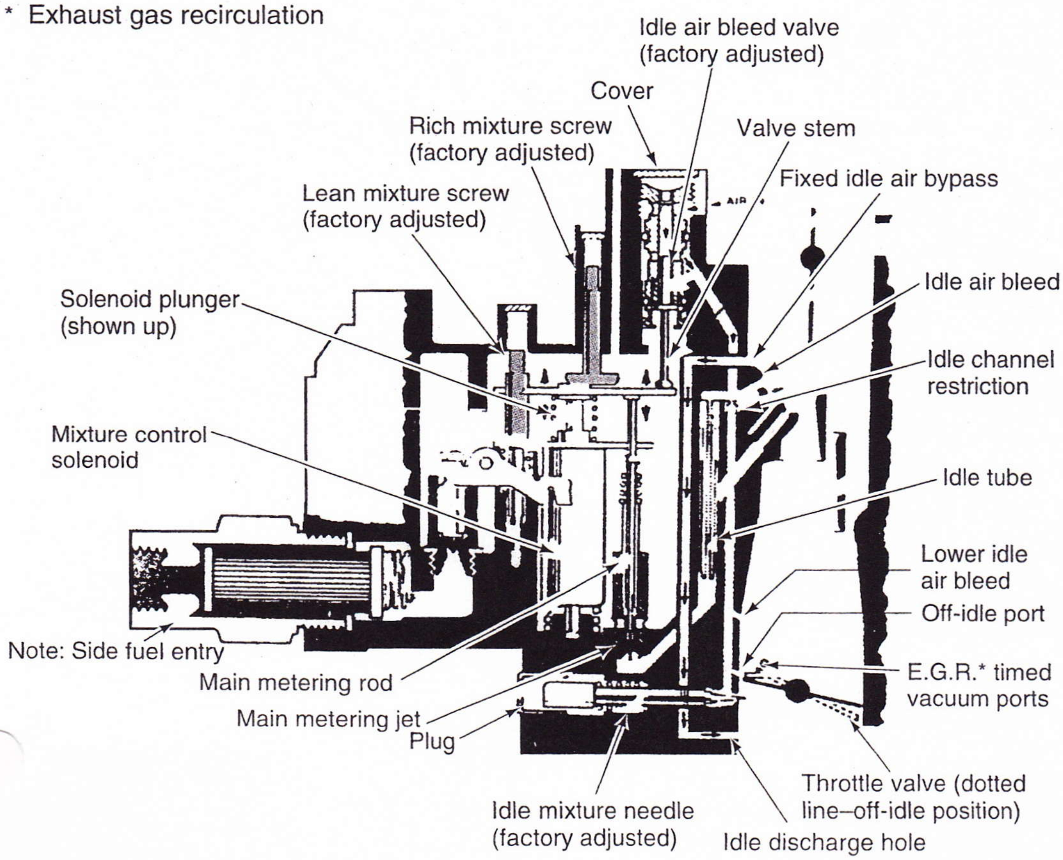


CARBURETORS 24

OBJECTIVES

◆ ***Describe the basic principles of carburetion.*** ◆ ***Explain the purpose and operation of the different carburetor circuits.*** ◆ ***Describe the various auxiliary carburetor controls.*** ◆ ***Describe the different types of carburetors.*** ◆ ***Recognize carburetor-related performance problems.*** ◆ ***Explain how various carburetor adjustments are made.***

The carburetor is a device used to mix, or meter, fuel with air in proportions that satisfy the energy demands of the engine in all phases of operation. A carburetor is a very complex mechanism (Figure 24–1). Some of the larger two- and four-barrel carburetors can have over 200 parts. These parts make up the metering systems and subsystems that are necessary for matching air and fuel delivery with engine perfor-



* Exhaust gas recirculation

FIGURE 24–1 Typical late-model carburetor. *Courtesy of Chevrolet Motor Division, General Motors Corporation*

mance demands. Each of these systems must be functional and properly adjusted if the engine is to operate efficiently.

Although fuel injection systems have replaced carburetion in all passenger cars and light trucks, there are many carbureted engines still on the road. Technicians must understand the principles of carburetion and how carburetors are constructed and operate before they can successfully diagnose and tune carbureted engines. Carburetors have a venturi and work under the principle of pressure differential. The amount of air and fuel delivered to the engine depends on the difference between the low pressure (vacuum) in the engine and the pressure of the outside air (atmospheric pressure).

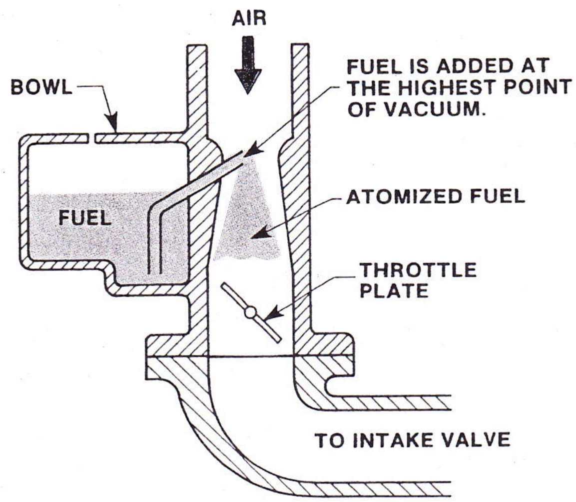


FIGURE 24–3 The vacuum produced at the venturi is used to draw in the fuel from the carburetor.

VENTURI

Air is drawn into the engine by the intake stroke. As vacuum is created, it draws air through the carburetor and venturi into the engine.

A **venturi** is a streamlined restriction that partly closes the carburetor bore (Figure 24–2). Air is forced to speed up as it enters the venturi to pass through the restriction. This restriction causes the formation of a vacuum below the venturi. As engine speed increases during acceleration, more air is drawn into the carburetor. As a result, venturi vacuum increases because the greater the velocity of air passing through the venturi, the greater the vacuum.

Venturi vacuum is used to draw in the correct amount of fuel through a discharge tube (Figure 24–3). As the air flows through the venturi, vacuum draws the fuel from the carburetor bowl into the stream of air going into the engine. More fuel is drawn in as venturi vacuum increases, and less as the vacuum decreases.

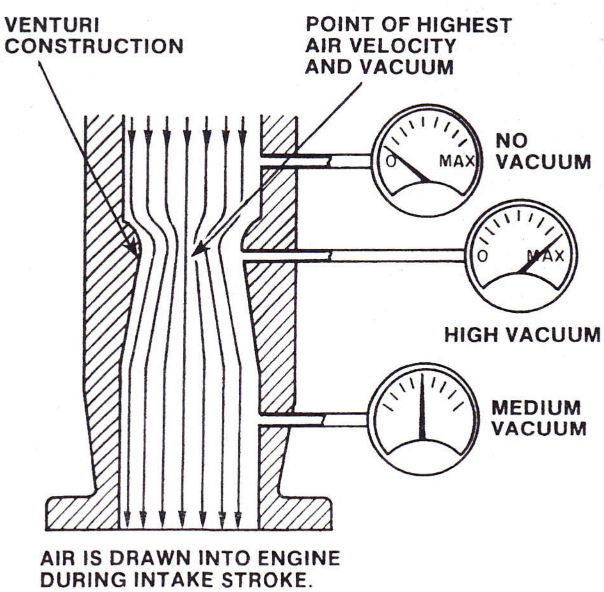


FIGURE 24–2 A venturi is a restriction in the path of airflow. A vacuum is produced at the point of greatest restriction.

CARBURETION

The three general stages involved in carburetion are metering, atomization, and vaporization.

Metering

Metering is another term for measuring. In the process of carburetion, fuel is metered into the air passing through the barrel of the carburetor. The mixture of air and fuel is called an **emulsion**. The ideal air/fuel ratio at which all the fuel blends with all the oxygen in the air is called the **stoichiometric ratio**. This ratio is about 14.7:1. If there is more fuel in the mixture, it is called a **rich** mix. If there is less fuel, it is called a **lean** mix. The amount of fuel metered into the air is varied in relation to the amount of air passing through the carburetor. Additional factors that influence the amount of fuel metered into the air include engine temperature, load and speed requirements, and the amount of oxygen in the exhaust stream.

Atomization

Atomization is the stage in which the metered fuel is drawn into the airstream in the form of tiny droplets. The droplets of fuel are drawn out of passages called discharge ports.

Vaporization

The surface area of an atomized droplet is in contact with a relatively large amount of surrounding air. In addition, the venturi is a low-pressure area. These factors combine to create a fine mist of fuel below the venturi in the bore. This is called **vaporization**—

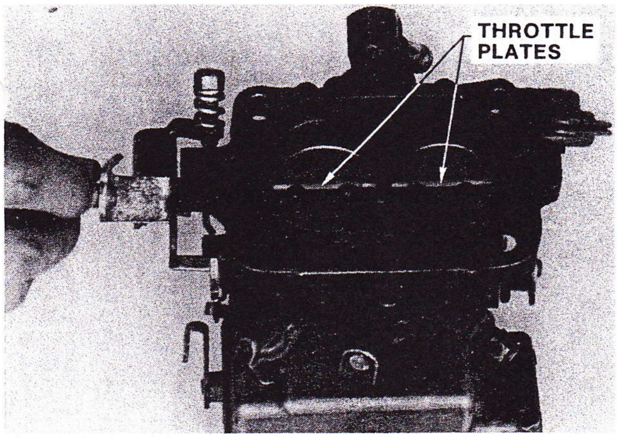


FIGURE 24–4 The throttle plate is a circular disc attached to a center rod. As the rod is turned, the throttle plate opens and closes.

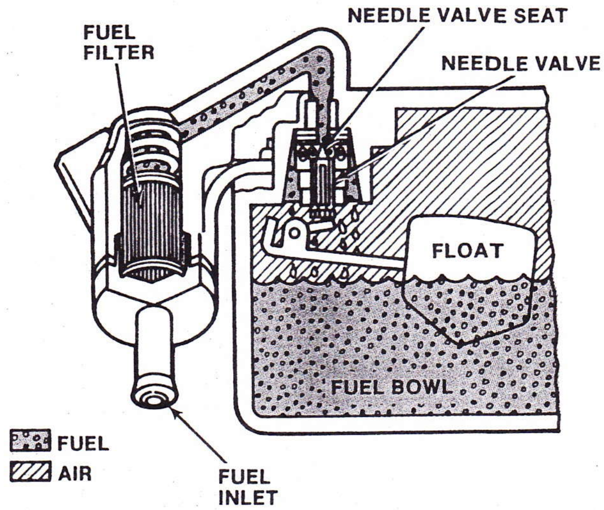


FIGURE 24–5 Fuel inlet system.

the last stage of carburetion. It occurs below the venturi, in the intake manifold, and within the cylinder. Swirl, turbulence, and heat within the intake manifold and cylinder also enhance vaporization.

THROTTLE PLATE

The throttle plate controls the amount of air and fuel that flows through the carburetor into the engine. It is a circular disc that is placed directly in the flow of air and fuel, below the venturi. It is connected to the driver's throttle pedal so it opens to a vertical position as the pedal is depressed. When the throttle plate is all the way open, there is very little restriction of air. This is a maximum speed condition. As the driver's foot is removed, a spring closes the throttle plate. This restricts the amount of air going into the engine. This is a low speed condition. Figure 24–4 shows a throttle plate assembly.

BASIC CARBURETOR CIRCUITS

Variations in engine speed and load demand different amounts of air and fuel (often in differing proportions) for best performance and present complex problems for the carburetor. At engine idle speeds, for example, there is insufficient air velocity to cause fuel to be drawn from the discharge nozzle and into the airstream. Also, with a sudden change in engine speed, such as rapid acceleration, the venturi effect (pressure differential) is momentarily lost. Therefore, the carburetor must have special circuits or systems to cope with these situations. There are seven basic circuits used on a typical carburetor.

1. Float
2. Idle
3. Off-idle
4. Main metering
5. Full power (or power enrichment)
6. Accelerator pump
7. Choke

Float Circuit

A **float** circuit or fuel inlet system (Figure 24–5) of a typical carburetor consists of the fuel bowl, fuel inlet fitting, fuel inlet needle valve and seat, and the float. A full screen or filter is usually installed at the fuel inlet to prevent dirty fuel from mixing in the carburetor and causing a problem.

The float system stores fuel and holds it at a precise level as a starting point for uniform fuel flow. Fuel enters the carburetor through the inlet line and passes through an inlet filter to the inlet needle valve and seat. The incoming fuel is captured and stored in the reservoir or fuel bowl. The fuel bowl is normally an integral part of the main casting but can be a separate casting attached to the carburetor body with screws. Carburetors with primary and secondary venturis might have two separate fuel bowls.

The level of the fuel in the bowl is maintained at a specified height by the rising and falling of the float in the fuel bowl. Early floats were made of brass stampings soldered into an airtight lung. Floats (Figure 24–6) made of **nitrile rubber**, a closed cell material made of thousands of tiny hollow spheres, are used most exclusively on domestic cars. Hollow plastic floats can also be found in carburetors.

As fuel enters the bowl, the float, which is connected to a hinged lever, rises and closes the inlet needle valve. With the needle valve closed, fuel is prevented from entering the carburetor. Fuel pressure against the inlet needle valve tends to force it open while the buoyancy of the float in the bowl tends to force it closed. This action establishes the precise fuel level for

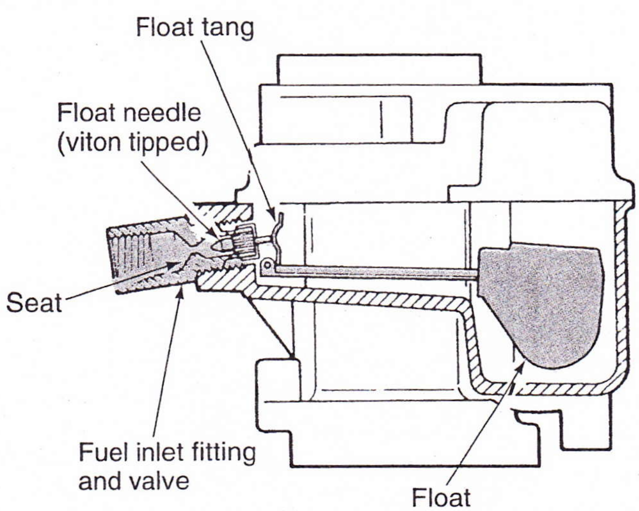


FIGURE 24–6 Float system with pivoted float, needle, seat, and inlet. *Courtesy of Chrysler Corporation*

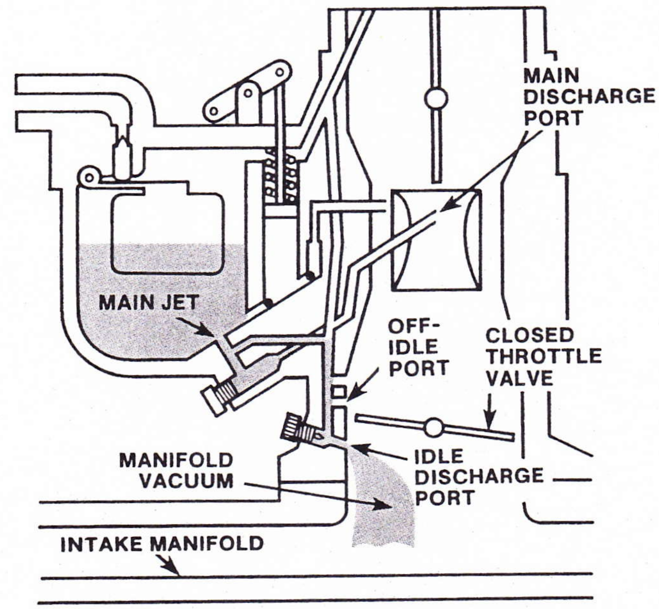


FIGURE 24–7 An idle discharge port draws fuel from the carburetor to allow the engine to run at idle.

the carburetor. To prevent the float from bouncing and vibrating, a bumper spring is usually installed under the float or to a tang connected to the float.

The metering systems of a carburetor are designed to function properly only when the fuel level in the bowl is at a specific level. The specific level is adjusted with the carburetor partially disassembled on most models. However, it can be adjusted externally on a few carburetors by turning a threaded inlet valve assembly.

The fuel bowl is vented internally to the air horn by a vent tube in the carburetor body. Prior to the introduction of emission controls, most primary fuel bowls were also vented to the atmosphere when the engine was at idle or turned off. Since the introduction of evaporative control systems, all fuel bowls are vented by a valve to a charcoal canister, which absorbs and stores fuel vapors. The vapors are returned to the engine when it is restarted.

Idle and Off-Idle Circuits

At idle, the engine requires a richer air/fuel mixture than during normal cruising conditions. This is because residual exhaust gases remain in the combustion chambers during low-engine rpm and dilute the air/fuel charge. The idle circuit supplies the richer air/fuel mixture to operate the engine at idle and low speeds.

During idle conditions, there is not enough air entering the venturi to cause a vacuum to move the fuel. The throttle plate is almost all the way closed as shown in Figure 24–7. During this condition, there is a large vacuum below the throttle valve. This vacuum causes fuel to be drawn from the carburetor float bowl through internal passages to the idle port below the throttle plate. As fuel is drawn from the float ball to the idle port, air is drawn in through an air-bleed passageway near the top of the carburetor. Only a small amount of air passes by the throttle plate. The end result is the richer air/fuel mixture needed for idle operation.

As the throttle plate is opened during low-speed operation, a transfer slot located above the throttle plate is progressively exposed to vacuum, and the air/fuel emulsion is also discharged from the **transfer slot**. The increased air/fuel mixture flow provides a smooth transition between idle and cruising modes of operation. Some carburetors have a series of holes called off-idle air passages, instead of a transfer slot. Like the transfer slot, the holes permit increased fuel delivery as the throttle opens. This is called an off-idle system.

On older carburetors there is an idle mixture needle valve. This valve is used to control or adjust the amount of air and fuel at idle. More current carburetors, however, have limiting caps on the idle mixture screws, which limit the amount of adjustment available. On newer carburetors, the idle mixture screws are sealed with steel plugs to eliminate all adjustment.

To improve idle quality when meeting emission standards, a variable air bleed idle system is used on some carburetors (Figure 24–8). In this system there are two idle air bleeds. One idle air bleed is installed normally in the air horn. An auxiliary idle air bleed is drilled into the lower skirt of the venturi. The air entering through the auxiliary passage is adjusted by an idle air adjusting screw. The screw is turned clockwise to enrich the idle mixture and counterclockwise to lean out the idle air/fuel mixture.

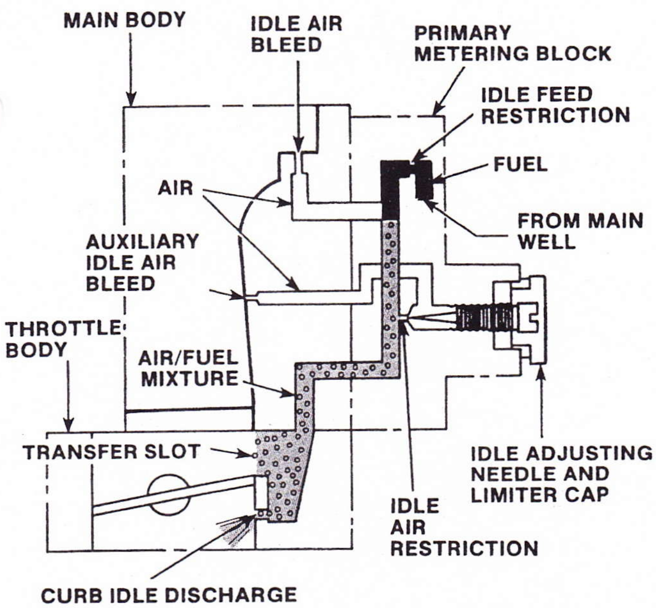


FIGURE 24–8 The idle discharge port and off-idle transfer slot supply fuel to the carburetor at low speeds.

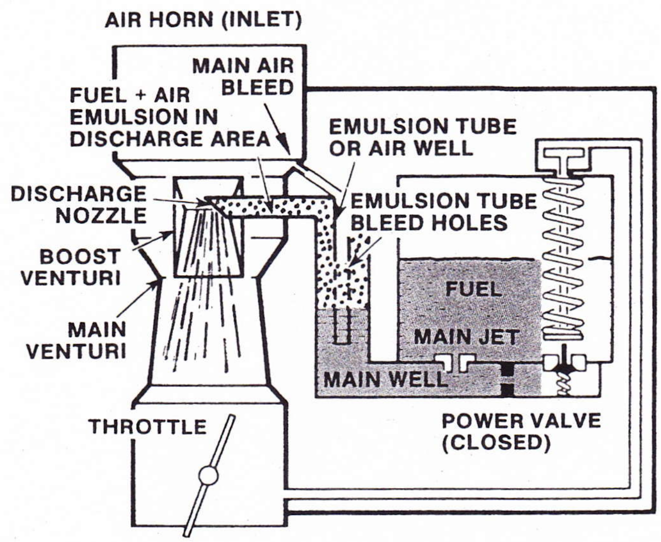


FIGURE 24–10 Air/fuel mixture routed to the venturi via the main metering circuit and discharge nozzle.

SHOP TALK

On most late-model carburetors, the idle mixture is factory set and the adjustment screw is covered with a plate or plug. This ensures that the CO percentage in the exhaust meets emissions standards and prevents anyone from tampering with the factory setting. Earlier carburetors had an idle limiter cap attached to the idle mixture screw (Figure 24–9). The limiter cap prevents the factory setting from being tampered with but allows the idle mixture to be adjusted within a narrow range (about 3/4 of a turn). ■

Main Metering Circuit

The main metering circuit (Figure 24–10) comes into operation as engine speed increases. Opening the throttle plate past the idle position increases the air flowing through the venturi and creates enough vacuum to allow atmospheric pressure to force fuel through the main metering system and out the main fuel discharge nozzle, located in the center of the venturi. As engine speed is increased, the vacuum at the discharge nozzle increases.

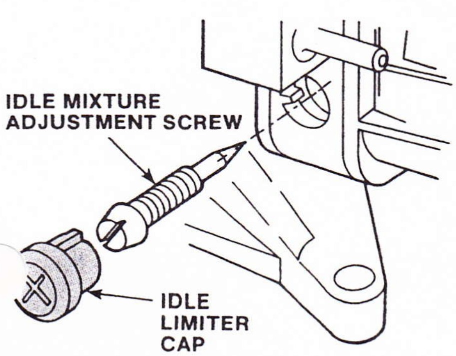


FIGURE 24–9 Idle limiter caps restrict the amount of adjustment allowed for idle mixture.

This vacuum or pressure differential causes fuel to flow out of the fuel bowl, through the main metering jet, and into the main well. On most carburetors, the main well is vented through a precisely sized opening called the main well air bleed. The main well air bleed allows air to enter at the top of the main well. Air entering the calibrated main air bleed prevents a vacuum from developing in the main well. The air also allows for aeration of the fuel as it leaves the main well and travels up the well tube. This allows the fuel to be partially atomized as it travels toward the discharge nozzle.

Air flows through the bleeds because it draws air from the high-pressure area above the venturi. The main metering discharge nozzle is in the low-pressure venturi level.

As the air speed increases through the venturi, more fuel is drawn from the main well. This lowers the fuel level in the main well and exposes more air bleed openings in the main well tube. This causes extra air to enter the well tube, mix with the fuel, and dilute or lean the mixture. This action circumvents the richening effect caused by the increased carburetor airflow. If the fuel were not diluted as such, the air/fuel mixture would richen at high speed as the venturi vacuum increased faster than the engine's need for additional fuel.

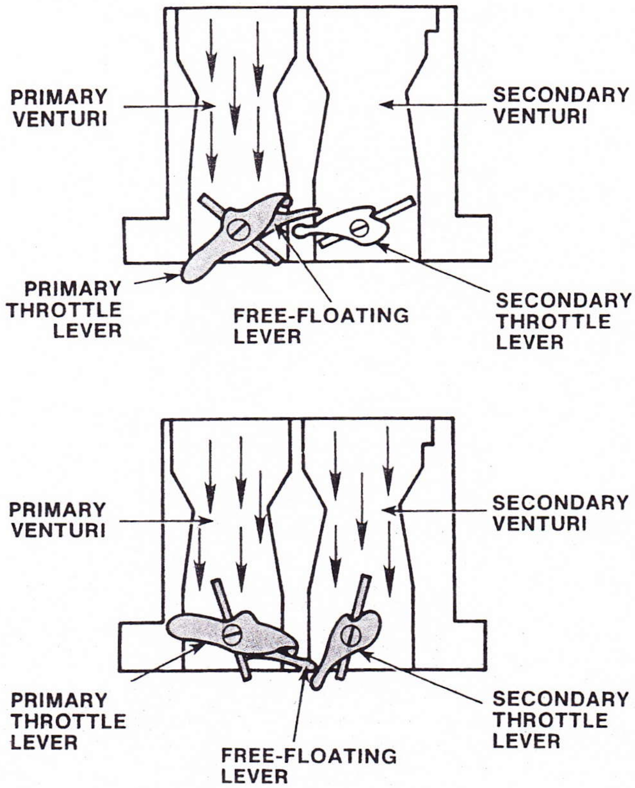


FIGURE 24–11 Mechanically actuated secondary throttle plates.

Secondary Metering System Some carburetors have more than one **barrel** or air horn. Each barrel has a throttle plate and main metering system (as well as other circuits). When all throttle plates open and close simultaneously, the carburetor is called a **single-stage** carburetor.

Some carburetors have two stages, called **primary** and **secondary stages**. In the primary stage, one or two throttle plates operate normally as in a single-stage carburetor. The secondary stage throttle plates, however, only open after the primary throttle plates have opened a certain amount. Thus, the primary stage controls off-idle and low cruising speeds. The secondary stage opens when high cruising speeds or loads require additional air and fuel. The added flow capacity raises the engine power output.

The secondary throttle plates can be opened mechanically or by a vacuum source. Mechanically actuated secondary throttle plates are opened by a tab on the primary throttle linkage. After the throttle primary plates open a set amount (usually 40 to 45 degrees), the tab engages the secondary throttle linkage, forcing the plates open (Figure 24–11). Vacuum-actuated secondaries have a spring-loaded diaphragm. Vacuum is supplied to the diaphragm from ports in the primary and secondary throttle bores. When the vacuum in the primary bore reaches a specific level, the vacuum supplied to the diaphragm overcomes the spring and opens the secondary throttle plates (Figure 24–12). The vacuum created in the secondary throttle bore increases the vacuum signal to the diaphragm, opening the secondary throttle valves still farther.

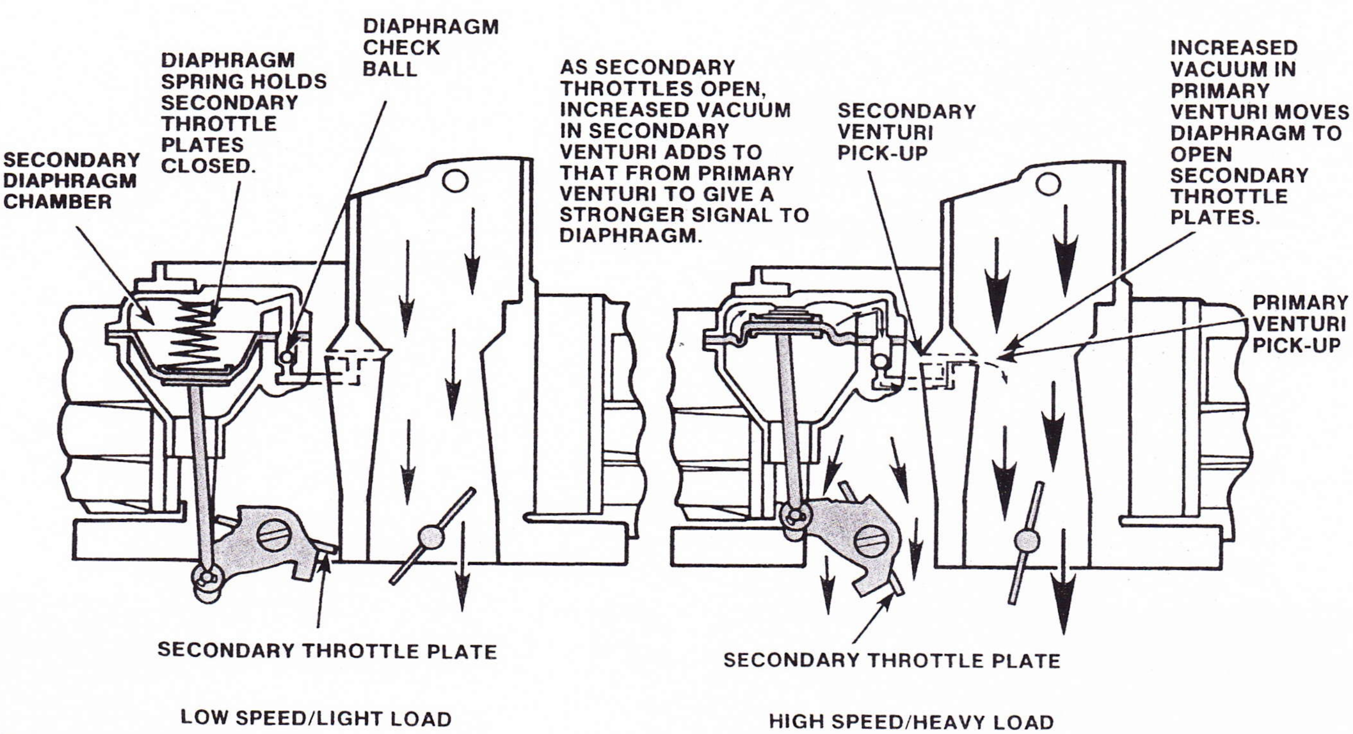


FIGURE 24–12 Vacuum-controlled secondary system.

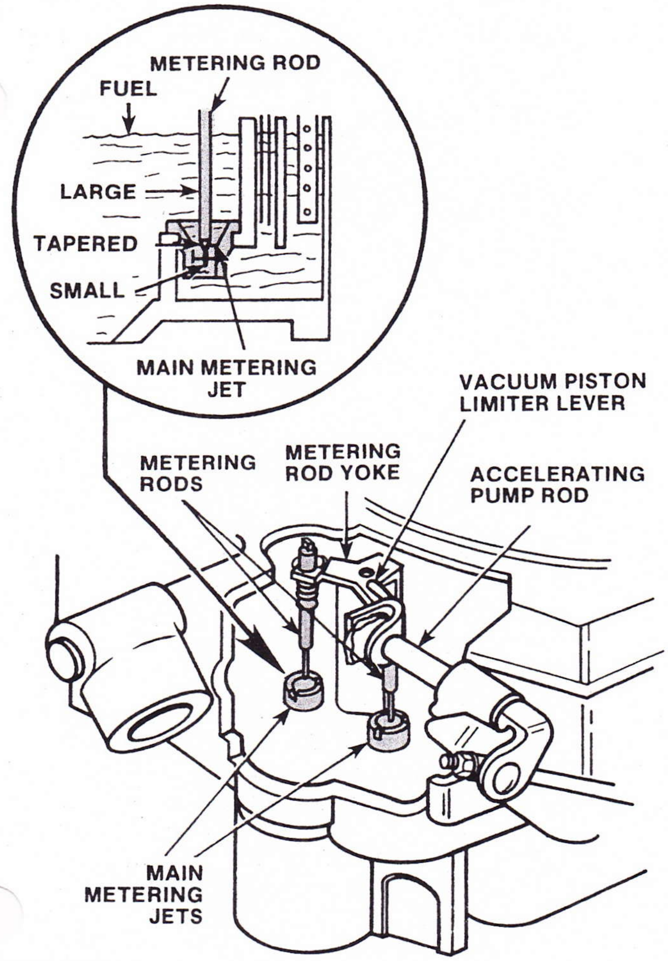


FIGURE 24–13 Some power systems consist of metering rods placed in the main jets.

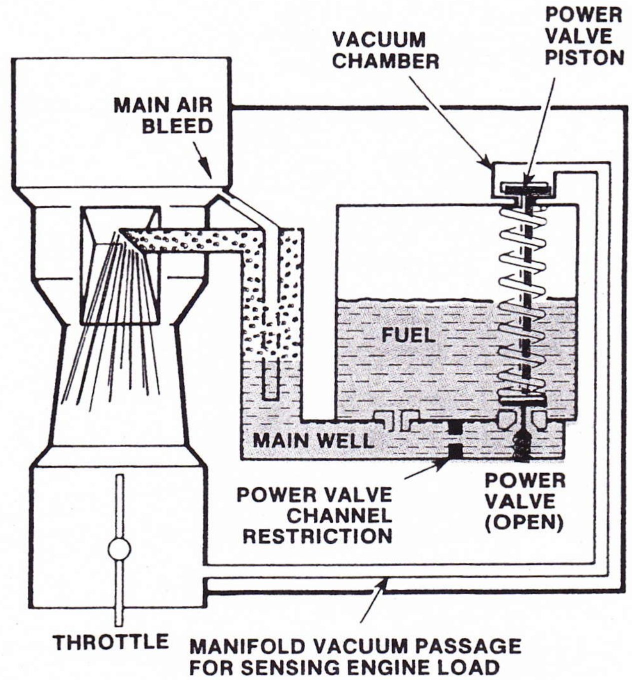


FIGURE 24–14 Power valve system.

Power Enrichment Circuit

At wide open throttle, the engine needs a richer-than-normal air/fuel mixture. This mixture cannot be supplied by the main metering system. So, an additional fuel enrichment or full-power system is provided on most carburetors. The power enrichment system meters additional fuel into the mixture. This can be accomplished in several ways.

Metering Rods In some carburetors, power enrichment is provided by **metering rods** placed in the main jets (Figure 24–13). The metering rods are actuated mechanically or by vacuum. When the throttle is not wide open (or nearly so), the throttle linkage keeps the rods in the jets, providing normal fuel flow. When the throttle is opened wide, either a mechanical link in the throttle linkage or vacuum-actuated lever lifts the rods out of the jets, enabling more fuel to be forced into the main well. The additional fuel flow richens the air/fuel mixture.

Power Valve The **power valve** (Figure 24–14) is basically a vacuum-operated metering rod. It consists of a vacuum diaphragm or piston, a spring-loaded valve, and a metering rod inside an auxiliary fuel jet usually located in the bottom of the fuel bowl. A vacuum passageway machined into the main body casting supplies manifold vacuum to the diaphragm or piston. During idle and low cruising speeds, the vacuum holds the power valve closed. As engine speed and load increases and the vacuum signal drops to a specific level, the spring overcomes the vacuum and forces the power valve out of the jet. This increases the fuel flowing into the main well.

The power valve has been replaced or modified in today's feedback carburetor. In a feedback system, an electrical solenoid controls the metering fuel jets or idle air bleeds to regulate the air/fuel mixture. Feedback carburetors are discussed later in this chapter.

Accelerator Pump Circuit

The off-idle or transfer circuit discussed earlier allows the engine to be accelerated smoothly without hesitation or lags. However, during sudden acceleration, the engine experiences a momentary drop in power unless additional fuel is simultaneously introduced into the air charge.

During sudden acceleration, the air flowing through the carburetor reacts almost immediately to each change in the throttle plate opening. However, since fuel is heavier than air, it has a slower response time. Fuel in the main metering system or idle system takes a fraction of a second to respond to the throttle opening. This lag in time creates a hesitation of fuel flow whenever the accelerator pedal is quickly depressed.

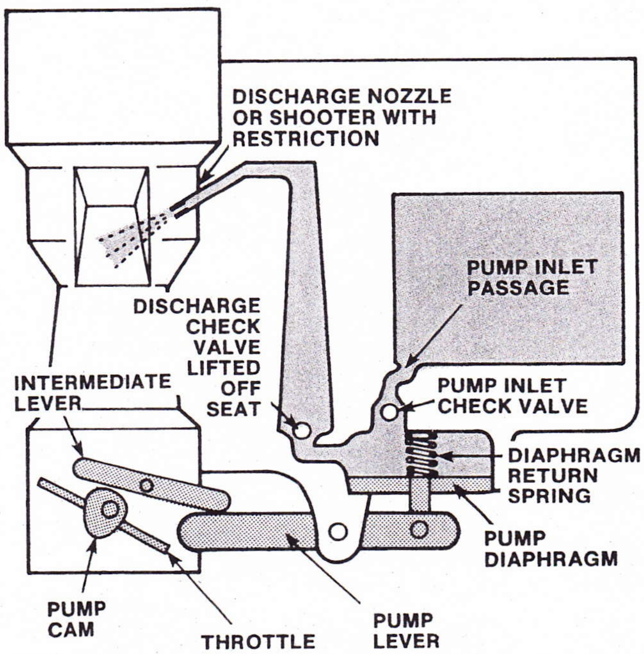


FIGURE 24–15 Diaphragm accelerator pump.

The accelerator pump system solves this problem by mechanically supplying fuel until the other fuel metering systems are able to supply the proper mixture.

One type of accelerator pump (Figure 24–15) is the diaphragm type located in the bottom of the fuel bowl. Locating the pump in the bottom of the fuel bowl ensures a more solid charge of fuel (fewer bubbles).

When the throttle is opened, the pump linkage, activated by a cam on the throttle lever, forces the pump diaphragm up. As the diaphragm moves up, the pressure forces the pump inlet check ball or valve onto its seat. This prevents the fuel from flowing back into the fuel bowl. At the same time, the pressure of the fuel causes the discharge check ball or valve to rise and fuel is then discharged into the venturi.

As the throttle returns toward the closed position, the linkage returns to its original position and the diaphragm return spring forces the diaphragm down. The pump inlet check valve is moved off its seat and the diaphragm chamber is refilled with fuel from the fuel bowl.

Another common type of accelerator pump is shown in Figure 24–16. This type of pump uses a plunger rather than a diaphragm. As the throttle moves toward the open position, pressure from the plunger forces an inlet ball onto a check valve, sealing the inlet valve. At the same time, a ball is forced off the outlet check valve and fuel is discharged from the shooter nozzle. As the throttle moves back toward the closed position, the plunger retracts, allowing the inlet check valve to open and fuel to refill the pump.

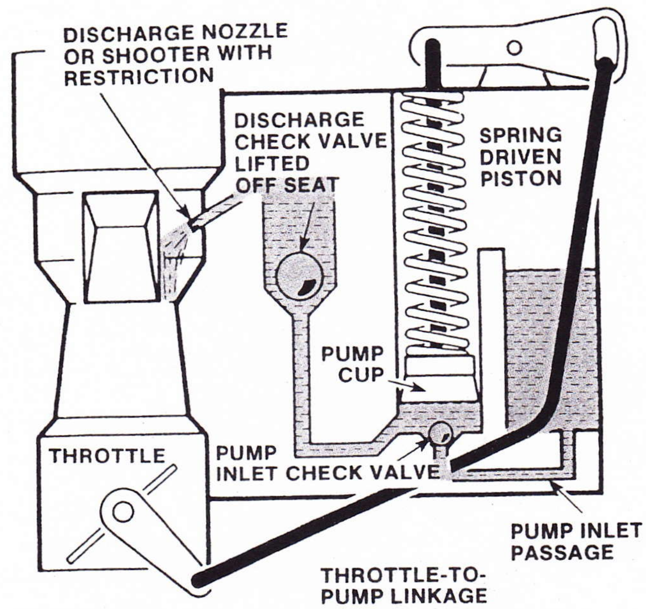


FIGURE 24–16 Plunger accelerator pump.

Choke Circuit

A cold engine needs a very rich air/fuel mixture during cranking and startup. Providing the rich mixture is the job of the **choke** circuit (Figure 24–17).

During a cold startup, the choke should be closed. This creates a very high vacuum level in the air horn below the choke plate. As the air pressure outside the carburetor forces its way into the low-pressure areas, it draws with it a rich air/fuel mixture. When the throttle plate is closed, the mixture is forced out through

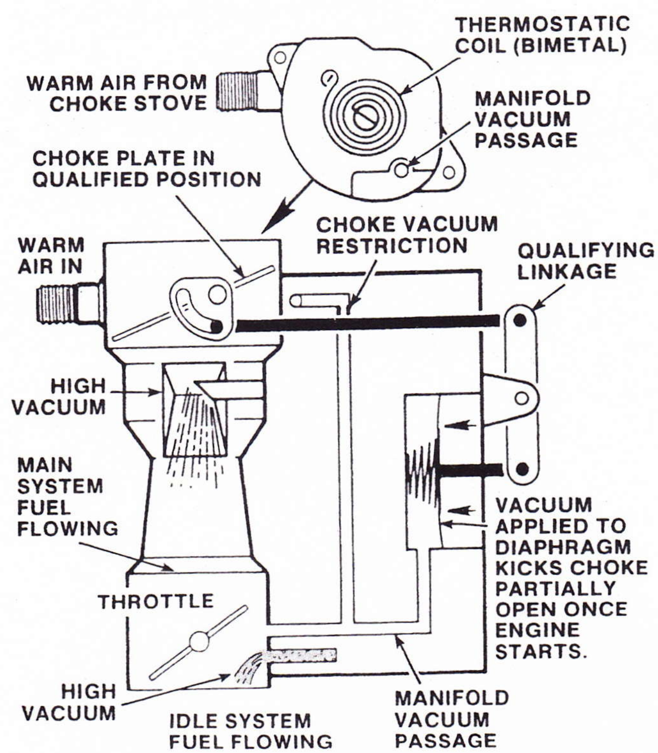


FIGURE 24–17 Choke system.

the idle port or ports below the throttle valve. If the throttle valve is opened to assist in starting the engine, additional ports are exposed to the low-pressure manifold pressure and additional fuel is forced into the air horn. After the engine starts, a leaner mixture can be used to keep the engine running. Therefore, the choke should be opened some to allow increased airflow. After the engine has warmed to normal operating temperatures, the choke should be opened completely to allow the throttle to control airflow and fuel metering.

Before the introduction of automatic chokes, the opening and closing of the choke plate was manually controlled by the driver. A choke cable was connected to a knob inside the passenger compartment on the dash. To close the choke, the driver simply pulled the knob out. As the engine warmed, the choke knob was gradually pushed in to open the choke.

Modern carbureted vehicles have an automatic choke that operates without any driver assistance. Being more sensitive to engine temperature, an automatic choke is more efficient.

The typical automatic choke has a bimetal coil called a thermostatic spring. When the coil is cold, it forces the choke plate closed. As the bimetal coil warms, it expands and pulls the choke plate open (Figure 24–18).

The bimetal coil can be mounted directly on the carburetor. This type is called an integral choke (Figure 24–19). The bimetal coil may also be mounted on the intake manifold or in a heat well in the exhaust heat passage of the intake manifold. This type is called a divorced or remote choke (Figure 24–20).

The integral choke normally has a heat source to warm the bimetal. The heat source might be hot air (Figure 24–21) or coolant. Many integral chokes also have an electrical heater to assist in warming the coil during warm weather or hot startup. The bimetal coil

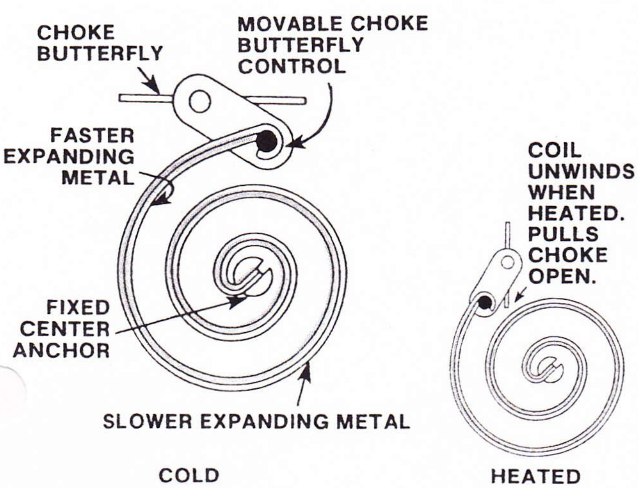


FIGURE 24–18 Principle of a bimetallic spring.

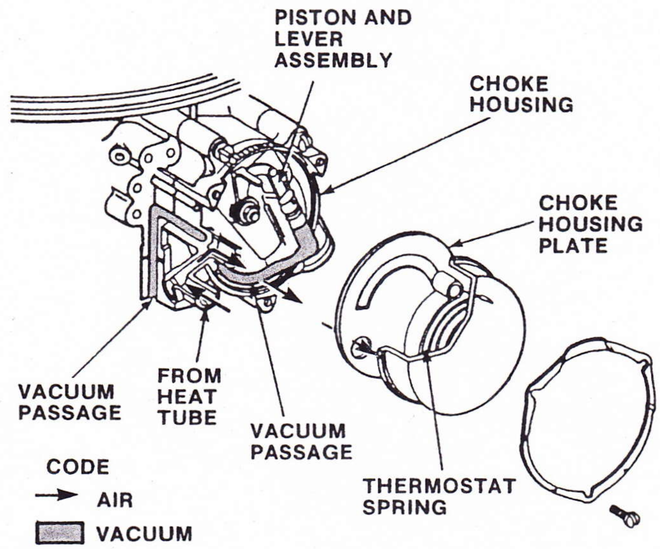


FIGURE 24–19 Integral automatic choke.

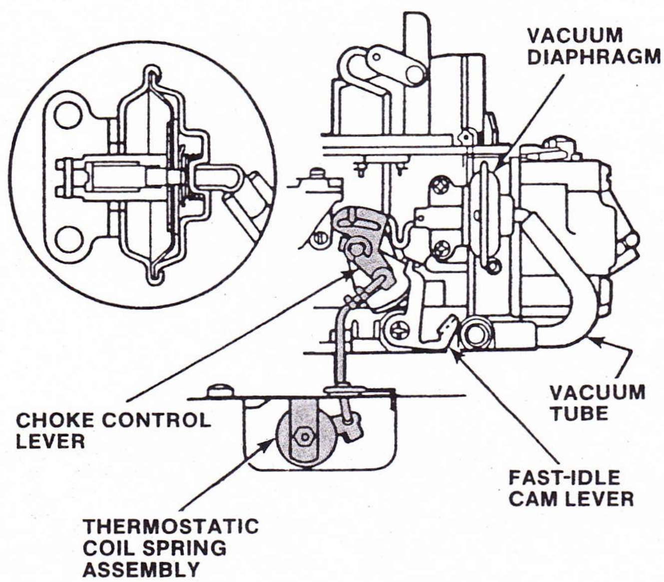


FIGURE 24–20 Divorced choke thermostatic element mounted in heat well.

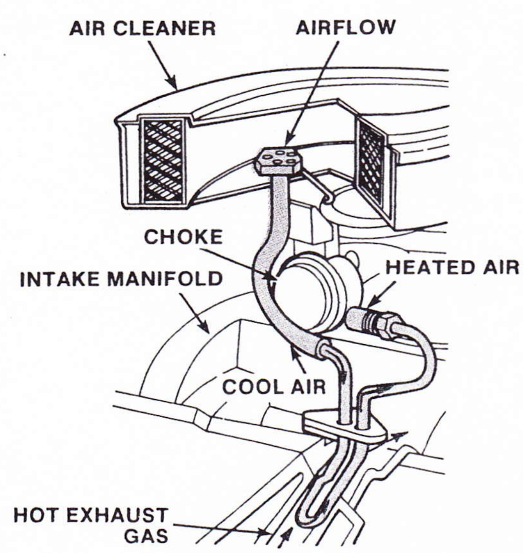


FIGURE 24–21 Hot air choke system.

on many feedback carburetors is heated solely by a solid state heating element. Voltage is usually provided to the heating element from the alternator circuit.

ADDITIONAL CARBURETOR CONTROL

To meet complex fuel economy and emission requirements, carburetors require the help of auxiliary controls. The following describes some of the more common assist devices you are likely to encounter when servicing a carburetor.

Choke Qualifier

Once the engine has started, a leaner mixture is needed. If the choke stays shut, the rich mixture floods the engine and causes stalling. Therefore, the automatic choke has a choke-qualifying mechanism to open the choke plate slightly after the engine has started.

Many integral chokes have a vacuum piston in the choke housing that opens the choke slightly when manifold vacuum reaches a certain level (immediately after the engine starts). Some integral chokes and all divorced chokes have a qualifying diaphragm (also called a choke pull-off diaphragm or vacuum break) instead of a vacuum piston (Figure 24–22). The diaphragm is connected to manifold vacuum. When the engine starts, the diaphragm retracts, pulling the choke open. The amount of opening, or the distance between the upper edge of the choke plate and the side of the air horn, is called the qualifying dimension or setting. In some carburetors, the pull-off diaphragm has a modulator spring that varies the qualifying setting based on ambient temperatures.

Dashpot

The **dashpot** (Figure 24–23) is used during rapid deceleration to retard the closing of the throttle. This allows a smooth transition from the main metering system to the idle system and prevents stalling due to the overly rich air/fuel mixture. It also controls the level of HC in the exhaust during deceleration.

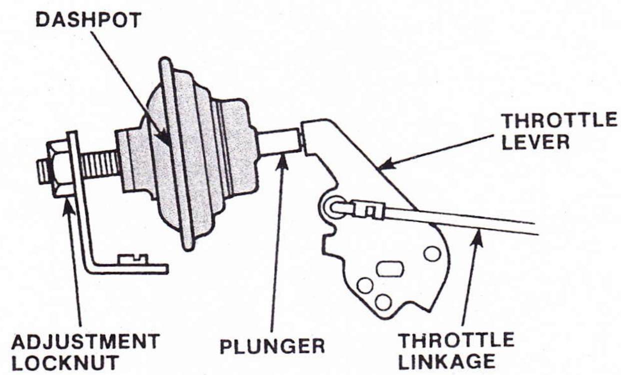


FIGURE 24–23 Typical carburetor dashpot installation.

The dashpot consists of a small chamber with a spring-loaded diaphragm and a plunger. A link from the throttle comes in contact with the dashpot plunger as the throttle closes. As the throttle linkage exerts force on the plunger, air slowly bleeds out of the diaphragm chamber through a small hole. This slows the closing action of the throttle plate.

Hot-Idle Compensator (HIC) Valve

When the engine is overheated, a hot-idle compensator opens an air passage to lean the mixture slightly (Figure 24–24). This increases idle speed to help cool the engine (by increased coolant flow) and to prevent excess fuel vaporization within the carburetor. The **hot-idle compensator** is a bimetal, thermostatically controlled air bleed valve.

Dual Vacuum Break

Some carburetors are equipped with a fuel vacuum break system, which includes a primary diaphragm and a secondary diaphragm. The primary vacuum diaphragm opens the choke valve slightly as soon as the engine starts to keep the engine from overchoking and stalling. The secondary vacuum diaphragm, which is also attached to the choke lever, opens the

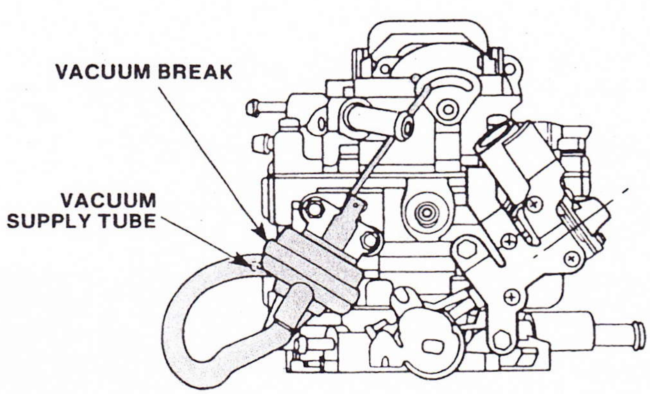


FIGURE 24–22 Vacuum break.

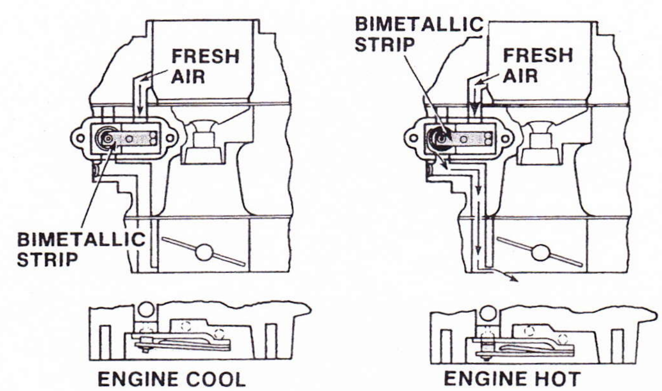


FIGURE 24–24 Hot-idle compensator operation: engine hot, valve open.

choke valve slightly wider in warm weather or when a warm engine is being started.

Vacuum to the secondary diaphragm is controlled by a thermal vacuum switch or valve (**TVV**). The TVV releases vacuum to the secondary vacuum break when the engine reaches a certain temperature. This prevents a rich fuel mixture and the high emissions that result form starting a cold engine in warm weather or when a warm engine is started.

Choke Unloader

To be able to start a cold engine that has been flooded with gasoline, a **choke unloader** is required. The choke unloader (Figure 24–25) is throttle linkage actuated and opens the choke whenever the accelerator pedal is floored. At wide-open throttle, the partially opened choke allows additional air to lean out the mixture and reduce fuel flow.

Deceleration Valve

The deceleration valve (Figure 24–26) is designed to prevent backfire during deceleration as the fuel mixture becomes richer. The valve, which operates only during deceleration, is usually located between the intake manifold and the air cleaner. A typical valve has a cam-shaped diaphragm housing on one end. A control manifold-vacuum line is attached to a port under the diaphragm housing. The other end of the valve is connected by hoses to the intake manifold and air cleaner. When deceleration causes an increase in manifold vacuum, the diaphragm opens the **deceleration valve** and allows air to pass from the air cleaner into the intake manifold, leaning the fuel mixture and preventing exhaust system backfire.

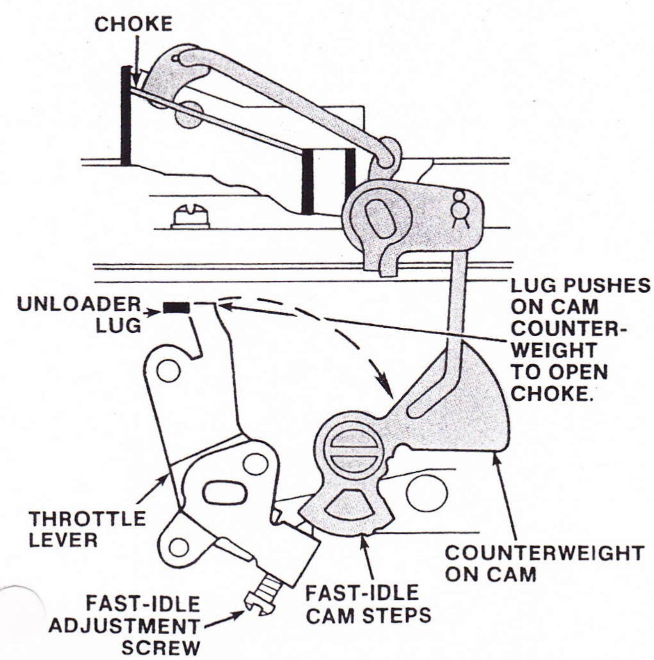


FIGURE 24–25 The choke unloader opens the choke any time the gas pedal is floored. The lug pushes on the cam counterweight to open the choke.

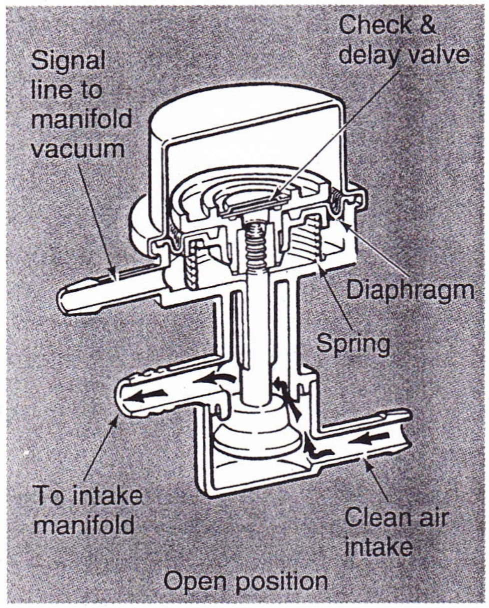


FIGURE 24–26 Vacuum-operated decel valve. *Courtesy of Pontiac Motor Division, General Motors Corporation*

Throttle Position Solenoid

The throttle position solenoid is used to control the position of the throttle plate (Figure 24–27). It can have several functions, depending on its application. When the basic function is to prevent dieseling, the solenoid is called a **throttle stop solenoid** or an **idle stop solenoid**. When the engine is started, the solenoid is energized and the plunger extends, pushing against the throttle linkage. This forces the throttle plates open slightly to the curb idle position. When the ignition switch is turned off, the solenoid is de-energized and the plunger retracts. This allows the throttle plate to close completely, and it shuts off the air/fuel supply to prevent dieseling or run-on.

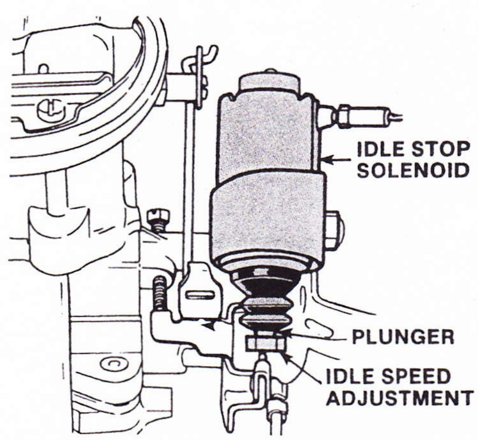


FIGURE 24–27 An idle stop solenoid is used to control the position of the idle setting when the ignition is turned off and on. *Courtesy of Echlin Manufacturing Company*

The throttle position solenoid is also used to increase the curb idle speed to compensate for extra loads on the engine. When this is its primary function, the solenoid might also be called an idle speed-up solenoid or a **throttle kicker**. This feature is most often used on cars with air conditioners. When the air conditioning is turned on, a relay energizes the solenoid so the plunger extends farther, raising the idle rpm. This keeps the engine running at a higher speed, which is required to maintain a smooth idle speed and to ensure adequate emission control.

The throttle position solenoid is also used to control idle speed when the transmission is engaged. A relay in the park/neutral switch signals the solenoid to extend when the transmission is shifted into gear. This opens the throttle slightly to compensate for the increased load on the engine.

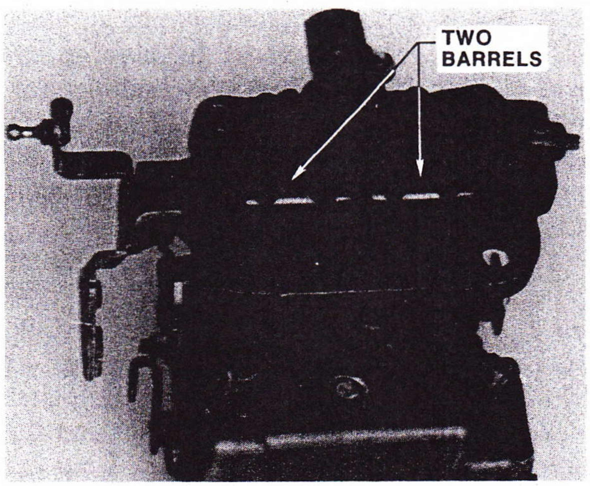


FIGURE 24–28 Carburetors are also classified by stating the number of barrels. This is a two-barrel carburetor with two throttle plates.

TYPES OF CARBURETORS

Many types of carburetors have been built to accommodate different load conditions, engine designs, and air/fuel requirements. Different carburetors feature different drafts, different numbers of barrels, different types of venturi, and different flow rates.

Carburetor Draft

Draft is defined as the act of pulling or drawing air. A carburetor's direction of draft is one way in which carburetors are classified. Most engines have a **downdraft** carburetor that has air flowing vertically down into the engine. In the **sidedraft** carburetor, air flows through the carburetor in a horizontal direction. Many early sports cars used a sidedraft carburetor. An **updraft** carburetor brings the air and fuel into the engine in an upward direction. Not many automobiles use this type, but they are used in forklifts and other industrial engine applications.

Carburetor Barrels

A carburetor barrel is a passageway or bore used to mix the air and fuel. It consists of the throttle plate, venturi, and air horn. A one-barrel carburetor is used on small engines that do not require large quantities of air and fuel.

A two-barrel carburetor has two throttle plates and two venturis. Figure 24–28 shows the throttle plates of a two-barrel carburetor. The area where the air comes into the carburetor is common on both barrels. A two-barrel carburetor may have one barrel that is smaller in diameter than the other one.

Figure 24–29 shows a four-barrel carburetor. It has four barrels to mix the air and fuel. The engine

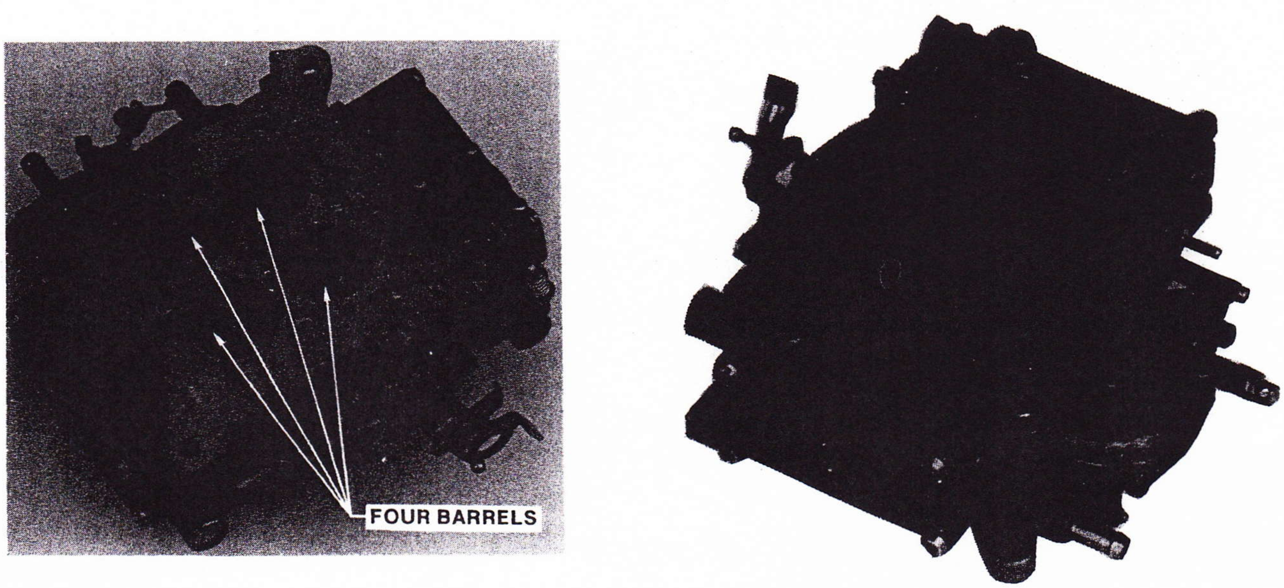


FIGURE 24–29 A four-barrel carburetor has four barrels and four throttle plates.

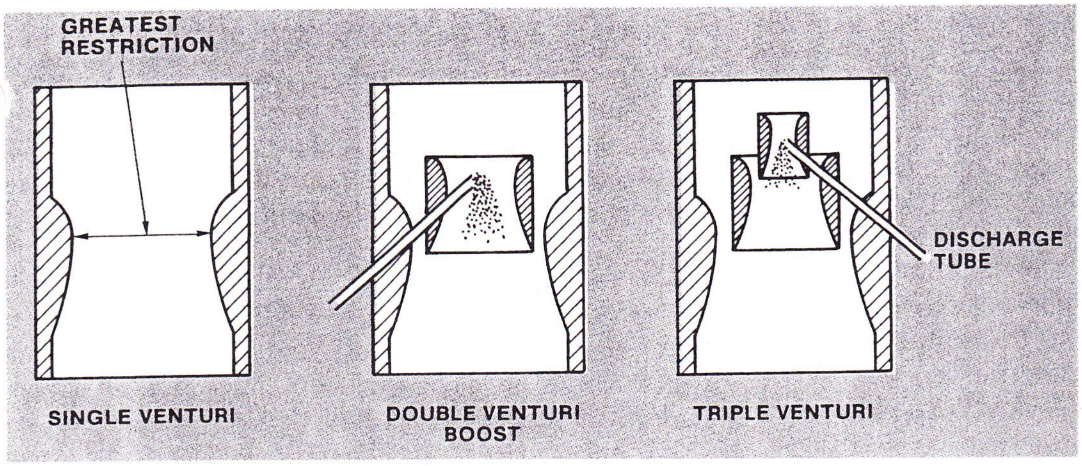


FIGURE 24–30 Carburetors have several types of venturis. One, two, and three venturis can be used. These can also be called boost venturis.

operates on two barrels during most driving conditions. When more power is needed, the other two barrels add fuel to increase the amount of horsepower and torque produced by the engine.

Venturi Types

Carburetors are also categorized according to the type of venturi they use (Figure 24–30). Simple carburetors have a single venturi. The double (dual) venturi has an additional secondary or **boost venturi**. The bottom of the center (boost) venturi is located at the greatest restriction area of the next larger venturi. This arrangement multiplies the vacuum developed in the venturi. The result is better vaporization and atomization and more control of fuel entering into the air stream. Thus, increasing the venturi effect increases the efficiency of the carburetor.

Even more control and atomization occur with a triple venturi design. The discharge tube feeds fuel into the smallest venturi for maximum control and atomization. Some carburetors have a variable or changing venturi. As the throttle pedal is depressed, the venturi increases in size. The venturi decreases in size when the throttle pedal is released.

VARIABLE VENTURI CARBURETOR

A fixed venturi does not change shape and size to accommodate changing engine performance demands. Therefore, the speed of the air flowing through the venturi varies according to engine rpm and load. Because the vacuum in the venturi is the result of moving air, the amount of fuel drawn from the discharge nozzle varies as air velocity (and vacuum) in the venturi fluctuates. In some engine operating modes, the air speed, vacuum level, and fuel discharge are matched to the needs of the engine. At other times, the fuel discharge might be too little or too much. To compensate for the inadequacies of a fixed venturi, idle systems, power systems, and choke systems are needed to supplement the main metering system.

These assist systems are not necessary when a **variable venturi** is used. A variable venturi increases in size as engine demands increase. In this way, airflow speed through the venturi and the resulting pressure differential remains fairly constant. Thus, a variable venturi carburetor is also known as a constant velocity carburetor or a constant depression (vacuum) carburetor.

An example of a variable venturi carburetor is shown in Figure 24–31. The venturi valves are controlled by a vacuum diaphragm that receives vacuum from ports in the throttle bores between the venturi valves and the throttle plates. As the throttle plates open, vacuum in the throttle bore increases and the venturi valves open farther. As the valves open, tapered metering rods attached to the valves retract from metering jets in the sides of the throttle bores. This increases the size of the jet openings, allowing additional fuel to be drawn into the airstream so the air/fuel ratio remains constant. By metering both the fuel and airflow simultaneously, better fuel economy and lower emissions are possible.

FEEDBACK CARBURETOR SYSTEM

The latest type of carburetor system is the electronic feedback design, which provides better combustion by improved control of the air/fuel mixture.

The feedback carburetor was introduced following the development of the three-way catalytic converter. A three-way converter not only oxidizes HC and CO but also chemically reduces oxides of nitrogen (NO_X).

However, for the three-way catalyst to work efficiently, the air/fuel mixture must be maintained very close to a 14.7 to 1 ratio. If the air/fuel mixture is too lean, NO_X is not converted efficiently. If the mixture

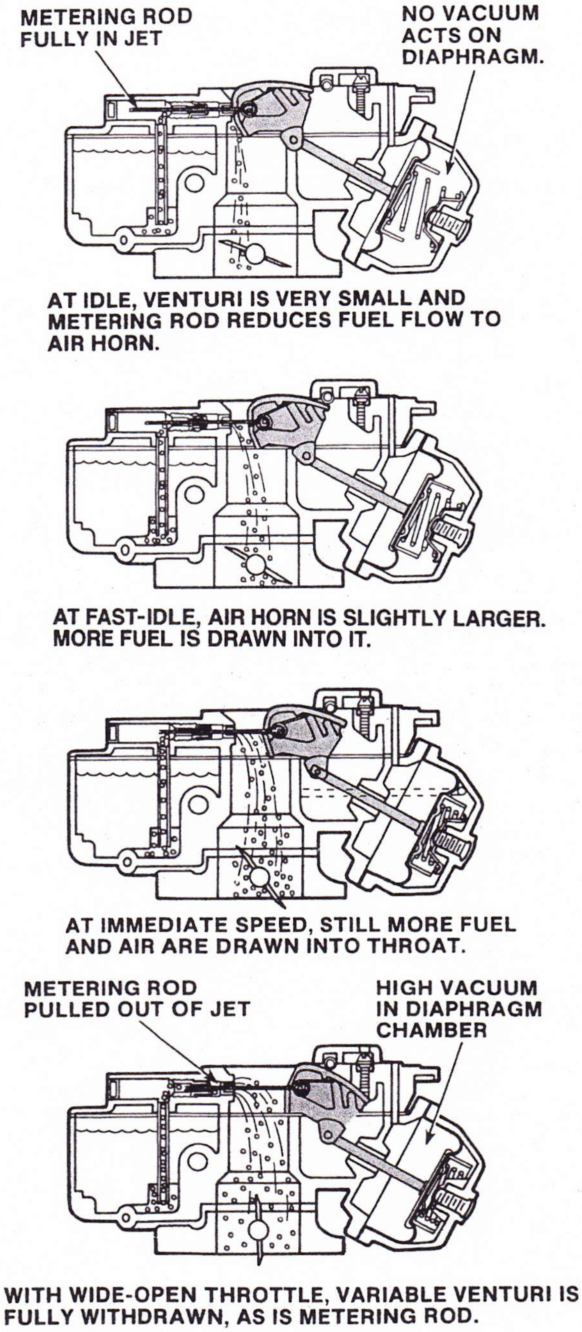


FIGURE 24–31 Diaphragm controls variable venturis in this carburetor design.

is too rich, HC and CO does not oxidize efficiently. Monitoring the air/fuel ratio is the job of the exhaust gas oxygen sensor (Figure 24–32).

An oxygen sensor senses the amount of oxygen present in the exhaust stream. A lean mixture produces a high level of oxygen in the exhaust. A rich mixture produces little oxygen in the exhaust. The oxygen sensor, placed in the exhaust before the catalytic converter, produces a voltage signal that varies with the amount of oxygen the sensor detects in the exhaust. If the oxygen level is high (a lean mixture),

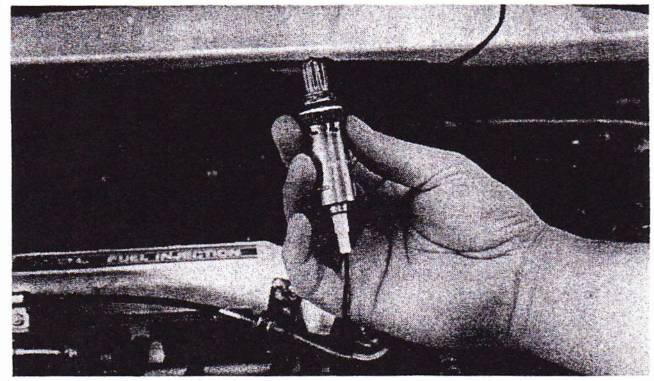


FIGURE 24–32 Exhaust gas oxygen sensor.

the voltage output is low. If the oxygen level is low (a rich mixture), the voltage output is high.

The electrical output of the oxygen sensor is monitored by an electronic control unit (ECU). This microprocessor is programmed to interpret the input signals from the sensor and in turn generate output signals to a mixture control device that meters more or less fuel into the air charge as it is needed to maintain the 14.7 to 1 ratio.

Whenever these components are working to control the air/fuel ratio, the carburetor is said to be operating in **closed loop**. Closed loop is illustrated in the schematic shown in Figure 24–33. The oxygen sensor is constantly monitoring the oxygen in the exhaust, and the control module is constantly making adjustments to the air/fuel mixture based on the fluctuations in the sensor's voltage output. However, there are certain conditions under which the control module ignores the signals from the oxygen sensor and does not regulate the ratio of fuel to air. During these times, the carburetor is functioning in a conventional manner and is said to be operating in **open loop**. (The control cycle has been broken.)

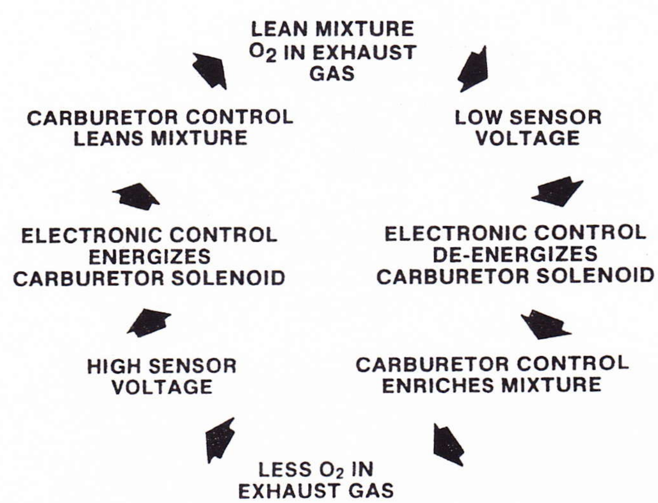


FIGURE 24–33 Closed loop operation.

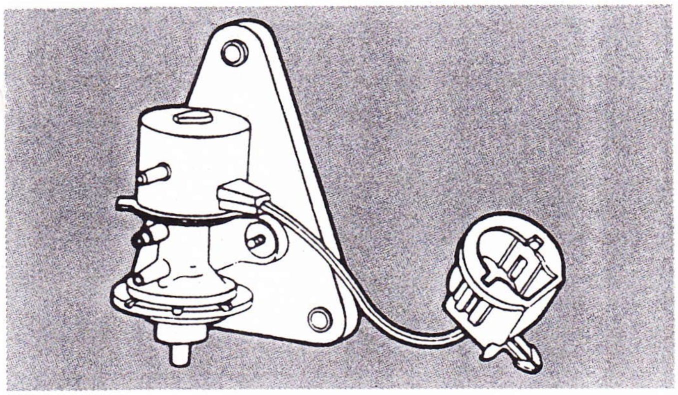


FIGURE 24–34 Remote-mounted fuel control solenoid.

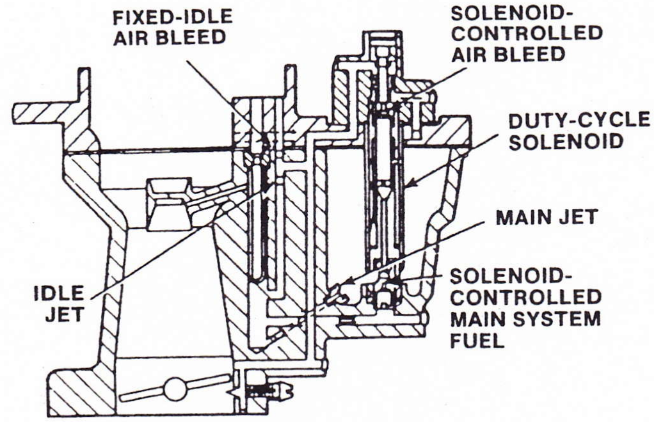


FIGURE 24–35 Electronic feedback carburetor.

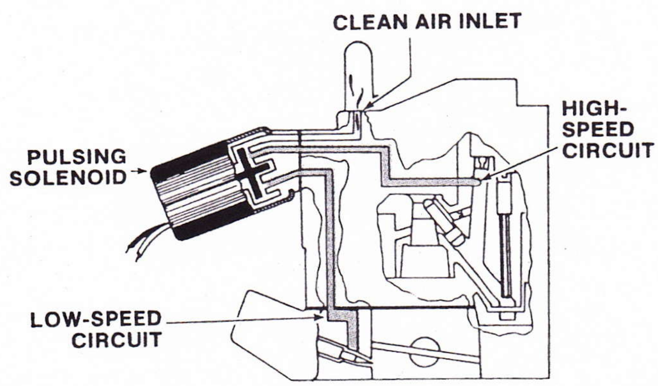


FIGURE 24–36 Carter thermo-quad with O_2 feedback.

The carburetor operates in open loop until the oxygen sensor reaches a certain temperature (approximately 600°F). The carburetor also goes into open loop when a richer-than-normal air/fuel mixture is required, such as during warm-up and heavy throttle application. Several other sensors are needed to alert the electronic control module to these conditions. A coolant sensor provides input relating to engine temperature. A vacuum sensor and a throttle position sensor indicate wide open throttle.

Early feedback systems used a vacuum switch to control metering devices on the carburetor. Closed loop signals from the electronic control module are sent to a vacuum solenoid regulator (Figure 24–34), which in turn controls vacuum to a piston and diaphragm assembly in the carburetor. The vacuum diaphragm and a spring above the diaphragm work together to lift and lower a tapered fuel metering rod that moves in and out of an auxiliary fuel jet in the bottom of the fuel bowl. The position of the metering rod in the jet controls the amount of fuel allowed to flow into the main fuel well.

The more advanced feedback systems use electrical solenoids on the carburetor to control the metering rods (Figure 24–35). These solenoids are generally referred to as duty-cycle solenoids or **mixture control (M/C) solenoids**. The solenoid is normally wired through the ignition switch and grounded through the electronic control module. The solenoid is energized when the electronic control module completes the ground. The control module is programmed to cycle (turn on and off) the solenoid ten times per second. Each cycle lasts 100 milliseconds. The amount of fuel metered into the main fuel well is determined by how many milliseconds the solenoid is on during each cycle. The solenoid can be on almost 100 percent of the cycle or it can be off nearly 100 percent of the time. The M/C solenoid can control a fuel metering rod, an air bleed, or both.

In the Carter thermo-quad carburetor shown in Figure 24–36, variable air bleeds control the air/fuel ratio. This carburetor contains two fuel supply subsystems: the high-speed system and the low-speed system. The high-speed system meters fuel with a tapered metering rod positioned in the jet by the throttle. Fuel is metered into the main nozzle well where air from the feedback-controlled variable air bleed is introduced. Since this air is delivered above the fuel level, it reduces the vacuum signal on the fuel, thereby reducing the amount of fuel delivered from the nozzle.

The idle system is needed at times of low airflow through the venturi because there is insufficient vacuum at the nozzle to draw fuel into the airstream. After leaving the main jet, fuel is supplied to the idle system by the low-speed jet. It is then mixed with air from the idle by-pass, then accelerated through the economizer and mixed with additional air from the idle bleed before being discharge from the idle ports below the throttle. Air from the variable air bleed is introduced between the idle air bleed and idle port. This air reduces the vacuum signal on the low-speed jet and, consequently, the amount of fuel delivered to the idle system.

The thermo-quad uses a mixture control or pulse solenoid to control the variable air bleeds. The sole-

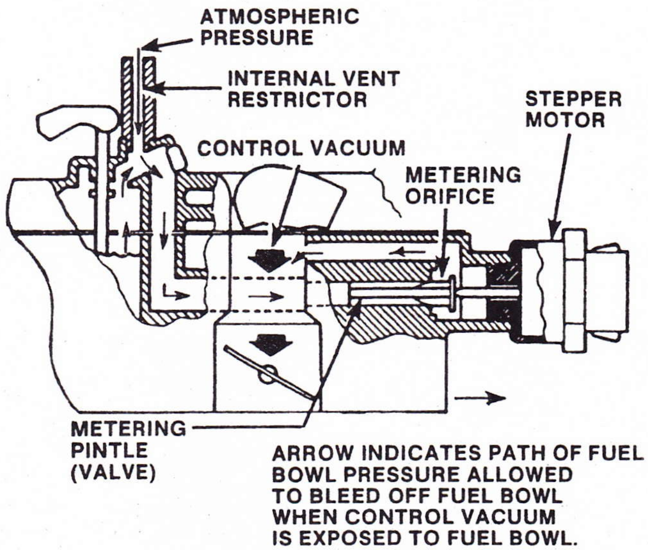


FIGURE 24–37 Back suction feedback system.

noid has only two positions of operation: opened when energized to bleed air to both the high speed and low-speed circuits or closed when de-energized, cutting off the air bleeds.

A less common method to control the air/fuel mixture is with a back suction system feedback. Figure 24–37 shows a variable venturi carburetor with an electric stepper motor rather than a duty-cycle solenoid. The back suction system consists of an electric stepper motor, a metering pintle valve, an internal vent restrictor, and a metering orifice. The stepper motor regulates the pintle movement in the metering orifice, thereby varying the area of the opening communicating control vacuum to the fuel bowl. The larger this area, the leaner the air/fuel mixture. Some of the control vacuum is bled off through the internal vent restrictor. The internal vent restrictor also serves to vent the fuel bowl when the back suction control pintle is in the closed position.

The 7200 VV carburetor was also produced with a feedback stepper motor that controls the main air bleed (Figure 24–38). The stepper motor controls the pintle movement in the air metering orifice thereby varying the amount of air being metered into the main system discharge area. The greater the amount of air, the leaner the air/fuel mixture. A hole in the upper body casting of the carburetor allows air from beneath the air cleaner to be channeled into the main system discharge area. The metered air lowers the metering signal at the main fuel metering jets.

Electronic Idle-Speed Control

To maintain federally mandated emission levels, it is necessary to control the idle speed. Most feedback systems operate in open loop when the engine is

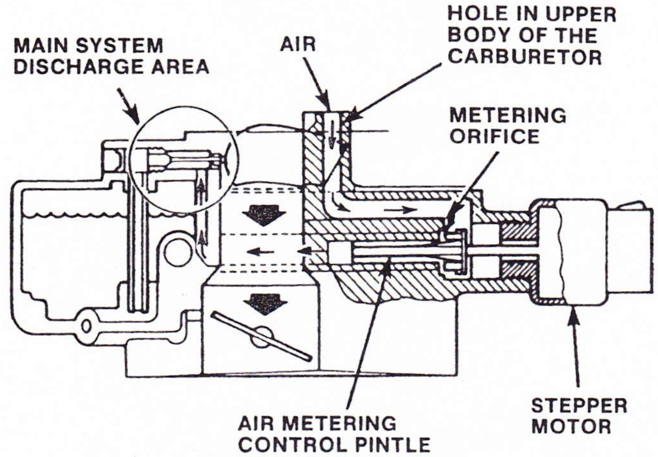


FIGURE 24–38 Air bleed feedback system.

idling. To reduce emissions during idle, most feedback carburetors idle faster and leaner than nonfeedback carburetors.

To adjust idle speed, many feedback carburetors have an idle speed control (**ISC**) motor controlled by an electronic control module. The ISC motor is a small, reversible, electric motor. It is part of an assembly that includes the motor, gear drive, and plunger (Figure 24–39). When the motor turns in one direction, the gear drive extends the plunger. When the motor turns in the opposite direction, the gear drive retracts the plunger. The ISC motor is mounted so the plunger can contact the throttle level. The ECU controls the ISC motor and can change the polarity applied to the motor's armature to control the direction in which it turns. When the idle tracking switch is open (throttle closed), the ECU commands the ISC motor to control idle speed. The ISC provides the correct throttle opening for cold or warm engine idle.

The electronic control module receives input from various switches and sensors to determine the best idle speed. Some of the possible inputs follow.

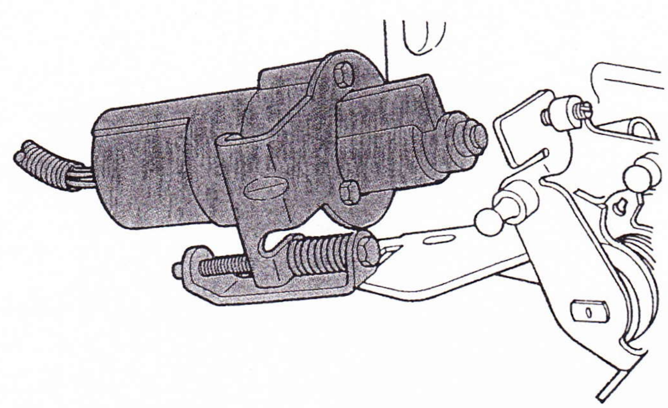


FIGURE 24–39 The idle speed control (ISC) motor stem contacts the throttle linkage. *Courtesy of Ford Motor Company*

- Engine coolant temperature sensor
- Air charge temperature (ACT) sensor
- Manifold absolute pressure (MAP) sensor
- Barometric pressure (BP) sensor
- Park/neutral or neutral gear switch
- Clutch engaged switch
- Power steering pressure switch
- A/C clutch compressor switch
- Idle tracking switch (ITS)

Based on the input signals from the system's sensors, the ECU increases the curb idle speed if the coolant is below a specific temperature, if a load (such as air conditioning, transmission, power steering) is placed on the engine, or when the vehicle is operated above a specific altitude.

During closed choke idle, the fast-idle cam holds the throttle blade open enough to lift the throttle linkage off the ISC plunger. This allows the ISC switch to open so the ECU does not monitor idle speed. As the choke spring allows the fast-idle cam to fall away and the throttle returns to the warm idle position, the ECU notes the still low coolant temperature and commands a slightly higher idle speed.

As the engine warms up, the plunger is retracted by the electronic control module. If the A/C compressor is turned on, the ECU extends the plunger a certain distance to increase engine idle speed to compensate for the added load. When the throttle is opened and the lever leaves contact with the plunger, an idle tracking switch (**ITS**) in the end of the plunger signals the ECU. The electronic control module then fully extends the plunger where, upon contact with the lever (during deceleration), it acts as a dashpot, slowing the return of the throttle lever. When the engine is shut down, the plunger retracts, preventing the engine from dieseling. It then extends for the next engine startup.

In some systems, if the engine starts to overheat, the ECU commands a higher idle speed to increase coolant flow. Also, if system voltage falls below a predetermined value, the ECU commands a higher idle speed to increase alternator speed and output.

Normally, idle speed adjustments are not possible on carburetors with electronic idle speed control. Attempting to adjust idle speed by adjusting the ISC plunger screw results in the ECU moving the plunger to compensate for the adjustment. Idle speed does not change until the ISC motor uses up all of its plunger travel trying to compensate for the adjustment, at which point the system is completely out of calibration. When idle speed driveability problems occur, the ISC system is usually responding to or being affected by the problem, not causing it.

CUSTOMER CARE

Remember that the customer is not a technician. Listen to the customer's description and analysis of a problem, but do not accept the customer's conclusions without performing a test drive and the appropriate diagnostic test yourself. For instance, the average driver cannot detect a miss in one cylinder. While driving down the highway at 50 to 70 mph, the car runs reasonably well; but when the driver pulls up to a stop signal and returns to an idle condition the engine idles roughly. So the driver brings the car to you complaining of a rough idle. Accepting that diagnosis without making your own and attempting to adjust the idle does more harm than good. ■

CARBURETOR DIAGNOSIS AND ADJUSTMENT

The tuneup procedure of a late-model carbureted engine does not include as many carburetor adjustments as were once required, prior to the introduction of feedback carburetors and electronic engine controls. Idle mixture is factory set to meet precise emission control levels and is no longer an adjustable item. Idle speed is more often than not controlled by a computer and cannot be adjusted. About the only adjustment necessary on a properly operating carburetor is the fast-idle speed.

However, a malfunctioning carburetor can cause a variety of performance problems. Sometimes the problem is easily observed, such as a choke plate stuck open or an accelerating pump that is not pumping. Other problems require further testing.

A troubleshooting chart for carburetors is included in the *Tech Manual*. Use of the chart assumes that the engine is in good mechanical condition and properly tuned. Keep in mind that many ignition and carburetor problems have similar symptoms. An analysis of the engine's performance, using an engine analyzer with oscilloscope and exhaust analysis functions, help pinpoint the actual fault.

Some general test and adjustment procedures are given in the remainder of this chapter. However, for specific instructions and specifications, always refer to the manufacturer's service manual.

Carburetor Adjustments

Often a carburetor problem cannot be corrected without removing the carburetor from the engine and rebuilding it. Carburetor rebuilding goes beyond the scope of engine tuneup. However, there are other tests and adjustments that can be made without removing the carburetor. Some of those procedures are given here.

Idle Speed Adjustment As mentioned earlier, most vehicles with computer-controlled fuel systems have no provision for adjusting the idle speed. This is a function of the electronic control module. An idle speed that is not to specifications is a sign that a malfunction, such as an air leak, is occurring somewhere in one of the engine systems. Idle speed is checked using a tachometer.

If idle speed adjustment is possible on the carburetor, be sure to follow the manufacturer's instructions given on the emissions decal. Typical instructions might include the following.

1. Warm the engine to normal operating temperatures.
2. Make sure the choke plate is open and the throttle linkage is off fast-idle.
3. Set the parking brake and block the wheels.
4. Turn off all accessories (such as the air conditioner) and close the doors.
5. Shift the transmission into park, neutral, or drive.
6. Vehicles with feedback carburetion might also require that certain connectors be disconnected to keep the carburetor in open loop.

Then, while watching the tachometer, turn the idle-speed adjusting screw to adjust the idle rpm (Figure 24–40).

Fast-Idle Adjustment Instructions for setting **fast-idle speed** are also contained on the emissions decal or in the manufacturer's service manual. Most carburetors have a fast-idle screw (Figure 24–41) that can be adjusted to correct the fast-idle speed. After satisfying any pretest conditions (such as A/C off or transmission in gear), place the specified step of the fast-idle cam on the adjusting screw. Turn the screw clockwise to increase rpm and counterclockwise to decrease rpm.

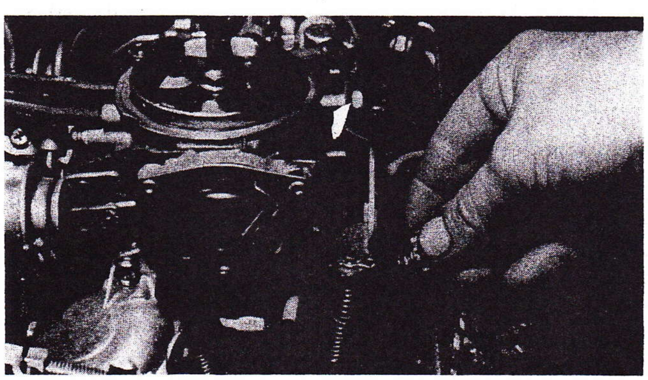


FIGURE 24–40 Adjusting the idle speed.

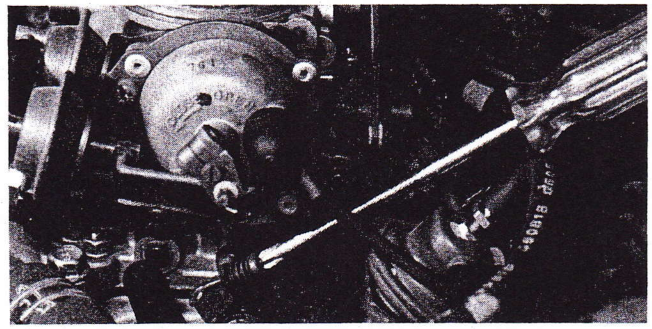


FIGURE 24–41 Adjusting a fast-idle screw.

USING SERVICE MANUALS

Beside providing disassembly instructions, checks, tests, adjustments, and troubleshooting charts, carburetor service manuals offer tuning tips and methods for controlling fuel percolation. ■

Idle Mixture Adjustment As stated earlier, idle mixture adjustments have been eliminated on the newer carburetors. On older carburetors that allow for idle mixture adjustment, a simple procedure is as follows.

1. Adjust the idle speed to the specified rpm.
2. Turn the mixture screws to obtain the smoothest idle.
3. Readjust the idle speed to specifications.
4. Repeat steps 2 and 3 until the engine idles smoothly at the correct engine rpm.
5. Turn the idle mixture adjustment screw in (in the lean direction) as far as possible without a loss of smoothness. Some procedures require leaning the mixture until there is a definite drop in rpm and loss of smoothness and then backing out the idle mixture screws one quarter.

Idle Adjustment Using Propane Enrichment Method By the mid-1970s, the combination of catalytic converters and very lean mixtures made it difficult to properly perform curb idle speed and mixture adjustments. However, these adjustments must be properly made to ensure that emission control devices limit CO, HC, and NO_X to the specified levels. The solution was to use propane gas to assist in achieving correct idle settings.

When a controlled amount of propane is injected into the carburetor at idle, there is a direct correlation between the air/fuel ratio and engine rpm gain. If the rpm gain is less than the specifications found on the emissions control decal, the air/fuel ratio is too rich. If the rpm gain is more than specified, the air/fuel ratio is too lean.

Setting idle mixture using the artificial enrichment method requires a commercially available bottle of propane, a metering valve, a length of hose, and an adapter to connect the hose to the carburetor or air cleaner.

SHOP TALK

During the enrichment test, the propane tank must be upright to allow an even flow of gas. A practical and common way to do this is to hang the tank from the hood. ■

Although the propane injection method varies slightly from one manufacturer to another (check the service manual), the following procedure can be considered basic.

PROCEDURES

Adjusting the Idle—the Propane Injection Method

1. Apply the parking brake and block the wheels. Disconnect the automatic brake release, and plug the vacuum connection.
2. Connect a tachometer to the engine.
3. Disconnect the fuel evaporative purge return hose at the engine and plug the connection.
4. Disconnect the fuel evaporative purge hose at the air cleaner and plug the nipple.
5. Disconnect the flexible fresh air tube from the air cleaner duct or adapter. Using a propane enrichment tool, insert the tool's hose approximately 3/4 inch of the way into the duct or fresh air tube. If necessary, secure the hose with tape and hold the bottle upright for an even flow of propane.
6. For vehicles equipped with an air injector system, revise the dump valve vacuum hoses.
   - For dump valves with two vacuum fittings, disconnect and plug the hoses.
   - For dump valves with one fitting, remove the hose at the dump valve and plug it. Connect a slave hose from the dump valve vacuum fitting to an intake manifold vacuum fitting.
7. Verify that the idle mixture limiter is set to the maximum rich position (counterclockwise against the stop). Correct if required.
8. Check the engine curb idle rpm (for A/C-off rpm). If necessary, reset to specification.
9. With the transmission in neutral, run the engine at approximately 2,500 rpm for 15 seconds before each mixture check.
10. With the engine idling at normal operating temperature, place the transmission selector in the position specified for the mixture check. Gradually open the propane tool valve and watch for engine speed gain, if any, on the tachometer. When the engine speed reaches a maximum and then begins to drop off, note the amount of speed gain.
11. Compare the measure speed gain to the specified speed gain on the engine decal or specification sheet. If the idle rpm gain is not to specifications, adjust the mixture according to the reset rpm specification.
    - If the measured speed gain is higher than the speed gain specification, turn the mixture screw/limiter counterclockwise (rich) in equal amounts. Simultaneously repeat steps 8 through 10 until the measured speed rise meets the reset rpm specification.
    - If the measured speed gain is lower than the speed gain specification, turn the mixture screw/limiter clockwise (lean) in equal amounts. Simultaneously repeat steps 8 through 10 until the measured speed rise meets the reset rpm specification.

Choke Adjustments

A malfunctioning choke can cause a variety of performance problems, from no-start to missing and power loss at cruising speeds. These problems can be caused by choke stuck closed, choke stuck open, inoperative choke pull-off, or malfunctioning bimetal choke coil.

A visual inspection might identify the trouble spot quickly. Remove the air cleaner, making sure to label each vacuum hose as it is disconnected. If the engine is cold, the choke should be closed. Watch the choke plate as another technician cranks the engine. When the engine starts, the choke pull-off should open the choke slightly (about 1/4 inch). As the engine warms, make sure the bimetal coil slowly opens the choke to its fully-open position. The absence of one or more of these choke movements indicates the cause of a driveability problem.

Exact choke servicing and adjustment procedures vary with choke type and carburetor model. In fact, on today's electronically controlled vehicles, the electronic choke is sealed to prevent tampering and misadjusting. Operation of the heating element is checked with a digital volt-ohmmeter. Refer to the manufacturer's service manual for procedures and specifications.

Before making any choke adjustments, move its linkage by hand to be certain there is no binding or sticking in the linkage, shaft, or choke plate. Use an approved carburetor cleaner to remove any gum deposits that interfere with its operation.

Adjusting the Choke Index If the choke housing permits adjustment of the choke setting, the choke can be adjusted to enrich or lean the air/fuel mixture. With an integral choke, manufacturers recommend specific alignment of the choke index marks. A mark on the plastic choke cover must be lined up with a mark on the metal choke housing or body. This initial choke setting usually provides adequate choke operation.

Check the thermostat housing index setting (Figure 24–42) against the specification on the engine decal or the vehicle's service manual.

For example, if the choke setting is specified as index, the index mark on the cap should be aligned with the center mark on the cap, which should be aligned with the center (index) notch on the housing. A specification of 1R, 2R, or 3R means the cap index mark should be aligned with the housing marks 1, 2, or 3 notches to the right of the center notch. Specifications reading 1L, 2L, or 3L, require positioning the index mark to the left of the center notch.

To adjust the choke setting, loosen the cap screws and the hot air or coolant tubes (if applicable). Turn the cap to realign the index mark with the specified notch on the housing. Then, retighten the tubes and screws.

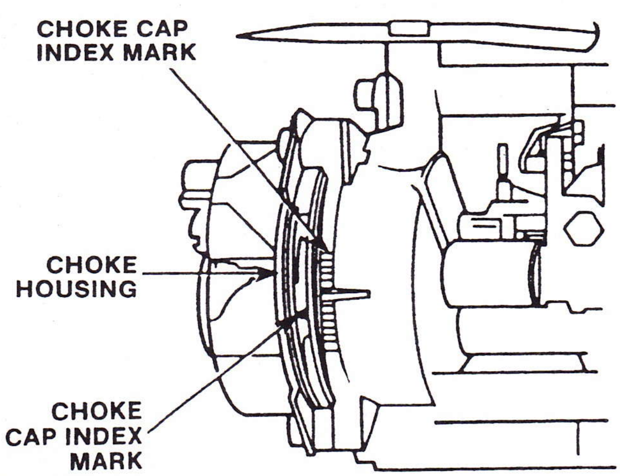


FIGURE 24–42 Choke index adjustment.

PROCEDURES

Divorced Choke Adjustment

1. Disconnect the choke rod from the choke plate and close the plate.
2. Move the rod up or down as directed in the service manual. Check whether or not the rod is above or below the hose in the check plate. The bottom of the rod should align with the top edge of the hole. With choke plates that use a sliding fit, the rod is usually set at the middle of the slot. However, always check the manufacturer's instructions.
3. Bend the choke rod to lengthen or shorten it as required.

WARNING!

Improper bending can cause the choke rod to bind. ■

4. Test for free movement between open and closed choke positions. There must not be any binding or interference.

CAUTION:

Never attempt an adjustment on the thermostatic coil spring. ■

Choke Pulldown Adjustments If the choke plate is not opening when the engine starts, check for a vacuum leak in the choke qualifying mechanism. If a diaphragm vacuum break is used, look for a cracked vacuum hose or loose hose connections. To check the diaphragm, remove the vacuum hose, and install a vacuum pump (Figure 24–43). Apply vacuum to the pump diaphragm. If the diaphragm does not hold vacuum or if the vacuum leaks down faster than the manufacturer specifies it should, the vacuum break should be replaced.

SHOP TALK

Before many types of vacuum breaks can be tested with a vacuum pump, a bleed hole must be plugged. To do so, place your finger or a piece of tape over the bleed hole. Figure 24–44 shows several vacuum break styles with the recommended procedure for blocking the bleed hole prior to testing. ■

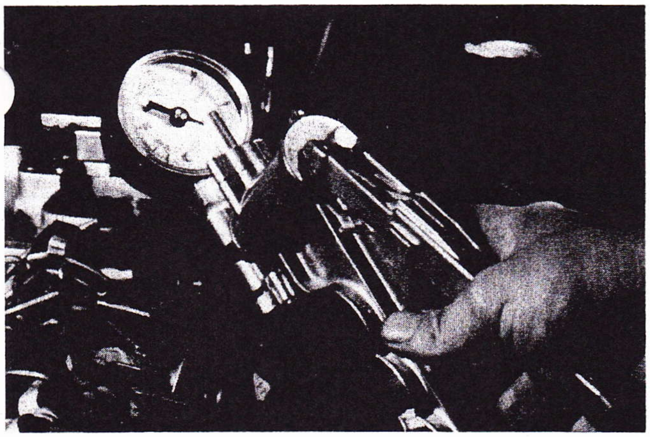


FIGURE 24–43 Checking vacuum break diaphragm with a vacuum pump.

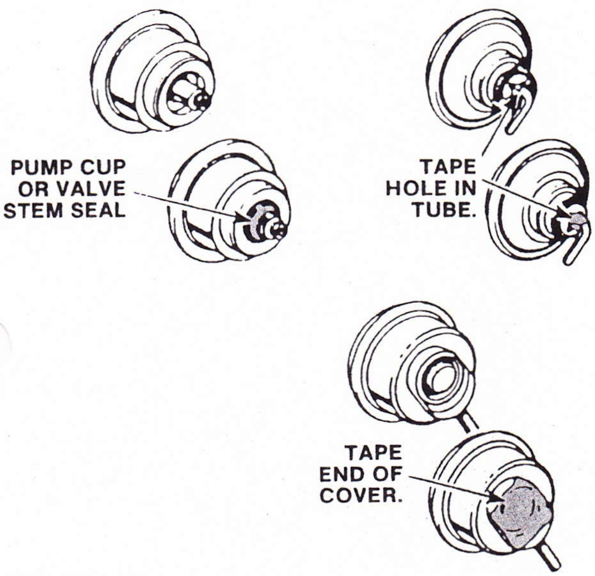


FIGURE 24–44 Methods of plugging air bleed holes prior to testing a vacuum break.

If the carburetor has a secondary vacuum break, test the thermal vacuum valve or choke vacuum thermal switch. Consult the manufacturer's service manual for temperature specifications. Connect a vacuum pump to the lower port and a vacuum gauge to the upper port. Apply the specified vacuum and alternately warm and cool the valve or switch. The valve should permit vacuum passage when the valve is warm, and block vacuum when the valve is cold.

If a vacuum piston is used to open the choke, remove the choke housing cap and inspect the piston and cylinder for carbon deposits. If the piston is sticking and not moving freely, remove the choke housing and clean the pull-off piston and vacuum passageways. Also, check the choke heat tube for carbon deposits. An exhaust leak in the area of the choke stove causes the carbon deposits. Locate and correct the problem.

If the engine runs rough initially after startup, the choke might not be opening the specified amount. To check the qualifying dimension, apply the specified vacuum to the diaphragm, using a vacuum pump. Measure the clearance between the upper edge of the choke plate and the air horn wall, using a drill bit with a diameter equal to the specified dimension. To adjust the dimension, bend the choke linkage with a pair of pliers.

Choke Unloader Adjustment The unloader can be adjusted following this procedure.

1. With the throttle plates wide open, close the choke plate as far as possible without forcing it.
2. Use a drill bit with a diameter equal to the specified unload dimension as a gauge. Place it between the upper edge of the choke valve and the air horn.
3. Bend the unloader tang on the throttle lever to obtain the dimension as listed in the specifications.

Checking the Accelerator Pump

If the accelerator pump is not operating properly, the engine hesitates when the accelerator pedal is depressed.

To check for accelerator pump operation, remove the air cleaner top. Make sure the actuating linkage is not binding. Using a flashlight, look down into the air horn while quickly moving the throttle linkage forward (Figure 24–45). Each time you do so, a stream or squirt of fuel from the discharge tube should be visible. If not, remove the air horn and service the accelerator pump following the specific procedures outlined in the manufacturer's service manual.

Float Adjustments

An improperly operating float system can result in a variety of performance problems: flooding, rich fuel mixture, lean fuel mixture, fuel starvation (no fuel), stalling, low-speed engine miss, and high-speed engine

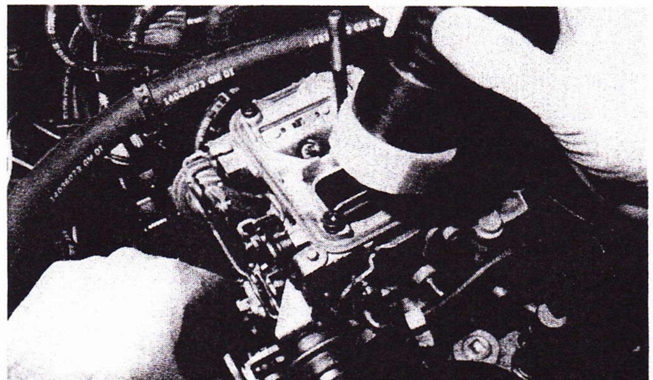


FIGURE 24–45 Checking accelerator pump operation.

miss. Thus, a faulty float system can affect engine operations at all speeds.

On some carburetors, the fuel level in the fuel bowl can be checked without removing the air horn assembly from the carburetor. A gauge is placed into the fuel bowl through a vent hole. The level of the fuel in the bowl is an indication of the float condition. Most carburetors, however, require the air horn assembly be removed from the carburetor to inspect and adjust the float.

An error in float adjustment as small as 1/32 inch can change the air/fuel ratio sufficiently to make other carburetor adjustments difficult, if not impossible. Adjustments include the float level, **float drop, float toe,** and float adjustment. Since most do not require all four adjustments, check the vehicle's service manual or the rebuilding kit instruction sheet for the adjustment that must be performed.

Some carburetors have a sight glass or plug in the fuel bowl that makes it possible to check the float level while the engine is operating. Float levels on these carburetors can be adjusted by an external screw or threaded inlet valve. Checking the fuel level on a carburetor with a sight glass not only aids in adjusting the float level but also in locating float problems.

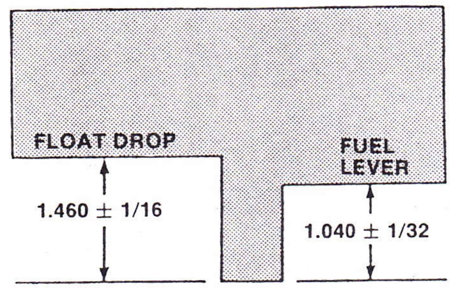


FIGURE 24–46 Float gauge.

PROCEDURES
Float Level Adjustment

1. Remove the upper body assembly (air horn assembly) and the upper body gasket. Install a new gasket before making the adjustment.
2. From cardboard, fabricate a gauge to the specified dimension following the specifications given in the service manual or rebuilding kit. Figure 24–46 shows a typical float gauge. Carburetor rebuilding kits often have these gauges included. Check the service manual for the exact dimensions.
3. With the upper body inverted, place the fuel level gauge on the cast surface of the upper body or gasket and measure the vertical distance from the surface and the bottom of the float. The service manual notes the desired location of the gauge for this check.
4. To adjust, bend the float operating level away from the fuel inlet needle to decrease the setting and toward the needle to increase the setting.
5. Check and adjust the float drop by turning the upper body over and allowing the float to drop.
6. Place the gauge into position and measure float drop.
7. Correct as needed, by bending the float's stop tab.
8. Reinstall the upper body assembly.

Float Toe Adjustment In addition to the float level and drop adjustments, some carburetors also have a float toe adjustment. To make this adjustment, the air horn is turned over (no gasket installed) and checked to make sure the float toes are flush with the air horn casting (Figure 24–47A). If the float has dimples (Figure 24–47B), measure from the dimples to the top of the gasket. In either case the float arm is bent to where it meets the float.

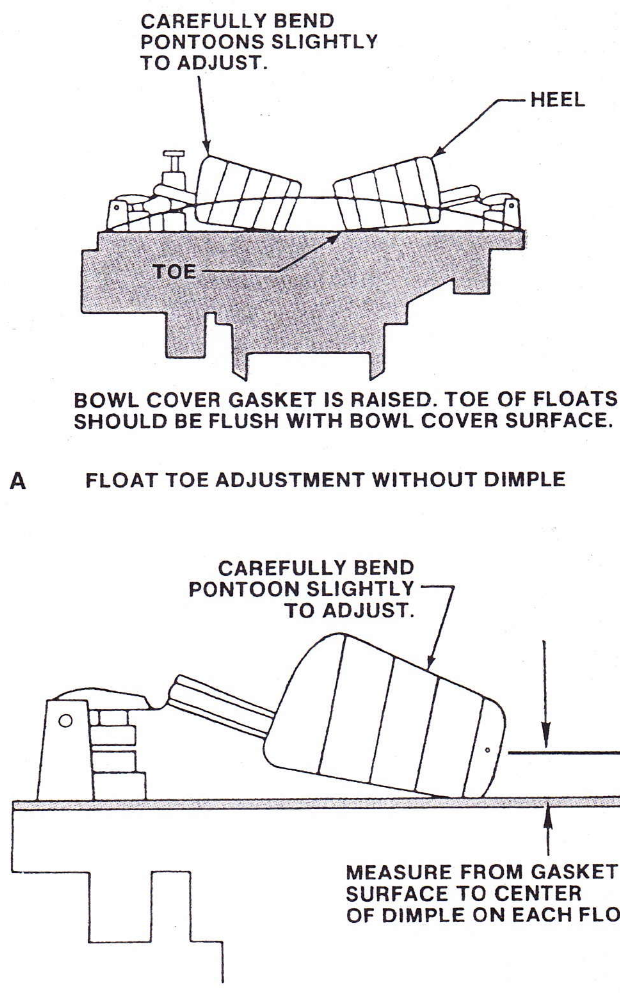


FIGURE 24–47 Checking float toe.

After making a toe adjustment, be sure to recheck the float level and drop to see if they have changed.

CASE STUDY

A customer mentions he noticed when checking the oil that the level has increased.

In response, the technician checks the oil by smelling it. The odor of gasoline in the oil leads the technician to check the fuel pump for a leak, but the pump is in good working order. The technician checks for an alternative cause. Realizing that a heavily choked engine will cause raw fuel to slip past the rings and into the crankcase area, the technician verifies by a visual inspection that the choke is not adjusted properly. The choke is readjusted according to the manufacturer's specifications. The oil and filter are changed. No further problems are reported.

KEY TERMS

Atomization
Barrel
Boost venturi
Choke
Choke unloader
Closed loop
Dashpot
Deceleration valve
Downdraft
Draft
Emulsion
Fast-idle speed
Float
Float drop
Float toe
Hot-idle compensator
Idle stop solenoid
ISC motor
ITS
Lean
Metering
Metering rod
Mixture control (M/C) solenoids
Nitrile rubber
Open loop
Power valve
Primary stage
Rich
Secondary stage
Sidedraft
Single stage
Stoichiometric ratio
Throttle kicker
Throttle stop solenoid
Transfer slot
TVV
Updraft
Vaporization
Variable venturi
Venturi

SUMMARY

- Carburetion means enriching a gas by combining it with a carbon-containing compound. Three general stages of carburetion are metering, atomization, and vaporization.
- A venturi is a streamlined restriction that partly closes the carburetor bore. This restriction causes an increase in vacuum.
- The flow of air and fuel through the carburetor is controlled by the throttle plate.
- There are six basic carburetor circuits: float, idle, main metering, full power, accelerator pump, and choke.
- The float system stores fuel and holds it at a precise level as a starting point for uniform fuel flow.
- The idle circuit supplies a richer air/fuel mixture to operate the engine at idle and low speeds.
- The main metering circuit comes into operation when the engine speed reaches about 1,500 rpm or higher.
- The power system provides the engine with a richer air/fuel mixture at wide open throttle.
- The accelerator pump mechanically supplies extra fuel during sudden acceleration.
- The choke circuit provides a very rich mixture during cranking and startup of a cold engine.
- Additional carburetor controls include the choke qualifier, dashpot, hot-idle compensator, dual vacuum break, choke unloader, deceleration valve, and throttle position solenoid.
- Carburetors are designed with different drafts, different numbers of barrels, different types of venturi, and different flow rates.
- The latest type of carburetor system is the electronic feedback design, which provides better combustion by control of the air/fuel mixture.
- About the only adjustment necessary on a properly operating carburetor is the fast-idle speed.
- A malfunctioning choke can cause a variety of performance problems, from no-start to missing and power loss at cruising speeds. If the accelerator pump is not operating properly, the engine hesitates when the accelerator pedal is depressed. An improperly operating float system can result in a variety of performance problems: flooding, rich fuel mixture, lean fuel mixture, fuel starvation (no fuel), stalling, low-speed engine miss, and high-speed engine miss.