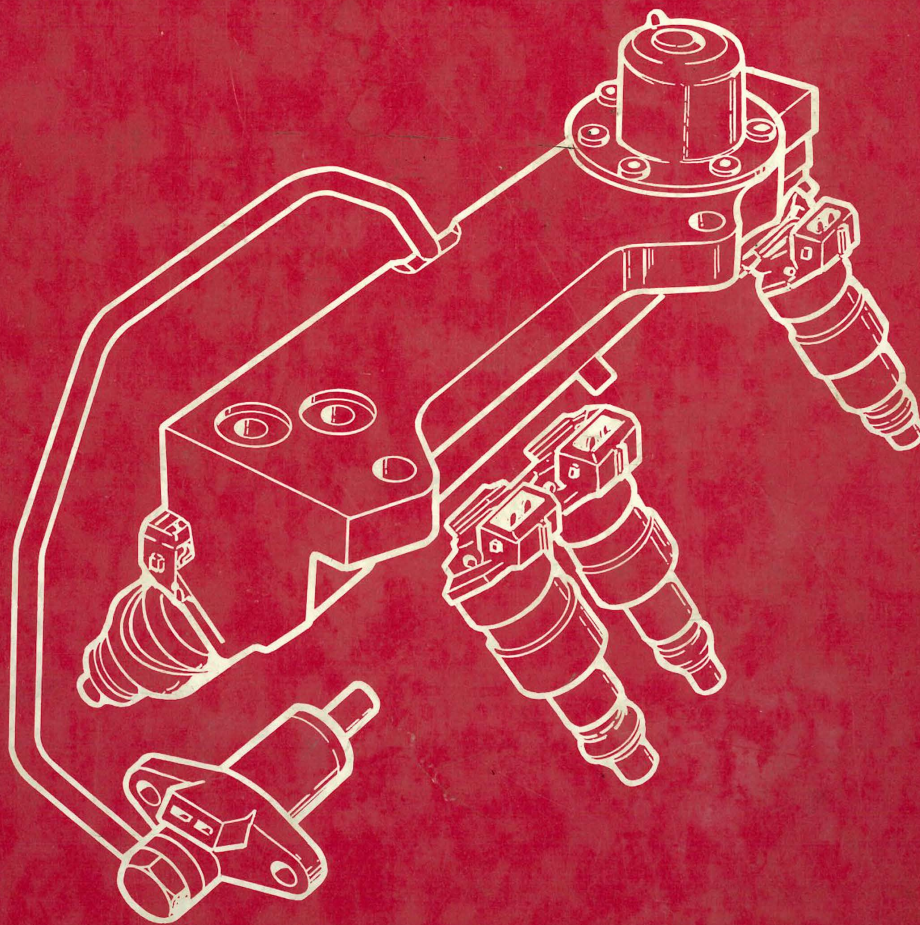


Auto Fuel Systems

DUFFY/SMITH



*Principles, Diagnosis, Service of Carburetor,
Gasoline Injection, and Diesel Systems*

EX1016
HARBOR FREIGHT TOOLS
IPR2025-01121

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INTRODUCTION

AUTO FUEL SYSTEMS is designed to help prepare you to properly diagnose and repair all types of automotive fuel systems. It provides full coverage of both the theory and the service procedures that you will need to be a fuel system technician.

A few years ago, carburetors and simple mechanical fuel pumps were used on almost all passenger cars. This made fuel system service a comparatively simple job. Today, late model cars come equipped with electronically controlled carburetors, electronic fuel injection—both multi and single point, as well as diesel injection. Various emission control devices, engine sensors, and the computer also add to fuel system complexity. As a result, there is a demand for technicians capable of repairing fuel systems and related components.

The book is divided into five sections and 26 chapters. The first section is a quick review of fundamentals: engine operation, safety, special service tools and equipment, measurements, formulas, fuels, and combustion. The other sections cover the operation, construction, and service of fuel system components.

Usually, one chapter will cover the theory and construction of a part or subsystem. Then, the following chapter will summarize the diagnosis, testing, and repair of the same system. As a result, a buildup of knowledge occurs as you progress through the book.

Each chapter opens with learning objectives so you will know what you are expected to learn in the chapter. The end of each chapter has “Know These Terms” and “Review Questions” so that you can check how well you understand what you have studied. Both conventional and ASE certification type questions are used.

AUTO FUEL SYSTEMS will prepare you to pass three of the ASE certification tests—Engine Performance, Engine Repair, and Electrical Systems. Potential questions for these tests relate to fuel system service. You will also need additional work experience and study in other fields.

To help you learn the “language” of a fuel system technician, all technical terms are printed in italics and defined immediately after their first use. This highlights the word and reminds you it is a word or term you must understand.

AUTO FUEL SYSTEMS is a valuable guide to anyone wanting to learn about today's automotive fuel systems. It will help students enter the trade more easily, as well as help the experienced mechanic become more informed of new advances in technology. It is an excellent reference for the car owner who wants to know more about the operation and service of fuel systems.

James E. Duffy
Howard Bud Smith

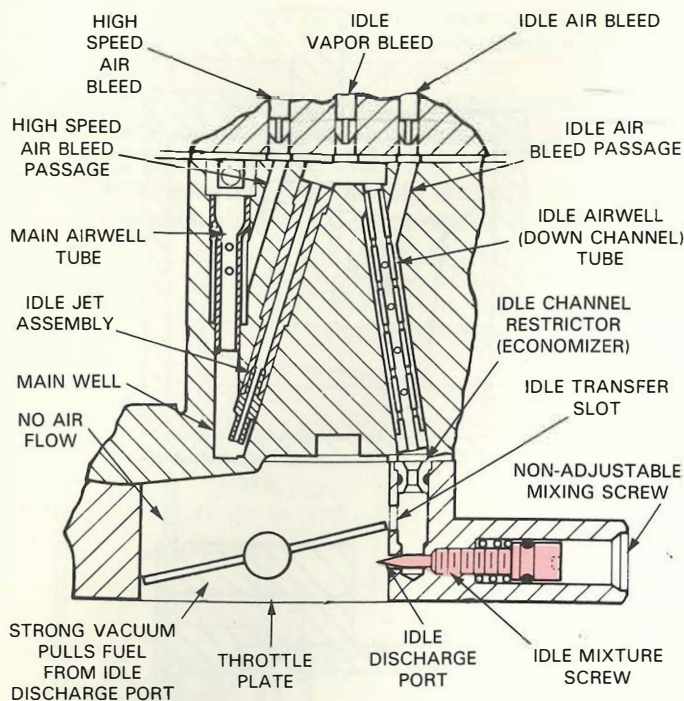


Fig. 12-12. Elements of idle circuit. Fuel is routed to enter carburetor throat below throttle valve at idle discharge port. (Ford)

main discharge passage, runs through a low speed jet, an economizer (restriction in passage), and down to the idle port. Beyond the idle screw restriction, it opens into the air horn just below the throttle valve. See Fig. 12-13.

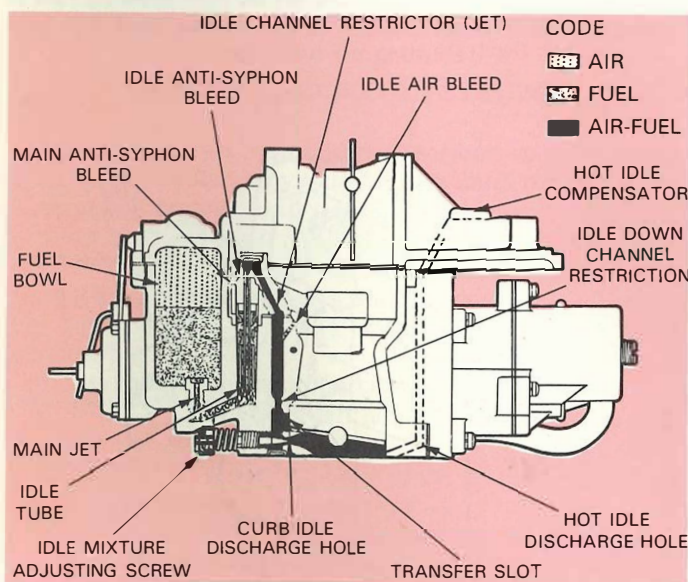


Fig. 12-13. Study parts and fuel flow in this basic idle circuit. Understanding idle circuit operation is very important to study of carburetion. Air mixes with fuel in idle tube. This assists fuel atomization and vaporization and engine efficiency at idle. Idle anti-syphon bleed prevents fuel syphoning (fuel continues to flow out of circuit when engine is shut off). (Ford)

Idle system operation

During idle system operation, the throttle plate is closed. Intake manifold vacuum, below the butterfly, sucks gasoline from the idle screw port. Fuel flows out the float bowl and through the low speed jet. This jet limits maximum fuel flow.

At the *bypass* (an idle air bleed port), outside air is pulled into the system. This partially atomizes the fuel. The amount of air entering is controlled by the bypass diameter. The bypass helps control flow and mixes tiny air bubbles with the liquid fuel. More air bubbles enter at the off-idle ports. This helps cut fuel consumption at idle speeds. Finally, the air bubbles and fuel pass the idle mixture screw and empty into the air horn.

Idle mixture screw

The *idle mixture screw*, Fig. 12-14, is fitted into the idle port. It can be adjusted to control the EXACT AMOUNT OF FUEL entering the engine at idle. Normally, turning the idle mixture screw IN leans the mixture and OUT richens the mixture.

Most new carburetors do not have ADJUSTABLE idle mixture screws. This helps prevent misadjustment and air pollution. See Fig. 12-15.

OFF-IDLE SYSTEM

The *off-idle circuit* consists of either holes or a slot in the air horn just above the throttle plate, Figs. 12-14 and 12-16. It is an extension of the idle circuit intended to provide extra fuel during transition from idle operation to higher speeds. Also called the IDLE TRANSFER PASSAGES, they open into the idle system fuel passage.

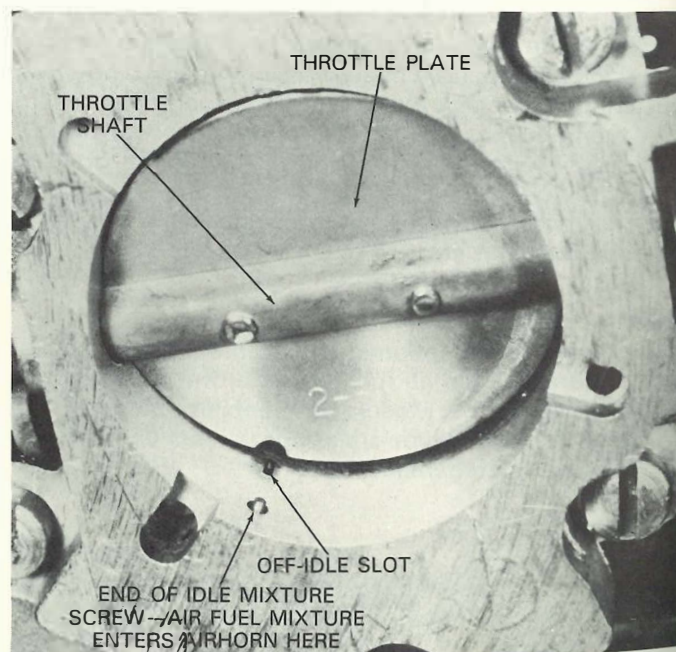


Fig. 12-14. Bottom view of carburetor bore shows off-idle fuel openings. Below off-idle slot is end of mixture screw. Notch in throttle plate helps control both idle and off-idle circuit transition. (Carter Carburetor Div.)

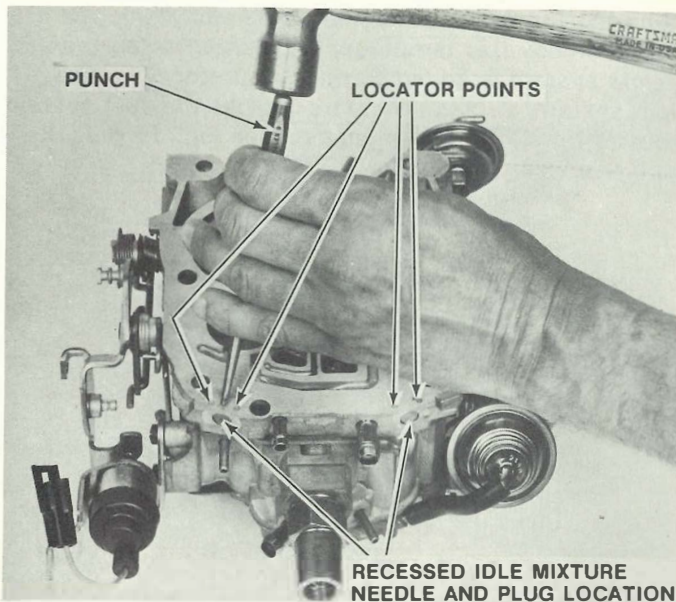


Fig. 12-15. On modern carburetors, idle mixture screws are covered with metal plugs to prevent tampering. Changing factory setting could upset mixture and increase exhaust emissions. (General Motors)

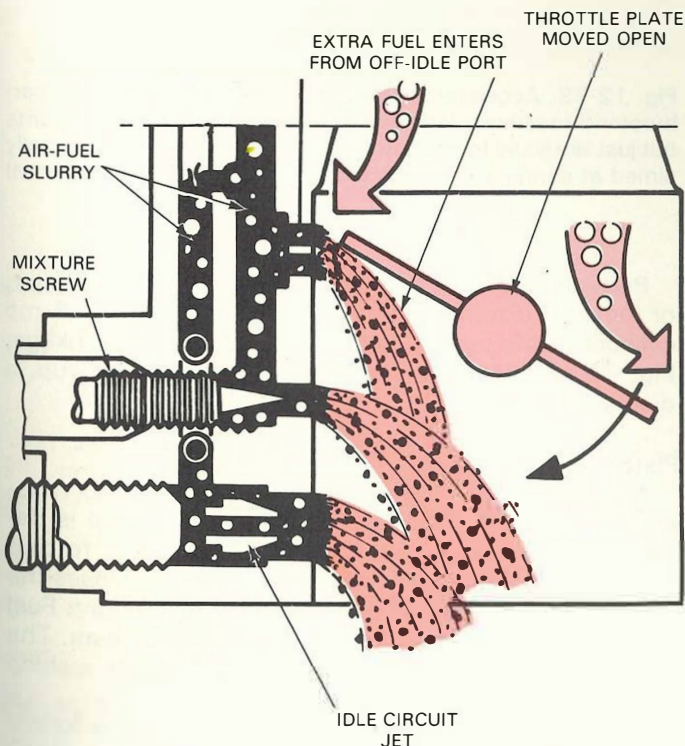


Fig. 12-16. Make a "mental picture" of an off-idle circuit. Note position of throttle plate and how fuel enters carburetor throat. (Renault)

When the throttle plate is closed, the off-idle opening (or openings) act as additional air bleeds for the idle circuit. When the throttle plate swings open, the addi-

tional openings are EXPOSED to intake manifold vacuum. Then, they too begin to supply gasoline. As more air rushes past the opened butterfly, the added fuel is necessary to maintain correct air-fuel ratio.

The main discharge tube cannot provide fuel until a larger quantity of air is passing through the venturi. The off-idle system helps keep the engine from running lean, hesitating, or stumbling during initial acceleration from an idle.

FUEL CUTOFF SOLENOID

Carburetors can use a fuel cutoff solenoid to prevent engine dieseling or after-running. Look at Fig. 12-17.

An electric solenoid is wired to the ignition switch and battery. The plunger of the solenoid operates a needle valve inside the idle fuel passage.

Whenever the ignition is ON, the fuel cutoff solenoid

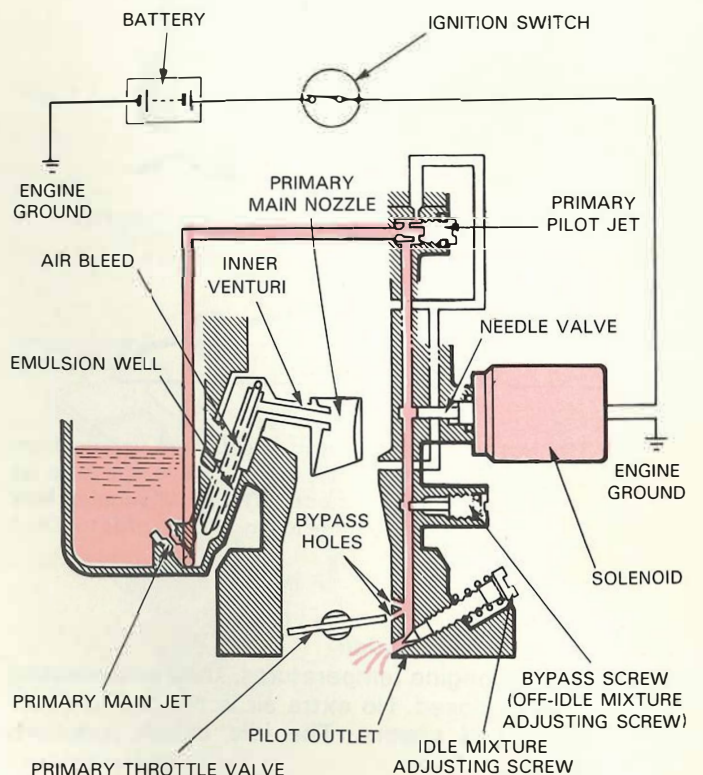


Fig. 12-17. Fuel shutoff solenoid prevents dieseling by closing idle circuit fuel passage. It blocks idle circuit whenever ignition switch is off. Fuel cannot drip from idle system to support combustion and dieseling. (Chrysler Corp.)

is energized and retracted. This lets the idle circuit function normally. When the engine is turned off, the fuel shutoff solenoid is deenergized. The plunger and needle valve slide out to block the idle fuel passage.

* Note! Some fuel cutoff solenoids are wired to the throttle position sensor through the computer. This allows the fuel cutoff solenoid to stop fuel flow when the engine is decelerating. This improves fuel economy.

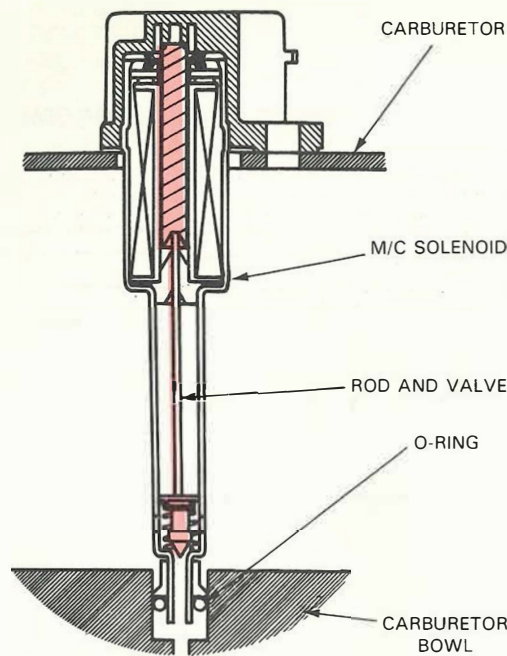


Fig. 12-28. Electrical impulses to solenoid control this electric metering rod. Solenoid pulls rod in and out of its jet to match fuel mixture to engine's needs. (Buick)

POWER VALVE (POWER JET)

In many carburetors, a *power valve* or *jet* serves the same purpose as a metering rod. In a sense, it also provides for better gas mileage at low power output. Hence, the power valve is sometimes called an **ECONOMIZER VALVE**, Fig. 12-29.

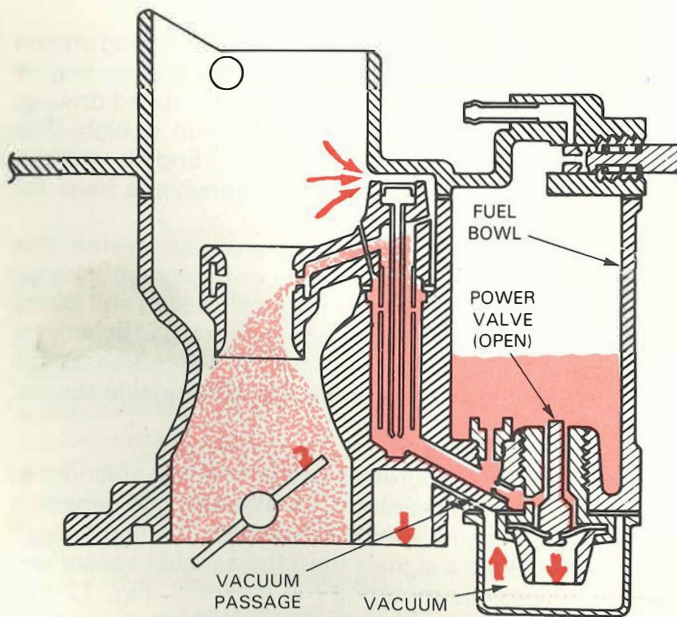


Fig. 12-29. Power valve or economizer valve enriches the high speed fuel mixture. It is controlled by engine vacuum, an indicator of engine power demands. (AMC)

The power valve consists of a flexible diaphragm attached to a spring-loaded valve, Fig. 12-30. A vacuum passage goes to the bottom of the carburetor air horn. On one side of the power valve diaphragm is a supply of gasoline, on the other side, engine vacuum.

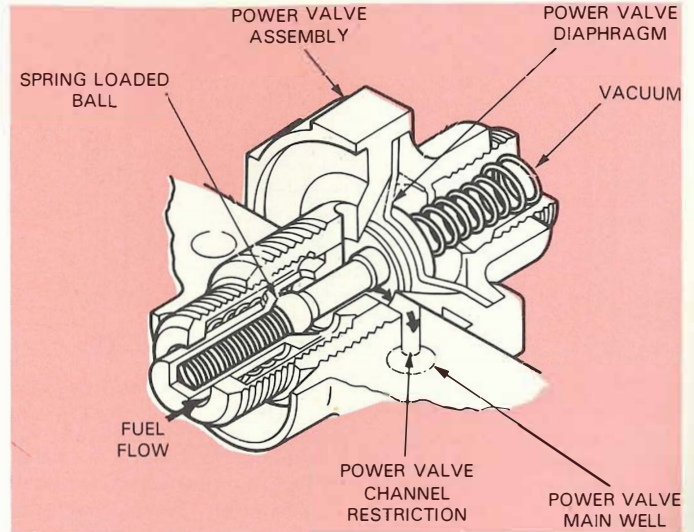


Fig. 12-30. Cutaway shows parts and construction of two-stage power valve. (Ford)

Two-stage power valve

A *two-stage power valve* reacts to different vacuum levels to meter fuel more precisely into the engine. Refer again to Fig. 12-30. With moderate vacuum, the valve is pulled midway so fuel is drawn through a first stage orifice. With full acceleration, the valve is pulled fully open to allow full fuel enrichment.

*CHOKE SYSTEM

The *choke circuit*, Fig. 12-31, supplies an extremely rich fuel mixture for cold engine starting. A choke valve closes off flow of outside air into the engine. As a result, a very strong vacuum is formed inside the air horn by the downward movement of the piston on the intake stroke. The strong suction pulls a huge amount of gasoline out of the main discharge passage. The engine's intake manifold is, literally, flooded with raw fuel. Vapors rise off the liquid fuel in the intake and improve cold engine operation.

Parts of a choke system

Depending upon its design, a choke system will include a *choke plate* (or butterfly valve), thermostatic spring, and some linkage connecting its parts. Additional parts are found on specific choke types.

The *choke plate* is a disc-type valve with a rod through its middle supported by the top of the air horn in a way that allows the plate to swing through an arc of 90 degrees to block off the top of the air horn.

The *thermostatic spring* is an automatic device which

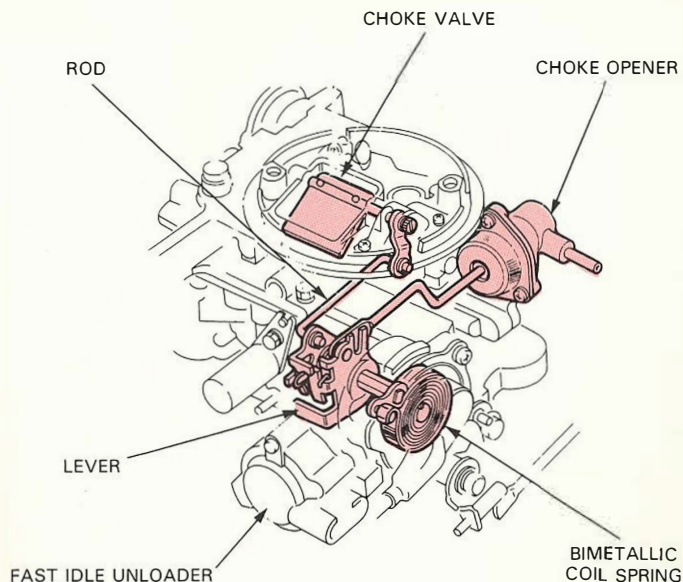


Fig. 12-31. Basic parts of choke circuit. Choke valve is also known as a butterfly valve. It is hinged to top of air horn. (Honda)

is linked to the choke plate. Its purpose is to open and close the choke plate as the spring reacts to the temperature of the engine and the air around it.

There are two basic types of carburetor chokes, MANUAL and AUTOMATIC.

Manual choke

As its name suggests, a *manual choke* is hand operated. It has a steel control cable which runs from the driver's compartment to the carburetor. When the choke knob on the dashboard is PULLED, the cable slides inside the stationary cable housing. The movement of the inner cable pulls on the choke plate arm and closes the choke.

Automatic choke

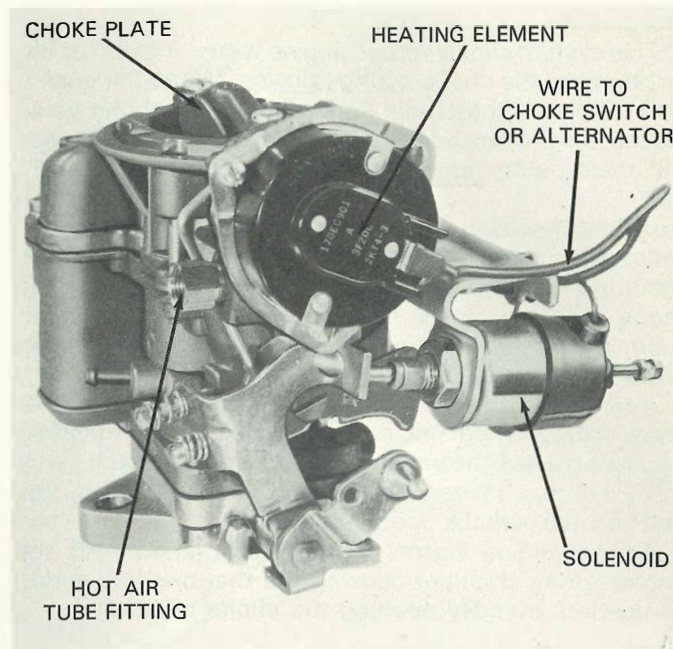
Many cars have an *automatic choke* that operates without driver assistance, Fig. 12-32A. Being more sensitive to engine temperature, an automatic choke is more efficient.

There are several types of automatic carburetor chokes:

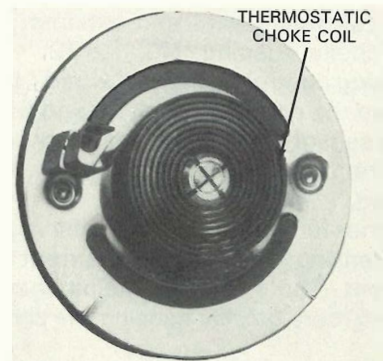
1. An integral hot air type mounted on the carburetor.
2. A separate hot air choke mounted in the intake manifold and linked to the carburetor.
3. A combination hot air-electric choke.
4. An all electric choke.
5. A hot water (coolant) choke.

Thermostatic (bimetallic) spring

The primary control element of hot air type automatic chokes is a small *thermostatic spring*, Fig. 12-32B. The bimetallic spring is heat sensitive. When COLD, the spring coils up tightly. When HOT, the spring expands and unwinds into a larger spiral. This coiling and uncoiling action is used to open and close the thermostatic choke plate.



A



B

Fig. 12-32. A—Note parts of electric assist choke. Small heat element placed next to thermostatic spring speeds choke opening. B—View of thermostatic choke coil. (Ford and Chevrolet Motor Div.)

Integral hot air choke

Basically, the *integral hot air choke* consists of the butterfly valve, choke shaft, lever, bimetallic spring, spring housing, choke piston, vacuum passage, choke stove, and hot air tube.

With a cold engine, the coil spring winds up and closes the choke plate. When the engine starts, engine vacuum pulls on the choke piston and cracks open the choke to prevent engine flooding. The cold thermostatic spring keeps the choke from fully opening.

As the engine warms, hot air flows up from the exhaust manifold into the spring housing. The hot air causes the thermostatic spring to unwind, opening the choke butterfly. At engine operating temperature, the vacuum piston and the bimetallic spring keeps the choke fully open.

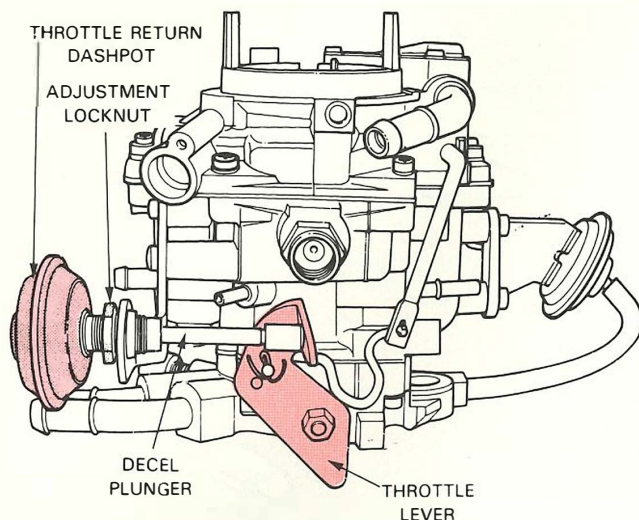


Fig. 12-37. Throttle dashpot keeps engine from stalling during rapid deceleration. Throttle lever strikes dashpot plunger which slowly returns throttle to curb idle. (Chrysler Corp.)

ANTI-DIESELING SOLENOID

Engines which must power automatic transmissions and air conditioning systems require higher idle speeds. The *anti-dieseling solenoid* is an electrically activated device designed to increase idle speed while the engine is running, but drop it to curb idle speed when the ignition is turned off. Refer to Fig. 12-38.

The solenoid is mounted like a throttle return dashpot, its plunger rod resting against the throttle linkage. Turning on the ignition energizes the solenoid which pushes

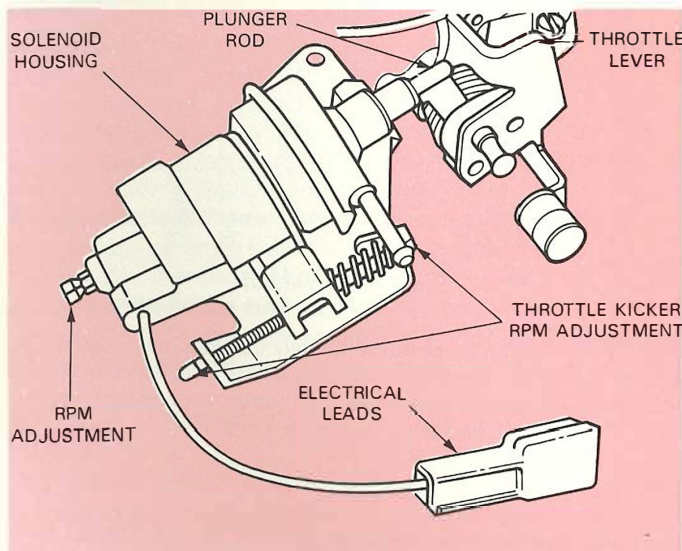


Fig. 12-38. Anti-dieseling solenoid increases idle speed when ignition is ON. It holds throttle linkage off curb idle screw to improve idle under added load of air conditioning and automatic transmission. Then solenoid prevents dieseling by fully closing throttle plates to curb idle when ignition is turned off. (Ford)

the rod outward, opening the throttle valve to a faster idle. Turning off the ignition de-energizes the ignition and the rod retracts. Too little fuel enters the carburetor throat to support combustion. Dieseling is avoided.

Most fast-idle solenoids are adjustable. The plunger rod or the mounting bracket can be turned IN or OUT to adjust engine speed.

ALTITUDE COMPENSATOR

An *altitude compensator* is a device that changes the carburetor's air-fuel mixture with changes in height above or below sea level. The compensator normally has an *aneroid* (bellows device that expands and contracts with changes in atmospheric pressure). See Fig. 12-39.

When a car is traveling up a mountain, for example, the density of the air decreases with height. This tends to make the air-fuel mixture richer. The reduced air pressure causes the aneroid to expand, opening an air valve. Extra air flows into the air horn producing a leaner air-fuel mixture. This action reverses when the car's height above sea level decreases.

CARBURETOR VACUUM CONNECTIONS

A modern carburetor has numerous vacuum connections, Fig. 12-40. When the vacuum connection or port is **BELOW** the carburetor throttle plate, the port always receives full intake manifold vacuum. However, when the vacuum port is above the throttle plate, vacuum is present only when the throttle is opened.

Typical components that operate off carburetor vacuum connections are:

1. EGR VALVE (exhaust emission control device).
2. DISTRIBUTOR VACUUM ADVANCE (diaphragm for advancing ignition timing).
3. CHARCOAL CANISTER (emission control container for storing fuel vapors).
4. CHOKE BREAK (diaphragm for partially opening choke when engine is running).

COMPUTER CONTROLLED CARBURETORS

A *computer controlled carburetor* normally requires a solenoid-operated valve to respond to commands from a microcomputer (electronic control unit). The system uses various sensors to send information to the computer. The computer then calculates how rich or lean to set the carburetor's air-fuel mixture. A typical system is shown in Fig. 12-41.

Computer system sensors

A computer controlled carburetor system, sometimes called a computer controlled emission system, consists of the components shown in Fig. 12-41. Included are:

An *oxygen sensor* or *exhaust gas sensor*, Fig. 12-42, signals any change in oxygen content (an indicator of air-fuel ratio) in the exhaust gases. An O_2 sensor produces a voltage output of about 0.2 volts when the mixture is lean and up to 1.0 volts when the mixture is rich. The oxygen sensor only functions when heated by the exhaust to about 600°F (316°C).

The *temperature sensor's* resistance changes with

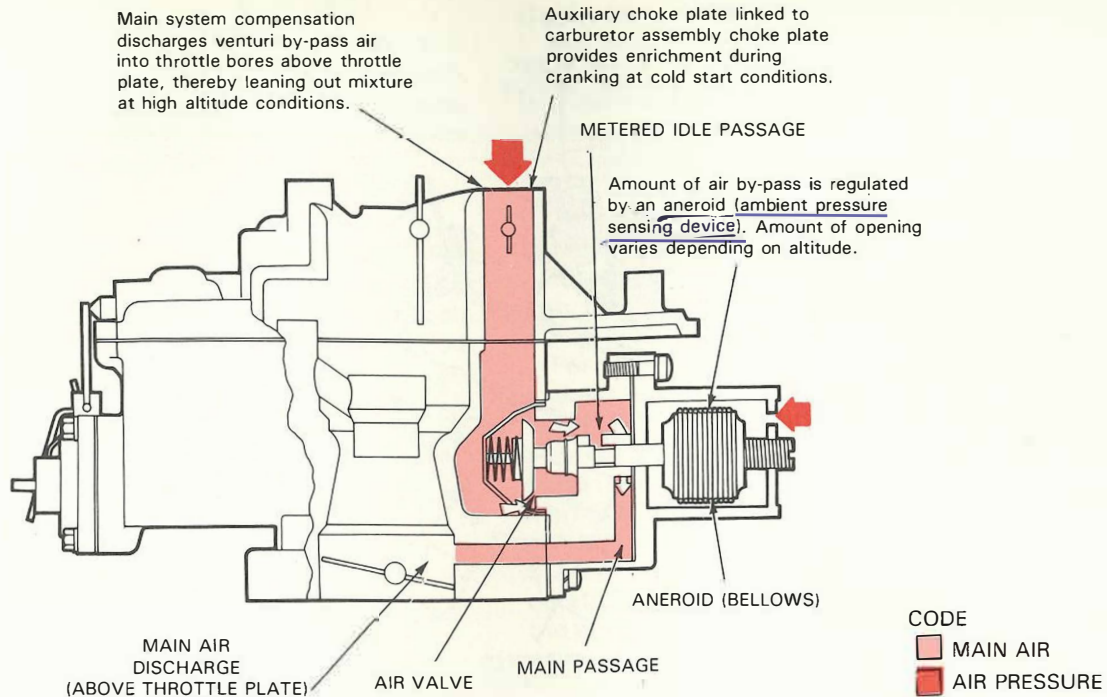


Fig. 12-39. Cutaway shows aneroid device which expands and contracts like an accordion as it responds to atmospheric pressure. This action moves a rod which opens and closes air valve. It controls amount of air entering air horn just above throttle plate.

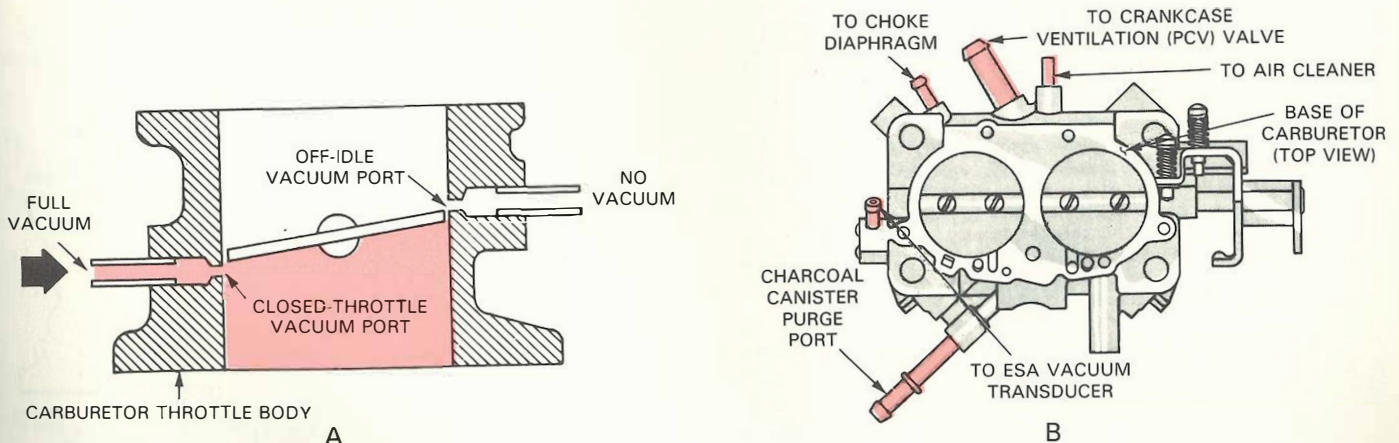


Fig. 12-40. Typical carburetor has several vacuum connections. A—Ports located below throttle valve have full vacuum at all times. Those located above throttle plate have vacuum only when throttle is open. B—Carburetor provides vacuum for many different accessories. (Ethyl Corp. and Chrysler Corp.)

the temperature of the engine coolant. This allows the computer to enrich the fuel mixture during cold engine operation and lean the mixture as the engine warms.

A *pressure sensor* measures intake manifold vacuum and engine load. High engine load or power output causes intake manifold vacuum to drop. The pressure sensor, in this way, can signal the computer with a change in resistance and current flow.

When the manifold pressure drops, the computer increases the air-fuel mixture for added power. If intake

manifold vacuum increases, the computer makes the carburetor setting leaner for improved economy.

A *throttle position sensor* is used on some carburetors to monitor the movement of the throttle plates. One is shown in Fig. 12-43.

As the throttle opens for acceleration, for example, the sensor changes resistance. Change in current flow signals the computer. The computer can then richen the mixture for more power. When the throttle is closed, the position sensor lets the computer know that a leaner mix-

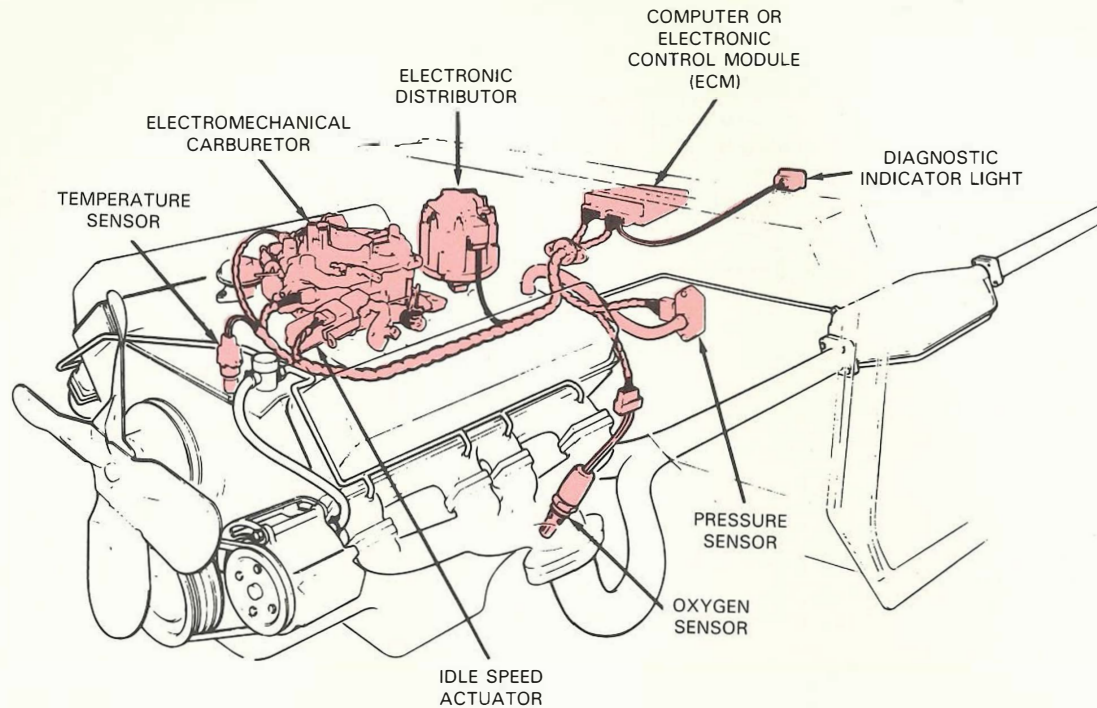


Fig. 12-41. Typical setup for computer controlled carburetor. Sensors feed information to computer (ECM). (General Motors Corp.)

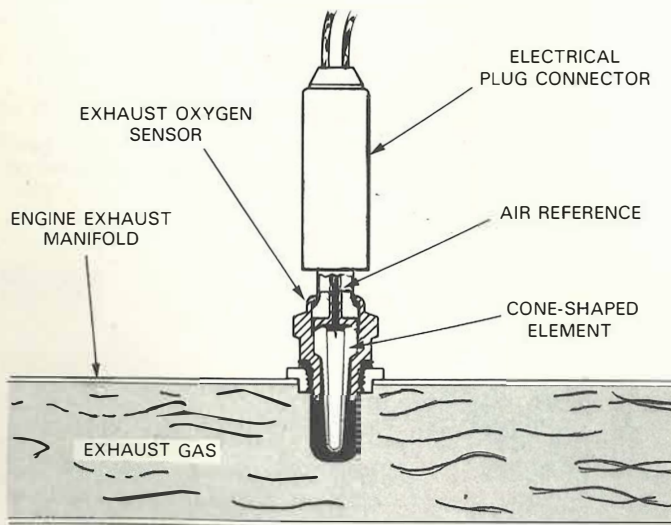


Fig. 12-42. Oxygen sensor detects amount of oxygen in exhaust by comparing sample to outside air. High oxygen means lean mixture—low oxygen, rich mixture. Computer corrects air-fuel mixture as needed. (AC)

ture is needed.

A WOT (*wide open throttle*) cutoff switch is designed to signal the computer when the carburetor throttle plates are swung open for rapid acceleration. The computer may then shut off the air conditioning compressor and other power-robbing accessories to help the car increase its speed more quickly.

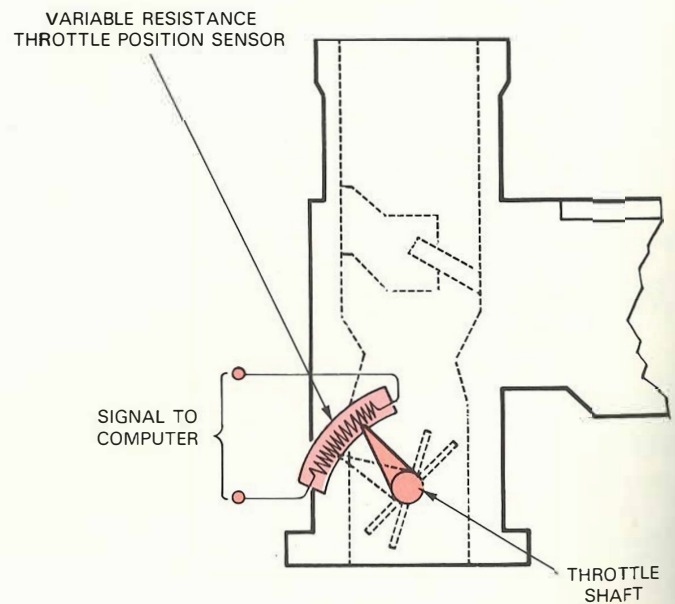


Fig. 12-43. Throttle position sensor is actually a potentiometer. Throttle shaft movement will change current flow in circuit to computer. Changes tell computer whether throttle plate is open or closed or somewhere in between. (Ford)

Note! Other sensors can also be used in a computer controlled carburetor system. These sensors are explained in Chapter 15, Gasoline Injection System Operation.

Electromechanical carburetor

An *electromechanical carburetor* is controlled by both electrical and mechanical devices. This type is used with a computer control system. It has electrical components (sensors and actuators) for interfacing with the computer and conventional mechanical parts as well.

Mixture control solenoid

A *mixture control solenoid* in the computer controlled carburetor responds to electrical signals (or dwell signals) from the computer to alter the air-fuel ratio. The signals trigger the solenoid to open and close air and fuel passages in the carburetor. See Fig. 12-44.

Fig. 12-45 shows two other types of mixture control solenoids. Fig. 12-46 illustrates mixture control solenoid action.

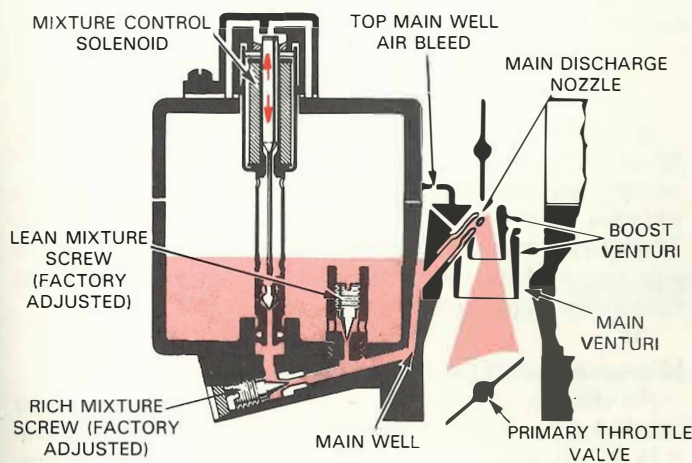


Fig. 12-44. Computer can activate mixture control solenoid in electromechanical carburetor to quickly open or close valve that changes carburetor's air-fuel ratio. Electric pulses from computer move plunger in solenoid. It operates mixture valve. Study how solenoid can regulate fuel flow. (Pontiac)

Carburetor control computer

The system computer, usually called the *electronic control unit*, is a small solid-state electronic device. One is shown in Fig. 12-47. This device has both logic circuits (artificial intelligence) and control circuits (power transistors) that are contained in one or more integrated circuit chips.

The electronic control unit (ECU) is capable of receiving information sent to it by sensors located in various places on the automobile. It can process this information and then electronically control the carburetor's mixture control solenoid.

For example, the ECU will receive reports from the oxygen sensor in the exhaust system about the amount of oxygen in the exhaust gas. The ECU, which can do very complicated math in a fraction of a second, compares this signal with the information stored in its memory. If the oxygen makeup of the exhaust gas is not correct, the memory sends a signal to other parts of the ECU. A control signal will then be sent out to the carburetor's mixture solenoid which is energized to adjust the air-fuel mixture for the correct oxygen content in the exhaust gas.

Computer controlled carburetor operation

In a computer controlled carburetor, the air-fuel ratio is maintained by CYCLING the mixture solenoid ON and OFF several times a second. Fig. 12-48 shows how the control signals from the computer can be used to meter different amounts of fuel out of the carburetor.

When the computer sends a rich command to the solenoid, the signal voltage to the mixture solenoid is usually OFF more than it is ON. This causes the solenoid to stay open more. Typically, the idle air bleed valve and main metering rod move up to increase fuel flow.

During a lean signal from the computer, the signal usually has more ON time. This causes less fuel to pass through the solenoid valve. The mixture becomes leaner. The idle air bleed valve and main metering rod move down to restrict fuel flow.

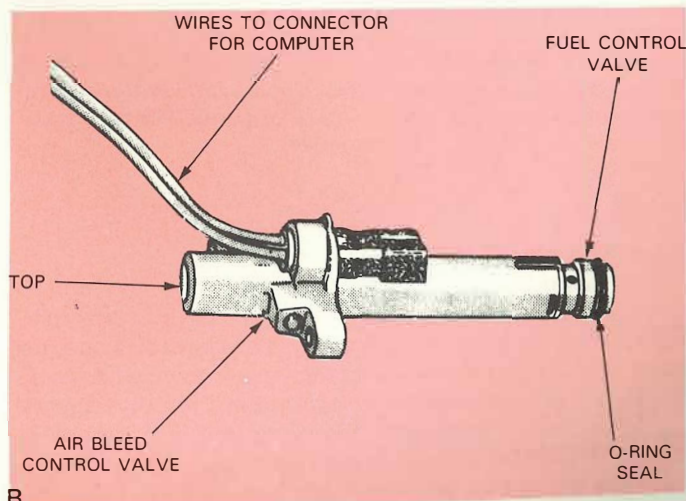
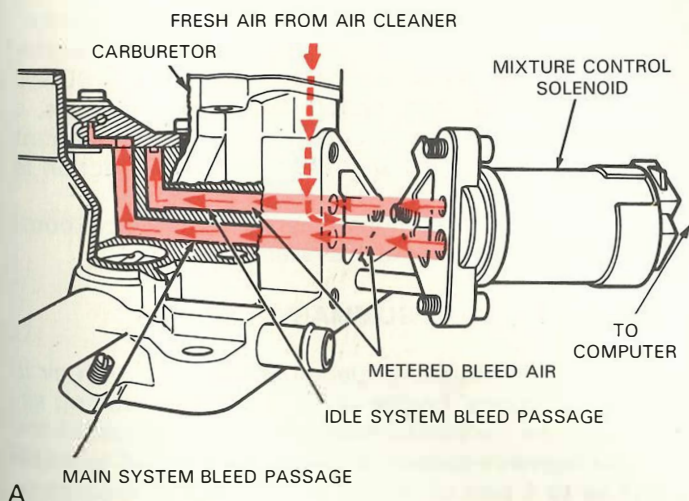


Fig. 12-45. Mixture control solenoids. A—This one opens and closes air passages to control mixture ratio. B—This one controls both air and fuel flow. (Ford and Chrysler)

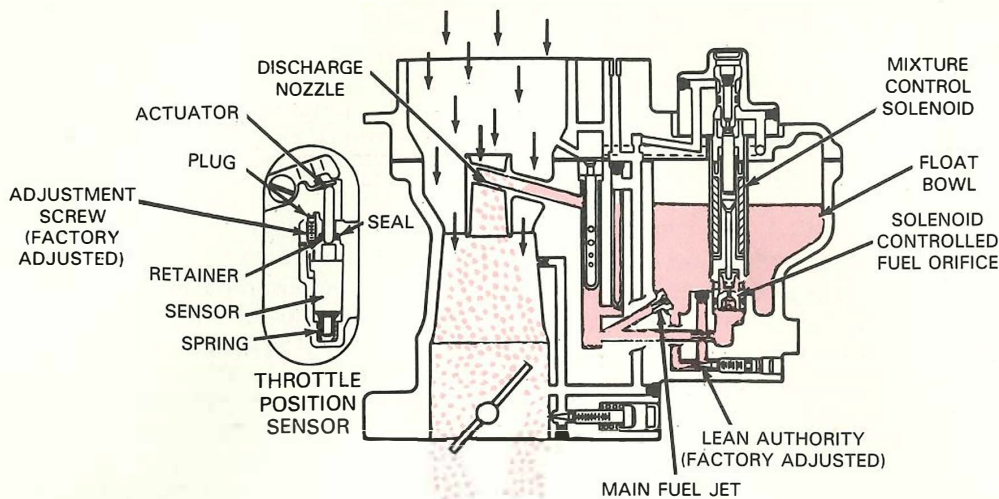


Fig. 12-46. Cutaway shows mixture control solenoid. Its up and down motion controls amount of fuel entering main discharge nozzle. (Pontiac)

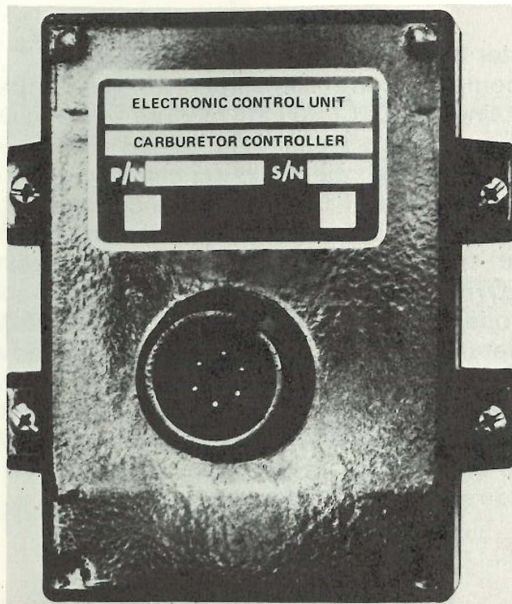


Fig. 12-47. Electronic control unit has both logic circuits (artificial intelligence) and control circuits (power transistors) that are contained in one or more integrated-circuit chips. (Oldsmobile)

Open and closed loop operation

The term, open loop, means that the system is operating on preset values in the computer. For example, right after cold engine starting, the computer will operate open loop. The sensors, especially the oxygen sensor, CANNOT provide accurate information when cold.

Closed loop means that the computer is using information from the oxygen sensor and other sensors. The information forms an imaginary loop (circle) from the computer, through the engine fuel system, into the exhaust, and back to the computer through the oxygen sensor. Look at Fig. 12-49.

A computer controlled carburetor system normally operates in the closed loop mode after engine and oxygen sensor warm up. Using data from the engine sensors, a very precise air-fuel ratio can be maintained. The system monitors its own efficiency and the mixture can be changed with the slightest change in engine operating conditions.

Idle speed actuator (control motor)

An *idle speed actuator* or *control motor* may also be used to allow the computer to change engine idle speed. It is usually a tiny electric motor and gear mechanism. Responding to computer control current, it holds the carburetor throttle lever in the best position for idling. Fig. 12-50 illustrates an idle speed control motor mounted on a carburetor's linkage.

More information

Note! Computerized carburetor systems vary. For exact details, refer to a factory service manual. The manual will explain how the specific system functions.

As you will learn in later chapters, a computer controlled carburetor system is very similar to **ELECTRONIC FUEL INJECTION**. Both systems use engine sensors, a computer, and a solenoid action to control the amount of fuel entering the engine. Electronic fuel injection is covered in Chapters 15, 16, and 17.

Fig. 12-51 gives a wiring diagram for a typical computer controlled carburetor system.

SUMMARY

For good combustion, fuel must be mixed with air in exact proportions. Engine vacuum and the resulting air-stream in the carburetor help atomize and vaporize the fuel. At highway speeds, an air-fuel ratio of 15 to 1 (15 parts air to 1 part of fuel) would be ideal. A mixture of 20:1 is a lean mixture and 8:1 rich. Either a too-rich or too-lean mixture results in poor engine performance.

A carburetor is a hydraulic, mechanical, vacuum

Fundamentals of Carburetion

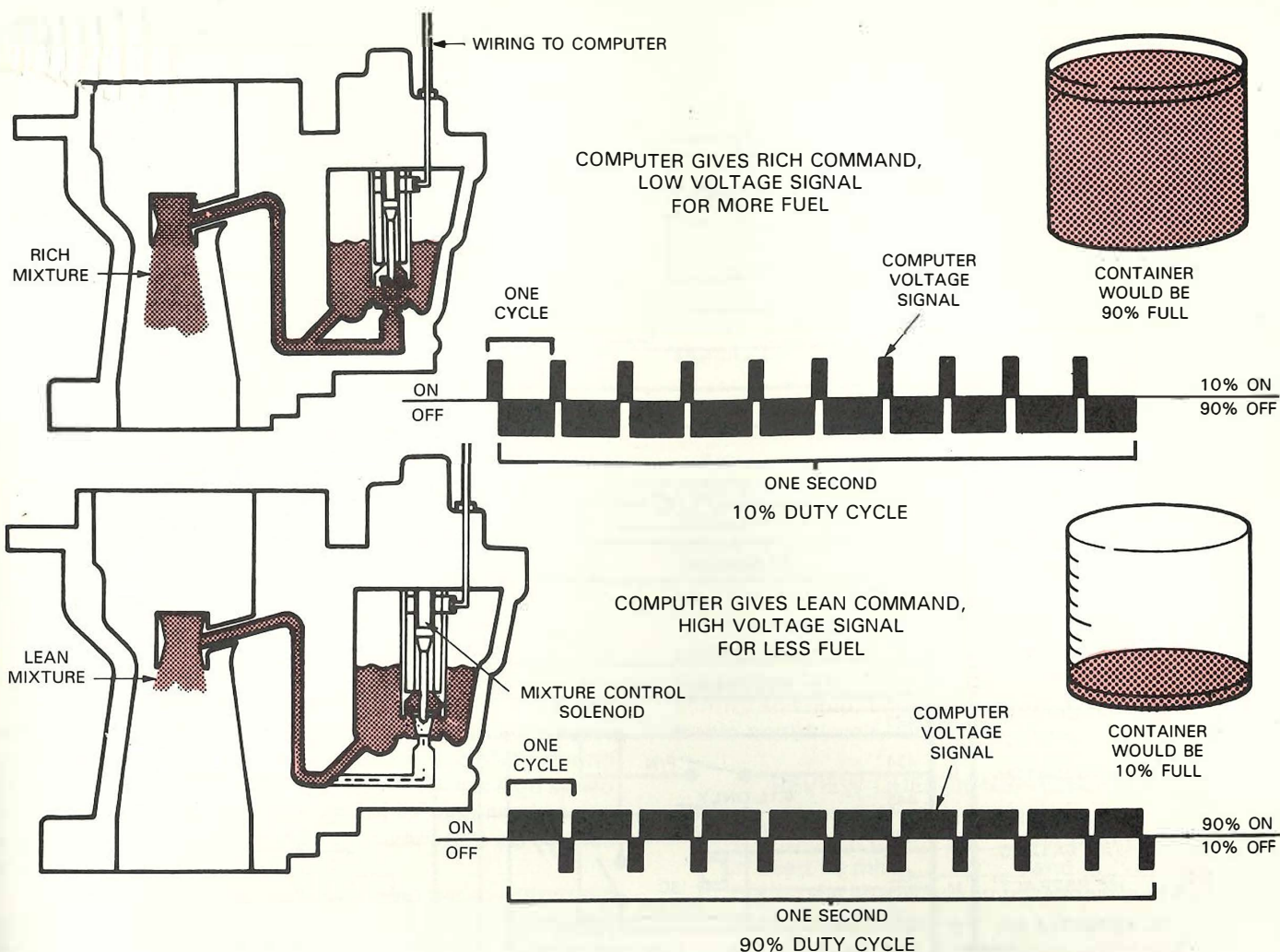


Fig. 12-48. Computer rapidly pulses mixture control solenoid OFF and ON to control air-fuel ratio. Note that, with this carburetor, longer OFF time enriches mixture. Shorter OFF time makes mixture leaner. (Chrysler Corp.)

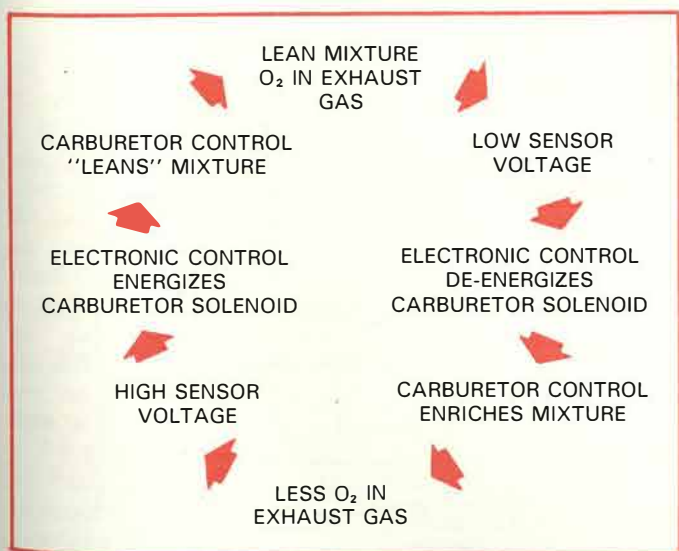


Fig. 12-49. Closed loop operation. Computer is continually receiving information from sensors and sending "commands" to solenoid as operating conditions change. (Buick)

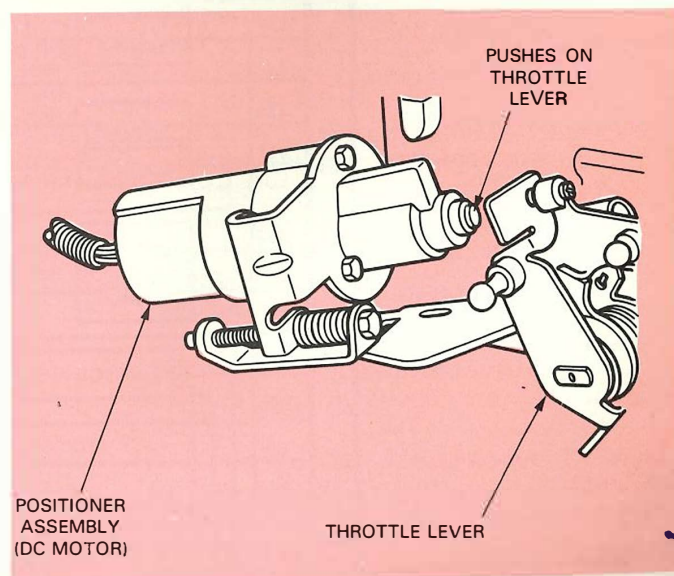
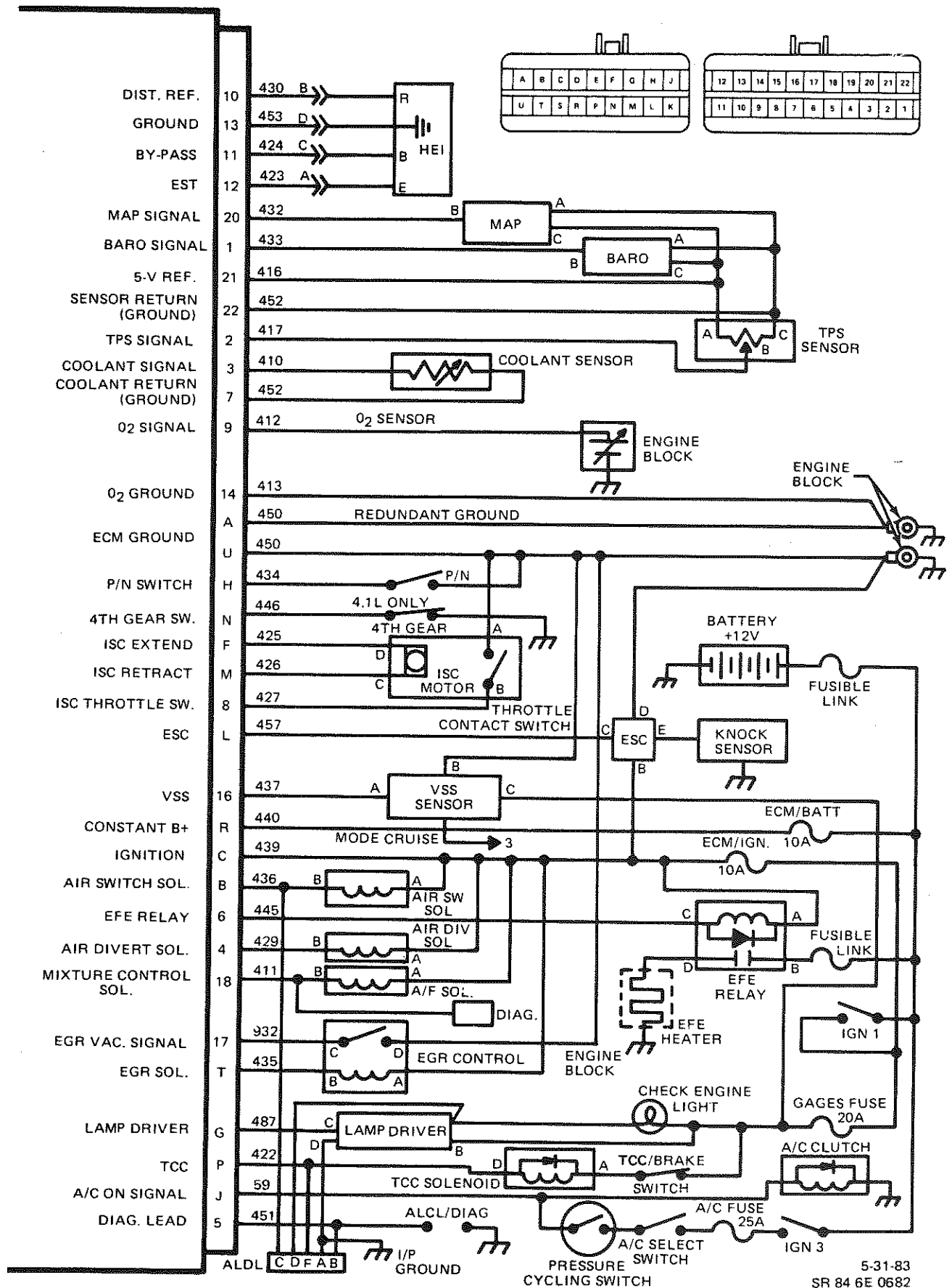


Fig. 12-50. DC motor, controlled by computer, can adjust idle speed of engine precisely. It moves throttle lever. (Ford)



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Fig. 12-51. This is a typical wiring diagram for a computer controlled carburetor system. Study components and electrical connections going to computer. (General Motors)

device for metering and mixing fuel and air in exact amounts. It has five basic functions: atomize fuel into tiny droplets, meter fuel, regulate airflow into engine, and control external vacuum powered components.

An air horn or throat is the metal passage through the carburetor body. The fuel bowl stores extra gasoline. To keep fuel in the bowl at a constant level, a float mechanism is used. The main discharge tube routes fuel from the bowl to the air horn.

Venturi action is used to increase air horn vacuum at low engine speeds. Air bleeds mix air bubbles with fuel to speed atomization. Jets control the amount of fuel or air flowing in a carburetor circuit. To control airflow in the carburetor, a throttle valve is positioned at the bottom of the throat. At the top of the air horn, a choke butterfly is utilized to richen the mixture for cold engine starting.

A carburetor system (or circuit) is a network of fuel passages, air passages, and related parts which supply the correct fuel mixture during a specific engine demand. There are seven basic carburetor systems: float, idle, off-idle, acceleration, high speed, full power, and choke.

An idle mixture screw can be adjusted to control the fuel mixture at idle. A bypass (air bleed) is located in the idle circuit to improve atomization. The accelerator pump squirts a stream of gasoline into the air horn whenever the throttle plate is opened. It prevents stalling during initial acceleration. A metering rod allows the high speed system to increase mixture richness for increased engine power output. A power or economizer valve also varies the high speed mixture ratio.

Chokes can be either manual or automatic. Automatic chokes can be integral hot air, separate hot air, combination hot air-electric, hot water or all electric. A fast idle cam is usually linked to the choke plate. During cold engine choke operation, the fast idle mechanism increases engine idle rpm to prevent stalling. A choke break or mechanical unloader assures choke opening upon engine starting. This prevents engine flooding and stalling.

A throttle return dashpot keeps an automatic-transmission-equipped car from stalling upon rapid deceleration. A hot idle compensator leans the idle fuel mixture during periods of excessive heat and fuel evaporation.

A vacuum choke break or air valve dashpot pulls the choke valve off full choke as soon as the cold engine starts. On engines with automatic transmissions, a throttle return dashpot brings the engine to idle speed slowly so that the drag of the transmission does not cause stalling.

Engines with today's higher idle speeds are very prone to "dieseling" (running on after ignition is turned off). An anti-dieseling solenoid increases idle speed when the engine is running but drops it to curb idle when the ignition is turned off.

An altitude compensator automatically changes the air-fuel mixture with changes in altitude. Normally an aneroid device is used. It expands and contracts with changes in atmospheric pressure.

Various vacuum ports located on the carburetor are intended to operate various devices: EGR valve, distributor vacuum advance, charcoal canister vapor storage, and choke break.

On computer controlled carburetors, various actuators respond to commands from the on-board computer to change settings that lean or richen the air-fuel mixture.

Sensors, located at various points, feed information to the computer. They measure oxygen content of the exhaust gas, temperature of the engine, manifold vacuum, engine load, and throttle position.

The on-board computer or electronic control unit (ECU) is a solid-state device which has both logic circuits and control circuits in one or more integrated-circuit chips. It can receive information, process it, and send out signals that control the operation of the fuel system.

KNOW THESE TERMS

Atmospheric pressure, Vacuum, Air horn, Throttle valve, Venturi, Main discharge tube, Carburetor system, Float, Needle Valve, Bowl vent, Idle mixture screw, Accelerator pump, Main jet, Metering rod, Power valve, Thermostatic spring, Mechanical choke unloader, Vacuum choke break, Fast idle cam, Fast idle solenoid, Throttle return dashpot, Hot idle compensator, Altitude compensator, Primary, Secondary, CFM, Variable venturi carburetor, Computer controlled carburetor, Mixture control solenoid, Engine sensors, Oxygen sensor, Electronic control unit, Open loop, Closed loop.

REVIEW QUESTIONS—CHAPTER 12

1. The force of the _____ entering the carburetor is used to mix _____ and _____.
2. During the process of atomization, liquid fuel (select best answer):
 - a. Is turned into a vapor.
 - b. Turns into tiny droplets.
 - c. Becomes a gaseous mixture.
3. What six factors affect fuel vaporization?
4. A _____ fuel mixture contains a high ratio of air compared to fuel.
5. List and describe the function of each of the 11 essential parts of a basic carburetor.
6. A modern automobile would NOT run well on the basic carburetor described in the first section of this chapter. True or false?

MATCHING TEST: On a separate sheet of paper, match the terms with the appropriate statements.

- | | |
|---|-------------------------|
| 7. _____ Provides small amount of fuel for low-speed engine operation. | a. Off-idle system. |
| 8. _____ Supplies lean air-fuel mixture at cruising speed. | b. Full power system. |
| 9. _____ Supplies correct air-fuel mixture slightly above idle speed. | c. Idle system. |
| 10. _____ Supplies slightly richer air-fuel mixture when engine power demands are high. | d. Choke system. |
| 11. _____ Gives an extremely rich air-fuel mixture for cold engine starts. | e. Acceleration system. |
| 12. _____ Squirts fuel into air horn | f. High speed system. |
| | g. Float circuit. |