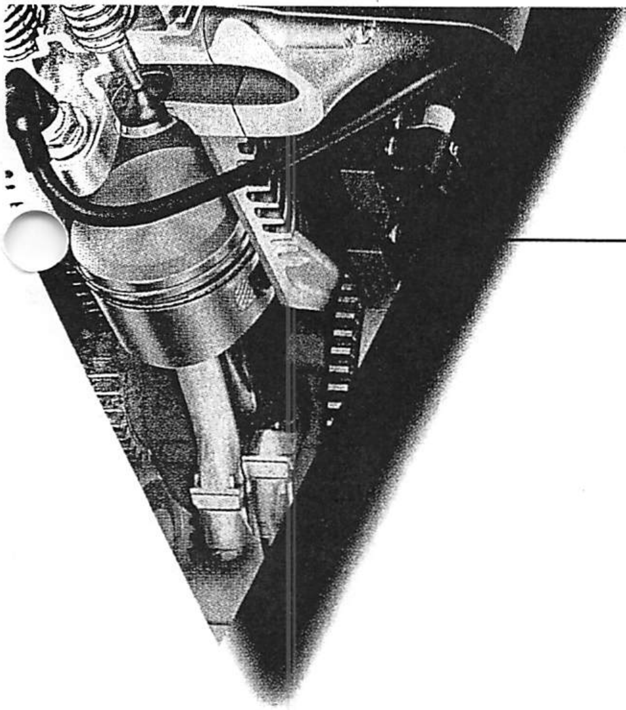

CHAPTER 8

# Carburetion

After studying this chapter, you will be able to:
- ▼ List and explain the principles of carburetion.
- ▼ Identify the three basic types of carburetors.
- ▼ Explain float-type carburetor operation.
- ▼ Explain the operation of the diaphragm-type carburetors.
- ▼ Define manual throttle controls.
- ▼ List the basic functions of a governor.
- ▼ Adjust and maintain common governors.
- ▼ Describe the purpose of an air cleaner.

## Principles of Carburetion

A carburetor's primary purpose is to produce a mixture of fuel and air to operate the engine. This function, in itself, is not difficult. It can be done with a simple mixing valve.

The mixing valve, however, is limited in efficiency. It cannot, for example, provide economical fuel consumption and smooth engine operation over a wide range of speeds. Meeting these performance goals requires a much more complex mechanism. This is the main reason why there are so many styles and designs of carburetors.

Gasoline engines cannot run on *liquid* gasoline. The carburetor must vaporize the fuel and mix it with air in the proper proportion for varying conditions:
- Cold or hot starting.
- Idling.
- Part throttle.
- Acceleration.
- High speed operation.

Basically, air enters the top of the carburetor and is mixed with liquid fuel, which is fed through carburetor passages and sprayed into the airstream. The ***air-fuel mixture*** that results is forced into the intake manifold by atmospheric pressure and burned in the combustion chamber of the engine.

**Figure 8-1** shows how a typical carburetor operates. In this particular small gasoline engine

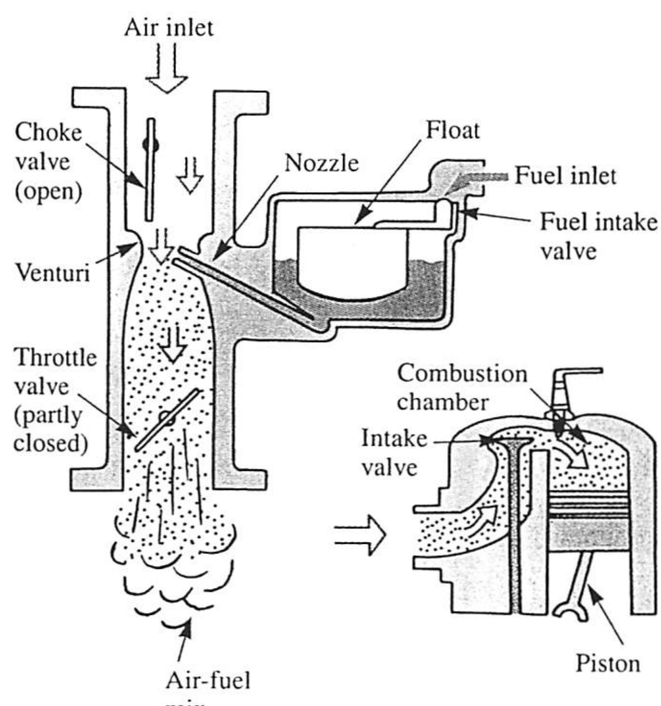


**Figure 8-1.** *Air entering carburetor mixes with fuel in proper proportion, and mixture flows into combustion chamber. (Deere & Co.)*

application, the engine is at part throttle operation. Note that the choke valve is open, while the throttle valve is partly closed.

## *Air-fuel mixture*

The amount of air needed for combustion is far greater than the amount of fuel required. The usual weight ratio is 15 parts of air to 1 part of fuel. One pound of air would take up a much greater space than one pound of fuel. Therefore, by volume, one cubic foot of gasoline would have to be mixed with 9000 cu ft of air to establish a 15 to 1 weight ratio.

Small gasoline engines use varying air-fuel ratios, depending on engine speed and load. The chart in **Figure 8-2** shows how the mixture changes for various operating conditions.

## *Carburetor pressure differences*

A ***carburetor*** is a device that is operated by pressure differences. When discussing pressure differences, several terms are commonly used. They are vacuum, atmospheric pressure, and venturi principle.

### Vacuum

An ***absolute vacuum*** is any area completely free of air or atmospheric pressure. This condition is difficult to obtain and is never reached in a small gasoline engine. Therefore, any pressure less than atmospheric pressure generally is referred to as a ***vacuum.***

### Atmospheric pressure

The pressure produced by the weight of air molecules above the earth is called ***atmospheric pressure.*** The amount of atmospheric pressure varies with altitude. A person standing on a beach at sea level, for example, would be under a higher vertical column of air than a person standing on a mountaintop. Therefore, the total weight of air molecules would be greater at sea level. See **Figure 8-3.**

Furthermore, any time air molecules are removed from a particular space, a vacuum is created. If conditions permit, this space immediately fills with air under atmospheric pressure.

The effect of atmospheric pressure can be related to small gasoline engines. The downward movement of the piston creates a partial vacuum in the cylinder. As soon as the intake valve opens or the intake port is uncovered, atmospheric pressure forces air through the carburetor and manifold to fill that vacuum.

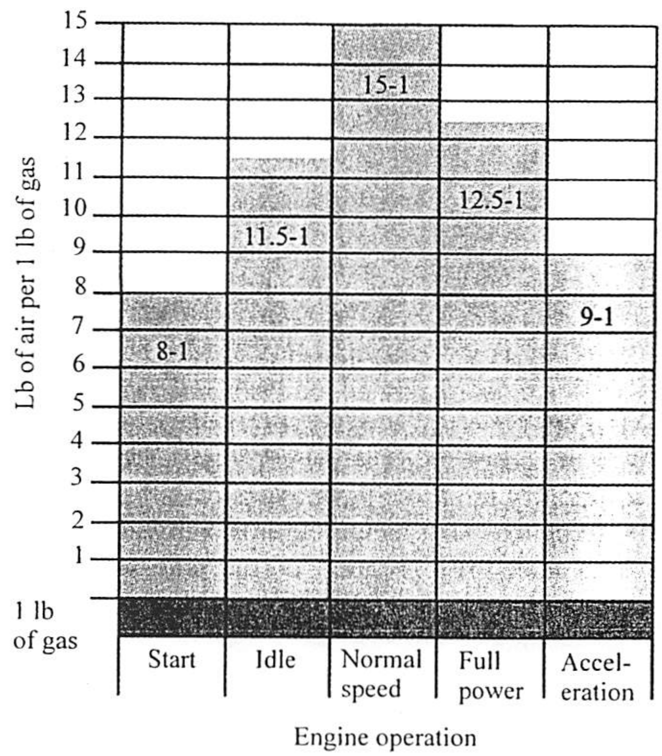


**Figure 8-2.** *Air-fuel mixture requirements vary depending upon operating conditions. Chart shows approximate air-fuel ratios for various operating conditions.*

| Mean Atmospheric Pressure at 68° F (20°C) | |
|---|---|
| ***Altitude (ft)*** | ***Atmospheric Pressure (inches Hg.)*** |
| 9000 | 20.92 |
| 8000 | 21.92 |
| 7000 | 22.92 |
| 6000 | 23.92 |
| 5000 | 24.92 |
| 4000 | 25.92 |
| 3000 | 26.92 |
| 2000 | 27.92 |
| 1000 | 28.92 |
| Sea level | 29.92 |

**Figure 8-3.** *Weight of air exerted on a given object is determined by height and density of a column of air above object. Air is less dense at higher altitudes. For every 1000′ above sea level, mercury column pressure is reduced by 1.0″.*

## Venturi principle

The carburetor creates a partial vacuum of its own by means of a venturi for the purpose of drawing fuel into the airstream. A ***venturi*** is a restriction in a passage, which causes air to move faster (increase velocity). The gauge shown at the top in **Figure 8-4** indicates no change in velocity. Therefore there is no change in pressure. The area in which the air is moving faster (middle gauge) develops a lower pressure.

**Figure 8-5** shows a simple carburetor with fuel being drawn from the float bowl through the main discharge nozzle. This nozzle is located so that its outer end is in the low pressure area of the venturi section. Fuel coming from the discharge nozzle is still in relatively large liquid droplets that do not burn well. To further atomize the fuel, an air bleed passage is built into the air horn. See **Figure 8-6.** A small portion of the air rushing through the carburetor is forced through the air bleed passage to the main discharge tube. This air mixes with the stream of fuel, breaking it into small particles before it reaches the venturi. The small particles of fuel are broken into even finer particles by the air rushing through the venturi.

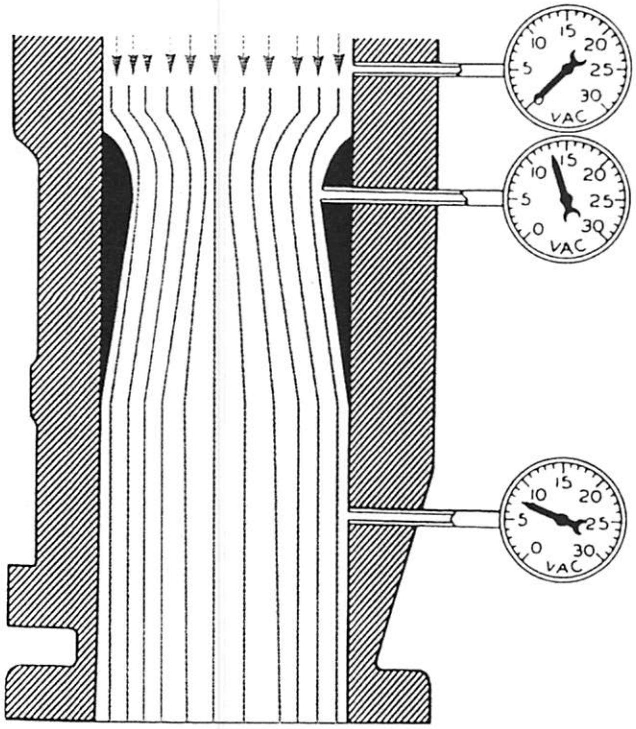

**Figure 8-4.** *The venturi principle. A restriction in a passage will cause incoming air to increase its velocity, while pressure will be reduced. Reduction in pressure draws fuel into airstream.*

When the fuel moves into the intake manifold (which is under partial vacuum), the boiling point of the gasoline is lowered. This causes many of the atomized particles to *boil* or *flash* into a vapor. See **Figure 8-7A.** As the partially vaporized fuel moves through the manifold, it is warmed by the heat of the manifold walls. This causes further vaporization. See **Figure 8-7B.** When the mixture enters the combustion chamber, the swirling motion and the sudden increase in temperature due to the compression stroke complete the vaporization of the fuel.

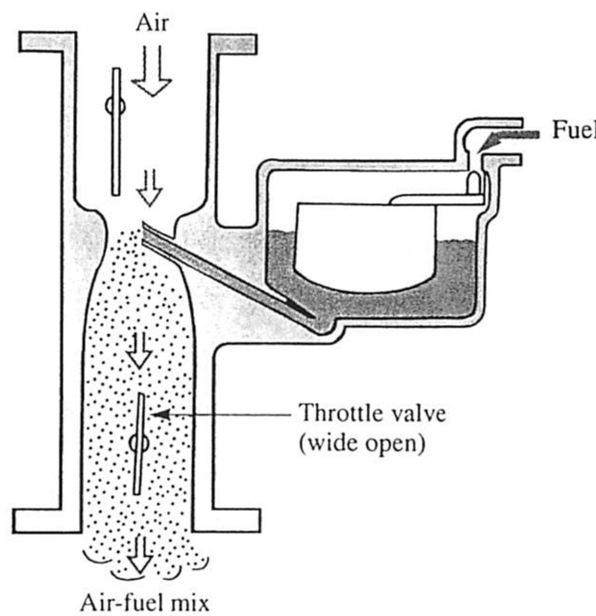


**Figure 8-5.** *Air flowing through venturi has reduced pressure around nozzle. Fuel is drawn up nozzle by vacuum and mixes in airstream. (Deere & Co.)*

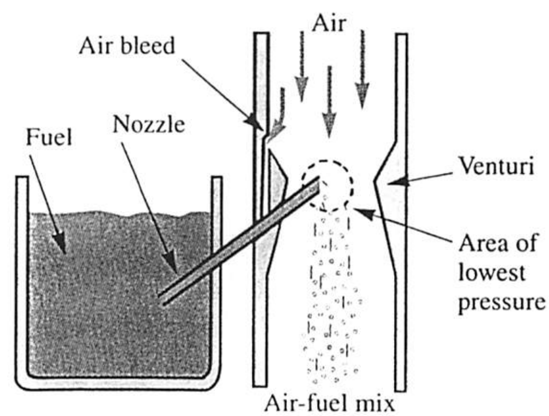


**Figure 8-6.** *To atomize fuel into finer particles, an air bleed is used. Higher pressure of air horn forces some air to enter at a port midway in nozzle, so fuel is partly atomized before leaving nozzle.*

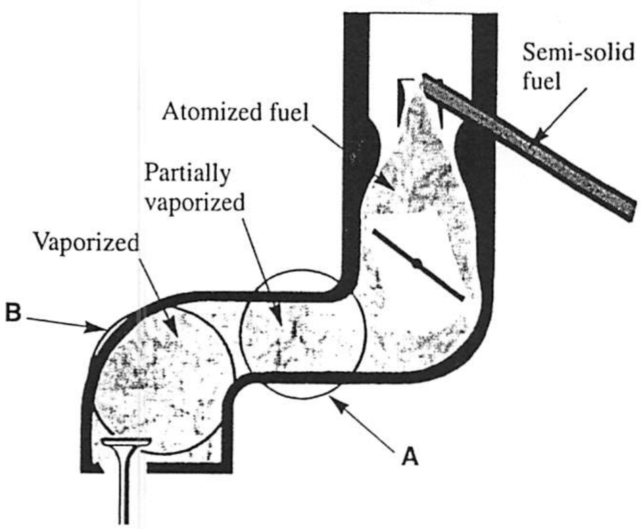

Figure 8-7. *In addition to air bleed and venturi, fuel is further vaporized. A—By vacuum in manifold. B—Engine heat.*

## Types of Carburetors

The three basic types of carburetors are named according to the direction that air flows from their outlets to the engine manifold. These types are the natural draft or side draft, the updraft, and the downdraft.

The ***natural draft carburetor*** is used when there is little space on top of the engine. The air flows horizontally into the manifold. See **Figure 8-8.**

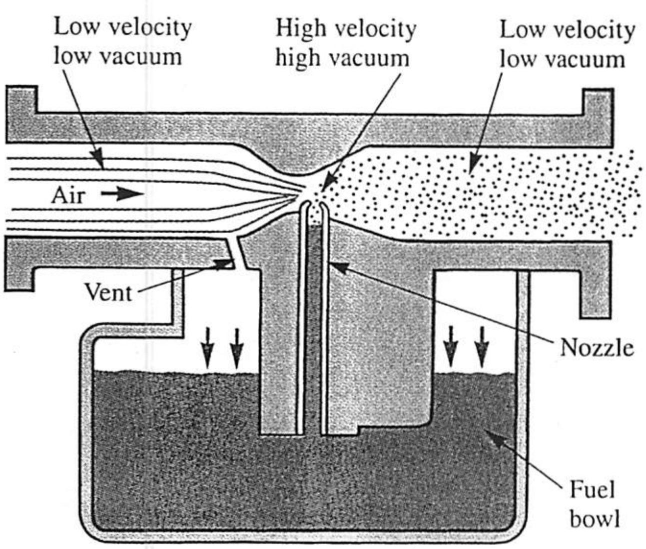

Figure 8-8. *Natural draft carburetor has horizontal air flow through it. (Deere & Co.)*

***Updraft carburetors*** are placed low on the engine and use a gravity-fed fuel supply. See **Figure 8-9.** However, the air-fuel mixture must be forced upward into the engine. The air velocity must be high, so small passages must be used in the carburetor and manifold.

***Downdraft carburetors*** operate with lower air velocities and larger passages. See **Figure 8-10.** This is because gravity assists the air-fuel mixture flow to the cylinder. The downdraft carburetor can provide large volumes of fuel when needed for high speed and high power output.

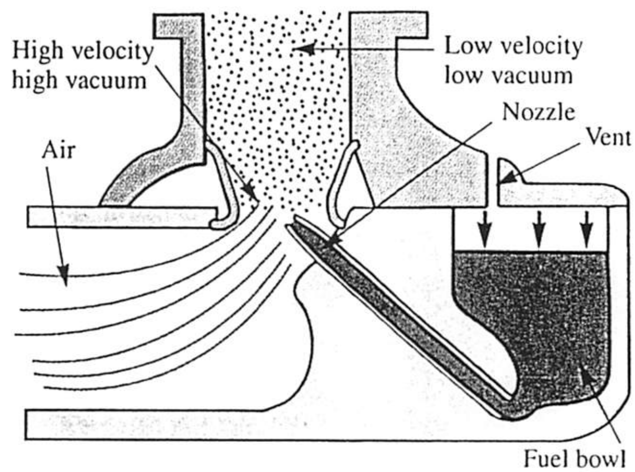

Figure 8-9. *Air flowing through updraft carburetor moves vertically upward into venturi. Passages must be comparatively smaller than those in the downdraft carburetor to increase air velocity so it will carry fuel upward.*

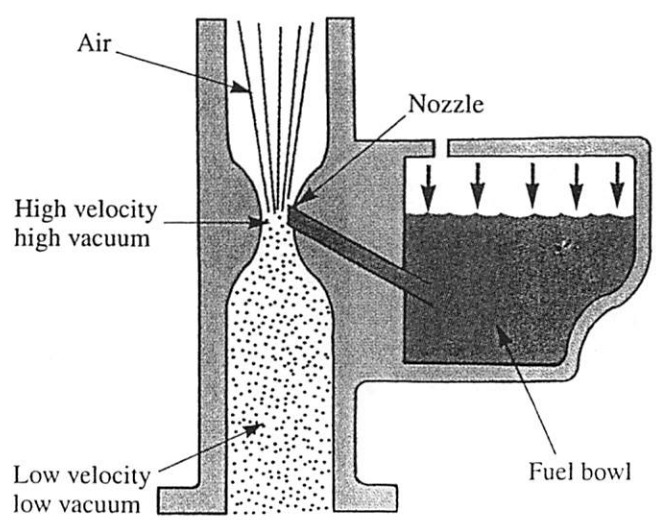

Figure 8-10. *Downdraft carburetor has downward flow of air through venturi. Since it can operate with lower velocities, it has larger passages.*

## *Float-type carburetors*

The carburetor ***float*** is a small sealed vessel made of brass or plastic. Some floats are made of solid flotation materials that eliminate the possibility of leakage. See **Figure 8-11.**

The purpose of the carburetor float is to maintain a constant level of fuel in the float bowl. The float rises and falls with the fuel level. As fuel is used from the float bowl, the float lowers and unseats a needle valve, which lets fuel enter the bowl. This, in turn, raises the float, seating the needle and shutting off fuel supply to the bowl.

The closed position of the needle valve is illustrated in **Figure 8-12.** The needle valve illustrated in **Figure 8-13** shows valve action in greater detail. The neoprene needle point is soft and seats well in the valve. Also, it is not as likely to wear out as a brass needle point.

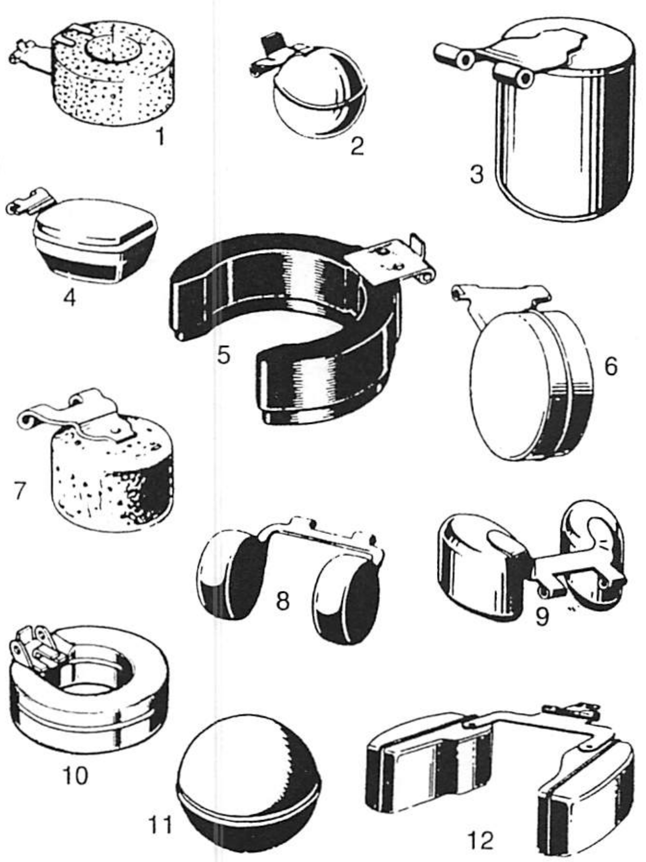


**Figure 8-11.** *Various float designs. 1—Doughnut-shaped cork. 2—Ball-shaped metal. 3—Cylindrical metal. 4—Rectangular metal. 5—Horseshoe-shaped plastic. 6—Cylindrical metal. 7—Round cork. 8 and 9—Twin-type metal. 10—Doughnut-shaped metal. 11—Ball-shaped metal. 12—Twin-type plastic.*

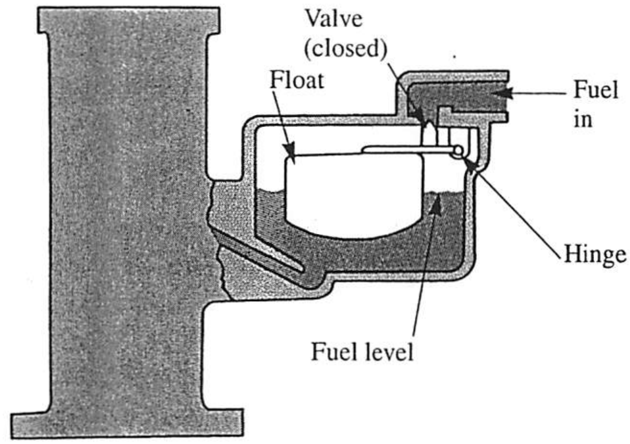


**Figure 8-12.** *Float in float bowl maintains a constant fuel level. When fuel level rises, float closes needle valve, stopping incoming fuel. When fuel level lowers, float unseats needle and lets more fuel in. (Deere & Co.)*

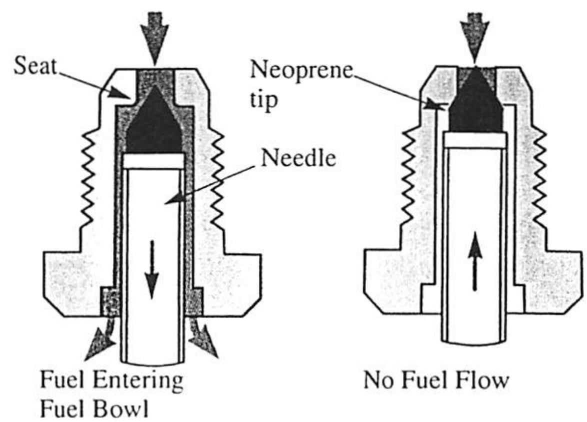


**Figure 8-13.** *Needle in float bowl opens and closes fuel passage into chamber. Needle is operated by hinged arm of float. (Evinrude Motors)*

### Float bowl ventilation

Most carburetors are sealed and balanced to maintain equal air pressure. The air pressure above the fuel in the bowl and the air pressure entering the carburetor are equalized by a vent in the float bowl. See **Figure 8-9.** This vent assures a continuous, free flow of fuel.

### Choke system

The carburetor ***choke*** is a round disc mounted on a shaft located at the intake end of the carburetor. See **Figure 8-14.** When closed, the choke provides a rich air-fuel mixture, which is necessary when starting a cold engine. It allows less air to enter the carburetor. The manifold vacuum draws harder on the fuel nozzle. Therefore, more fuel and less air enters the combustion chamber.

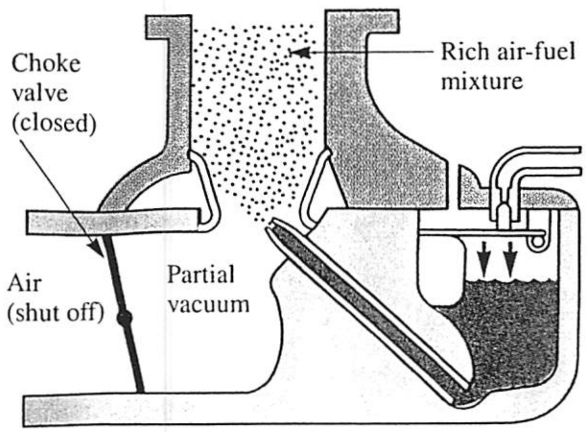


**Figure 8-14.** *Choke valve is closed and vacuum is high in carburetor. Fuel mixture entering intake manifold is extremely rich.*

## Throttle system

Like the choke, the ***throttle*** is a round disc mounted on a shaft. This valve, however, is located beyond the main fuel nozzle. See **Figure 8-15.**

The main purpose of the throttle valve is to regulate the amount of air-fuel mixture entering the cylinders. It also permits the operator to vary engine speed to suit conditions or to maintain a uniform speed when the load varies.

On many engines, a linkage connects the throttle valve to a governor. The governor, in turn, is connected to a speed control lever. When the speed control lever is set for a given speed, the governor will maintain that speed until the engine reaches its limit of power.

When the load on the engine increases, the governor automatically opens the throttle valve. This permits more air-fuel mixture to enter the engine,

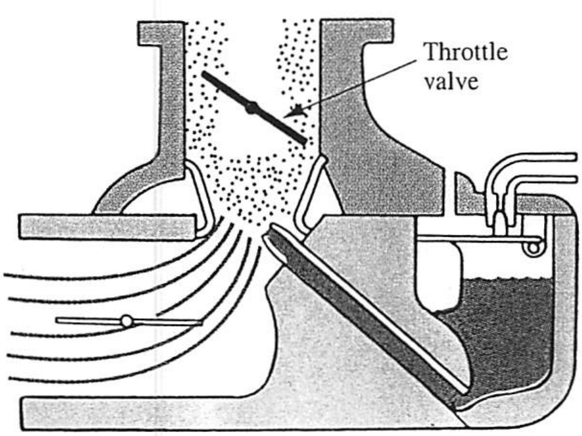


**Figure 8-15.** *Throttle valve is located beyond main fuel nozzle. Throttle regulates amount of air-fuel mixture entering engine.*

providing increased power to maintain a uniform speed. When the load decreases, the governor closes the throttle to reduce engine power. More details on governors is presented later in this chapter.

## Load adjustment

The amount of fuel entering the main discharge nozzle is sometimes regulated by a ***load adjusting*** needle. See **Figure 8-16.** Many carburetors have a fixed jet or orifice, which is preset to allow proper fuel flow for maximum power and economy. Carburetors equipped with a fixed jet are nonadjustable.

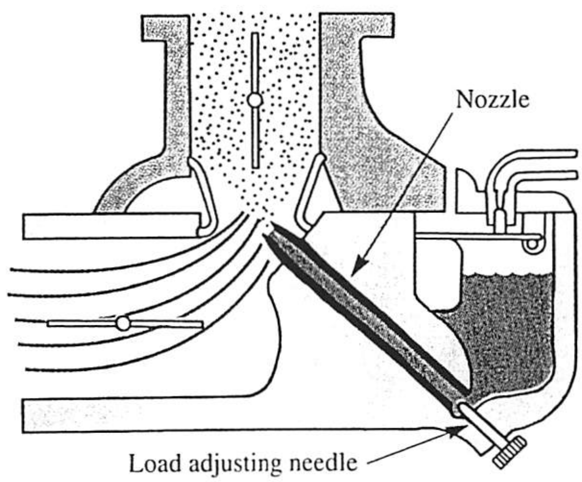


**Figure 8-16.** *A load adjusting needle, located as shown, regulates amount of fuel entering main nozzle.*

## Acceleration system

When the throttle valve is opened quickly for acceleration, a large amount of air is allowed to enter. Unless some method is used to provide additional fuel to maintain a satisfactory air-fuel ratio, the engine will slow down and possibly stop. On larger engines and multi-cylinder engines, a mechanical plunger-type pump is connected to the throttle linkage. When the throttle valve is opened on acceleration, the pump automatically depresses and forces fuel into the carburetor.

## Acceleration well

An ***acceleration well*** is a reservoir of fuel. During idling (when load nozzle is inactive), fuel rises inside the nozzle. The fuel flows through holes in the side of the nozzle and into the acceleration well. See **Figure 8-17.**

When the throttle valve is opened quickly, the stored fuel rushes through the holes in the nozzle

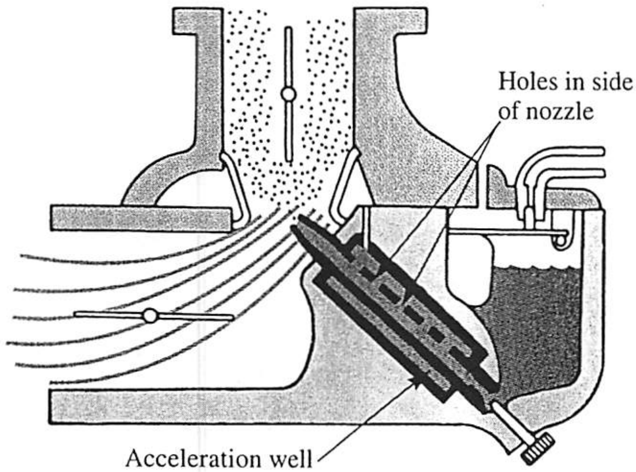


**Figure 8-17.** *Acceleration well stores fuel for use during rapid acceleration. When fuel has been used from acceleration well, nozzle holes act as air bleeds. (Deere & Co.)*

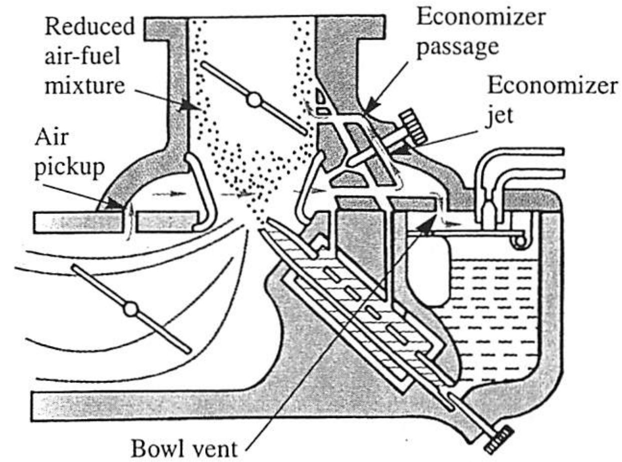


**Figure 8-18.** *Economizer system creates a reduced pressure in float bowl during part throttle operation, which retards amount of fuel discharged from main nozzle.*

without being metered by the adjusting needle. This fuel combines with the fuel in the nozzle, and the double charge enters the airstream. This provides a much richer air-fuel mixture when there is a sudden need for more power. As the fuel supply decreases in the accelerating well and the holes are uncovered, they become air bleeds for the main nozzle.

## Economizer circuit

During operation at part throttle, the full capacity of the main nozzle is not required. To reduce capacity, some carburetors are equipped with economizer circuits. The ***economizer circuit*** is designed to retard fuel flow to the engine at part throttle.

The basic *economizing* process is the same for all carburetors. **Figure 8-18** shows an updraft carburetor with the bowl vent passage extended to a point near the throttle valve. When the throttle valve is partially open, the economizer passage is on the engine side of the plate. This permits the engine to draw air through the passage, reducing air pressure in the bowl and cutting down on fuel flow from the nozzle.

## Idling circuit

During idling operation, the throttle valve is closed. In this condition, the idling system of any type of carburetor supplies just enough air-fuel mixture to keep the engine running. However, actual idling system operation varies in updraft, downdraft, and natural draft carburetors.

The ***updraft carburetor*** in **Figure 8-19** is in the idling mode of operation. The choke is partially closed, directing airflow through the pickup. Since the throttle valve is closed, the air moves through a passage outside of the venturi to the idle orifice. At this point, the idle adjusting needle regulates the amount of air mixing with the fuel in the idle orifice. Less air provides a richer mixture, more air produces a leaner mixture.

At slow idle, the throttle valve is closed. Only the primary orifice is exposed to allow fuel to

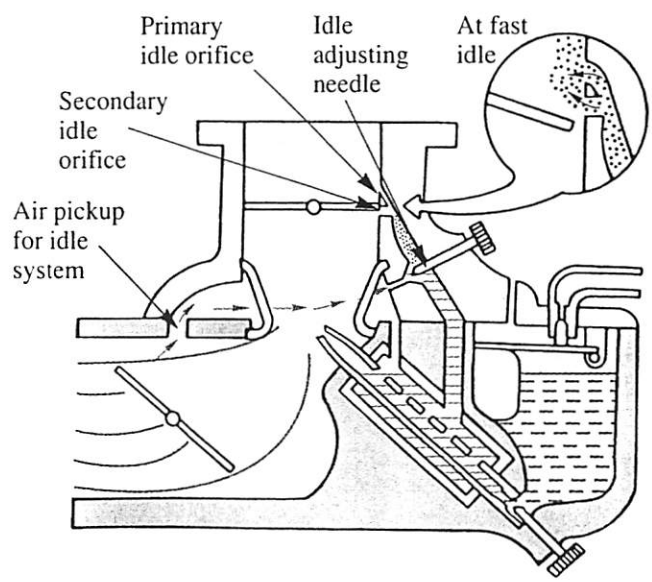


**Figure 8-19.** *During idling, some incoming air is directed through a passage around venturi. This air mixes with fuel and is drawn out primary and secondary idle orifices. Throttle valve is closed for idle and slightly opened for fast idle.*

enter into the manifold. At fast idle, the throttle valve opens slightly to expose both primary and secondary orifices. Remember, the speed and power of the engine is directly related to the amount of air-fuel mixture allowed to enter the cylinder. Note that at idling speed, the main discharge nozzle is inoperative due to lack of airflow through the venturi.

The *downdraft carburetor* in **Figure 8-20** is in the idling mode. The air bleed is located above the venturi and serves both the idling ports and main discharge nozzle.

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Main discharge nozzle is not shown in **Figure 8-20** for purpose of clarity. It would be located as shown in **Figure 8-10.** The idle adjustment screw in this carburetor regulates flow of air-fuel mixture.

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The *natural draft carburetor* in **Figure 8-21** is in the idling mode. The throttle valve is closed, and the engine is running from the primary idle discharge hole. The choke valve is wide open. The engine is idling.

## Part-throttle, full-throttle sequence

Beyond idling speed, the carburetor has other circuits for part-throttle and full-throttle operation. In **Figure 8-22,** the throttle valve in this natural draft carburetor is partly open. The primary and

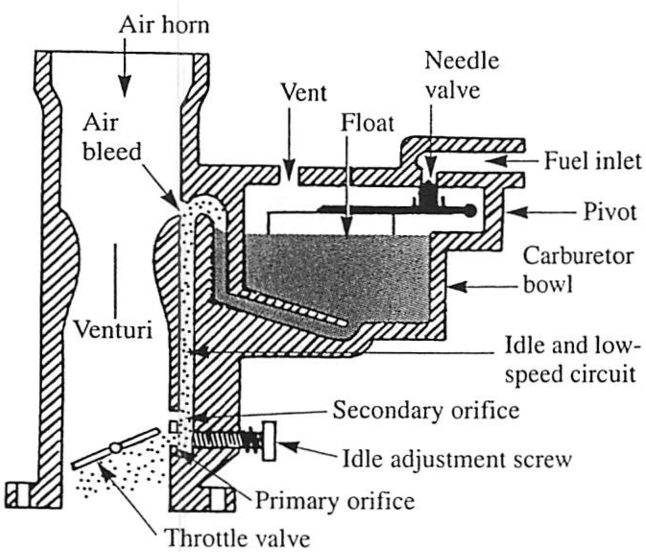



**Figure 8-20.** *In downdraft carburetor, incoming air enters in air bleed above venturi and travels with fuel to idle orifice. Carburetor is in idling state, since throttle valve has uncovered primary orifice only. (Deere & Co.)*

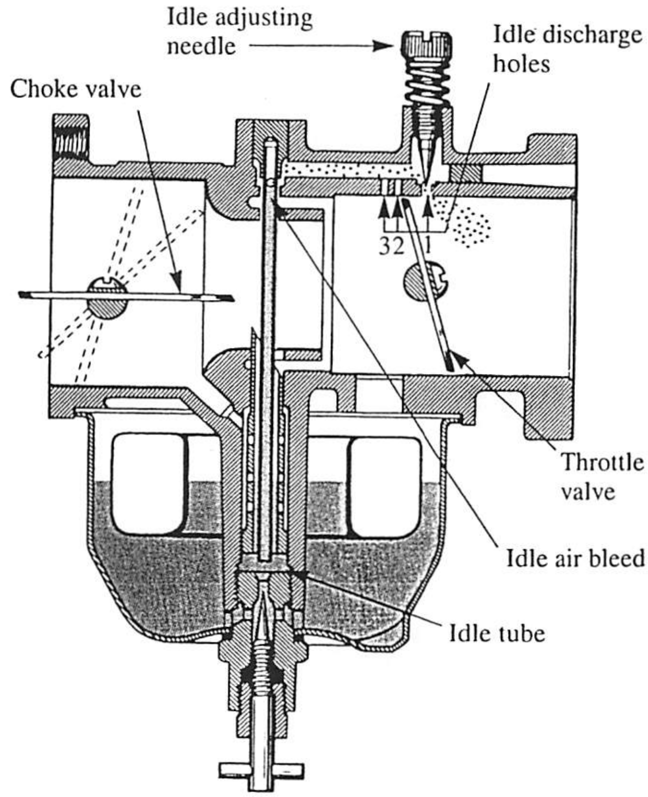



**Figure 8-21.** *Idling. Throttle valve is closed, and engine is operating from primary idle orifice. (Zenith Div., Bendix Corp.)*

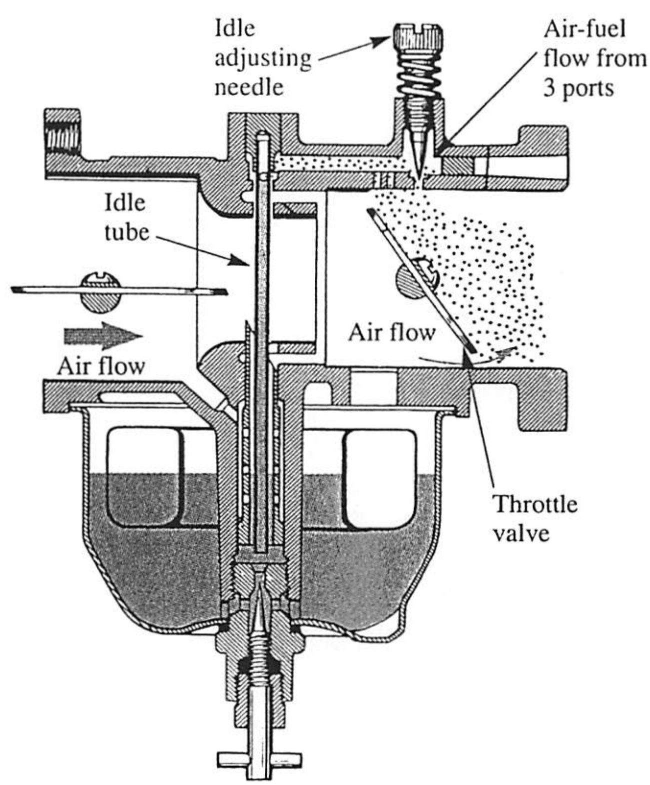



**Figure 8-22.** *Part throttle. Engine is running from primary and secondary orifices.*

secondary discharge holes are open, allowing more air-fuel mixture to enter. The engine is running at part throttle.

See **Figure 8-23** for full-throttle mode of operation. The throttle is wide open, and the maximum amount of air is flowing through the venturi. The main discharge nozzle is operating because of high vacuum in the nozzle area. The maximum air-fuel mixture is entering the cylinders, and the engine is developing full speed and power.

**Figure 8-24** shows an exploded view of the natural draft carburetor shown in **Figure 8-21** through **Figure 8-23.**

## Primer

Some carburetors are equipped with primers. The ***primer*** is a hand-operated plunger, which, when depressed, forces additional fuel through the main nozzle prior to starting a cold engine.

In operation, the primer pumps air pressure into the float bowl, forcing fuel up the nozzle. A primer mounted on a float-type carburetor is shown in **Figure 8-25.**

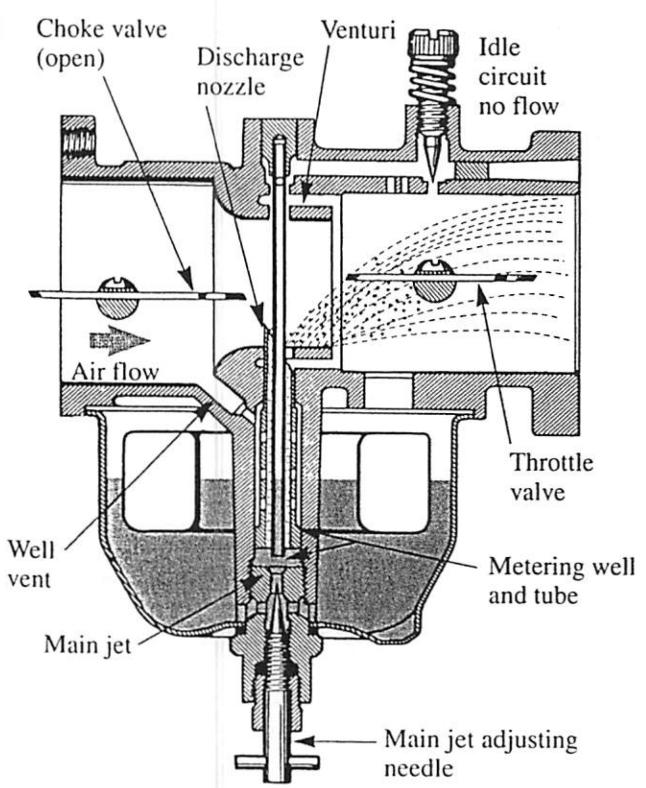



**Figure 8-23.** *Full throttle. Idle orifices have stopped feeding fuel due to reduced vacuum in that part of carburetor. A full flow of fuel is being drawn from main nozzle.*

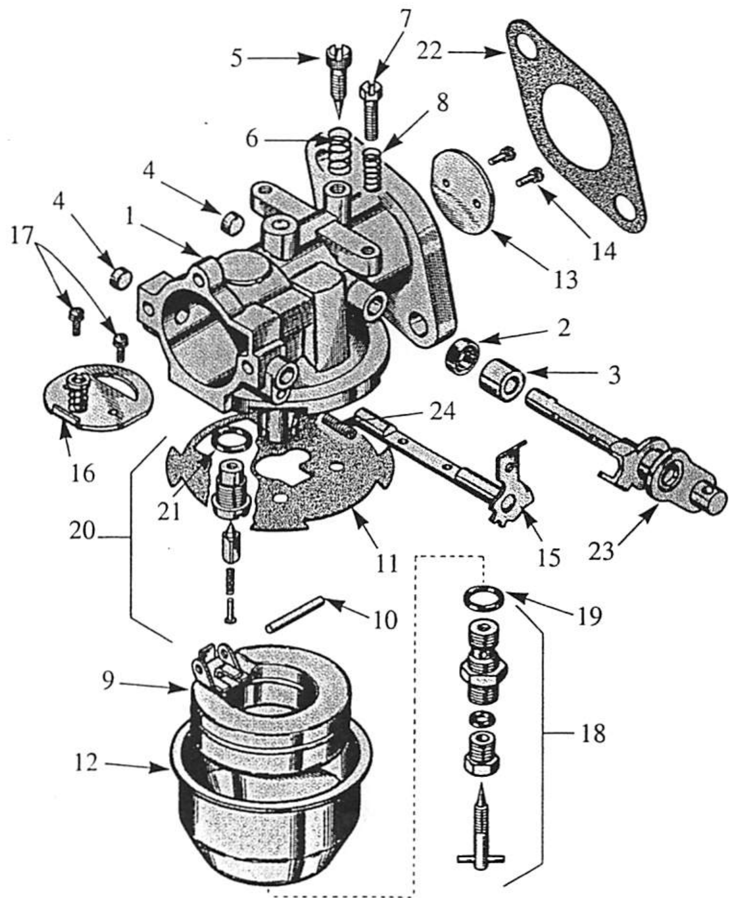



**Figure 8-24.** *An exploded view of natural draft carburetor: 1—Throttle body. 2—Seal. 3—Retainer. 4—Cup rings. 5—Idle adjustment needle. 6—Spring. 7—Throttle stop screw. 8—Spring. 9—Float and hinge assembly. 10—Float pin. 11—Gasket. 12—Fuel bowl. 13—Throttle valve. 14—Screw. 15—Lever and shaft assemble for choke. 16—Choke valve. 17—Screw. 18—Main jet and adjustment assembly. 19—Washer. 20—Fuel valve and seat assembly. 21—Gasket. 22—Flange gasket. 23—Throttle shaft and lever assembly. 24—Spring. (Zenith Div., Bendix Corp.)*

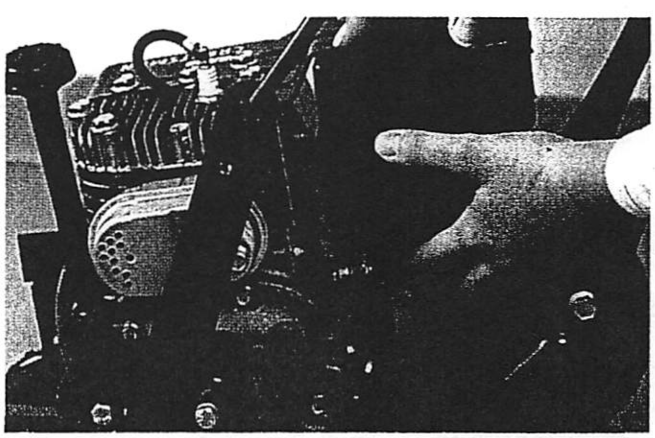


**Figure 8-25.** *A primer plunger mounted on the carburetor.*

## *Diaphragm-type carburetors*

The ***diaphragm carburetor*** does not have a float system. Instead, the difference between atmospheric pressure and the vacuum created in the engine pulsates a flexible diaphragm. A diaphragm, control needle, and needle seat are shown in **Figure 8-26.** The diaphragm draws fuel into a chamber of the carburetor from which it is readily drawn into the venturi.

The carburetor shown in **Figure 8-27A** is a diaphragm-type, natural draft carburetor. Views **B** and **C** illustrate the operating system of the carburetor.

In **Figure 8-27B,** vacuum created in the manifold draws fuel from the upper chamber through the check valve into the venturi. Then, reduced pressure in the upper chamber allows atmospheric pressure to lift the diaphragm, compressing the inlet tension spring. Finally, movement of the diaphragm opens the fuel valve, permitting fuel to flow into the upper chamber. Remember, this action takes place on the intake stroke of the piston.

In **Figure 8-27C,** manifold pressure increases to equal atmospheric pressure when the piston rises on the compression stroke. Since there is no difference in pressure between the upper chamber and the lower chamber, the inlet tension spring closes the fuel valve and returns the diaphragm to a neutral position. The check valve closes immediately when the pressure is equalized. Therefore, the retracting diaphragm draws fuel into the upper chamber before the fuel valve closes completely.

The pulsation of the diaphragm takes place on every intake and compression stroke, regardless of the number of engine cylinders. On four-cycle engines, fuel is drawn into the cylinder on the downstroke of the piston. On two-cycle engines, fuel is drawn into the crankcase during the upstroke of the piston.

In some applications, the diaphragm spring is adjustable (adjustment screw not shown) to balance the force of the inlet tension spring.

### Diaphragm carburetor operation

A study of the various circuits of a typical diaphragm-type carburetor will help clarify operating principles. The carburetor shown in **Figure 8-28** is in starting condition with the choke valve closed. Follow the arrows that indicate direction of fuel flow.

Fuel is drawn from the idle discharge ports and main nozzle because manifold vacuum is high. The carburetor diaphragm is drawn upward during the intake stroke of the engine piston, unseating the fuel inlet needle to allow fuel to flow. Note that the natural draft carburetor in

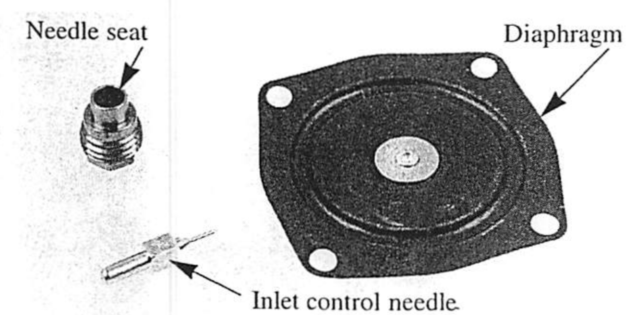



**Figure 8-26.** *A diaphragm, control needle, and needle seat used in a diaphragm carburetor system. (Deere & Co.)*

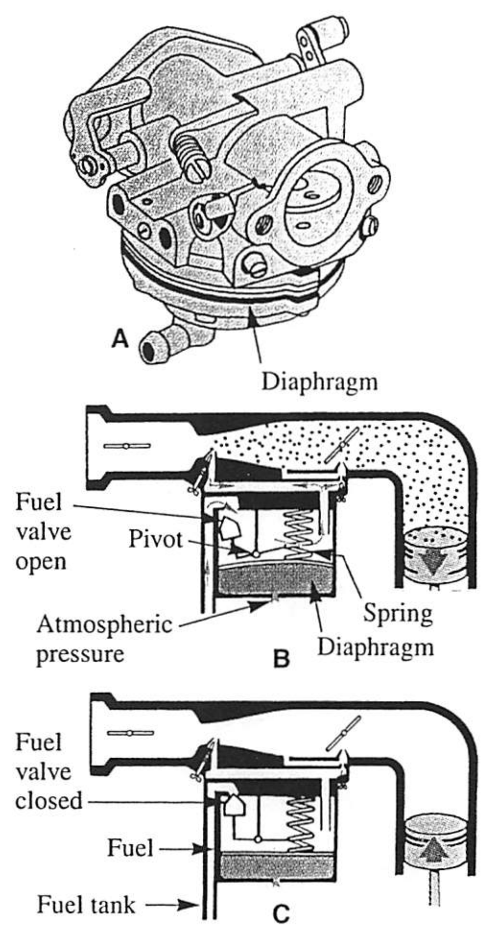
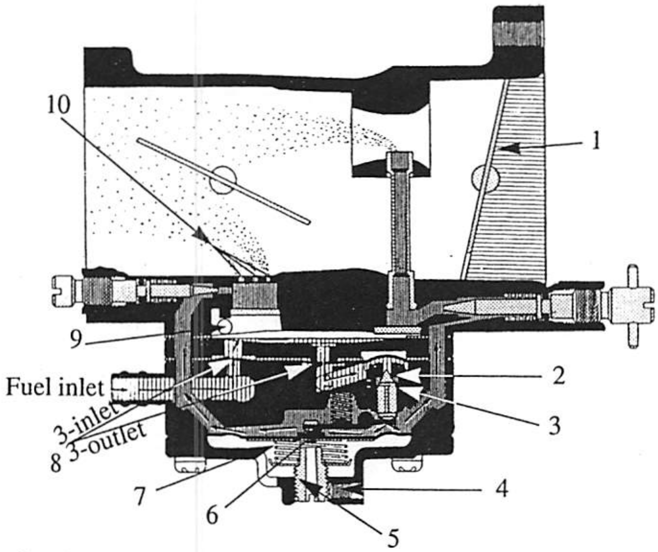


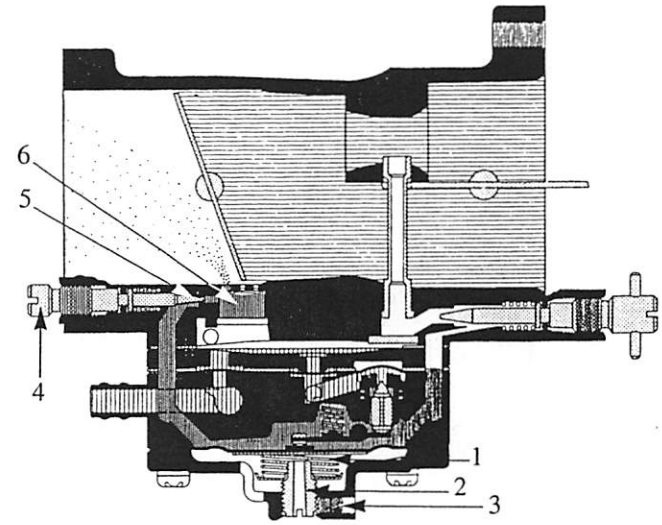

**Figure 8-27.** *A—A diaphragm-type, natural draft carburetor. B—Diaphragm is lifted by manifold vacuum while fuel is being drawn from jets. C—When vacuum is reduced, diaphragm returns to normal, drawing new fuel into upper fuel chamber.*




Starting (Choke) Operation

1-Choke valve.
2-Inlet control valve.
3-Valve seat.
4-Lock screw.
5-Adjustment screw
6-Inlet control lever.
7-Diaphragm spring.
8-Check valve.
9-Impulse channel.
10-Idle discharge port.

**Figure 8-28.** *With choke plate closed, a very strong vacuum is formed in air horn. A large quantity of gasoline is sucked out of idle jets and main nozzle. A rich mixture results, which can support cold engine operation.*




Idling Operation

1-Diaphragm spring.
2-Adjustment screw.
3-Lock screw.
4-Idle mixture screw.
5-Idle mixture screw orifice.
6-Idle fuel supply channel.

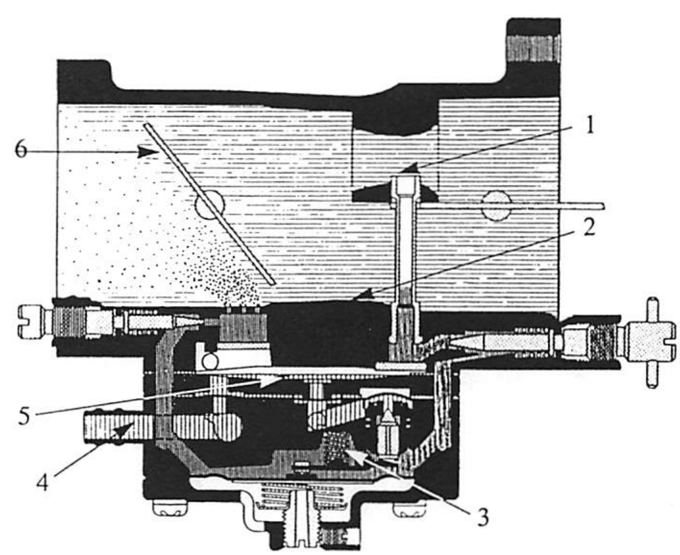
**Figure 8-29.** *During idling or very slow speed operation, only the primary orifice (passage) is feeding fuel to engine. Air velocity is not high enough to draw fuel out of the high speed circuit. Remember, this circuit controls fuel mixture when an engine is idling.*

**Figure 8-30** also incorporates a fuel pump diaphragm in its body.

**Figure 8-29** shows idling operation with the choke valve open and the throttle valve closed. Vacuum is in effect on the engine side of the throttle valve. Since only one idle discharge port is exposed, a small quantity of fuel is being used, and the engine runs slowly.

**Figure 8-30** shows the throttle partially open for intermediate speed. Airflow through primary venturi is still not great enough to draw fuel up the main nozzle. Three idle discharge ports are feeding fuel for medium speed. These extra idle discharge ports are termed off-idle ports. They must supply more fuel than the single idle port, yet not as much as the main discharge port. The intermediate circuit must provide fuel for transition from idle to high-speed operation.

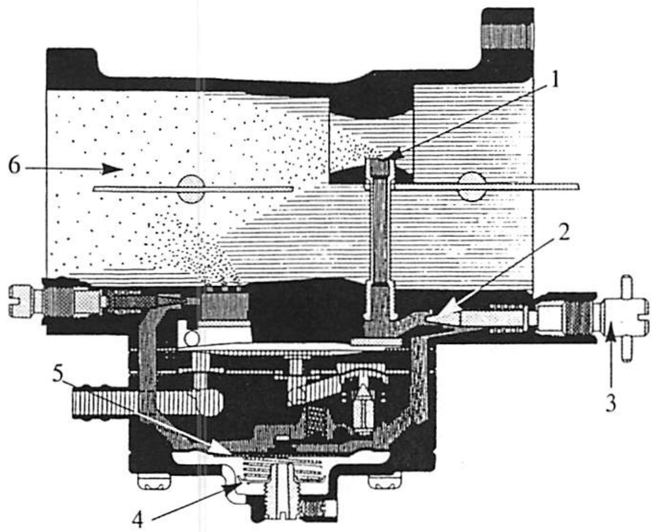
**Figure 8-31** illustrates high-speed operation with maximum air and fuel flowing through the carburetor. All idle ports and the main nozzle are feeding fuel. Notice that the choke and throttle valves are open.




Intermediate Operation

1-Primary venturi.
2-Secondary venturi.
3-Inlet tension spring.
4-Fuel inlet.
5-Fuel pump diaphragm.
6-Throttle valve.

**Figure 8-30.** *Fuel feeding from idling discharge ports provides intermediate speed operation. (Rupp Industries, Inc.)*




High-Speed Operation

| | |
|---|---|
| 1-Main fuel discharge port. | 3-High-speed mixture screw. |
| 2-High-speed mixture screw orifice. | 4-Spring seat. |
| | 5-Main diaphragm. |
| | 6-Maximum airflow. |

**Figure 8-31.** *During high-speed operation, fuel flow from main nozzle and idle jets combines with maximum airflow.*

## *Manual throttle controls*

A basic ***manual throttle control*** consists of either mechanical linkage or a flexible cable. One end of the control is attached to the throttle shaft lever. The other end is connected to a lever, slide, or dial that is operated manually to open and close the throttle valve.

The manual throttle can be used as the sole control for positioning the throttle valve. Typical applications of this type of throttle are chain saws, motorcycles, snowmobiles, and outboard engines. In some installations, the manual control is used in conjunction with a governor. This setup permits governed speed to be changed when desired.

**Figure 8-32** shows a manual remote control using a flexible cable to transmit motion from the speed control lever to the throttle valve. In this case: A–Motion changes tension on the governor spring. B–Tension on governor spring changes the throttle valve position.

**Figure 8-33** shows a throttle control that varies governor spring tension, positions the throttle valve, and actuates the choke for starting. In **Figure 8-33A,** the control knob is turned to *Start,*

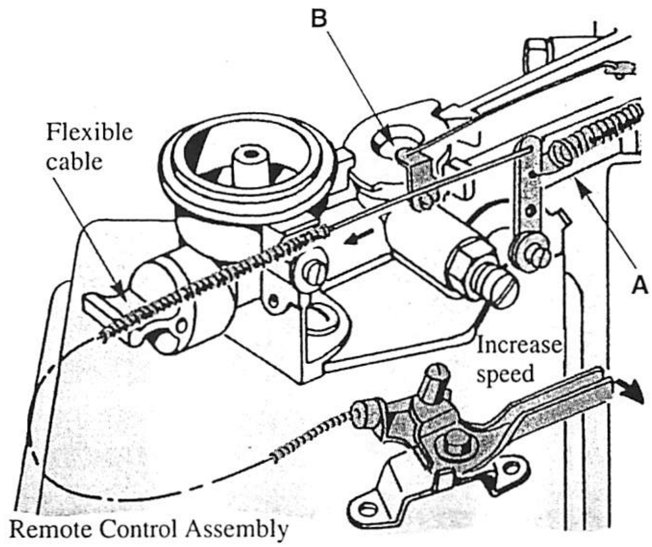
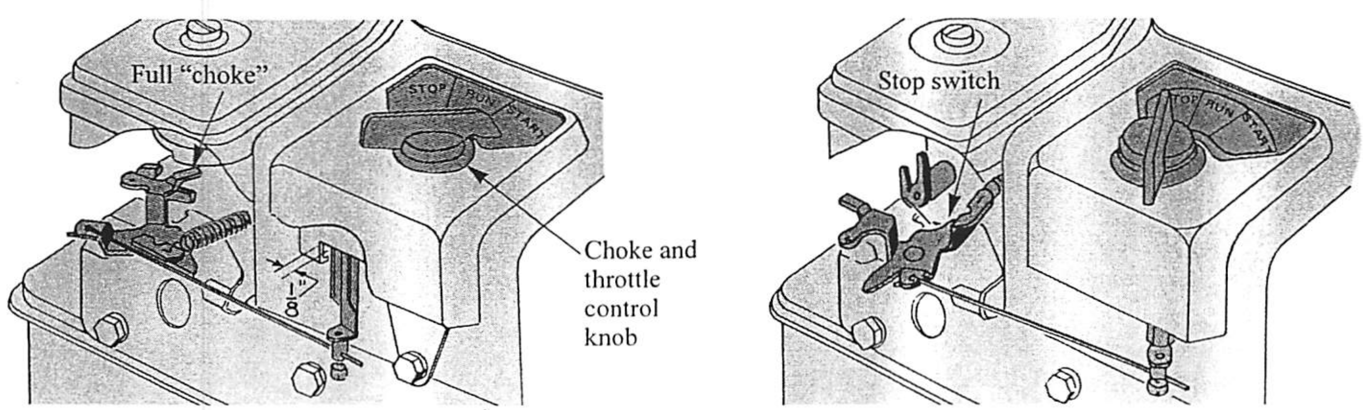



**Figure 8-32.** *This manual throttle control uses a flexible cable to transmit motion from hand lever to governor spring lever. (Briggs and Stratton Corp.)*




A B

**Figure 8-33.** *Combined manual throttle and choke control. A—Control knob turned to* Start *activates choke. B—Knob turned to* Stop *closes stop switch.*

which rotates the choke valve shaft to the choked position. When the engine is started, the control knob is turned to *Run*.

To stop the engine, the knob is turned to *Stop*, as shown in **Figure 8-33B.** The stop switch grounds the ignition system, cutting off the flow of electricity to the engine.

---

This switch is illustrated in detail in Chapter 9 of this text.

---

## *Governor throttle controls*

In many small gasoline engine applications (lawn mowers, generators, and garden tractors), the load on the engine can change instantly. The change in load would require constant throttle changes on the part of the operator. Instead, ***governors*** are used to provide a smooth, constant speed, regardless of engine loading.

### What an engine governor does

Governors can be designed to serve three basic functions:

- Maintain a speed selected by operator that is within range of governor.
- Prevent overspeeding that may cause engine damage.
- Limit both high and low speeds.

In **Figure 8-34,** observe how tractor speed varies without a governor, but stays constant with a governor.

Small engine governors are generally used to maintain a fixed speed not readily adjustable by the operator or to maintain a speed selected by means of a throttle control lever. In either case, the governor protects against overspeeding. If the load is removed, the governor immediately closes the throttle. If the engine load is increased, the throttle will be opened to prevent engine speed from being reduced.

For example, a lawn mower normally has a governor. When mowing through a large clump of grass, engine load increases suddenly. This tends to reduce engine speed. The governor reacts by opening the carburetor throttle valve. Engine power output increases to maintain cutting blade speed. When the mower is pushed over a sidewalk (no grass or engine load), engine speed tends to go up. The governor reacts by closing the carburetor

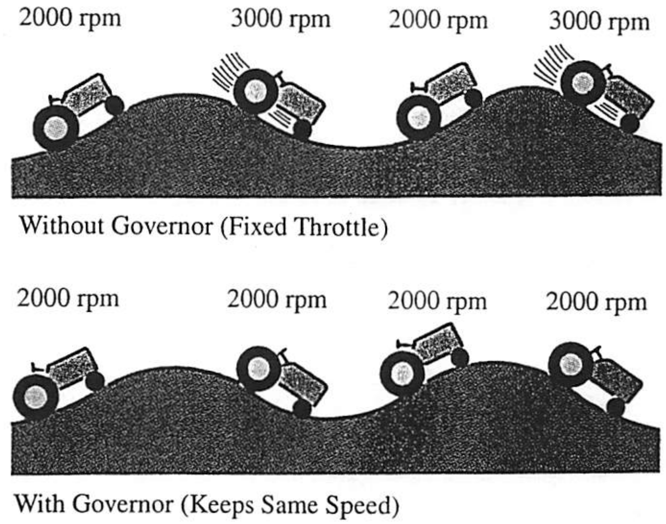



**Figure 8-34.** *Notice what the governor does for the engine. (Deere & Co.)*

throttle valve. This limits maximum cutting blade speed. As a result, mower engine and cutting blade speeds stay relatively constant.

### Types of governors

There are several types of engine governors: ***air vane*** (also called ***pneumatic***), ***centrifugal*** (also called ***mechanical*** and shown in **Figure 8-35**), and ***vacuum.*** Most modern governors are air vane types, which adjust fuel intake according to engine demands. See **Figure 8-36.** However, centrifugal governors are also fairly common. Vacuum governors are usually found on farm and industrial engines. Basically, all governors accomplish the same purpose—to protect the engine from overspeeding and to maintain a constant speed, independent of load. However, different speed sensing devices are used.

### *Air vane governor*

The ***air vane governor*** is operated by the stream of air created by the flywheel cooling fins. The force developed by the airstream is in direct proportion to the speed of the engine.

A lightweight, thin strip of metal called an air vane is placed in the direct path of the airstream. It is pivoted on a pin or shaft set near one end. The vane is connected, with linkage, to the throttle shaft lever. When the engine is running, the airstream pivots the vane and attempts to close the throttle valve. See **Figure 8-36.**

The governor spring is attached to the throttle lever or to linkage from the vane. This spring is

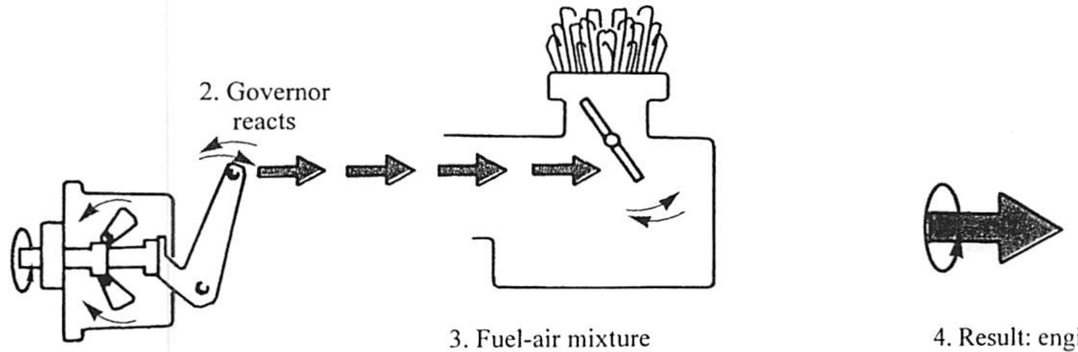



**Figure 8-35.** *Centrifugal governor controls engine speed by varying fuel mixture. (Deere & Co.)*

designed to pull the throttle valve to wide open position.

Note how the airflow pivots the vane, causing it to exert rotary pressure on the upper throttle shaft lever while the governor spring tries to pull the throttle valve open. The ratio of pressure developed by the vane, as opposed to the tension of the governor spring, determines throttle valve position. When the engine is stopped, the airstream ceases and the throttle valve is pulled to wide open position by the governor spring. The governor spring bracket can be moved to vary the amount of tension exerted by the spring. This will alter vane spring pressure balance and establish a new throttle setting.

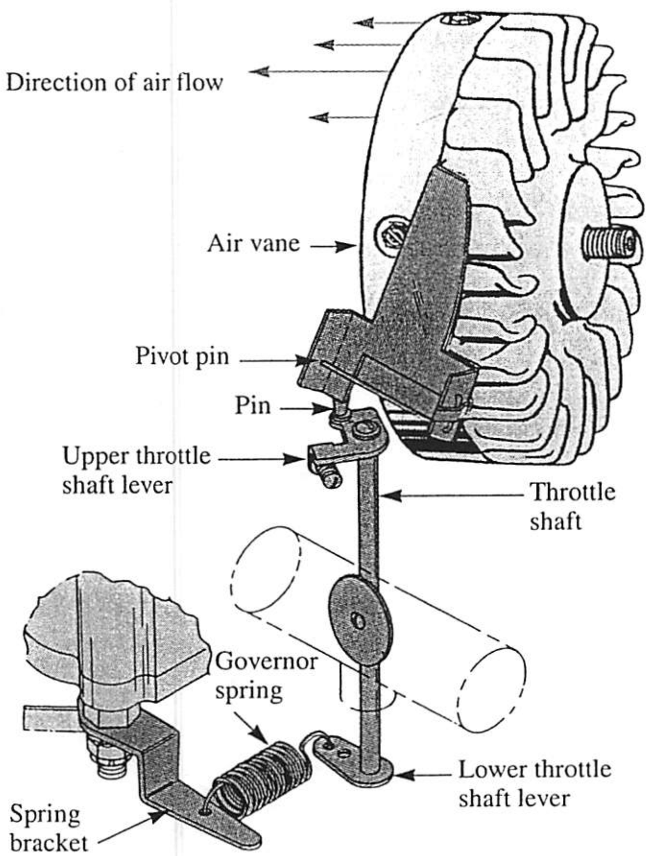



**Figure 8-36.** *Schematic illustrates operation of an air vane governor. Vane tries to close throttle valve, while governor spring tries to open it. Balance between these two forces determines throttle position. (Tecumseh Products Co.)*

Governor spring tension is carefully calibrated by the manufacturer. If the spring is stretched or altered in any way, it should be replaced with a new spring designed for that make and model engine. If the linkage is bent, worn, or damaged, it should be straightened, repaired, or replaced. See **Figure 8-37.**

If it is necessary to replace any component on an air vane governor, the top no-load rpm should be checked with an accurate tachometer. The top speed *must not exceed* the maximum recommended rpm for the implement being driven.

In the case of lawn mowers, blade tip speed should not exceed 19,000 feet per minute in a no-load condition. If necessary, change the governor spring or adjust the top speed limit device so the engine stops accelerating at the recommended rpm, which is based on blade length. See **Figure 8-38.**

Since blade tip speed is a function of blade length and engine rpm, longer blades require lower engine speeds. It is suggested that top governed engine speed be adjusted at least 200 rpm lower than the speeds shown in **Figure 8-38** to account for tachometer inaccuracy.

**Fixed speed.** If the engine is designed to run at only one specific rpm setting, the tension of the governor spring is carefully adjusted until the speed is correct. Then it is left at this setting, Figure 8-39. Fixed speed engines of this type have a limited range of governor spring adjustment. When the engine is started, the force of the airstream on the vane closes the throttle until that force is equal to spring tension.

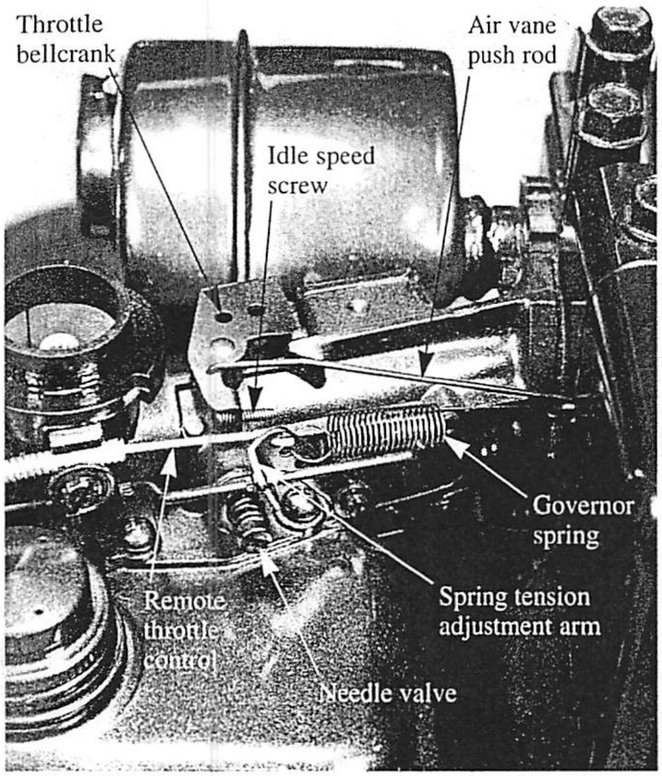
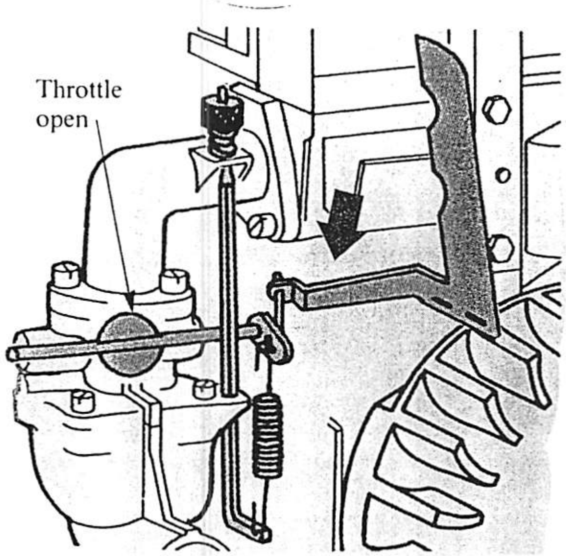



Figure 8-37. *Parts of a typical governor system for actual engine. Note location of idle speed screw and needle valve screw.*

**Variable speed.** It is often desirable to have an engine operate at many different speeds that may be quickly and easily set by the operator. In this case, a variable speed air vane governor is used. See **Figure 8-40.** Engine rpm is changed by pivoting the governor spring bracket. Remember, the throttle control adjusts governor spring tension. The spring is not connected directly to the throttle lever.

| *Blade Length in Inches (millimeters)* | *Maximum Rotational (rpm)* |
|---|---|
| 18 (460) | 4032 |
| 19 (485) | 3820 |
| 20 (510) | 3629 |
| 21 (535) | 3456 |
| 22 (560) | 3299 |
| 23 (585) | 3155 |
| 24 (610) | 3024 |
| 25 (635) | 2903 |
| 26 (660) | 2791 |

Figure 8-38. *Chart lists various lengths of lawn mower blades and maximum rotational speeds, which produce blade tip speeds of 19,000 feet per minute. It is recommended that top speeds be set 200 rpm less than shown.*



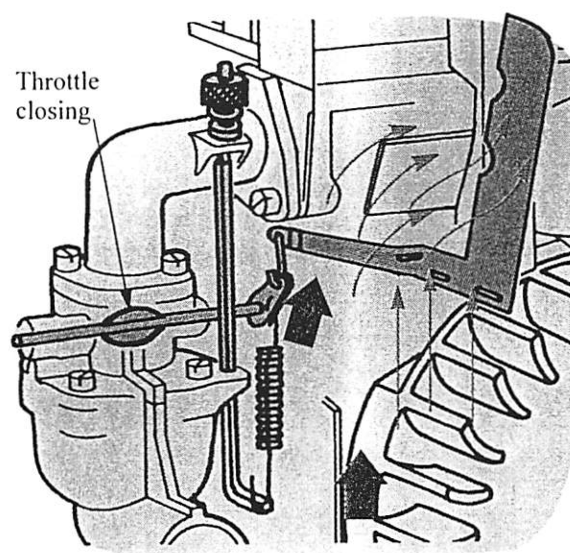




Figure 8-39. *Air vane governor. A—Engine stopped. Spring holds throttle open. B—Engine running. Air pressure pivots vane of fixed speed governor and shuts throttle valve until spring pressure and vane pressure are balanced. Knurled nut alters spring tension and adjusts speed. (Briggs and Stratton Corp.)*

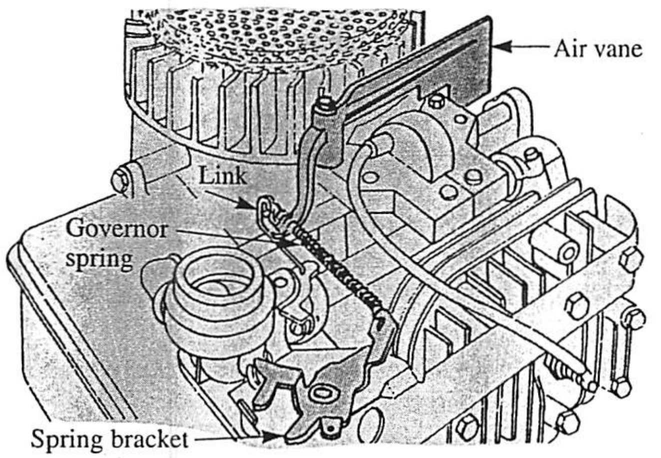



**Figure 8-40.** *Variable speed air vane governor. To change rpm, operator alters governor spring tension by rotating spring bracket.*

## *Centrifugal or mechanical governor*

Like the air vane governor, the centrifugal (mechanical) governor also controls engine speed. The centrifugal governor, however, utilizes pivoted flyweights that are attached to a revolving shaft or gear driven by the engine. With this setup, governor rpm is always directly proportional to engine rpm.

**Figure 8-41** shows how centrifugal governors operate. When the engine is stopped, the heavy ends of the flyweights are held close to the shaft by the governor spring. The throttle valve is held fully open as illustrated in **Figure 8-41A.**

When the engine is started, the governor is rotated. As its speed increases, centrifugal force increases and causes the flyweights to pivot outward. This forces the spool upward, raising the governor lever until spring tension equals the centrifugal force on the weight. This action partially closes the throttle valve shown in **Figure 8-41B.**

If the engine is subjected to a sudden load that reduces rpm, the reduction in speed lessens centrifugal force on the flyweights. The weights move inward, lowering the spool and governor lever. This series of actions opens the throttle valve and lost rpm is regained.

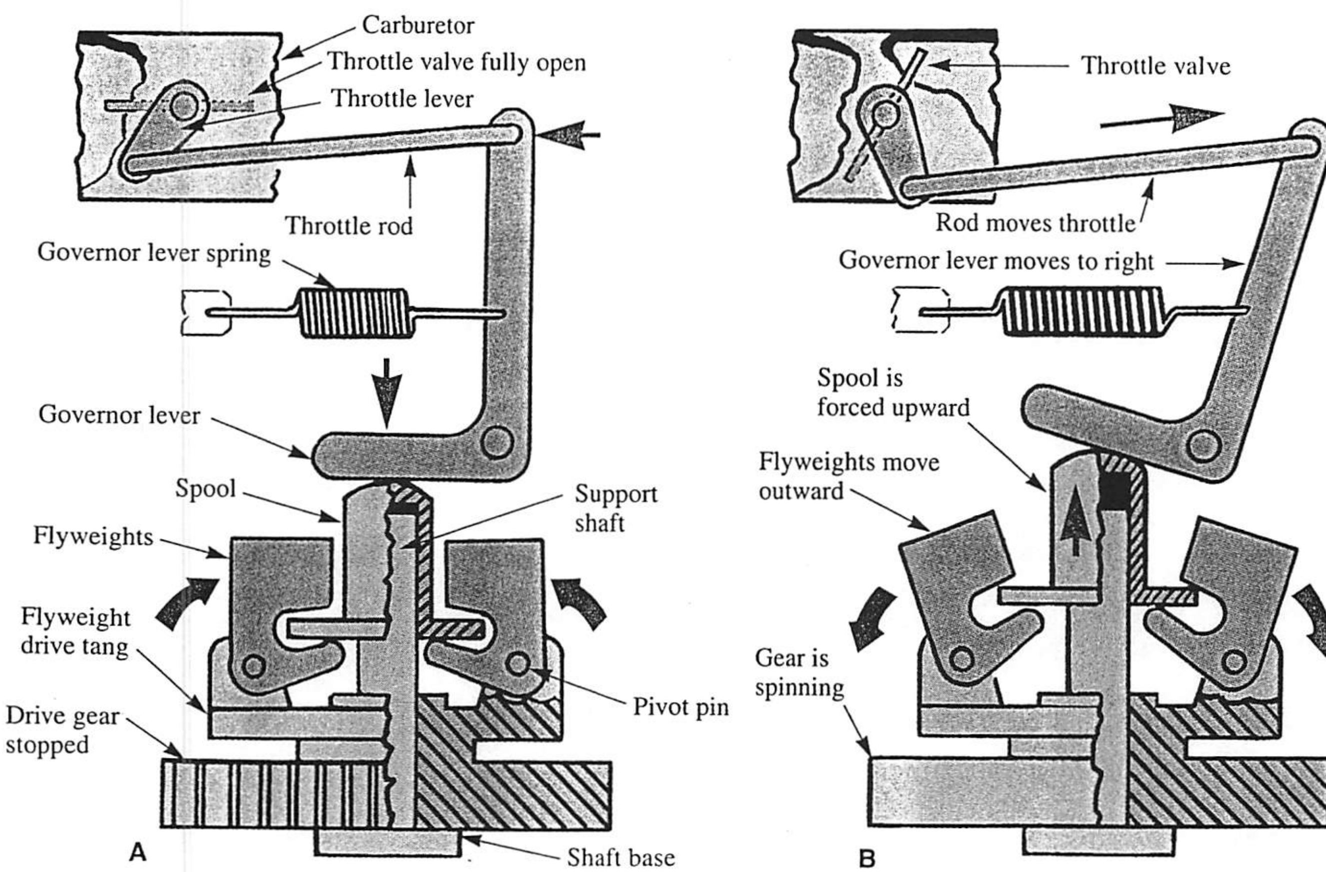



**Figure 8-41.** *A centrifugal-type governor. Centrifugal force causes flyweights to pivot outward, raising spool. Spool rotates governor lever which closes throttle valve. Balance between centrifugal force and governor spring tension determines throttle valve setting.*

**Changing governor speed setting.** The centrifugal governor speed setting can be changed by turning a knurled adjusting nut on the end of the tension rod. See **Figure 8-42.** This system is used when the engine is expected to run at a constant speed setting for long periods of time.

A remote, hand-controlled cable that alters spring tension also can be used to set governor speed. See **Figure 8-43.** Movement of the control handle increases or decreases spring tension, which speeds up or slows down the engine. The operator can quickly select any speed within the range of the governor.

Another type of governor speed adjusting arrangement is shown in **Figure 8-44.** Movement of the governor adjusting lever changes spring tension and engine rpm.

**Hunting of centrifugal governors.** Frequently, when an engine is first started or is working under load, its speed becomes erratic or oscillates. The engine speeds up rapidly; the governor responds and engine speed drops quickly. The governor stops functioning and engine speed again increases. The governor responds and this action is repeated over and over. This condition is known as ***hunting.***

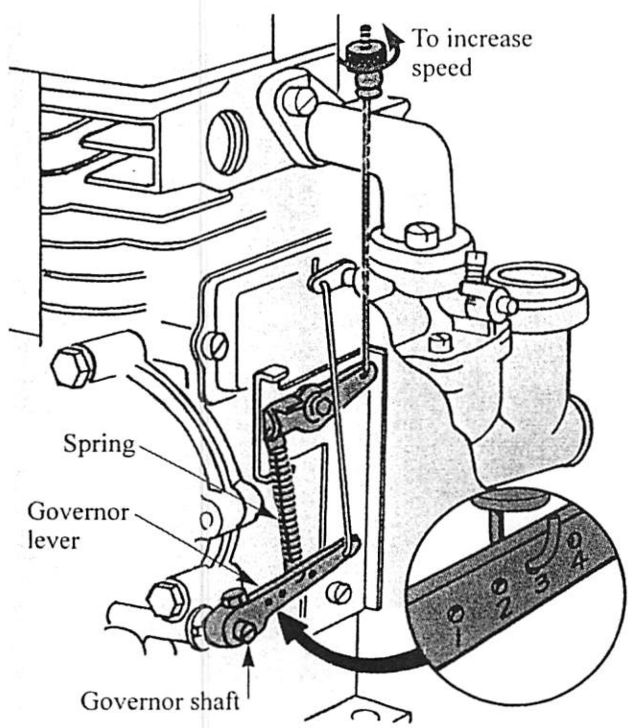



**Figure 8-42.** *Single speed setting, using knurled nut to provide a limited governor speed range. (Briggs and Stratton Corp.)*

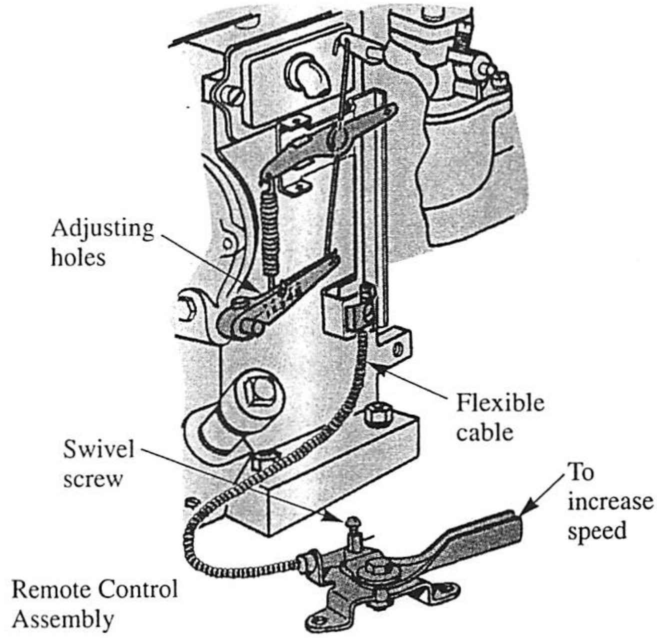



**Figure 8-43.** *Operator-controlled governor speed setting device allows quick, wide, governed speed changes. (Briggs and Stratton Corp.)*

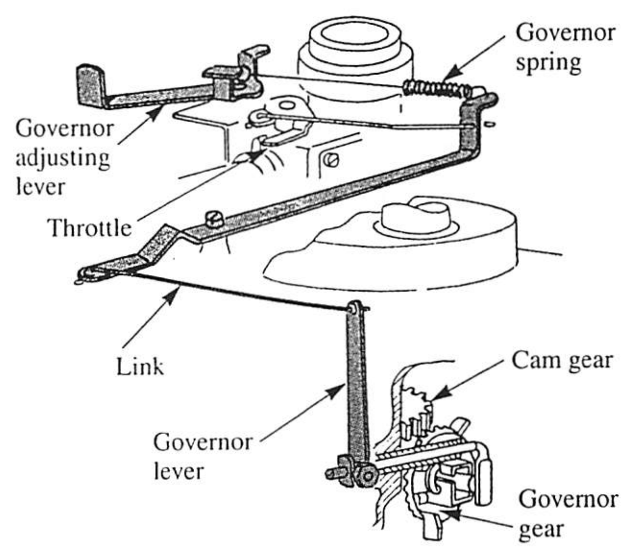



**Figure 8-44.** *Method of setting governed speed by using an adjusting lever to control governor spring tension.*

Hunting is usually a result of improper carburetor adjustment. Leaning or richening the fuel mixture can often correct the problem. Also, the governor may cause hunting if it is too stiff or binds at some point. It must work freely.

### *Vacuum governors*

Farm and industrial engines are often equipped with a vacuum governor for regulating maximum engine speed. The vacuum governor is located between the carburetor and the intake manifold. See **Figure 8-45.** It senses changes in intake manifold pressure (vacuum). There is no other mechanical connection between the governor and other parts of the engine.

As the engine speed and the suction (vacuum) increase, the governor unit closes the throttle butterfly valve. This causes a decrease in fuel flow and engine speed.

When engine speed and vacuum decrease, the spring opens the throttle valve. This action causes the fuel flow and engine speed to increase. An adjustment of spring tension is used to set the desired speed range.

### Governor features

The operating principles of the governor mechanism are quite simple and reliable. Governors provide accuracy and efficiency of operation combined with convenience and comfort for the operator. Two of the most important operating features of engine speed and power output governors are stability and sensitivity. ***Stability*** is the ability to maintain a desired engine speed without fluctuating. Instability results in hunting or oscillating due to over-correction. Excessive stability results in a dead-beat governor (one that does not correct sufficiently for load changes). ***Sensitivity*** is the percent of speed change required to produce a corrective movement of the fuel control mechanism. High governor sensitivity will help keep the engine operating at a constant speed.

## *Air cleaners and air filters*

An engine breathes a tremendous quantity of air during its normal service life. If the incoming air is not thoroughly cleaned by passing it through a filtering device, dirt and grit entering the cylinder would cause rapid wear and scoring of machined parts throughout the engine. Engine life, under severe dust conditions, actually could be reduced to minutes. Refer to the *Appendix* for engine failure analysis information.

Three types of air cleaners widely used in small gasoline engines are the ***oil-wetted, dry types,*** and ***dual-element.***

### Oil-wetted air cleaner

The oil-wetted air cleaner utilizes a filtering element (crushed aluminum, polyurethane foam, etc.) dampened with engine oil. **Figure 8-46** shows a polyurethane foam oil-wetted element in place and cover open. In operation, the air is drawn directly through the oil-wetted element where the damp material effectively filters out contaminants. This type of element can be reused by rinsing in soapy water, drying, and re-oiling.

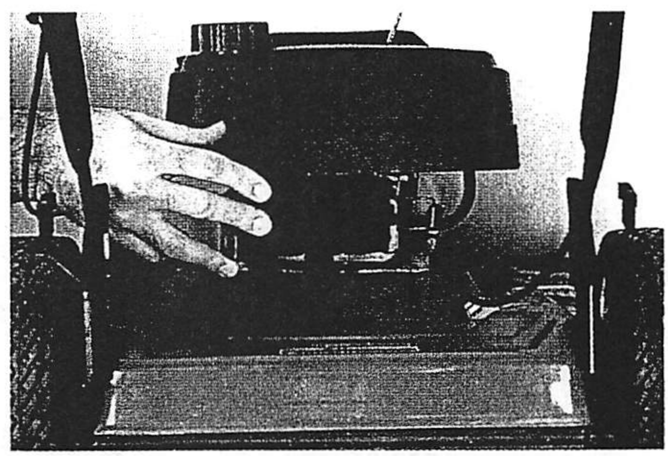


**Figure 8-46.** *An oil-wetted air cleaner. Polyurethane foam is dampened with oil and contained in a vented case attached to carburetor.*

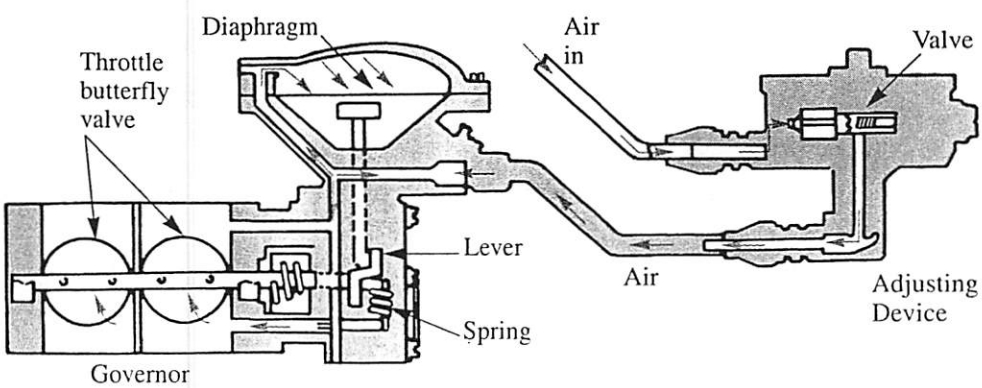



**Figure 8-45.** *A vacuum governor must maintain a preset maximum engine speed, independent of engine load.*

The air cleaner functions to keep dirt, dust and gritty substances from entering the engine during running. In doing so, the dirt, dust and grit becomes trapped on the external side of the filter and even within the filter material. As the filter pores become filled with debris, less air can get through the filter which has the effect of changing the air-fuel mixture ratio. The engine will run as if the choke is partially closed and a very rich mixture of fuel with less air enters the combustion chamber. The engine begins to run poorly, use more fuel, generate less power, and carbon accumulation on internal parts increases. Also, lubricating oil becomes dirty, diluted, and internal engine wear increases. When the air cleaner gets very dirty the engine may become difficult to start. When the engine does start, black smoke from the rich mixture may show up in the exhaust. Removing an air filter element is usually quite easy so that it can be maintained regularly by the operator. However, this simple task is sometimes neglected until engine damage is already done.

### *When to service the air cleaner*

There are many different designs of air cleaners as illustrated by a few examples in **Figure 8-47.** Because engines are used in many different environments the length of running time before cleaning may vary considerably. However, for average applications such as lawn mowing, cleaning every 25 hours of operating time is recommended, or once a season, whichever comes first. In dustier conditions cleaning should be done more often. Regular inspections of the filter element is the best way to determine whether it should be cleaned or even replaced.

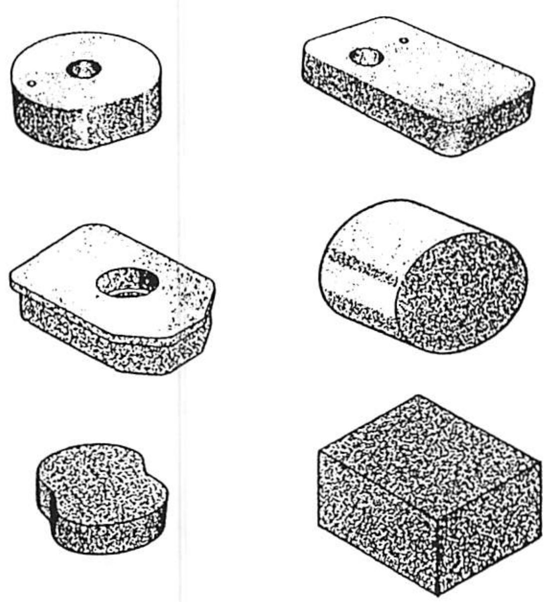


**Figure 8-47.** *A few examples of plastic foam air cleaners. Many special shapes are available for specific engines.*

### *Removing air cleaner foam element*

Remove the screw, wing nut, or other fastening device to uncover the air cleaner plastic foam element. **Figure 5-48** shows the filter receptacle with the cover open and foam element removed. The plastic foam filter material can be pulled from the receptacle. Care should be taken not to drop any dirt into the carburetor throat during this procedure. **Figure 5-49** illustrates an air cleaner and its parts with some instructions about assembly.

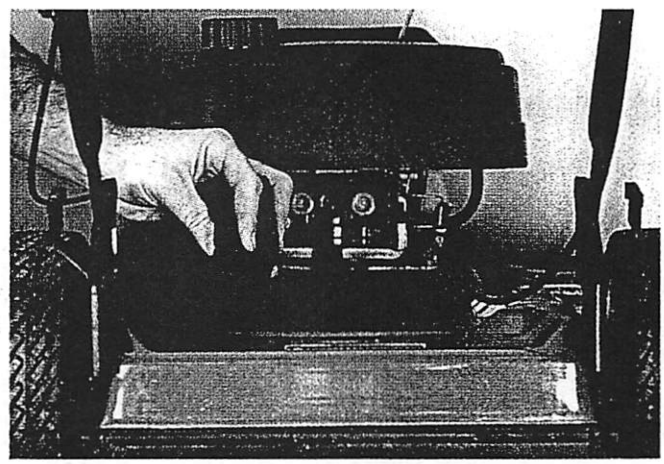


**Figure 8-48.** *Polyurethane foam filter can be removed, cleaned, and reoiled.*

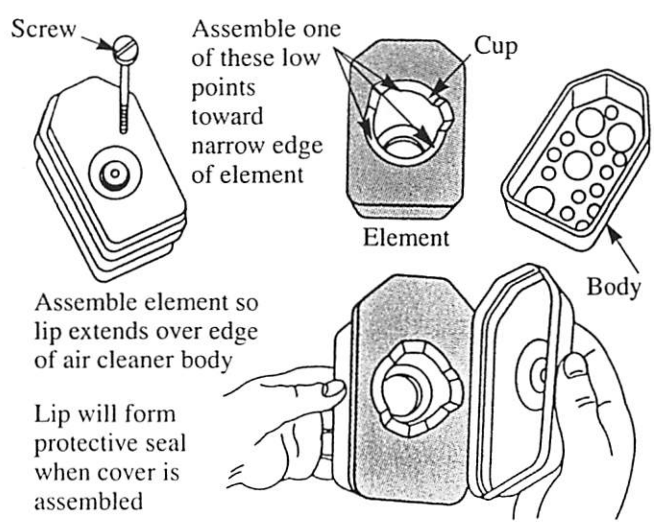



**Figure 8-49.** *Removal of the air cleaner is relatively easy so servicing can be done regularly. (Briggs and Stratton Corp.)*

### *Cleaning the plastic foam air cleaner element*

To clean the plastic foam air cleaner element, do the following:

1. Wash the plastic foam element in kerosene or liquid detergent and water.

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Kerosene is a flammable liquid and should be used with extreme care and away from heat or flame. Detergent and water are safer and recommended here. See **Figure 8-50A.**

---

2. Wrap the plastic foam element in dry cloth and squeeze the element dry. Absorbent toweling works well for this procedure. See **Figure 8-50B.**
3. The plastic foam should be saturated with clean engine oil. See **Figure 8-50C**.
4. Squeeze excess oil out of the foam as shown in **Figure 8-50D.**

---

Reassemble the air filter unit. Follow any special instructions found in the owners manual for the specific engine and filter.

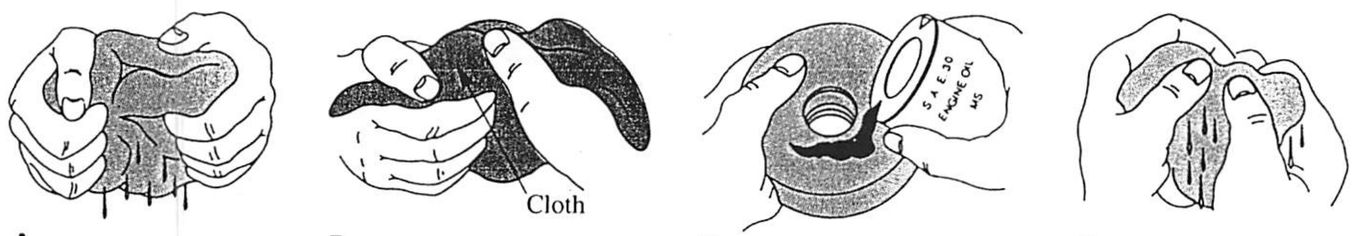
---

## Dry-Type Air Cleaner

Dry-type air cleaners pass the airstream through treated paper, felt, fiber, or flocked screen. Some filter elements (flocked screen) can be cleaned, but most are designed to be thrown away when they become dirty.

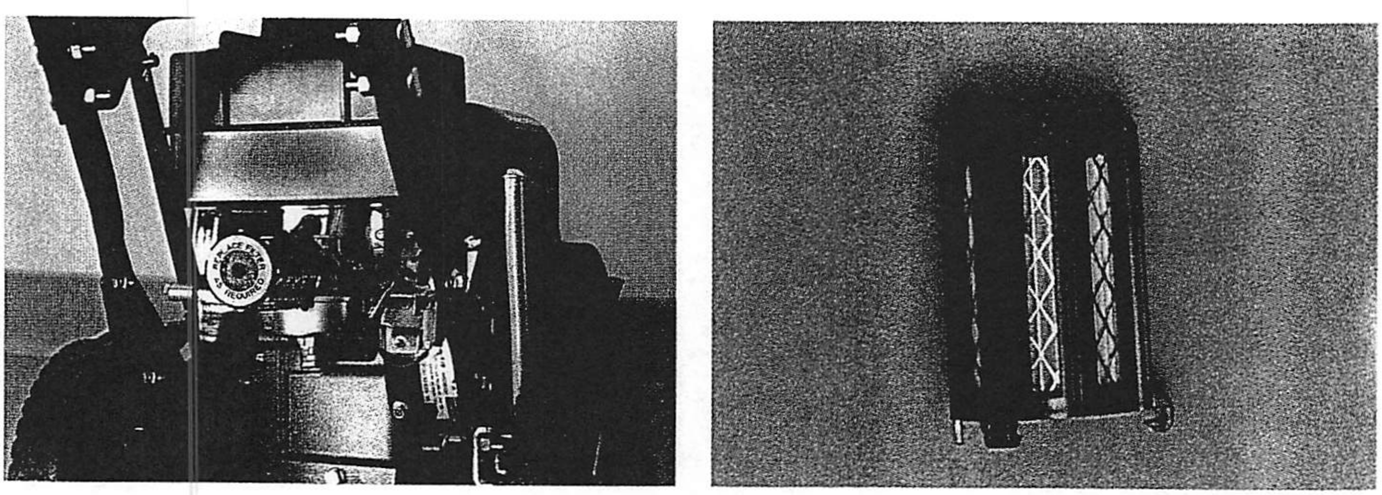
A typical treated paper air cleaner element is shown in **Figure 8-51.** You can clean this filter by tapping it on a flat surface to dislodge light accumulations of dirt. However, when it will not tap clean, a treated paper filter must be replaced with a new element designed for the given engine application.

A new style of dry-type filter cartridge is the pleated paper design shown in **Figure 8-52.** The



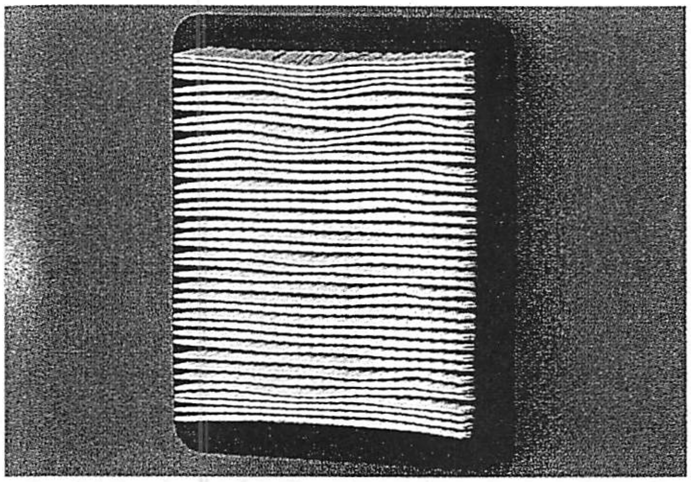

A B C D

**Figure 8-50.** *Follow these steps when cleaning an oil-wetted foam element: A—Wash the element in a detergent and water solution. B—Wrap the element in a clean cloth and squeeze dry. C—Saturate the element in clean engine oil. D—Squeeze the excess oil out of the element. (Briggs and Stratton Corp.)*

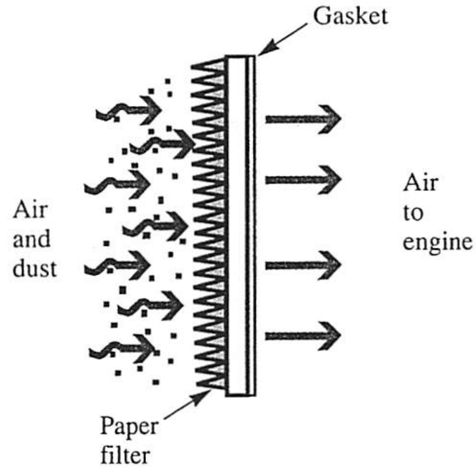


A B

**Figure 8-51.** *Dry-type filter element can be partially cleaned by tapping gently. New element should be installed as needed.*



A




B

**Figure 8-52.** *Air and dust particles travel through pleated paper filter element trapping dust. Clean air continues to engine. Gasket seals element.*

paper filter material is a special treated paper with porosity of extremely small size to let air flow through while preventing fine particles of dirt and dust from penetrating. The pleated design provides great surface area to collect particulates. This design is similar to the filters used in today's automobiles. A flexible plastic gasket material is molded around the edges of the paper filter to establish the overall dimensions and seal the unit in the receptacle. Cleaning is accomplished by tapping the cartridge with the external side down to shake off dirt. Care must be taken to prevent distortion of the pleated paper. If the dirt will not separate from the filter, throw it away and replace it with a new filter.

Never use compressed air to clean the paper filter because the porosity enlarges and the filter will not prevent fine dirt from penetrating and entering the engine.

When installing the pleated paper type air filter cartridge the pleated paper should face the external side of the receptacle. See **Figure 8-53.**

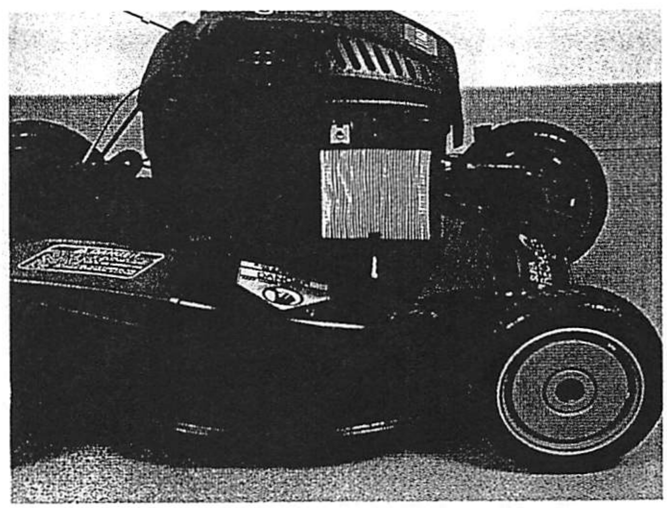


**Figure 8-53.** *When installing the pleated paper air cleaner cartridge place the paper element toward the external cover side of the receptacle.*

## Dual element air cleaners

Engines to be used in greater than normal dusty conditions may have dual element air cleaners that provide more protection. Dual element air cleaners contain a dry or oiled plastic foam filter pre-cleaner followed by a pleated paper type cartridge. See **Figure 8-54.** Some pre-cleaners are oiled and some are non-oiled type. The dual element filters are contained in specially designed receptacles. See **Figure 8-55.** The cartridges and receptacles are found in a variety of designs such as the cylindrical vertical mount, the front mount, and the horizontal mount. See **Figure 8-56.** The pre-cleaner can be washed clean with detergent and water and squeezed dry. The paper filter cartridge should be cleaned by shaking.

Every engine to be serviced or repaired should have the air cleaner examined. If the air cleaner element and/or cartridge is damaged or shows signs of restriction replace them. Worn or damaged mounting gaskets and air cleaner gaskets

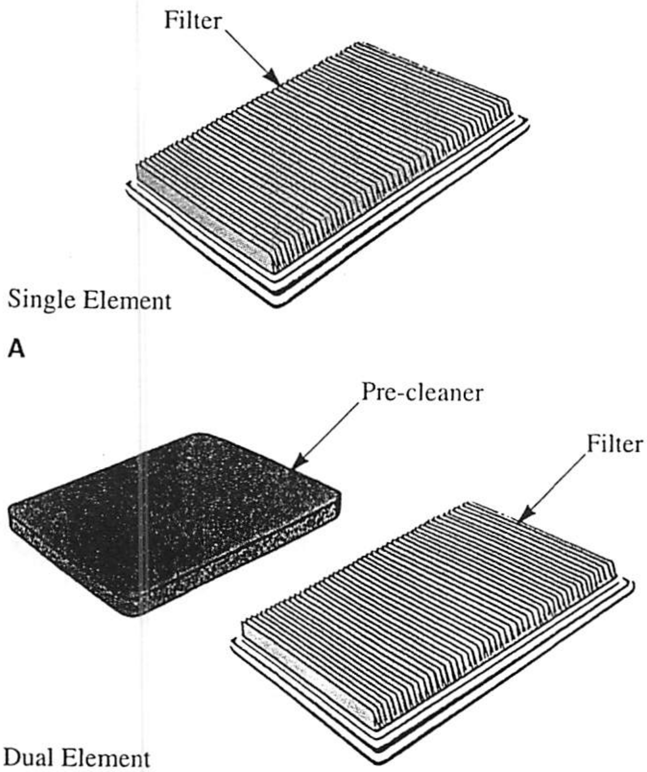



**Figure 8-54.** *Single filters used for mild conditions. Dual element filters used for extremely dirty conditions.*

should be replaced to prevent dirt and dust from entering the engine through improper sealing around the filter.

## Summary

The main purpose of the carburetor is to produce a mixture of fuel and air to operate the engine. The gasoline engine cannot run on *liquid* gasoline. The carburetor must vaporize the fuel and mix it with air.

The amount of air needed for combustion is far greater than the amount of fuel required. The average weight ratio is 15 parts air to 1 part fuel.

The carburetor is operated by pressure differences. It creates partial vacuum by means of a venturi. A venturi is a restriction in a passage that causes air velocity to increase and pressure to decrease. Reduction in pressure draws fuel into the airstream.

Three basic types of carburetors include the natural draft, the updraft, and the downdraft. These carburetors are named according to the direction that the air flows from their outlets to the engine manifold.

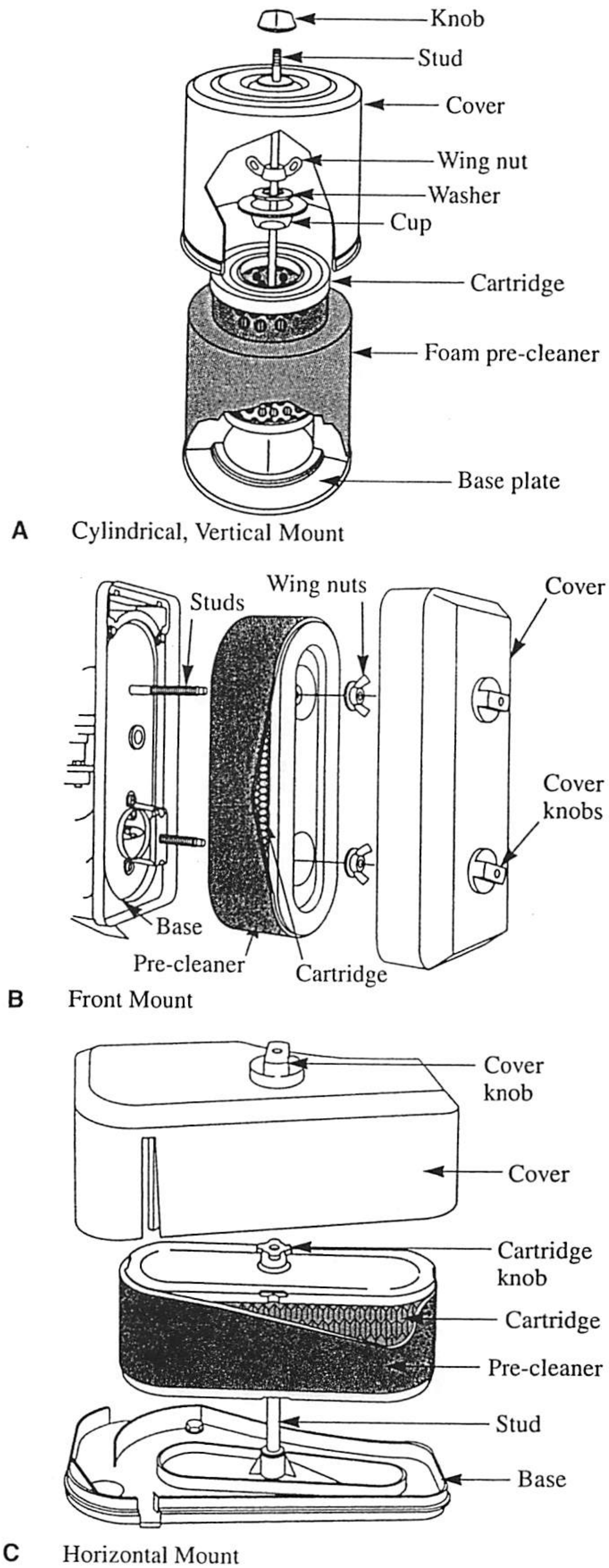



**Figure 8-55.** *A—A dual element air cleaner of the cylindrical vertical mount. B—Front mounted dual element air cleaner. C—Horizontal mounted dual element air cleaner. (Briggs and Stratton Corp.)*

Some fuel systems are equipped with float-type carburetors. The purpose of a carburetor float is to maintain a constant level of fuel in the float bowl.

A diaphragm carburetor does not have a float. Instead, the engine vacuum pulsates a flexible diaphragm. The diaphragm draws fuel into a chamber of the carburetor from which it is readily drawn into the venturi.

A manual throttle control consists of mechanical linkage or a flexible cable that is operated manually to open and close the throttle valve.

In many small engine applications, the load on the engine changes constantly. This change would require constant throttle changes on the part of the operator. Governors work to maintain speed selected by the operator, prevent overspeeding, and limit high and low speeds.

A filtering device is used to clean incoming air. If air is not properly filtered, dirt entering the cylinder will cause rapid wear and scoring of machined parts throughout the engine.

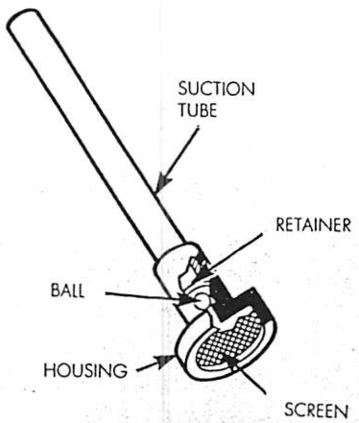
## Know These Terms

| | |
|---|---|
| carburetor | load adjustment |
| air-fuel mixture | acceleration well |
| vacuum | economizer circuit |
| atmospheric pressure | idling circuit |
| venturi | primer |
| venturi principle | diaphragm carburetor |
| natural draft carburetor | manual throttle control |
| updraft carburetor | governor throttle control |
| downdraft carburetor | hunting |
| float | stability |
| choke | sensitivity |
| throttle | air cleaner |

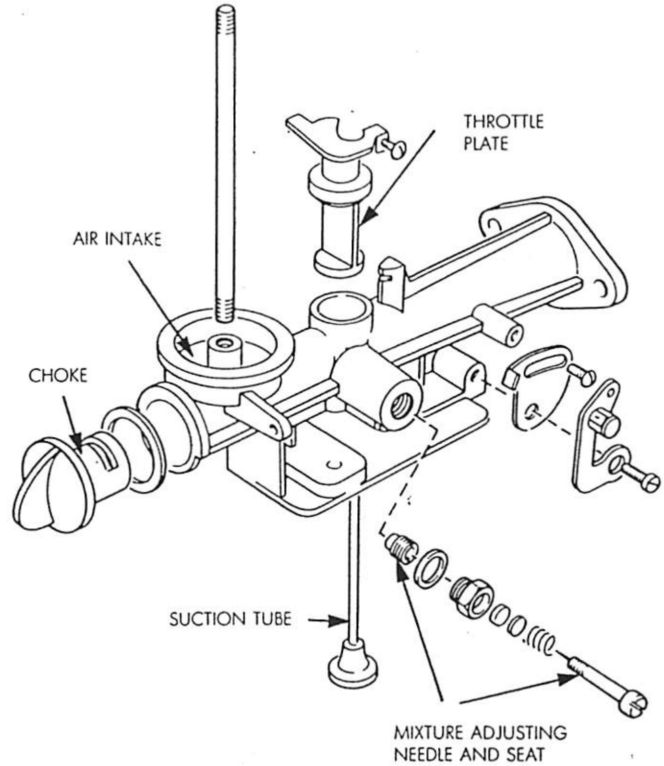
## Chapter 8 Review Questions

***Answer the following questions on a separate sheet of paper.***

1. Give five different engine running conditions that must be met by the carburetor.
2. Normal air-fuel mixture by weight is __________.
   a. 12 to 1
   b. 13 to 1
   c. 14 to 1
   d. 15 to 1
3. If barometric pressure on a standard day at 1500′ MSL was 29.95, then at 3500′ MSL the barometric pressure would be __________. (See **Figure 8-3.**)
   a. 30.95″ Hg
   b. 31.95″ Hg
   c. 29.95″ Hg
   d. 27.95″ Hg
4. In a venturi, __________.
   a. air pressure is greatest where velocity is greatest
   b. air pressure is least where velocity is greatest
   c. velocity is least where air pressure is least
   d. the volume of air entering is slightly greater than the air leaving due to the restriction to flow
5. Name the three basic types of carburetors. (Consider direction of airflow.)
6. Which type of carburetor would normally require a smaller air passage than the other two types?
7. Needle valve points in the carburetor float chamber are usually made from one of two materials. The two materials are __________ and __________.
8. The choke valve in the carburetor is always located __________.
   a. nearest the intake end of carburetor
   b. nearest the manifold end of carburetor
   c. in the center of the carburetor
   d. above the float chamber level
9. Richest air-fuel mixture takes place during __________.
   a. full throttle
   b. half throttle
   c. idle
   d. starting
10. On some carburetors, the amount of fuel that enters the main discharge nozzle is regulated by __________.
    a. the float level
    b. a load adjusting needle
    c. the idle adjustment needle
    d. a spray bar needle valve

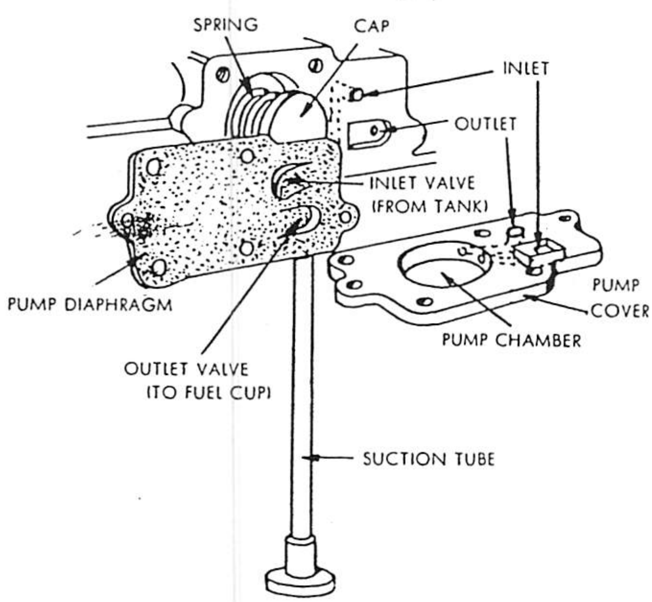



*The screen must be clean and the check ball free to move.*

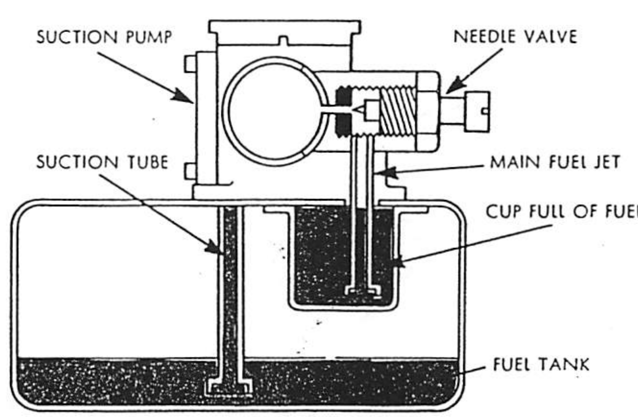



*Exploded view of suction feed carburetor*

An improvement on this carburetor uses a built-in diaphragm fuel pump operated by intake vacuum. The pump keeps a small cup in the fuel tank full of gasoline. The carburetor draws fuel from the cup so it is not affected by the level of gasoline in the tank. Excess fuel pumped into the cup spills over into the tank.




*Parts of a vacuum operated fuel pump on the side of a carburetor*




*Cutaway of a carburetor with built-in fuel pump*

# Basic Carburetor Operation

The carburetor controls the engine speed, and provides it with a correct air fuel mixture through a range of speeds, loads, and temperatures.

**Vacuum & Pressure**
As the piston travels down the cylinder on the intake stroke, it is creating a low pressure area above the piston, just like the plunger of a syringe. This low pressure is known as vacuum. The air pressure outside of the engine (14 psi) is higher than the low pressure above the piston, so the air from the outside gets "sucked" in past the open intake valve to compensate for it. During the exhaust stroke the air pressure is higher above the piston than outside the engine, so the air gets "blown" out past the exhaust valve.

**Speed Control & Vacuum**
Speed is controlled in the engine by the throttle valve, which restricts the airflow through the carburetor. Because the throttle valve is restricting the airflow into the intake manifold, a vacuum is created behind the valve, known as "intake manifold vacuum". Intake manifold vacuum will be low when the engine is at full throttle because the throttle restriction is low. Intake manifold vacuum will be high when the engine is slowing down, or idling because the throttle restriction is high.

**Air Fuel Mixture**
A correct air fuel mixture is necessary to make the engine run smoothly and have power at any speed. There should be enough air for all the available fuel to burn. A mixture that has too much fuel is rich, and will cause rough running, reduced power, and build up of carbon on the piston, valves, and head. A mixture that is too little fuel is lean, and will cause loss of power, surging, and if the engine is operated under load with a lean mixture, it will cause overheating.

**The Venturi**
The venturi is a narrowed area in the carburetor, which creates a low-pressure area and draws fuel into the carburetor. As air passes through the narrower venturi, it speeds up. This speeding up of the air creates a low pressure area (called venturi vacuum) in the venturi.
A tube is connected from the fuel bowl into the venturi, so that fuel is drawn (sucked) from the fuel bowl into the venturi vacuum. When the throttle is closed, venturi vacuum is low because there is little air flow through the venturi. As the throttle is opened the airflow speed increases, and the venturi vacuum increases. As the throttle opens further, the airflow speed increases further and venturi vacuum becomes even greater. This is what supplies more fuel to the engine as the engine speed and airflow increases. As a result the air fuel mixture remains relatively constant through a wide range of engine speeds.

**Choke Circuit**
The choke is a restriction in the carburetor, which provides an extra rich mixture for starting by limiting the amount of air that can enter the carburetor. It is a butterfly valve, and it is placed before the throttle valve and fuel inlets. The choke is placed in a fully closed or nearly closed position for cold starting. It may be partly closed or wide open for warm or hot starting. The choke may be operated manually, or automatically by a thermostatic device.

**Float Circuit**
The float circuit controls how much fuel can enter the fuel bowl. A constant level of fuel in the fuel bowl is necessary to maintain a stable air fuel mixture. Slight differences in the level of fuel in the fuel bowl will affect engine power and performance. The float circuit works like a toilet float. The float and it's needle and seat maintain the level of fuel in the float bowl. As the fuel in the float bowl is used up, the level of the fuel drops, and so does the float. As the float drops, the float needle moves off of its seat, and allows fuel into the float bowl. As fuel enters the float bowl, the float rises, and the float needle closes, which stops any more fuel from entering.

**High Speed Circuit.**
During part / full throttle operation, the throttle valve is open. The fuel enters through the fuel inlet, passes the float needle, and enters the float bowl. The fuel then passes through the bottom of the float bowl, past the high speed mixture screw, and up into the main nozzle. Vacuum from the venturi pulls the fuel up the main nozzle, toward the discharge holes in the venturi area. Here the fuel exits the main nozzle and mixes with air, entering the engine.

**High Speed Mixture Screw.**
The high speed mixture screw controls how much fuel is entering the main nozzle. As the screw is turned in (clockwise) less fuel can pass by the valve, and the fuel mixture becomes leaner. As the screw is turned out, more fuel can pass by the valve, and the fuel mixture gets richer. This adjustment affects engine power and how smooth it runs when it is working hard.
If the engine surges or runs roughly and it emits black smoke from the exhaust pipe, the mixture is too rich. Turn the needle valve in (clockwise) slowly until the engine smoothes out. If the engine surges and runs roughly without emitting black smoke, turn the mixture screw out (counterclockwise) to smooth out engine performance.

**Idle Circuit.**
As the engine is idling, the throttle valve is closed. This lowers the air flow in the carburetor, and lowers the vacuum in the venturi. The fuel enters through the fuel inlet, passes the float needle, and enters the float bowl. The fuel then passes through the bottom of the float bowl, past the high speed mixture screw, and up into the main nozzle. Vacuum from the intake stroke of the engine (not the venturi) pulls the fuel up the main nozzle. Since air is not flowing quickly, there is not enough vacuum to pull the fuel out of the discharge holes, so it continues up the main nozzle to the idle mixture screw. It enters the air stream through the idle port just past the throttle valve.

**Idle Speed Mixture Screw.**
The idle speed mixture screw controls how much fuel passes through the idle port. As the screw is turned in (clockwise) less fuel can pass by, and the fuel mixture becomes leaner. As the screw is turned out, more fuel can pass by, and the fuel mixture gets richer. This adjustment affects how smoothly the engine runs when it is idling. Run the engine at least three minutes to warm up before adjusting. If the engine will not start, turn the needle valve in (clockwise) until it closes. Back the screw out approximately one and one-half turns. This is not a correct adjustment, but it is rich enough to start most engines.

**Idle Speed Adjustment**
The idle-speed adjustment is a stop screw on the throttle shaft which prevents the throttle from closing farther. Single cylinder, air-cooled engines idle much faster than multicylinder engines. Normal idle speed for engines of less than ten horsepower is 1750 to 1800. If the engine will not accelerate properly from idle after the idle speed is set as described above, the idle speed may be too slow. An engine that idles too slowly will overheat because the air flow through the cooling fins will not be sufficient to cool the engine.

## Basic Carburetor Parts