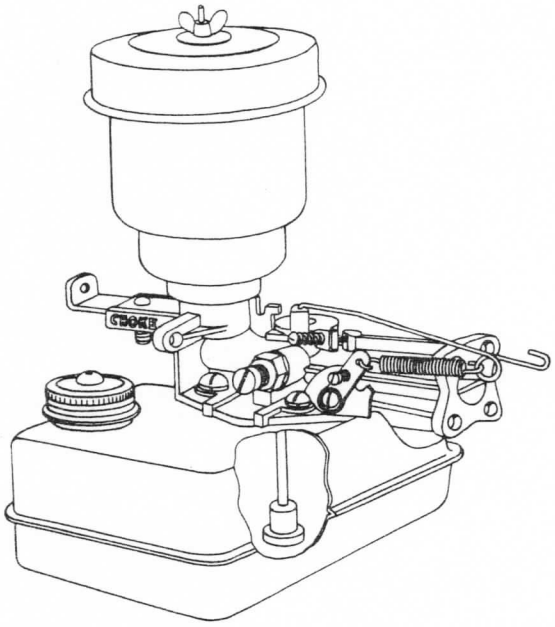


unit 9
fuel systems

The engine operates on a mixture of air and fuel. The fuel system has two main parts, as shown in Figure 9-1. The fuel tank or gas tank allows the engine to store enough fuel for several hours of operation. The engine part used to mix air and fuel together is called a *carburetor*. There are many types of carburetors. They all work in the same basic way. In this unit we will study the operation of the fuel system.

LET'S FIND OUT: **When you finish reading and studying this unit, you should be able to:**

1. **Explain the parts and operation of a basic carburetor.**
2. **Describe the parts and operation of a vacuum or suction carburetor.**
3. **Describe the parts and operation of a float carburetor.**
4. **Describe the parts and operation of a diaphragm carburetor.**
5. **Explain the operation of a sliding valve carburetor.**

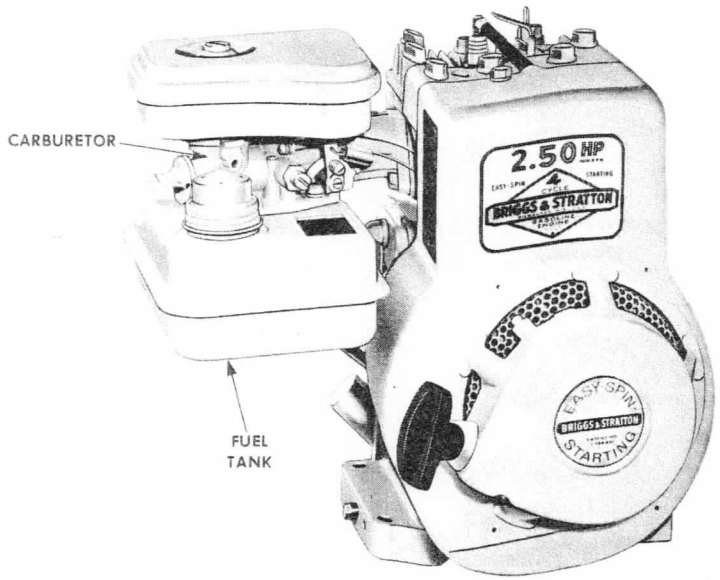


Figure 9-1. The two main parts of the fuel system are fuel tank and carburetor. (Briggs & Stratton Corp.)

THE CARBURETOR

One of the engine's strokes is called the *intake stroke.* On this stroke the piston moves down very fast. At the same time, the intake valve is opened. This fast downward movement causes a vacuum in the cylinder, and this is how the air-fuel mixture gets into the cylinder.

The carburetor's job is to mix the air and fuel together in just the right amount. Next to the intake valve, the carburetor is attached to the engine. A carburetor is shaped like a tube, as shown in Figure 9-2. The tube is open at one end. When the piston is on the intake stroke, air is pulled in the open end of the carburetor. The air can get into the engine through the open intake valve.

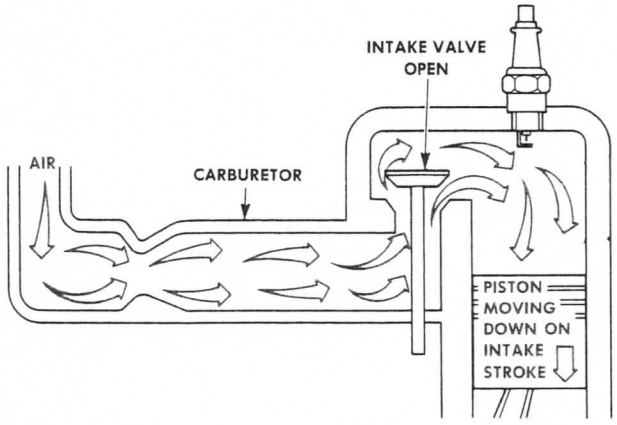


Figure 9-2. A carburetor is a tube open at one end, attached to the engine.

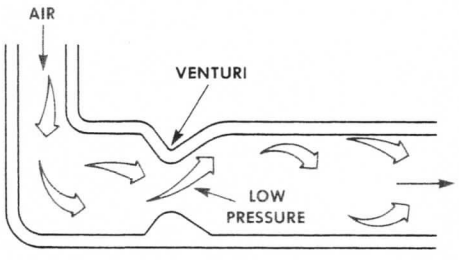


Figure 9-3. The venturi is a raised part of the carburetor that causes a low-pressure area.

Venturi

The middle of our carburetor tube has a partially restricted area. This area is called the *venturi,* Figure 9-3. Air has a hard time getting through the venturi. As the air does get through, it speeds up, leaving low pressure in the venturi. This low pressure will pull in fuel.

Fuel Pickup

We must have a way of mixing fuel with the air. A small amount of fuel is stored in the carburetor, as shown in Figure 9-4. The fuel is right under the venturi. A hollow pickup tube runs from the fuel to the venturi.

When air goes through the venturi, it causes a low pressure. This low pressure sucks fuel up the pickup tube. The fuel mixes with the air. The mixture of air and fuel goes into the engine.

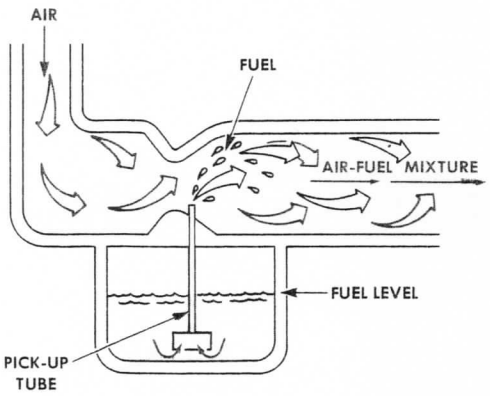


Figure 9-4. The pickup tube lets fuel mix with the air.

Throttle Valve

There are times when we want an engine to run fast. At other times we want it to run slowly. If a large amount of air-fuel mixture enters, the engine runs fast. If just a little air-fuel mixture gets in, the engine will run slowly.

We use a part called the *throttle valve* to control engine speed. A throttle valve is shown in Figure 9-5. The throttle valve is a round plate. It fits in the end of the carburetor tube. The valve may be opened or closed by the person using the engine.

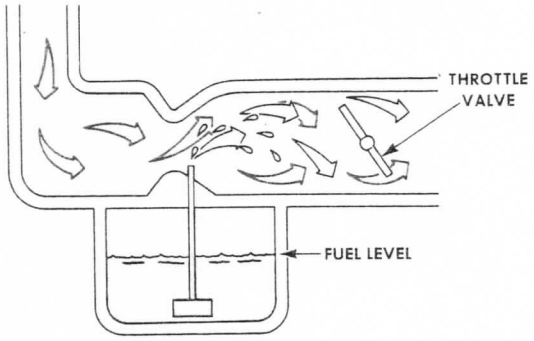


Figure 9-5. The throttle valve fits in the end of the carburetor.

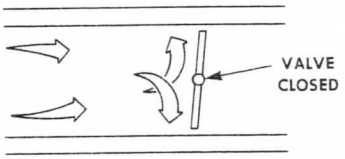


Figure 9-6. A closed throttle valve prevents air and fuel from getting into the engine.

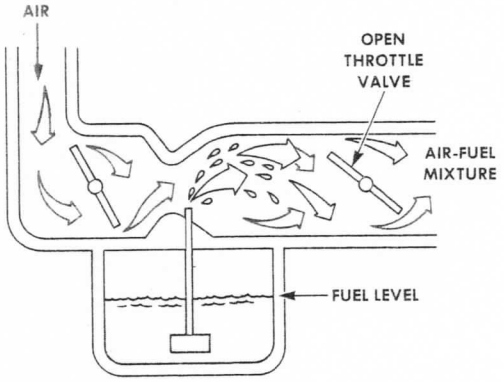


Figure 9-7. An open throttle valve lets in a large amount of air-fuel mixture.

A closed valve is shown in Figure 9-6. Very little air and fuel can get into the engine, so the engine runs slowly. The more the valve is opened, the more air-fuel mixture gets into the engine, and the faster the engine runs. An open throttle valve is shown in Figure 9-7.

Choke

When an engine is cold, it is hard to start. A carburetor has a choke, Figure 9-8, which helps start a cold engine.

The choke is a small round valve. It looks a lot like the throttle valve. The choke valve fits in the carburetor near where the air comes in.

When the engine is cold, we close the choke valve. Very little air can get into the carburetor. The piston going down causes a vacuum. This strong vacuum pulls a lot of fuel out of the pick-up tube. The fuel goes into the cylinder. All this fuel helps the engine start more easily.

The choke valve usually is connected to a lever, Figure 9-9. The lever is on the outside of the carburetor. We use the level to close the choke valve when the engine is cold. We move the lever to open the choke valve when the engine is warm.

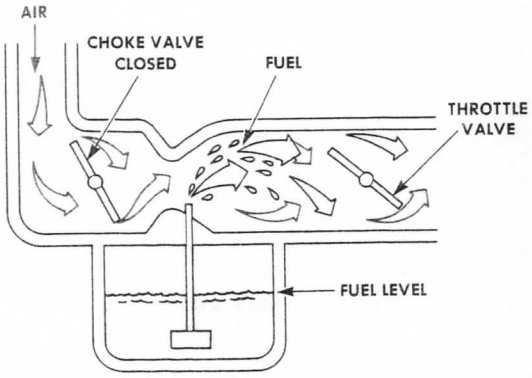


Figure 9-8. When the choke valve is closed, a lot of fuel is pulled up the pickup tube.

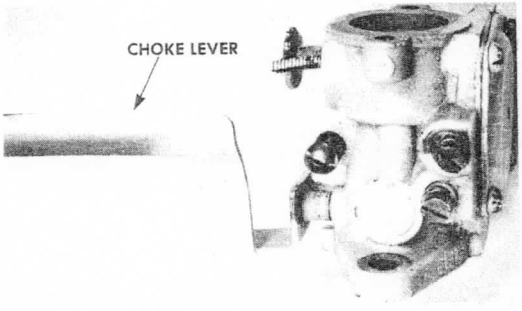


Figure 9-9. A choke lever is used to open and close the choke valve.

High-Speed Fuel Adjustment Screw

When the engine runs at high speed, it needs a lot of air and fuel. Air enters the carburetor and goes through the venturi. A vacuum in the venturi pulls fuel up the pickup tube. The fuel mixes with the air and enters the cylinder.

We need a way of controlling the amount of fuel that goes up the pickup tube. A screw with a pointed end fits in the side of the carburetor as shown in Figure 9-10. The end of the screw goes into the pickup tube. We use the screw to open or close the pickup tube. If we turn the screw all the way in, not much fuel can go up the tube. If we turn the screw out, a lot of fuel can go up the tube.

This screw is called the high-speed fuel adjustment screw. We use it to adjust the amount of fuel going into the engine at high speed. In a later unit we will see how to adjust this screw.

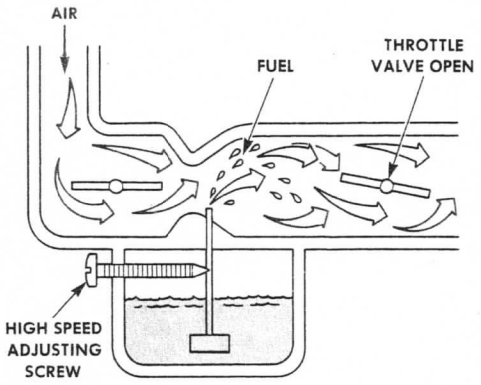


Figure 9-10. The high-speed adjustment screw controls the fuel coming up the pickup tube.

Low-Speed Fuel Adjustment Screw

When we want an engine to run slowly, we close the throttle valve, so that very little air goes through the venturi and very little fuel is pulled up the pickup tube. We need a way to get a small amount of fuel into the engine so it will run. We do this by having a small hole behind the throttle valve. Fuel is pulled through a passage and out the hole as shown in Figure 9-11.

We need a way to control the amount of fuel that comes out the hole. A small screw with a pointed end is used, Figure 9-12. The screw goes through the side of the carburetor. The pointed end goes into the fuel passage. If the screw is turned all the way in, very little fuel can come out

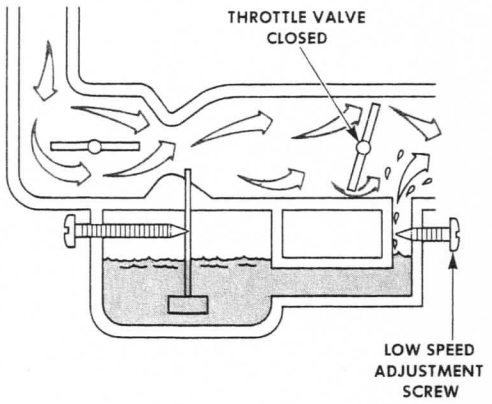


Figure 9-11. The low-speed screw controls the fuel coming out behind the throttle valve.

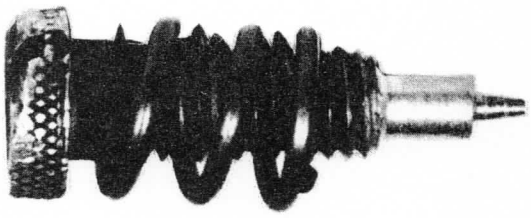


Figure 9-12. Low-speed adjustment screw.

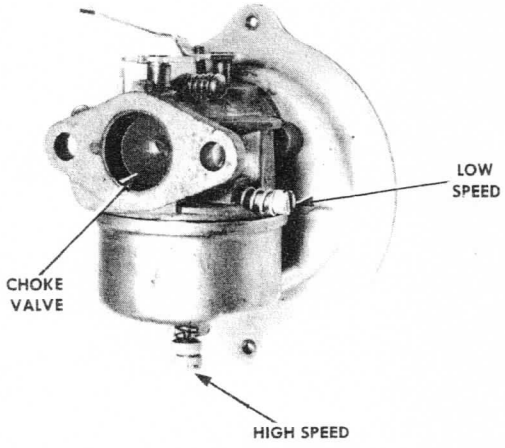


Figure 9-13. The low-speed and high-speed adjustment screws and the choke valve can be seen in this carburetor.

the hole. If the screw is turned out, more fuel can get out the hole. We will learn how to adjust this screw in a later unit. The carburetor shown in Figure 9-13 has the low-speed fuel adjustment screw, the high-speed fuel adjustment screw and the choke valve identified.

SUCTION CARBURETOR

The suction or vacuum carburetor is one of the most common carburetors. Many small engines use a vacuum carburetor. A vacuum carburetor is mounted on top of a fuel tank. Fuel is pulled out of the fuel tank by a vacuum. All vacuum carburetors work the same. They are sometimes called vacu-feed or vacu-jet carburetors.

Suction Carburetor Parts

A vacuum carburetor is shown in Figure 9-14. The carburetor has two bolt holes used to mount it to the engine. There is an opening at the top of the carburetor, which allows air to enter. The air goes through the center of the carburetor. A choke is mounted next to the air opening. The choke can be used to open or close the air opening.

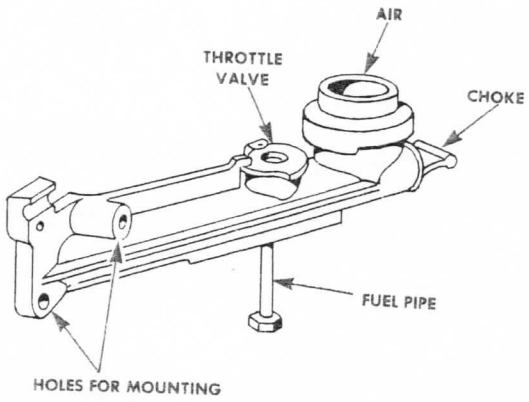


Figure 9-15. Parts of a vacuum carburetor. (Briggs & Stratton Corp.)

A throttle valve is inside the carburetor. Right below the throttle valve is a tube called the *fuel pipe*, which brings fuel up into the carburetor. A fuel pipe is shown in Figure 9-15. There is a small screen in the bottom of the pipe. The screen stops dirt from going up the pipe and into the carburetor. A small ball fits in the bottom of the pipe, Figure 9-16. The ball lets fuel go up the pipe, but it will not let fuel run back out of the pipe. If the pipe is empty, it takes a long time to start the engine.

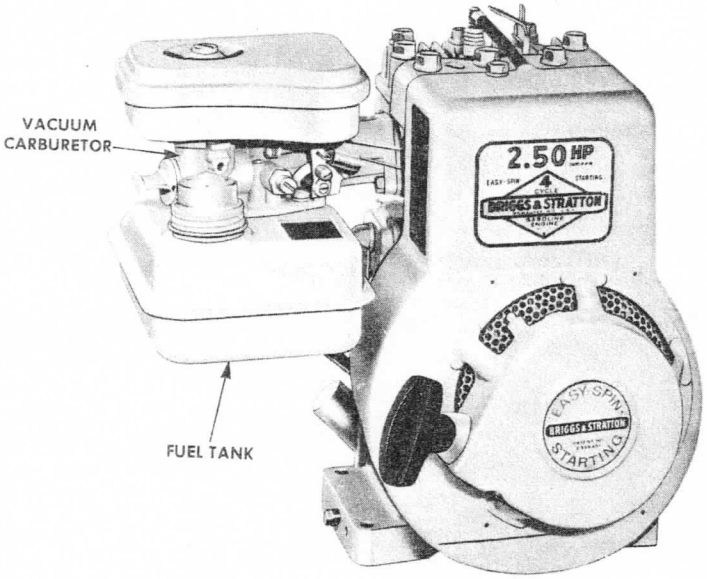


Figure 9-14. An engine with a suction or vacuum carburetor. (Briggs & Stratton Corp.)

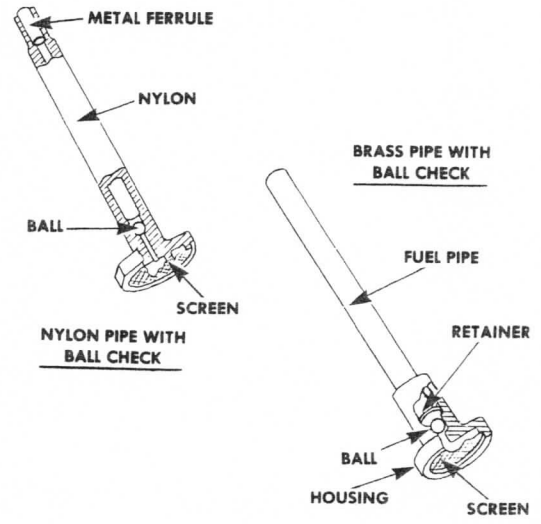


Figure 9-16. The fuel pipe has a screen and ball. (Briggs & Stratton Corp.)

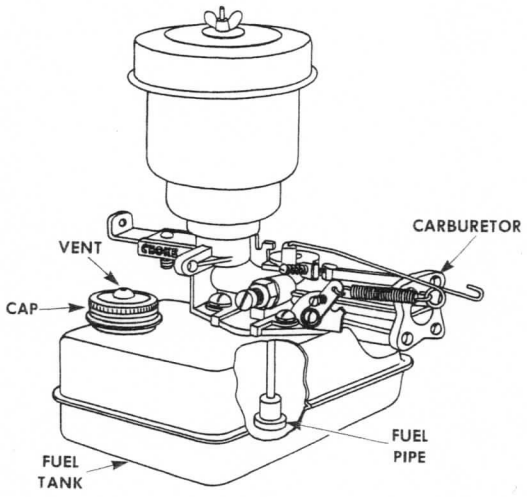


Figure 9-17. The carburetor is mounted to the fuel tank. (Briggs & Stratton Corp.)

The fuel tank is attached to the bottom of the carburetor. A fuel tank and carburetor are shown in Figure 9-17. The fuel tank is used to store fuel. There is enough gasoline in the tank to allow the engine to run for several hours. The cap on the fuel tank has a small hole in it, called a *vent*. The vent allows air to get into the tank. Without a vent, a vacuum could form in the tank and prevent fuel from going up the fuel pipe. The fuel pipe on the carburetor fits down into the fuel tank.

How the Suction Carburetor Works

As the piston moves down in the cylinder, a vacuum is created inside the carburetor. A vacuum inside the carburetor pulls fuel up the fuel pipe. The amount of fuel is controlled by a high-speed adjustment screw, shown in Figure 9-18. The throttle valve slows down the air much like a venturi; this helps pull fuel up the pipe. There are

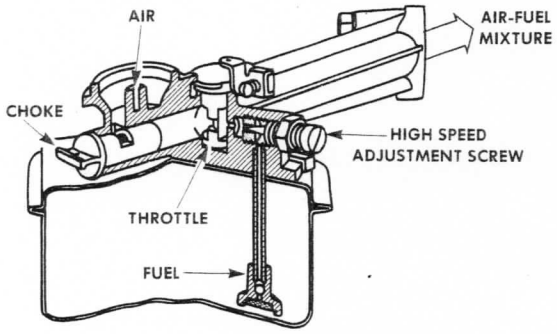


Figure 9-18. Air going through the carburetor causes a vacuum that pulls fuel out of the fuel tank. (Briggs & Stratton Corp.)

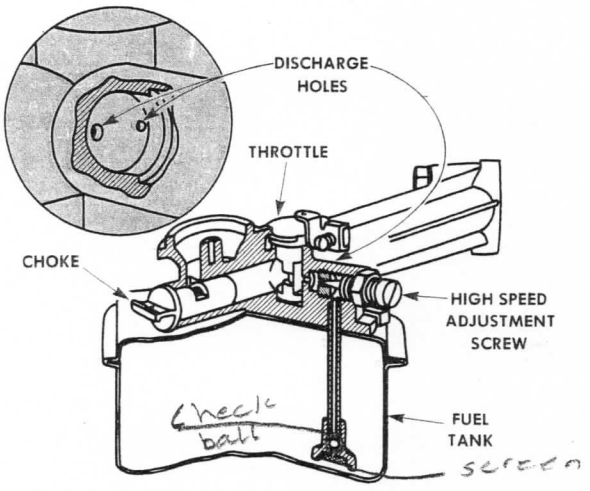


Figure 9-19. Fuel enters through two discharge or metering holes. (Briggs & Stratton Corp.)

two holes through which the fuel enters the carburetor. These are called *metering* or *discharge holes,* Figure 9-19. When the throttle is open, fuel comes out both holes. When the throttle is closed, a small amount of fuel can come out one of the holes. This allows the engine to run with a closed throttle.

The choke is a sliding plate mounted at the outer end of the carburetor, Figure 9-20. The choke is pulled out to close off the air. This helps in starting a cold engine. The choke is pushed in as soon as the engine starts.

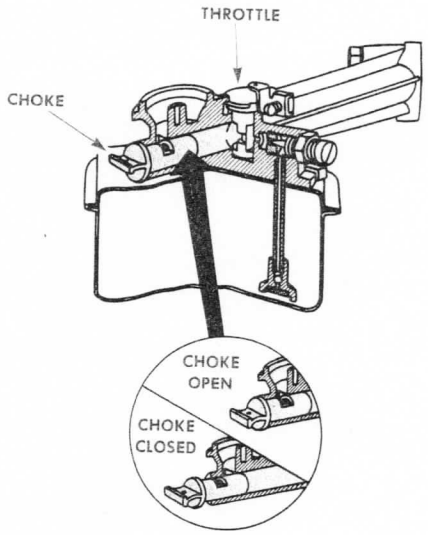


Figure 9-20. The choke is opened to let in air and closed to stop the air. (Briggs & Stratton Corp.)

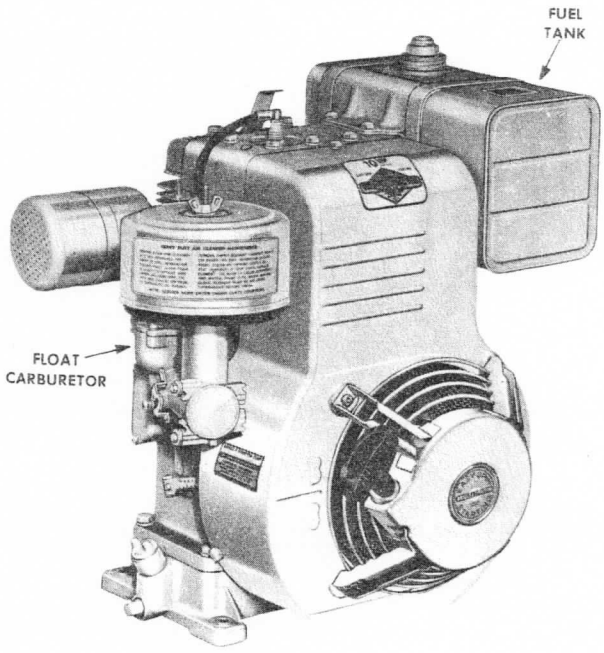


Figure 9-21. An engine with a float carburetor. (Briggs & Stratton Corp.)

FLOAT CARBURETOR

Many small engines use a float carburetor, Figure 9-21. A separate fuel tank is used with a float carburetor. The fuel tank is attached to another part of the engine. The fuel tank is mounted higher than the carburetor, as shown in Figure 9-22. Fuel flows from the tank through a fuel line to the carburetor. Gravity makes the fuel flow. A float in the carburetor controls the flow of fuel from the tank.

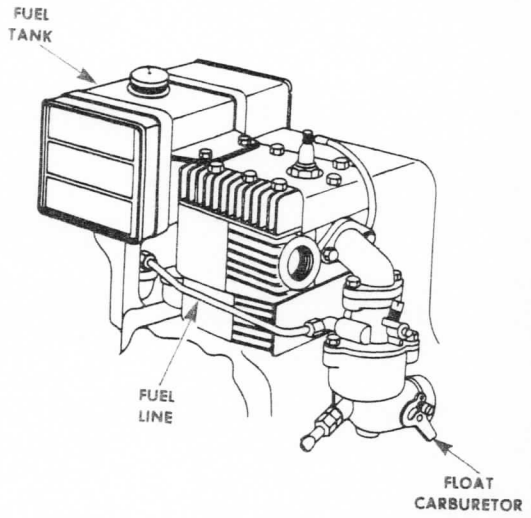


Figure 9-22. The fuel tank is mounted above a float carburetor. (Briggs & Stratton Corp.)

The Float

The fuel line from the fuel tank brings fuel into the carburetor. The fuel line is connected to a hole, called the *fuel inlet*, in the side of the carburetor. The fuel goes into an area called the *float bowl.* An inlet and float bowl are shown in Figure

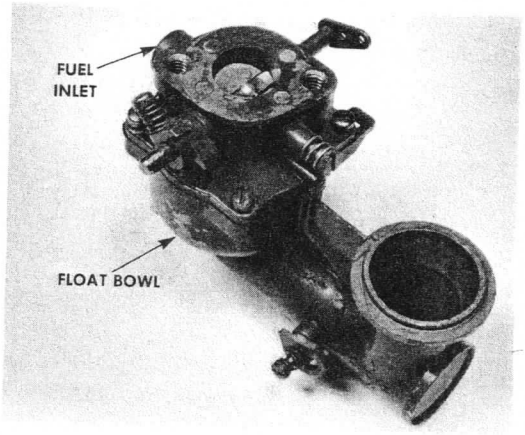


Figure 9-23. A float carburetor.

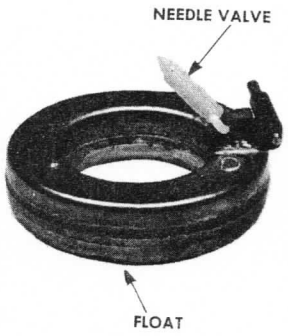


Figure 9-24. A float and needle valve.

9-23. Fuel in the float bowl is used to run the engine.

The amount of fuel in the float bowl is controlled by a float. The float is shown in Figure 9-24. It is a small hollow piece of copper or plastic. The float is light enough to float on top of gasoline. The float is connected to a pivot on the side of the bowl. A small, round piece of metal with a sharp end fits on top of the float. This part is called a *needle valve*, Figure 9-25. The needle valve fits into the fuel inlet. There is a small vent in the top of the bowl to let in air and equalize pressure in the float chamber.

As the engine runs, some of the fuel in the float bowl is used up. As the fuel level in the bowl drops, the float drops. As the float moves down, the needle valve is moved out of the inlet hole. Fuel can come in through the inlet hole from the fuel tank, as shown in Figure 9-26.

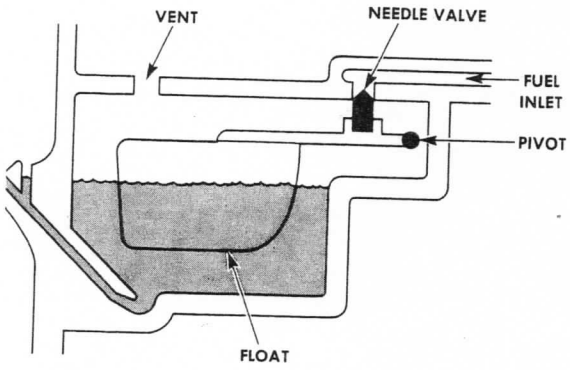


Figure 9-25. Parts of the float system.

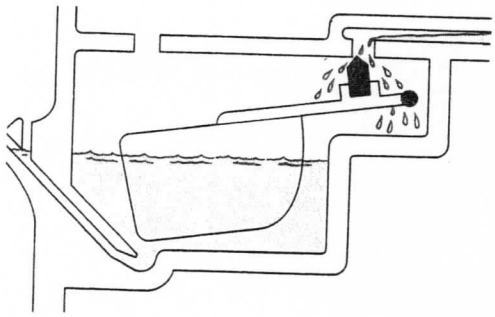


Figure 9-26. When the float is down, the needle valve lets fuel come in.

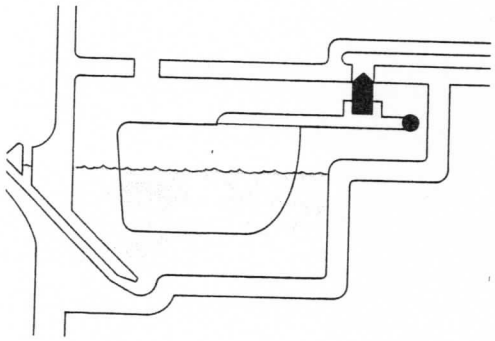


Figure 9-27. As the fuel level goes up, the float goes up and shuts off the fuel.

The fuel level will rise as more fuel comes into the bowl. The float will also rise, pushing the needle valve into the inlet, as shown in Figure 9-27. Now fuel cannot get into the bowl around the needle valve. Flow from the fuel tank is stopped.

Float Carburetor Parts

All float carburetors use a float to control the fuel level. A float carburetor has the same basic parts as other carburetors we have studied. Two types of float carburetors are shown in Figure 9-28. Many float carburetors have a low- and a high-speed adjustment screw. They have a throttle valve and choke valve.

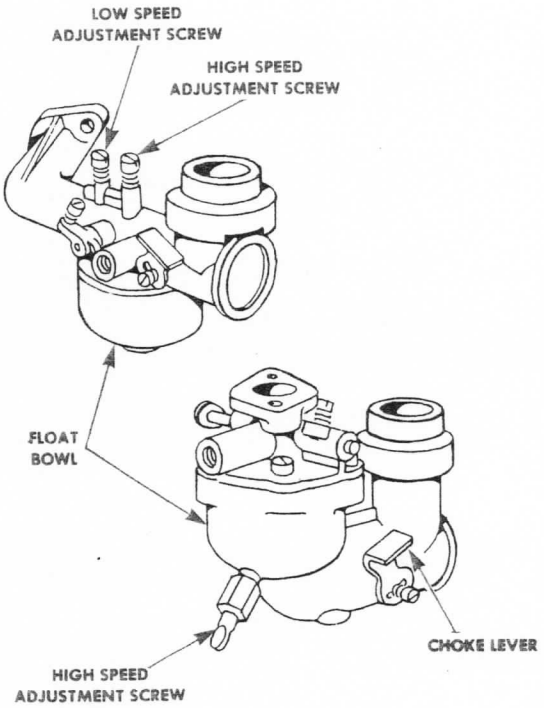


Figure 9-28. Parts on the outside of two float carburetors. (Briggs & Stratton Corp.)

The inside parts of a float carburetor are shown in Figure 9-29. There is a tube with holes in it. It brings fuel from the float bowl to the venturi. The tube is called a *nozzle*. It does the same job as the fuel pipe in a suction carburetor.

How The Float Carburetor Works

When the engine is running fast, the throttle valve is open as shown in Figure 9-30. Air comes

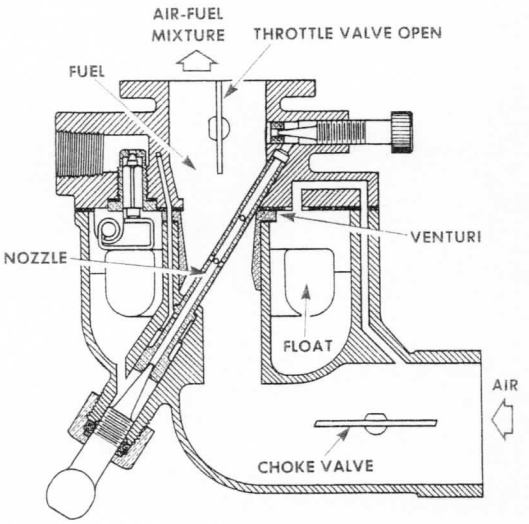
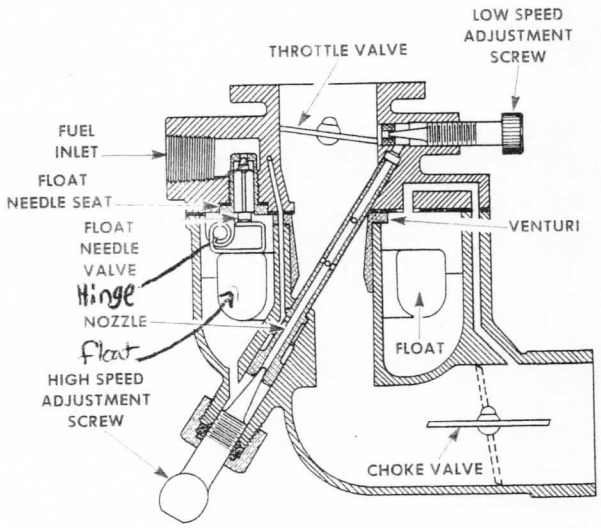


Figure 9-30. Air flowing through the venturi causes fuel to be pulled through the nozzle.

Figure 9-29. Parts inside a float carburetor.



in the carburetor. As air goes through the venturi, low pressure is developed. Fuel is pulled out of the float bowl through the nozzle. Air and fuel mix together in the venturi. The air-fuel mixture enters the engine cylinder. The amount of fuel that can go up the fuel nozzle is controlled by the high-speed adjustment screw. Air bleed holes in the nozzle help break up the fuel on its way out of the nozzle.

When the engine is running slowly, the throttle valve is closed. There is a small hole on the engine side of the throttle valve. A vacuum at this hole causes fuel to be pulled up the nozzle. A small amount of fuel goes out of this hole and into the engine as shown in Figure 9-31. This is enough fuel for the engine to run.

A choke valve is used for cold starting. The choke valve is closed as shown in Figure 9-32. Not much air can enter the carburetor. A strong vacuum is caused by the engine's piston. This strong vacuum pulls a lot of fuel out of the nozzle. The fuel goes into the engine to help it start.

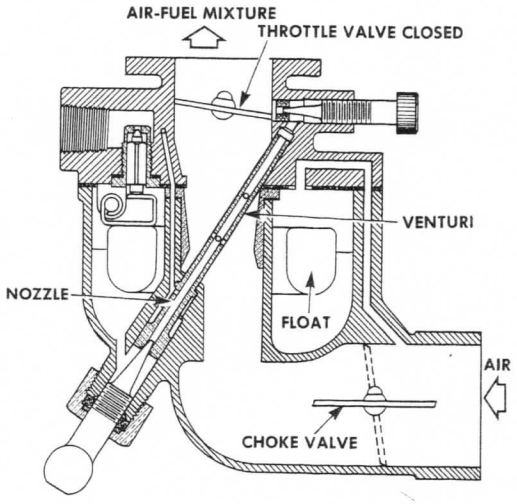


Figure 9-31. Fuel comes out of a hole behind the closed throttle valve.

DIAPHRAGM CARBURETOR

Another kind of carburetor is used on many small engines. It is called a *diaphragm carburetor.* Float and suction carburetors work only on engines that are used upright. If a float or suction engine is turned on its side, the carburetor will not work properly. Some engines are used in many positions. For example, a chainsaw, Figure 9-33, must work in any position. A diaphragm carburetor is made to work in any position.

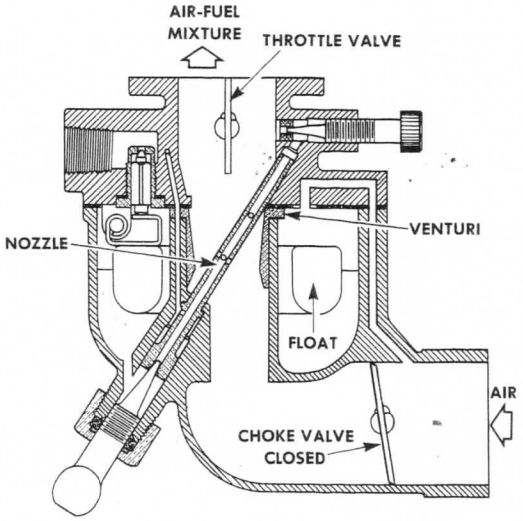


Figure 9-32. A closed choke valve causes a lot of fuel to be pulled out of the nozzle.

Figure 9-33. A chainsaw needs a diaphragm carburetor so it can work in all positions. (McCulloch Corp.)

Diaphragm Carburetor Parts

The outside parts of a diaphragm carburetor are shown in Figure 9-34. The top part of the carburetor is the same as a float or suction carburetor. It has a choke valve, throttle valve and venturi. The diaphragm carburetor has a high- and low-speed adjustment screw, Figure 9-35, just like other carburetors.

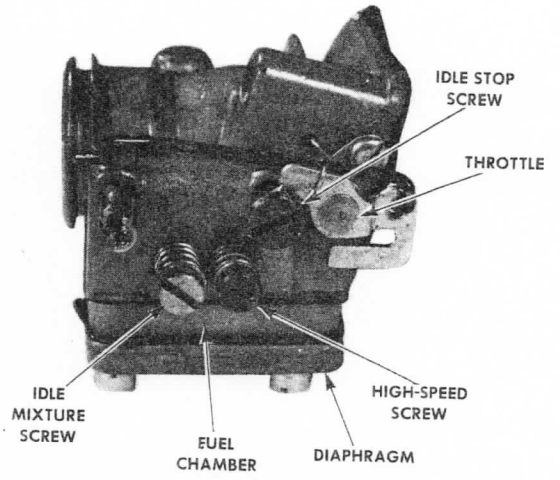


Figure 9-34. The outside parts of a diaphragm carburetor.

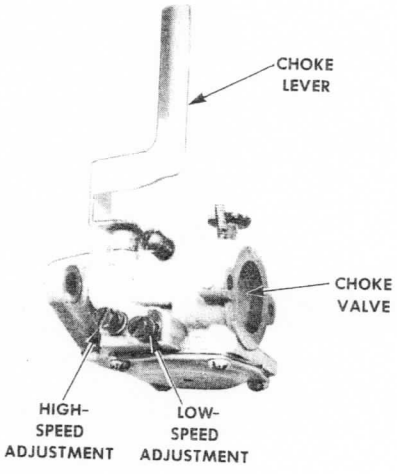


Figure 9-35. A diaphragm carburetor has a low- and a high-speed adjustment screw like other carburetors.

This kind of carburetor does not have a float bowl. Instead, it has a part called a *diaphragm.* The diaphragm controls a small amount of fuel in a fuel chamber. A fuel inlet allows fuel to enter the carburetor.

How a Diaphragm Carburetor Works

The diaphragm is made from a flexible rubber-like material. The diaphragm is stretched across a small space called a *chamber*, Figure 9-36.

A small control lever is connected from the center of the diaphragm to a needle valve. The needle valve has the same job as the needle valve in a float carburetor. A small spring fits between the top of the chamber and the control lever. The control lever is connected to a small pivot.

The fuel flows from the fuel tank to the fuel inlet. The spring pushes down on the control lever. This allows the needle valve to drop down.

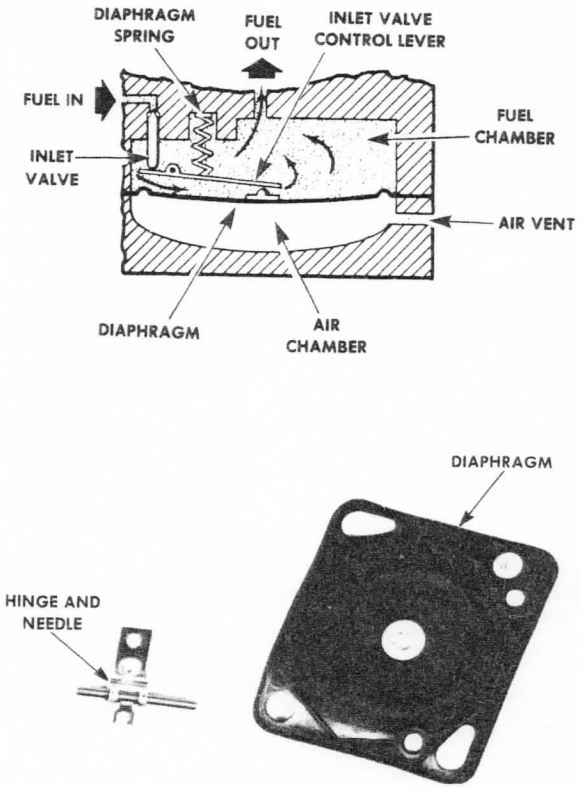


Figure 9-36. Diaphragm parts. (McCulloch Corp.)

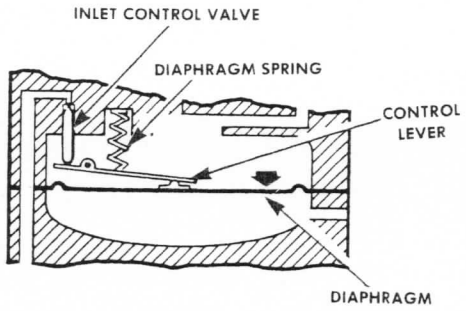


Figure 9-37. Fuel comes into the chamber around the needle valve.

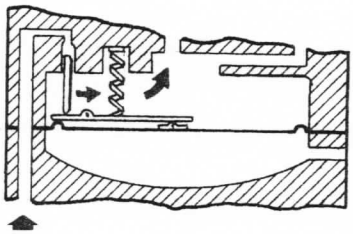


Figure 9-38. When the chamber is full, the diaphragm moves down and pushes the needle valve up.

Fuel can come in around the needle valve, as shown in Figure 9-37.

As the fuel fills up the chamber, it pushes down on the diaphragm. Downward movement of the diaphragm causes the control lever to pivot upward. This pushes up on the needle valve. The fuel inlet is now closed, as shown in Figure 9-38. When fuel is used up, the diaphragm comes back up. The needle will open to let fuel in again.

The diaphragm will work the same way no matter what position the engine is in. The engine can run even if it is upside down.

The rest of the carburetor works in the same manner as a float or suction carburetor. Air enters the carburetor and flows over a venturi. Low pressure in the venturi allows fuel to be pulled out of the fuel chamber. Fuel mixes with the air and enters the engine cylinder. An exploded view of a diaphragm carburetor is shown in Figure 9-39.

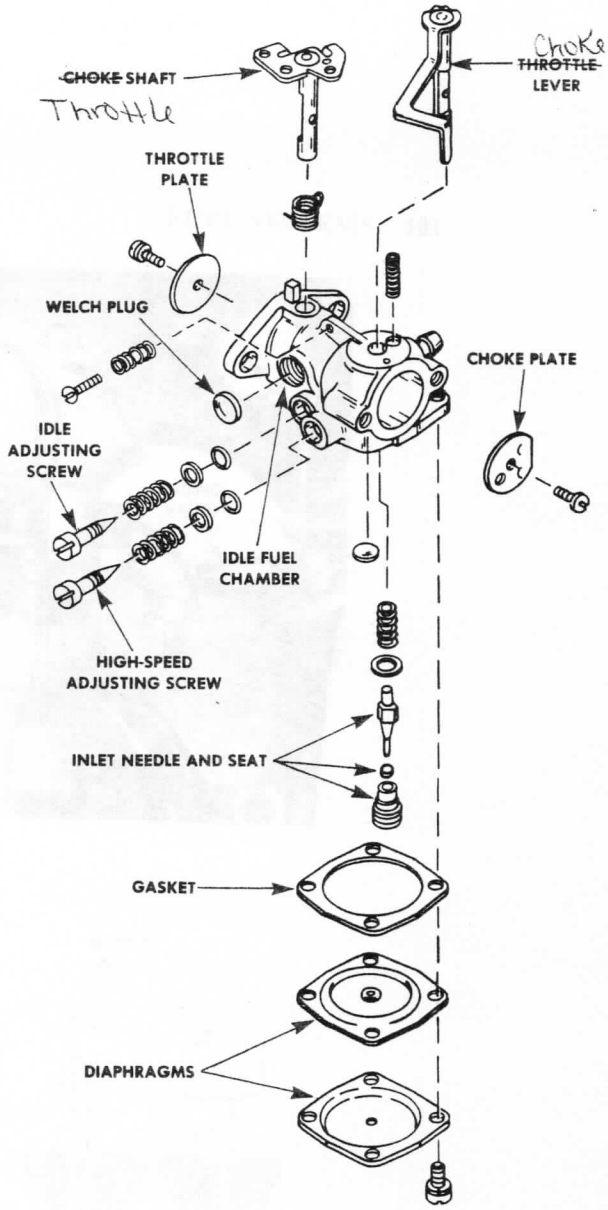


Figure 9-39. An exploded view of a diaphragm carburetor. (Tecumseh Products Co.)

SLIDING VALVE CARBURETOR

Many moped and motorcycle engines use a carburetor called a *sliding valve*. The carburetor gets its name from a piston shaped valve that slides up and down inside the carburetor, Figure 9-40. On the end of the sliding valve is a long needle valve. The valve controls the amount of

Figure 9-43. This mower needs a governor to keep the engine speed steady. (The Toro Co.)

there is another control over speed. This control comes from a *governor.*

A governor is used to hold an engine at a steady speed. Let's say you are mowing a lawn. You set the throttle on your mower at the right speed. Then you start mowing the grass, Figure 9-43. When you come to very high grass, the mower engine has to work very hard. The engine will start to slow down.

The governor's job is to keep the engine running at a steady speed. It does this by opening or closing the throttle valve. The governor closes the throttle valve if the engine is not working hard. It opens the throttle for more power if the engine has to work hard. Engines used on lawn mowers and tillers use a governor. There are two types of governors. One is called an *air vane* and the other a *mechanical governor.*

Air Vane Governor

An air vane governor uses the force of air coming off the flywheel. A small, flat piece of plastic or steel is mounted above the flywheel, as shown

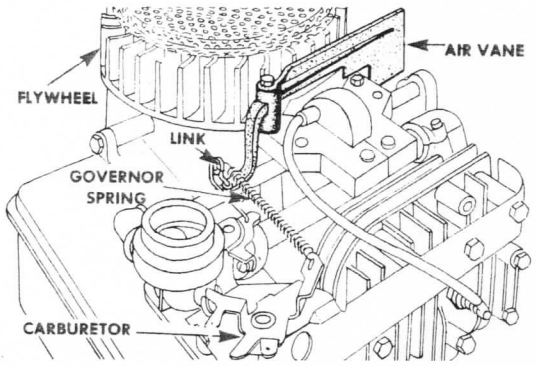


Figure 9-44. Air vane governor parts. (Briggs & Stratton Corp.)

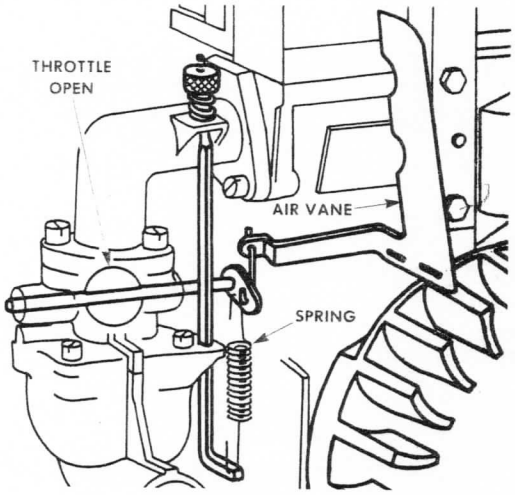


Figure 9-45. The governor spring tries to hold the throttle open. (Briggs & Stratton Corp.)

in Figure 9-44. This is called the *air vane.* The air vane is connected to the throttle valve by a piece of wire, called a *link.* A spring is connected to the link. The spring is connected so that it tries to open the throttle, Figure 9-45.

When the engine is running, air is thrown off the flywheel. The air hits the air vane as shown in Figure 9-46. The vane and link try to close the carburetor throttle. The faster the engine is running the more air hits the vane. The stronger the push on the vane, the more force there is to close the throttle valve.

The governor spring works against the air vane. It tries to pull the throttle open. The spring usually is connected to a hand control as shown in

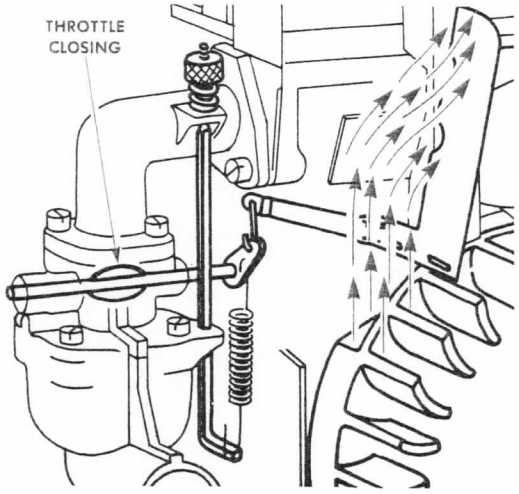


Figure 9-46. When air hits the air vane, the throttle is closed.

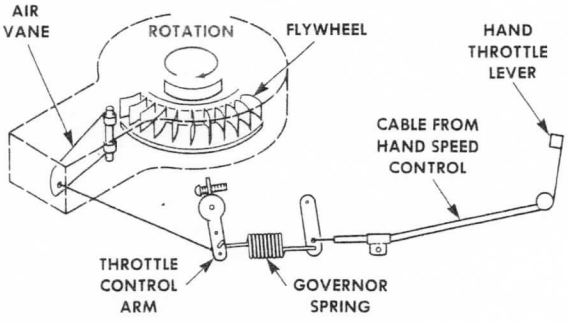


Figure 9-47. The parts of a hand throttle control.

Figure 9-47. When you work the hand throttle lever on a mower, you are pulling on a cable. The cable is connected to the governor spring. Putting tension on the spring will make the engine run faster. Releasing the spring will allow the engine to run slower. The spring and air vane work together to keep the engine speed steady.

Mechanical Governor

Some engines use a mechanical governor. Part of this governor is inside the engine. A small gear rides on the camshaft gear. Attached to the gear is a small set of weights as shown in Figure 9-48. A governor spring, like the one in an air vane governor, is used. The spring holds the throttle open. The spring is attached to the hand control.

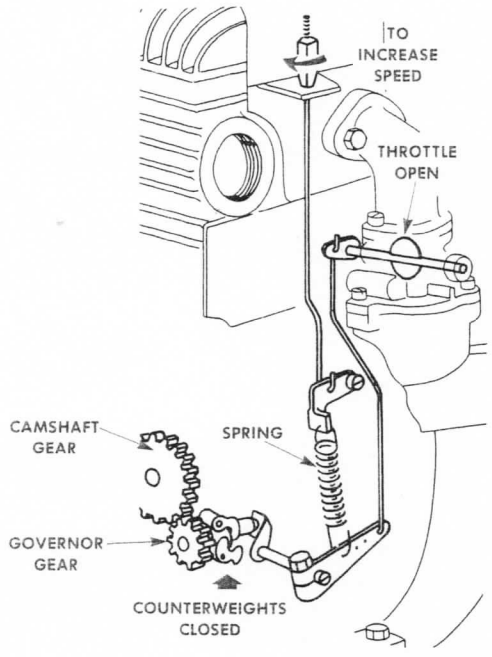


Figure 9-48. The governor spring tries to hold the throttle open. (Briggs & Stratton Corp.)

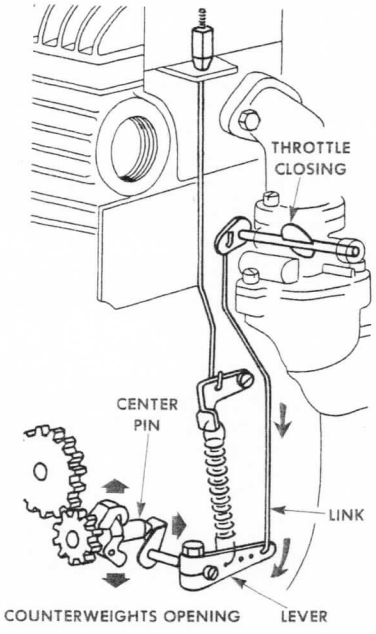


Figure 9-49. As the weights fly out, they move a lever to close the throttle. (Briggs & Stratton Corp.)

As the engine runs, the camshaft gear makes the governor gear turn. The high speed of the governor gear causes the counterweights to fly outward as shown in Figure 9-49. A pin attached

to the weights moves. This pushes against an arm and lever. Movement of the lever pulls on the link. The link is connected to the throttle. The throttle is closed. The engine slows down. The spring and counterweights work together to keep the engine speed steady.

AIR CLEANER

On each intake stroke the engine pulls in a lot of air. There is dirt in the air. This dirt must not get into the engine cylinder. Dirt will scratch the cylinder and rings. A dirty engine will wear out very fast. An air cleaner is used to clean the air before it enters the engine.

Oil Bath Air Cleaner

Several types of air cleaners are used on small engines. One common type is called an *oil bath air cleaner*. Like other air cleaners, the oil bath type is mounted to the carburetor. An oil bath air cleaner is shown in Figure 9-50.

All the air going into the carburetor must go through the air cleaner first. The oil bath air cleaner is a can with air passages in it. Dirty air comes in the top of the can as shown in Figure 9-51. The air goes down the inside of the can. The air must then change direction and start back up the can again.

There is a pool of oil in the bottom of the can. The air changes direction right over the oil. Dirt in the air is too heavy to make the quick turn. The dirt keeps going straight into the oil. The oil traps the dirt. The cleaned air goes through an oiled screen. Any dirt left in the air sticks to the oiled screen. Cleaned air then goes down the center of the can and into the carburetor.

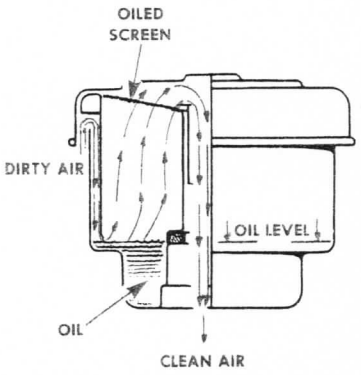


Figure 9-51. A cutaway view of an oil bath air cleaner. (Briggs & Stratton Corp.)

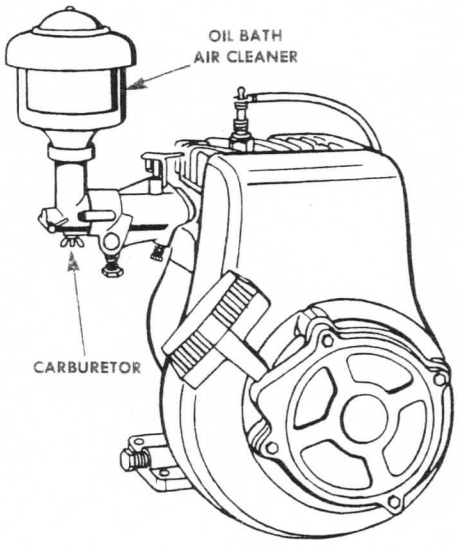


Figure 9-50. An oil bath air cleaner mounted on top of a carburetor. (Clinton Engines Corp.)

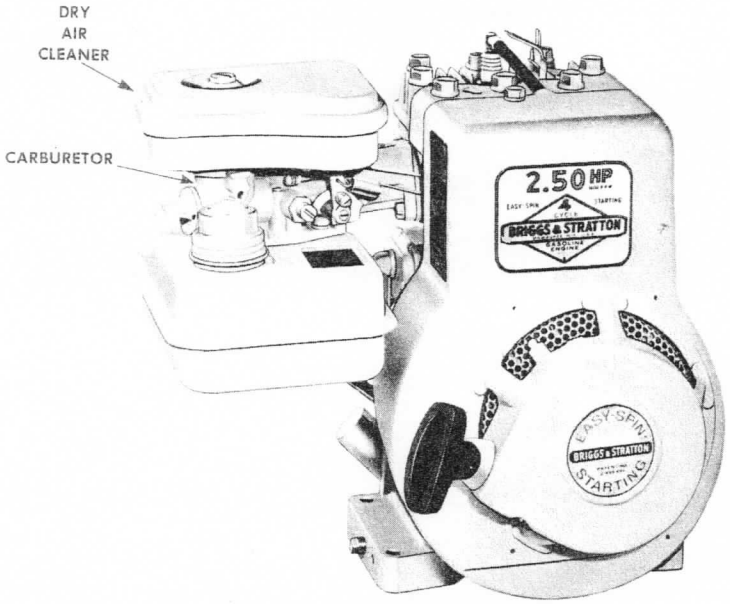


Figure 9-52. A dry air cleaner mounted to a carburetor. (Briggs & Stratton Corp.)

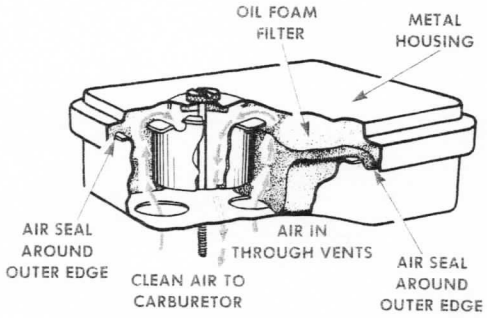


Figure 9-53. A cutaway of an oil foam air cleaner. (Briggs & Stratton Corp.)

Dry Element Air Cleaner

Many small engines use an air cleaner that does not have oil in it. This is called a *dry element air cleaner*, Figure 9-52. One common type of dry element is the foam type, which has a filter element that looks like a sponge. Air enters the foam air cleaner through large holes in the bottom of the metal housing. Air must go through the small holes in the foam filter to get into the engine. The small holes in the foam filter out dirt before it can get into the engine. Air flow through a foam filter is shown in Figure 9-53.

Some dry air cleaners use a paper filter, Figure 9-54. The paper filter has tiny holes in it. Air can

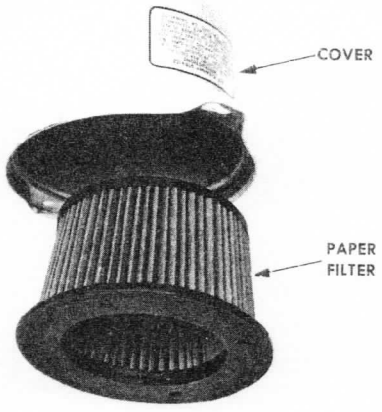


Figure 9-54. Air is cleaned as it goes through this paper filter.

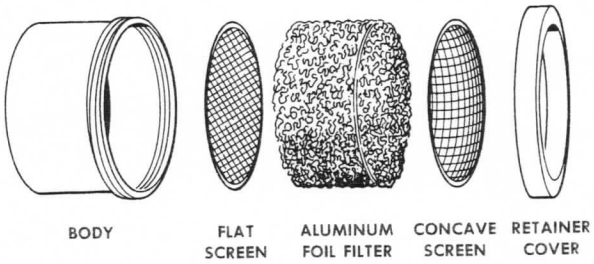


Figure 9-55. Parts of an aluminum foil air filter.

get through the filter paper. Dirt sticks to the outside.

Another type of dry air cleaner uses a filter made of aluminum foil, Figure 9-55. Strips of aluminum foil are pressed together. Air must make its way through the strips. There is a light coat of oil on the aluminum. Dirt sticks to the oil.

NEW TERMS

air cleaner: A filter mounted above the carburetor to clean the air before it enters the engine.

carburetor: Small engine component that mixes fuel with air in the correct amount for combustion.

diaphragm carburetor: A type of carburetor in which the amount of fuel in the carburetor is controlled by a diaphragm.

float: The part of the carburetor that controls the amount of fuel in the float bowl.

float carburetor: A carburetor that controls the amount of fuel with a float.

high-speed adjustment: Carburetor adjustment used to adjust fuel mixture when engine is running at high speed.

low-speed adjustment: Carburetor adjustment used to adjust fuel mixture when engine is running at low speed.

sliding valve carburetor: A carburetor that uses a sliding valve attached to a needle to regulate fuel.

SELF CHECK

1. What engine part mixes the air and fuel?
2. When does the air-fuel mixture go into the engine?
3. How does fuel get into the venturi area on a vacuum or suction carburetor?
4. Explain how a float works to control fuel flow.
5. Describe how a float carburetor works.
6. Why do some engines need a diaphragm carburetor?
7. What is the diaphragm used for?
8. How does a sliding valve carburetor work?
9. What is the purpose of the governor?
10. What is the purpose of the air cleaner?

DISCUSSION TOPICS AND ACTIVITIES

1. Study all the engines in the shop. Can you identify all the different types of carburetors used?
2. Use a cutaway model of any carburetor type. Try to trace the flow of fuel and air through the carburetor.