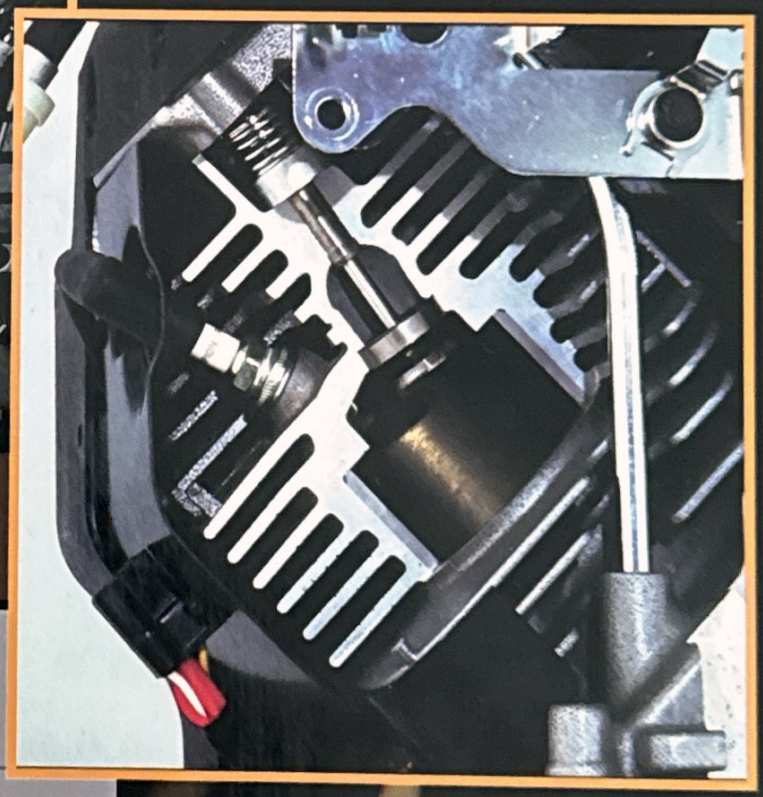
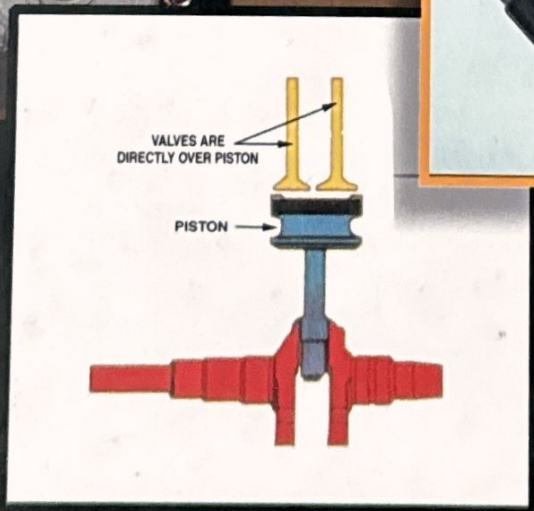
Small Engine Technology

SECOND EDITION





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William A. Schuster

SMALL ENGINE TECHNOLOGY, SECOND EDITION

William A. Schuster

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CHAPTER 4

Carburetors

INTRODUCTION

The carburetor measures the correct quantity of fuel to be supplied to the engine, breaking it down into small droplets called atomization and mixing the fuel with air. The carburetor must correctly proportion the amounts of fuel and air, regardless of the speed and load at which the engine is operating. Due to the differences in weight between fuel and air and the changing pressures to which they are subjected, the problem of maintaining correct mixture proportions is very difficult. For this reason, good carburetors have complicated construction.

The carburetor breaks the fuel into various sizes of drops suspended in an air stream so that the droplets vaporize easily before they reach the combustion chamber. The completeness of the vaporization depends on the following factors:

1. Volatility of the fuel. The more volatile fuels vaporize more rapidly.
2. Temperature of the air. Higher temperatures increase the rate of vaporization.
3. Degree of atomization. A greater degree of fuel atomization presents the maximum amount of surface, and the fuel is more readily vaporized.

In the time allowed for mixing the vapors of fuel with air, it is not possible to obtain a thorough mixing so that all the fuel particles will react with all of the oxygen particles. In order to consume all of the fuel or oxygen, there must be an excess of one or the other. Maximum power will occur when all the oxygen is consumed, which necessitates extra fuel particles. Maximum power fuel will be a rich mixture. The most economical mixture will have all the fuel particles consumed by supplying a lean fuel mixture with excessive air.

A carburetor must be able to provide different air-fuel ratios between 11:1 and 16:1 to provide the maximum power and greatest economy.

CARBURETOR CONSTRUCTION

A carburetor is a metering device for mixing fuel and air, as shown in Figure 4-1. The correct mixture in the combustion chamber is essential for the engine to run properly. Two conditions must be met for proper carburetion. The fuel must be introduced to the incoming air stream and it must be vaporized.

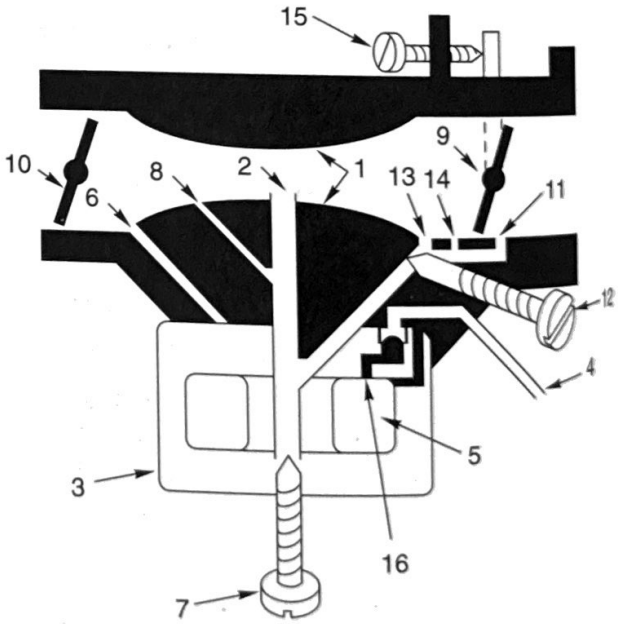

Fig. 4-1 Carburetor construction. (*Courtesy of William A. Schuster*)

VENTURI

The venturi, marked with #1 in Figure 4-1, is the narrowed part of the carburetor tube where a suction is created and the velocity of the incoming air is increased (see Figure 4-2). If you open the choke and throttle plate of the carburetor and look through the channel or air horn, you will notice that the venturi is the constricted section, as shown in Figure 4-3.

MAIN DISCHARGE TUBE

The main discharge tube, marked with #2 in Figure 4-1, is the part through which the fuel travels from the fuel container to the air stream in the venturi during high-speed operation.

The main discharge tube of the carburetor is a tube, one end of which is connected to the venturi and the other in the fuel container found below. While air is flowing through the venturi, the effect will be the same as putting a straw in one's mouth and sucking on it. If one end of the straw is placed into a liquid, the fluid will be drawn up the straw. The fuel container can be the float bowl, part of the fuel tank, or the entire fuel tank. The fuel is actually pushed through the main jet tube by the difference in pressure between the atmosphere and the venturi throat, as shown in Figure 4-4. Normal atmospheric pressure pushes on the fuel in the reservoir and moves the fuel to the low pressure area in the venturi.

The greater the volume of air passing through the venturi, the higher the vacuum and the larger the amount of fuel that will be sprayed into the air stream at the main discharge tube.

Effects of venturi
1. Air speed increased.
2. Vacuum created.

Fig. 4-2 Effects of venturi. (*Courtesy of William A. Schuster*)

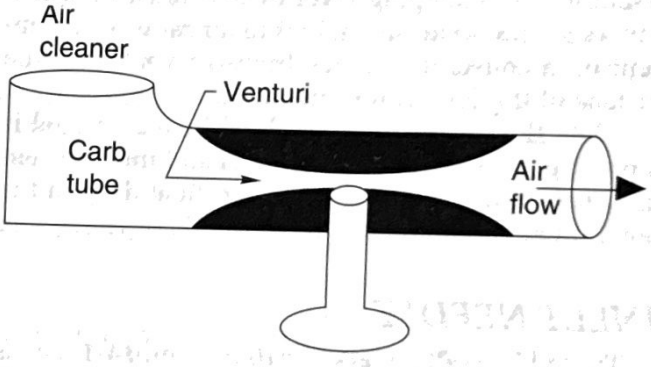

Fig. 4-3 Venturi is the constricted section in the air horn. (*Courtesy of William A. Schuster*)

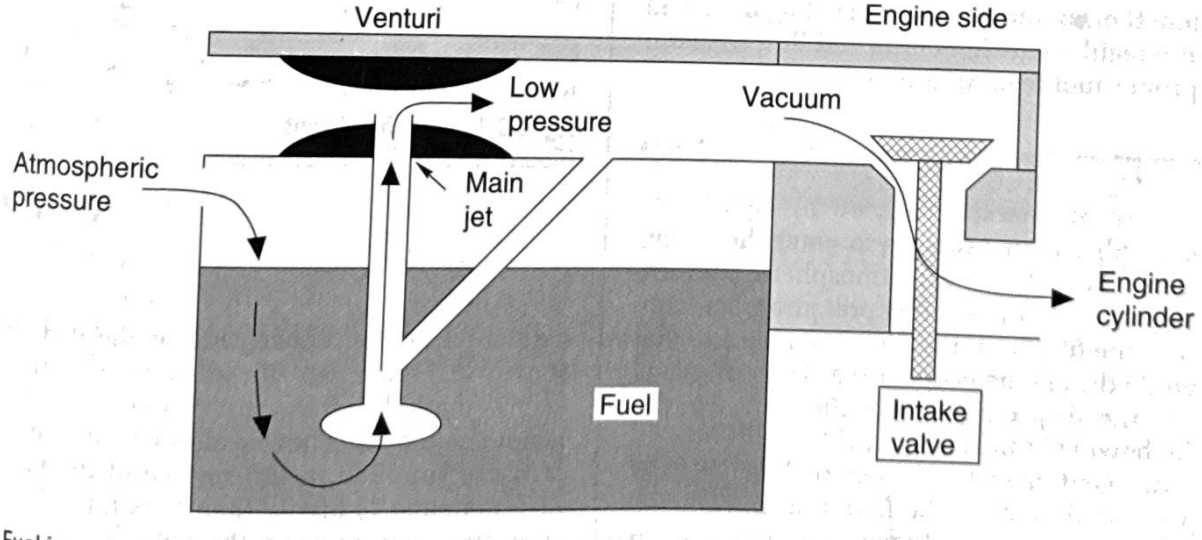

Fig. 4-4 Fuel is pushed through the main jet tube. (*Courtesy of William A. Schuster*)

FUEL CONTAINER

The fuel container, marked with #3 in Figure 4-1, holds the fuel for use by the different metering circuits in the carburetor.

FUEL SUPPLY INLET

The fuel supply inlet, marked with #4 in Figure 4-1, is where fuel enters the fuel container from the engine's fuel tank.

FLOAT

The float, marked with #5 in Figure 4-1, is used to control the level of fuel in the fuel container. An essentially unchanging level of fuel must be maintained. Proper metering of fuel-to-air ratios is dependent on a constant distance from the venturi to the surface of the fuel in the container.

When the engine speed or load increases, fuel is rapidly pulled out of the fuel bowl and into the venturi. This makes the fuel level and float drop in the bowl. Fuel enters the bowl and the float rises.

INLET NEEDLE

The inlet needle, marked #16 in Figure 4-1, opens as the float level drops and fuel is allowed to enter the bowl area. As the fuel level rises, the float pushes the inlet needle back and shuts off the incoming fuel. When the engine is operating, the float and inlet needle regulate the incoming fuel flow to maintain the proper fuel level in the fuel container.

BOWL VENT

The bowl vent, marked with #6 in Figure 4-1, allows atmospheric air pressure to enter the carburetor system. The difference in atmospheric pressure (relatively high) and the venturi pressure (relatively low) pushes the fuel from the fuel container into the venturi while the engine is operating. The vent tends to maintain the air pressure above the surface of the fuel in the bowl at atmospheric levels.

The bowl vent may be an external or internal type. An external vent can be found on the outside of the carburetor body, as shown in Figure 4-5. An internal vent is commonly found in the carburetor air horn near the choke side of the carburetor, as shown in Figure 4-6. An advantage of an internal vent is that a larger venturi can be used in order to maximize the horsepower of the engine because the pressure supplied to the surface of the fuel in the fuel container is higher than the atmospheric pressure since air moving through the carburetor is forced into the vent opening.

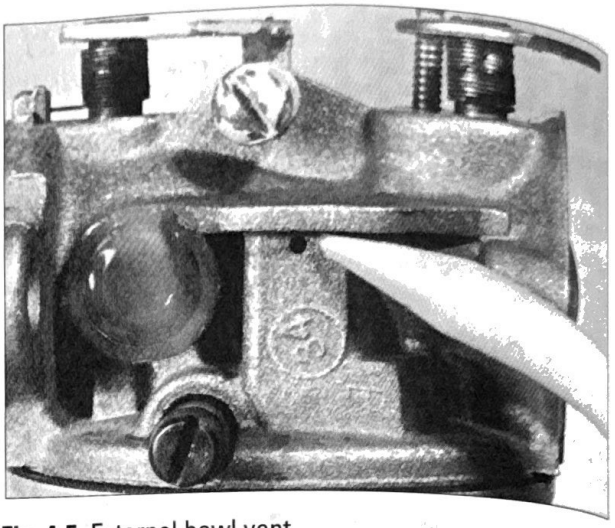

Fig. 4-5 External bowl vent.
(*Courtesy of William A. Schuster*)

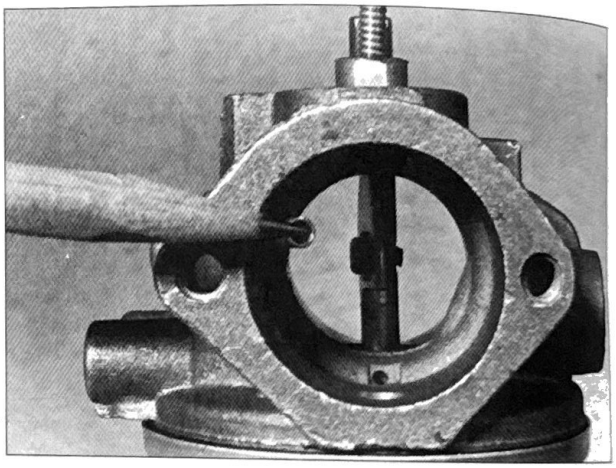

Fig. 4-6 Internal bowl vent.
(*Courtesy of William A. Schuster*)

HIGH-SPEED MIXTURE ADJUSTMENT NEEDLE

The high-speed mixture adjustment needle, marked with #7 in Figure 4-1, is used to control the amount of fuel entering the air stream at high speed. It can be turned in to decrease the amount of fuel, which makes the air-fuel mixture lean (in fuel), or turned out for a rich (in fuel) air-fuel mixture.

HIGH-SPEED AIR BLEED

The high-speed air bleed, marked with #8 in Figure 4-1, allows air to break up the fuel before entering the air stream in the venturi. When the air enters the carburetor, it forms a slight pressure near the venturi as the molecules are backed up while waiting to enter the venturi. This backup of air molecules increases the pressure slightly on the choke side of the venturi. With the high-speed air bleed located in this high-pressure area, some of the air moves through this channel to mix with the fuel in the main discharge tube.

THROTTLE PLATE

The throttle plate, marked with #9 in Figure 4-1, controls the air flow through the venturi, thereby controlling the fuel flow to the engine. When the throttle plate is closed, all the air flow to the engine would cease; therefore, the throttle plate must be held open slightly by the idle speed screw, marked with #15 in Figure 4-1. When the throttle plate is opened fully, the air flow into the engine is limited by the size of the venturi.

CHOKE PLATE

The choke plate, marked with #10 in Figure 4-1, partially blocks off air flow, creating low pressure throughout the carburetor to provide a rich in-fuel mixture for cold starting. The fuel is drawn into the limited air flow from the main discharge tube and the idle passages.

IDLE PASSAGE

The idle passage, marked with #11 in Figure 4-1, connects the carburetor's bowl to the engine side of the throttle plate. Fuel is forced through this passage when the throttle plate moves to the idle position.

LOW-SPEED MIXTURE ADJUSTMENT SCREW

The low-speed mixture adjustment screw, marked with #12 in Figure 4-1, is used to meter the precise amount of fuel for engine operation at idle.

IDLE AIR BLEED

The idle air bleed, marked with #13 in Figure 4-1, allows air to atomize the fuel before entering the air stream while the engine is idling. This premixing of the fuel and air increases the efficiency of engine combustion. When the throttle plate is in the idle position, the transitional fuel passage, marked with #14 in Figure 4-1, also allows air to bubble into the idle passages.

TRANSITIONAL FUEL PASSAGES

The transitional fuel passage, marked with #14 in Figure 4-1, provides a temporary fuel supply to the engine during the transition from idle to high-speed operation. As the throttle plate begins to open, both the transitional fuel passages and the idle passage provide the air-fuel mixture.

CARBURETOR FUNCTIONS

EVAPORATION OF GASOLINE

Liquid gasoline will not support rapid combustion without being changed to a mist or broken down or atomized into tiny drops. When liquid gasoline is introduced to the venturi, it is gasified by its collision with the rapidly moving air mass. The atomized fuel then flows to the intake manifold where the pressure is low, and any remaining liquid gasoline evaporates further. Vaporization is finally completed with the heat generated by the compression of the air-fuel mixture in the cylinder.

FUEL CONTROL

The size of the venturi is matched with the power of the engine. If the engine is operated constantly in a full-load condition, a relatively large venturi can be used for maximum efficiency and power, but since most engines are designed to run from no-load to full-load (idle to high speed), the air-to-gasoline ratio must be changed for different operating conditions. Heavy loads and fast acceleration necessitate a richer mixture. The venturi is narrowed enough to allow good suction at midrange speeds, and an idle circuit is added so that the engine will still draw fuel at low speeds. Either a fuel adjustment screw regulates the amount of fuel going up the main nozzle or a nonadjustable metering jet is used.

The venturi size directly affects the volumetric efficiency of the engine, which determines the horsepower rating of the engine.

EFFICIENT COMBUSTION

If the engine is warm, the air-fuel mixture enters the combustion chamber in a vaporized state. In an engine that has not yet reached operating temperature, some of the gasoline condenses before it goes into the cylinder. The ratio of air-fuel for proper combustion is dependent upon engine and intake air temperatures as well as many other factors.

During combustion the air-fuel mixture burns very rapidly. Combustion is not an uncontrolled explosion, but rather a regulated burn with a rapid release of heat energy, causing the air molecules in the cylinder to expand and force the piston downward.

STARTING THE ENGINE

When the air-fuel mixture is drawn into the cylinder on the intake stroke of the piston and the engine is cold, the gasoline vapors tend to condense into large drops on their way to the cylinder. Because all the gasoline supplied to the cylinders does not vaporize, it becomes necessary to supply a rich mixture in order to have enough vapor for combustion to occur. This is accomplished by a choke, enrichment system, or primer.

Choke system

When the choke is tilted in the carburetor to restrict the amount of air entering the air horn, greater suction is created and a larger amount of fuel is drawn into the combustion chamber from the idle passages and the main discharge tube, as shown in Figure 4-7.

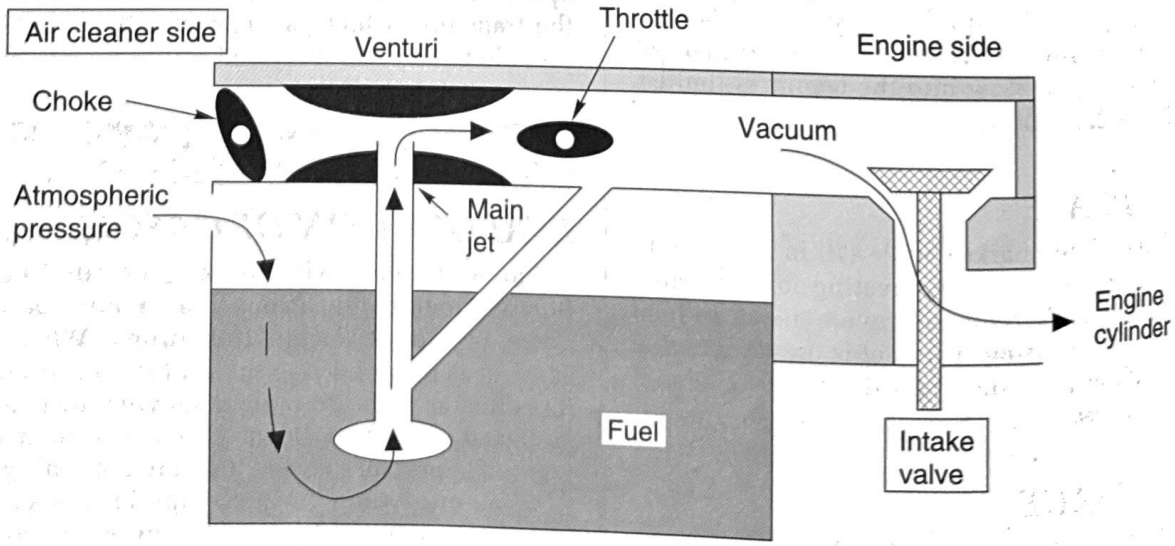

Fig. 4-7 Choke system. (*Courtesy of William A. Schuster*)

Enrichment system

An enrichment system is an air-fuel metering circuit separate from other carburetor circuits. Fuel for the circuit is drawn from the float bowl through an enrichment jet. The enrichment jet is activated by the user through a special lever. When the plunger is down, the enrichment circuit is blocked and does not operate. When the plunger is raised, a rich air-fuel mixture is discharged from the enrichment port, which is located directly behind the venturi.

Primer system

The primer system provides a rich mixture by increasing the pressure in the top of the fuel bowl to force extra fuel into the venturi. Another way is by pushing down on the float to force a higher than normal float bowl level and create a rich condition.

In a diaphragm carburetor, the diaphragm may be lifted mechanically or pneumatically, as shown in Figure 4-8.

HIGH-SPEED OPERATION

The high-speed circuit is provided by the main discharge tube, marked with #2 in Figure 4-1, which is centered in the venturi. When the throttle plate is opened sufficiently, the air passing through creates a pressure difference in the venturi, which causes a discharge of fuel from the nozzle, as shown in Figure 4-4. Throughout the intermediate and high-speed ranges, this discharge increases with the volume of air passing through it so that a uniform air-fuel mixture ratio is maintained.

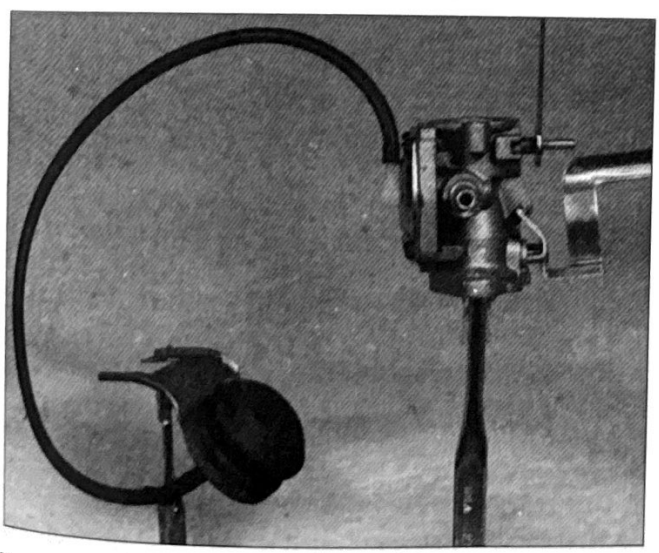

Fig. 4-8 Pneumatic primer system. (Courtesy of William A. Schuster)

An adjusting needle or preset main jet controls the amount of fuel that enters the air stream. Maximum power is obtained with a mixture of from 12 to 14 parts of air to 1 part fuel. An excessively lean or rich fuel mixture will not burn properly and will not produce maximum power. If an engine is operating on too lean a mixture for maximum power and carburetor adjustments are made to increase the amount of fuel in the mixture, the horsepower output will also increase.

At partially open throttle plate position, it is possible to obtain maximum power at a leaner fuel mixture wherein the best air fuel ratio is 16:1.

IDLE SPEED OPERATION

When the throttle plate is closed or slightly open, only a small amount of air can pass through the air horn and flow around the throttle plate, as shown in Figure 4-9. The air speed is so low, and there is such a small amount of air passing through, that hardly any vacuum develops in the venturi; thus, the main discharge tube in the venturi will not feed any fuel. For this reason, the carburetor must have an idle circuit.

When the throttle plate is in the idle position, the amount of air and fuel is greatly reduced as compared with wide-open throttle plate conditions. The mixture tends to burn more slowly and a richer fuel mixture is necessary.

Idling speed of the engine is controlled by the air flow past the throttle plate, and the volume of the air flow is controlled by the setting of the idle speed adjusting screw.

INTERMEDIATE SPEED OPERATION

When the throttle plate is placed at a position that is less than the high-speed position but greater than the idle position, not only does the vacuum formed in the main venturi draw fuel into the air stream, but

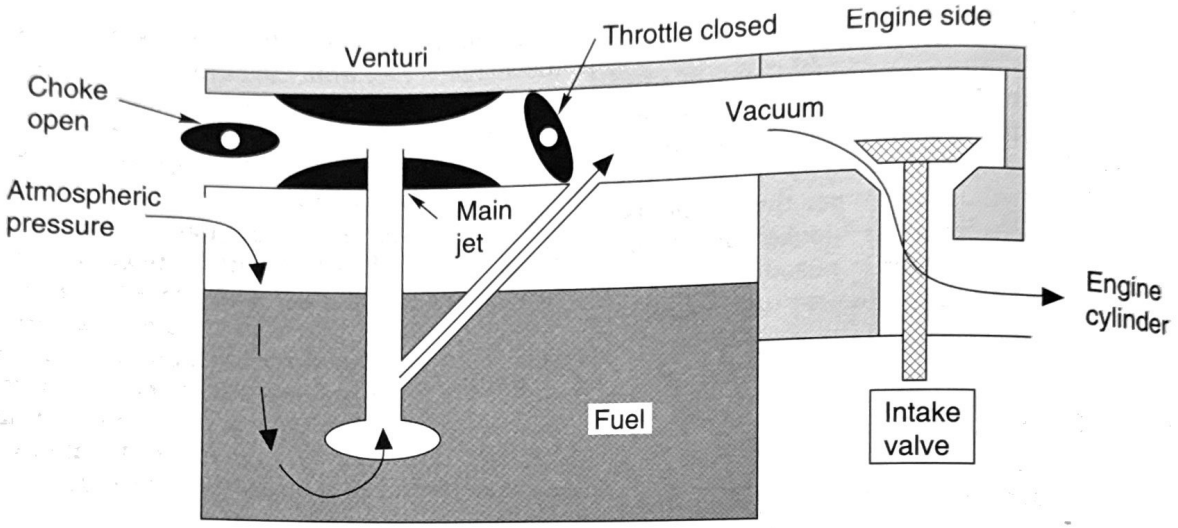

Fig. 4-9 Idle speed operation. (*Courtesy of William A. Schuster*)

the idle circuit also delivers fuel at the secondary low-pressure area around the idle fuel inlets. Both the high-speed and the low-speed mixture adjustments affect the air-fuel ratio.

MAINTENANCE AND TROUBLESHOOTING

Many engine performance problems are mistaken for carburetor malfunctions.

PRELIMINARY CHECKLIST

Good carburetor adjustments require reasonable integrity of all other engine systems.

Fuel tank

The interior of the tank must be free of corrosion or other contaminants that may settle in the bottom and block the flow of fuel.

Fuel lines

The fuel line must not be bent so that the flow of fuel is obstructed in any way. Some fuel lines may disintegrate and collapse, causing the flow to the carburetor to stop.

Clean fuel

Check the fuel to determine if it is stale or dirty. White scale in the carburetor is evidence of water in the fuel. Once this type of oxidation has developed, there is no stopping it. The carburetor must be replaced.

Filter

The filter must be clean and installed in the correct direction. Arrows are stamped on the filter's cover showing the direction of the flow. The filter should be changed often.

Ignition

The symptoms of poor-running carburetor adjustment may stem from a faulty ignition. A faulty ignition will cause an intermittent symptom of carburetor misadjustment. The proper spark plug must be used, with the gap adjusted to the manufacturer's specifications.

Compression

Without proper compression, the engine will be difficult to adjust. Ensure that the compression is adequate.

Exhaust

A restricted exhaust port will cause a loss of power and difficulty in adjusting the carburetor. Make sure that the exhaust port is clear of any carbon obstructions.

Manifold gasket

The manifold gasket must be in good condition and not leak. An air leak will cause the engine to operate in a lean condition. An intake manifold leak can be detected by putting oil in the area while the engine is idling and then listening for a change in engine speed. The oil will temporarily block the leaking gasket, and the mixture and engine sound will be affected.

Vapor lock

Vapor lock is a term used to describe the action of liquid fuel transforming into a gaseous "vapor" state, typically caused by heat. During this transformation, air bubbles are formed. Always use clean, fresh fuel that has been blended for the appropriate season.

Air bubbles from a vapor lock condition can become trapped at a high point in the fuel line or at a fuel filter, stopping the flow of fuel. Vapor lock may occur when the equipment is being operated or when restarting a warm engine.

Vapor lock during operation can be caused from insufficient cooling air. The exhaust gases may be trapped by the equipment design and recirculated to the cooling system. The warm cooling air may be misdirected near or at fuel lines, carburetor, and fuel supply.

Vapor lock occurs when a hot engine is shut down. Since the engine is hottest at about 1 minute after it has been turned off, it is best to cool the engine by letting it run at a speed just above idle for about 30 seconds before stopping it.

AIR CLEANER

Observe how the unit has been maintained. Check to see if the air cleaner is plugged or missing. The poly-foam element may have been oiled incorrectly. A dirty element can cause cylinder bore wear that will affect performance. Dirt may be brought into the engine with air that is sucked around a worn choke or throttle plate shaft, and the engine may be difficult to adjust properly. Tecumseh furnishes dust seals on chrome-plated shafts on their current carburetors to prevent this type of wear.

INITIAL SETTINGS

Make certain the governor linkage is connected correctly and adjust the mechanical governor. Make the initial settings on the carburetor and let the engine warm up for 3 to 5 minutes.

PROPER ADJUSTMENT

The home technician may have fine-tuned his or her machine, and the repair job may be as simple as correcting the work by adjusting the carburetor. Find the lean and rich points of the main adjustment screws and put the setting at halfway between the two points. It is best to find the lean point first, then the rich point, to make a proper adjustment.

Bring the engine to idle and adjust the idle screw in the same manner as the main mixture adjustment. Although the idle mixture screw may be adjusting either air or fuel flow, the procedure will apply to both systems.

Take the engine back to high speed and reset the main mixture adjustment. Return the engine to idle again and reset the idle mixture adjustment. It is important to make the adjustment between the main and idle at least twice in order to ensure proper operation.

AIR LEAKS

Air leaks at the carburetor gaskets can cause a hunting condition. Anytime a gasket is disturbed, a new one should be used in its place. Make sure the float is adjusted properly.

FUEL SYSTEM FAILURES

Although the fuel system is very simple, pinpointing the difficulty can be frustrating. Fuel system problems can be separated into five categories:

1. Incorrect fuel
2. Bad fuel

3. Too little fuel
4. Too much fuel
5. No fuel supplied to the engine

Incorrect fuel

Some possible ways incorrect fuel may make its way into the system are:

- Fuel with an excessive amount of alcohol
- Diesel fuel put into the tank by mistake
- Fuel blended for one season, but used in another

Bad fuel

Some possible ways bad fuel may make its way into the system are:

- Fuel deteriorated
- Fuel with sand, dirt, grass, etc. in it
- Fuel left out in the rain without a cap

Too little fuel

The following may prevent the engine from receiving enough fuel:

- A partially plugged fuel filter
- A restricted fuel tank vent
- A pinched fuel line
- A collapsed fuel line that has separated internally
- A fuel pump with damaged, worn, or dirty parts
- An engine with a poor crankcase vacuum caused by leaking gaskets, loose oil-fill caps, loose oil filters, leaking piston rings, or bad seals
- A sticking or misadjusted carburetor inlet needle
- Damaged, dirty, or misadjusted carburetor mixture jets
- The wrong mixture jets in the carburetor
- The wrong carburetor
- An incorrect or missing air filter
- An excess amount of air being forced through the carburetor by the air intake system
- An incorrectly oiled air filter precleaner
- A loose air cleaner housing
- A worn throttle plate shaft or carburetor b
- Loose, warped, or damaged connections in intake manifold, which allows air to be dra

Too much fuel

Check for these problems which can result in much fuel being supplied to the engine:

- Misadjusted or leaking carburetor fuel needle
- Misadjusted or damaged carburetor fuel ture jets
- Leaking internal welch plugs
- Leaking, missing, or incorrectly installed gas
- The wrong mixture jets installed in carburetor
- A fuel pump that has a high output pressur
- The wrong carburetor

No fuel supplied to the engine

Look for the following possible problems:

- A plugged fuel cap vent
- A plugged fuel filter
- An incorrectly positioned or missing fuel pickup hose
- A pinched-off fuel line
- An internally collapsed fuel line
- A disconnected fuel line
- A failed fuel pump
- A sticking or plugged carburetor inlet need
- Misadjusted or plugged carburetor fuel mix jets

MISCELLANEOUS PROBLEMS

If the engine dies in-between idle and high sp the idle circuit must be cleaned with the w plugs removed.

If the carburetor floods, it is generally because inlet seat is leaking. The new inlet seat must installed in the carburetor body in proper direct

A plugged atmospheric vent hole will cause a lean setting in the carburetor. The external vents must be kept free of debris.

BRIGGS & STRATTON CARBURETORS

INTRODUCTION

The basic purpose of a carburetor is to produce a mixture of fuel and air in the correct proportions so that the engine will operate properly at different speeds and loads. Briggs & Stratton manufactures three different basic types, designated as Vacu-Jet, Pulsa-Jet, and Flo-Jet. Because environmental safety demands stricter emission and performance controls, many manufacturers realize that it is more cost-effective to contract another company (that specializes in carburetors) to design and build them. Briggs & Stratton has entered into a business relationship with Walbro carburetors, and together they are producing a Flo-Jet type of carburetor with both of their names on it.

Prior to removing any carburetors for repair, note and record the position of governor springs, governor link, remote control, or other attachments in order to facilitate reassembly.

VACU-JET CARBURETOR

Vacu-Jet construction

The Vacu-Jet is a simple carburetor that is used in many small displacement Briggs & Stratton engines and functions adequately. The manufacturing cost of this carburetor has helped the corporation stay competitive. It is adjusted differently than are other carburetors because of its unique features, as described below.

Vacu-Jet identification

The easiest way to identify the Vacu-Jet design is to check the engine's model number, as shown in Figure 4-10. Another method is by recognizing its appearance. This is sometimes difficult to do because of changes in outward features from time to

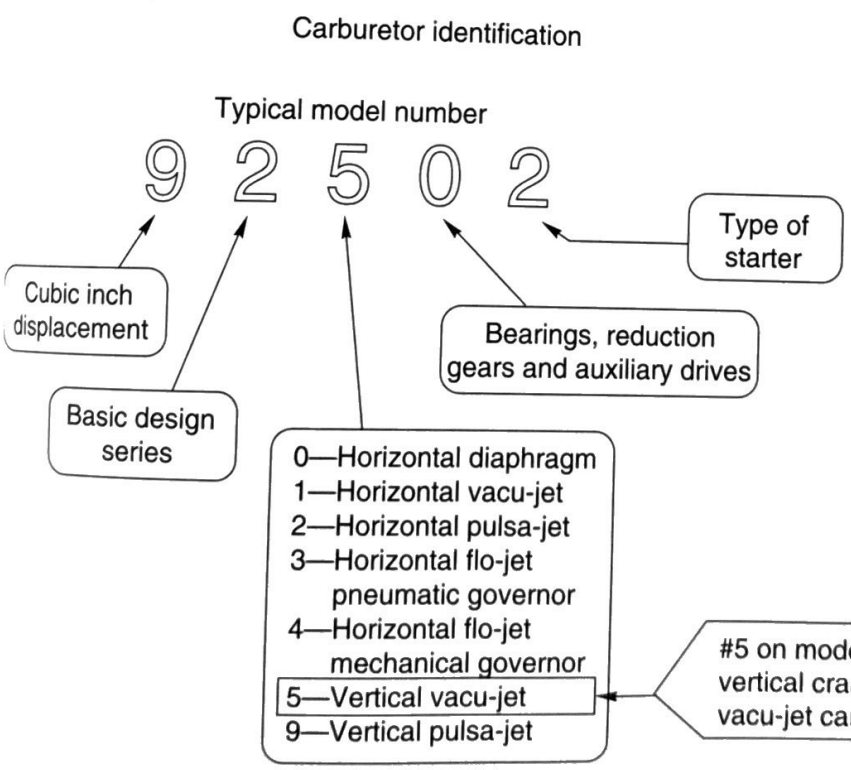

Fig. 4-10 Briggs & Stratton Vacu-Jet identification. (*Courtesy of William A. Schuster*)