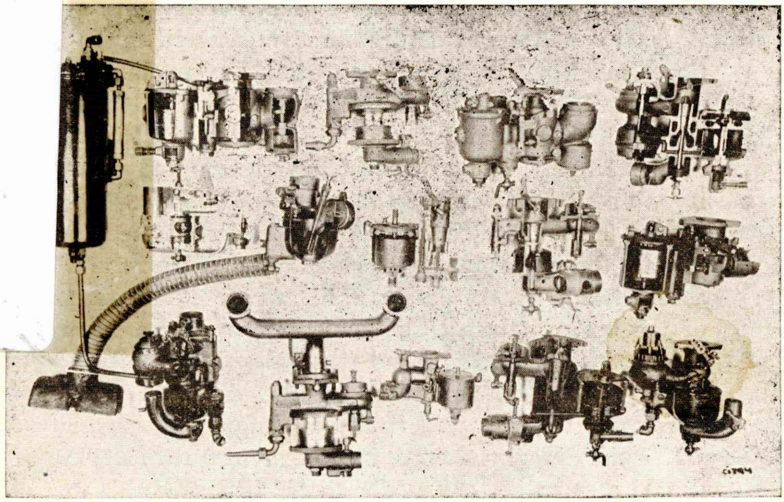
OFFICIAL PUBLICATION OF

IOWA STATE COLLEGE

OF AGRICULTURE AND MECHANIC ARTS

Vol. XIV JULY 10, 1915 No. 6



SOME ... ON CARBURETION

Including Mechanical ... ors

By

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Engineering Extension Department
Bulletin No. 8
Automobile Institute

Published Tri-Monthly by the Iowa State College of Agriculture and Mechanic Arts. Entered as Second-class Matter, at the Post Office at Ames, Iowa, under the Act of Congress of August 24, 1912

THE purpose of this pamphlet is to explain in non-technical language the principles which underlie the action of the better known types of carburetors, and show why certain mechanical devices are utilized to secure improvement in operation. Much has been written concerning the subject of carburetion and a large amount of attention given to showing views and sections of a great number of different makes and models of carburetors and writing a text fully describing the details of each instrument. The writer of this bulletin has attempted to explain the reason for the existence of, and the results accomplished by, the devices which are found in some of the better known instruments. The figures have been made to illustrate the text instead of the text having been written to explain the different carburetors. With an understanding of the purpose which the different devices in a particular carburetor should accomplish, the reader should be better able to understand the manufacturer's instructions for adjustment and to make an intelligent diagnosis of a case of trouble. The text is prepared under four main headings:

I What the Carburetor is For.
II Some Mechanical Features of Carburetors.
III Conditions Which Exist in the Manifold.
IV Gasoline.

Other bulletins in the series, which may be had by writing the department, are "A Motor Trouble Chart," "A Cost Keeping System for the Automobile" and "The Wear and Care of Automobile Tires."

I. WHAT THE CARBURETOR IS FOR

If a large mouthed bottle is filled nearly to the neck with gasoline and a spark plug with wires attached is submerged, sparks can be produced beneath the surface of the gasoline without igniting it. (See Fig. 1.) If a few drops of gasoline are shaken in a closed bottle and a light or spark is held at the neck, a sudden blue flame or explosion will occur. This illustrates the fact that gasoline is not explosive while in the liquid state, but if it is mixed thoroughly with air, the mixture becomes explosive.

The purpose of a carburetor is to supply a mixture consisting of finely atomized spray or vapor of gasoline (or other suitable fuel) and air in the proper proportion to burn in the cylinder. Since this mixture must have definite proportions of fuel and air to burn completely, the carburetor must maintain the proper quality at all times. Too large a proportion of gasoline will result in a part escaping unburned and a part remaining in the cylinder in the form of carbon deposit. Too large a proportion of air results in loss of power from weak explosions. A mixture of fifteen parts of air to one of gasoline (by weight) is correct for complete combustion, and should give maximum power. A somewhat leaner mixture will give better economy but noticeably less power.

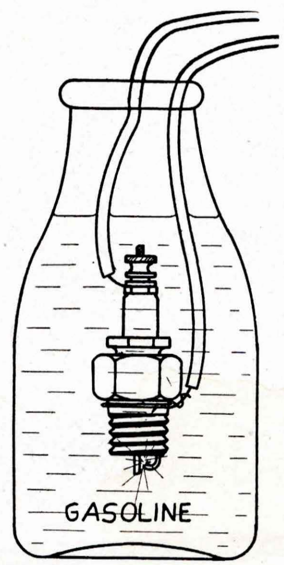


FIG. 1

Since there is no practical method of weighing or measuring the proportion of fuel and air, the operator is compelled to judge the quality of the mixture by the behavior of the motor and so adjust the regulating devices as to secure the best results.

HOW THE CARBURETOR OPERATES

In most modern carburetors the mixing of the air and gasoline is accomplished by drawing a stream of air past a nozzle, from which it picks up a spray of gasoline. The accompanying diagrams will illustrate the principles of the spraying carburetor.

The motion of the piston toward the bottom of the cylinder, during the suction stroke, causes air to rush in through the carburetor and inlet manifold. The air enters the carburetor (Fig. 2) at A and passes through the mixing chamber, which is made smaller than the rest of the air passage in order that the velocity may be high. In the smallest portion of this mixing chamber is located a tube, called a spray nozzle or jet, which is normally filled almost to the tip with gasoline. The high velocity of the air causes sufficient suction to raise the gasoline and pick it up in the form of a fine spray, which goes with the air into the cylinder.

The gasoline coming from the supply tank passes through tube L and valve I into the portion of the carburetor known as the float chamber. A float of cork covered with shellac, or of hollow metal, is lifted by the gasoline and, when the depth is just a little below the tip of the spray nozzle, closes the valve I and prevents the entrance of more gasoline. In the mechanism shown in Fig. 2, the float bears against the outer ends of leaves JJ, which are pivoted at MM, and the inner ends of which push the float needle down against its seat at I.

If the flow of gasoline were at all times exactly proportional to the flow of air, it would be necessary only to make the gasoline nozzle the right size for a given air opening and the carburetor would supply the same quality of mixture at all times. Gasoline behaves something as one would expect molasses to, in that it offers some resistance to flowing. If the spray nozzle of the carburetor is provided with a needle valve, this can be opened or closed a little to regulate the quantity of gasoline passing through to mix with a given quantity of air.

The behavior of the motor will serve to inform the operator as to the quality of the mixture. If the throttle is opened wide and the needle is turned back and forth, there will be found one position where the motor seems to run at the best speed. If the valve is opened wider, the motor will slow down and will seem to "choke up," and black smoke will issue from the exhaust pipe. If a priming cup were opened, or the color of the flame coming from the exhaust port of the cylinder could be seen, a yellow color like that from the flame of a kerosene lamp would indicate the richness of the mixture. The flame from a correct mixture would be the color of that from a gasoline blow torch or from a gas stove. If the needle is closed down too far, the motor will begin to miss explosions and there will be popping noises in the manifold and carburetor. Possibly blue flame can be seen coming out of the air intake during this backfiring. The odor of the exhaust will also indicate, to one who has had some experience, the quality, an over rich mixture producing a foul odor and irritating the eyes. "Galloping" when the motor is running idle at slow speed will also result from an over rich mixture.

If the throttle is partly closed to reduce the quantity of mixture entering the cylinder, a new setting of the needle valve will be required, due to the tendency of the mixture to thin out because the air moving at a slower velocity picks up less than the quantity of gasoline necessary for a correct mixture. Suppose

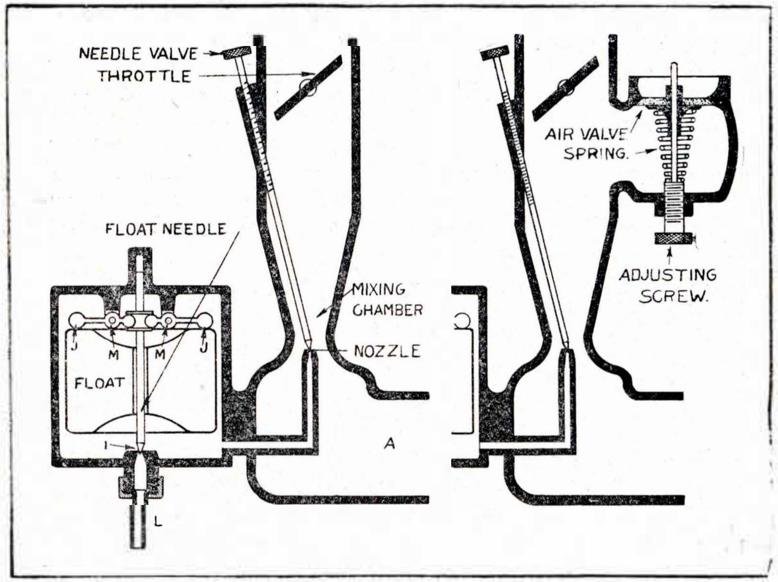


FIG. 2 FIG. 3

PARTS OF A SIMPLE CARBURETOR

the needle valve be set to give the correct quality of mixture with the throttle nearly closed and then the throttle be opened wide, five times as much air passing through the mixing chamber will pick up a great deal more than five times as much gasoline and the mixture will become entirely too rich. The mixing chamber of the carburetor should be small enough so that the air will pass through with sufficient velocity to carry gasoline with it when the throttle is nearly closed, as when the engine is running idle or the car is throttled down to five miles per hour on high gear. Because the mixing chamber is small, a sudden demand for more mixture (opening the throttle) results in two conditions—not enough quantity is supplied to the cylinders and what there is is of entirely too rich a quality. Since insufficient quantity is obtained, it is much better to dilute the over rich mixture with air, thereby obtaining a larger volume of the proper quality, than to cut down the gasoline, and secure a small volume of the proper quality. The admission of more air is accomplished in a great many of the modern carburetors by a device known as the auxiliary air valve or simply as the air valve. Fig. 3 shows the air valve added to the simple mixing chamber. The spring holds the air valve against its seat when the demand on the carburetor is small, as when the engine is running idle. After the engine has run long enough to be warmed up, the throttle is nearly closed and the needle valve is adjusted back and forth until a satisfactory mixture is found. Then the throttle is opened suddenly and the behavior of the motor noted. If the mixture is too lean, back-firing will result. If it is too rich, the motor will not respond as quickly as it should. Since it is usually easier to detect too lean a mixture than too rich a one, it is always safe to loosen the tension on the air valve a little at a time until sudden opening of the throttle causes back-firing and then to tighten it enough to prevent the backfiring.

II. SOME MECHANICAL FEATURES OF CARBURETORS

With a mixing chamber small enough to permit satisfactory operation at small throttle opening and an air valve which will let in just enough air to give a satisfactory mixture with the throttle wide open, many of the older types of carburetors were unable to give anywhere near the maximum power or speed of the car. Thus, it was that a carburetor of larger size was generally substituted for racing. The problem of the designer was to get more power without sacrificing the capacity of the motor for pulling the car on high gear smoothly at low speeds. Many additions to the mechanical devices shown in Figs. 2 and 3 have been resorted to in attempts to improve the art. Some of these,

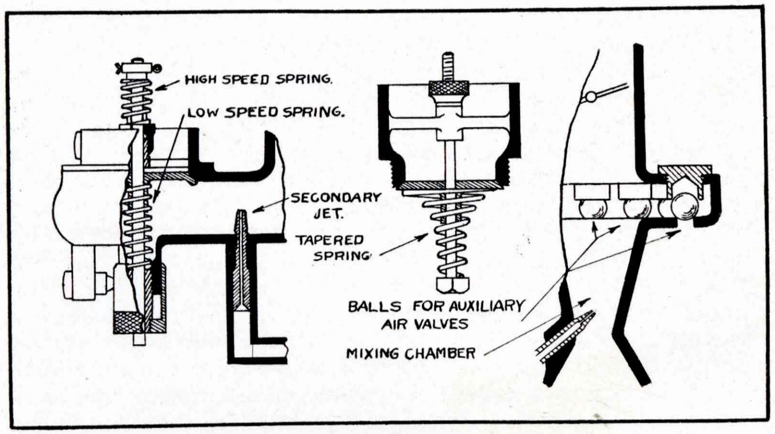


FIG. 4 (Stromberg "G") (Schebler) **FIG. 5** (C. & A.)

TYPES OF AIR VALVE SPRINGS

The air valve is controlled by two springs, the stiffer upper one coming into action after it is partly open.

A tapered spring resists too great an opening of the air valve, more than a straight one would.

Steel balls are used instead of the usual spring controlled air valve.

which have found wide application, will be explained in the following paragraphs.

TYPES OF AIR VALVE SPRING

Experience has shown that if a nozzle is placed in a mixing chamber and is adjusted to give the correct quality of mixture for light demand, and an air valve, the action of which is controlled by a spring, is utilized to admit the amount of auxiliary air necessary to maintain the correct mixture at intermediate demand, there will be a tendency toward thinning out when the motor is running at high speed with the throttle wide open. Some designers have employed two springs on the air valve. After the air valve is opened a short distance against the tension of the first spring, Fig. 4, it strikes the second spring and is thereby prevented from being opened so wide by the section as to admit too much air when the motor is running at high speed with wide open throttle. Some manufacturers wind their wire springs, not on a cylinder, but on a taper, Fig. 4. When a spring is wound with a few large soft coils to be compressed first, followed by the smaller and stiffer ones, it becomes stiffer very much more rapidly than would one wound on a cylinder, and tends to prevent the entrance of too much air at high speed.

WEIGHTED AIR VALVE

Some manufacturers use a set of balls seating over a set of holes, as shown in Fig. 5, instead of the spring controlled air valve. Some instruments use as many as ten of these balls. The number and size of the balls and seats are determined experimentally to give satisfactory operation. One manufacturer places a small gasoline jet beneath each ball.

In Fig. 14 the auxiliary air supply is controlled by the weight of valve A.

SECONDARY GASOLINE NOZZLE (DOUBLE JET CARBURETOR)

Since a rather small mixing chamber is specially desirable in order that the velocity of the air past the nozzle may be high enough to pick up gasoline when the throttle is nearly closed and the motor is running idle, the air valve should let in only a definite amount of air to thin down this mixture.

If the over rich mixture be thinned down, not with a fixed quantity of pure air but with a larger quantity of thin mixture, a carburetor of the same size can be made to deliver a larger quantity of satisfactory mixture to the engine. This thin mixture can be obtained by introducing a secondary nozzle into the auxiliary air passage as shown in Fig. 4.

When the air attains sufficient velocity, it draws a spray from this nozzle. Often instead of a fixed nozzle, one where the size

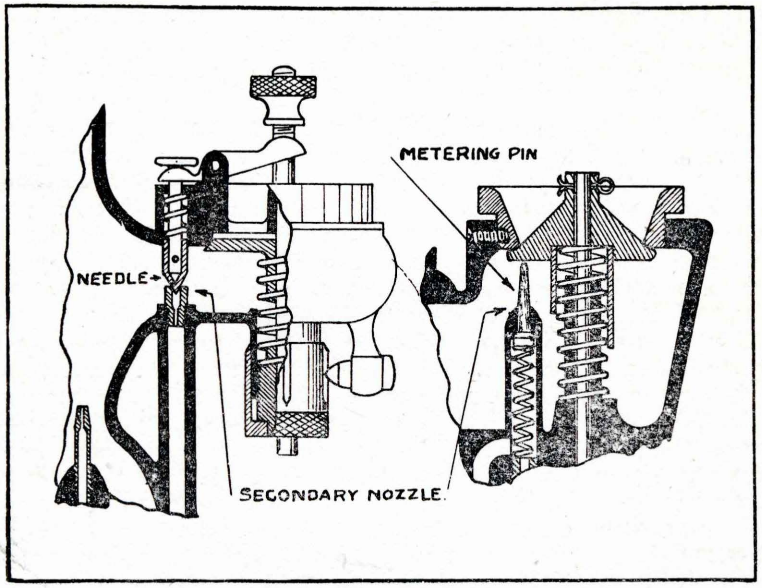


FIG. 6 **FIG. 7**

SECONDARY NOZZLE OR JET

The valve when partly open lifts the needle opening the secondary jet.

The air valve as it opens pushes down the tapered metering pin to give increased flow of gasoline.

of the orifice is controlled by the motion of the air valve is used. Fig. 6 shows one where the air valve must open a little before it begins to raise the tapered needle valve to admit the secondary supply of gasoline, the amount being adjustable by turning the threaded collar up or down on the stem. Fig. 7 shows a secondary nozzle so constructed that the opening of the air valve depresses a tapered needle or metering pin and increases the size of the gasoline opening.

MULTIPLE AND VARIABLE SIZE MIXING CHAMBERS

Some carburetors have been made in which a small mixing chamber is used to supply the engine with mixture when the throttle is nearly closed and a larger one comes into action when the demand is larger. In some the throttle, generally the barrel type, opens two or more mixing chambers progressively.

Fig. 8 shows a carburetor with two mixing chambers. When the motor is running slowly or with the throttle nearly closed, the air enters the primary mixing chamber, the quality of the mixture being adjusted by the low speed needle valve. As the throttle is opened and the demand increases, the suction lifts the flap valve and air passes through the secondary mixing chamber.

ber. The spring prevents the secondary mixing chamber from coming into action before it is needed to supply the demands of the motor. The quality of the mixture supplied by the second mixing chamber can be adjusted by the high speed needle valve.

The barrel throttle and multiple nozzle of an instrument, which has come into some prominence on racing cars in this country, is illustrated in Fig. 9. When the barrel throttle is nearly closed, the mixing chamber is small and is fed by one or two of the jets. As it is opened wider to admit more air, more of the jets are uncovered to admit more gasoline.

When a carburetor is so constructed that the passage through the mixing chamber is very large, it should offer little resistance to the flow of the mixture and should permit the motor to develop very near its maximum power. With the simple nozzle some trouble may be experienced with a lean mixture if the throttle is thrown suddenly to wide open position when the motor has been running slowly on nearly closed throttle. With many different types of carburetors, better acceleration will result if the throttle is opened as the motor picks up instead of being thrown suddenly to wide open position.

PRIMARY NOZZLE CONTROLLED BY THE THROTTLE

In some models and makes of carburetors a mechanical connection is made between the throttle and the needle valve so that

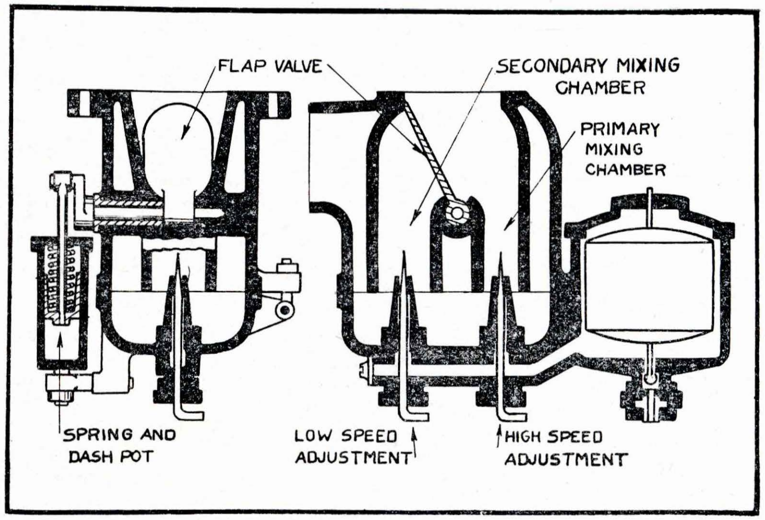


FIG. 8 (Saurer)

DOUBLE MIXING CHAMBER

When the demand exceeds the capacity of primary mixing chamber, suction raises the automatic valve, permitting the secondary chamber to come into action.

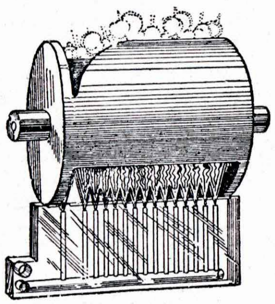


FIG. 9 (Master)

VARIABLE MIXING CHAMBER AND MULTIPLE N ZZLE

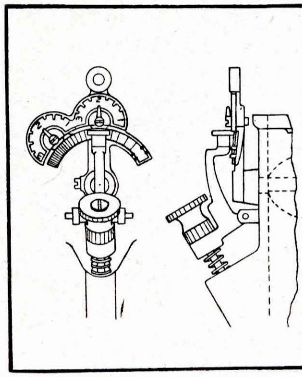
As the barrel throttle is opened wider the jets are progressively uncovered.

as the throttle is opened the tapered needle is drawn out of the fuel orifice, thereby increasing the flow of gasoline. An adjustment is usually provided to regulate the amount that the needle valve will be lifted when the throttle is moved from closed to open position. Fig 10. shows a simple connection between an eccentric on the throttle arm and the needle valve. Fig. 11 shows an arrangement whereby the amount which the throttle lifts the needle can be adjusted at one-half and at wide open positions by changing the position of the hands on the dials. Fig. 12 shows a cam on the throttle shaft which can be so adjusted as to give a great or small amount of lift to the primary needle as the throttle is opened. Needle N (see Fig. 14) is pushed down toward its seat by spring S, and can be lifted by the lever fixed to the inner end of shaft M. Secured to the outer end of shaft M is a lever A (see Fig. 12) against the lower end of which bears the points of low speed adjusting screw L. Tightening this screw moves the lower end of lever A to the left and raises needle N to admit more gasoline. The low speed screw L is mounted on one arm of a bell crank lever B, which is loose on shaft M, the other end of which bears against a cam E mounted on the throtle shaft. As the throttle is open the cam E pushes down on the arm of bell crank B, causing the lower arm which carries L to move to the left. This moves lever A and lifts needle valve N to admit more gasoline. The amount which the cam E moves bell crank B can be adjusted by turning high speed adjusting screw H. Extending through lever A is a shaft secured to the lower end of which is an eccentric V, and to the upper end ,a lever X operated by a wire W, which extends to within easy reach of the driver's seat. This is used to give slight motion to lever A one way

FIG. 10

PRIMARY GASOLINE NOZZLE CONTROLLED BY THE THROTTLE

As the throttle is opened, the needle is lifted to admit more gasoline.



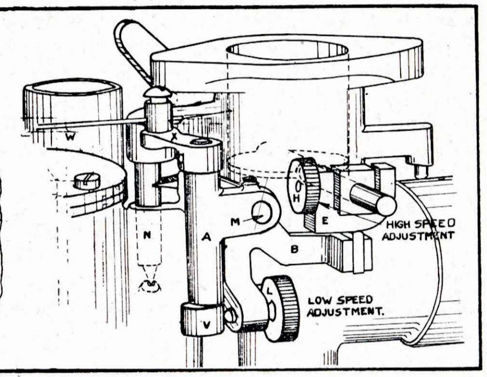


FIG. 11 (Schebler "L") **FIG. 12** (Rayfield

PRIMARY GASOLINE NOZZLE CONTROLLED BY THE THROTTLE

As the throttle is opened the inclined track is moved past the roller on the lever and the gasoline needle is raised.

As throttle is opened the cam on the throttle shaft raises the needle through a system of levers. A wire within easy reach of the driver's seat can be used to change the initial setting of the needle.

or the other to raise or lower needle valve N and change the quality of the mixture.

PRIMARY NEEDLE CONNECTED TO AIR VALVE

Fig. 13 shows the needle N connected to the air valve V by lever pivoted at P so the opening of the air valve lifts the tapered needle out of the primary gasoline opening, thereby increasing the flow. The position of the needle valve, when the air valve is against its seat, is regulated by turning the air valve cage C up and down, it being open when the air valve is screwed down, this being the low speed adjustment. The tension of the spring controlling the air valve can be adjusted by turning the adjusting screw, this constituting the high speed adjustment.

AUXILIARY AIR VALVE CONNECTED TO THROTTLE

Fig. 14 shows an interconnection of the throttle with a mechanically controlled auxiliary air valve. The most used instrument, which embodies this feature, also uses a spring controlled air valve and a needle in the primary gasoline orifice lifted by a cam on the throttle arm, and in some models a secondary gasoline orifice. Later models of the same make have the air valve, which was formerly opened by the throttle, connected to the automatic or spring controlled air valve, and a secondary nozzle with a tapered needle, controlled by the air valve, is employed. (See Fig. 7.)

DASH POT ON THE AIR VALVE

The variable suction which acts on an air valve nearly always causes it to flutter to an objectionable extent. In many carburetors a device known as a dash pot, is used to prevent this. Fig. 14 shows a dash pot in connection with the air valve. On the lower end of the valve stem is secured a plunger or piston P, which is as near a tight fit in cylinder P, as is practical without danger of its sticking. The cylinder in which this moves may be air filled or may be connected with the float chamber. The gasoline is much more effective in preventing flutter than air is. The engine will generally accelerate somewhat better if there is a dash pot on the air valve because of the fact that the air valve will not suddenly be sucked too far open. Fig. 15 shows a gasoline filled dash pot. Fig. 13 shows an air filled dash pot at D.

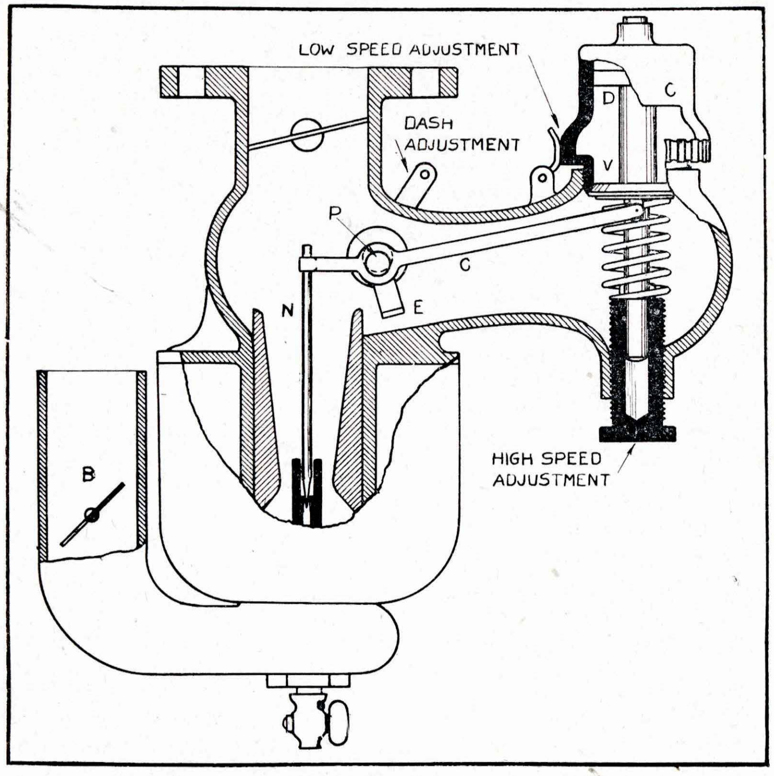


FIG. 13 (Schebler "R")

PRIMARY GASOLINE NOZZLE CONTROLLED BY THE AUXILIARY AIR VALVE

As auxiliary air valve opens it raises the gasoline needle to increase the supply. The initial setting of the air valve is made by turning the air valve cage. Moving the dash adjustment lever first raises the needle, then holds the air valve shut for starting.

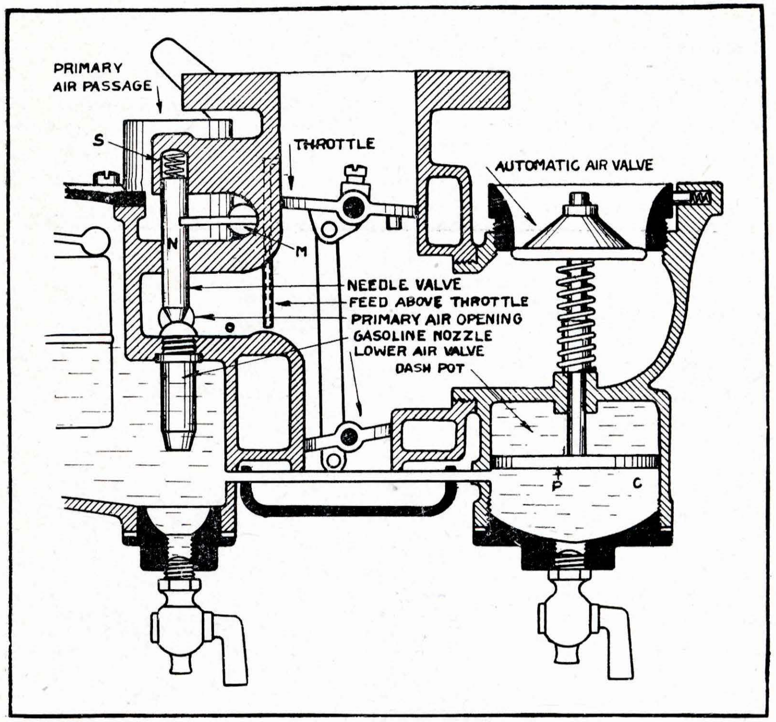


FIG. 14 (Rayfield)

This instrument embodies mechanically controlled air valve, automatic air valve with dash pot, feed above the throttle for idling, and interconnection of throttle with primary needle valve.

Fig. 15 illustrates another carburetor in which the size of the primary fuel orifice is increased as the auxiliary air is admitted. The primary air supply enters at AA, and passes through drilled holes HH, past spray nozzle located in mixing chamber at E. Gasoline from the float chamber comes through passages SS, past needle valve of metering pin P, to spray nozzle at E, from which it mixes with the air to form a fine spray. Whenever the motor requires more mixture than can be supplied through passages H and mixing chamber E, the suction lifts the whole air valve A, which is a free fit in guide K, off of its seat at I thereby admitting more air. As air valve A lifts away from tapered metering pin P, a larger quantity of gasoline is drawn up through the nozzle, thereby maintaining the desired quality of mixture. To the lower end of air valve A is attached a disc D which is submerged in gasoline and acts as a dash pot to prevent fluttering or too sudden opening of the air valve. To afford easy means of changing the quality of mixture, the height of needle P can be changed by a rack and pinion, M N, controlled from the driver's seat by suitable rod and lever mechanism. With this the driver can secure richer mixture for starting and can thin it out as the motor warms up. The taper of the pin and the weight of the valve are determined experimentally by the manufacturer and cannot be improved upon by one who is not an expert.

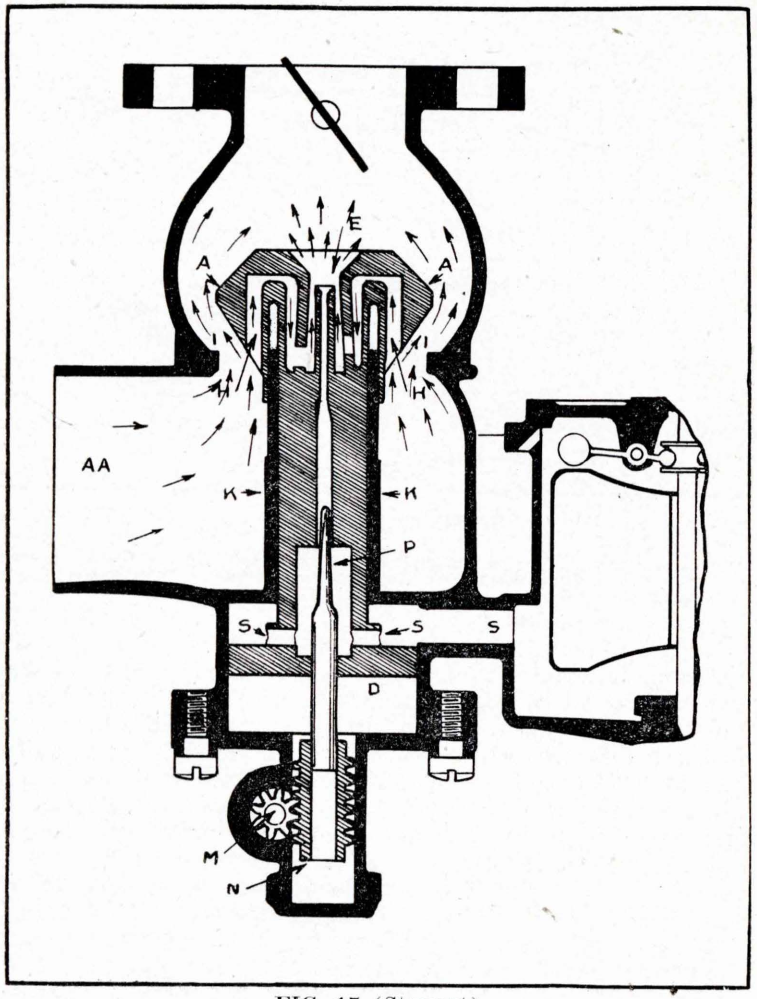


FIG. 15 (Stewart)

As the suction raises the air valve admitting more air it draws away from the tapered metering pin thus admitting more gasoline. The dash pot is used to reduce fluttering of the air valve.

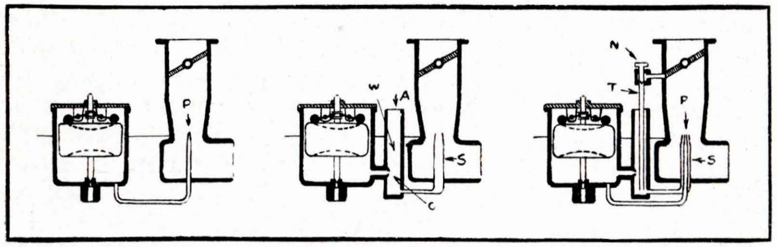


FIG. 16

GRAVITY COMPENSATED COMPOUND NOZZLE

The primary nozzle P is located in the mixing chamber and is in direct communication with the float chamber.

Gasoline flows by gravity through the hole C from float chamber into well W and is drawn out through secondary nozzle S.

The primary and secondary nozzles are combined to form a compound nozzle. A feed under the edge of the throttle is added.

GASOLINE PUMP CONNECTED TO THE THROTTLE

One manufacturer in adapting the type of carburetor he has used for a number of years on four cylinder cars to a new eight cylinder model, added a small gasoline pump so constructed to the throttle shaft that the sudden opening of the throttle for quick acceleration causes an extra supply of gasoline and, consequently, a slightly richer mixture. Repeated opening and closing of the throttle would maintain the richer mixture.

COMPENSATION BY GRAVITY FED WELL AND COMPOUND NOZZLE

A carburetor in extensive use abroad and of some prominence in this country, begins with a mixing chamber and nozzle of approximately the correct size to give the proper quality of mixture and sufficient quantity for the maximum demands of the motor. Since this arrangement would ordinary tend to supply a thinner and thinner mixture as the throttle is closed, and in addition the suction would be so low with the throttle nearly closed that no gasoline would be lifted from the nozzle, some additions are required. Since the flow of gasoline falls short of that required, more noticeably as the speed and the throttle opening are decreased, all that is necesary is to add to the gasoline supplied by the main nozzle enough to make up for this shortage and the carburetor should supply the correct proportion of air and gasoline under all conditions.

The diagram in Fig 16 illustrates the principle of compensation which underlies the action of this carburetor. Gasoline is maintained at an established depth in the float chamber by a conventional float mechanism. Nozzle P is directly connected with float chamber and is of such size that it is capable of supplying practically all the gasoline needed when the throttle is wide open. A well W opened at the top to the air at A is supplied with gasoline from the float chamber through a hole at C and is filled to the same depth as the float chamber when the engine is not running. From this well is a passage which communicates with tube S, surrounding the main fuel nozzle P. Whenever the suction in the mixing chamber is great enough, it draws gasoline from both main nozzle and outer nozzle. The amount it can take through outer nozzle, S, is limited by the size of the hole C and the height of the gasoline above it in the float chamber. This is to be just the amount by which the main nozzle falls short, due to the failure of the flow of gasoline to be exactly proportional to the flow of air, and is referred to as the amount necessary for "compensation." The orifice C is known as the "compensator" and different sizes can be substituted. Since the mixing chamber, or "Venturi Tube," must be large enough to supply sufficient air for the maximum demands of the motor at high speeds and wide open throttle, the suction will be so small with the throttle nearly closed that gasoline will not be lifted from the nozzle. To supply gasoline when the throttle is nearly closed, a tube or drilled passage, T, is provided, one end of which opens under the edge of the throttle and the other extends to the bottom of well W. The amount of gasoline which it can take can be adjusted by means of a needle valve, N, and is limited by the amount which will run into the well, W, through hole C.

When throttle is nearly closed, the suction under the edge of the throttle disc is so great that the gasoline is drawn through tube T. (If the engine is cranked with throttle nearly closed, the gasoline with which the well is filled will make starting easier.) As soon as the throttle is opened wider and the suction in the mixing chamber is higher than that under the edge of the throttle, the gasoline flows through the outer nozzle S. As the suction in the mixing chamber increases and the gasoline is drawn out of the well as fast as it can run in, air is drawn through with it and serves to assist in breaking it up into a finer spray. Fig. 17 shows two sections through the carburetor which embodies the features explained. The lettering corresponds as far as possible to that in the discussion of the diagrams. The essential difference lies in the construction of the device for feeding gasoline under the edge of the throttle for low speed. Air enters around low speed adjusting needle, N, passes down between space between inner well, V, and tube, T, and picks up a spray of gasoline, which comes from outer well, W, through hole O. This mixture of air and spray is drawn up through tube and drilled passage, T, and enters under the edge of the throttle. The quality of the mixture for low speed can be adjusted by means of screw, N, until the motor idles properly.

This type of carburetor has the advantage of maintaining the

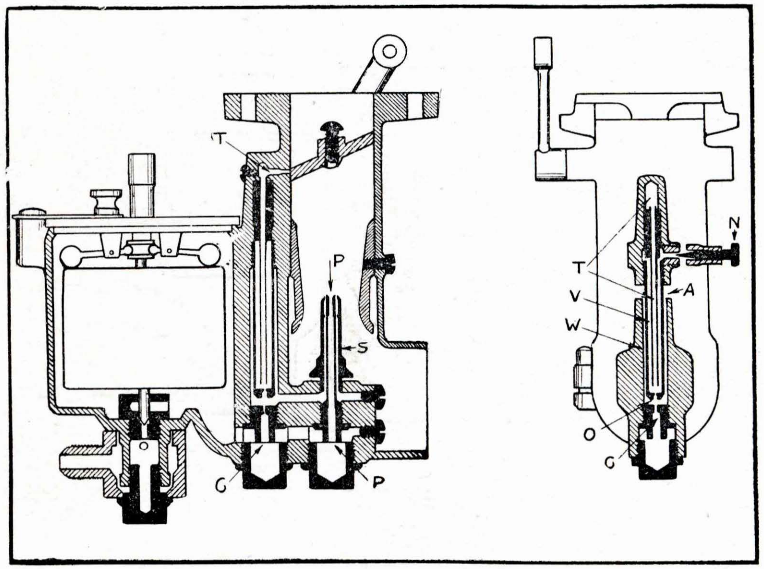


FIG. 17 (Zenith)

A section through the instrument embodying the gravity fed well, compound nozzle, and feed under the edge of the throttle for low speed.

correct proportion of fuel and air automatically and still being free from any multiplicity of moving parts, and once properly installed offers very little opportunity for the car owner who does not understand what he is doing to tamper with it and throw it out of adjustment.

FEED ABOVE THE THROTTLE—OR BY-PASS TUBE

Figs. 14, 17, 18 and 19 show several examples of feed under the edge of or above the throttle. Since the velocity of the air through the mixing chamber is so small when the motor is running idle, or the throttle is nearly closed, that it will not carry up a spray of gasoline, there will be an accumulation of liquid. In Fig. 14 it will be on the shelf at O. In Fig. 18 it will accumulate around the outside of the venturi tube. The tube and drilled passage will carry it up to the opening at the edge of the throttle where the suction is high. In Fig. 20 a plug with a hole drilled at K serves to regulate the quantity drawn up for the motor to idle on.

AIR BLED COMPOUND NOZZLE

Fig. 19 shows a construction in which air is mixed with the gasoline before it leaves the nozzle, breaking it up into a very

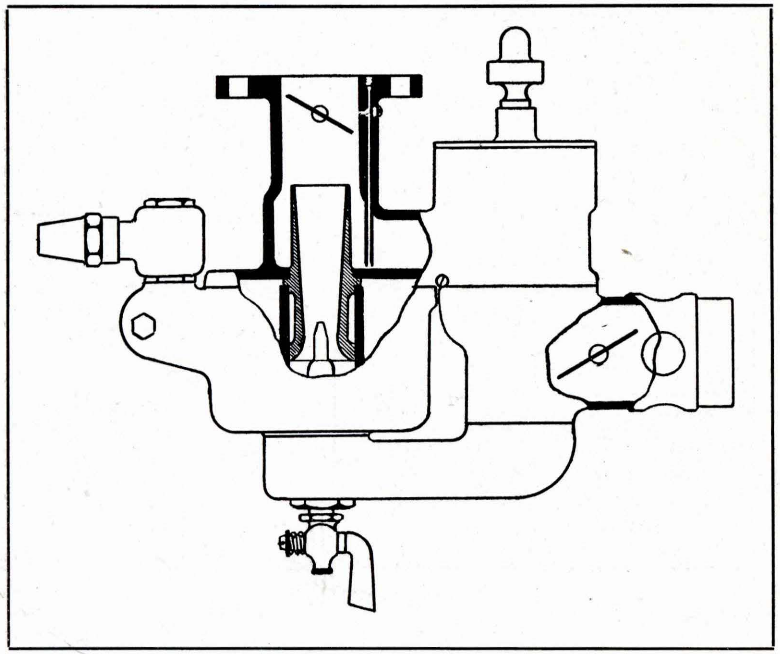


FIG. 18 (Stromberg "K")

All of the air entering passes a butterfly valve which can be partly or entirely closed by a control within easy reach of the driver to enrich the mixture or facilitate starting. A passage is provided to feed gasoline above the throttle for low speed running.

fine spray. Gasoline flows from the float chamber though passage G and hole Q into the inner nozzle P. Air comes through hole in plug at A and passes through W to the outer nozzle S. Holes H, the size and location of which have been determined experimentally, are drilled in the walls of the inner nozzle P and permit the gasoline and air to mix, thereby producing a very finely broken up spray.

The nozzle or combining tube in Fig. 20 is supplied with gasoline from the float chamber through tube E and adjustable needle controlled by F, and with air through tube L, annular space I, and holes G, the resultant finely divided spray leaving the nozzle.

DASH ADJUSTMENTS OR METHODS OF VARYING THE QUALITY OF THE MIXTURE FROM THE DRIVER'S SEAT—DEVICES TO FACILITATE STARTING

The behavior of gasoline when subjected to the cold is practically the same as that of stiff oil or molasses, in that the flow

will be appreciably diminished. Tests have shown that the flow through a carburetor nozzle will increase about 35% when the temperature of the gasoline rises from 50° to 90° F. Since the temperature under the hood is often higher than 100°, this is of great importance. If the carburetor is adjusted to supply the correct mixture after the engine is warm, the engine cannot be expected to fire regularly or pull well on the lean mixture, which it will draw when cold. This explains the necessity of "getting the motor warmed up."

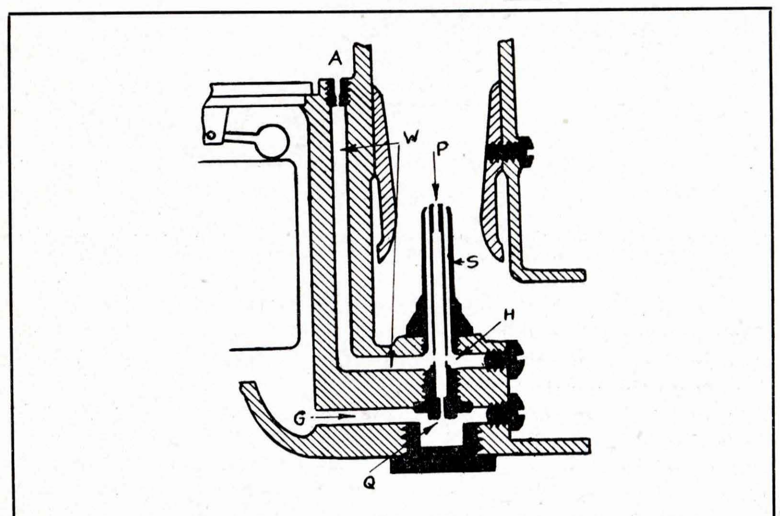
In addition, with the present heavy grade of fuel, starting the motor when cold by cranking without making provision to enrich the mixture would be very difficult, if at all possible.

FLOODING

On many carburetors devices are built which permit the driver, by means of a wire or rod, to depress the float or hold the float valve open until the float chamber fills to overflowing. This causes a richer mixture when the motor is cranked and facilitates starting. Fig. 21 shows two devices for "priming," "flooding," or "tickling," as it is called.

STRANGLING THE AIR SUPPLY

On a great majority of the modern carburetors some arrangement for shutting off all or most of the air supply while the motor is being turned over cold, is provided.



AIR BLED COMPOUND NOZZLE

This nozzle discharges a finely broken up spray of air and gasoline instead of the liquid

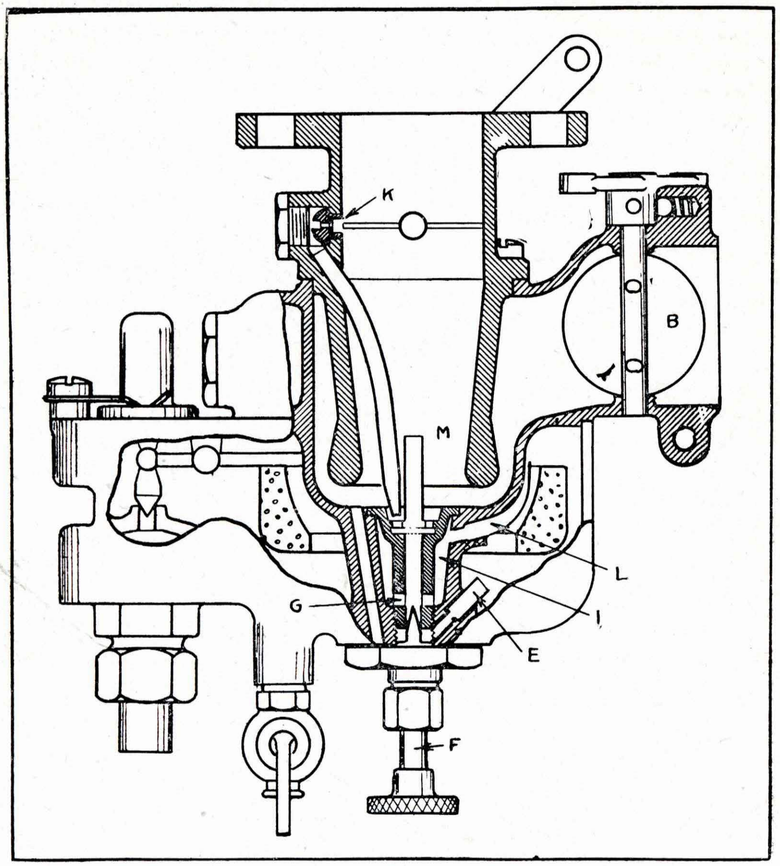


FIG. 20 (Holley "H-6 Cyl.")

This instrument uses a by-pass above the throttle for low speed, air bled nozzle with one adjustment, and butterfly for strangling air to facilitate starting.

Figs. 13, 18, 19, 22 and 23 show several satisfactory devices for shutting off or reducing the air supply to cause greater suction in the mixing chamber and to draw a greater supply of gasoline from the nozzle for starting.

Turning lever L, Fig. 22, by means of a rod, the end of which is within easy reach of the driver when he is about to start the engine, closes the butterfly valve B and brings cam C under the stem of air valve V, thus cutting off practically all the air supply except what can pass in through two notches cut in the butterfly.

In Fig. 13 the changing of the position of the lever L lifts the lever C and the gasoline needle N during the first part of its

motion. Then it brings another lever E against the one which connects the air valve with the needle valve, thus holding the air valve V against its seat to enrich the mixture for starting. In some instruments of this make, there is also a butterfly B in the primary air intake. Shutting off all the entering air might be more effective than shutting off only that which comes through the air valve.

In Figs. 13, 18 and 23 the butterfly B is in the passage through which all the air must enter the carburetor.

INCREASING GASOLINE FLOW BY ENLARGING NOZZLE OPENING

Some designers provide simply an adjustment of the primary gasoline orifice which is to be enlarged to facilitate starting. This permits a greater flow of gasoline from the nozzle but lacks the effect of the partial vacuum which accompanies the shutting off of the air supply in aiding vaporization.

DASH ADJUSTMENTS

For a device whereby the quality of the mixture can be controlled from the driver's seat without the necessity of stopping the car, either one regulating the size of the gasoline orifice, one to change the spring tension on the air valve, or one to cut down the size of the passage, through which the air enters the car-

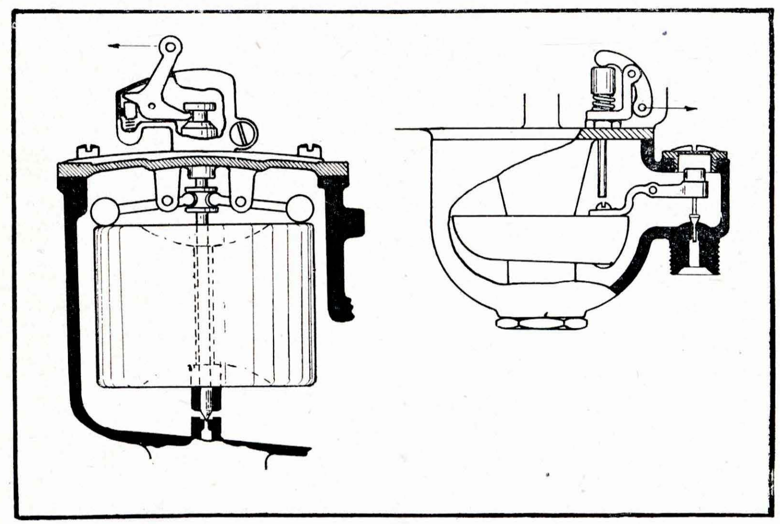


FIG. 21

FLOODING DEVICES

A mechanism is arranged so that the float may be depressed or the float needle raised to fill or "flood" the float chamber.

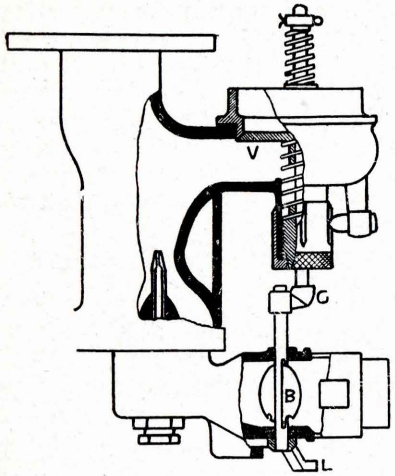


FIG. 22 (Stromberg)

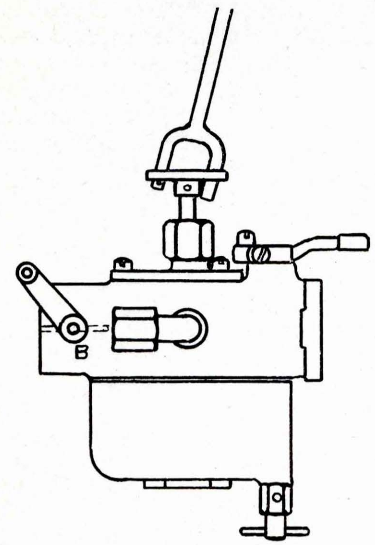
A mechanism is arranged for closing both the air valve and the primary air entrance to facilitate starting.

buretor, may be used. Fig. 23 shows a simple forked end rod which extends from a knurled head on the dash to the needle valve. The driver generally has the knurled head so marked that he can screw it down tight and reset it when occasion makes it desirable to check the carburetor adjustment. The butterfly valve B, Figs. 18, 20 and 23, could be used either to cut off most of the entering air to give easy starting, or to increase the vacuum in the body of the carburetor and enrich the mixture until after the motor has warmed up. Fig. 12 shows a connection of a wire running from the dash or from the steering column to a lever secured to a shaft, at the lower end of which is an eccentric V. Turning this eccentric causes the needle valve N to be raised or lowered, thereby, affecting the flow of gasoline and the quality of the mixture. In Fig. 15 a lever, controlled by a wire or rod, extending to within easy reach of the driver, operates the rack and pinion mechanism, M-N, thereby, raising or lowering needle of metering pin P to change the quality of mixture.

If no such control is provided and it is impractical to arrange one to regulate either the gasoline nozzle or the air valve, it is possible to attach a small valve to the intake manifold above the carburetor, which can be opened and closed conveniently by a rod from the driver's seat. This suffers the disadvantage of having its greatest effect upon the mixture when the throttle is nearly closed and, hence, must not be open when the motor is to be run slowly. Such an auxiliary air opening affords the driver means of thinning out the mixture after the carburetor has once been adjusted.

DEVICES TO SAVE GASOLINE

Since the quality of mixture which gives the maximum power and best acceleration is generally not the one for best economy, and the mixture supplied by the carburetor is too thin before the motor has been "warmed up" or else too rich for economical running, the dash adjustment is a very desirable attachment to any carburetor. If one is provided, there is no particular advantage



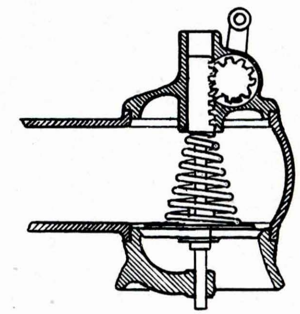


FIG. 23 (Holley-Ford) **FIG. 24**

"DASH" ADJUSTMENTS

A rod extends from the dash to the carburetor adjusting needle and is turned to regulate the quality of mixture.

By means of a rod and lever the rack and pinion mechanism is used to increase the tension on the air valve spring.

to be obtained from admitting more air to the manifold above the carburetor, as long as the adjustment is correct.

An examination of almost any carburetor will show that it contains many of the features described in the foregoing paragraphs. Instruction sheets supplied by the manufacturers should be consulted when adjustments are to be made on unfamiliar instruments. The practice of marking all adjusting devices before they are moved (especially if the adjustment of the instrument is supposed to be anywhere near right) in order that they can be restored to their original setting if desired is to be commended.

III. CONDITIONS WHICH EXIST IN THE MANIFOLD

HEAT A VALUABLE AID TO THE VAPORIZATION OF GASOLINE

If the hand is dipped in gasoline and exposed to a draft of air, a sensation of cold results because the heat necessary for vaporization is partly drawn from the hand. Tests have shown that the amount of heat necessary to cause complete vaporization of the fuel in a mixture of fifteen parts air to one of gasoline will cause a reduction in the temperature of the mixture to a point from 40° to 45° Fahrenheit colder than the incoming air. This accounts for the coldness of the inlet manifold.

If a glass plate or window is placed in the manifold just above the carburetor, close observation will disclose the fact that much of the gasoline is passing through the manifold in the form of a fine spray instead of vapor. This is particularly true when the motor is pulling hard at moderate speed, as in climbing a hill on high gear. If a plate is placed in the wall of the manifold just beyond a bend, it will be found that much of this gasoline spray has been thrown on to the wall and is flowing along the wall instead of remaining in the air.

The air and gasoline leaving almost any carburetor will be found to be in a well mixed condition. No matter how well it is mixed with the air, even if some type of auxiliary mixing device such as a mechanical agitator or an air jet to stir up the mixture above the throttle be used, the gasoline if in the condition of a spray, instead of a vapor, will separate from the air to a great extent when the mixture travels at high rate of speed around the bends in the manifold.

LOADING

Incomplete vaporization of the gasoline in the mixture accounts for much of the peculiar behavior of the motor when the accelerator pedal is suddenly depressed or when the car is making a long hard pull on high gear. When the car has been throttled down and the accelerator pedal is suddenly pushed clear down the engine may fire one or two shots from the mixture in the manifold and then miss and backfire for a few revolutions. This happens because the mixture in traveling at high speed around the bends in the manifold loses much of the gasoline spray and arrives at the cylinders too lean. A few revolutions later the gasoline which is traveling on the walls of the manifold reaches the cylinders. For a short time there is an over rich mixture with attendant missing and smoke from the exhaust. This is followed by the proper proportion of gasoline and air and regular running.

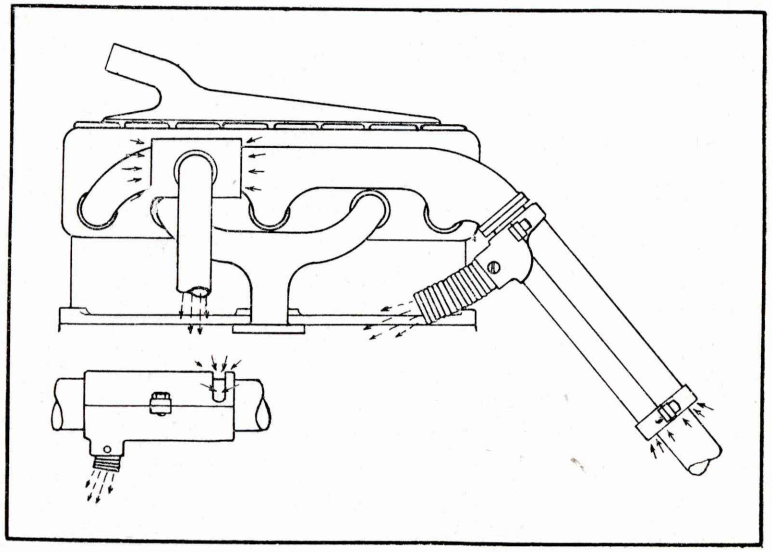


FIG 25

Devices for warming the air before it enters the carburetor.

When a car is pulling on a long hill on high gear liquid gasoline accumulates in the manifold. If the clutch is released, the motor tries to speed up but is choked by drawing in too much of this liquid gasoline. If after a half mile of hard pulling on high gear the engine were stopped and a vessel placed beneath the carburetor a considerable quantity of gasoline would be found to run back from the manifold. If the gasoline which is mixed with the air were in the condition of a vapor, instead of a spray, this behavior would be avoided.

A few years ago there was much less trouble experienced from condensation or "loading" in the manifold because the gasoline which was on the market at that time was more easily vaporized. Most modern carburetors, in order that they may handle the heavier grades of gasoline satisfactorily, are equipped with some arrangement for supplying heat to aid in vaporization.

METHODS OF USING HEAT TO AID THE VAPORIZATION OF GASOLINE

Fig. 25 shows some forms of heating "stoves" which are clamped to the exhaust pipe. The air is drawn along the exhaust pipe and warmed and passes through a tube, often a flexible metal hose, into the carburetor. Hot water, or sometimes exhaust gas is passed through a jacket surrounding the mixing chamber of the carburetor to aid vaporization. In a few instances the inlet manifold has been jacketed and hot water or exhaust gas has been used to prevent condensation or loading. The exhaust gas should be more effective than water because the boiling point of a large per cent of any sample of present day gasoline is higher than that of water. In many modern block motors the inlet manifold is cored within the main cylinder casting and is surrounded by the water jacket. In one or two foreign built motors the inlet manifold has been built inside of the exhaust and all possibility of condensation has been eliminated.

EFFECT OF TOO MUCH HEAT

If the body of the carburetor becomes so hot that the gasoline boils in the float chamber, the operation of the motor will be unsatisfactory. It will appear to fire with perfect regularity and will accelerate well when running idle but will not develop much power.

Heating the charge before it enters the cylinders expands it, and the cylinders therefore, draw a smaller quantity of mixture. This should reduce the power of the engine to some extent. This can be demonstrated in the testing laboratory but on the road a car in which enough heat is used to prevent loading in the manifold will climb a hill on high gear, which it cannot climb without the heat. When no heat is used the engine will spit or backfire when it should accelerate, particularly if the mixture is lean enough to give good economy. With sufficient heat it will accelerate smoothly even with a rather lean mixture because more of the gasoline is in the condition of a vapor or true gas instead of a fine spray of liquid.

FAILURE OF A MOTOR TO START

Failure of a motor to start may be due to either too little or too much gasoline. If the motor is cold, it is generally too little. Injection of a teaspoonful of gasoline into each cylinder should permit the motor to be started. If it stops after running a few revolutions, it should be determined whether there is sufficient gasoline in the float chamber. This generally can be done by depressing the float and watching for flooding. Failure to get gasoline may be due to closed valve or obstruction in the feed pipe, empty tank, or a lack of air pressure. If gasoline is present in the float chamber failure to keep running may be due to closed or obstructed spray nozzle, water with the gasoline or an air valve which does not seat properly.

OVERPRIMING A WARM MOTOR

If a warm motor is given too much gasoline by over-priming or by cranking with the air shutter held closed, it will become flooded and fail to fire. Shutting either the valve in the gasoline line or the needle valve regulating the fuel orifice, blocking the air valve open, or opening the priming cups and cranking for a short time, will remedy this condition.

FLOODING CARBURETOR

Flooding or overflowing may be caused by dirt under the float needle, leaky float or deranged adjustment of mechanism. A suitable strainer and trap in the feed pipe or a wire gauze screen in the carburetor, through which the asoline must pass before

entering the float chamber, will save much trouble. If such is not provided, filtering the gasoline into the tank through a chamois skin will remove dirt and water. A leak in the metal float can be located by immersing it in hot water, its location being indicated by bubbles. It should be cleaned, soldered and held beneath the surface of gasoline until cold. A cork float should be dried thoroughly and given a coat of shellac.

DIFFERENT CAUSES OF UNSATISFACTORY OPERATION

If the motor starts up and runs, there are many symptoms of improper mixture but as most of these may be the results of other causes, it is well to be certain that other conditions are right before any change is made in the carburetor adjustment.

The compression should be equal in all cylinders. If it is not, leaks past valve caps, spark plugs and other joints should be stopped. Such leaks can be located by running oil around all joints and turning the motor over, their presence being indicated by bubbles. Valves, particularly the exhaust, should be ground in if necessary. The distance between valve stems and tappets should be only sufficient to prevent their being held open when the motor is hot.

The ignition system must be in such condition that a good spark occurs in each cylinder at the proper time. The spark plugs must have their points properly spaced and the porcelain or insulating material must be clean and in good order. The spark plug wires may have defective insulation or the distributor (of magneto or battery system employing one coil for more than two cylinders)may be so dirty that leakage and missfiring, particularly on a hard pull, result. The contacts in a circuit breaker or timer, or the vibrator contacts on a spark coil may be dirty, burned, pitted, or improperly adjusted, or the primary wires may be loose at the terminals, resulting in failure of ignition in one or more of the cylinders under certain conditions of speed and load.

Too rich a mixture will cause black smoke in the exhaust (blue smoke is the result of over-lubrication) and sooted spark plugs. The flame issuing from priming cups, opened while the motor is running, should be blue; an over-rich mixture will make it yellow. A yellow tinge to the flame issuing from one priming cup, may be due to over lubrication, resulting from faulty ignition or other cause in that cylinder. Galloping when the motor runs idle is a result of over-rich mixture. Another result is a tendancy to fire each cylinder every fourth instead of every second revolution of the crank shaft or at least it will miss many explosions. Excessive richness will cause a motor to run hot.

To lean a mixture will cause missing and backfire through the carburetor. This back-fire is brought about by the fresh entering gas coming in contact with flame in the cylinder, which remains from the explosion stroke, due to the slowness of the burning of a weak mixture. A lean mixture results in increased mileage per gallon of gasoline but also in some loss of power and ability to accelerate and often in a greater tendency to knock.

For good economy the mixture should be thinned out by means of the dash adjustment as much as is possible after the motor has run enough to be warmed up. With such a proportion the motor will nearly always back fire if the throttle is opened suddenly and will fall short of the maximum power on a hill, necessitating an increase in richness under these conditions. Much greater smoothness of operation, with weak mixtures, can be obtained by the use of heat to aid in the vaporization of the gasoline as explained in foregoing paragraphs.

IV. GASOLINE

Fifteen years ago the gasoline and the so-called naphtha were disposed of at whatever price could be obtained and kerosene and illuminating oil were the important products. Of late years, with the automobile and gasoline engine and the use of electricity for illuminating in the towns and cities, conditions have been reversed.

THE REFINING PROCESS

In the refining process the crude oil is located in large stills and the lighter constituents as they are driven off are condensed in a cooled worm. In a few refineries the more volatile products are kept separate. In others they pass through the worm uncondensed and are burned beneath the still. Continued application of heat drives off first the gasoline and naptha and then the heavier and less volatile liquids, including kerosene, distillate, and light lubricating oils. In many refineries all the product from the still, down to a certain gravity as determined by a hydrometer, is run into the gasoline. A number of years ago is was customary to run gasoline and three grades of naphtha, A, B and C. Ten years ago most of the gasoline bought in the open market tested in the neighborhood of 70° on the ordinary Baume hydrometer. Now a great part of it tests between 57° and 60°. The natural object of the refiner is to run as much of the condensed product into the gasoline as possible without making the mixture unsatisfactory for use in motor cars. In the summer he generally uses a heavier product than in winter.

THE HYDROMETER

The hydrometer, the instrument commonly used for determining the gravity of gasoline, is shown in Fig. 26. It is of hollow

glass and is loaded at the lower end with lead shot or mercury. When placed in a liquid the depth to which it sinks is an indication of the gravity. It will not sink so deep in a heavy liquid as in a light one. The type of instrument commonly used for testing gasoline in the United States is graduated in degrees on an arbitrary scale devised by a chemist named Baume. It happens that a liquid which has a reading of 70° on the Baume scale has the same specific gravity. Some corresponding figures on the two scales are given.

84° Baume= .654 Sp. Gr
60° Baume= .737 Sp. Gr.
46° Baume= .796 Sp. Gr.
28° Baume= .886 Sp. Gr.
0° Baume=1.000 Sp. Gr.

Since liquids expand and contract with changes of temperature their density changes. It is customary to test gasoline at a temperature of 60° Fahrenheit. For every ten degrees colder than that the liquid gets its gravity drops one degree lower on the Baume scale. Specific gravity is the ratio of the weight of a substance to the weight of the same volume of water. If a liquid has a specific gravity of .9. it is nine-tenths as heavy as water. The Baume scale runs exactly opposite to one graduated to indicate specific gravity.

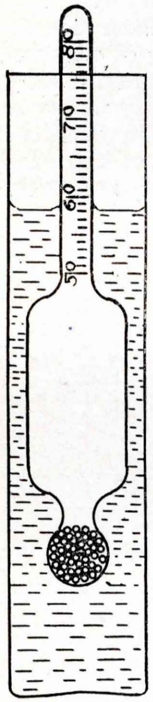


FIG. 26

Hydrometer for determining the gravity of gasoline.

RELATIVE ADVANTAGES OF HIGH AND LOW TEST GASOLINE

The heavier gasoline will develop more heat per gallon, and if the engine runs well with it, it should give more mileage and slightly more power. The lighter gasoline or higher test will evaporate more easily and should permit much easier starting in the cold weather. It will give smoother operation on cars where the carburetor or the air entering it is insufficiently heated.

Gravity test alone is not a positive indication of how volatile a sample of gasoline is. Two samples of the same gravity made from different crudes may show quite a difference in the time required to evaporate under the same conditions. Two samples from the same crude showing the same gravity may differ in composition. One 60 test sample might contain liquids ranging from 55 to 70 but averaging 60; another might contain liquids ranging from 47 to 90 and still have the same average of 60. A small portion of the second one would be quite volatile but it might cause more trouble with loading in the manifold, due to the amount of kerosene it contains.

A simple method of comparing two samples of gasoline obtained from different sources is to dip strips of paper of equal size to the same depth in the two samples and expose them side by side to the air and note the difference in the rapidity of evaporation. Equal volumes of two samples could be placed in saucers in an open window where they would be subjected to the same draft and the portion left after most has evaporated could be compared. This might show one to contain more of a qiquid comparing favorably with kerosene in density, odor and other properties.

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