July 13, 1937. A. M. PRENTISS 2,087,116

CARBURETOR

Filed June 7, 1932

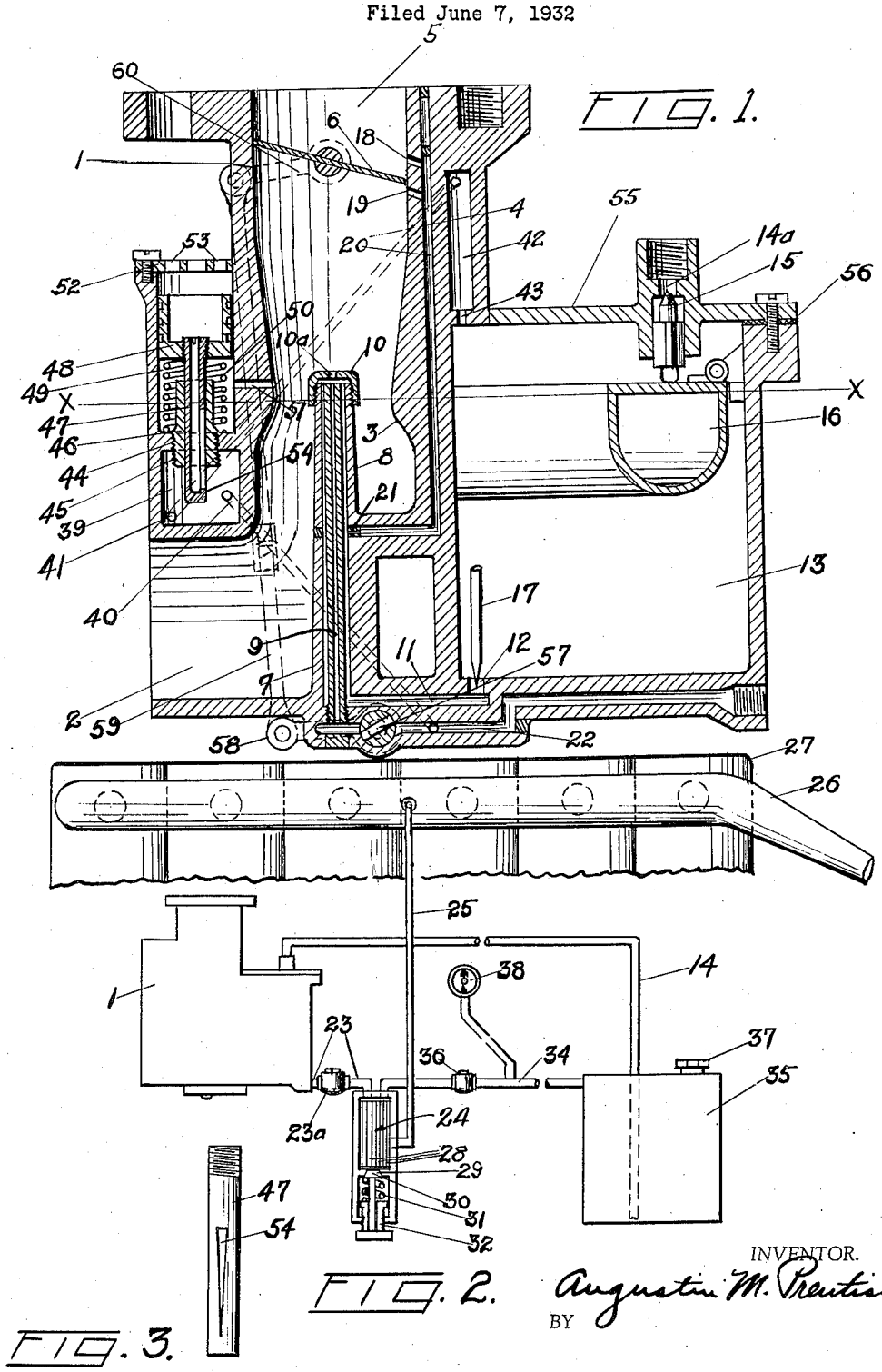


FIG. 1.

FIG. 2.

FIG. 3.

INVENTOR.

Augustin M. Prentiss.

BY

ATTORNEY.

Patented July 13, 1937 2,087,116

UNITED STATES PATENT OFFICE

2,087,116

CARBURETOR

Augustin M. Prentiss, San Antonio, Tex.

Application June 7, 1932, Serial No. 615,840

20 Claims. (Cl. 261—16)

This invention pertains to carburetors and more particularly has reference to carburetors of the pressure feed compensating type wherein the liquid fuel is fed into the mixing chamber of the carburetor under a superatmospheric pressure and its flow regulated so as to always bear a desired ratio to the air component of the mixture.

The invention herein disclosed is an improvement upon the invention described in my United States Patent No. 1,329,309, issued January 27, 1920.

While the carburetor disclosed in the patent cited gave greatly improved results over the prior art suction-operated devices, it was attended with certain practical difficulties in manufacture and adjustment which I have overcome by the greatly simplified construction herein disclosed.

I have also further discovered that still greater improvement in operation can be secured by subjecting the liquid fuel to compressed carbon dioxide instead of compressed air for the following reasons.

I have found that in gasoline carbon dioxide is from three to five times more soluble than air depending upon the temperature and pressure of charging. Also the solubility of carbon dioxide in gasoline increases very rapidly with increase in charging pressure even at moderate pressures above atmospheric. Moreover, when the gasoline is released from the charging pressure the carbon dioxide separates out almost instantaneously and with such vigor as to greatly increase the dispersion and atomization of the liquid gasoline as compared to the similar effects of compressed air.

Another advantage of using carbon dioxide instead of air is that the solubility of the former in gasoline is more responsive to temperature changes than the latter, and, while the solubilities in gasoline of both carbon dioxide and air vary inversely with the temperature of the gasoline, the effect of temperature on the degree of solubility is much more marked in the case of carbon dioxide than with air, so that a greater degree of temperature compensation of the fuel-air mixture is automatically secured by atomizing the liquid fuel with carbon dioxide rather than air.

Still another advantage of using carbon dioxide instead of air for atomizing the liquid fuel is that carbon dioxide under suitable pressures can be obtained direct from the engine exhaust manifold and no air pump or other pressure device is required.

This invention has for its objects:

First; to provide an improved carburetor of the pressure feed, compensating type wherein the liquid fuel is fed into the mixing chamber by a variable superatmospheric pressure so controlled as to make the liquid fuel feed responsive to the demands of the engine under all operating conditions.

Second; to provide a carburetor in which the liquid fuel is atomized by carbon dioxide under a superatmospheric pressure whereby greatly increased atomization of the liquid fuel is secured.

Third; to provide a carburetor of the pressure feed type in which the degree of atomization of the liquid fuel is automatically compensated for temperature, i. e., the lower the operating temperature of the carburetor, the greater the degree of atomization of the liquid fuel, whereby a greater uniformity of the fuel-air mixture is obtained under all operating temperatures.

Fourth; to provide a pressure feed, compensating carburetor of greatly simplified construction, in which the operating adjustments are simple and reduced to the minimum.

Fifth; to provide an improved apparatus of this kind wherein the pressure on the liquid fuel is a maximum when the engine is idling and is gradually decreased as the speed of the engine increases until it reaches a minimum value when the engine is operating at its highest rated speed.

Sixth; to provide a carburetor wherein the pressure on the liquid fuel varies directly with the pressure in the mixing chamber of the carburetor.

Seventh; to provide a device wherein the ratio of liquid fuel to air is constantly maintained at a predetermined value throughout all changes in operating conditions of the engine, by subjecting the liquid fuel to such a superatmospheric pressure as will make it follow the law of gas flow.

Eighth; to provide an inproved carburetor of this nature having means for supplying carbon dioxide under superatmospheric pressure to break up the liquid fuel within the fuel nozzle before it issues therefrom and thus secure a high degree of atomization of the liquid fuel regardless of variations in its specific gravity.

With these and other objects in view which may be incident to my improvements, my invention consists in the combination and arrangement of elements hereinafter described and illustrated in the accompanying drawing in which:

Figure 1 is a central longitudinal section of a carburetor constructed in accordance with the present invention;

Figure 2 is an elevation, largely diagrammatic,

showing the operating connections between the carburetor, the exhaust manifold of the engine, and the main fuel supply tank;

Figure 3 is an elevation, on a slightly enlarged scale, of the stem of the liquid fuel pressure regulating valve.

Unless specially controlled and regulated to the contrary, the flow of liquid fuel through a carburetor follows the general law of liquid flow and the flow of air follows the law of adiabatic gas flow. As to the air flow, it is logical to assume that the expansion of a gas approaching an orifice, being rapid, is adiabatic, and the authorities generally agree that the flow of air through a carburetor is, for all practical purposes, sensibly adiabatic. The observed data support this view.

The general formula for liquid flow and adiabatic gas flow, as applied to a carburetor, may be expressed as follows:

$$G_1=\mu_1 F_1 \gamma_1 \sqrt{2g\frac{(P_n-P_m)}{\gamma_1}} \quad (1)$$

$$G_2=\mu_2 F_2 \left(\frac{P_m}{P_n}\right)^{.71} \sqrt{6.88 g P_n \gamma_2 \left[1-\left(\frac{P_m}{P_n}\right)^{.29}\right]} \quad (2)$$

G_1 is the rate of liquid flow in pounds per second.

G_2 is the rate of air flow in pounds per second.

μ_1 is the coefficient of efflux for liquid flow.

μ_2 is the coefficient of efflux for adiabatic gas flow.

F_1 is the cross-sectional area of the liquid fuel passageway of the carburetor—generally the area of the metering restriction in the fuel passageway.

F_2 is the cross-sectional area of the main air passageway of the carburetor in the zone of the fuel jet orifice—generally the area of the smallest section of the Venturi throat.

γ_1 is the unit weight of the liquid fuel, in pounds per cubic foot at 32° F. temperature.

γ_2 is the unit weight of the air in pounds per cubic foot at normal atmospheric pressure of 32° F.

g is the acceleration of gravity.

P_n is the superior pressure causing the fluid flow, which, in suction-operated carburetors, is the atmospheric pressure outside the carburetor.

P_m is the absolute pressure in the mixing chamber of the carburetor in the zone of the fuel jet orifice.

The foregoing nomenclature and formulas are, in accordance with Church's "Mechanics of Engineering", Part IV, Chapter VIII on "Kinetics of Gaseous Fluids".

For convenience of reference in this specification, I shall follow Church's terminology and refer to the formula for liquid flow (formula (1) above) as the "water formula" and the formula for air flow, (formula (2) above), as the "adiabatic formula". It will also be understood that where I refer, in this specification, to the air supply to the mixing chamber of the carburetor as being fed into said chamber "in accordance with the law of liquid flow", I mean in accordance with the "water formula" (formula (1) above). That is to say, the total weight of air passing into the mixing chamber, per unit of time, for any given pressure (vacuum) in said chamber, is that found from the "water formula" ((1) above) for "P_m" equal to the pressure (vacuum) in said chamber, and not from the "adiabatic formula" ((2) above) which normally governs the flow of air through a carburetor.

It will be further understood that where I refer, in this specification, to the air suppy to the mixing chamber being fed into the mixing chamber in accordance with the normal law of air or gas flow, I mean in accordance with the "adiabatic gas formula" (formula (2) above) and where I use the term "normal operating conditions" I mean conditions of steady flow through the carburetor which excludes momentary fluctuations due to sudden changes in throttle opening.

This invention broadly comprehends means for applying a superatmospheric gas pressure upon the liquid fuel in the float reservoir of the carburetor whereby the liquid fuel is caused to be fed into the mixing chamber in accordance with the law of gas flow under a superatmospheric pressure which varies with the demands of the engine, the pressure being continuous and at a maximum when the engine is idling and gradually decreasing as the speed of the engine increases. The reasons for applying this superatmospheric pressure were fully explained in my patent cited above and are controlling in this invention also.

This invention further contemplates the use of compressed carbon dioxide as the means for dispersing and atomizing the liquid fuel, said carbon dioxide being obtained direct from the engine with which the carburetor is used, thereby eliminating all pumps or other pressure devices.

More particularly, this invention comprises means for diverting a portion of the spent gases from the exhaust manifold of the engine through the carburetor so as to secure the feed of the liquid fuel under a superatmospheric pressure, and increased atomization of the liquid fuel by the superior atomizing power of the carbon dioxide. The invention further proposes the use of exhaust gas pressure to lift the liquid fuel from the main supply tank to the carburetor and thereby eliminate the use of fuel pumps or other fuel lifting devices. While the use of exhaust gas pressure to lift the liquid fuel from the main supply tank to the carburetor is old in the art, and, per se, forms no part of this invention, the use of exhaust gas pressure to feed the liquid fuel into the mixing chamber under a superatmospheric pressure is novel, as is also the combined use of the exhaust gases for both purposes.

Under normal operating conditions, the exhaust gas of an internal combustion engine consists of the following components in the approximate average proportions indicated: Nitrogen, 85.15%; carbon dioxide, 10.55%; carbon monoxide, 3.50%; and oxygen 0.80%. In addition, there are also usually present traces of vaporized gasoline and lubricating oil.

I have found that when ordinary liquid fuel (gasoline) is placed in a closed vessel and subjected to the exhaust gas of the engine under a superatmospheric pressure, there is a progressive absorption of the carbon dioxide in the liquid fuel, the percentage so absorbed varying with the pressure of the exhaust gas and the time during which the liquid fuel is subjected to the charging pressure.

The traces of liquid fuel and lubricating oil present in the exhaust gas condense to liquids and mix with the liquid fuel. The nitrogen and carbon monoxide components do not appear to be dissolved in the liquid fuel to any appreciable extent, under the pressures and temperatures prevailing, while the oxygen component is so small as to exert no noticeable effect upon the liquid fuel. From a comparison of the behavior of gasoline, charged with exhaust gas, and gasoline, charged with pure carbon dioxide, it is

apparent that the other components of the exhaust gas have little or no effect upon increasing the atomization and evaporation of the gasoline when released from the charging pressure. On the contrary, the marked increase in these effects is due almost entirely to the carbon dioxide absorbed from the exhaust gases.

I have further found that the combustibility of liquid fuel in air can be considerably varied, and, within certain limits, controlled by varying the percentage of carbon dioxide in solution therein. Thus, with a given throttle opening, the speed and power output of an internal combustion engine can be controlled by varying the percentage of carbon dioxide in solution with the liquid fuel. While the only component of the exhaust gas which exerts any appreciable effect upon the liquid fuel is the carbon dioxide, it is obvious that other inert gases (derived from some other source) could also be used to control the combustion of the liquid fuel.

For convenience of reference in this specification, I shall, therefore, use the term "inert gas" to designate not only the carbon dioxide component of exhaust gas but also any gas, inert to combustion, that may be dissolved in the liquid fuel and exert a retarding effect upon its combustion by diluting the percentage of oxygen in the combustible mixture.

In the drawing I have illustrated a preferred embodiment of my invention, and the particular construction shown comprises a casing or body 1, having a main air inlet 2, Venturi throat 3, mixing chamber 4, and mixture outlet 5 controlled by a butterfly throttle valve 6, all arranged as in a conventional plain tube suction-operated carburetor.

Integral with the bottom wall of air intake 2 is a main nozzle 7 which consists of an outer liquid fuel tube 8 and a concentric inner gas tube 9, both rising to a point slightly above the center of Venturi throat 3 and surmounted by a cap 10 screw-threaded on tube 8, having a central aperture 10*a* through which the main jets of liquid fuel and gas are discharged into chamber 4.

Tube 8 is connected by a passageway 11 and port 12 with a liquid fuel reservoir 13 which receives liquid fuel through a supply pipe 14 and inlet 14*a*, the latter being controlled by a valve 15 actuated by a float 16 so as to always maintain a constant liquid fuel level, X—X, in said reservoir. Port 12 is controlled by a manually adjustable valve 17 which regulates the normal flow of liquid fuel. Two idling fuel feed ports 18 and 19 bestride the throttle 6 (when in closed position) and are connected by a passageway 20 and metering restriction 21 with tube 8 of nozzle 7, as clearly shown in Figure 1.

Gas tube 9 of nozzle 7 is connected through a passageway 22, pipe 23, and reduction valve 23*a* to a gas pressure-regulating chamber 24, which in turn is connected by a pipe 25 with the exhaust manifold 26 of an internal combustion engine 27. The valve 23*a* maintains a sufficient pressure differential between chamber 24 and the carburetor to lift the fuel from a main supply tank 35.

Within chamber 24 are arranged a series of parallel small bore tubes 28 which are open at both ends so as to form a plurality of restricted passageways through chamber 24. These tubes serve to baffle and cool and extinguish all flame in the exhaust gases passing through chamber 24.

The bottom wall of chamber 24 is provided with an aperture 29 which serves as a seat for a pressure-regulating poppet valve 30. The force with which valve 30 is held to its seat determines and controls the pressure of the gases in chamber 24 and this force is regulated by a spring 31 which seats against the head of an adjusting screw 32 so that by turning said screw, the tension of said spring may be varied as desired. Thus, by means of valve 30, spring 31, and screw 32, the pressure in chamber 24, and in pipe 23, is regulated and kept substantially constant while the engine is running. Aperture 29 also serves as a blow-off outlet for any liquids which are condensed by the cooling of the gases in chamber 24. Such part of the fuel vapor in the products of combustion as passes through chamber 24 and is not condensed therein, reaches the carburetor where it is again used to form a combustible mixture for the engine.

As the exhaust gases supplied to the carburetor are only a small fraction of the total exhausted from the engine, and the pressure in the cylinders and exhaust manifold of the engine is instantly created as soon as the engine starts firing, there is at all times while the engine is running available for the carburetor a sufficient supply of gas under the desired pressure even when the engine is running at its lowest operating speed.

Connected to chamber 24 is a branch pipe 34 which communicates with a main supply tank for liquid fuel, 35, and transmits thereto the pressure of the gases in chamber 24. The pressure thus produced in tank 35 is sufficient at all times while the engine is running to lift the liquid fuel from said tank and feed it into the reservoir 13 of the carburetor, since the pressure in tank 35 is always superior to that transmitted to reservoir 13 as will hereinafter appear. The buoyancy of the float 16 is, however, always sufficient to close valve 15 and cut off the flow of liquid fuel to reservoir 13 when the liquid fuel in said reservoir reaches the level X—X against the maximum pressure of the gas in tank 35.

Inserted in pipe 34 is a check valve 36 which prevents the escape of gas pressure from tank 35 while the engine is at rest and there is no pressure in pipe 23. While the filling cap 37 which seats with an air-tight fit on tank 35 is removed to refill the tank with liquid fuel, the gas pressure therein, of course, falls to atmospheric pressure, but this causes no operating difficulties as the float chamber 13 of the carburetor holds a sufficient quantity of liquid fuel to start and run the engine until the full gas pressure is restored to tank 35. A gas pressure gauge 38 is connected to pipe 34 and placed upon the instrument board of the car to show the amount of pressure in tank 35 at all times.

In order to apply the necessary variable pressure to the liquid fuel in reservoir 13 to cause the flow of liquid fuel to the mixing chamber 4 to always bear the desired ratio to the air flow therethrough, I have provided the following novel pressure control mechanism. An auxiliary gas pressure chamber 39 is connected by a passageway 40 with passageway 22, and by another passageway 41, supplementary chamber 42, and port 43, with reservoir 13. Passageway 40 is much smaller than gas line 22, and passageway 41 is still smaller, being only sufficient to maintain a static pressure in reservoir 13, as no gas current flows therethrough except that absorbed.

The top wall of chamber 39 has a central

screw-threaded aperture 44 into which screws a sleeve 45 in a position vertically adjustable. A central bore 46 in sleeve 45 receives a hollow stem 47 which is attached by screw threads to a piston 48 adapted to reciprocate with an air-tight fit in a cylindrical chamber 49, as clearly shown in Figure 1. Interposed between piston 48 and the top wall of chamber 39 is a helical spring 50 which tends to force piston 48 upwardly in chamber 49 against the vacuum of mixing chamber 4 which is transmitted to chamber 49 by a passageway 51. Whenever the force exerted on the valve 30 due to the vacuum in mixing chamber 4 is greater than the force of spring 50, piston 48 is drawn down towards the bottom of chamber 49 until the bottom of piston 48 contacts with the top of sleeve 45, and conversely, when this vacuum is weaker than spring 50, piston 48 is forced up in chamber 49 until the upper edge of said piston contacts with a cover 52 on chamber 49. Cover 52 is provided with a plurality of vents 53 so that any air in chamber 49 above piston 48 readily escapes into the outside atmosphere and atmospheric pressure is maintained at all times in the space in chamber 49 above piston 48.

Hollow stem 47 is open at its upper end and closed at its lower end and is provided with an elongated slot 54 in one side. It will be noted from Figure 3 that this slot is of peculiar shape, being generally triangular in outline with the apex of the triangle at the bottom of the slot. The sides of the slot are, however, not strictly straight, but are slightly curved, so that as stem 47 is moved down through sleeve 45 the area of the slot exposed to chamber 39 progressively increases so that the amount of gas escaping from chamber 39 through said slot is sufficient to produce in chamber 39 the pressure desired to be exerted upon the liquid fuel in reservoir 13 for each position of stem 47 which corresponds to a predetermined vacuum in the mixing chamber 4.

The vents 53 in the cover 52 of chamber 49 are of sufficient size to permit the free escape into the atmosphere of the maximum amount of gas discharged through stem 47 when said stem is in its lowest position, so that the pressure on the upper side of piston 48 is substantially atmospheric at all times.

From the foregoing description it is apparent that the pressure of the gas in passageway 22 is transmitted through passageway 40 to chamber 39, and through passageway 41, chamber 42, and port 43 to liquid fuel reservoir 13. If now stem 47 is in its uppermost position so that the lower end of slot 54 is completely covered by sleeve 45, no gas can escape through slot 54, and the gas entering chamber 39 can leave only through passageway 41. But since reservoir 13 is closed air-tight by means of a cover 55 and gasket 56, it is evident that the gas entering reservoir 13 from chamber 39 can only escape by dissolving in the liquid fuel contained in reservoir 13, and, as only a relatively small percentage of the gas entering reservoir 13 will dissolve in the liquid fuel therein, a substantially constant static pressure is maintained in chamber 39 and reservoir 13 at all times while the engine is running, and slot 54 is closed. When stem 47 descends and exposes a portion of slot 54 to chamber 39, there is at once an escape of gas from chamber 39 out through stem 47, chamber 49 and vents 53, but as long as the exposed area of slot 54 is less than the cross section of passageway 40, only a portion of the gas entering chamber 39 escapes, since the gas can flow into said chamber faster than it can escape therefrom. As the exposed area of slot 54 is increased by the descent of stem 47 there is a corresponding increase in the portion of gas escaping and a corresponding reduction of pressure in chamber 39 and reservoir 13. When the exposed area of slot 54 exceeds the cross section of passageway 40 the gas in chamber 39 escapes faster than it can enter, and the pressure in chamber 39 and reservoir 13 falls below that of passageway 40.

From what has just been said it follows that the pressure on the liquid fuel in reservoir 13 can be varied from a maximum of the pressure in passageway 22 to a minimum of substantially atmospheric pressure, and that this variation can be controlled with respect to the vacuum in the mixing chamber 4 in any manner desired by a proper design of the slot 54 in stem 47. In this way the amount of superatmospheric pressure applied to the liquid fuel in reservoir 13 can be so regulated as to make the discharge of liquid fuel from nozzle 7 follow the law of gas flow and thus a true parity between the air flow and the liquid fuel flow to the mixing chamber can be maintained under all operating conditions.

Since the maximum area of slot 54 exposed to chamber 39 is not infinite, and there is some retardation to the gas escaping from said chamber due to friction caused by passing through a relatively long and narrow slot, there will always be some superatmospheric pressure in chamber 39 even when stem 47 is in its lowest position and the area of slot 54 is a maximum, as long as the engine is running. Thus, while the minimum pressure in chamber 39 may be substantially atmospheric, it is never quite actually equal to atmospheric pressure, due to the small superatmospheric pressure just mentioned. The minimum pressure in chamber 39 can be regulated by adjusting the maximum exposure of slot 54 when stem 47 is in its lowest position. This adjustment is effected by raising or lowering the sleeve 45 by screwing it up or down in threaded aperture 44.

While the carburetor is in operation the pressure in passageway 22 is substantially constant due to the action of valve 30 (Figure 2) and hence gas enters chamber 39 at a substantially constant pressure, but the pressure in said chamber is varied by the movement of stem 47 which is controlled by the vacuum in mixing chamber 4, so that the greater the vacuum in mixing chamber 4, the smaller the pressure in chamber 39 and reservoir 13.

The flow of air through mixing chamber 4 is dependent upon and proportional to the vacuum therein, and this flow, by virtue of Venturi throat 3, produces a corresponding suction on the main nozzle 7, so that (disregarding the aspirating effect of the gas jet in nozzle 7) the flow of liquid fuel to chamber 4 would be that induced by the vacuum in said chamber alone, provided the pressure in reservoir 13 were only atmospheric. This is the basic principle of all suction-operated carburetors. But it has been shown that, due to the difference in laws of flow of gases and liquids, a common vacuum inducing both flows cannot maintain a parity, or desired ratio, between these flows as the effective head (suction) varies.

In order, therefore, to maintain a desired ratio of flow between the air and liquid fuel components of the mixture under all operating con-

ditions, in this invention I subject the liquid fuel to a variable head consisting of: (*a*) the vacuum in the mixing chamber, or more properly, the vacuum produced by the flow of air through a Venturi throat induced by the vacuum in the mixing chamber; (*b*) the aspirating effect of the gas column escaping from nozzle 7, which is relatively small; and (*c*) a variable superatmospheric pressure on the liquid fuel in reservoir 13 which varies from a predetermined constant pressure above atmospheric when the vacuum in the mixing chamber is a minimum to a pressure slightly above atmospheric when the vacuum in the mixing chamber is a maximum. The maximum superatmospheric pressure in reservoir 13 is adjusted so that, together with the vacuum in the mixing chamber and the aspirating effect of the gas jet in nozzle 7, it is just sufficient to produce the proper flow of liquid fuel from nozzle 7 under the highest operating pressure in the mixing chamber 4. In this way, I overcome the retarding effects of surface tension and inertia of the liquid fuel column when the vacuum in the mixing chamber is low and thus secure a proper feed of liquid fuel at the lowest operating speeds where suction-operated carburetors are notoriously deficient.

The minimum superatmospheric pressure in reservoir 13 is adjusted so that, together with the vacuum in the mixing chamber 4 and the aspirating effect of the gas jet in nozzle 7, it is just sufficient to produce the proper flow of liquid fuel from nozzle 7 under the lowest operating pressure in the mixing chamber 4. In this way, I supplement the feed of liquid fuel at the highest operating speeds and when the vacuum in the mixing chamber is at its maximum and thus secure increased power and speed from the engine when operating under its maximum load and speed.

At all intermediate speeds and loads when the vacuum in the mixing chamber varies from its lowest to its highest value, the superatmospheric pressure in reservoir 13 is made to vary so as to cause the liquid fuel flow from nozzle 7 to follow the law of gas flow and thus keep in step with the air flow under all operating conditions. In other words, the size of nozzle 7 is made such that it just passes the correct amount of fuel to form the proper mixture under highest operating speeds and highest vacuums in the mixing chamber. This is accomplished by properly calibrating the aperture 10*a* in cap 10 or by placing a metering restriction in the liquid fuel tube 9 or passageway 11, or valve 17 may be so adjusted as to give this proper flow without the use of a metering restriction. With the high speed jet thus fixed, as the vacuum in the mixing chamber decreases, there would be gradual thinning out of the mixture if the liquid fuel feed depended upon the vacuum in the mixing chamber alone, as in suction-operated carburetors, because of the difference in the laws of gas and liquid flows. But by the use of a supplemental pressure upon the liquid fuel adjusted so as to compensate for this natural tendency of the liquid fuel flow to fall off more rapidly than the air flow as the vacuum in the mixing chamber is decreased, I secure complete compensation of the mixture under all operating conditions without restoring to the use of air bleeds in the liquid fuel jet, supplementary air valves, or other expedients which have been resorted to in an attempt to compensate for the deficiencies of suction operation of the liquid fuel feed.

In the foregoing discussion of the function and evaluation of the supplementary superatmospheric pressure applied to the liquid fuel in reservoir 13, it is to be understood that the effect of the gas jet escaping from tube 9 of nozzle 7 on the flow of liquid fuel from said nozzle is taken into consideration at all times, as this is one of the three factors which control the flow of liquid fuel into the mixing chamber 4. Since gas tube 9 is of fixed and constant size, and the gas pressure therein is substantially constant while the carburetor is in operation, it is evident that a substantially constant flow of gas would occur therefrom under all operating conditions if this flow were not otherwise controlled. I have found that the minimum flow of gas that will effectively atomize the liquid fuel issuing from nozzle 7 is about three per cent by weight of said liquid fuel flow. If now the size of tube 9 were fixed such as to pass a flow of gas equal to three percent of the maximum flow of liquid fuel from nozzle 7, this flow of gas would constitute an increasingly larger percentage of the liquid fuel flow as the liquid fuel flow decreased from its maximum, since the pressure in passageway 22 is substantially constant. Accordingly, when the liquid fuel flow was at its minimum, this gas flow would constitute about thirty percent of the liquid fuel flow. I have found, however, that as the percentage of carbon dioxide in the mixture is increased, there is a corresponding decrease in the combustion and power of the mixture, until a point is reached when the carbon dioxide is 17% of the air, at which point combustion is completely prevented. In order, therefore, to prevent the percentage of carbon dioxide from exceeding an efficient value, I have provided a valve 57 connected with the throttle 6 by arm 58, adjustable link 59 and arm 60, to control the amount of gas flowing to and from tube 9 in proportion to the flow of mixture from the mixing chamber as controlled by the throttle 6. By adjusting the opening of valve 57, with respect to the throttle 6, by means of link 60, I can vary the percentage of carbon dioxide in the mixture and thus control the operation of the engine at its lower speeds.

Since, with a constant pressure in passageway 22, the pressure in chamber 39 depends only upon the relative sizes of the passageway 40 and the slot 54, and not upon their absolute sizes, the passageway 40 is made as small as possible without causing too great a friction loss with the maximum flow of gas therethrough. It is thus only a fraction of the size of passageway 22 so that even when slot 54 is fully opened, the actual flow of gas through passageway 40 will be only a small percentage of the flow through passageway 22. In this way the maximum escape of gas through passageway 40 is not sufficient to appreciably affect the flow of gas through passageway 22 and tube 9. The capacities of pipes 23 and 25 and chamber 24 are made sufficient to supply the maximum flow of gas required through nozzle 7 at the highest speed of the engine. At slower speeds, any excess gas that might be supplied to chamber 24 over that permitted to pass through passageway 22 by valve 57 would be blown off through regulating valve 30.

The sole function of chamber 42 is to prevent the entrance of liquid fuel into passageway 41, due to splashing, and when the carburetor is tilted at any angle.

The operation of my device is as follows. When the engine is at rest, there is no pressure

in the exhaust manifold **26**, and consequently no pressure in pipes **23** and **25** and chamber **24**. Also throttle **6** and valve **57** are closed, as is also slot **54** in stem **47**. At the same time, pressure from previous operation is retained in tank **35** by check valve **36**, and in pipe **14** by valve **15** which is held closed by float **16**. When the engine is turned over by the starter, the throttle **6** is in the restricted position shown in Figure 1 and the high suction above throttle **6** acting through port **18** and passage **20** on the liquid fuel which normally stands in said passage at the static level X—X, lifts this fuel up through port **18** into mixture outlet **5**. At the same time air enters port **19** and mixes with this fuel, forming a rich starting mixture, in the conventional way.

With the first explosions of the engine, a gas pressure is at once built up in the exhaust manifold **26** and this pressure is transmitted through pipe **25**, chamber **24**, pipe **23**, passageway **22**, and gas tube **9** to nozzle **7** where it comes in contact with the liquid fuel issuing from tube **8**, and forces said liquid fuel out through the aperture **10***a* in the form of a finely atomized spray. At the same time, the pressure in passageway **22** is transmitted through passageway **40** to chamber **39**, and thence to reservoir **13**, where it acts upon the liquid fuel in said reservoir and feeds it out of nozzle **7** in the proper proportion to the air flowing through the mixing chamber, to form the desired mixture.

As the engine gains speed, the vacuum in the mixing chamber rises, and in proportion to said rise, opens slot **54** in stem **47**, thereby gradually relieving the superimposed pressure in reservoir **13**, so as to cause the liquid fuel flow to follow the law of gas flow, instead of the usual law of liquid flow, and thus keep in step with the air flow at all speeds. From what has been said concerning the action of slot **54** and stem **47** on the pressure in reservoir **13**, it is clear that, while the pressure in said reservoir varies in general with the pressure in the mixing chamber **4**, (i. e., it increases with an increase in mixing chamber pressure), the ratio between these pressures is not constant, nor even strictly linear, as the chamber pressure varies. Therefore, it will be understood that where I use the expression—"the pressure in the float reservoir varies directly with the pressure in the mixing chamber,"—I means to express a qualitative and not a strictly quantitative relationship.

Due to its greater solubility in gasoline, the use of carbon dioxide instead of air to feed the liquid fuel and atomize it in the mixing chamber, affords marked advantages in increased atomization and in the elimination of an air pump. Also, since the solubility of carbon dioxide in gasoline is more responsive to temperature changes than is the case with air in gasoline, the use of carbon dioxide permits a better temperature compensation of the mixture. As the percentage of carbon dioxide also affects the power and combustion of the mixture, the operation of the engine at slow speeds can be more effectively regulated and controlled by a proper adjustment of the percentage of carbon dioxide in the mixture rather than cutting down the total volume of the mixture, as when air alone is used.

It will be noted that this carburetor is exceedingly simple in construction and has only two operating adjustments: viz, the valve **17** and the link **60**, and when these are once set for proper operation, no further adjustments are necessary.

While I have shown and described the preferred embodiment of my invention, I desire it to be understood that I do not limit myself to the constructional details or arrangements indicated, as these may be varied by those skilled in the art without departing from the spirit of my invention, or exceeding the scope of the appended claims.

I claim:

1. The method of carburetion characterized by forming a combustible mixture comprising an air component, and a liquid fuel component having an inert gas dissolved therein, said liquid fuel being atomized by the liberation of said gas when said liquid fuel is introduced into said air component.

2. In a carburetor having a mixing chamber, a fuel reservoir, means for maintaining in said reservoir a superatmospheric inert gas pressure, and means for regulating said pressure so as to cause the liquid fuel to be fed into the mixing chamber in accordance with the law of gas flow.

3. In a carburetor, a mixing chamber, a liquid fuel reservoir communicating therewith, means for maintaining a superatmospheric inert gas pressure in said reservoir and for varying said pressure directly as the pressure in said mixing chamber to force said liquid fuel into said chamber in accordance with a definite predetermined variation of flow.

4. The method of carburetion comprising the formation of an explosive mixture by introducing into an air component under a variable subatmospheric pressure, an inert gas component under a superatmospheric pressure, and a liquid fuel component under a superatmospheric pressure which varies directly as the pressure of said air component.

5. In a carburetor, a mixing chamber, and means, including a source of soluble, inert gas under pressure separate from said carburetor, for feeding liquid fuel to said chamber under a pressure which varies directly with the pressure in said mixing chamber, and at a rate which varies in accordance with the law of air flow to said chamber.

6. In a carburetor, a mixing chamber, a liquid fuel reservoir communicating therewith, and means, including a source of soluble, inert gas under pressure separate from said carburetor, for maintaining upon the liquid fuel in said reservoir such a pressure as will force said liquid fuel into said chamber at a rate varying in accordance with the law of air flow to said chamber, said pressure varying directly with the pressure in said mixing chamber.

7. The method of carburetion comprising the formation of a homogeneous mixture by introducing a liquid fuel component, charged with a soluble, inert elastic fluid under a superatmospheric pressure, into an air component under a lower pressure, whereby the liquid fuel is highly atomized by said fluid while commingling with said air, and controlling the relative flows of said components by coordinating the pressures thereon, whereby definite predetermined proportions between said components are maintained under all operating conditions.

8. In a carburetor having a throttle, an atomizing nozzle, means for supplying to said nozzle liquid fuel and an elastic fluid, each under a superatmospheric pressure, means for automatically keeping the pressure on said fluid supply

constant, and means for automatically varying the flow of said fluid in accordance with the movement of said throttle, whereby said liquid fuel is highly atomized by said fluid even when the flow of said fuel from said nozzle is at a minimum.

9. In a carburetor, having a throttle, a mixing chamber, an atomizing nozzle associated therewith, means for supplying liquid fuel and an elastic fluid each under a superatmospheric pressure to said nozzle, and means actuated by said throttle for regulating the flow of said fluid, and a pressure-responsive means for regulating the flow of said liquid fuel.

10. In a carburetor having a throttle, a mixing chamber, an atomizing nozzle associated therewith, means for supplying liquid fuel under a superatmospheric pressure to said nozzle, means, including a conduit, for supplying an elastic fluid under a constant superatmospheric pressure to said nozzle, means controlled by said throttle for varying the size of said conduit, and means responsive to the pressure in said chamber for regulating the superatmospheric pressure on said liquid fuel supply to said chamber.

11. In a carburetor having a throttle, a mixing chamber, means, including conduits, for supplying liquid fuel and gas thereto, each under a superatmospheric pressure, means responsive to said throttle for varying the size of said gas conduit, and means responsive to the vacuum in said chamber for varying the superatmospheric pressure on said liquid fuel.

12. In a carburetor for an internal combustion engine, a mixing chamber having an air supply thereto, a liquid fuel supply to said chamber under a pneumatic superatmospheric pressure derived directly from said engine, said pressure being greater than the pressure on said air supply outside said carburetor, and means for varying said pneumatic pressure so that said liquid fuel supply always bears a predetermined ratio to said air supply.

13. In a carburetor for an internal combustion engine, a mixing chamber having an air supply thereto, a liquid fuel supply to said chamber under a pneumatic superatmospheric pressure derived directly from said engine, said pressure being greater than the pressure on said air supply outside said carburetor, and means for varying said pneumatic pressure so that said liquid fuel supply always enters said chamber at a rate which varies in accordance with the law of gas flow, whereby said liquid fuel supply always bears a predetermined ratio to said air supply.

14. In a carburetor having a liquid fuel reservoir, a mixing chamber having an air supply and a liquid fuel supply thereto, means, separate from said carburetor, for maintaining a superatmospheric soluble, inert gas pressure on said liquid fuel supply in said reservoir, and means for varying said pressure so that said liquid fuel is fed from said reservoir to said chamber at a rate which varies in accordance with the law of gas flow.

15. In a carburetor, a mixing chamber having an air supply and a liquid fuel supply thereto, means, separate from said carburetor, for maintaining a superatmospheric soluble, inert gas pressure on said liquid fuel supply, and means for varying said pressure so as to make said liquid fuel supply enter said chamber at a rate which varies in accordance with the law of gas flow whereby said liquid fuel supply always bears a predetermined ratio to said air supply.

16. In a carburetor, a mixing chamber, a fuel feeding nozzle associated therewith, means for supplying liquid fuel under superatmospheric pressure to said nozzle, means for supplying compressed inert gas to said nozzle, and an automatic pressure means for regulating the liquid fuel supply to said nozzle, the pressure in said regulating means varying directly as the pressure in said mixing chamber.

17. In a carburetor, a mixing chamber, a liquid fuel reservoir in communication therewith, means for maintaining liquid fuel in said reservoir at a constant level, and means for maintaining such a variable superatmospheric inert gas pressure upon said liquid fuel as to force said fuel from said reservoir into said chamber in accordance with the law of gas flow.

18. A carburetor comprising a throttle, a liquid fuel reservoir with liquid fuel supply thereto under a constant superatmospheric pressure, an atomizing nozzle with a gas supply and liquid fuel supply thereto, both under superatmospheric pressures, and a means responsive to the throttle for regulating the supplies of liquid fuel and gas to said nozzle.

19. In a carburetor, a mixing chamber, an air supply and a liquid fuel supply thereto, and means, including a source of pressure separate from said carburetor, for controlling said liquid fuel supply so as to make it always bear a predetermined ratio to said air supply, the pressure in said means varying directly as the pressure in said mixing chamber.

20. In a carburetor, a mixing chamber, an air supply thereto under a subatmospheric pressure, and a liquid fuel supply thereto under a continuous superatmospheric pneumatic pressure from a source separate from said carburetor, said pressures varying directly with each other.

AUGUSTIN M. PRENTISS.