May 23, 1944. G. L. PRATT 2,349,676

CARBURETING APPARATUS

Filed Oct. 13, 1941 2 Sheets-Sheet 1

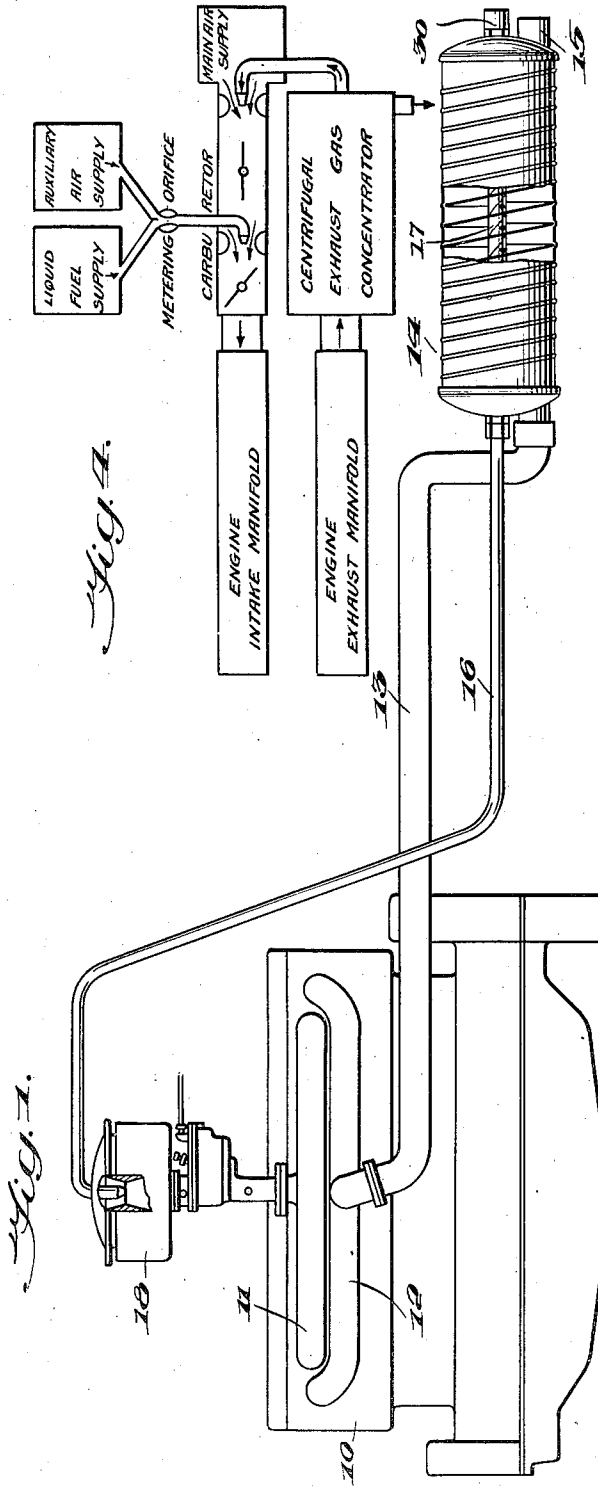


Fig. 1.

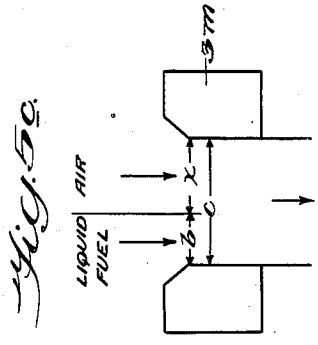


Fig. 5c.

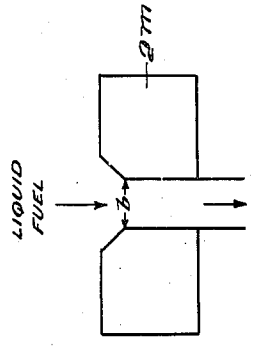


Fig. 5b.

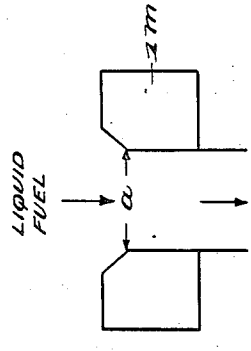


Fig. 5a.

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CARBURETING APPARATUS

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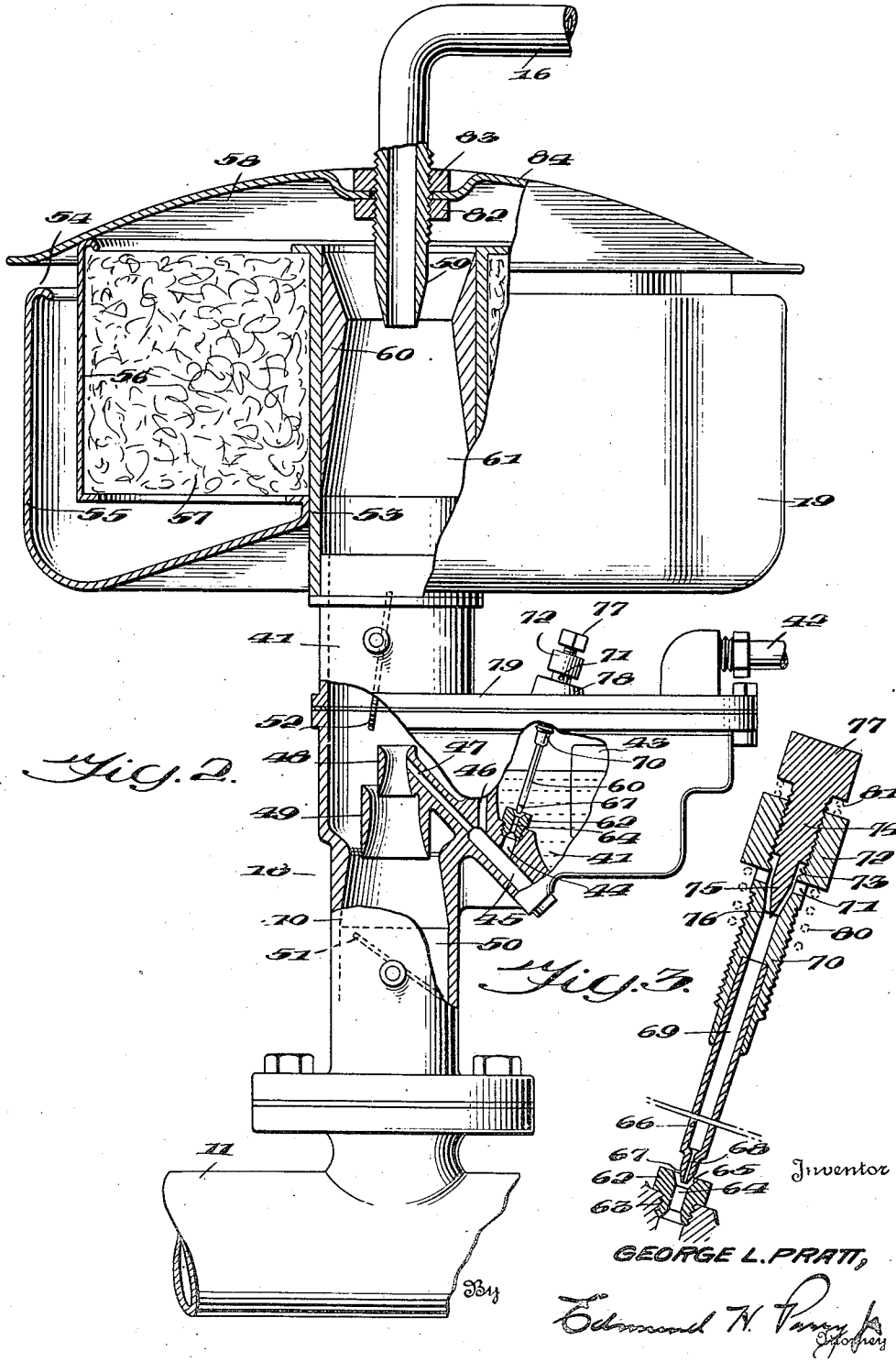


Fig. 2.

Fig. 3.

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UNITED STATES PATENT OFFICE

2,349,676

CARBURETING APPARATUS

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Application October 13, 1941, Serial No. 414,872

1 Claim. (Cl. 261—16)

This invention is directed to an improved carbureting apparatus for internal combustion engines. The same aims to provide the proper proportioning of the ingredients making up the engine operating charge.

The invention is primarily designed for use in conjunction with the system of treating and reutilizing portions of the engine exhaust gases as a combustible ingredient of an engine operating charge according to my prior Patent No. 2,147,670, granted February 21, 1939. In such system the combustion gases exhausting from an engine are centrifuged to effect the removal of portions of the heavier combustibly inert ingredients (carbon dioxide and nitrogen) and to provide a reusable combustible portion which is enriched in the lighter combustible ingredients (hydrogen, carbon monoxide and methane).

Because the exhaust gases returned to the engine are combustible and constitute an explosive, power-producing ingredient of the engine charge, a substantially less quantity of fresh fuel is required in the charge. Consequently a smaller size metering orifice is required in the carburetor. The usual metering orifice for the high speed nozzle of a carburetor of conventional automobile engines has a relatively small effective opening when the engine operates with a conventional charge of gasoline and air. When operating with my system of reutilizing exhaust gases as an operating component of the charge, the size of the metering orifice must be materially reduced, preferably as much as half, more or less. It has been found that the orifice in the case of a six-cylinder automobile engine of popular make must be so minute in proportions that foreign matter tends to clog the orifice so as to require frequent cleaning. The same problem is encountered regardless of whether the metering orifice is of the fixed size type, or is variable in its effective size through the use of a needle valve. Various makes of filters for the gasoline were tried out to overcome the problem of clogging of the orifice without measurable success. The present invention successfully overcomes the problem and insures reliable operation of the orifice in supplying the proper proportion of gasoline, or equivalent liquid fuel, independent of the use of a fuel filter.

According to my prior Patent No. 2,147,670, above referred to, the centrifuged exhaust gases are drawn back under control of a special regulatory valve located in the return conduit into the intake manifold of the engine under the engine suction and therein admixed with air and fuel supplied from a carburetor. With the system as so arranged it is found difficult to maintain a proper proportion of the exhaust gas component to the air and fresh fuel components under varying conditions of engine speed and load because the suction in the intake manifold is greater than the effective suction in the carburetor because of the regulatory action in the carburetor of the throttle valve. This difficulty has now been overcome through the improved system according to my copending application, Serial No. 414,870, filed October 13, 1941, through the return of the exhaust gases into the carburetor on the air intake side of the throttle valve so that the admission of all components of the charge are subject to the regulatory action of the carburetor throttle valve. The carbureting unit of the present application incorporates constructional features for this purpose, and serves in conjunction with the feature above mentioned to cause the carburetor to supply a properly constituted high explosive charge of gasoline, refined exhaust gases and air.

The invention will be understood by reference to the accompanying illustrative drawings and the following detailed description.

In such drawings:

In Fig. 1 is shown a complete charge-forming system wherein the present carbureting apparatus is primarily designed to be used;

Fig. 2 is a view in elevation and partly in section illustrating a carbureting unit embodying the invention;

Fig. 3 is an enlarged view in longitudinal section of certain parts shown in Fig. 2;

Fig. 4 is a schematic view to explain the operation of the carbureting unit of Fig. 2 in conjunction with the system of Fig. 1; and

Figs. 5*a*, 5*b* and 5*c* are comparative diagrammatic views serving to explain certain features of the invention.

A conventional internal combustion automobile engine is shown at **10**, the same having an intake manifold **11** and an exhaust manifold **12**. As in the case of my prior Patent 2,147,670, the exhaust manifold discharges into a centrifugal gas treating device **14** through an exhaust pipe **13**, and in such device the exhaust gases under the force of their discharge from the engine are caused to rapidly traverse a helical path which effects a partial stratification of the gases. The treated portion of the gases for reuse, enriched in the lighter combustible components of the exhaust, concentrate in the central area of the centrifuge. The residual waste exhaust gases

are discharged through an outlet 15. The centrifuged exhaust gases are returned to the engine through pipe 16 which connects with an apertured pipe 17 located centrally of the centrifuge 14.

The returned exhaust gases are introduced at the air intake side of the carburetor 19 and where, as shown, an air cleaner 18 is employed, the exhaust return pipe 16 may be led into the carburetor through the housing of the air cleaner.

The carburetor 18 here illustrated is of the down draft type, includes a main body portion 40, and a connecting upper portion 41 which for convenience is hereafter referred to as the air inlet portion. The carburetor is provided with a conventional fuel reservoir 41 in which fuel entering through fuel pipe 42 is maintained at a substantially constant level by means of a valve (not shown) controlled by float 43. Connecting passages 44 and 45 conduct the fuel from the reservoir to the idling passage 46, and to the main high speed nozzle 47. A series of venturis 48, 49 and 50, or some other conventional arrangement, may be employed to cause the downward flow of air through the carburetor to draw fuel into the main mixing conduit 50. The carburetor at its lower end connects with the intake manifold of the engine. An effective suction, controlled in amount by throttle valve 51 in conduit 50 is transmitted to the carburetor from the engine and causes the same to function to supply a mixed charge varying in volume according to the setting of the throttle valve.

The upper, or air inlet, portion 41 of the carburetor has an air inlet or choke valve 52. Exhaust gases are introduced into the carburetor under the inrushing flow of air. To this end the carburetor is provided with an extension conduit 53 surrounded, where desired, by an air cleaner 19 wherein air enters at 54 and after passing downwardly between walls 55 and 56 passes upwardly through a filtering medium 57 into the top portion 58 and thence enters the upper end of extension conduit 53 of the carburetor. The exhaust gas return pipe 16 is provided with a nozzle 59 mounted centrally of conduit 53, and surrounded by a venturi 60 serving to produce an effective suction which will draw exhaust gases from the centrifuging device 14 (Fig. 1) through pipes 17 and 16 into the carburetor for admixture with the air in the preliminary mixing chamber 61 on the inlet side of air control valve 52. The suction effect at nozzle 59 is of course determined by the effective suction created in the carburetor by the engine according to the position of throttle valve 51 and the speed of the engine, and more particularly by the inflow of air into the carburetor under such suction.

With the construction as shown, it will be evident that the exhaust gases are mixed with the air ingredient of the charge to be formed preliminary to the admixture of the air with the gasoline supplied through the high speed nozzle 47. The amount of exhaust gases under varying conditions of engine speed and load vary with changes in velocity of air as the effective suction in the carburetor demands more or less amounts of air. The proportion of fuel varies in the same manner, and all of the ingredients are maintained in proper proportion in relation to each other to supply a properly constituted combustible operating charge for the engine through intake manifold 11.

To meter the liquid fuel a metering orifice plug 62 is provided between the fuel reservoir 41 and the high speed nozzle 47. For reasons which will hereafter appear it is desirable that such plug shall be submerged and separated from the outlet end of nozzle 47 by a substantial length of passage. Preferably the plug is located in the fuel reservoir 41, as shown in Figure 2, and provided with a threaded portion 63 seating in a threaded portion of passage 44.

The effective size of the metering orifice is an important factor in the production of a properly proportioned combustible engine charge since it determines the fuel-air ratio of the charge. Since, as mentioned in my prior patent, my system of reutilizing centrifuged portions of the exhaust gases as a supplementary fuel component of the charge requires a smaller quantity of liquid fuel than in a conventional charge forming system wherein the charge is formed only of liquid fuel and air, the effective metering opening must be substantially smaller. In fact the same must be so small as to frequently become clogged by foreign matter carried in the fuel supply. The problem is the same regardless of whether a fixed metering opening is employed, determined only by the diameter of the orifice in the metering plug or whether the metering opening is provided by associating a needle valve with the orifice plug which is adjustable relative to a valve seat in the orifice plug to provide an annular metering opening of varying size. I have discovered, however, that this problem may be successfully overcome in connection with either of the arrangements just mentioned by using a metering orifice of larger effective opening than will pass the quantity of liquid fuel required for the engine charge under any predetermined fuel-air ratio. This is made possible by diluting the liquid fuel with another fluid immediately at or adjacent the point of passage of the liquid fuel through the metering opening, the quantity of the supplementary fluid being sufficient that the combined quantity of gasoline and fluid will be accommodated in an opening of sufficient size to avoid clogging by foreign matter at the metering point. The diluting fluid will preferably comprise a supplementary air supply which will be subject to the same effective suction as acting on the liquid fuel so that desired proportions of the liquid fuel and air passing through the metering device may be maintained.

The several points just discussed may be understood by reference to the comparative showings in Figs. 5*a*, 5*b*, and 5*c*. In Fig. 5*a* is shown a metering plug *1m* having a metering orifice with a diameter *a*. If liquid fuel alone be supplied through the orifice the stream thereof will be of the same size as the diameter of the orifice. If only liquid fuel is to be supplied through the metering orifice but a substantial quantity of treated exhaust gases are employed as a component of the fuel charge, the size of the metering orifice must be reduced. If, for example, under such conditions only half the quantity of liquid gasoline is required than before, the size of the metering orifice must be diminished by approximately one-half. In Fig. 5*b* is shown a metering plug *2m* having a diameter *b* which will permit the flow through the orifice of a stream of gasoline only half the size of the stream

passed by metering plug 1*m* of Fig. 5*a*. It will be understood, of course, that the representative showings in these figures are greatly exaggerated, and that the actual size of the opening in the metering plug 2*m* will be of approximately pinhole size. An opening of such extremely small size will obviously clog extremely easily. According to the invention, a metering plug such as 3*m* in Fig. 5 may be employed having an orifice of diameter *c*, substantially larger than the opening of plug 2*m*, and even larger than the opening of plug 1*m*, yet the same may be caused to pass only the same quantity of liquid fuel as plug 2*m* of diameter *b*. Air is supplied to the opening in plug 3*m* in quantity represented by the partial diameter *x* so as to limit the liquid fuel to the quantity which would pass through the plug if the opening had a size represented by the partial diameter *b*. As represented in Fig. 5*c*, and as preferred in actual practice, the liquid fuel and air are brought together at the point of entrance to the metering orifice. Within practical limits the quantity of air may be varied so as to increase and decrease the quantity of liquid fuel passing through the orifice plug. This makes it possible to construct the orifice plug of sufficient diameter to insure against clogging by foreign matter, and then limit the quantity of liquid fuel to the quantity required through regulation of the quantity of air supplied through the orifice.

The principles just explained may be applied in a carburetor wherein the metering orifice is constituted solely by the bore through a metering plug, by feeding air through a suitable passage to the metering plug bore at the inlet end or at an intermediate point in the length thereof. Likewise the same may be applied in a carburetor where the metering opening is of annular form and provided by coaction of a needle valve with a valve seat in the bore of a metering plug. The latter construction is illustrated in Fig. 2.

Referring again now to Fig. 2 and considering Fig. 3 in conjunction therewith, the metering plug **62** is provided at its inlet end of its bore **64** with a conical valve seat **65**. As before noted the metering plug **62** is located below the liquid level in the fuel reservoir **41** and is constantly submerged at all times. A needle valve **66** is provided having a tapered end portion **67** coactive with valve seat **65** of the plug to provide an adjustable annular metering orifice. Bore **64** will be of relatively large diameter to insure against clogging by foreign matter, preferably being larger than conventionally employed where the charge is constituted of gasoline and air with the use of exhaust gases as a supplementary fuel component. A small bore **68** is provided in the tapered end portion **67** of the needle valve. The main stem of the needle valve is formed by a hollow tube having an interior passage **69** communicating with the bore **68** in the tapered end portion. A threaded hollow sleeve **70** is secured to the upper end of the valve stem having a cross bore **71** in the upper end thereof beneath enlarged head **72**, such cross bore being in communication with the axial bore of the needle valve. Head **72** of the needle valve is provided with a threaded bore **73** receiving the threaded stem **74** of a further needle valve having a tapered lower end **75** coactive with a conical valve seat **76** in the hollow sleeve. Valve stem **74** is provided with an enlarged head **77** by which the needle valve **74** may be adjusted independently of needle valve **66** to vary the effective annular opening between end **75** and seat **76** and thereby control the quantity of fluid passing through needle valve **66** from cross bore **71**.

The needle valve assembly just referred to may be supported by a threaded bushing **78** in the top wall **79** of the liquid reservoir **71** with the cross bore **72** communicating with the air exteriorly of the carburetor. The size of the main metering orifice at plug **62** may be varied by turning head **72** to raise or lower the needle valve stem **66**, thereby to vary the quantity of liquid fuel passing from the reservoir **41** through bore **64** of the metering plug **62**. The quantity of air admixed with the liquid fuel at the metering point in the inlet end of plug **64** may be varied in relation to the quantity of gasoline independently of the size of the main metering orifice at plug **64** by turning head **77** of the upper needle valve **74** which controls the flow of air through the hollow stem of the needle valve.

In view of the fact that the flow of both air and gasoline through the metering orifice of plug **64** is determined by the effective engine suction acting in the carburetor under control of the throttle valve, and more specifically, by the flow of fluid under such suction through the venturis **48** and **49** past the outlet end of the high speed nozzle **47**, the supply of supplementary air and the liquid fuel will be maintained in proper proportion to limit the liquid fuel to the quantity required even though the effective opening provided by the coaction of the needle valve end **67** with the valve seat **65** of plug **64** is of substantially larger size than would limit the liquid fuel to the quantity required if the supplementary air supply were not employed to dilute the liquid fuel.

The position of the metering plug **64** in the liquid reservoir is desirable so that the supplementary air and fuel are required to traverse a substantial distance, as represented by the combined length of passages **44** and **45** before being discharged from the outlet end of nozzle **47**. Through this arrangement the supplementary air is given an opportunity to become at least partially saturated with the liquid fuel so as to effect partial vaporization of the fuel before discharge from the nozzle. Such admixture is, of course, initially promoted by reason of the fact that the air is introduced into the gasoline in the form of a fine stream at the metering point, so that both the air and liquid fuel are reduced to a more or less comminuted condition incident to their admixture.

The complete operation of the carburetor as shown in Fig. 2 in producing an engine charge, and more particularly the operation thereof in conjunction with the use of treated exhaust gases as a component of the charge, will be understood by reference to Fig. 4. As therein shown, the intake manifold of the engine creates an effective suction in the carburetor which serves to draw the main air supply into the carburetor conduit, and at the same time to draw centrifuged portions of the exhaust gases from the centrifugal device into the carburetor through the exhaust gas nozzle mounted in the air supply inlet about which the inflowing air rushes through a surrounding venturi. The main throttle valve of the carburetor determines the effective engine suction acting therein and the quantity of both exhaust gases and air under varying conditions of engine speed and load. The liquid fuel supply supplemented and diluted by an auxiliary air supply are combined

and metered by passing through a metering orifice as heretofore explained, and after preliminary admixture discharged into the main carbureting mixing chamber for admixture with the previously admixed exhaust gases and main air supply in the main carburetor mixing chamber, the quantity of liquid fuel and air being both controlled by the effective suction in the mixing chamber, and particularly by reason of the rush of mixed air and exhaust gases through the venturi, or venturis, surrounding the high speed fuel nozzle. The engine charge is completely admixed in the carburetor and is passed therefrom into the engine intake manifold and thence to the engine cylinders.

It will be understood that metering plug 62 with its manually-adjustable needle valve control 66 need not be the sole metering means for delivering fuel from the reservoir to the high speed nozzle. In many cases an additional cooperating metering device will be employed comprising a metering plug having an opening controlled by a metering pin which is automatically regulated through the carburetor throttle valve.

The special construction of the needle valve performs an additional beneficial function besides supplying the auxiliary air for limiting the amount of liquid fuel passed through the metering plug 62. When the engine is at idling speed and the high speed fuel nozzle 47 is inoperative, only a small quantity of fuel is supplied from the fuel reservoir 41 to the idling speed fuel supply passage 46, and no auxiliary air is drawn in through the needle valve. Under such conditions fuel from the reservoir backs up through bore 68 into the enlarged interior 69 of the needle valve seeking the same level prevailing in the reservoir 41. When the high speed nozzle 47 comes into operation to increase the speed of the engine by opening wider the butterfly valve 51, the increased suction acts to increase the flow through the metering plug 62. Under these conditions the fuel which has accumulated in portion 69 of the needle valve will be drawn out through bore 68 to supplement the fuel admitted to the metering plug from the reservoir, and no auxiliary air will be supplied through the needle valve until the accumulated fuel therein has been exhausted. This increased quantity of fuel which momentarily enriches the carburetor charge at the moment of acceleration is very desirable to prevent momentary skipping or sluggishness of the engine. In the past carburetors have been built to embody an accelerating pump for momentarily injecting an additional quantity of fuel during acceleration. With the present arrangement, through the construction of the needle valve with an enlarged portion 69 as shown in Fig. 3, it is found possible to dispense with such an accelerating pump and thereby simplify the carburetor construction.

The carburetor, as shown in Fig. 2, is provided with an exhaust gas delivery nozzle 59 located therein on the air intake side of throttle valve 51. Preferably, the same is located on the air intake side of the high speed nozzle 47 and choke valve 52. As shown, nozzle 59 is mounted in extension conduit 53 of the air intake conduit. In the present form the nozzle is mounted in a central opening and covering 84 of air cleaner 19 and secured to such cover through nuts 82 and 83. Of course the air cleaner may be dispensed with, or again may not be manufactured and sold as a part of the carbureting unit, and therefore it may be desirable to mount nozzle 59, permanently or detachably, centrally of the air intake conduit proper of the carburetor through the use of any suitable type of mounting which will not interfere with the free flow of air into the carburetor around nozzle 59. Regardless of the exact position of nozzle 59, it is important that venturi 60 be provided to surround the nozzle so that the inflow of air through the venturi will produce an adequate suction at the nozzle to draw exhaust gases into the carburetor in sufficient quantity to constitute a balanced charge with the air and fresh fuel. It may be explained in this connection that the effective suction in the carburetor from the engine is relatively low and incapable of withdrawing exhaust gases into the carburetor in sufficient quantity to constitute a primary component of the engine charge. This is particularly true under conditions where the engine is running at relatively low speed and the throttle valve is only slightly open. The use of the venturi, due to the increased velocity therethrough of the incoming air serves to produce an increased local suction effect at nozzle 59 and result in the delivery of an adequate exhaust gas supply which is automatically varied according to the volume of air admitted under adjustment of the main throttle valve.

In the improved system shown in Fig. 2 the centrifuged exhaust gases are returned to the carburetor from the centrifuge 14 under the suction developed at nozzle 59 in the carburetor, hence the inflow of air into the carburetor determines the quantity of the exhaust gases returned rather than the return flow of exhaust gases determining the quantity of air admitted to the carburetor. As pointed out in my prior Patent No. 2,147,670, the exhaust gases in the state in which they are discharged from the engine are not in suitable condition for use as a fuel component of the engine charge, and cannot be returned in any substantial quantity without interfering with combustion of the fresh hydrocarbon fuel component and consequential loss of power in the engine. However, the centrifugal treatment of the exhaust gases conditions them for use as a primary fuel component of the engine charge so as to enable them to be returned in substantial quantity with resulting economy in the fresh fuel consumption. It will therefore be evident that the present carburetor, for employment in such a system of centrifuging and reusing the exhaust gases, must be so constituted that the fuel metering mechanism is so designed as to restrict the delivery of fresh fuel to an amount such as to compensate for the supplementation thereof by combustible fuel values of the returned exhaust gases, and similarly the means above described for delivering the exhaust gases into the carburetor should be so designed as to deliver the exhaust gases in sufficient quantity to enable an appreciable savings to be effected in the consumption of the fresh fuel and to maintain a balance in the proportion of the centrifuged exhaust gases to the proportions of fresh fuel and air.

I am aware that various proposals have been made for introducing exhaust gases, in the state in which they are discharged from the engine and usually under the pressure of their discharge, into the carburetor. In such prior devices the exhaust gases were utilized for available heat to promote vaporization of the liquid fuel, and/or through their delivery under pressure into the carburetor to aid in the delivery of air or liquid fuel. By reason of the condition in which the ex-

haust gases were returned they could not be used in any appreciable amount, nor could they function as a combustible fuel component of the charge. Consequently, and contrary to the present invention, the careful proportioning of the exhaust gases to the fresh fuel and air in such prior devices was not necessary, and similarly, the provision of means for restricting the fresh fuel to any appreciable extent was not a problem since the exhaust gases in the form and quantity returned could not function as a fuel component and effect a saving in the fresh fuel consumption.

The complete charge forming system for an engine wherein centrifuged exhaust gases are combined as a primary component of the engine charge has been explained in the present application to make clear the utility of certain features of the carburetor construction. The present application is directed to the carbureting unit per se, and the improved charge forming system as such forms the subject-matter of my separate copending application, Serial No. 414,870, filed October 13, 1941.

It will be evident that the carbureting unit herein shown is merely illustrative, and that the features of carburetor construction constituting the invention may be incorporated in carburetors of other types in a variety of ways without departing from the intended scope of the invention.

I claim:

In an internal combustion engine carburetor, a mixing chamber, a main air intake delivering air to the mixing chamber, a liquid fuel delivery nozzle extending into the mixing chamber, a liquid fuel reservoir, a fuel delivery passage connecting the lower portion of the fuel reservoir and said fuel delivery nozzle, fuel economizing means diminishing the liquid fuel required to be delivered through said fuel delivery passage to the mixing chamber to form a combustible charge, said fuel economizing means comprising a second nozzle adapted to deliver charge forming components of the engine exhaust gases to the mixing chamber for admixture with the fuel and air, submerged fuel metering means in the fuel delivery passage having an opening of larger area than required to deliver the quantity of fuel necessary for the combustible charge, the size of said opening decreasing the likelihood of clogging of the opening by foreign matter such as may be delivered with the fuel, and means for restricting the quantity of liquid fuel delivered through said metering opening to the quantity of fuel required by the charge formed with the air and exhaust gas components, and comprising a needle valve having an air delivery passage therein delivering air for passage through the metering opening with the fuel and being adjustable to vary the ratio of fuel to air passing through the metering opening.

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