Aug. 6, 1935. E. V. BEALS 2,009,992

CARBURETOR

Filed Dec. 11, 1929 3 Sheets-Sheet 1

Fig. 1.

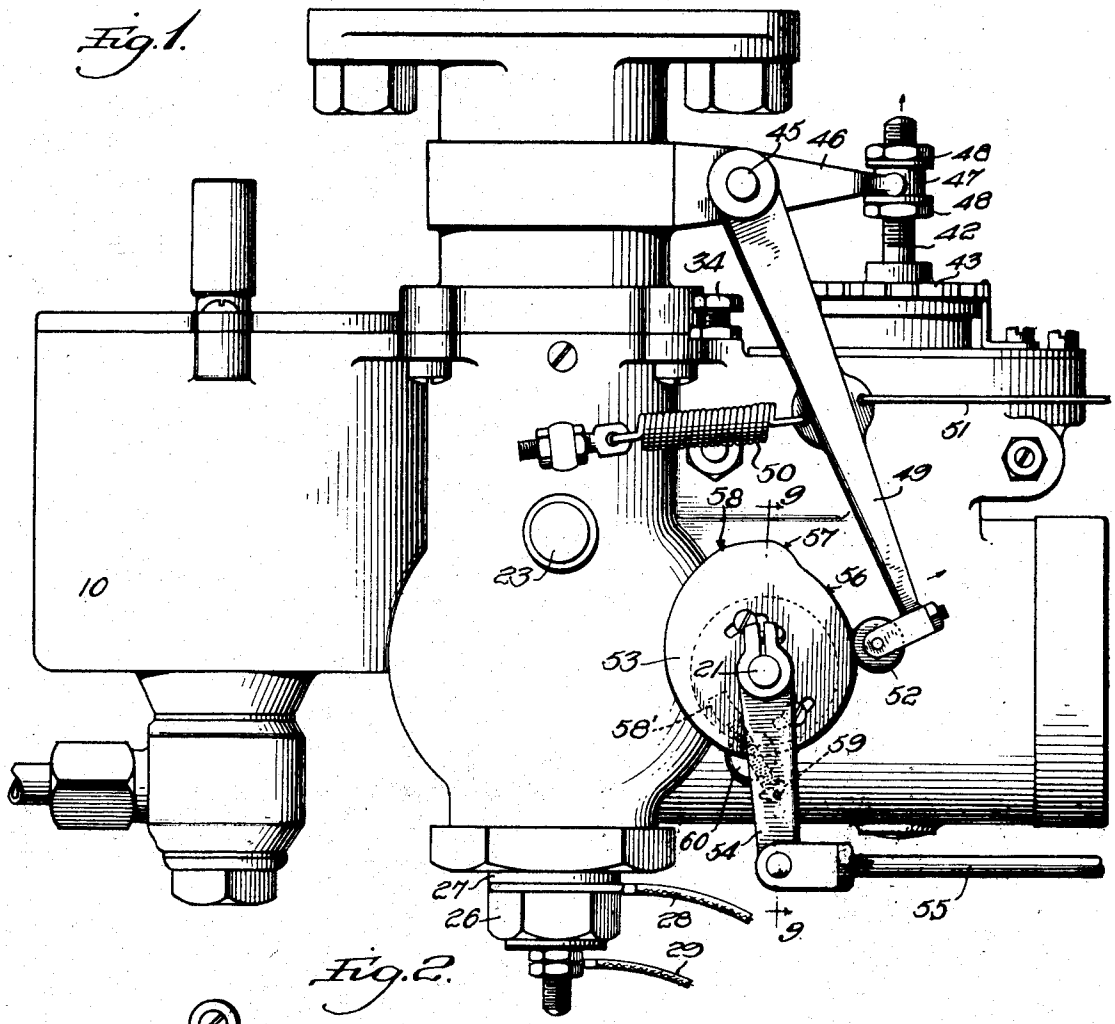
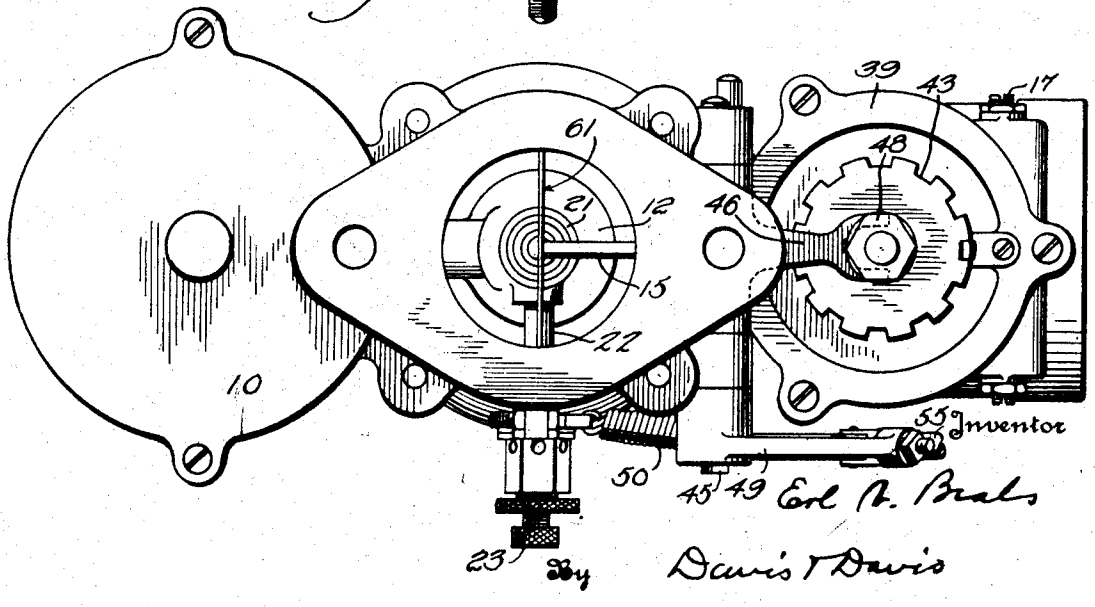


Fig. 2.



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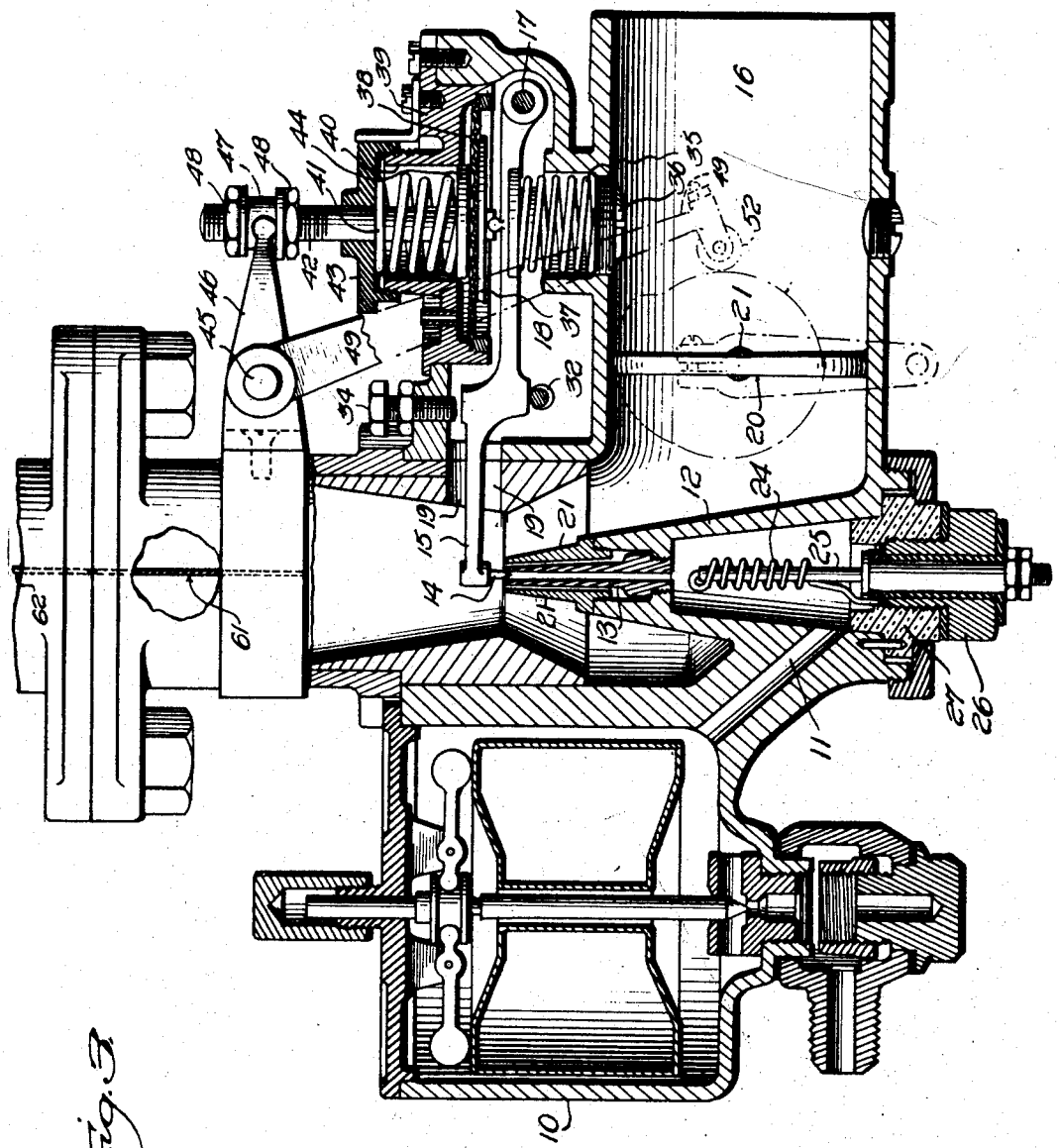


Fig. 3

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CARBURETOR

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Fig. 4.

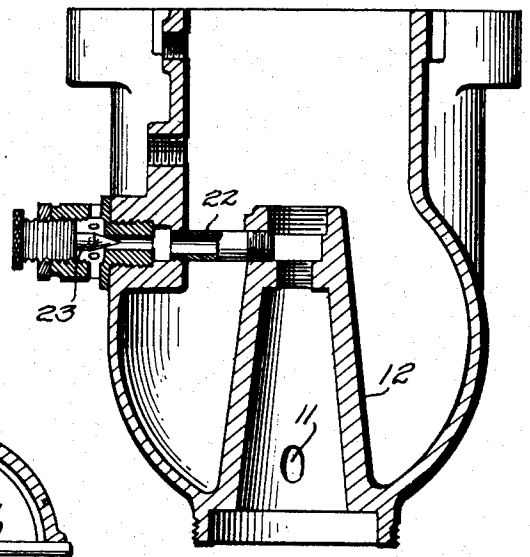
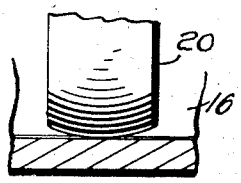


Fig. 10.



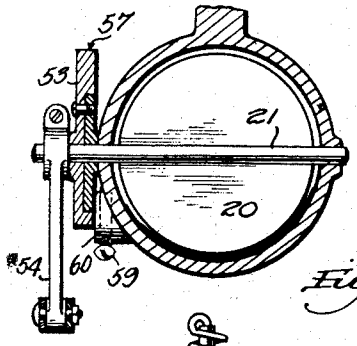
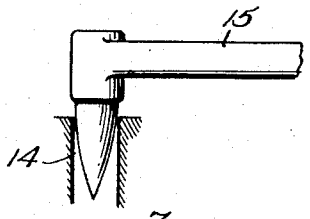


Fig. 9.

Fig. 5.



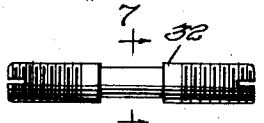


Fig. 6.



Fig. 7.

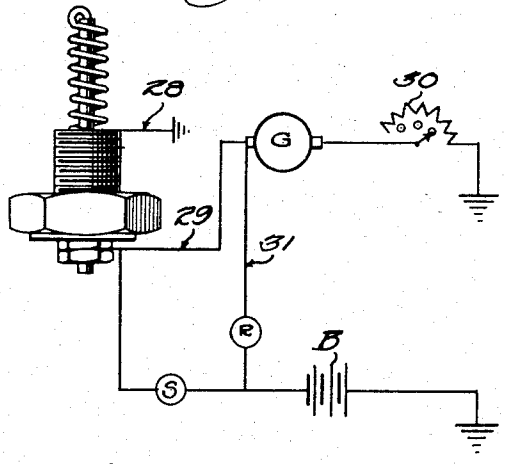


Fig. 8.

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2,009,992

UNITED STATES PATENT OFFICE

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CARBURETOR

Erl Vinton Beals, Boston, Mass.

Application December 11, 1929, Serial No. 413,405

6 Claims. (Cl. 261—50)

The main object of this invention is to provide a construction which, when adjusted properly to suit the particular engine to which it is applied, will function automatically to supply the engine with a minimum of fuel required for the efficient operation of the engine. The inventor also has other objects in view which will appear in the course of the specification.

In the drawings annexed—

Fig. 1 is a side elevation of my device;

Fig. 2 is a plan view thereof;

Fig. 3 is a vertical longitudinal section of the device;

Fig. 4 is a vertical fragmentary section taken on a line at right angles to the line on which Fig. 3 is taken;

Fig. 5 is a detail side elevation of the fuel-valve;

Figs. 6 and 7 are detail views of the eccentric idling-stop;

Fig. 8 is a diagram showing the desirable wiring system for the electric heater.

Fig. 9 is a sectional view taken on the line 9—9 of Figure 1.

Fig. 10 is a fragmentary portion of Figure 3 on a larger scale.

Referring to the drawings annexed by reference-characters, 10 designates the usual float-chamber which is connected by a conduit 11 to the lower end of a tube 12 projecting upwardly into the intake of the carburetor, the upper end of this tube 12 being provided with a fuel-nozzle 13 which extends up into the mixing-chamber and is controlled by a fuel-valve 14 carried by a vertically-swinging lever 15 whose outer end extends toward the outer end of an intake-tube 16 and is pivoted at 17 within a chamber 18 which is always in connection with the mixing-chamber through the medium of a hole 19. In the intake-tube 16 is a butterfly-valve 20 mounted on a rock-shaft 21. This valve in the usual construction is mounted in the outlet of the mixing-chamber. In my construction, for reasons hereinafter set forth, it is mounted at the intake side of the carburetor.

Surrounding the fuel-nozzle is an air-nozzle 21 which is sufficiently larger than the fuel-nozzle to form therewith an annular air-space whose exit surrounds the exit-end of the fuel-nozzle. A supplemental supply of air is delivered into the space between the nozzles by means of a lateral duct 22 which extends through the side wall of the carburetor and has its inlet-end under control of an adjustable valve 23. This duct is open all the time and its main function is to supply air to the mixing-chamber for idling purposes while the butterfly 20 is closed.

I mount within the tube 12 an electric heater consisting of a nichrome wire 24 whose upper end is connected to an upstanding central metal pin 25 and whose lower end is electrically connected to a plug 26 up through which the pin 25 extends but is insulated from the plug. The screw-plug 26 is screwed into an insulating bushing 27 which is removably fastened into the bottom end of the tube 12 in any suitable manner. One of the terminals 28 of the electric wiring system is connected to the plug 26 and the other, 29, is electrically connected to the projecting end of the pin 25 so that current will heat the nichrome wire to the desired degree and thus prepare the fuel for quick evaporization after it issues from the nozzle. With a heating device of this sort, it will be seen that the entire structure can readily be detached from the carburetor in the manner of a spark-plug, for the purpose of cleaning and repairing. In Fig. 8, I show a desirable parallel system for heating the nichrome wire, particularly when this carburetor is used on a motor car with standardized electric wiring. The conductor 28 is grounded on the frame of the car, and the other conductor, 29, is connected to a generator G, whose other pole is grounded through a rheostat 30. A battery B has one of its poles connected to the conductor 29 through a manually-operable switch S and its other pole to the ground. Between the battery and the switch, a conductor 31 connects the same pole of the battery to the conductor 29. In this conductor 31 is a relay cutout R (which exists in all battery-charging systems) and which works to prevent the battery from acting on the heating unit when the engine is left idle and switch S is open. The dash switch S, manually controlled, is a plain two-pole switch and is used merely to open and close the circuit.

By properly adjusting the rheostat or other manual or automatic device, the amount of current supplied to the heater may be regulated to maintain the proper temperature required for different grades of fuel. It is desirable to maintain approximately a boiling temperature in the tube 12, so that the fuel will be so highly heated when it is discharged into the mixing-chamber in finely divided droplets that it will instantly flash into a vapor. It is not desirable that the fuel shall form into vapor before issue from the orifice and so the temperature is kept down to a point where the discharge of the fuel into the mixing-cham-

ber under running conditions will be sufficient to prevent accumulation of vapor in the tube 12.

The fuel-lever 15 vibrates between two stops, a lower adjustable eccentric stop 32 and an upper adjustable set-screw stop 34. When the lever is against the lower stop 32, upon which it normally rests, the fuel-pin is in adjusted idling position, this position being shown in Fig. 3. In this position also the butterfly 20 is in idling position and the air needed for idling is drawn in almost exclusively through the supplemental duct 22. When the lever is held against the upper stop 34, all parts, including the fuel-valve and the air valve 20, are in extreme positions for the highest power possible within the limits of the settings.

A coil-spring 35 is arranged under the lever 15 and its tension is adapted to be regulated by a screw-plug 36. On the top side of the lever is mounted a plate 37 (the mounting being preferably a ball or universal joint device) and the top side of this plate presses against the diaphragm 38 forming a part of the top wall of the aforesaid vacuum chamber 18. This diaphragm is carried by a removable cover-plate 39 projecting down through a hole in the top wall of the vacuum chamber 18 and having an upstanding cylinder 40 in which is mounted an expansible coil-spring 41. The spring 41 surrounds a rod 42 projecting up through a cap 43 covering the upper end of the tube 40, and the lower end of the spring normally presses against a flange 44 bearing normally on the top side of the diaphragm.

To compress the spring 41 by elevating the plunger 42, I provide the following simple mechanism: a bell crank having a short arm 46 and a long arm 49 mounted on a rock-shaft 45. The short arm 46 terminates in forked ends which engage between the flanges of a spool 47 adjustably mounted, by means of nuts 48, on the upper threaded end of the rod 42, a slight clearance being left between the rounded ends of the fork and the adjacent face of the upper flange of the spool 47. Affixed to the rock-shaft 45 is another lever 49 which normally pulls to the left, to thus swing down the forked arm 46 by means of a retractile spring 50. Connected to this lever 49 is a wire or rod 51 which enables the lever to be pulled to the right against the action of the spring 50 and to raise the plunger 42 manually from any point convenient to the driver. The lower end of lever 49 is provided with a roller 52 which is normally drawn toward a cam 53 mounted adjustably on the shaft 21 on the butterfly throttle. The shaft 21 is provided with an operating-arm 54 which by means of a rod 55 may be manipulated by means of the usual accelerator-pedal. The cam 53, at a point above the roller 52, has a surface 56 which increases in radius up to a predetermined point, and then there is a sudden increase in radius at the shoulder 57, and then beyond the shoulder there is a circular section 58, so that upon pushing upon the rod 55 the cam will be rotated toward the roller 52 and thus gradually open the air valve and gradually lift the plunger 42 to a certain predetermined point, whereupon the cam-nose 57 will give a sudden movement to the right until the roller 52 passes onto the circular part 58, whereupon further movement of the lever 49 and its connected parts is arrested. To arrest the cam in the position shown in Fig. 1, I provide a stop-lug 58' carried by the cam and a stationary set-screw 59 carried by a lug 60 projecting laterally from the carburetor-casing.

I divide the outlet of the mixing-chamber into two channels by a transverse partition 61 which meets a similar partition 62 in the inlet-end of the manifold. The object of this is to divide the outgoing mixture into two streams so that the mixture will be better distributed amongst the cylinders of the engine. In the present practice, in some instances, two independent carburetors are employed for obtaining as nearly as possible a proper distribution of the mixture to the cylinders, this arrangement being employed in 8-cylinder engines, where the ordinary single-conduit manifold and single carburetor fail to deliver a proper quantity of mixture to the end cylinders, where the stroke overlap occurs. By thus dividing the outlet of the mixing-chamber, I divide the stream of outgoing mixture centrally so as to accomplish what is gained by the use of a dual carburetor arrangement.

The parts are shown in idling position in Fig. 3. In this position, the two springs 41 and 50, assisted by the diaphragm which is being sucked down, (there being desirably a slight clearance between the anti-friction roller 52 and the face of the cam at this point) overcome the upward pressure of spring 35 and thus hold the fuel-lever 15 down on the idling cam-stop 32. In this position, the air valve 20 is closed and practically all the air that is needed for idling is taken in through the lateral duct 22. When the butterfly is opened for average running conditions, the actuation of the lever 49 by the cam will permit the raising of the plunger 42 and distension of spring 50 and thus relieve the lower spring 35 from opposition to the extent of movement of the cam, thereby permitting spring 35 to move the fuel-lever upwardly against the downward suctions of the diaphragm, and thus increase the supply of fuel in proportion to the additional air that is admitted through the usual intake 16. The farther the air valve is opened, the greater will be the movement of the lever 49 and hence the possible increase in admission of the fuel as the air valve is opened wider for increased speed. This may be continued until the shoulder 57 of the cam reaches the roller 52, whereupon a further movement of the cam gives to the lever 49 a sudden movement to the right far enough to permit wheel 52 to ride on the circular part 58 of the cam; this final adjustment of the air valve and cam is resorted to when the highest possible power within the limits of the setting is desired for hill-climbing, etc. This final power adjustment permits the spring 35 to throw the lever 15 up against the high-power stop 34, the downward suction on the diaphragm being about nil when the air valve is wide-open, thereby holding the fuel-needle 14 in its full-open position during high-power requirements. It will be understood that for average running conditions, the increase in fuel will be positively limited by the eccentric part 56 of the cam and that only when unusually high power is needed will the parts 57—58 of the cam be brought into use.

I prefer that the valve disk 20 be thicker than usual and have its circular edge made convex, the arc of this convex surface being struck from the center of the butterfly-shaft 21. The object of this is to slightly retard the ingress of air with respect to the opening movement of the fuel-pin, in order that upon opening the air valve a richer mixture will be momentarily maintained, to thus provide for a quick get-away. It will be observed that with this convex edge, the butterfly will not admit any air during its initial

movement; but will admit air only after it is moved a predetermined distance, and that while it is moving this distance the fuel-valve has been opened farther and has admitted the additional fuel needed for a quick get-a-way from idling position. The cam and other parts may be so adjusted and shaped as to thus delay the ingress of air until the fuel-valve has been opened, but, in view of the nice adjustment required and the fact that wear of the parts may interfere with this nice adjustment, it is desirable to retard the admission of air momentarily by the device described, namely, by employing a butterfly with a wide edge, the surface of which is a portion of a sphere having its center at the center of the axis of the butterfly.

I prefer employing a fuel-pin having a paraboloidal rather than the usual conical end portion. In this type of carburetor, in order to avoid unnecessary use of fuel and drenching the engine, it is imperative that the fuel-needle variations shall be very minute. Consequently, it is necessary to avoid a too-great opening movement of the fuel-pin when the butterfly is actuated to open position. With a straight-taper pin, a half opening of the butterfly will cause approximately a three-quarters opening of the fuel-valve because, as is well known, a movement of a conical fuel-pin to the extent of half its stroke from the fully closed to the fully opened position will increase the fuel-orifice about three-quarters and thus give an over-supply of fuel in comparison with the air supply, i. e., a supply in which the proper proportions of air and fuel are not maintained. In my carburetor, a straight-taper pin can be made to work satisfactorily only in idling position and in full-open position for high power purposes; in all the intermediate adjustments of the fuel-pin the proper proportion of air and fuel is not maintained. With a parabolic pin, I find that the proper proportions of air and fuel are maintained under all positions of the butterfly throttle because a movement of the parabolic pin any fraction of its full stroke will change the fuel-orifice by the same fraction. It is thus obvious that in a carburetor of the type herein described, a proper proportioning of the fuel and air can be maintained throughout all running conditions by the use of a parabolic fuel-pin.

It will be noted that the controlling butterfly is in the position of the usual choke in the intake of the carburetor, and it should be noted also that the usual throttle is omitted so that there is no obstruction in the passage between the fuel-nozzle and the engine manifold. This positioning of the air valve subjects the entire interior of the carburetor to more or less suction during operation of the engine. The diaphragm is mounted between upper and lower opposed springs and is subject to the suction within the carburetor by reason of its location in the chamber **18**. The springs act to neutralize each other after a fashion. The diaphragm in the particular embodiment of the invention illustrated on the drawings has a maximum fluctuation of 0.032". This amount of movement effects a maximum action of ⅛th inch of the needle-point, the lever ratio being about four to one. The normal or mean lever position is determined by the adjustable, neutralizing compression of the upper spring. The adjustments of these springs are for attuning the carburetor to the various engine requirements, and when once set need never be disturbed. The diaphragm responds sensitively to the variations of suction in the carburetor and the fuel-needle correspondingly varies the fuel orifice in response thereto within the limits prescribed by the cam **53**.

It will be readily understood from the foregoing that the fuel is "lifted" at the orifice by the suction and not alone by air velocity on the usual Venturi principle. In fact, there is no venturi needed except at wide-open throttle, in which case the pressure in the manifold is little below atmospheric. In the structure illustrated the Venturi choke is not severe and the efficiency of the manifold passageway is only slightly reduced thereby. Due to the suction at the orifice during ordinary operation, the size of orifice required for the delivery of sufficient fuel is relatively small, especially where the viscosity of the liquid fuel is greatly reduced by its being heated nearly to the boiling point. This fact in itself, irrespective of the effect of the heater, serves to break up or finely atomize the fuel to a degree unattainable by straight Venturi action.

Furthermore, the sudden drop in pressure to which the nearly boiling fuel is subjected as it passes the orifice lowers its boiling point and causes it to flash into substantially dry vapor before it reaches the manifold. Then too, as the mixture is perfected, it meets with no obstruction to its passage into the manifold, as stated, and, even if it were a wet mixture (which it is not) there is no intervening partially-opened butterfly on which to become condensed.

As stated, for idling purposes a supplementary air intake is provided which furnishes adjustably metered air to the annular orifice surrounding the orifice of the fuel-nozzle. This permits the idling air and the finely atomized fuel to meet and mingle as they enter the mixing chamber from their respective orifices.

It will be noted also that, when adjusted for maximum power purposes, the function of the upper spring is entirely eliminated and the fuel-needle will take a position determined by the set-screw stop; this abnormally increases the orifice-opening and affords the richer mixture which is needed for maximum-power purposes. But at any position of the air valve other than its wide open or nearly wide open position, the roller rides on the reduced cam-face **56** and permits the diaphragm to control the position of the fuel needle in response to suction variations in the mixing chamber, the movements of the diaphragm being modified by the opposing springs **35** and **41**.

The carburetor here described and illustrated lends itself especially to a quick get-away. For this purpose, requiring a sudden and drastic increase of power in the engine, a preliminary charge of extra richness is required to meet the instant demand of the engine. This is obtained in the present carburetor structure as follows. When the accelerator pedal is depressed to its limit, for a quick get-away, the air valve **20** is swung to its open or nearly open position. Prior to this moment, the engine has been presumably idling or operating with a comparatively high vacuum in the mixing chamber, this vacuum exerting a strong suction on the fuel orifice. As hereinbefore described, the fuel needle **14** is so shaped and adjusted that excessive inflow of fuel through the orifice under the influence of the high vacuum in the mixing chamber is prevented by the small clearance afforded between the fuel needle and the sides of the orifice. When the air valve **20** is suddenly swung open, the cam which is

mounted on the valve shaft rocks the bell crank 46 and 49 so as to lift the fuel needle 14 to its extreme upper position. In the brief interval of time during which air rushes past the open valve 20 to relieve the vacuum within the mixing chamber, this vacuum has a momentary opportunity to act upon the fully opened fuel valve so that a heavy charge of fuel is sucked into the mixing chamber to be carried along with the rush of air entering past the valve 20. Thus a rich charge is at once supplied to the engine with a corresponding response in immediate generation of power. Even after the initial vacuum has been relieved by the inrush of air, the Venturi action of air rushing past the fuel orifice results in the drawing of a copious stream of fuel through the fuel orifice which is being maintained at its maximum adjusted opening.

Furthermore, the automatic action of the fuel-needle facilitates the adapting of the carburetor to the various peculiarities of different engines. It is not necessary to "cut and try" to find just the right size jet suitable for the particular need of the particular engine. In my carburetor, the orifice is infinitely variable and this variability is fixed or controlled with the utmost ease by adjustment of the coil-springs which may be scientifically calibrated. Another point of advantage over jet carburetors is that dirt and water will not put it out of commission. If any dirt or water tends to clog the fine clearance between the fuel needle 14 and the adjacent sides of the nozzle orifice, a momentary depression of the accelerator pedal to lift the needle to its wide open position will result in a surge of fuel out of the orifice which will sweep any obstructing material and leave the orifice clean.

A still further important advantage of my automatic needle arrangement is the relative unimportance of fuel level which is so essential to the proper function of straight Venturi action. The two elements in my carburetor which contribute to this valuable characteristic are the "geyser action" of the heat-unit and the straight pull of the suction, this latter being due to the location of the valve in the air intake. The heat-unit does not ordinarily generate a vapor below the needle-point, but does heat the fuel to a temperature near its boiling point so that its viscosity is low and it is ready to evaporate instantly upon merging from the orifice into the low pressure in the mixing chamber. When the engine is idling or running at moderate speed, the flow of fuel through the tube 12 to the discharge orifice will be relatively slow since under such conditions the fuel requirements of the motor are low. While the amount of current supplied to the heating element 24 is automatically varied to some extent to compensate for the different rates of flow of fuel through the tube 12 by the varying speeds at which the generator is driven by the engine, a slow movement of fuel through the tube 12 will result in the heating of the fuel up to a point very near to the boiling point, so that if, under those conditions, the accelerator pedal is fully depressed for a quick get-away, the sudden reduction of pressure on the fuel column within the tube 12 resulting from the sudden removal of the fuel needle from the orifice, will result in a momentary boiling within the upper portion of the fuel column after the manner of a geyser so that a mixture of vapor and liquid will be ejected into the mixing chamber to supply a rich initial charge to the motor for a quick pick-up of power. This geyser action is only momentary but is of sufficient duration to supply an instant rich charge to the motor. In ordinary operation, there is no ebullition within the fuel below the fuel orifice. All these advantages tend to make homogeneous and near-dry gaseous mixture which passes into the firing-chamber without condensing and collecting on the walls and in the corners of the manifold. Also, a charge is provided which is more easily fired, resulting in more complete combustion and therefore avoiding leakage of fuel past the piston-rings and the consequent contamination of the crank-case oil. Above all these advantages is the fuel eceonomy and the beneficial effects on the life of the engine.

From the foregoing, it will be understood that one of my chief objects is to adapt this carburetor for use with heavy hydrocarbons, this being possible not only because of the use of the heating unit, but also because of the great efficiency in atomizing the fuel that is obtained by placing the air valve at the intake of the carburetor. The use of fuel oils renders this carburetor especially advantageous in connection with aeroplanes, busses, motor-boats, and rail-coaches, since in these classes of vehicles it is highly desirable to do away with the use of gasoline on account of the fire hazard.

As hereinbefore stated, I provide for a clearance between the fork 46 and the upper flange of the collar 47. In practice, this clearance need not be more than $\frac{1}{64}$th of an inch, but it is very important in that under average running conditions this clearance insures that the fuel-needle shall ride on the vacuum, so to speak. This clearance is not taken up entirely until the roller 52 starts to ride up the base of the shoulder 57 of the cam, so that during average running conditions the diaphragm is under the influence solely of the two springs 35 and 41 together with the suction induced by the engine. Running under these conditions, the tendency of the suction is to pull the diaphragm down and thus tend to reduce the fuel-orifice. The higher the speed of the engine with a given opening of the air valve, the greater the suction and, therefore, the greater the downward pull on the diaphragm. This results in a partial closing of the fuel valve so that the fuel supply is automatically regulated in accordance with the power requirements of the engine. Thus, for example, if the car is travelling along a level road with the air valve at a given opening, and thereafter reaches a moderate downward slope so that the load on the motor is reduced, the car will tend to run faster, increasing the suction within the carburetor, pulling down the diaphragm, and thus reducing the rate of fuel supply so that a leaner mixture results, this leaner mixture being sufficient for the reduced power requirements of the engine. This automatic response of the carburetor to the requirements of the engine results in a marked economy of fuel.

In accordance with the provisions of the patent statutes, I have herein described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiments thereof, but I desire to have it understood that the apparatus disclosed is only illustrative and that the invention can be carried out by other means. Also, while it is designed to use the various features and elements in the combinations and relations described, some of these may be altered and others omitted and some of the features of each mod-

ification may be embodied in the others without interfering with the more general results outlined, and the invention extends to such use.

What I claim as new is:

1. A carburetor embodying a fuel-nozzle arranged to deliver fuel into the mixing-chamber, an air-valve in the intake of the carburetor, a fuel-needle, and means whereby opening of the air valve will permit a proportionate opening movement of said needle, said means embodying a lever carrying the needle, a valve-opening spring tending to actuate said lever in an opening direction, a diaphragm and a valve-closing spring tending to actuate said lever in a closing direction, and a device actuated from the air valve for relieving the diaphragm of the action of its valve-closing associated spring.

2. A carburetor embodying a fuel-nozzle arranged to deliver fuel into the mixing-chamber, a butterfly air valve revoluble on a shaft in the intake of the carburetor, a fuel-needle, and means whereby opening of the air valve will permit a proportionate opening movement of said needle, said means embodying a cam actuated from said shaft, a diaphragm open to the suction of the engine, a spring normally forcing said diaphragm in one direction, another spring normally forcing said diaphragm in the opposite direction, a needle-carrying member arranged to follow the movement of said diaphragm to thus open and close the fuel-needle, and a lever arrangement actuated by said cam for relieving the diaphragm of the action of one of said springs.

3. A carburetor having a mixing chamber, a main air inlet leading into said chamber, an air valve in said inlet, means including a fuel nozzle for supplying fuel to said mixing chamber, a fuel valve in said nozzle, means actuable to open and close said air valve, and control means responsive to opening and closing movement of said air valve to hold said fuel valve in its positions of maximum and minimum opening, respectively, when said air valve is in its fully opened and closed positions, said control means including a diaphragm exposed to mixing chamber pressures for regulating the degree of opening of the fuel valve in response to suction conditions in the mixing chamber when the air valve is partly open.

4. A carburetor having a mixing chamber, a main air inlet leading into said chamber, means for supplying fuel to said chamber including an upwardly projecting nozzle terminating in a discharge orifice, a needle valve in said orifice movable upwardly to open-valve position, adjustable means definitely limiting the opening and closing movement of the needle, an air valve in said air inlet, and means for regulating the fuel needle, said regulating means including a diaphragm exposed to pressure conditions in said mixing chamber and tending to close said needle valve in response to suction in the mixing chamber, a valve-opening spring tending to open said needle valve, a valve-closing spring tending to close said needle valve, said regulating means also including means responsive to movement of said air valve to hold said needle valve in its position of minimum opening when the air valve is fully closed and to hold said needle valve in its position of maximum opening when said air valve is fully open.

5. A carburetor having a mixing chamber and a fuel nozzle opening upwardly thereto, a fuel valve element movable into and out of the orifice of said nozzle, a lever arm pivoted at one end and having said fuel valve element mounted on its other end, opposed abutment elements engageable by an intermediate portion of said lever arm and separately adjustable to determine the limiting upper and lower positions of said fuel valve element, and means including a diaphragm tending to lower said valve element in response to suction in said chamber.

6. A carburetor having a mixing chamber and a main air inlet leading thereto, means for supplying fuel to said mixing chamber including a nozzle projecting upwardly into said chamber, a manually operable air valve in said air inlet, a fuel valve element movable into and out of the orifice of said nozzle, a lever arm pivoted at one end and having said fuel valve element mounted on its other end, means for adjusting independently the upper and lower limits of movement of said lever arm on its pivot whereby the extreme positions of said fuel valve element relative to said orifice are determined, and means responsive to movement of said air valve for rocking said lever arm.

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