March 1, 1960 F. C. MELCHIOR 2,926,893

CARBURETOR

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Fig. 1

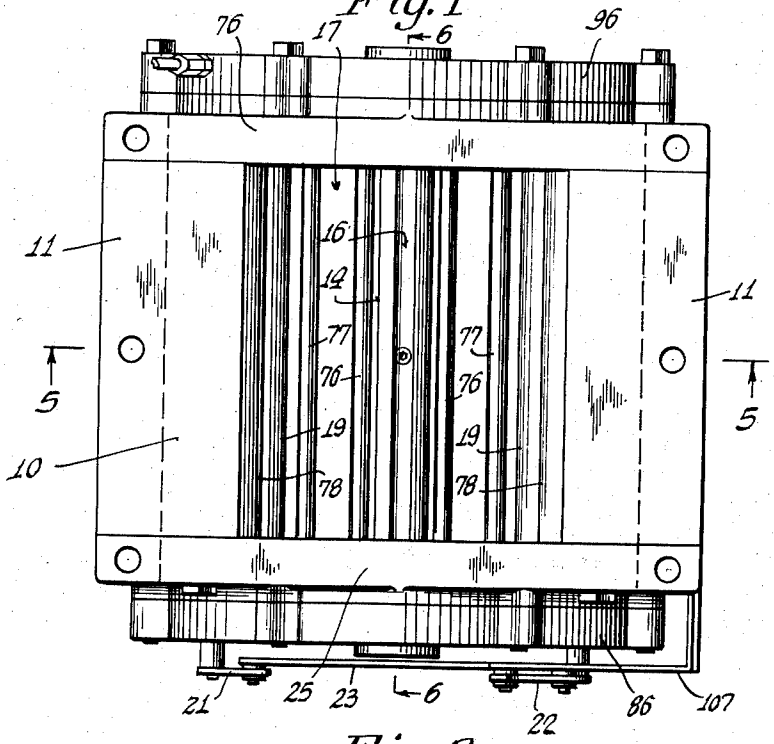
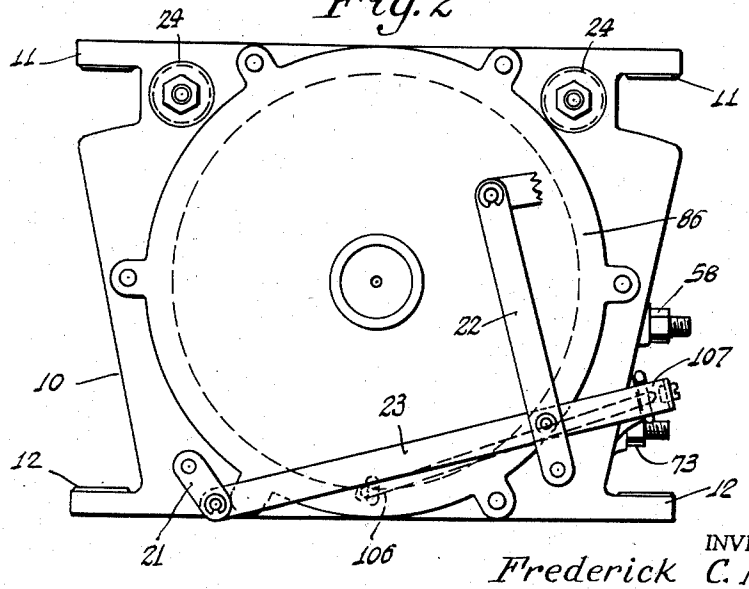


Fig. 2



INVENTOR.
Frederick C. Melchior
BY
Munn, Liddy, Daniels & March
ATTORNEYS

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CARBURETOR

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Fig. 3

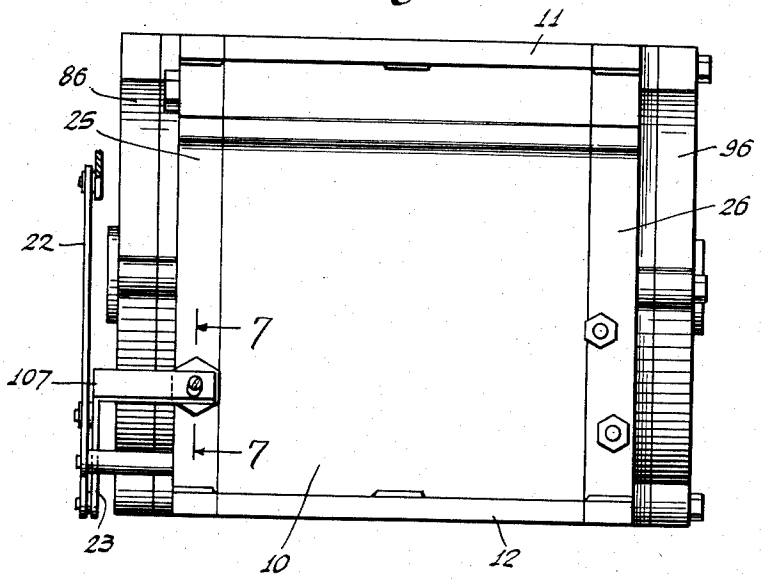
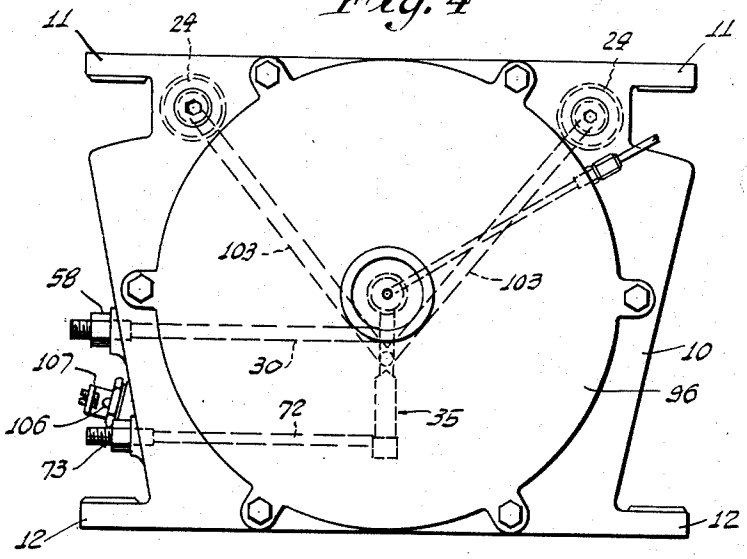


Fig. 4



INVENTOR.
Frederick C. Melchior
BY
Munn, Liddy, Daniels & March
ATTORNEYS

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CARBURETOR

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Fig. 5

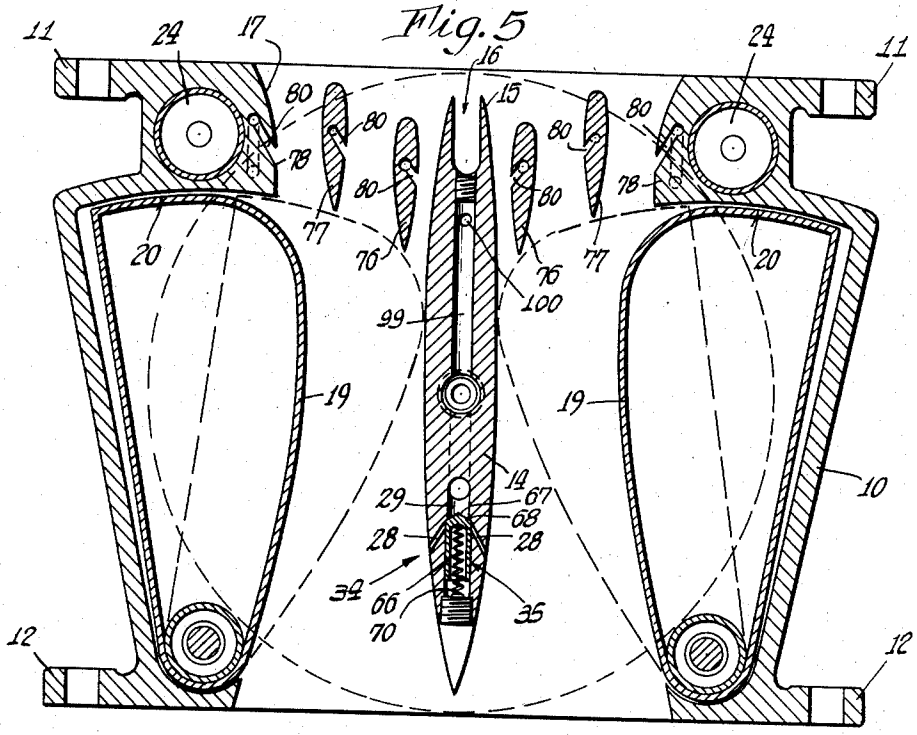


Fig. 8

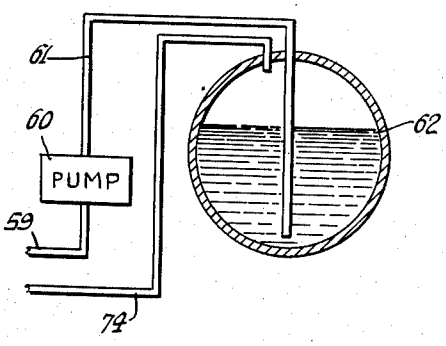
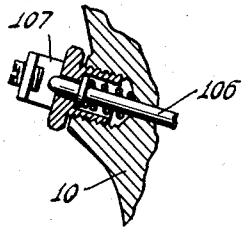


Fig. 7



INVENTOR

Frederick C. Melchior

BY

Munn, Liddy, Daniels & March

ATTORNEYS

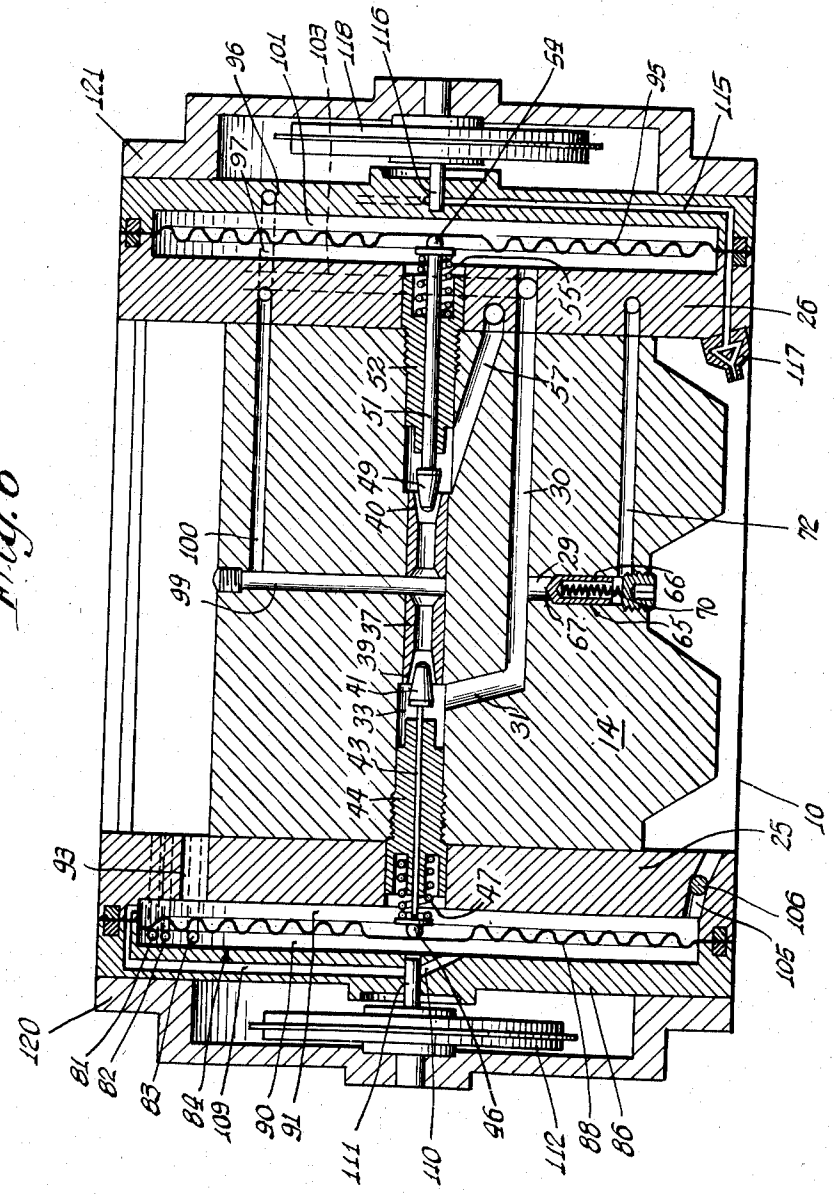
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Fig. 6



INVENTOR.

Frederick C. Melchior

BY

Munn, Liddy, Daniels & March

ATTORNEYS

United States Patent Office 2,926,893 Patented Mar. 1, 1960

2,926,893

CARBURETOR

Frederick C. Melchior, New York, N.Y.

Application December 12, 1957, Serial No. 702,393

12 Claims. (Cl. 261—36)

This invention relates to carburetor devices which mix fuel with air to provide a combustible mixture for internal combustion engines, and more particularly to devices of this type which utilize the injection principle in supplying the fuel mixture.

The invention is especially concerned with improvements in the carburetor disclosed and claimed in my Patent No. 2,793,014 dated May 21, 1957.

Heretofore, various types of fuel injector devices have been proposed and are being utilized, in an effort to improve the efficiency of the process by which a combustible mixture is brought into the cylinders of internal combustion engines. Prior devices included such means as individual cylinder injectors, by which a fuel mixture is supplied separately to each of the cylinders. These devices are costly, do require precise maintenance, and do not provide satisfactory idling speeds as required by automatic transmissions, due to the difficulty of obtaining exact uniform metering of fuel in the minute quantity required for each cylinder at very low speeds.

The present invention obviates the above drawbacks and disadvantages of prior, injection-type fuel-atomizing devices, and one object of the invention is to provide a novel and improved injection-type carburetor utilizing manifold injection as distinguished from individual cylinder injection, which carburetor employs a true, pressurized injection principle involving control wholly by the rate of flow of air through the carburetor. In other words, the injection of fuel is made to constitute substantially a function of the mass flow of air.

Another object of the invention is to provide an improved injector-type carburetor as above set forth, which will be effective in providing a substantially uniform and equal distribution of fuel mixture by way of the intake manifold to the individual cylinders of an internal combustion engine.

A feature of the invention resides in the provision of an injection type carburetor as above characterized, where the effect of vapor pressure is nullified in a closed system, that is, the effect of the vapor pressure existing in the fuel supply tank is cancelled out so as to eliminate vapor pressure as a factor of the injection function, thereby enabling the carburetor to be effectively used in conjunction with fuels containing a wide range of volatility, including LP gas, and to meter such fuels while in the liquid state.

Another object of the invention is to provide an improved injection-type carburetor wherein the fuel injection is effectively controlled by differential air pressures made to exist in the intake air passage.

Yet another object of the invention is to provide, in a differential-pressure controlled injection type carburetor, improved boost Venturi means, in conjunction with a Venturi-type variable throttle, thereby to obtain the best possible and most effective pressure differential from the air flow.

Another feature of the invention resides in the provision of a novel, variable air-bleed means, in an injection-

type carburetor as above outlined, thereby to not only effect a disposal of condensate but also to obtain a fine calibration of the carburetor and automatic enrichment of the fuel mixture, together with adjustability for handling fuels having different energies.

Yet another feature of the invention resides in the provision of simplified and effective valve control means, in an injection-type carburetor as above set forth, whereby simple yet positive valve actuation is obtained under all conditions of use.

Other features of the invention include increased efficiency and stability in the utilization of fuel, uniformity of performance under various operating conditions, and ability to handle fuels showing a wide diversity of volatility, including fuels containing propane or other LP gas.

Other advantages will also hereinafter appear.

In the drawings accompanying this specification, similar characters of reference indicate corresponding parts wherever possible throughout the several views, in which:

Fig. 1 is a top, plan view of an improved injection-type carburetor made in accordance with the invention.

Fig. 2 is an end elevational view of the carburetor shown in Fig. 1.

Fig. 3 is a side elevational view of the carburetor.

Fig. 4 is an elevational view of the opposite end of the carburetor.

Fig. 5 is a vertical sectional view taken on line 5—5 of Fig. 1.

Fig. 6 is a vertical sectional view of the carburetor taken on the line 6—6 of Fig. 1, and showing additional end caps and control elements contained therein.

Fig. 7 is a fragmentary sectional view taken on the line 7—7 of Fig. 4.

Fig. 8 is a diagrammatic representation of a fuel tank and fuel pump, together with fuel and vapor lines, adapted for use with the carburetor of Figs. 1–6.

The present improved carburetor is in many respects similar to that shown in my patent above identified, and accordingly reference may be had to such patent for details not completely set forth herein.

As with my patented carburetor, the present device may be installed to replace the conventional carburetor commonly employed with internal combustion engines, without requiring major changes or alterations. The present carburetor may thus be thought of as a "down draft carburetor," although actually it will operate in any position, inasmuch as the fuel is metered and supplied under pressure, in conjunction with a completely closed fuel supply system.

Referring now to the figures, the carburetor structure shown therein comprises a housing **10** preferably formed of non-rusting metal in any suitable manner, as by a casting process. The housing **10** may have upper and lower attaching flanges **11** and **12** by which, in the well known manner, it may be incorporated in the fuel intake system of the engine.

Within the housing **10** there is provided a nozzle bar **14** having a leading edge **15** provided with a pressure trough **16** adapted to receive the impact of intake air passing into an intake scoop **17**.

Cooperable with the nozzle bar **14** are synchronized, variable Venturi throttles **19** having convex upper surfaces **20** which are movable in a curved path across the central air passage through the body **10**, between the full-line positions shown in Fig. 5 and the broken-line position shown therein. As seen in Fig. 2, the throttles **19** may be actuated by lever arms **21** and **22** connected together by a link **23**.

The casing **10** may be provided with accelerator pumps **24** in those portions disposed above the Venturi throttles **19**, as shown. Details of such accelerator pumps are

not given here, since they are well understood in the art.

Referring to Fig. 6, the housing 10 may have oppositely disposed end walls 25 and 26 between which the nozzle bar 14 extends, and which it engages. At its lower or trailing edge the nozzle bar 14 is provided with orifices 28 which constitute a spray nozzle, through which fuel is injected into the air passage below the Venturi throttles 19. The orifices 28 communicate with bores 29, 30 and 31, the latter bore opening into a central bore 33 in the nozzle bar 14. The spray nozzle, indicated generally at 34, includes a nozzle valve means 35 which is hereinafter in the claims also termed a "first valve." The function and structure of such valve means will be hereinafter given.

In the central bore 33 a two part valve seat assembly 37 is provided, having valve seats 39 and 40 facing in opposite directions. One part of the assembly 37 is concerned with a fuel regulating jet and the other part is concerned with a fuel metering jet. Cooperable with the valve seat 39 is a valve 41, termed in the claims a "second valve," which has a metering function and which I also term a "fuel metering valve." Such valve is carried on a push rod 43 or valve stem, disposed in a bearing sleeve 44, and this stem 43 at its left extremity (as viewed in Fig. 6) mounts a rounded abutment head 46, by which it may be actuated through means later to be described. A helical compression coil spring 47 disposed in the sleeve 44 normally yieldably urges the valve stem or rod 43 to the left, with a very light pressure.

Co-operable with the valve seat 40 is a valve 49 which is termed in the claims a "third valve" and which serves to regulate the fuel supplied to the fitting 37. I term such valve a "fuel regulator valve," since it regulates the fuel supply. The valve 49 is carried on a stem or push rod 51 which bears in a bearing sleeve 52 carried in the nozzle bar 14. The rightmost end of the valve stem 51 as viewed in Fig. 6 is provided with a rounded abutment head 54 engaged by a helical compression coil spring 55 carried in the sleeve 52. The spring 55 yieldably urges the valve stem 51 and the valve 49 to the right, as viewed in Fig. 6, with a very light force.

Communicating with the bore 33 in the nozzle bar 14 is a fuel inlet passage 57, which also extends through the end wall 26 and is connected with a line fitting 58, Figs. 2, 3 and 4.

Considering the fuel inlet, the fitting 58 may be connected to a fuel line 59, Fig. 8, fed by a pump 60 which is in turn connected through a fuel line 61 to a fuel tank 62.

As will be hereinafter disclosed, the valves 41 and 49 are actuated one in response to air pressure differential in the air passage and the other in response to fuel pressure differential as measured ahead of and following the valve 41.

In accordance with the present invention, the injection of the fuel into the air stream from the spray nozzle 35 is made to be a true function of differential air pressure in the air stream, irrespective of vapor pressure which may exist in the fuel tank 62, and in conjunction therewith there is provided a completely closed fuel supply system embracing both the fuel and the vapor of the fuel tank. Moreover, with such system as provided by the invention, fuels of high volatility may be handled, including propane or other LP gas, and metering of such fuel is accomplished in the liquid state, as distinguished from metering of gases or volatilized fuel.

In accomplishing the above, the spray nozzle valve 35 is so constituted that it may respond to oppositely acting pressures. One such pressure is that of the pumped fuel, including the fuel vapor pressure from the tank 62, and opposing such pressure is solely the fuel vapor pressure in the tank. Thus, the vapor pressures will cancel each other, leaving only the pump originating pressure to act on the valve 35.

As shown in Figs. 5 and 6, the lower or trailing edge of the nozzle bar 14 has an enlarged bore 65 constituting a guide for a deep cup-shaped valve member 66 having a valve face 67 which engages a valve seat 68 formed as a shoulder between the enlarged bore 65 and the smaller, fuel-passage bore 29. A helical compression spring 70 within the valve member 66 normally urges the latter upward into engagement with the valve seat 68. Communicating with the bore 65 below the pistons is a vapor passage 72 which extends through the end wall 26 and communicates with a fitting 73 to which the vapor line 74 of Fig. 8 may be connected. Such vapor line is shown as extending into the upper interior portion of the tank 62. By such construction the inside of the valve member 66 will be subjected directly to the vapor pressure from the tank, whereas the outer and upper side of the valve member will be subjected to the pressure of the liquid fuel, which is equal to the pressure created by the pump 60 plus the vapor pressure within the tank 62. In consequence, the resultant pressure tending to open the valve 66 will be only that provided by the pump 60, and will be independent of vapor pressure in the tank 62. The closed fuel supply system thus provided is therefore adaptable for high volatility fuel, while at the same time the metering of such fuels and injection of the same by the valves 41, 49 and 35 will advantageously occur with the fuel in a liquid state where precise control thereof may be had. This is especially important where fuels like propane gas or other LP gases are utilized. By metering such fuels in the liquid state as distinguished from the gaseous state, there is a much better control of the fuel mixture and of the quantities to be injected for combustion. It should be understood that fuels other than LP gas may be utilized with the same advantages by the present improved carburetor. Particularly the improved project means as provided herein has utility with all types of fuels regardless of volatility.

In addition to the vastly superior metering accuracy obtained by the present carburetor, as compared with the conventional method of metering LP gas in the gaseous state after it has passed through a pressure reducing valve, there is obtained the further advantage that the temperature drop from vaporization is confined to the intake manifold. The desirable effect of such cooling of the manifold is a corresponding increase in the density of the charge, resulting in a proportional increase in power under a given set of conditions.

In connection with the metering of the fuel by the valve 41 it may be noted that at the present time the larger engines in new passenger automobiles are approaching and in certain instances exceeding in displacement the 400 cubic inch mark, wherein the ratio between maximum and minimum mass flow of air will be somewhere around 50:1. Considering the minimum rate of flow, in a carburetor having a single throat or "barrel," and with a conventional throttle control system, this leaves a metering force which is $\frac{1}{2500}$ of the optimum full throttle pressure differential, representing a figure which is removed by a couple of decimals from practical, operational limits. To offset such inadequate values and ratios required diverse, compromise solutions, such as multiple "barrels" and nozzles, idling jets, etc.

In accordance with the invention wherein the valve 41 is actuated in response to a differential pressure created by the air stream flowing through the carburetor, improved means are provided for obtaining an effective and reliable, relatively large pressure differential in conjunction with the Venturi throttles 19 substantially in first power proportion to the mass flow of air. Referring to Fig. 5, I provide a plurality of spaced, booster Venturi members 76, 77 and 78 disposed on each side of the nozzle bar 14 and having trailing edges disposed closely adjacent the path of travel of the convex surfaces 20 of the throttle members 19. The booster Venturi

members 78 may be constituted as integral parts of the housing 10, as shown. All such Venturi members have downwardly extended slits 80, said slits being paired and communicating with passages 81, 82 and 83, see Fig. 6, opening into a chamber 84 formed between the end wall 25 and an end cap 86.

To obtain an adequate metering force in the lower speed range, and to bring such force into a first exponential power relation to the mass flow of air, I provide the above three sets or "stages" of boost Venturis as indicated. Referring to Fig. 5, the innermost pair 76 is seen to be located close to the nozzle bar 14, so that with the Venturi throttles 19 in the near-closed position, as in idling, the air will flow through a small area of, say 1/8 of the total area available at full throttle. This would imply a velocity of a little over 1/8 and a consequent metering force of about 1/40 of the respective optimum values obtained at full throttle. Furthermore, the passages or apertures 81—83 through which the booster Venturi members communicate with the metering diaphragm are made progressively small for the succeeding stages. For example, 1/8" 1/16" and 1/32" diameter passages would give ratios of 16:4:1, thus providing a means to control the bleed-back so as to obtain a smooth gradient of the metering force. In experimental units, of course, set-screws may be used to determine the optimum ratios between the apertures.

Also, in accordance with the invention an improved and simplified valve actuator is provided in the chamber 84, in the form of a corrugated metering diaphragm 88 which is clamped in any suitable manner with packing rings, as shown. The diaphragm 88 divides the chamber 84 into a left portion 90 and a right portion 91, and the passages 81, 82 and 83 communicate with the left portion, as shown. Communicating with the right portion 91 is a passage 93 which leads to the pressure trough or impact trough 16 in the upper, leading edge of the nozzle bar 14. The center of the diaphragm 88 engages the abutment head 46 of the valve stem 43, and the diaphragm when relaxed is biased to the right so as to be convex as viewed from the interior of the carburetor. When free of opposing pressures, the biased diaphragm will effect a closing of the valve 41.

I have found that the combination of the biased diaphragm 88 in the chamber 84 with the multiple boost Venturis 76—78 disposed along the path of movement of the throttles 19 provides a uniformly large and effective differential-pressure actuator which is of considerable advantage when used as a control for the metering valve 41. The gradient providing a first power relation between the mass flow of air and the aforesaid pressure differential is obtained through the cooperation between the aforesaid Venturi throttles and the spaced boost Venturi. The position of the valve 41 is effectively made a function of the air flow through the carburetor responding to the rate of flow or, in other words, the mass flow of air. The abutting connection established between the diaphragm 88 and the valve stem 43 eliminates any tendency for friction or sticking of these parts. Moreover, the large area presented by the diaphragm enables it to respond to the pressure differential with great sensitivity.

The abutting connection established between the diaphragm 88 and the valve stem 43 eliminates any tendency for friction or sticking of these parts. Moreover, the large area presented by the diaphragm enables it to respond to the pressure differential with great sensitivity.

By the present invention I provide a similar, sensitive actuator for the valve 49, by which such valve is responsive to the differential between the two pressures on opposite sides of the metering valve 41 i.e. the pressure drop across the metering valve.

As shown, the diaphragm 95 is clamped against the end wall 26 by an end cap 96, and engages the abutment head 54 of the valve stem 51. The passage 30 communicates with the left portion 97 of the diaphragm chamber, and passages 99 and 100 leading from the valve assembly 37 communicate wtih the right portion 101 of the diaphragm chamber. The diaphragm 95 is biased to the right as viewed in Fig. 6, whereby when not subjected to opposing pressures it allows the fuel regulator valve 49 to remain open. When in such position the diaphragm 95 is concave, as viewed from the interior of the carburetor. The fuel passage 30 also communicates with passages 103 which lead to the accelerator pumps 24, see Figs. 3 and 5.

Further, in accordance with the present invention, I provide a variably-controlled bleed channel 105 in the end wall 25 of the housing 10, and control such channel by a bleed valve 106, Figs. 2, 3, 4 and 6, said valve being actuated by an extension 107 on the link 23 of the throttle control. The variable bleed means for one thing provides for disposal of condensate which may form in the diaphragm chamber portion 91. It also enables a fine calibration of the carburetor to be had, and effects automatic enrichment of the fuel at high power settings, due to decreased bleed rate at higher manifold pressures. The variable bleed valve enables adjustment to be made for variations in the calorific value of different fuels, moreover.

Operation of the fuel control system as set forth above is seen to be simple. Fuel from the pump 60 is delivered at fairly constant pressure to the fuel regulator valve 49 governing the admission flow to the metering valve 41. After the pressure drop across the fuel regulator valve 49, there exists between the two valves "unmetered" fuel pressure, which is communicated to the far side of the regulator diaphragm 95; after the further pressure drop across the metering valve 41 there remains "metered" fuel pressure (the same as the spray nozzle pressure) which is communicated to the chamber portion 97 at the near side of the diaphragm 95. Thus, the differential between the two pressures, the pressure drop across the metering valve 41, becomes the only factor to actuate the fuel regulator diaphragm 95. The cooperation between the two diaphragms 88 and 95 is now clear, with the fuel regulator valve 49 admitting fuel to the metering valve 41 in an inverse proportion to the pressure drop across the latter valve.

To complete the pressure equation, the unmetered fuel pressure (spray nozzle pressure) is absorbed by two factors, the nozzle-closing pressure, which may be adjusted to a desired value, and the pressure drop of the friction of the flow. As already described, the spray nozzle valve 35 consists of a cup-like piston 66 in the cylindrical chamber 65 which is of somewhat larger diameter than that of the fuel passage 29 communicating with it. The shoulder thus formed between them is the valve seat 68 against which the top of the valve 66 is held by pressure of the internal spring 70, adjustable by an Allen plug which seals off the nozzle chamber from the outside. As the valve 66 is forced down by fuel pressure, it uncovers the slits 28 in the nozzle bar 14 (Fig. 5), through which the fuel is squeezed out, in "atomized" form.

The end cap 86 may be provided with passages 109 and 110 as shown in Fig. 6, controlled by a plunger valve 111 actuated by an aneroid capsule 112 to effect altitude correction, as in my patent above referred to.

Also, the end cap 96 may have a passage 115 controlled by a plunger valve 116 and leading to a spray nozzle 117, by which a water-alcohol mixture may be injected. The valve 116 may be controlled by an aneroid capsule 118, also as disclosed in my referred to patent. Additional end caps 120 and 121 may be provided, as shown, to enclose the aneroid capsules 112 and 118.

I may also provide a bi-metallic thermostat (not shown) to augment the spring-loading of the metering valve 41 against the diaphragm 88 while the engine is cold, and such device would constitute a simple and func-

tional substitute for a choke, to insure reliable cold engine starting and operation.

It will now be understood from the foregoing that I have provided a novel and improved, differential pressure-controlled injector-type carburetor, in conjunction with a closed fuel supply system, whereby highly volatile fuels and liquified gaseous fuels may be readily metered and injected into the intake manifold of an internal combustion engine while in a liquid state, and a precise control effected by a pressure differential produced in the air flow through the carburetor. The present improved carburetor is of relatively low cost, does not require precision maintenance, and provides a uniform fuel supply to each cylinder in the very low speed range, as well as for high speeds and powers, thereby to obviate idling difficulties. The carburetor has a high efficiency and stability, and is characterized by uniformity of performance under all operating conditions, together with versatility in handling fuels of varying degrees of volatility, including LP gas.

The present improved carburetor may be used as a replacement for conventional carburetors without requiring major installation changes. It works equally well in any position, and effectively utilizes the differential between impact (dynamic) pressure and Venturi (suction) pressure by the booster Venturis controlling the metering valve. The operation of such valve is a function of the mass flow of air, for a given density, and is substantially proportional to the square of the flow velocity. The air flow is controlled by the synchronized Venturi throttles which for all practical purposes form true Venturi passages at all throttle openings. The passage below the fuel spray nozzle is free of obstructions, such as the conventional "butterfly" valve, on which atmospheric moisture could freeze and form ice.

The large-area diaphragms 88 and 95 constitute inherent self-contained spring members, and are concentrically corrugated and constituted so that their sensitivity is practically infinite, with deflection substantially perfectly linearly proportional to pressure increments. Accurate repeat deflections are had with such diaphragms, with an overall accuracy including hysteresis or spring lag of better than one part in one thousand, within their range. Thus, the actuation of the valves 41 and 49 is carried out in an extremely effective and reliable manner.

Variations and modifications may be made within the scope of the claims, and portions of the improvements may be used without others.

I claim:

1. In combination, a fuel tank and fuel pump connected thereto; a differential-pressure controlled injection-type carburetor having an air passage, a fuel passage connected with the fuel pump and fuel tank, and a spray nozzle connected with the fuel passage for discharging fuel into the air passage; valve means in said fuel passage for controlling the flow of fuel therethrough, including a movable valve movable to open position in response to the pressure of fuel in that portion of the passage which is located ahead of said valve means; and means including a pressure-responsive device acting on said valve to oppose opening movement thereof by the fuel pressure, said last-named means further including a vapor line connected to the upper portion of the aforementioned fuel tank above the liquid line thereof.

2. The invention as described in claim 1, in which the valve means comprises an annular valve seat in the fuel passage, in which the movable valve comprises a deep, cup-shaped member, in which there is means providing a bearing on which said cup-shaped member is axially movable, and in which the vapor line is connected with said bearing-providing means.

3. The invention as described in claim 1, in which there is a central nozzle bar carrying the said fuel passage, spray nozzle, valve means and vapor line.

4. In combination, a fuel tank and fuel pump connected thereto; a differential-pressure controlled injection-type carburetor having an air passage, a fuel passage connected with the fuel pump and fuel tank, and a spray nozzle connected with the fuel passage for discharging fuel into the air passage; valve means in said fuel passage for controlling the flow of fuel therethrough, including a movable valve movable to open position in response to the pressure of fuel in that portion of the passage which is located ahead of said valve means; and means including a pressure-responsive device acting on said valve to oppose opening movement thereof by the fuel pressure, said last-named means further including a vapor line connected to the upper portion of the aforementioned fuel tank above the liquid line thereof; a Venturi in said air passage; a second valve means including a second movable valve in said fuel passage, located upstream of said first-mentioned valve means; and means for actuating said second movable valve in response to the air-pressure differential across said Venturi.

5. The invention as described in claim 4, in which the means for actuating the second movable valve comprises a diaphragm and comprises means providing a diaphragm chamber in which the diaphragm is disposed, said diaphragm dividing the chamber into two portions, one portion of which is connected with the Venturi, and which there is a pressure trough connected with the other portion of the chamber.

6. A differential-pressure controlled injection-type carburetor having an air passage, a fuel passage adapted to be connected with a fuel pump and fuel tank, and a spray nozzle connected with the fuel passage for discharging fuel into the air passage; valve means in said fuel passage for controlling the flow of fuel therethrough, including a movable valve movable to open position in response to the pressure of fuel in that portion of the passage which is located ahead of said valve means; and means including a pressure-responsive device acting on said valve to oppose opening movement thereof by the fuel pressure, said last-named means further including a vapor line adapted to be connected to the aforementioned fuel tank; a Venturi in said air passage; a second valve means including a second movable valve in said fuel passage, located upstream of said first-mentioned valve means; and means for actuating said second movable valve in response to the air-pressure differential across said Venturi, the said means for actuating the second movable valve comprising a diaphragm and comprising means providing a diaphragm chamber in which the diaphragm is disposed, said diaphragm dividing the chamber into two portions, one portion of which is connected to the Venturi; a pressure trough connected with the other portion of the said chamber; means providing a bleed passage between the one portion of the chamber and the said air passage; and a throttle device and means responsive to actuation of said throttle device, controlling the flow of air through the said bleed passage.

7. The invention as described in claim 5, in which the diaphragm is resilient and biased to one extreme position.

8. The invention as described in claim 7, in which the means for actuating the second movable valve includes a valve push rod connected with said valve, and spring means yieldably holding said valve push rod against the diaphragm in a direction to oppose the bias thereof.

9. A differential-pressure controlled injection-type carburetor having an air passage, a fuel passage adapted to be connected with a fuel pump and fuel tank, and a spray nozzle connected with the fuel passage for discharging fuel into the air passage; valve means in said fuel passage for controlling the flow of fuel therethrough, including a movable valve movable to open position in response to the pressure of fuel in that portion of the passage which is located ahead of said valve means; and means including a pressure-responsive device acting on said valve to oppose opening movement thereof by the

fuel pressure, said means further including a vapor line adapted to be connected to the aforementioned fuel tank; a Venturi in said air passage; a second valve means including a second movable valve in said fuel passage, located upstream of said first-mentioned valve means; and means for actuating said second movable valve in response to the air-pressure differential across said Venturi; a third valve means including a third movable valve in said fuel passage, located upstream of said second valve means; and means for actuating said third movable valve in response to the fuel pressure differential across said second valve means.

10. The invention as described in claim 9, in which the means for actuating the movable valves include diaphragms and means providing chambers in which the diaphragms are disposed and which the diaphragms divide into two portions, and include valve push rods connected with the valves and spring means holding said push rods in abutting engagement with the diaphragms.

11. A differential-pressure controlled injection-type carburetor having an air passage, a central nozzle bar in said air passage, a fuel passage and a nozzle in the nozzle bar and connected with the fuel passage for discharging fuel into the air passage; a pair of movable, Venturi-type throttle members disposed on opposite sides of, movable against and cooperable with said nozzle bar to control the intake of air in the air passage, said members having convex surfaces facing opposite to the direction of air flow through the air passage and movable in a curved path of travel; a plurality of spaced booster Venturi members disposed on each side of the nozzle bar, having trailing edges disposed closely adjacent the path of travel of the said convex surfaces of the throttle members.

12. The combination of a fuel tank having a vapor line communicating with its upper interior and a fuel line communicating with its lower interior; a fuel pump connected to said fuel line; a differential-pressure controlled injection-type carburetor having an air passage, a fuel passage connected with the fuel pump, and a spray nozzle connected with the fuel passage for discharging fuel into the air passage; valve means in said fuel passage for controlling the flow of fuel therethrough, including a movable valve movable to open position in response to the pressure of fuel in that portion of the fuel passage which is located upstream of said valve means; and means including a pressure-responsive device acting on said valve to oppose opening movement thereof by the fuel pressure, said means further including the said vapor line communicating with the fuel tank.

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