March 31, 1942. F. C. MOCK ET AL 2,277,930

CARBURETOR

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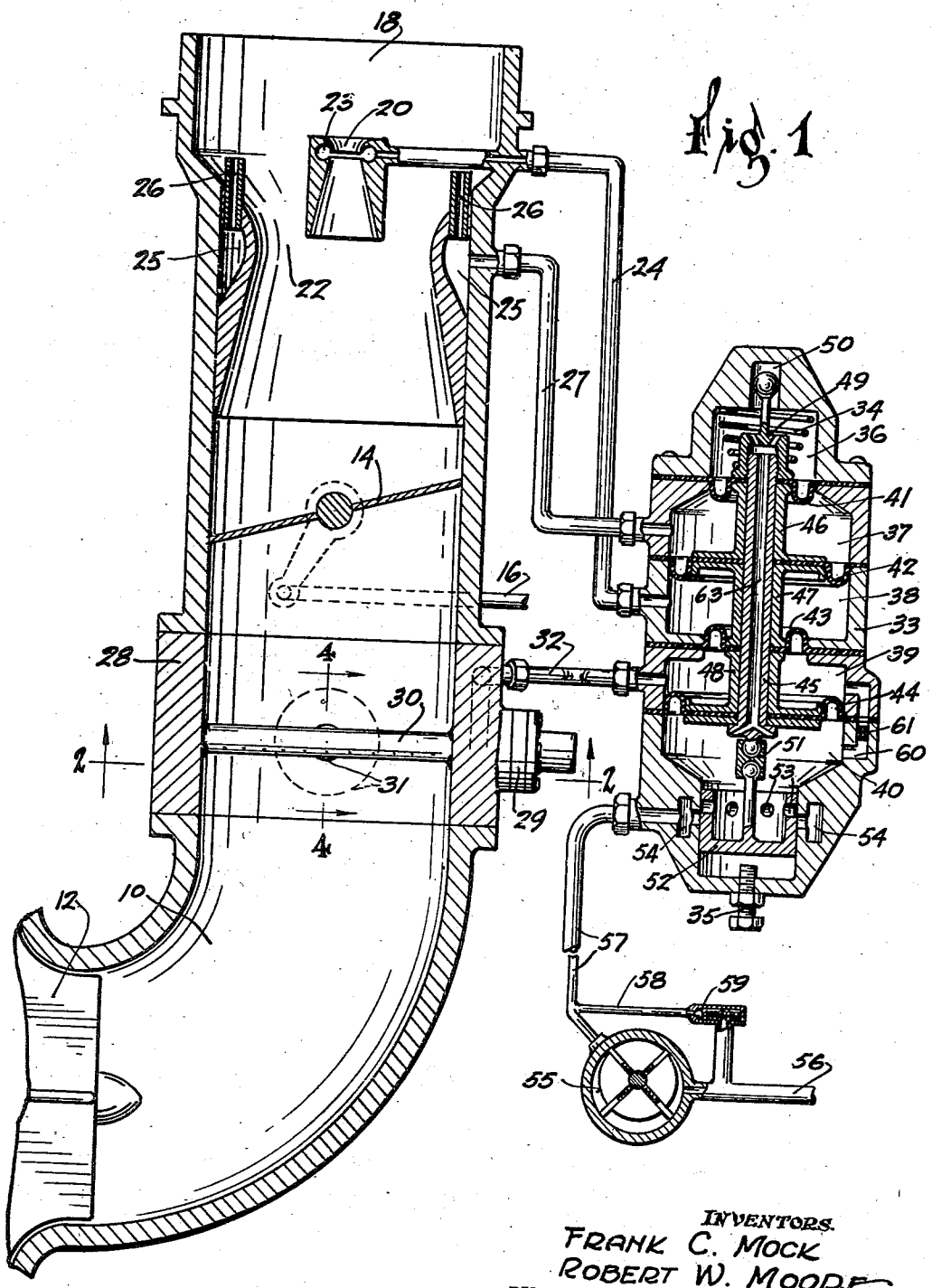


Fig. 1

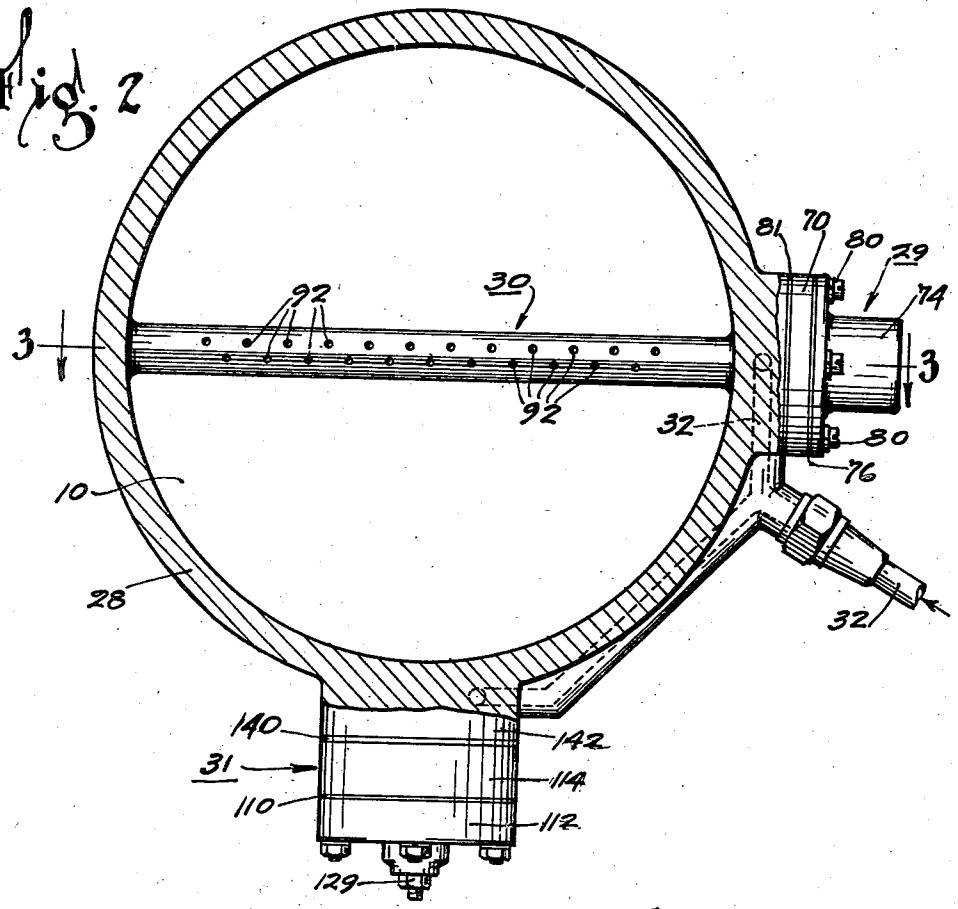
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Fig. 2



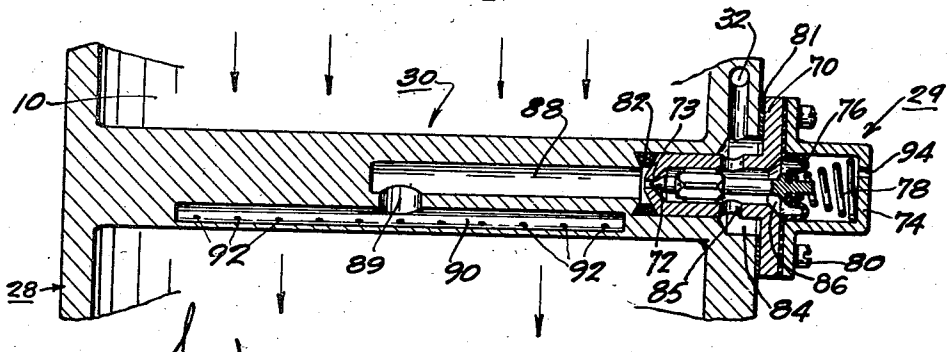


Fig. 3

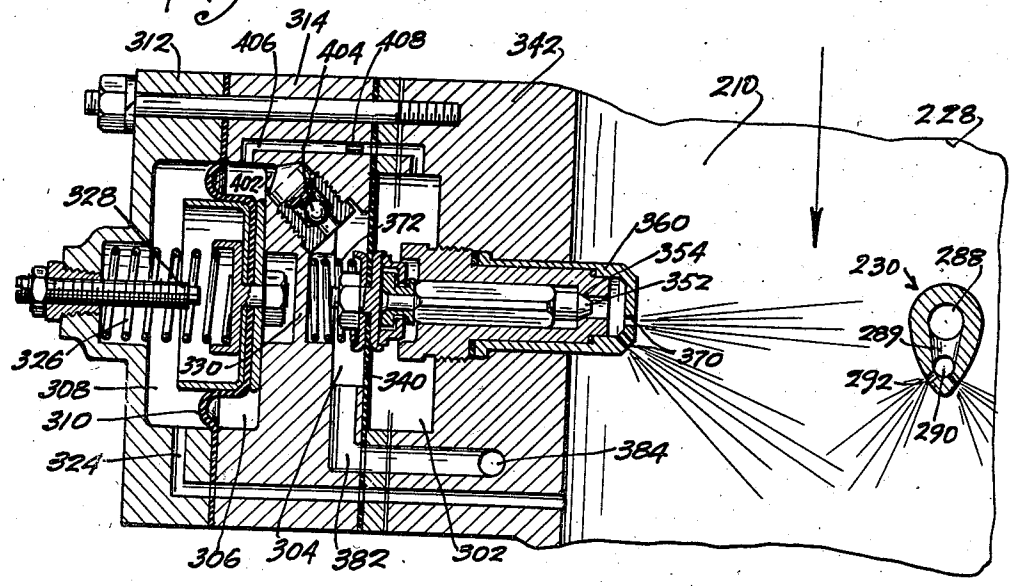
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Fig. 5



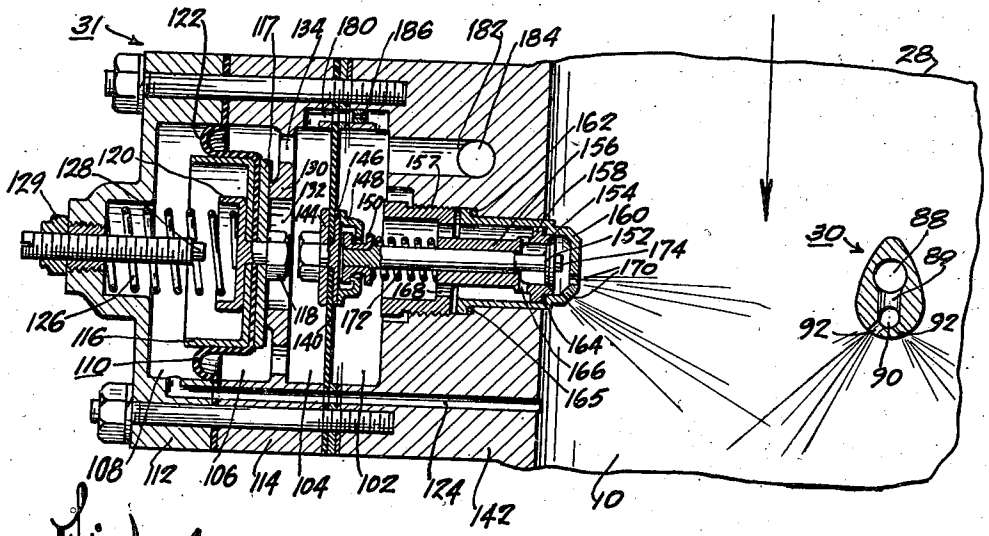


Fig. 4

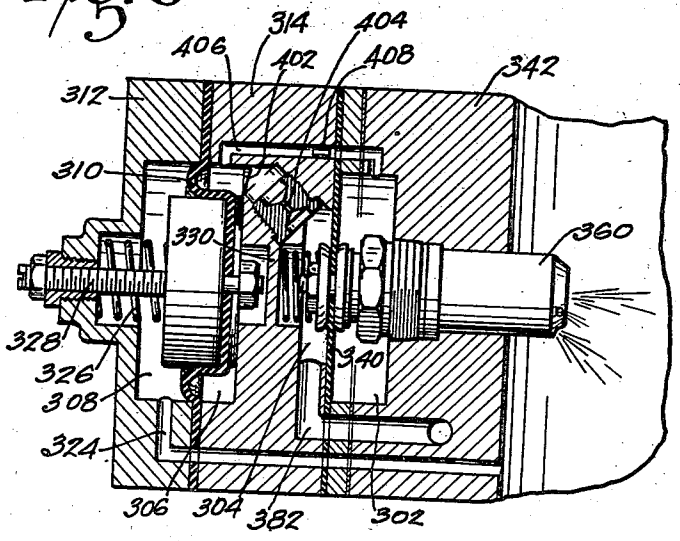
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CARBURETOR

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Fig. 6



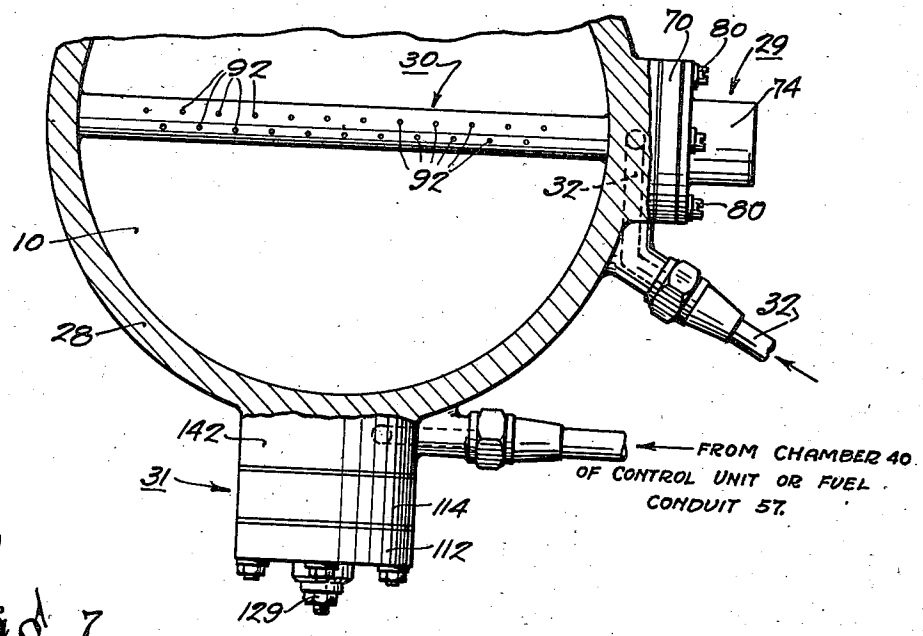


Fig. 7

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UNITED STATES PATENT OFFICE

2,277,930

CARBURETOR

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Application May 11, 1939, Serial No. 272,990

21 Claims. (Cl. 261—34)

This invention relates to carburetors and more particularly to means for supplying an accelerating charge of fuel to a carburetor under certain conditions of operation.

In all types of carburetors, including the type wherein the fuel for ordinary operation is injected under pressure, an increase in the rate of air flow resulting from rapid opening movement of the throttle does not immediately produce a corresponding increase in the rate of fuel flow. This slight lag in fuel delivery accompanying a sudden opening of the throttle results in a temporary leanness of the mixture. In order to overcome this temporary leanness it has been common practice to use a piston type pump directly operable by the throttle shaft and so arranged that a small amount of extra fuel is immediately forced into the air stream as the throttle is opened.

Acceleration pumps of this type have several inherent disadvantages, especially when applied to carburetors of the pressure feed type disclosed in the copending application of F. C. Mock, Serial Number 202,206, filed April 15, 1938. In this type of carburetor the throttle and the acceleration pump may be at widely spaced points and to mechanically connect them would result in the use of an extensive system of cooperating linkages. This is especially hazardous in aircraft use since any sticking or jamming of the piston or linkage locks the throttle. Also, the necessary kinematic relationship between the throttle and the pump is difficult to obtain in the design of some carburetors.

It is an object of the invention to provide improved means whereby the tendency for the mixture ratio to be temporarily lean immediately following an opening of the throttle is overcome.

It is a further object to provide an acceleration pump having greater accessibility so that the pump capacity can be readily adjusted.

A further object is to provide a pressure feed carburetor having improved acceleration characteristics.

Further objects and advantages of the invention will be apparent from the following description, taken in conjunction with the accompanying drawings, in which:

Figure 1 is a diagrammatic sectional view of a device embodying the invention;

Figure 2 is an end view of the adapter flange as indicated by the line 2—2 in Figure 1;

Figure 3 is a sectional view of the discharge bar and nozzle taken on the line 3—3 in Figure 2;

Figure 4 is a sectional view of the acceleration pump taken on the line 4—4 in Figure 1;

Figure 5 is a sectional view of another modification of the acceleration pump.

Figure 6 is a sectional view of another modification of the acceleration pump; and

Figure 7 is a fragmentary view of the adapter flange depicting alternate arrangements for supplying fuel to the acceleration pump.

Referring more specifically to Figure 1, the carburetor proper comprises an induction passage 10 leading to a supercharger 12 of an internal combustion engine of any desirable type. The passage 10 is controlled by a throttle 14 operable by a rod 16 extending from the pilot's cockpit or driver's compartment. The operator therefore directly controls the air charge to the engine while the fuel charge is automatically controlled by apparatus hereinafter described.

Anterior to the throttle 14 is an air inlet or scoop 18 leading to a primary venturi 20 located in series with a secondary venturi 22. Primary venturi 20 is formed with an annular chamber 23 opening into the venturi in the vicinity of the venturi throat and communicating through pressure conduit 24 with the control unit hereinafter described. The secondary venturi 22 is formed with an annular chamber 25 communicating through a plurality of tubes 26 with the air scoop 18 and through pressure conduit 27 with said control unit.

Posterior to the throttle 14 is an adapter section 28 forming a portion of the induction passage 10 and having a pressure responsive fuel discharge nozzle indicated generally at 29 which controls the flow of fuel from the conduit 32 to a fuel discharge bar 30. An acceleration pump generally referred to at 31 is also carried by the adapter section 28 and as shown is spaced approximately 90° from the nozzle 29.

The control unit comprises a hollow casing 33, which may be formed from a plurality of die-cast sections, assembled and secured together as shown. The interior of the casing is divided into five chambers 36, 37, 38, 39 and 40 by the four flexible diaphragms 41, 42, 43 and 44, each of which has its outer end clamped between adjacent sections of the casing to form a fluid-tight gasket, and its central portion apertured and secured to a control rod 45 by means of hubs 46, 47 and 48 having flanges at their ends which clamp the diaphragms between them and limit flexure thereof to an annular looped portion be-

tween the flanges and the casing, which permits vertical movement of the control rod 45. The hubs and diaphragms are held in assembled relation on the control rod by means of a threaded cap 49 which terminates in a spherical end slidably movable in a recess 50 at the upper end of the casing, thus forming a guide bearing for the control rod assembly. A spring 34 in recess 36 yieldingly urges the rod downwardly as shown.

The lower end of the control rod is connected through a double ball-and-socket universal joint 51, with a fuel valve 52 of the sleeve type having ports 53 controlling the admission of fuel to the lower chamber 40. An adjustable stop 35 limits downward movement of the control rod and valve 52. An annular fuel chamber 54 surrounds the valve 52, and has an annular groove adapted to register with the ports 53. Any commercial fuel pump arranged to deliver fuel at substantially constant pressure may be used to deliver fuel to the fuel chamber 54. The one shown at 55 is of a rotary type having a fuel inlet 56, fuel outlet 57 and a by-pass channel 58 controlled by a pressure responsive valve 59.

The diaphragms used in the control unit are preferably formed of material such as silk fabric impregnated with Neoprene or other artificial rubber compound. Such diaphragms have substantially no inherent resiliency.

In the operation of the device as thus far described, fuel is delivered at substantially constant pressure to fuel chamber 54, whence it flows through ports 53, the effective area of which is controlled by the axial movement of the control rod 45, into the unmetered fuel chamber 40, and thence through a passageway 60 containing metering orifice 61, into the metered fuel chamber 39, and thence through passageway 32 to the discharge nozzle 29 and discharge bar 30. Unmetered fuel chamber 40 also communicates, through a longitudinal passage 63 in the control rod 45 and cap 49, with chamber 36, so that the pressures in the two chambers are at all times equal.

Chamber 37 communicates through passageway 27 with the annular chamber 25 in the secondary venturi and is therefore subjected to the pressure existing in the air scoop 18. Chamber 38 communicates through passageway 24 with the annular chamber 23 in the primary venturi 20 and is therefore subjected to the pressure existing at the throat of said venturi. The differential in pressure between air scoop and venturi throat is proportional to the square of the rate of air flow. These two pressures acting on opposite sides of diaphragm 42 create a net force on the control rod which is also proportional to the square of the rate of air flow and is in a direction tending to open ports 53 in slide valve 52 and increase the quantity of fuel flowing through the control unit to the nozzle as the rate of air flow increases.

Flow of fuel from chamber 40 through passageway 60 and restriction 61 into chamber 39 results in a pressure drop across said restriction which is proportional to the square of the quantity of fuel flowing. The fuel pressures in chambers 40 and 39, differing in degree by the pressure drop across the restriction, act on opposite sides of diaphragm 44 and create a net force on the control rod which is proportional to the square of the rate of fuel flow and is in a direction tending to close valve ports 53 as the rate of fuel flow increases, thereby opposing the previously mentioned force generated by air flow. As a result, for any given conditions of operation, the control rod assembly and attached valve 52 will move to a position such that the force created by fuel flow will be maintained equal to the force created by the air flow. Since these forces are respectively proportional to the squares of the quantities of fuel and air flow, it is apparent that the square of the fuel flow is maintained in constant proportion to the square of the air flow and hence the mixture ratio, that is the ratio of the weight of fuel to the weight of air, is maintained at a constant value unless altered by extraneous means such, for example, as those disclosed in the copending application of F. C. Mock, Serial Number 202,206.

The discharge nozzle assembly 29, better shown in Figures 2 and 3, comprises a nozzle body 70, valve 72 arranged to seat at 73, cap 74, a diaphragm 76, and compression spring 78, and is held securely in place in the adapter section by screws 80, gasket 81, and packing 82.

Fuel under pressure is received from the control unit through conduit 32, whence it flows into the annular fuel chamber 84 and through ports 85 into the chamber 86, where its pressure is exerted upon diaphragm 76 to cause valve 72 to move off its seat against the action of the compression spring 78 and thereby allows the fuel to flow through passageways 88, 89 and 90 and to discharge through the orifices 92 into the air flowing through the induction passage 10. Nozzle cap 74 can be vented through the passageway 94 to either the atmosphere as shown, or to venturi suction or air scoop pressure to control the fuel delivery pressure characteristic as fully explained in Mock-Partington application, Serial Number 243,067 filed November 30, 1938. In place of the specific discharge bar and nozzle disclosed herein, any of the nozzle arrangements disclosed in the above mentioned application may be used.

The acceleration pump 31 (see Figure 4) comprises three chambers—an inner chamber 102, an intermediate chamber divided into two portions 104, 106 by a web 130, and an outer chamber 108. Chamber 108 is separated from the intermediate chamber by a diaphragm 110 which has its outer edge clamped between the pump body sections 112 and 114, and its center portion apertured and secured between the diaphragm cup member 116 and a plate 117 by the nut 118 cooperating with the threaded bolt-like extension of the spring retaining cup 120. The diaphragm 110 is formed with an annular groove as indicated at 122 so as to provide a relatively large stroke-diameter ratio for the diaphragm. A passageway 124 connects the chamber 108 with the air conduit 10 at a point posterior to the throttle. The suction transmitted through said passageway urges diaphragm 110 to the left, in opposition to a compression spring 126, against an adjustable stop 128 which is locked in place by the locking nut 129.

The body member 114 is provided with an inwardly extending radial flange or web 130 having a relatively large central aperture 132 and arranged to contact the plate 117 to limit movement of the diaphragm 110 to the right. The flange 130 is also provided with a plurality of apertures 134 to maintain unrestricted communication between the two positions of the intermediate chamber.

Chamber 102 is separated from the intermediate chamber by a diaphragm 140 which has its outer edge clamped between the pump body sec-

tion 114 and a pump boss 142 on the adapter section 28 and its central portion apertured and secured between a washer 144 and a flat headed bolt 146. A bifurcated cylindrical cup 148 is welded or riveted to the head of bolt 146 and is adapted to engage an annular groove in a cylindrical cap 150 which is riveted to the end of the pump valve 152. Lateral clearance as well as a slight amount of endwise or axial clearance is provided between the bifurcated cup 148 and the groove of cap 150 to permit a free but limited lateral movement of the valve 152 relative to the diaphragm after assembly, for purpose of self-alignment.

The diaphragm 140 can be of the flat or unformed type since its stroke need only be sufficient to move the valve 152 a small distance from the seat 154 in the pump nozzle body 156.

The pump nozzle body is threaded into the adapter section 28 at 157 and is provided with a shoulder 158 cooperating with a step in the nozzle cap 160 to securely hold said cap against a shoulder 162 in the adapter section. Gaskets 164 and 165 at shoulders 158 and 162 prevent any passage of fuel from the chamber 102 into the conduit 10 except by way of the valve 152 and seat 154. Apertures 166 and 168 in the pump nozzle body 156 afford unrestricted communication between the chamber 102 and the pump valve and seat.

The nozzle cap 160 is provided with one or more orifices 170 which can be varied in size or number and location to respectively control the rate and direction of the acceleration pump fuel delivery.

A compression spring 172 urges the valve 152 and attached diaphragm 140 to the left against the valve seat 154. An extension 174 from the end of the valve contacts the inner surface of the nozzle cap 160 to limit the opening movement of the valve.

Chamber 102 is connected to chamber 104 by passageway 180 and to a source of fuel by passageways 182 and 184. A restriction 186 in passageway 180 may be varied in size or completely eliminated to control the pump characteristics as hereinafter explained. The passageway 184 may lead to a source of metered fuel such as the metered fuel chamber 39 of the control unit or the main discharge nozzle supply conduit 32, as shown in Figure 2; or may lead to a source of unmetered fuel such as the unmetered fuel chamber 40 of the control unit or the discharge conduit 57 of the engine driven fuel pump 55, as depicted in Figure 7. The principle of operation with each of these arrangements is explained immediately hereinafter.

Operation with fuel supply from metered fuel

Assume that the engine is operating at relatively light load with a partially closed throttle. The diaphragm 110 will be urged to the left, in opposition to the spring 126, against the stop 128 by vacuum transmitted to the chamber 108 from the mixture conduit 10 posterior to the throttle acting on one side of diaphragm 110 and by the pressure of the fuel in chamber 106 acting on the other side of the diaphragm. Chambers 102, 104 and 106 are filled with fuel under a pressure equal to that of the fuel in the metered fuel chamber 39 or main discharge nozzle conduit 32. Since the pressures acting on opposite sides of diaphragm 140 are equal, the pump valve 152 will be held in a closed position by the spring 172.

When the throttle is suddenly opened the vacuum in chamber 108 is destroyed and spring 126 urges diaphragm 110 to the right, thereby forcing fuel from the chamber 106 through the restriction 186 and passageway 180. A pressure is thus created in chamber 104 in excess of that existing in chamber 102. This difference in pressure on opposite sides of diaphragm 140 urges the diaphragm to the right and opens the pump discharge valve 152. Since the fuel in chamber 102 is under a pressure at least equivalent to that in the main fuel nozzle conduit, fuel will issue as a jet from the pump discharge orifices 170. After the fuel displaced by diaphragm 110 has been forced through orifice 186 a condition of pressure equilibrium will be re-established across the diaphragm 140, and the valve 152 will close.

If the throttle is now partially or completely closed, a high vacuum will obtain in the conduit 10 posterior to the throttle and hence in chamber 108, which will draw the diaphragm 110 against the stop 128 and refill chamber 106 with fuel drawn from the conduit 32. Since the fuel flowing from the control unit into conduit 32 is metered in proportion to the air flowing through the air conduit, any fuel flow into the acceleration pump results in a decreased quantity discharged from the main fuel nozzle and hence in a deficiency of gasoline discharged into the air stream. The rate of "fuel robbing," that is the rate of refilling the pump chamber, can be controlled by varying the size of restriction 186 or by using a restriction in the passageway 182; the majority of engines, however, will continue to operate and no ill effects are noticed from the "fuel robbing" action following a closing of the throttle even though the restrictions are omitted.

If the pump orifices 170 have a combined area which is relatively large as compared to the discharge orifice of the main fuel nozzle, the pressure in chamber 102 will decrease upon opening of the valve 152 to a value less than the normal fuel nozzle discharge pressure and part of the metered fuel which would normally be discharged into the air stream from the main fuel nozzle is diverted during periods of acceleration and discharged through the pump discharge nozzle. Conversely, by making the pump orifices small and/or increasing the strength of the pump spring 172 a part of the fuel displaced by the pump diaphragm 110 can be forced to discharge through the main discharge nozzle.

It is apparent that by proper adjustment of the size of orifices 170, pump spring 172, and restriction 186, the total quantity of fuel delivered to the air stream during the active period of pump operation can be apportioned as desired between the main fuel nozzle and the pump nozzle. It is also apparent that the discharge period of the pump can be lengthened or shortened by making the restriction 186 smaller or larger so as to vary the time required to re-establish an equilibrium of pressure across the diaphragm 140.

These particular features are desirable when using a fuel discharge bar of the type shown in Figure 3. This type of bar tends to run practically empty of fuel during periods of operation when the vacuum posterior to the throttle is high and full of fuel when the vacuum is low. A portion of the metered fuel supply is therefore used for filling the bar upon a transfer from a condition of high vacuum operation to one of low vacuum operation, as is experienced in any

period of acceleration. With the acceleration pump just described a portion of the pump charge can be diverted to the discharge bar to aid in this filling operation. The bar also acts as a reservoir which continues to supply fuel to the air conduit during the robbing period which accompanies a transfer back to a high vacuum operating condition.

It should be noted that with the pump fuel supply from metered fuel as just described, the total quantity of fuel delivered to the intake conduit during the acceleration period is that quantity which would normally be supplied by the main control unit, together with the quantity displaced by the diaphragm **110**.

Operation with fuel supply from unmetered fuel

If the acceleration pump supply conduit **184** communicates with the unmetered fuel chamber **40**, fuel at unmetered fuel pressure will be delivered to the orifices **170** during the entire period that the valve **152** is opened in response to a differential in pressure across the diaphragm **140**, created as previously explained. The rate of discharge of this acceleration fuel will depend upon the difference in pressure between the fuel pressure in the unmetered chamber and the pressure in the air conduit **10** and the size of the restriction through which the fuel must flow such as orifices **170**. The quantity of extra fuel delivered into conduit **10** by this arrangement will depend not only upon the rate of discharge but also upon the length of time valve **152** remains open. The time available for discharge can be varied by adjustment of the size of restriction **186** since decreasing or increasing said restriction will respectively increase or decrease the time required for pressure equalization across the diaphragm **140**. The quantity of extra fuel for acceleration purposes is therefore not dependent upon the volume displaced by diaphragm **110**, and hence large quantities of acceleration fuel can be handled with but a very small pump structure.

Since the pressure in the unmetered fuel chamber varies with the rate of air and fuel flow, and since the quantity of acceleration fuel delivered into the air conduit depends upon the unmetered fuel pressure, it is apparent that the quantity of acceleration fuel will vary somewhat with the rate of air flow at the time of the acceleration. This variation has been found desirable on certain engines and undesirable on others and may be eliminated if desired by the arrangement of Figure 7 in which the acceleration pump receives fuel from the discharge conduit of a constant pressure fuel supply pump.

A modified form of the invention is shown in Figure 5 in which the reference numerals of Figure 4 with the addition of **200** have been used to designate similar parts.

The pump is composed of the four chambers **302**, **304**, **306** and **308** separated respectively by the diaphragm **340**, a solid web **330**, and the diaphragm **310**. Chamber **308** communicates through passageway **324** with the air conduit posterior to the throttle. A passageway **402** in the web **330** connects chambers **306** and **304** and is provided with a one-way check valve **404** to prevent flow of fuel from chamber **306** to chamber **304** and to permit flow in the reverse direction. Chamber **306** is also connected to chamber **302** by a passageway **406** which may be provided with a restriction **408**. Passageways **382** and **384** connect the chamber **304** with a source of fuel which may either be metered or unmetered fuel as previously explained in connection with Figure 4. A valve **352**, attached to diaphragm **340**, is urged to the right against a seat **354** by the compression spring **372** and controls the passage of fuel from chamber **302** into the air conduit **210**.

Assume that the engine is operating under relatively light load with the throttle in a partially closed position and the acceleration pump fully charged. If the throttle is now suddenly opened, the vacuum in chamber **308** will be destroyed and spring **326** will urge the diaphragm **310** to the right, thereby forcing the fuel from chamber **306**, through passageway **406**, restriction **408** and into chamber **302** where it will increase the pressure on the right side of diaphragm **340** and open the valve **352**, thereby allowing the fuel to discharge into the air conduit.

Check valve **404** prevents any of the fuel displaced from chamber **306** by diaphragm **310** during the pump discharge period from entering the chamber **304**. It is apparent that the additional fuel delivered to the air conduit during the acceleration period, irrespective of whether the fuel source is from metered or unmetered fuel, is merely the volume of fuel displaced by the diaphragm **310**, and the entire quantity is discharged through the pump discharge nozzle. The rate of delivery of the acceleration pump charge can be increased or decreased by respectively increasing or decreasing the size of the restriction **408**.

Upon a subsequent closing of the throttle the diaphragm **310** is drawn to the left by the vacuum transmitted to chamber **308** and fuel is drawn through passageways **384** and **382**, thence through chamber **304** and check valve **404** to refill the chamber **306**. If the acceleration pump fuel supply is from the main nozzle conduit **32**, the check valve may be limited in size to restrict, if necessary, the rate of "fuel robbing."

The modification of Figure 6 is similar to that of Figure 5 except that a calibrated restriction **404'** has been used in place of the check valve **404**. Corresponding parts have therefore been indicated by like reference numerals. In this modification part of the fuel from chamber **306** is forced through passageway **384** to the fuel source and the balance through the pump discharge nozzle. The actual apportioning of the acceleration pump charge between these two available paths of flow can be accomplished by adjustment of the relative sizes of the restrictions **408** and **404'**.

In the description of the several embodiments of the invention, the terms "upward" and "downward" as well as "left" and "right" have been used for convenience, but it will be understood that the control mechanism may be inverted relative to the carburetor, or the control unit and carburetor inverted relative to the engine, or the engine and all its accessories may be inverted (as in acrobatic flight) without greatly affecting the operation as above described.

Although the invention has been described with specific reference to certain embodiments thereof, it should not be inferred that the invention is limited thereto nor otherwise except in accordance with the following claims.

We claim:

1. In a charge forming device for an internal combustion engine, an induction passage, a throttle controlling the same, and an acceleration

pump comprising a pressure chamber connected to said induction passage posterior to the throttle, a fuel chamber separated from the pressure chamber by a diaphragm, a second fuel chamber connected to said first fuel chamber by a passageway and to a source of fuel, a third fuel chamber separated from the second fuel chamber by a diaphragm, a duct connecting said first and third fuel chambers, a conduit connecting said third fuel chamber with the induction passage, and a valve attached to said second diaphragm controlling said conduit.

2. The invention defined in claim 1 together with check valve means in said passageway to prevent fuel flow in the direction of the fuel source upon fuel chamber reducing movement of said first-named diaphragm.

3. In a charge forming device for an internal combustion engine, an induction passage, a throttle controlling said induction passage, and an acceleration pump comprising a pressure chamber connected to said induction passage posterior to the throttle, a fuel chamber separated from the pressure chamber by a diaphragm, a second fuel chamber separated from said first fuel chamber by a diaphragm, said fuel chambers being adapted to contain fuel under superatmospheric pressure, a passageway connecting said fuel chambers, a duct for supplying fuel under superatmospheric pressure to said second fuel chamber, a conduit connecting said second fuel chamber with the induction passage, a valve operably connected to said second diaphragm controlling said last-named conduit, and a spring urging the first named diaphragm in a direction to decrease the volume of the first named fuel chamber whereby a sudden rise in pressure in the pressure chamber will increase the pressure in the first named fuel chamber to thereby urge the second diaphragm in a direction to open the valve.

4. In a charge forming device for an internal combustion engine, an induction passage, a throttle controlling said induction passage, and an acceleration pump comprising a pressure chamber connected to said induction passage posterior to the throttle, a second chamber separated from the pressure chamber by a movable wall and having an outlet, resilient means urging said wall in a direction to decrease the size of the second chamber, a fuel chamber separated from said second chamber by a movable wall and containing fuel under superatmospheric pressure, a passageway connecting said fuel chamber with a source of fuel under pressure, a conduit connecting said fuel chamber with the induction passage, and a valve operably connected to said second-named movable wall controlling said conduit.

5. In a charge forming device for an internal combustion engine, an induction passage, a throttle controlling the induction passage, and an acceleration pump comprising a pressure chamber connected to said induction passage posterior to the throttle, a second chamber separated from the pressure chamber by a movable wall, a second movable wall arranged to be subjected to pressures created in said second chamber, a pump discharge nozzle in the induction passage, a conduit leading from a source of fuel under pressure to said nozzle to supply fuel under superatmospheric pressure thereto, a valve connected to said second movable wall and normally closing said conduit, and spring means urging said first named movable wall in a direction to increase the pressure in said second chamber to thereby open said valve upon a sudden rise in pressure in said pressure chamber.

6. The invention defined in claim 5 together with yielding means urging said valve toward a closed position.

7. In a charge forming device for an internal combustion engine, an induction passage, a throttle controlling the same, and an acceleration pump comprising a pressure chamber connected to said induction passage posterior to the throttle, a fuel chamber separated from said pressure chamber by a movable wall, yielding means urging said movable wall in a direction to decrease the size of said fuel chamber, a second fuel chamber having a movable wall and being closed to atmosphere to be thereby adapted to contain fuel under superatmospheric pressure, a passageway interconnecting said fuel chambers, a conduit connecting one of said fuel chambers with a source of fuel under positive pressure, a duct connecting said second fuel chamber with the induction passage, and valve means attached to said second movable wall to control the flow of fuel through said duct.

8. In a charge forming device, an induction passage, a throttle controlling the same, a source of fuel under pressure, a fuel conduit connecting said source with the induction passage, a second fuel conduit connecting said first fuel conduit at a point at which the fuel pressure is superatmospheric to the induction passage, a valve in said second-named fuel conduit, and means responsive to variations in the pressure in the induction passage posterior to the throttle for temporarily opening said valve to thereby permit fuel under superatmospheric pressure to discharge into the induction passage through said second fuel conduit, said last mentioned means comprising a variable pressure chamber connected to the induction passage posterior to the throttle, a second chamber separated from the pressure chamber by a movable wall capable of relatively large displacements, and a second movable wall capable of relatively small displacements connected to said valve and arranged to be subjected to pressures created in said second chamber for actuating the valve.

9. In a charge forming device, an induction passage, a throttle controlling the same, a fuel nozzle discharging into said induction passage, a pressure responsive valve controlling said nozzle, a fuel conduit connecting a source of fuel under pressure with said fuel nozzle, a second fuel conduit connecting the induction passage with said first-named fuel conduit anterior to said nozzle, a normally closed valve in said second fuel conduit, and means responsive to an increase in the pressure in the induction passage posterior to the throttle for temporarily opening said valve comprising a variable pressure chamber connected to the induction passage posterior to the throttle, a fuel chamber connected to receive fuel from one of said conduits, a movable wall separating said pressure and fuel chambers and capable of relatively large displacements to vary substantially the volume of said fuel chamber, a second fuel chamber forming a portion of said second fuel conduit and having a movable wall connected to the valve, and means effective upon fuel chamber reducing movement of the first movable wall for opening said valve by subjecting the last named movable wall to pressures created in the first named fuel chamber and for transmitting fuel from the first named fuel chamber to the said second fuel conduit.

10. In a charge forming device, an induction passage, a throttle controlling the same, a source of fuel under pressure, a main fuel nozzle discharging in the induction passage, a fuel duct connecting said source with the main fuel nozzle, a fuel regulating means in said duct including a metering restriction, and an acceleration pump comprising a pump discharge nozzle, a conduit connecting said pump discharge nozzle with the fuel duct posterior to the metering restriction, a valve in said conduit, a diaphragm attached to said valve, a variable capacity chamber associated with said conduit and having a movable wall operable in the chamber increasing direction in response to suction in the induction passage posterior to the throttle and spring urged in the chamber reducing direction upon a decrease in said suction, hydraulic means connecting said movable wall and said diaphragm to temporarily open the valve upon chamber reducing movement of the movable wall, and means to apportion between the main fuel nozzle and the pump nozzle the total fuel flowing through the metering restriction during the period said valve is opened.

11. In a charge forming device for an internal combustion engine, an induction passage, a throttle controlling the same, a fuel nozzle discharging into said induction passage, a fuel duct connecting a source of fuel under pressure and the nozzle, regulating means in said duct including a metering restriction, a conduit connecting the induction passage with the duct posterior to the metering restriction, a valve in said conduit, a diaphragm attached to said valve, a variable capacity chamber associated with said conduit having a movable wall operable in a chamber reducing direction upon increase in the pressure in the induction passage posterior to the throttle, and hydraulic means associated with the movable wall and the diaphragm to open said valve during chamber reducing movement of said wall.

12. The invention defined in claim 11 together with means to control the rate of movement of said wall upon an increase in pressure in the induction passage posterior to the throttle thereby to control the time said valve remains in an open position.

13. In a charge forming device having an induction passage, a throttle therein, a fuel duct leading from a source of fuel under pressure to the induction passage posterior to the throttle, and a pressure responsive valve in said duct whereby the fuel in said duct anterior to said valve is maintained under superatmospheric pressure: the combination therewith of an acceleration pump comprising a pressure chamber connected to said induction passage posterior to the throttle, a second chamber separated from the pressure chamber by a movable wall, a second movable wall arranged to be subjected to pressures created in said second chamber, a valve connected to said second movable wall to be actuated thereby, and a fuel conduit controlled by said valve and leading from the fuel duct anterior to said pressure responsive valve to the induction passage posterior to the throttle whereby fuel under superatmospheric pressure will be discharged therefrom into the induction passage upon a sudden rise in pressure in said pressure chamber.

14. In a charge forming device having an induction passage, a throttle therein, a fuel source, a fuel conduit leading from the source and having a pair of branches discharging in the induction passage posterior to the throttle, a control unit including a valve responsive to the rate of air flow through the induction passage for controlling the fuel flow through the conduit, a pressure responsive valve controlling one of said branches, a second valve controlling the other of said branches, and means for actuating said second valve including a pressure chamber connected to the induction passage posterior to the throttle, a second chamber separated from the pressure chamber by a movable wall, and a second movable wall arranged to be subjected to pressures created in said second chamber and connected to said second valve for actuating the same.

15. In a charge forming device for an internal combustion engine having an induction passage, a throttle therein, a main fuel nozzle discharging in said induction passage posterior to the throttle, and a control unit responsive to the rate of air flow through the induction passage for supplying fuel under superatmospheric pressure to said nozzle comprising a fuel conduit having a metering restriction therein, unmetered and metered fuel chambers in communication with the conduit respectively anterior and posterior to the metering restriction, a fuel control valve, and movable wall means in said chambers for actuating said valve: in combination therewith of an acceleration pump including a fuel duct leading from said fuel conduit at a point a which the fuel pressure is superatmospheric to the induction passage, a valve in said duct, and means responsive to a sudden increase in the pressure in the induction passage posterior to the throttle for temporarily opening said valve.

16. In a charge forming device having an induction passage, a throttle therein, a fuel nozzle discharging fuel into the induction passage, a source of fuel, a fuel conduit connecting said source and the nozzle and having a metering restriction, and a control unit for controlling the flow of fuel to said nozzle in response to the air flow through the induction passage and to the fuel flow through the metering restriction: in combination therewith of an acceleration pump comprising a pressure chamber connected to said induction passage posterior to the throttle, a fuel chamber separated from said pressure chamber by a movable wall, yielding means urging said wall in a direction to decrease the size of the fuel chamber, a second fuel chamber having a movable wall, a passageway interconnecting said fuel chambers, a fuel passage connecting one of said fuel chambers with the fuel conduit posterior to the metering restriction, a duct connecting the second fuel chamber with the induction passage, and valve means attached to the second movable wall to control the flow of fuel through said duct.

17. The invention defined in claim 16 comprising in addition a one-way check valve in said fuel passage.

18. In a charge forming device, an induction passage, a throttle controlling the same, and an acceleration pump comprising a pressure chamber connected to the induction passage posterior to the throttle, a fuel chamber separated from the pressure chamber by a movable wall, a second fuel chamber having a movable wall adapted to be subjected to pressures created in said first fuel chamber, a fuel conduit including at least one of said fuel chambers for conducting fuel under positive pressure from a source to an outlet in the induction passage, and a valve closely adjacent said outlet for controlling the flow of fuel therefrom, said valve being connected to the sec-

ond named movable wall to be actuated thereby.

19. The invention defined in claim 18 comprising in addition a check valve in said fuel conduit.

20. The invention defined in claim 18 comprising in addition a pair of restrictions in said fuel conduit respectively anterior and posterior to a fuel chamber included thereby.

21. In a charge forming device, an induction passage, a throttle controlling the same, a fuel nozzle discharging therein, a fuel pump, a conduit connecting the pump and nozzle, a valve for varying the fuel flow through said conduit, means responsive to the rate of air flow through the induction passage for controlling said valve, a duct connecting the conduit with the induction passage, a valve in said duct, a fuel chamber in the duct having a movable wall connected to the second named valve, a variable pressure chamber connected to the induction passage posterior to the throttle, a second fuel chamber separated from the pressure chamber by a diaphragm, an annular groove in said diaphragm to permit substantial displacements thereof, a spring urging the diaphragm in a direction to decrease the volume of the fuel chamber, and means for supplying fuel to the second fuel chamber from the duct upon fuel chamber increasing movement of the diaphragm and for transmitting fuel from the second to the first fuel chamber upon fuel chamber decreasing movement of the diaphragm and for transmitting pressures created in the first fuel chamber to the movable wall for opening the said second valve upon fuel chamber decreasing movement of the diaphragm.

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