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CARBURETOR

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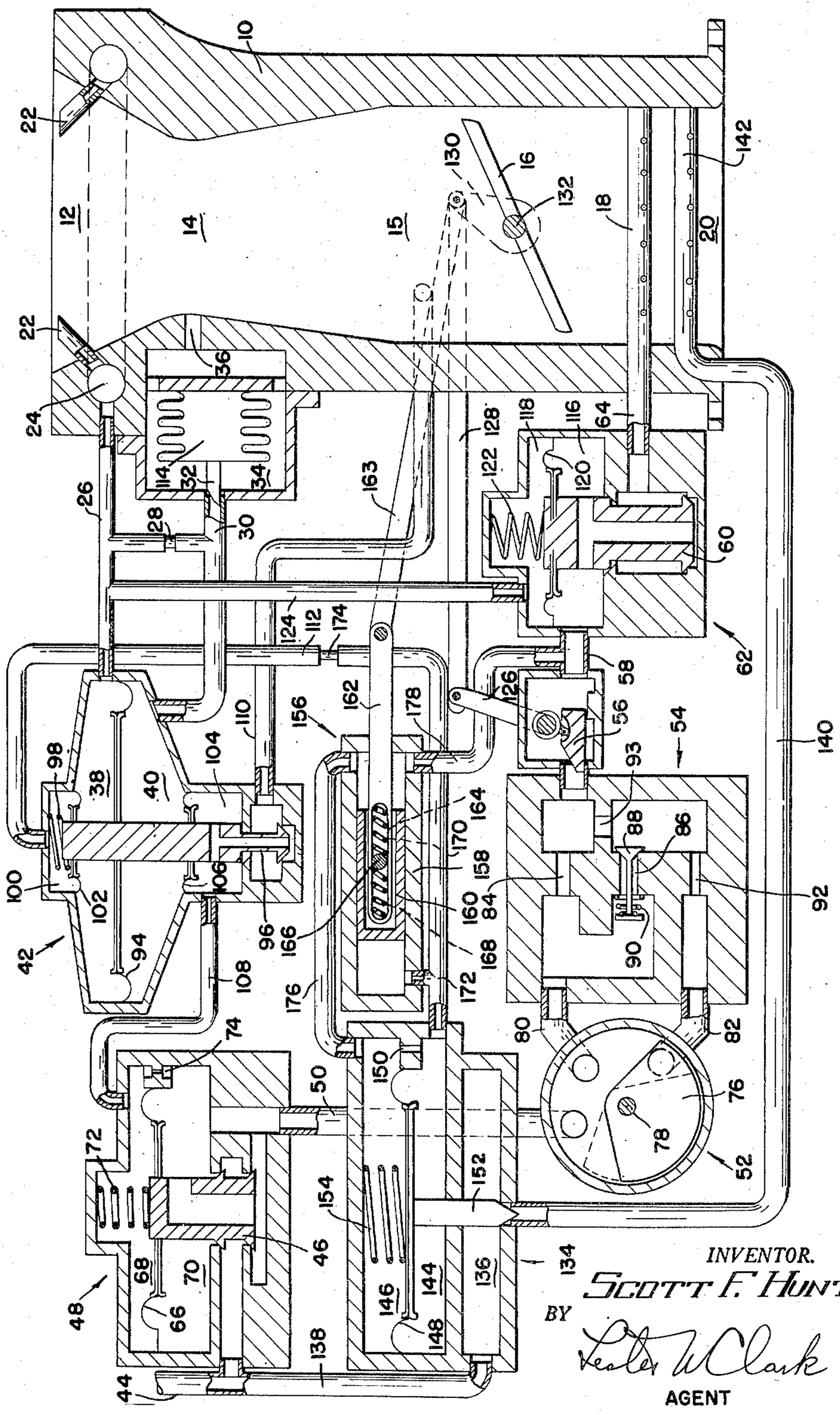

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CARBURETOR

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This invention relates to a carburetor for an internal combustion engine and particularly to means for operating such a carburetor so as to provide improved acceleration characteristics of the engine.

It has previously been proposed to provide, in a carburetor for an internal combustion engine, a device responsive to the air pressure in the air induction system at a point downstream from the throttle and effective upon an increase in such pressure, such as accompanies a sudden opening movement of the throttle, to inject into the air stream an additional supply of fuel so as to rapidly accelerate the engine. Examples of such devices are shown and described in my co-pending application for Carburetors, Serial No. 491,096, filed June 17, 1943, and matured into Patent No. 2,442,046, issued May 25, 1948.

With devices dependent for their action upon variations in air pressure there is an unavoidable small time lag between the movement of the throttle and the resultant increased or decreased pressure, and there is a further small time lag unavoidably incident to the transmission of the increased or decreased pressure to the devices which are used to deliver increased or decreased amounts of fuel. Furthermore, the variations in air pressure are not necessarily exactly commensurate with the rate of movement of the throttle and there may be indeterminate variations in the increased or decreased pressures.

The principal object of the present invention is to avoid the before-mentioned and other objections which are sometimes encountered when entire dependence is placed on changes in air pressure, without however sacrificing the advantages incident to prior mechanisms. The said principal object of the invention is attained by providing a means which is mechanically connected to operate in unison with the throttle and which serves in conjunction with associated elements to provide a fuel flow thru a secondary fuel conduit, or fuel flow at an increased or decreased rate thru the main fuel conduit, the said means being operable only upon sudden movement of the throttle. The said means on account of its mechanical connection with the throttle is free from any time lag and is entirely positive and determinate in its action.

A still further object of the invention is to provide a single means operable with the throttle, whether mechanically connected therewith or otherwise, and serving upon sudden opening movement of the throttle to provide a fuel flow thru a secondary fuel conduit and to also provide

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increased fuel flow thru the main fuel conduit, the said means preferably also serving upon sudden closing movement of the throttle to provide decreased fuel flow thru the main fuel conduit.

A further object of the invention is to provide certain improved features of construction and arrangement of parts which serve to effectively enable the throttle operated device to accomplish the desired results.

Other objects and advantages of the present invention will become apparent from a consideration of the appended specification, claims and drawing which shows a somewhat diagrammatic illustration of an internal combustion engine carburetor embodying the principles of my invention.

Referring to the drawing, there is shown a body 10 of a carburetor for an aircraft type internal combustion engine. Air enters the curburetor body 10 at an inlet 12 and flows thru a Venturi restriction 14 and a passage 15, past a throttle 16 and a fuel discharge nozzle 18 to an outlet 20. A supercharger may be provided between the outlet 20 and the intake manifold of the engine. In certain cases the supercharger may be upstream from the inlet 12, or two superchargers may be used, one in each place.

The Venturi restriction 14 produces a pressure differential between the inlet 12 and the throat of the restriction which varies substantially in accordance with the square of the velocity of the air passing thru the restriction. Since the cross-sectional area of the venturi is constant, this pressure differential may be taken as a measure of the volume of air flowing thru the passage per unit time. In order to obtain a pressure differential varying as a function of the mass of air per unit time flowing thru the venturi 14, the pressure differential between the entrance 12 and the throat of venturi 14 is utilized to create an air flow thru a secondary air passage extending from entrance 12 to the throat of venturi 14. A plurality of impact tubes 22 is provided, whose open ends project into the entrance 12 to receive the impact of the entering air. The secondary air passage may be traced from entrance 12, thru tubes 22, a passage 24 interconnecting the impact tubes, a conduit 26, a conduit having a restriction at 28, a conduit 30, a restriction controlled by a valve 32, a chamber 34 and a passage 36 in the body 10 to the throat of the venturi 14. The conduits 26 and 30 are connected respectively with chambers 38 and 40 in a pressure meter indicated generally at 42.

The fuel enters the carburetor from a fuel pump or other source of fuel under superatmospheric pressure. It flows thru a conduit 44, a valve 46 in a pressure regulator generally indicated at 48, a conduit 50, a mixture control unit generally indicated at 52, a jet system 54, past an idle valve 56, thru a conduit 58, a valve 60 in a second pressure regulator 62, and a conduit 64 to the fuel discharge nozzle 18. These several conduits and connections will be referred to collectively as the "main fuel conduit."

The pressure regulator 48 includes a diaphragm 66 separating a pair of expansible chambers 68 and 70 and connected at its center to the valve 46. A spring 72 biases the valve 46 toward open position. A restriction 74 connects the chambers 68 and 70. The position of valve 46 is determined by the balance between the pressure in chamber 70 acting on the diaphragm 66 in the valve closing direction and the spring 72 plus the pressure in chamber 68 acting on the diaphragm 66 in the valve opening direction. If the balance between these forces is upset, the diaphragm 66 and valve 46 move until the balance is restored.

The mixture control unit 52 includes a disc valve 76 fixed on a shaft 78. The disc valve 76 controls the flow of fuel thru ports opening into conduits 80 and 82 which lead into the jet system 54. When the disc 76 is in the position illustrated in full lines in the drawing, fuel can flow to the jet system only thru the conduit 80. This full line position of the disc valve 76 is known as the "lean" position of the mixture control 52. When the disc valve 76 is in the dotted line position shown in the drawing, the fuel can flow thru both the conduits 80 and 82. The dotted line position of disc valve 76 is termed the "rich" position of the mixture control. The disc valve 76 can also be moved to a "cutoff" position wherein it cuts off the flow thru both conduits 80 and 82.

The conduit 80 conducts fuel either thru a fixed restriction or jet 84, or thru a restriction 86 controlled by an enrichment valve 88 biased to closed position by a spring 90. The conduit 82 conducts fuel to a fixed restriction 92. Fuel flowing thru the restrictions 86 and 92 also flows thru another restriction 93 which limits the total flow thru restrictions 86 and 92. The valve 88 is normally closed, but opens at high pressure differentials across the jet system to increase the fuel-to-air ratio under heavy load conditions.

The pressure meter 42 has a diaphragm 94 separating the chamber 38 and 40, this diaphragm being connected with a valve 96. A spring 98 biases the valve 96 for movement in the closing direction. The meter 42 also has a chamber 100 separated from the chamber 38 by a diaphragm 102, and a chamber 104 separated from the chamber 40 by a diaphragm 106. The diaphragms 102 and 106 are operably connected with the valve 96. The chamber 104 is connected by a conduit 108 with the chamber 68 of the pressure regulator 48, and the downstream side of the valve 96 is connected by a drain conduit 110 with the main air passage 15. The connection of drain conduit 110 with the main air passage 15 is shown by way of example only. It may alternatively be connected to the fuel tank or to any point having a relatively low, substantially constant pressure. The chamber 100 is connected by a conduit 112 with the conduit 58 at the downstream side of the jet device 54. The last-mentioned connection is indirect and extends thru devices to be described. The pressure in the chamber 104 is the same as that in chamber 68 of pressure regulator 48, and the pressure in chamber 100 may be the same as that in the fuel line downstream from the jet system. The position of valve 96 is determined by the balance between the differential of the pressures in the chambers 38 and 40 plus the spring 98 acting in the valve closing direction and the differential of the pressures in the chambers 104 and 100 acting in the valve opening direction.

A portion of the fuel entering pressure regulator 48 flows thru chamber 70, restriction 74, chamber 68, conduit 108, chamber 104 in the pressure meter 30, past the valve 96, and thru drain conduit 110. The pressure in chamber 68 is a measure of the pressure in chamber 70, which is substantially the same as the pressure on the upstream side of the jet system 54. For any given constant cross-sectional area of the fuel passages thru the mixture control device 52 and the jet system 54, the pressure differential across them is a measure of the fuel flow thru them. Increased cross-sectional area thru the mixture control device and the jet system reduces the pressure in chamber 70, thus changing the balance of pressures on the diaphragm 66 and permitting the valve 46 to move in opening direction and increase the fuel supply. Conversely, decreased cross-sectional area increases the pressure in chamber 70 and causes the valve 46 to move in closing direction.

The valve 46 is further controlled by varying the pressure in the chamber 68 by means of the pressure meter 42 and devices associated therewith. As already explained, the valve 96 of the pressure meter 30 is positioned in accordance with the balance between two forces, one of which tends to close the valve and varies in accordance with the mass of air entering the carburetor, and the other of which tends to open the valve and varies in accordance with the mass of fuel flowing thru the carburetor. It will be apparent that increased air flow in the main air conduit tends to move the valve 96 in the closing direction, thus increasing the pressure in chamber 68 and moving the valve 46 in the opening direction. The resultant increased fuel flow increases the pressure differential between the chambers 104 and 100, thus tending to move the valve 96 in the opening direction. These two opposing tendencies establish a balance. Similar, but reversed, results follow from a decreased air flow.

The before-mentioned valve 32 in the secondary air passage constitutes a second restriction therein, the first restriction being at 28. It will be clear that closing or partial closing of this valve increases the pressure drop at that point, and correspondingly decreases the pressure drop at the restriction 28. Decrease of the pressure drop at 28 decreases the pressure differential on the diaphragm 94 and tends to move the valve 96 in the opening direction, and to thus decrease the fuel flow in the manner already described. Similarly, movement of the valve 32 in the opening direction increases the fuel flow. The valve 32 therefore serves as a means for regulating the fuel flow supplementally to the regulation effected by variations in air velocity. The valve 32 is connected with a bellows 114 filled with a fluid having a substantial coefficient of thermal expansion. Increased temperature or decreased pressure in the chamber 24 causes

the bellows to expand and move the valve 32 in the closing direction, thus decreasing the rate of fuel supply. Decreased temperature or increased pressure in the chamber 34 causes the bellows to collapse and move the valve 32 in the opening direction, thus increasing the rate of fuel supply.

The pressure regulator 62 operates to maintain a substantially constant pressure on the downstream side of the jet system 54 and thereby to prevent variations in pressure at the fuel discharge nozzle 18, which may be due to operation of the throttle or to variations in engine speed, from reaching the downstream side of the jet system and affecting the fuel flow. The pressure regulator 62 includes a pair of expansible chambers 116 and 118 separated by a flexible diaphragm 120, which is attached at its center to the valve 60. A spring 122 biases the valve 60 toward closed position. The chamber 118 is connected thru a conduit 124 to the conduit 26 and thence thru the passage 24 and impact tubes 22 to the air entrance 12. The chamber 116 is connected to the conduit 58.

At low air flows, such as are encountered under idling conditions, the pressure differential set up by the venturi 14 tends to be erratic, and is not a reliable indication of the volume of air entering the engine. Provision is made to control the fuel flow directly in accordance with the throttle position at such times. The spring 98 in the pressure meter 42 acts on valve 96 in the closing direction. When the differential pressure acting on diaphragm 94 is small, as under low air flow conditions, the spring 98 becomes the predominating force acting on valve 96. A closing movement of valve 96 causes an increase in the fuel flow thru the main fuel line, since the closure of valve 96 increases the pressure in chamber 104 of pressure meter 42 and thence in chamber 68 of pressure regulator 48. Furthermore, the spring 72 of pressure regulator 48 biases valve 48 in an opening or fuel flow increasing direction.

The idle valve 56 is pivotally attached to a lever 126, whose opposite end is connected by a link 128 to an arm 130 fixed on the shaft 132 of throttle 16. The idle valve is normally wide open when the throttle is beyond a range of positions near its closed position, usually termed the idling range. As the throttle moves into the idling range, thereby decreasing the air flow, the idle valve 56 moves toward closed position. At the same time, the springs 98 and 72 cause operation of valve 46 in an opening direction. The valve 46 is thereby opened sufficiently so that its restrictive effect on the fuel flow is less than that of the idle valve 56. Therefore the fuel flow under idling conditions is controlled primarily by the valve 56 in accordance with the position of the throttle, and not by the pressure meter 42 in accordance with the mass of air entering the engine.

While I have illustrated a particular type of carburetor, it will be appreciated by those skilled in the art that my invention may be applied with equal facility to other types of carburetors. The carburetor illustrated may, for example, be modified by omitting the pressure regulator 48 and placing the valve 96 of the fuel meter 42 directly in the fuel line between the pump and the mixture control 52. This would require that the valve 96 be reversed so that it would open in a downward direction and close in an upward direction, the same as the present valve 46.

Upon opening of the throttle 16, the pressure meter 42 and the devices associated therewith, operating as already described, serve to increase the rate of fuel supply so as to maintain the same fuel-to-air ratio, but when there is a sudden opening of the throttle, such as accompanies a sudden acceleration of the engine, the said pressure meter and associated devices, as heretofore described, may act too slowly, with the result that the fuel-to-air ratio is seriously reduced during the period of acceleration. Similar, but opposite, conditions result from a sudden closing of the throttle, such as accompanies a sudden deceleration of the engine. To meet this condition, means have been provided, as illustrated for instance in my said co-pending application, for utilizing the suddenly increased or decreased air pressure in the main air conduit to cause an increased or decreased quantity of fuel to be delivered during a limited period of time. In accordance with the present invention, similar results are obtained without depending upon changes in air pressure but by means mechanically operable in accordance with the throttle movement.

The aforesaid means mechanically operable in accordance with the throttle movement, can be widely varied as to details but, by way of example, I have shown a valve unit 134 having a chamber 136 connected with the fuel conduit 44 by means of a conduit 138. A conduit 140 leads from the chamber 136 to a supplemental discharge nozzle 142 in the main air passage. The valve unit 134 also has chambers 144 and 146 separated by a flexible diaphragm 148 and connected by a restriction 150. Operably connected with the diaphragm 148 is a valve 152 which normally closes the conduit 140 and which is biased toward its closed position by means of a coil spring 154 in the chamber 146, the valve being normally closed. The conduit 138, the chamber 136 and the conduit 140 will be referred to collectively as the "secondary fuel conduit."

For operating the valve unit 134, I provide a pressure unit in the form of an accelerating pump, generally indicated at 156. The pump comprises a cylinder 158 with a plunger 160 movable therein. The plunger 160 is connected to be operated in unison with the throttle 16 and as shown there is a rod 162 extending thru the right end of cylinder 158 and connected to a link 163 which is in turn connected to the arm 130 attached to the shaft 132 of throttle 16. A pin 166 carried by the plunger 160 extends into a slot in the rod 162 and is engaged by opposed coil springs 168 and 170 carried in the slot which tend to center the pin 166 therein.

The left end of the cylinder 158 is connected by conduit 172 with the chamber 144 of the valve unit 134 and is also connected with the before-mentioned conduit 112 thru a restriction 174. The right end of the cylinder 158 is connected by a conduit 176 with the chamber 146 of the valve unit 134 and is also connected by a conduit 178 with the before-mentioned conduit 58 at the downstream side of the idle valve. The connection from the chamber 100 of the pressure meter 42 may be traced thru the conduit 112, the restriction 174, the conduit 172, the chamber 144, the restriction 150, the chamber 146, the conduit 176, the right end of the cylinder 158 and the conduit 178 to the conduit 58. Thus when there is no movement of the plunger 160 the pressure in the chamber 100 is the same as the pressure at the downstream side of the idle valve.

When the throttle 16 is moved suddenly in the opening direction the plunger 160 is moved suddenly toward the left, thus forcing fuel thru the conduit 172 into the chamber 144 and withdrawing fuel thru the conduit 176 from chamber 146. This causes the diaphragm 148 to move upward to open the valve 152 and permit fuel to flow thru the conduit 140 to the supplemental discharge nozzle 142 and effect a "boosting" action. The increased pressure in the chamber 144 will be dissipated thru the restriction 150, but by making this restriction of a suitable size the valve 152 can be kept open for any required length of time to permit the engine to fully accelerate before the supplemental supply of fuel is cut off. As soon as the pressures in the chambers 144 and 146 are equalized, the valve 152 is closed by the spring 154.

Sudden movement of the plunger 160 toward the left also forces some of the fuel thru the restriction 174 and the conduit 112 into the chamber 100 of the pressure meter 42, thus increasing the pressure in that chamber. This increased pressure disturbs the balance theretofore existing in the pressure meter, and the valve 96 is moved in the downward or closing direction. This increases the pressure in the chamber 104 and correspondingly increases the pressure in the chamber 68 of the pressure regulator 48, thus moving the valve 46 in the opening direction and increasing the rate of flow of fuel thru the main fuel conduit and effecting an additional "boosting" action. This increased pressure in the chamber 100 is maintained so long as there is increased pressure in the chamber 144 of the valve unit 134. When this increased pressure in the chamber 144 is dissipated thru the restriction 150, the pressure in the chamber 100 is correspondingly reduced and the valve 96 is permitted to move to the position determined by the new balance of pressures established by the increased air flow resulting from the increased throttle opening. From the foregoing description it will be apparent that the connections for varying the pressure in the chamber 100 constitute supplemental fluid operated means for operating the pressure regulator 48 additionally to the normal operation thereof, the said normal operation being in accordance with variations in air pressure differential.

From the foregoing description it will be apparent that the sudden opening of the throttle and corresponding sudden movement of the plunger 160 toward the left serves not only to open the secondary fuel conduit to permit to pass therethru, but also to increase the rate of flow of fuel thru the main fuel conduit.

When the throttle 16 is moved suddenly in the closing direction the plunger 160 is moved toward the right, but the spring 168 is compressed and the plunger movement may be relatively slow. Some of the fuel in the right end of the cylinder passes thru the conduit 176 into the chamber 146, but the valve 152 is not moved inasmuch as it is already closed. At the same time some of the fuel passes thru the conduit 178 into the conduit 58. The quantity of fuel so delivered into conduit 58 is so small, however, compared with the amount regularly flowing thru conduit 58, that its effect on the operation of the engine is not appreciable. Fuel is simultaneously withdrawn thru the conduit 172 from the chamber 144 and is also withdrawn thru the restriction 174 and the conduit 112 from the chamber 100. Withdrawal of fuel from the chamber 100 decreases the pressure therein, and this decreased pressure disturbs the balance theretofore existing in the pressure meter and the valve 96 is moved in the upward or opening direction. This decreases the pressure in the chamber 104 and correspondingly decreases the pressure in the chamber 68 of the pressure regulator 48, thus moving the valve 46 in the closing direction and decreasing the rate of flow of fuel thru the main fuel conduit and effecting a "robbing" action.

It will be clear that fuel can flow into the left end of the cylinder only at the rate permitted by the rectrictions 150 and 174. By properly determining the sizes of these restrictions the rate of movement of the plunger 160 under the influence of the spring 168 can be predetermined, with the result that the before-mentioned decreased pressure in the chamber 100 can be maintained for a period of time sufficient to permit the engine to fully decelerate before the rate of fuel flow is increased to that determined by the new balance of pressures in the pressure meter established by the decreased air flow resulting from the decreased throttle opening.

When the throttle is moved slowly in the opening direction or in the closing direction, the plunger 160 is moved slowly, and the restriction 150 maintains an equalized pressure in the chambers 144 and 146. The valve 152 remains closed and there is no change of pressure in the chamber 100.

It has been made clear that upon a sudden opening movement of the throttle a single means, that is the pump 156, serves in association with other parts to cause fuel flow thru the secondary fuel conduit and also to cause increased fuel flow thru the main fuel conduit, and that this same means upon a sudden closing movement of the throttle serves to cause decreased fuel flow thru the main fuel conduit. It is therefore to be understood that when a single means serves as sated, the invention is not necessarily limited to a mechanical connection between such means and the throttle, it being only necessary that the means be operable when the throttle is suddenly moved whether as the result of mechanical connection or otherwise.

While I have shown and described a certain preferred embodiment of my invention, other modifications thereof will readily occur to those skilled in the art, and I therefore intend my invention to be limited only by the appended claims.

I claim as my invention:

1. A fuel supply system for an internal combustion engine, comprising a passage including a venturi therein for air flowing to said engine for combustion purposes, a throttle for controlling the flow of air thru the passage, a source of fuel under pressure, a main fuel conduit connected with the fuel source and serving to supply fuel to the engine, means controlled by variations in air pressure differential at the venturi for varying the rate of fuel supply thru the main fuel conduit in accordance with variations in the rate of air flow, a secondary fuel conduit connected with the fuel source and adapted to upply fuel to the engine, two chambers connected by a restriction and separated by a flexible diaphragm, a valve operably connected with the diaphragm and biased to normally close the secondary fuel conduit, a pressure unit comprising a cylinder and a plunger therein mechanically connected to be moved with the throttle upon movement

thereof in the opening direction, and two conduits connecting the end portions of the cylinder with the respective chambers whereby movement of the plunger corresponding to throttle movement in the opening direction serves to force liquid into one chamber and to withdraw liquid from the other chamber and to thereby tend to move the disphragm in the valve opening direction, the dissipation of liquid thru the restriction permitting the spring to hold the valve closed when the throttle and plunger are moved slowly but the valve being opened in opposition to the spring when the throttle and plunger are moved suddenly.

2. The combination in a fuel supply system for an internal combustion engine, a passage including a venturi thereon for air flowing to said engine for combustion purposes, a throttle for controlling the flow of air thru the passage, a fuel conduit serving to supply fuel to the engine and having a jet system therein, a pressure regulator including a valve for controlling the flow of fuel thru the fuel conduit, a pressure meter having two chambers separated by a flexible diaphragm and connected to apply to the diaphragm pressures varying with the air pressure differential at the venturi, the pressure meter also having a first fuel containing chamber which is unrestrictedly connected with the pressure regulator and in which the pressure is varied by a pressure controlled valve so that pressure variations in the said chamber operate the pressure regulator and the said pressure meter also having a second fuel containing chamber connected with the fuel conduit at the low pressure side of the jet system, and a device hydraulically connected in series between said second chamber and the low pressure side of said jet system, and mechanically connected for operation in unison with the throttle, and serving upon sudden movement of the throttle to change the pressure in said second chamber of the pressure meter and thereby move the pressure meter valve so as to operate the pressure regulator and thereby temporarily change the rate of fuel supply.

3. A fuel supply system for an internal combustion engine, comprising a main fuel conduit, a secondary fuel conduit connected in parallel with said main conduit, first and second valves for controlling the flow of fuel thru said main and secondary conduits respectively, operating means for each said valve, each operating means including an expansible chamber having a movable wall connected to its associated valve and adapted to move said valve in a direction to increase the fuel flow thru its associated conduit in response to an increase in pressure in said chamber, a throttle for controlling the flow of combustion air to said engine, a pump operable to discharge fluid upon a opening movement of the throttle, fluid pressure connections between the pump outlet and said chambers, and a pressure relief passage from each of said chambers including a fixed restriction, said passages being effective to relieve pressures due to slow opening movements of said throttle, said pump being effective upon a rapid opening movement of said throttle to increase the pressures in said chambers and thereby cause an opening movement of both said valves for a predetermined time.

4. A fuel supply system for an internal combustion engine, comprising a main fuel conduit, a secondary fuel conduit connected in parallel with said main conduit, first and second valves for

controlling the flow of fuel thru said main and secondary conduits respectively, operating means for each said valve, each operating means including an expansible chamber having a movable wall connected to its associated valve and adapted to move said valve in a direction to increase the fuel flow thru its associated conduit in response to an increase in pressure in said chamber, a throttle for controlling the flow of combustion air to said engine, a pump operable in one direction or the other upon an opening or closing movement of the throttle, connections between the pump and said chambers enabling the pump to increase the pressure in both chambers upon movement in one direction and enabling the pump to decrease the pressure in the chamber for the first valve upon movement in the other direction, and a pressure relief passage for said chambers including a fixed restriction, said passage being effective to avoid pressure changes due to slow opening movements of said pump and said restriction enabling the pump to be effective upon a rapid opening movement of said throttle to increase the pressure in both chambers and thereby cause an opening movement of both said valves for a predetermined time and to be effective upon a rapid closing movement of said throttle to decrease the pressure in the chamber for the first valve and thereby cause a closing movement of said valve for a predetermined time.

5. A fuel supply system for an internal combustion engine, comprising a main fuel conduit, a secondary fuel conduit connected in parallel with said main conduit, first and second valves for controlling the flow of fuel thru said main and secondary conduits respectively, operating means for each said valve, each operating means including an expansible chamber having a movable wall connected to its associated valve and adapted to move said valve in a direction to increase the fuel flow thru its associated conduit in response to an increase in pressure in said chamber, a throttle for controlling the flow of combustion air to said engine, a pump mechanically connected with said throttle to move in unison therewith so as to discharge fluid upon an opening movement thereof, fluid pressure connections between the pump outlet and said chambers, and a pressure relief passage from each of said chambers including a fixed restriction, said passages being effective to relieve pressures due to slow opening movements of said throttle, said pump being effective upon a rapid opening movement of said throttle to increase the pressures in said chambers and thereby cause an opening movement of both said valves for a predetermined time.

6. A fuel supply system for an internal combustion engine, comprising a main fuel conduit, a metering restriction in said main fuel conduit, first valve means for controlling the flow of fuel thru said main conduit, means for operating said first valve means under all conditions of engine operation including an expansible chamber having a movable wall connected to said valve means and fluid pressure means connecting said chamber and said main fuel conduit on the downstream side of said metering restriction, said valve operating means being effective upon an increase in the pressure in said chamber to move said valve means in a fuel flow increasing direction, a secondary fuel conduit connected in parallel with said main conduit, second valve means for controlling the flow of fuel thru said secondary conduit, operating means for said second valve means

including a second expansible chamber having a movable wall connected to said second valve means and adapted to move said second valve means in a fuel flow increasing direction in response to an increase in pressure in said second chamber, means biasing said second valve means to closed position, a throttle for controlling the flow of combustion air to said engine, a pump operable to discharge fluid upon an opening movement of the throttle, fluid pressure means connecting the pump outlet with both of said chambers, and a pressure relief passage for said chambers including a fixed restriction, said passage being effective to relieve pressures produced by said pump upon slow opening movements of said throttle, said pump being effective upon a rapid opening movement of said throttle to increase the pressure in both said chambers and thereby to cause an additional opening movement of said first valve means and to open said second valve means for a predetermined time.

7. A fuel supply system for an internal combustion engine, comprising a main fuel conduit, a metering restriction in said main fuel conduit, first valve means for controlling the flow of fuel thru said main conduit, means for operating said first valve means under all conditions of engine operation including an expansible chamber having a movable wall connected to said valve means and fluid pressure means connecting said chamber and said main fuel conduit on the downstream side of said metering restriction, said valve operating means being effective upon an increase in the pressure in said chamber to move said valve means in a fuel flow increasing direction, a secondary fuel conduit connected in parallel with said main conduit, second valve means for controlling the flow of fuel thru said secondary conduit, operating means for said second valve means including a second expansible chamber having a movable wall connected to said second valve means and adapted to move said second valve means in a fuel flow increasing direction in response to an increase in pressure in said second chamber, means biasing said second valve means to closed position, a throttle for controlling the flow of combustion air to said engine, a pump mechanically connected to said throttle to move in unison therewith so as to discharge fluid upon an opening movement thereof, fluid pressure means, connecting the pump outlet with both of said chambers, and a pressure relief passage for said chambers including a fixed restriction, said passage being effective to relieve pressures produced by said pump upon slow opening movements of said throttle, said pump being effective upon a rapid opening movement of said throttle to increase the pressure in both said chambers and thereby to cause an additional opening movement of said first valve means and to open said second valve means for a predetermined time.

8. In a fuel supply system for an internal combustion engine, the combination of a passage including a venturi therein for air flowing to said engine for combustion purposes, a throttle for controlling the flow of air thru the passage, a source of fuel under pressure, a secondary fuel conduit connected with the fuel source and adapted to supply fuel to the engine, a normally closed valve in the secondary fuel conduit, a main fuel conduit connected with the fuel source and serving to supply fuel to the engine, a pressure regulator including a valve for controlling the flow of fuel thru the main fuel conduit, a pressure meter, separate from said pressure regulator, controlled by variations in air pressure differential at the venturi, for normally controlling the operation of the pressure regulator to vary the rate of fuel supply thru the main fuel conduit in accordance with variations in the rate of air flow, supplemental means for operating the pressure regulator so as to temporarily increase the rate of fuel supply to the engine, said supplemental means including said pressure meter and a fluid displacement device mechanically connected to the throttle and operating in unison therewith for opening the valve in the secondary fuel conduit and also serving upon sudden opening of the throttle to cause said pressure regulator to temporarily increase the rate of fuel supply thru the main fuel conduit.

9. In a fuel supply system for an internal combustion engine, the combination of a passage including a venturi therein for air flowing to said engine for combustion purposes, a throttle for controlling the flow of air thru the passage, a source of fuel under pressure, a secondary fuel conduit connected with the fuel source and adapted to supply fuel to the engine, a valve operating unit comprising two chambers connected by a restriction and separated by a flexible diaphragm, a valve operably connected with the diaphragm and biased to normally close the secondary fuel conduit, a main fuel conduit connected with the fuel source and serving to supply fuel to the engine, a pressure regulator including a valve for controlling the flow of fuel thru the main fuel conduit, a pressure meter controlled by variations in air pressure differential at the venturi and normally operating the pressure regulator to vary the rate of fuel supply thru the main fuel conduit in accordance with variations in the rate of air flow, supplemental fluid operated means for operating the pressure regulator additionally to the normal operation thereof, a pump comprising a cylinder and a plunger therein mechanically connected to be moved with the throttle upon movement thereof in the opening direction, two conduits connecting the end portions of the cylinder with the respective chambers of the valve operating unit whereby movement of the plunger serves to force liquid into one chamber and to withdraw liquid from the other chamber and to thereby tend to move the diaphragm in the valve opening direction, and a conduit connecting one end of the cylinder of the pump with the supplemental fluid operated means, whereby the said means operates the pressure regulator so as to temporarily increase the rate of fuel supply thru the main fuel conduit.

10. In a fuel supply system for an internal combustion engine, the combination of a passage including a venturi therein for air flowing to said engine for combustion purposes, a throttle for controlling the flow of air thru the passage, a source of fuel under pressure, a secondary fuel conduit connected with the fuel source and adapted to supply fuel to the engine, a normally closed valve in the secondary fuel conduit, a main fuel conduit connected with the fuel source and serving to supply fuel to the engine, a pressure regulator including a valve for controlling the flow of fuel thru the main fuel conduit, a pressure meter, separate from said pressure regulator, controlled by variations in air pressure differential at the venturi, for normally controlling the operation of the pressure regulator to vary the rate of fuel supply thru the main fuel conduit in accordance with variations in the rate of air flow, supplemental means for operating the

pressure regulator so as to temporarily vary the rate of fuel supply to the engine, said supplemental means including said pressure meter and a fluid displacement device mechanically connected to the throttle and operating in unison therewith for opening the valve in the secondary fuel conduit and also serving upon sudden throttle movement to cause the said pressure regulator to temporarily vary the rate of fuel supply thru the main fuel conduit.

11. In a fuel supply system for an internal combustion engine, the combination of a passage including a venturi therein for air flowing to said engine for combustion purposes, a throttle for controlling the flow of air thru the passage, a source of fuel under pressure, a secondary fuel conduit connected with the fuel source and adapted to supply fuel to the engine, a normally closed valve in the secondary fuel conduit, a main fuel conduit connected with the fuel source and serving to supply fuel to the engine, a pressure regulator including a valve for controlling the flow of fuel thru the main fuel conduit, a pressure meter, separate from said pressure regulator, controlled by variations in air pressure differential at the venturi, for normally controlling the operation of the pressure regulator to vary the rate of fuel supply thru the main fuel conduit in accordance with variations in the rate

of air flow, and a fluid displacement device mechanically connected to the throttle and operating in unison therewith and upon sudden throttle movement in the opening direction serving to open the valve in the secondary fuel conduit and also serving upon sudden throttle movement in the opening direction to cause the pressure meter to operate the pressure regulator so as to temporarily increase the rate of fuel supply thru the main fuel conduit.

SCOTT F. HUNT.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,881,559	Heitger	Oct. 11, 1932
2,025,504	Geiger	Dec. 24, 1935
2,092,685	Viel	Sept. 7, 1937
2,277,930	Mock et al.	Mar. 31, 1942
2,316,300	Udale	Apr. 13, 1943
2,387,271	Kittler et al.	Oct. 23, 1945
2,391,755	Twyman	Dec. 25, 1945

FOREIGN PATENTS

Number	Country	Date
487,176	Great Britain	June 16, 1938