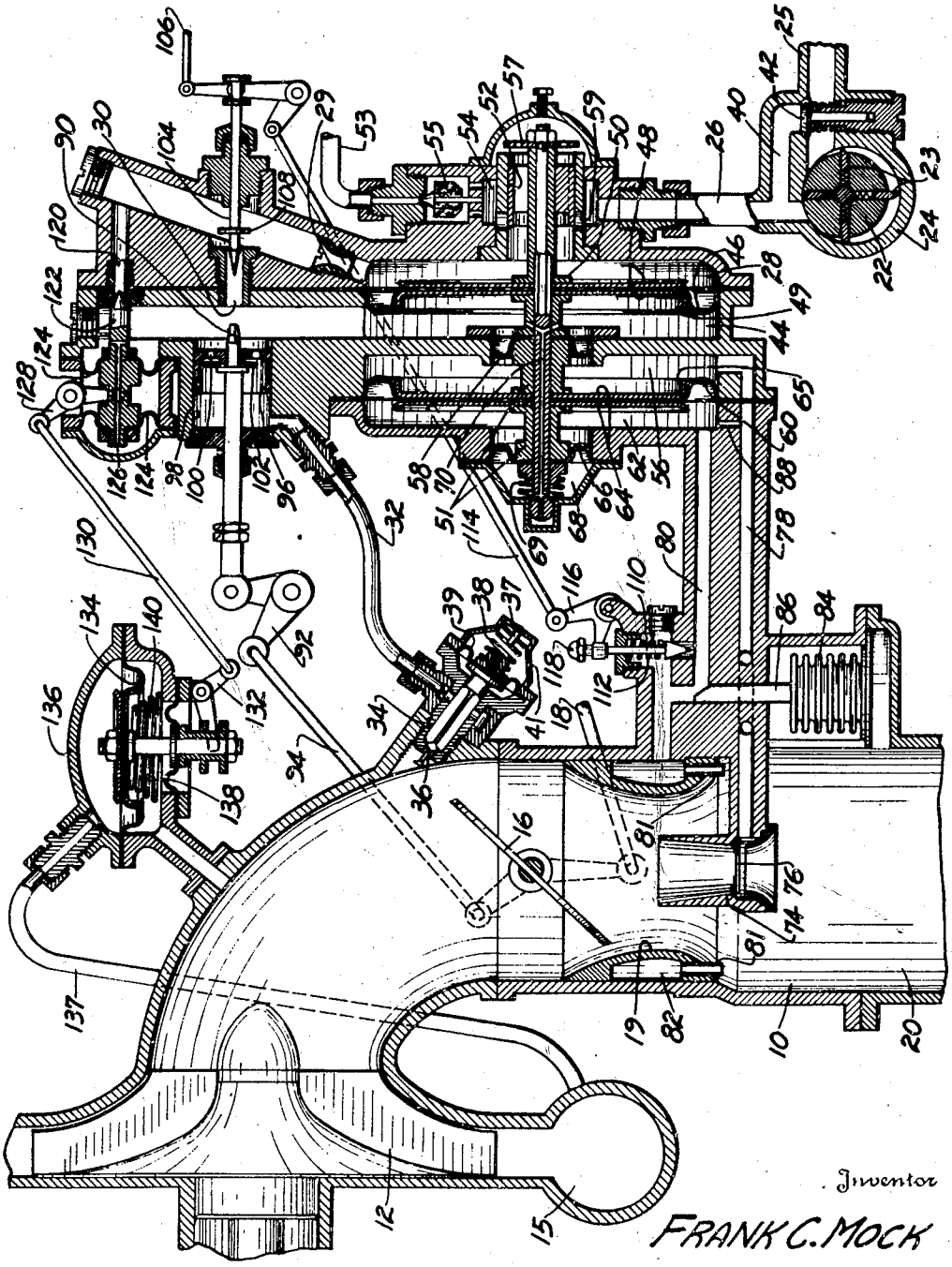
Aug. 17, 1948. F. C. MOCK 2,447,262

CHARGE FORMING DEVICE

Filed Jan. 21, 1948



Inventor

FRANK C. MOCK

By W. A. Gebhardt

Attorney

Patented Aug. 17, 1948

2,447,262

UNITED STATES PATENT OFFICE

2,447,262

CHARGE FORMING DEVICE

Frank C. Mock, South Bend, Ind., assignor to Bendix Aviation Corporation, South Bend, Ind., a corporation of Delaware

Application October 24, 1940, Serial No. 362,572, which is a continuation of application Serial No. 118,718, January 2, 1937. Divided and this application January 21, 1948, Serial No. 3,393

18 Claims. (Cl. 123—119)

1

This invention relates to fuel feeding devices or systems for engines or prime movers and more particularly to devices or systems in which liquid fuel is supplied under positive pressure to a fuel discharge nozzle, burner or the like. The invention is principally concerned with idling systems or low flow fuel control arrangements for fuel feeding devices of the aforesaid pressure type in which the fuel is maintained under positive pressure while being metered. This application is a division of my copending application Serial No. 362,572, filed October 24, 1940, which in turn is a continuation of my copending but now abandoned application Serial Number 118,718, filed January 2, 1937.

One of the principal objects of the invention is to supply the liquid fuel to the nozzle or burner under positive pressure, the fuel supply being regulated to maintain a proper fuel-to-air ratio. This arrangement causes the fuel to be atomized under pressure to produce a better mixture in carburetor or injection type engines, or to produce better combustion in burner type prime movers, and keeps the fuel under atmospheric or superatmospheric pressure at all times thereby eliminating boiling of the fuel and insuring accurate metering.

Another principal object of the invention is to provide an idling system in a pressure type fuel feeding device which is simple and inexpensive, but capable of producing any desired richness characteristic through the idle and low speed range.

A further object of the invention is to provide an idling system having no tendency to form ice which would interfere with idling operation. This is accomplished by injecting the fuel into a warm or hot part of the manifold system or the like, and posterior to the throttle in throttle controlled engines.

Another object is to provide a fuel feeding device or system which will operate properly in any position so that when it is installed on aircraft the engine will be properly supplied with fuel at idle as well as throughout the operating range regardless of the position of flight. This is highly important during maneuvers of different kinds at which time an adequate fuel supply is indispensable. This is particularly desirable at idle, so that when the engine is throttled back during a critical portion of the maneuvers the engine will not tend to stall.

This fuel supply apparatus, while especially applicable to fuel supply regulating systems of the character hereinafter particularly described,

2

is not limited to such use, but is available, with or without modification, in a great variety of cases where fuel is to be supplied under more or less analogous conditions against substantial back pressure; as, for example, that afforded by the spring of an injection valve, or by internal pressure in the vessel or chamber into which the fuel is introduced.

While a principal utility of the invention is in connection with aircraft engines, it is also applicable to engines of other types or to various other devices wherein fluids are to be metered. The characteristics and advantages of the invention are further sufficiently referred to in connection with the following detailed description of the accompanying drawing, which represents one preferred embodiment. After considering this example, skilled persons will understand that many variations may be made without departing from the principles disclosed; and I contemplate the employment of any structures, arrangements, or modes of operation that are properly within the scope of the appended claims.

In the drawing, the single figure is a diagrammatic sectional view of a preferred embodiment of the invention as applied to a carburetor for internal combustion engines.

In this figure, a main air intake conduit 10 leads to a rotary blower or supercharger 12 of an internal combustion engine which may be of any desirable type. The conduit 10 is controlled by a throttle 16 which is operated by a rod 18 extending from the pilot's cockpit. The pilot thus controls directly the air charge of the engine while the fuel charge is automatically controlled by the apparatus hereinafter described in detail. Anterior to the throttle is a venturi 19 of any suitable contour. In some cases a second supercharger may be employed to supply air at higher than atmospheric pressure to the entrance 20 of passage 10, and in such cases the supercharger 12 serves both to step up the pressure and as a fuel mixer and distributor. In other cases the entrance 20 is merely flared and opens in the direction of travel of the craft, so that the inertia of the entering air will build up a pressure above atmospheric at the entrance, which is in such cases usually referred to as a scoop.

An instrumentality such as the blower 12 is not essential to the invention, but is here shown as representing approved practice in aircraft engines, and serves to or assists in atomizing and properly distributing fuel introduced into the air line in the manner presently referred to. The blower discharges into a generally annular cham-

ber 16 from which pipes lead to the intake ports of the various cylinders, as usual in this type of engine.

It is to be understood that the entire air passage between the throttle and the engine intake ports of an internal combustion engine, and the air passage beyond the compressor in burner type engines represents broadly an intake manifold, and the term is to be so construed in this specification.

Any known or suitable fuel pump, capable of delivering fuel under positive pressure, is provided, that shown being of the sliding vane type and comprising a rotor 22 slidably carrying a set of vanes 23 and rotatably mounted in a casing 24.

The casing has a fuel inlet 25, an outlet 26, and a return bypass 40 controlled by a pressure responsive valve 42, so as to maintain a substantially constant outlet fuel pressure, in the known manner. The pump thus delivers fuel to passage 26 thence into the annular fuel chamber 54, through radial ports 59 which are varied in effective area by the movement of sleeve valve member 52, and thence into pressure chamber 28. From chamber 28 the fuel flows through fixed metering orifice 29, an adjustable metering orifice 30, ports 100, and passage 32 to a discharge jet 34 positioned in the conduit 10 posterior to the throttle.

The discharge jet 34 is provided with a valve 36 opening away from the manifold and connected to a flexible diaphragm 39. Fuel pressure entering through the passage 32 acts on the inner face of the diaphragm 39 tending to open the valve 36, and is opposed by a spring 38. A vent 41 to atmosphere is provided in the discharge jet cap to permit free movement of diaphragm 39. Since manifold vacuum is effective on valve stem 36 merely to the extent of its application on an area equivalent to that of the valve orifice, whereas the fuel pressure is effective to the extent of its application on the relatively large area of the diaphragm 39, the fuel discharge pressure is practically unaffected even by large changes in manifold vacuum. The relatively large diaphragm area also enables the valve to change from a nearly closed position to a wide open one (to give low and high rates of fuel discharge) with but a slight change in discharge pressure. This relatively constant pressure feature aids in obtaining accurate metering under variable operating conditions. A fixed stop 37 is preferably provided to limit opening of valve 36 to prevent damage in case of backfire or the like. The discharge jet cap may, if desired, be vented to a source of variable pressure, such as venturi suction, as is more particularly disclosed in Mock and Partington Patent No. 2,310,984, issued February 16, 1943.

A second pressure chamber 44 is positioned adjacent chamber 28 and is separated therefrom by a flexible diaphragm 46 which is preferably of the type having no elastic reaction to stress, comprising a fabric sheet secured at its outer edges and having its central portion secured between a pair of disks 48. The disks 48 are in turn secured to a rod 50 which carries a sleeve valve member 52 which controls the passage of fuel from a peripheral valve chamber 54 to the chamber 28, a suitable perforated disk 57 being provided to limit closing movement of the valve 52. The chamber 54 is preferably connected to the top of the fuel tank, not shown, by a pipe 53 controlled by a float valve 55 to vent back to the tank any air or vapor present in the fuel supplied by the pump.

Adjacent the chamber 44 is a chamber 56, separated therefrom by a small diaphragm 58. A second large diaphragm 60 separates chamber 56 from another chamber 62, and rod 50 is connected to the disks 64 of this diaphragm in the same manner as to those of diaphragm 46. A second small diaphragm 66 is secured to the end of rod 50 and separates the chamber 62 from a chamber 68 positioned adjacent thereto. A small spring 69 urges the rod 50 in a direction to open valve 52 for a purpose hereinafter described. In order to balance out the pressure effects of diaphragms 58 and 66, chambers 44 and 68 are interconnected by a pressure equalizing passage 70 formed in the rod 50.

The rod 50 carries enlarged cylindrical hub members 51 adjacent the diaphragms 58 and 66 of substantially the same diameter as the flat central portions of the diaphragms on the low pressure sides thereof. The diaphragms are formed with annular grooves as shown, the sides of which lie respectively against the members 51 and outer circular confining walls. Due to this construction the grooves in the diaphragms maintain substantially the same effective radius as the rod 50 moves so that the effective areas thereof remain constant regardless of movement of the rod 50. The same construction is preferably followed in connection with the diaphragms 46 and 60 by providing circular flanges 49 and 65 on the planes 48 and 64 respectively. This is an important feature since it enables the diaphragms always to exert the same force in response to equal pressures regardless of the deflection of the diaphragms.

A small venturi 74 is positioned in the intake conduit 10 concentrically with the venturi 19 and is formed with an annular opening 76 substantially at its throat which is connected through a passage 78 with chamber 56. A similar passage 80 leads from chamber 62 to an annular chamber 82 formed in the venturi 19 and communicating with the inlet end of the conduit 10 through a series of tubes 81 so as to be subject to the pressure of the incoming air. The tubes 81 project out a substantial distance so that any rain or the like washing up the walls of the air conduit 10 will flow around them and will not enter the chamber 82. The passage 80 is controlled by an altimeter or aneroid 84, shown as a corrugated bellows which carries a valve member 86 which tends to open passage 80 at high barometric pressures (as at ground or sea level) and to close the same at low pressures (as at high altitudes). A calibrated passage 88 connects the lower portion of the chamber 62 to the passage 78 and serves as a drain for any moisture collected in the chamber 62. Passage 88 also serves to draw air from chamber 62 and passage 80 into passage 78 so as to lower the pressure in chamber 62 and reduce the pressure differential acting on diaphragm 60, so as to decrease the richness of the mixture, whenever valve 86 is in a position where it restricts the passage 80, as it will be at all times when the vehicle is at such altitude as to make an altitude correction desirable. The bellows 84 preferably contains some air or other gaseous medium so that it will be responsive to changes in both temperature and pressure, the amount of temperature response being controlled by the amount of gas within the bellows at the time it is sealed.

The passage 30 is preferably controlled by a

valve 90 which is connected through a bell crank 92 and link 94 to the throttle valve 16 to be operated thereby. The valve 90 is so arranged as to throttle the flow of fuel through the passage 30 when the throttle valve 16 is closed to or near the idling position and to open the passage 30 fully as the throttle valve 16 is opened beyond idling position. The valve 90 carries a piston 96 slidably fitting in a cylinder 98 and formed with ports 100 for passage of fuel. A valve disk 102 is slidably mounted on the valve in a position to close the ports 100 so that when the throttle valve 16 is opened suddenly the piston 96 and cylinder 98 form a fuel pump to increase temporarily the flow of fuel to provide a rich mixture for acceleration. When the throttle valve 16 is stationary or is moved slowly the pressure of fuel moves the valve disk 102 to the position shown to uncover the ports 100.

The orifice 30 may further be controlled by a plunger 104 controlled manually from the pilot's seat through a linkage 106 to provide either a rich or lean mixture. When the end of the plunger 104 is projecting into the port 30 as shown the flow of fuel is restricted and a lean mixture results. To obtain a richer mixture the pilot may operate linkage 106 to withdraw the plunger 104 completely from the port 30 to leave it unrestricted. Preferably the plunger 104 carries a disk 108 adapted to close the port 30 completely so that the pilot can cut off the fuel supply at will in case of emergency or when the engine is to be stopped.

A further manual control is provided by a valve 110 in the passage 80 urged onto its seat by a spring 112 and connected to the linkage 106 by a link 114. The link 114 is pivoted to one end of a bell crank lever 116, the other end of which is slidable on the stem of the valve 110 and is adapted to engage a nut 118 on the end thereof. This arrangement provides a lost motion connection so that the plunger 104 can be operated as described above without affecting the valve 110. However, if the linkage 106 is pulled back to its extreme limit the valve 110 will be opened to admit air at intake pressure to the chamber 62 thereby opening the valve 52 further and increasing the richness of the mixture regardless of the position of valve 86.

In order to provide an enriched mixture under certain conditions of operation, a fuel bypass 120 controlled by a valve 122 is provided around the orifice 30, the valve 122 being controlled by barometric pressure, manifold pressure, and pressure at the supercharger outlet. A pair of diaphragms 124 is connected to the valve 122 to provide a leak-proof packing therefor and the valve is drilled at 126 to connect the outside surfaces of the diaphragms 124 to balance the pressure thereon. The valve 122 is connected to one end of a bell crank lever 128 whose other end is connected through a link 130 with one end of a lever 132, the opposite end of which is connected to a diaphragm 134. A casing 136 encloses the diaphragm 134 and is connected on one side to the air conduit 10 anterior to the supercharger 12 and on its other side through a conduit 137 to the manifold posterior to the supercharger. The casing 136 is closed by a diaphragm 138 and a spring 140 is provided to urge the diaphragm up in a direction to close the valve 122. The diaphragm 138 is exposed on one side to atmosphere and on its other side to the pressure in conduit 10 posterior to the throttle to modify the action of the diaphragm 134, the degree of modification being controlled by the relative sizes of the two diaphragms. As the quantity of air supplied to the engine increases, the pressure rise through the supercharger increases thereby increasing the differential pressure across diaphragm 134, and when this differential pressure reaches a predetermined value, the valve 122 opens to enrich the mixture as is desired under the relatively high power output then obtaining.

The operation of the apparatus thus far described is as follows:

Operation at sea level

In normal operation with the engine running and driving the pump 22 and supercharger 12, fuel is pumped into the chamber 28 past the valve 52 and through ports 29 and 30 into the chamber 44. Fuel flowing through the port 30 also passes through the openings 100 in piston 96 and through the pipe 32 to be sprayed into the manifold by the jet 34. Since the pressure variations in chamber 44 are maintained within narrow limits the pressure in chamber 28 will always be higher by an amount equal to the drop through orifice 29 and passage 30, excessive pressure in chamber 28 tending to close valve 52 and deficient pressure therein tending to open this valve. Thus the pressure differential acting on the diaphragm 46 is always a governing function of the flow through orifice 30 regardless of the discharge pressure, which may be high or low depending upon the setting of the jet 34.

Air flowing through the venturi 74 creates a depression at 76 which is transmitted through the passage 78 to the chamber 56. At the same time, due to the fact that the bellows 84 is contracted at sea level to open the valve 86, pressure of the incoming air will be communicated to the chamber 62 through the tubes 81, chamber 82 and passage 80. Thus there will be a pressure differential acting on the diaphragm 60 tending to open the valve 52 in a degree which is proportional to the rate of flow of air through the conduit 10 and venturi 74. Due to the relatively small size of the passage 88 it has substantially no effect when the valve 86 is open so the pressure relationship described is not materially affected by it.

With the system in equilibrium, the differential of pressure on the diaphragm 60, which is a function of the rate of air flow through the device, is balanced by the differential of pressure on the diaphragm 46, which is a function of the rate of fuel flow through the device. If now the pressure of fuel delivered by the pump 22 is increased, as by erratic operation of valve 42, the pressure in chamber 28 will tend to increase, which will cause valve 52 to move toward closed position and restore the pressure in the chamber to its original value. If the engine speed is decreased, by a change in the propeller pitch or from any other cause, the rate of air flow through venturi 74 decreases, decreasing the depression at 76 and chamber 56, causing valve 52 to move toward closed position and slightly decreasing the pressures in chamber 44, tube 32 and at nozzle 36. Valve 34 adjusts itself to the decreased pressure by moving toward closed position, with the result that the rate of fuel discharge is decreased to compensate for the decreased rate of air flow which initiated the adjustment. If the operator moves the throttle toward open position, other factors being constant, the engine speed will increase, increasing the depression at Venturi throat 76 and increasing the fuel flow accordingly. The

device thus operates to provide the desired fuel-air ratio at sea level under widely differing conditions of fuel pressure, engine speed, and throttle opening.

Due to the fact that the bellows 84 is responsive to temperature changes, it will expand slightly at high temperatures moving the valve 86 to a position to restrict the passage 80 to an extent dependent upon the temperature. As the passage 80 is restricted the effect of the passage 88 becomes more important and tends to reduce the pressure in the chamber 62, thereby reducing the pressure differential across the diaphragm 60. Consequently the fuel flow will be slightly reduced to provide a leaner mixture as the air density decreases due to rise in temperature.

Idling

When the throttle valve 16 is moved to substantially closed position for idling, the air flow and consequently the suction in venturi 74 drops. As a consequence the pressure differential across diaphragm 60 drops and valve 52 moves toward its closed position under the influence of the decreased pressure differential across the diaphragm 60. At this time the effect of the spring 69 becomes important to urge the rod 50 to the right, thereby requiring a greater pressure differential across the diaphragm 46 to balance it. The increment of force added by spring 69 tending to open valve 52 is relatively small, but it results in a substantial percentage increase in the valve opening force, when added to the relatively small force created by the differential air pressure across diaphragm 60. This results in increased fuel flow and a richer mixture for idling, without materially disturbing the richness at high air flows when the small spring force is negligible in comparison with the relatively large air flow force created by the high differential pressure then obtaining across diaphragm 60. In order to insure better control, ease of adjustment and more accurate metering at the low pressures and low flow velocities involved during idling, it has been found desirable to design the spring to give an excessively rich idle and then utilize the valve 90 connected to the throttle to be moved into the passage 30 when the throttle is closed to meter the fuel at this point. The valve 90 can be given any desired configuration to provide the desired rate of fuel flow at closed or substantially closed throttle. Of course, during normal operation the valve 90 occupies substantially the position shown and does not affect the fuel flow.

Operation of the economizer

When maximum possible power is required as in taking off or for emergency operation of other kinds the pilot opens the throttle to deliver mixture to the engine at high pressure. During this time it is desirable to increase the richness of the mixture considerably and for this purpose the diaphragm 134 will be depressed by the increased supercharger outlet pressure to open the valve 122. At this time the passage 120 conducts additional fuel around the passage 30 to increase the flow to the discharge jet 34 and increase the richness of the mixture. This emergency operation is ordinarily maintained for only a few minutes at a time to avoid overworking of and damage to the engine and as soon as the throttle is returned to cruising position the pressure on top of diaphragm 134 drops permitting it to rise under the influence of the spring 140 to again close the valve 122.

Operation of the plunger 104

When the engine is in operation and conditions are favorable, as when flying under good weather conditions and light load, the pilot may desire to reduce the richness of the mixture to conserve fuel. For this purpose he may operate the linkage 106 to move the plunger 104 more or less into the passage 30 to restrict the same. The rate of fuel flow is thereby restricted to lean the mixture.

Some operators desire to be able to regulate richness of the mixture during emergency operation when the valve 122 is open while others prefer that the richness of the mixture at this time shall be automatically regulated independently of the control of the pilot. Either of these conditions can be obtained as desired by inclusion or exclusion of the orifice 29 or by properly proportioning the size of this orifice. For example, if the combined area of passage 120 and passage 30 with plunger 104 in the lean position is greater than that of orifice 29, orifice 29 functions as the primary restriction to fuel flow at full power, operation of the plunger 104 then having substantially no effect on the fuel flow. On the other hand, if the restriction formed by the orifice 29 is omitted or the orifice is made larger than the combined areas of passages 120 and 30, fuel flow is metered by these two passages and the pilot, through plunger 104, may control the mixture both during normal and emergency operation.

Operation at higher altitudes

As the craft rises the atmospheric pressure drops and the bellows 84 expands, moving valve 86 toward its closed position. This restricts passage 80 and tends to cause equalization of pressure between chambers 56 and 62 due to the passage 88 so that the valve 52 will be moved toward its closed position to lean the mixture. It will be noted that the effective cross-sectional area of passage 80 as limited by valve 86 is varied in accordance with changes either in the temperature or pressure of the air acting on the bellows 84. In case a supercharger is used to supply air to the conduit 10 the bellows 84 is responsive to supercharger pressure and maintains the mixture at the correct value.

It will be understood that many changes might be made in form and arrangement of parts and it is not intended that the scope of the invention shall be limited to the forms shown and described, nor otherwise than by the terms of the appended claims.

I claim:

1. A device for supplying fuel to an internal combustion engine comprising an engine-driven fuel pump, a connection from said pump to the engine to supply fuel thereto, regulating means responsive to pressures variable in accordance with changes in the rate of flow of air to the engine to control the supply of fuel by said connection, a throttle valve to control the supply of air to the engine, and a valve in said connection connected to said throttle valve to control the supply of fuel therethrough when the throttle valve approaches closed position.

2. A device for supplying fuel to an internal combustion engine comprising an engine-driven fuel pump, a connection from the pump to the engine to supply fuel thereto, a valve in the connection responsive to pressures varying in accordance with changes in the rate of flow of air to the engine to control the supply of fuel by said connection, orifice means in said connection, a throttle valve for controlling the supply of air to

the engine, a valve connected to said throttle valve and variably restricting said connection when the throttle valve approaches closed position, and manual means for varying the effective area of said orifice means at will to vary the richness of the fuel-air mixture.

3. A device for controlling the supply of fuel to an engine comprising a connection for supplying fuel to the engine, regulating means responsive to pressures variable in accordance with changes in the rates of flow of air and fuel to the engine to control the supply of fuel by said connection, a throttle valve to control the supply of air to the engine, and means actuated by the throttle and effective during only a portion of the throttle operating range for controlling the fuel flow through the connection.

4. A device for controlling the supply of fuel to a throttle controlled engine comprising a connection for supplying fuel to the engine, diaphragm means responsive to the differential of pressures at spaced points in the connection for controlling the quantity of fuel supplied through the connection, and a throttle controlled valve in the connection between the said spaced points for varying the ratio between the differential in the pressures at the said spaced points effective on the diaphragm means and the quantity of fuel being supplied to the engine.

5. In a fuel control system for an internal combustion engine having an air supply duct, a throttle in the duct, means in the duct for creating a differential in the pressures at spaced points in the duct, a fuel conduit for supplying fuel to the engine, means in the conduit for creating a differential in the pressures at spaced points in the conduit, air and fuel chambers connected to said spaced points, movable walls in said chambers, means controlled by said walls for controlling the flow of fuel to the engine, and a throttle controlled valve in the conduit between the spaced points in the conduit for varying the ratio between the differential in the pressures at the spaced points and the quantity of fuel being supplied to the engine.

6. A device for controlling the supply of fuel to an engine comprising an air conduit, a fuel conduit for supplying fuel to the engine, and means for controlling the fuel supply including a valve, means responsive to pressures varying in accordance with the rate of fuel flow for urging said valve in a direction to decrease the fuel supply, means responsive to pressures varying in accordance with the rate of air flow to the engine for urging said valve in a direction to increase the fuel supply and yielding means resisting movement of the valve in the first mentioned direction to thereby increase the fuel flow at idle and richen the mixture.

7. A device for controlling the supply of fuel to an engine comprising a connection for supplying fuel to the engine, a control element for controlling the fuel supplied through the connection, means for creating a force varying in accordance with variations in the rate of fuel flow for urging said element in a direction to decrease the fuel supply, means for creating a force varying in accordance with variations in the rate of air flow to the engine for urging said element in a direction to increase the fuel supply, and means for applying an extraneous force to said control element to thereby modify the ratio of fuel and air supplied to the engine.

8. A device for controlling the supply of fuel to an engine comprising a throttle controlled air conduit, a venturi in the conduit, a connection for supplying fuel to the engine, a control element for controlling the flow through said connection, and means for controlling said element including a plurality of diaphragms subjected to the pressures at spaced points in said connection and at the venturi, and yielding means for influencing the control of said element.

9. Invention defined in claim 8 comprising in addition a throttle controlled valve in said connection between said spaced points.

10. A charge forming device for an internal combustion engine comprising a throttle controlled air conduit, a venturi therein anterior to the throttle, a source of fuel, a connection from said source to the conduit, a metering element in the connection, a valve for controlling the flow through the connection, a plurality of diaphragms for controlling said valve, means for subjecting the faces of said diaphragms to pressures in the connection on opposite sides of the metering element and at the venturi, and a spring for influencing the control of said valve.

11. A device for controlling the supply of fuel to an engine comprising a connection for supplying fuel to the engine, a valve in the connection responsive to pressures variable in accordance with changes in the rate of flow of air to the engine to control the supply of fuel by said connection, yielding means for urging said valve toward open position, a throttle valve to control the supply of air to the engine, and means actuated by the throttle to control the supply of fuel through the connection only when the throttle valve approaches closed position.

12. A device for supplying fuel to an internal combustion engine comprising an air passage, a venturi in said passage, a connection for supplying fuel from a source to the engine, a metering restriction in said connection, a valve in the connection anterior to the metering restriction, a second valve in the connection posterior to the metering restriction, diaphragm means connected to said first named valve, means for subjecting said diaphragm means to fuel pressures anterior and posterior to the metering restriction and to a pressure derived from the venturi, yielding means urging the first named valve toward open position and yielding means urging the said second valve toward closed position.

13. A charge forming device for an internal combustion engine comprising an air passage, a throttle therein for controlling the air supply to the engine, a differential pressure creating means in the passage anterior to the throttle, an engine-driven fuel pump, a duct for supplying fuel from the pump to the passage posterior to the throttle, a metering element in the duct, a fuel valve anterior to the metering element for controlling the fuel flow to the engine, a pair of diaphragms connected to said valve, means for subjecting said diaphragms to pressures derived from the differential pressure creating means and from the fuel duct anterior to the metering element, a second fuel valve posterior to the metering element, a diaphragm connected to the second fuel valve and subjected to the pressure of the fuel in the duct posterior to the metering element, a spring urging the first named fuel valve in a direction to increase the fuel flow to the engine, and a spring urging the second fuel valve in a direction to decrease the fuel flow to the engine.

14. A device for supplying fuel to an engine comprising an air conduit, a venturi therein, a fuel pump, a connection from said pump to the

air conduit, a valve in said connection, a metering restriction in the connection, diaphragms connected to said valve to operate it, means for transmitting air pressure from the venturi to one of said diaphragms, said pressure acting in a direction to close the valve, means for transmitting fuel pressure for the connection anterior to the metering restriction to one of said diaphargms, said fuel pressure tending to close the valve, a second valve in the connection posterior to the metering restriction and responsive to the pressure of the fuel in the connection posterior to the metering restriction, a spring urging the first named valve in a direction to open the valve, and a second spring urging the second valve in a direction to close the second valve.

15. In a device for controlling the supply of fuel to an engine, a main power control member for controlling the engine power output, a fuel conduit for supplying fuel to the engine, a valve in the conduit for controlling the fuel flow therethrough, means for urging said valve toward closed position with a force varying with variations in the differential of pressures at spaced points in said conduit, and a valve in the conduit between said spaced points actuated by the said member for varying the effective area of the conduit as the member approaches its engine idling setting.

16. In a device for controlling the supply of fuel to an engine, a fuel conduit for supplying fuel to the engine, a valve in the conduit for controlling the fuel flow therethrough, fuel metering means in the conduit, means for urging said valve toward closed position with a force varying with variations in the differential of the pressures in said conduit anterior and posterior to the fuel metering means, means for urging said valve toward open position with a force varying in response to variations in an engine condition, and a spring creating a substantially constant increment of force tending to open said valve.

17. In a device for controlling the supply of fuel to an engine, a fuel conduit for supplying fuel to the engine, a throttle controlled air passage for

supplying air to the engine, a valve in the conduit for controlling the fuel supply, means responsive to the differential in the pressures at spaced points in the conduit for urging said valve in a direction to decrease the fuel supply, means responsive to pressures varying in accordance with variations in the air supply to the engine for urging said valve in a direction to increase the fuel supply, yielding means urging the valve in a direction to increase the fuel flow at idle to richen the mixture, and a throttle controlled valve for increasingly restricting the conduit between said spaced points as the throttle approaches its idling setting for reducing the idle enrichment caused by said spring.

18. In a fuel feeding system for an engine, a first conduit for supplying combustion air to said engine, means associated with said conduit for producing two unequal pressures whose difference is a measure of the rate of flow of air through said conduit, a throttle for controlling the flow of air through said conduit, means for supplying fuel to the engine including a second conduit, a metering restriction in said second conduit for producing a differential pressure indicative of the quantity of fuel flow therethrough, means responsive to the difference between said air differential pressure and said fuel differential pressure for controlling the fuel supplied to the engine, and means controlled by said throttle for varying the supply of fuel to the engine during idling.

FRANK C. MOCK.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
644,406	Crawford	Feb. 27, 1900
2,004,869	Hogg	June 11, 1935
2,136,959	Winfield	Nov. 15, 1938
2,165,447	Browne	July 11, 1938

Certificate of Correction

Patent No. 2,447,262. August 17, 1948.

FRANK C. MOCK

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Column 4, line 33, for the word "planes" read *plates*; column 11, line 7, for "pressure for" read *pressure from*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 16th day of November, A. D. 1948.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.