Dec. 24, 1935. M. G. CHANDLER 2,025,091

FUEL FEEDING MEANS FOR INTERNAL COMBUSTION ENGINES

Filed Oct. 25, 1929 2 Sheets-Sheet 1

Fig. 1.

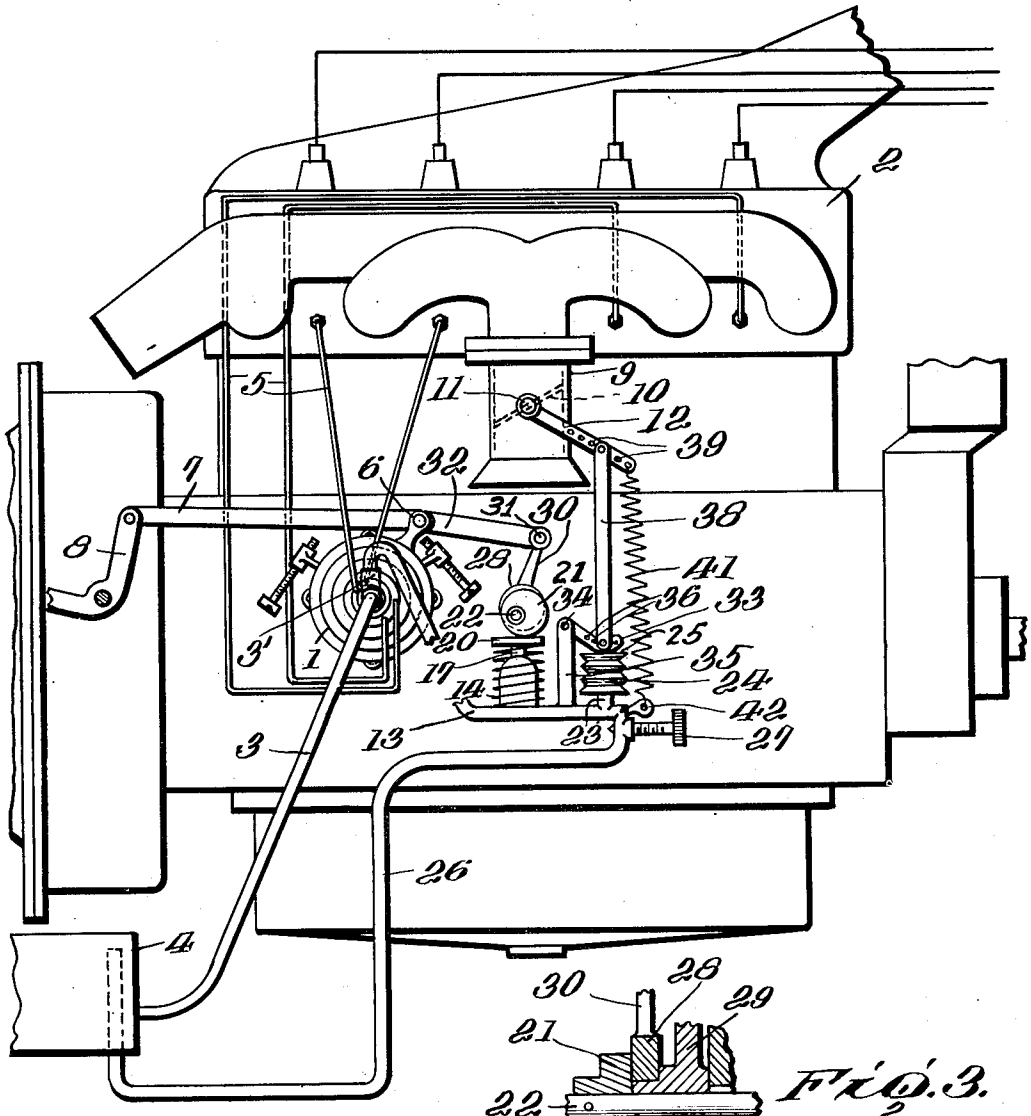


Fig. 3.

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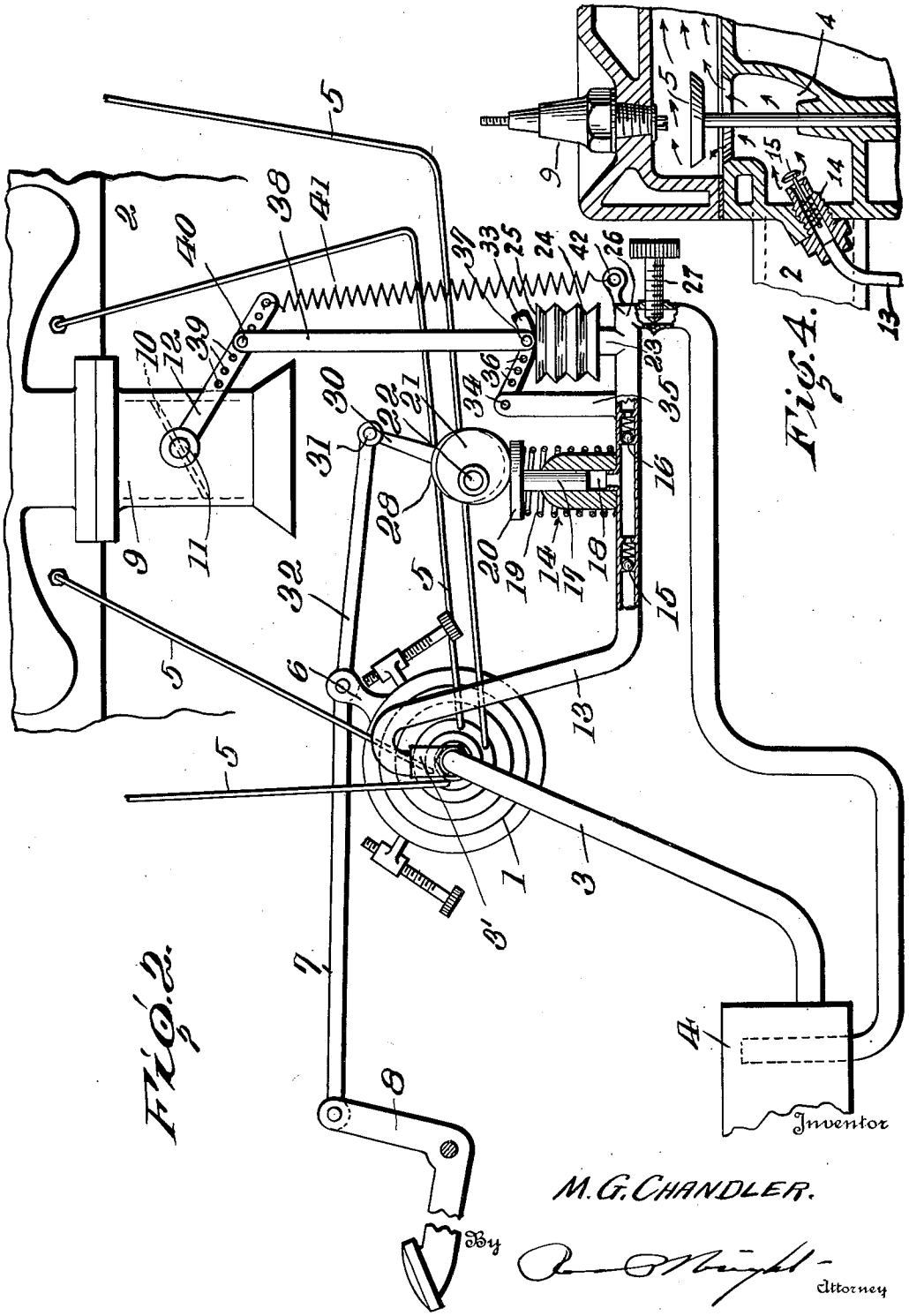


Fig. 2.

Fig. 4.

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2,025,091

FUEL FEEDING MEANS FOR INTERNAL COMBUSTION ENGINES

Milford G. Chandler, Flint, Mich.

Application October 25, 1929, Serial No. 402,420

42 Claims. (Cl. 123—139)

This invention relates to internal combustion engines, and more especially to novel means for feeding fuel to such engines.

In my prior application, filed July 5, 1928, Serial No. 290,492, I have disclosed improved means for pumping fuel directly to the intake ports of the engine cylinders in proper sequence, and the mixing of this fuel with the air entering through a common manifold. In such invention, the output of the pump is varied by manu-motive means, and this means is connected directly to the throttle valve of the air manifold, and consequently, each time the pump output is varied, the introduction of air is simultaneously varied therewith. I have found that installations of that character are very practical for aviation purposes, due to the small range of power at any given speed, but when such improvements are applied to automobile engines, they should be combined with automatic means to vary either the amount of fuel fed per aspiration, or the amount of air fed, due to the fact that an automobile motor is required to develop a great range of torque for each speed.

Regulation of the amount of fuel fed by the pump by means of manifold vacuum, has been demonstrated, but I have found it objectionable because of the slow response of the pump regulating means to changes in manifold vacuum. This resulted in poor acceleration, and rather inefficient compensation for quick changes in throttle position. With carbureters, it has been found desirable to provide some accelerating charge to moisten the manifold with fuel preparatory for the increased flow of air.

The primary object of this invention is to provide means to secure a proper relationship between the air and fuel content of the mixture, resulting from the operation of a device such as disclosed in my application, Serial No. 290,492, by which said mixture is modified to conform to the requirements of variable load, and variable speeds of the engine.

The means employed to secure the primary object provide also a means whereby a lag in the movement of the air controlling mechanism in its relation to the movement of the fuel controlling mechanism may be accomplished, to thus secure a transient superenrichment of the mixture during positive acceleration, which in some circumstances, may be very desirable when my invention is employed. But when an engine is supplied with fuel by my invention, the application of such a function is not so necessary as it is when the ordinary aspirating carbureter is used, because the inertia of the fuel is not effective to retard its movement relative to the movement of the air, as it is in an ordinary carbureter when the mixture is suddenly expedited by the opening of the throttle, to thereby temporarily impoverish the mixture, unless devices to secure an equivalent retardation for the air are provided.

A further object is to provide means of this character, including a main fuel pump and an auxiliary device. Such device may take many forms, for example, it may consist of an extra fuel pump, so linked to the main fuel pump that the amount of fuel delivered by it will be changed by the same means which changes the output of the main fuel pump. This auxiliary fuel pump preferably delivers fuel first to a pressure chamber having a yielding wall, and the discharge line from this pump is provided with adjustable means such as a needle valve, to vary the discharge of fuel from the auxiliary pump and thereby affect the pressure chamber. The yielding wall of said pressure chamber is operatively connected to a control member of the engine, for example, the air throttle, preferably through adjustable means, and in such manner that the throttle will be opened as the yielding wall is displaced, due to variations in the amount of fuel fed through said discharge line.

My construction is such that the additional delivery of fuel from the auxiliary pump will come at a time when an additional supply is delivered by the main pump, at a time interval of the additional supply from the main pump, so that the additional air cannot be admitted to the manifold until the additional fuel is available to the engine.

A further object of the invention is to provide a system of this character, in which the fuel fed by the auxiliary pump may be returned to the main fuel supply tank. Furthermore, the suction line of the auxiliary pump may be arranged to withdraw its fuel from a point in the feed system at which bubbles might collect, thus providing for the withdrawal of bubbles and foam, which otherwise might affect the performance of the main pump. These bubbles of vapor or air may be carried back into the main fuel supply in such a way that they are allowed to escape through a vent.

With the foregoing objects outlined and with other objects in view which will appear as the description proceeds, my invention consists in the novel features hereinafter described in detail, illustrated in the accompanying drawings, and

more particularly pointed out in the appended claims.

In the drawings,

Figure 1 is a side elevation of a four-cylinder internal combustion engine combined with my improvements;

Figure 2 is an enlarged elevation of my improvements, partly in section, and shown attached to the engine; and

Figure 3 is a vertical sectional view of the auxiliary pump operating means, and the adjustable stop for varying the stroke of the auxiliary pump piston.

In the drawings, 1 indicates a rotary pump of the type disclosed in my above mentioned application. This pump is operated from a movable part of the engine 2, and it draws fuel through a pipe 3 from a supply tank 4. Pipes 5 lead the fuel forced by the pump, in proper sequence, to the engine cylinders, and the outlets of these pipes are preferably arranged in close proximity to the intake valves of the cylinders, as will be clear from an inspection of the drawings of my said application, Serial No. 290,492.

As it is desirable in internal combustion engines to furnish different amounts of fuel to the cylinders under varying conditions of working, the pump 1 is of variable output type, and such variation is controlled by a lever 6, connected by a link 7 to a pivoted pedal 8, by means of which the operator may readily adjust the output of the main pump.

Air is conducted to the cylinders by means of a manifold 9 having a throttle valve 10 mounted on an oscillating shaft 11 which carries an external lever 12 that is fixed on the shaft.

In my before mentioned application, the lever 12 is operatively connected to the arm 6, and consequently, immediately the arm is moved, say to increase the amount of fuel delivered to the cylinders, the throttle valve 10 will commence to open. As before stated, such arrangement will function properly with aviation motors, but owing to different conditions encountered in the operation of automobile motors, it is desirable to keep the throttle valve 10 closed until a short time after the delivery of fuel to the cylinders is increased, in order to moisten the manifold with fuel, preparatory for the increased flow of air. The present invention furnishes means for effecting such a lag between the time of initial operation of the fuel pump, and the throttle valve 10.

Such means may include a pipe 13, through which fuel is drawn from an air collecting chamber 3' arranged in the pipe 3 at the highest point of the supply or highest point of the pump, by means of an auxiliary pump 14 which has an intake valve 15 and an outlet valve 16. This pump may be of the reciprocating piston type, and the piston is designated 17, and its cylinder 18. A spring 19 engages the head 20 of the piston, and moves the latter in one direction, and a cam 21, fast on a shaft 22, moves the piston in the opposite direction. Shaft 22, when the engine is in operation, is continuously rotated from some suitable moving part of the engine. As the piston 17 reciprocates, it circulates the fuel through a pipe 23 which is in communication with a pressure chamber 24, having an expansion or displacement wall 25, and this chamber is in communication with a pipe 26 that conveys the fuel pumped by the auxiliary pump 14, back into the upper portion of the tank 4. If the fuel was free to flow unobstructedly from the auxiliary pump through the pipes 23 and 26, the wall 25 of the chamber would remain stationary, but in order to utilize this wall as an actuating element for the throttle valve 10, I extend a needle valve 27 into the pipe 26. This valve obstructs the passageway through the pipe 26 to varying degrees to build up pressure in the pressure chamber, and this permits the chamber 24 to be expanded when the stroke of the pump 17 is varied. One of the simplest means for accomplishing such variation is an adjustable stop to more or less limit the upward movement of the piston 17. I have illustrated one practical embodiment of such means. It consists of a cam disk 28 eccentrically mounted on a stud 29 (Figure 3), which is concentric with, and acts as a bearing for the cam shaft 22.

The eccentric disk 28 has an integral arm 30 that is pivotally connected at the point 31 to a link 32, that is also pivotally connected to the control arm 6 of the pump.

From the above explanation, it will be readily understood that when the pedal 8 is operated to move the control arm 6 in a counter clock-wise direction to increase the output of the main fuel pump 1, the link 32 will swing the eccentric stop 28 to a position where it will function to lengthen the stroke of the piston of the auxiliary pump 14, and as more fuel will now be pumped through the pipes 23 and 26, the pressure in chamber 24 will be increased, and the wall 25 of the latter will move upwardly. The movement of this wall is utilized in the following way to open the throttle 10. An arm 33 rests upon the wall 25, and is pivotally connected at 34 to a support 35. This arm is preferably provided with a number of apertures 36, any one of which may receive a pin 37 that is employed in adjustably connecting a link 38 to the arm. The lever 12 also has a series of apertures 39, any one of which may receive a pin 40 that is used to pivotally connect the upper end of the link 38 to the lever. It will be recognized therefore that any rising movement of the wall 25 will cause the lever 12 to move in a counter clock-wise direction, and to thus open the throttle valve 10, but owing to the fact that the stroke of the auxiliary pump 14 must be varied, and the chamber 24 must be expanded before such movement can take place, of course, additional fuel will be delivered to the engine before the throttle valve 10 commences to open. While the parts 12 and 33 may be returned to normal position, due to the weight of such parts, I prefer to pull these parts downwardly by a spring 41 which has one of its ends connected to the lever 12, and its opposite end secured to a fixed support 42.

In the normal operation of the device, fuel is drawn to the main pump 1, and delivered therefrom by the pipes 5, to nozzles or jets located in the air passageways of the cylinders, in such a way that the fuel feed from said jets is aspirated with air to the several cylinders of the motor. Fuel is also taken from the passageway 13 to the auxiliary pump in quantities varying with the position of the eccentric stop 28, whereby the outputs of both pumps are simultaneously varied. This variation may be due to either of two causes, or a combination of the two; one of these causes is a variation in the engine speed resulting in variation in pump speed, while the second may be the result of a change of the position of the controls. As previously stated, these controls for the two pumps are linked together, and in a change of the amount of the fuel fed, due to any cause,

results in a change in the amount of air fed, and in this instance, this will be brought about through the action of the changed pressure of fuel acting upon the yielding wall 25 of the pressure chamber, and through the action of this upon the throttle.

While this device is shown in a diagrammatic way, with the auxiliary pump separately built and mounted, the preferred construction provides an auxiliary pump built into the main pump, and housed in such a way that the auxiliary pump will be concealed within the casing of the main pump; its control being eliminated, and its stroke actuated by the same cams which actuate the main pump plunger.

It will be recognized by those skilled in the art that the pressure in the chamber 24 will vary with every change in displacement of the auxiliary pump, whether this change results from a change in speed, or a change in control position resulting in changed stroke, or any combination of these factors, and that said change in pressure in the chamber 24 will result in a variation in the displacement of the wall 25, which will directly affect the position of the throttle, so as to properly proportion the amount of air to the amount of fuel fed by the main pump.

Obviously, there will be a slight lag in the opening of the throttle as increased fuel is fed, this lag being due to the displacement of the wall 25. This will result in the feeding of a slightly overrich mixture during the period of change, a feature which has been much sought in carbureter design, to carry it over the dead spot. This can be regulated by the proportions of the various parts in such a way as to produce the best results, it being manifest that a large pressure chamber would provide more lag than one quite small with respect to the size of the pump.

Due to the fact that in actual practice, only slight movement of the wall 25 will be needed, I prefer to employ between this wall and the lever 12, linkage which will amplify the movement of the throttle in relation to the movement of the wall 25.

It will readily be seen that an adjustment of the needle valve 27 will directly affect the degree to which the throttle is opened, thereby regulating the general proportioning of the air to the fuel. Any change in the amount fed through a limited range of operation, without changing the general proportionality, may be made by other means.

It will be apparent to those familiar with mechanism of this character, that various changes can be made in the details disclosed, without departing from the spirit of the invention, as expressed in the claims.

What I claim is:

1. In a positive fuel feeding means for internal combustion engines, means for supplying fuel thereto, means for supplying air thereto, additional means for circulating a fluid, regulating means for varying the pressure of said fluid and a pressure sensitive element for controlling said air supplying means.

2. In a positive fuel feeding means for an internal combustion engine, pump means for supplying fuel thereto, air supplying means, additional pump means for circulating a fluid, regulating means for varying the pressure created by said second pump means, and an element sensitive to said pressure for the purpose of controlling said air supplying means.

3. In an internal combustion engine, means to supply fuel to said engine, means to supply air to said engine, a throttle valve to control the flow of air, a fluid pressure producing device, a fluid pressure responsive device to control said throttle, a fluid pressure relieving device to modify the effect of said fluid pressure device upon said pressure responsive device, and means whereby the mutual relation of said fluid pressure producing device and said fluid pressure relieving device may be altered at will, to thereby change the relative flow of fuel and air.

4. In a fuel feeding device for internal combustion engines, variable means for feeding fuel to the engine, variable means for feeding air to the engine, and a connecting device between the fuel supply means and air supply means controlled by the speed of the engine for increasing the flow of fuel in advance of the flow of air.

5. In fuel feeding means for internal combustion engines, fuel feeding means for supplying fuel to the engine, controlling means for the fuel feeding means, means for supplying air to the engine, control means for said air supplying means, and means connecting the controlling means operated by the engine, whereby an increased flow of fuel is had in advance of the flow of air.

6. In fuel feeding means for internal combustion engines, a fuel pump operatively connected with the engine, controlling means for said pump, air supply means for the engine, means for varying the supply of air to the engine, and means connecting the last mentioned means to said control means, whereby the output of the pump is varied in advance of the movement of the air varying means.

7. In fuel feeding means for internal combustion engines, a fuel supply pump operatively connected to the engine, control means for the pump for varying the output of the latter, air supply means for the engine, means for varying the amount of air supplied to the engine, and connecting devices joining the last mentioned means to said control means, and so arranged that variations of the output of the pump will be accomplished in advance of variations in the flow of air to the engine.

8. In fuel feeding means for internal combustion engines a fuel supply pump operatively connected to the engine, control means for the pump for varying the output of the latter, air supply means for the engine, means for varying the amount of air supplied to the engine, and connecting devices joining the last mentioned means to said control means, and so arranged that variations of the output of the pump will be accomplished in advance of variations in the flow of air to the engine, said connecting devices including an auxiliary pump.

9. In fuel feeding means for internal combustion engines, a fuel supply pump operatively connected to the engine, control means for the pump for varying the output of the latter, air supply means for the engine, means for varying the amount of air supplied to the engine, and connecting devices joining the last mentioned means to said control means, and so arranged that variations of the output of the pump will be accomplished in advance of variations in the flow of air to the engine, said connecting devices including a variable stroke auxiliary pump, the stroke of which is varied in accordance with the movement of the control means.

10. In fuel feeding means for internal combustion engines, a main fuel pump for supplying

fuel to the engine, means for varying the output of said pump, means for supplying air to the engine, means for controlling said air supply, and means including an auxiliary pump operatively connected to said control means for causing the air supply control means to actuate subsequently to the control means of the pump.

11. In fuel feeding means for internal combustion engines, air supply means, a valve controlling said means, means including a chamber having a movable wall for actuating said valve, means for pumping fluid through said chamber, means for regulating the outflow of fuel from said chamber, and means for varying the output of said pump.

12. In fuel feeding means for internal combustion engines, an air manifold, a throttle valve therefor, a lever operatively connected to said valve, a pivotally mounted arm, a link joining the arm and lever, and a chamber having a movable wall for actuating said arm.

13. In fuel feeding means for internal combustion engines, an air manifold, a throttle valve therefor, means for feeding fuel to said air manifold, a control device for the last mentioned means, actuating means for the throttle valve including a pressure chamber having a movable wall, a pump for forcing fuel to said pressure chamber, and means operatively connected to said control means for varying the output of said pump.

14. In means for supplying fuel and air to internal combustion engines, a fuel pump, a control device for said pump for varying the output of the latter, a throttle valve, an auxiliary pump, means operatively connected to said control device for varying the output of the auxiliary pump, and means functioning due to variations in the feed of the auxiliary pump for actuating said throttle valve.

15. In fuel feeding means for internal combustion engines, an air intake, a throttle valve for said air intake, a fuel supply tank, a passageway extending from the tank in circuit back to the tank, a pump and an expansible pressure chamber interposed in said circuit, means for varying the output of said pump, means operatively connecting the pressure chamber to said throttle valve, and adjustable means for regulating the fuel discharged from the pressure chamber.

16. In fuel feeding means for multi-cylinder internal combustion engines, a main fuel pump, means for supplying fuel to the pump, means for leading fuel from the pump to the cylinders, a control device for varying the output of the pump, an air intake manifold operatively connected to the cylinders, a throttle valve in said manifold, means including an expansible pressure chamber for actuating said valve, an auxiliary pump for forcing fuel into the pressure chamber, and means actuated by said control device for varying the output of the auxiliary pump.

17. In an internal combustion engine, positive means to meter and force liquid fuel to said engine comprising a pump having a variable stroke, means for varying the stroke of said pump, an air conduit for said engine having means for controlling the passage of air therethrough, a pressure chamber, means operated by the pressure in said chamber for controlling the passage of air through said air conduit, an auxiliary pump driven and timed by the engine having means for varying the stroke of said pump for varying the pressure within the pressure chamber and a connection between the stroke varying means of said auxiliary pump and the stroke varying means of the main fuel feeding pump to increase the supply of air in proportion to the increased supply of fuel.

18. In a fuel feeding means for internal combustion engines, a fuel reservoir, a fuel injecting pump having its intake connected to said reservoir, a second pump connected to the intake of said first mentioned fuel injecting pump for drawing fuel and air therefrom and a conduit extending from said second pump to said reservoir.

19. In a fuel feeding means for internal combustion engines, a main fuel injecting pump for supplying measured charges of fuel to the cylinders of the engine, an auxiliary pump driven by the engine having its intake connected to the intake of the fuel injecting pump for removing air and fuel from the fuel supply of said fuel injecting pump at the point of admission of said fuel to said first pump.

20. In an internal combustion engine, positive pressure means driven and timed by the engine to meter and force liquid fuel to the engine, air supplying means for the cylinders of the engine, speed responsive means to vary the quantity of air supplied, means operable at will to vary the output of said pressure fuel forcing and metering means and means modifying the effect of said speed responsive means upon said air supplying means working in unison with said means for varying the output of the fuel forcing and metering means.

21. In a fuel feeding means for internal combustion engines, a fuel injecting pump driven and timed by the engine having means for varying the stroke thereof, a pressure responsive device, a pump driven by the engine for producing pressure therein provided with means for varying the stroke thereof, means for supplying air to the cylinders of the engine, means for controlling said air supply by the pressure within said pressure responsive device and a connection between the first and second stroke adjusting means for controlling the mixture ratio throughout the various ranges of speed and load.

22. A fuel injecting system for internal combustion engines comprising a pump for forcing measured quantities of fuel to the engine, a fuel reservoir, a conduit extending from said reservoir to said pump, a second conduit extending from said pump to said reservoir and a pump connected to said reservoir for causing fuel to circulate through said conduit for removing the air bubbles from the first mentioned pump at the suction side thereof at the point of admission of liquid fuel thereto.

23. In a positive force feed liquid fuel feeding means for internal combustion engines, a fuel injecting pump driven and timed by the engine having stroke adjusting means for delivering measured charges to said engine, an air conduit for supplying air to the cylinders of said engine having means for controlling the passage of air therethrough, a pressure responsive device for actuating said air controlling means, a pump driven by the engine having variable stroke adjusting means for producing pressure in said pressure responsive device and a connection between said stroke adjusting means of said pumps for controlling the mixture ratio throughout the various ranges of speed and load.

24. In a variable load internal combustion engine, positive means to meter and deliver meas-

ured charges of liquid fuel thereto, air supplying means for the cylinders of said engine, speed responsive means to maintain constant the air supplied to said engine, and manually operated means operable at will to vary the output of said pressure fuel injecting means and modify the effect of said speed responsive means to control said air supplying means for controlling the mixture ratio throughout the various ranges of speed and load.

25. In a fuel feeding system for an internal combustion engine, a piston pump driven by the engine in timed relation thereto for injecting measured quantities of fuel to the engine, means for varying the stroke of the pistons of said pump, an air intake for the engine, a valve controlling the quantity of air flowing through the intake to the engine, and means for operating said valve in delayed relation to the changes in stroke of the piston pump comprising a pressure system having a pressure responsive device, an auxiliary piston pump driven by the engine in timed relation thereto for maintaining pressure in said device in proportion to the speed of the engine, a connection between said device and said valve for moving said valve to increase the air supplied to the engine with an increase in the speed thereof, and control means for varying the stroke of said auxiliary pump, and a connection between said control means and the means varying the stroke of the fuel pump for increasing the stroke of said auxiliary pump with an increase of the stroke of the fuel pump.

26. In a fuel feeding system for an internal combustion engine, a pump driven by the engine in timed relation thereto for injecting measured quantities of fuel to the engine, means for varying the quantity of fuel injected by the pump per cycle of the engine, an air intake for the engine, a valve controlling the quantity of air flowing through the intake of the engine, a pressure system controlling said valve including a pressure responsive device and an auxiliary pump driven by the engine in timed relation thereto for varying the pressure in said system in proportion to the speed of the engine, a connection between said device and said valve moving said valve to vary the supply of air to the engine in direct proportion to the pressure in said system, control means for varying the displacement of said auxiliary pump, and a connection between said control means and the means for varying the discharge of the fuel pump increasing the displacement of said auxiliary pump with an increase of fuel discharged.

27. In a fuel feeding system for an internal combustion engine, a pump driven by the engine in timed relation thereto for injecting measured quantities of fuel to the engine, means for varying the quantity of fuel injected by the pump per cycle of the engine, an air intake for the engine, a valve controlling the quantity of air flowing through the intake to the engine, a pressure responsive device, a connection between said device and said valve moving said valve to vary the supply of air to the engine in direct proportion to the pressure in said device, an auxiliary pump in communication with said device driven by the engine in timed relation thereto for varying the pressure in said device in proportion to the speed of the engine and thereby increasing the air supplied to the engine with an increase in the speed thereof, control means operable at any given speed of said auxiliary pump to vary the pressure in said device, and a connection between said control means and the means for varying the discharge of the fuel pump actuating said control means to increase the pressure in said device, after a momentary delay, with an increase in the fuel discharged per engine cycle.

28. In a fuel feeding system for an internal combustion engine, a pump driven by the engine in timed relation thereto for supplying measured quantities of fuel under pressure to the engine, a control for varying the output of said pump, a valve controlling the quantity of air supplied to the engine, an actuator for said valve, a first means driven by the engine in timed relation thereto operative to move said valve actuator to increase the air supplied to the engine with an increase in speed thereof, and a second means operated by the control for said fuel pump for modifying the effect of said first means on said air valve actuator in a manner varying the supply of air to the engine in proportion to the variation in the output of the fuel pump.

29. In a fuel feeding system for an internal combustion engine, in combination, an air intake for the cylinders of said engine provided with a valve for varying the quantity of air supplied, a pump driven and timed by the engine for forcing fuel to said engine, means for varying the output of said pump, and means for operating said valve in delayed relation to the means for varying the output of the pump comprising a pressure system having means driven by the engine in timed relation to the speed thereof for producing pressure therein, control means for varying the effectiveness of said pressure producing means, a pressure responsive device in communication with said pressure system, a connection between said pressure responsive device and said valve operating to vary the supply of air in proportion to the pressure, and a connection between the means for varying the output of the fuel pump and the control means for said pressure producing means to vary the effectiveness of said pressure producing means in proportion to the output of said fuel pump.

30. In a fuel feeding system for an internal combustion engine, a pump driven by the engine in timed relation thereto for injecting measured quantities of fuel to the engine, means for varying the quantity of fuel injected by the pump per cycle of the engine, an air intake for the engine, a valve controlling the quantity of air flowing through the intake to the engine, and means for operating said valve in momentarily delayed relation to the means for varying the quantity of fuel injected by the pump comprising a pressure system having an auxiliary pump creating the pressure within said system, control means for varying the displacement of said auxiliary pump and thus vary the pressure created thereby at a given speed and a pressure responsive device, a connection between said device and said valve moving said valve to vary the supply of air to the engine in direct proportion to the pressure in said system, and a connection between said control means and the means for varying the discharge of the fuel pump increasing the displacement of said auxiliary pump with an increase of fuel discharged.

31. In a fuel feeding system for an internal combustion engine, a pump driven by the engine in timed relation thereto for injecting measured quantities of fuel to the engine, means for varying the quantity of fuel injected by the pump per cycle of the engine, an air intake for the engine, a valve controlling the quantity of air flow-

ing through the intake to the engine, and a pressure system controlling said valve including a pressure responsive device, a connection between said device and said valve moving said valve to vary the supply of air to the engine in direct proportion to the pressure in said system and an auxiliary pump driven by the engine in timed relation thereto varying the pressure in said system in proportion to the speed of the engine and thereby increasing the air supplied to the engine with an increase in the speed thereof to maintain a proper mixture ratio throughout the range of engine speed.

32. In an internal combustion engine having an engine driven pump with a variable means for supplying fuel to the engine, an air supply for said engine, an engine operated circulatory system, a pressure responsive device for controlling the passage of air to said engine in communication with said circulatory system, and means for varying the pressure in said circulatory system having a connection with said fuel varying means.

33. In fuel feeding means for internal combustion engines, a fuel pump operatively connected to said engine, control means for the pump for varying the output of the latter, air supplying means for said engine, means for varying the amount of air supplied to said engine, a circulatory system having means for circulating fluid therein driven by the engine, a pressure responsive device in communication with said circulatory system, means operated by said pressure responsive device for operating said air varying means, means for controlling the pressure in said circulatory system and a connection between the last mentioned means and the pump control means.

34. In a fuel feeding means for internal combustion engines, the combination with a pump for positively supplying fuel to said engine having means for varying the output of said pump, an air intake for said engine having a throttle valve, a circulatory system having a pump driven by the engine for circulating fluid therein, a pressure responsive device in communication with said circulatory system, means actuated by said pressure responsive device controlling the position of said air throttle, and means for varying the pressure acting on said pressure responsive device by the movement of the means for varying the output of said pump.

35. In an internal combustion engine, the combination with an engine driven fuel pump having means for feeding fuel to the engine, means for varying the quantity of fuel delivered to said engine, an air supply for said engine having a throttle valve controlling the passage of air to said engine, a circulatory system, a pump for circulating fluid through said circulatory system driven by said engine, a pressure responsive device in communication with said circulatory system, means for operating the air controlling valve by the pressure responsive device, means for varying the pressure in said circulatory system and manual motive means for operating the pressure varying means with the fuel varying means to maintain the proper proportion of fuel and air delivered to said engine.

36. The combination with an internal combustion engine, of a pump having a control for supplying fuel to said engine, an air intake for said engine having a throttle for controlling the passage of air therethrough, a circulatory system having engine driven means for circulating a fluid therein, a pressure responsive device in communication with said circulatory system, means operated by said pressure responsive device to control the position of said throttle valve, and means for varying the pressure in the circulatory system in accordance with the position of said pump control.

37. In a positive fuel feeding means for internal combustion engines, means for supplying air to said engine, means operated by said engine for supplying measured charges of fuel to said engine under pressure, means for varying said measured charges of fuel, a circulatory system, means for producing pressure in said circulatory system operated by said engine, a pressure responsive device in communication with said circulatory system for controlling the air supply to said engine, and means for varying the pressure acting on the pressure responsive device in accordance with the means for varying the measured charges of fuel.

38. In a positive fuel feeding means for internal combustion engines, the combination with a pump for forcing fuel to said engine, a control for said pump for varying the supply of fuel to said engine, an air intake for said engine having a throttle valve therein, a circulatory system having means driven by the engine for circulating a fluid therein, a pressure responsive device in communication with said circulatory system for controlling said throttle valve for controlling the admission of air to said engine, means for varying the pressure acting on said pressure responsive device and a connection between said last mentioned means and said pump controlling means to control the mixture ratio throughout the various ranges of speed and load.

39. In an internal combustion engine, the combination with an engine driven fuel pump having means for varying the stroke of the piston thereof for delivering variable measured charges of fuel to the engine, an air supply for said engine having a throttle valve controlling the passage of air to said engine, a circulatory system, a pump driven by the engine for circulating fluid through said circulatory system, a pressure responsive device in communication with said circulatory system for operating said air controlling means, and means working in unison with the fuel varying means for varying the pressure in the pressure responsive device for controlling the mixture ratio throughout the various ranges of speed and load.

40. A fuel feeding system for internal combustion engines comprising a pump driven and timed by the engine for delivering measured charges of fuel thereto, a control for varying said charges, means for delivering air to said engine, a throttle valve for controlling the admission of air to said engine, a pressure responsive device for controlling said air admitting means, a circulatory system in communication with said pressure responsive device, a pump driven and timed by the engine for circulating fluid through said circulatory system, means for varying the pressure in the pressure responsive device working in unison with said pump control for controlling the mixture ratio throughout the various ranges of speed and load.

41. A fuel feeding system for internal combustion engines having variable means driven by the engine for supplying fuel thereto, variable means for supplying air thereto, a circulatory system having means operated by the engine for circulating a fluid in said system, a pressure responsive device in communication with said cir-

culatory system, means operated by said pressure responsive device for controlling said variable air supply to said engine, means for varying the pressure in the circulatory system for varying the pressure in said pressure responsive device, and a connection between said means and the variable fuel supplying means.

42. In an internal combustion engine in communication with a fuel pump driven by the engine having means for varying the quantity of fuel delivered therefrom, of an air supply for said engine having a throttle valve, an engine operated circulatory system, a pressure responsive device in communication with said circulatory system, means operated by said pressure responsive device for controlling the position of said air throttle, means for varying the pressure in said circulatory system, and a connection with said last mentioned means and the varying means for delivering fuel to said engine for maintaining the proper proportion of fuel to air.

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