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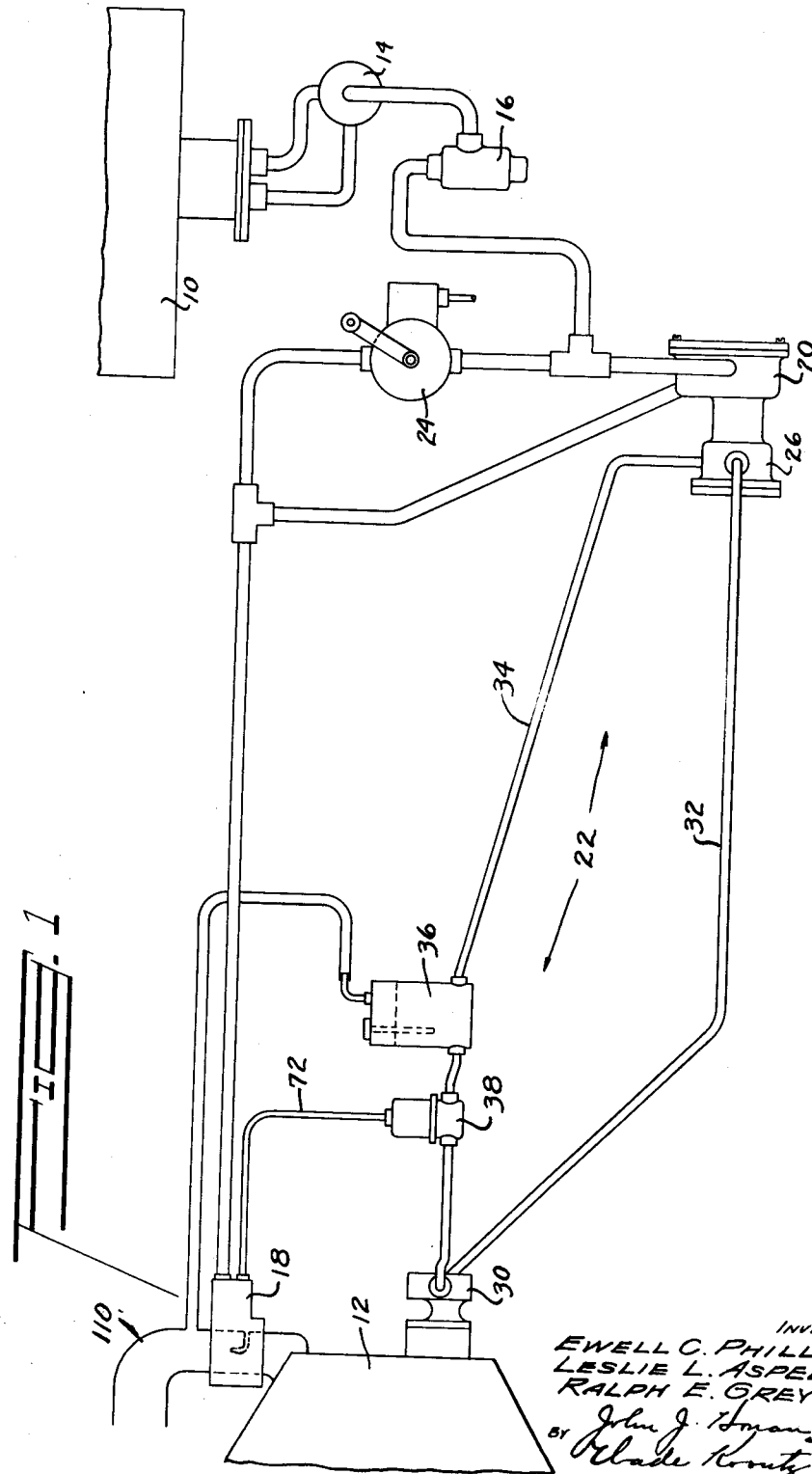
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2,183,586

FUEL FEEDING SYSTEM

Filed March 30, 1938

4 Sheets-Sheet 1



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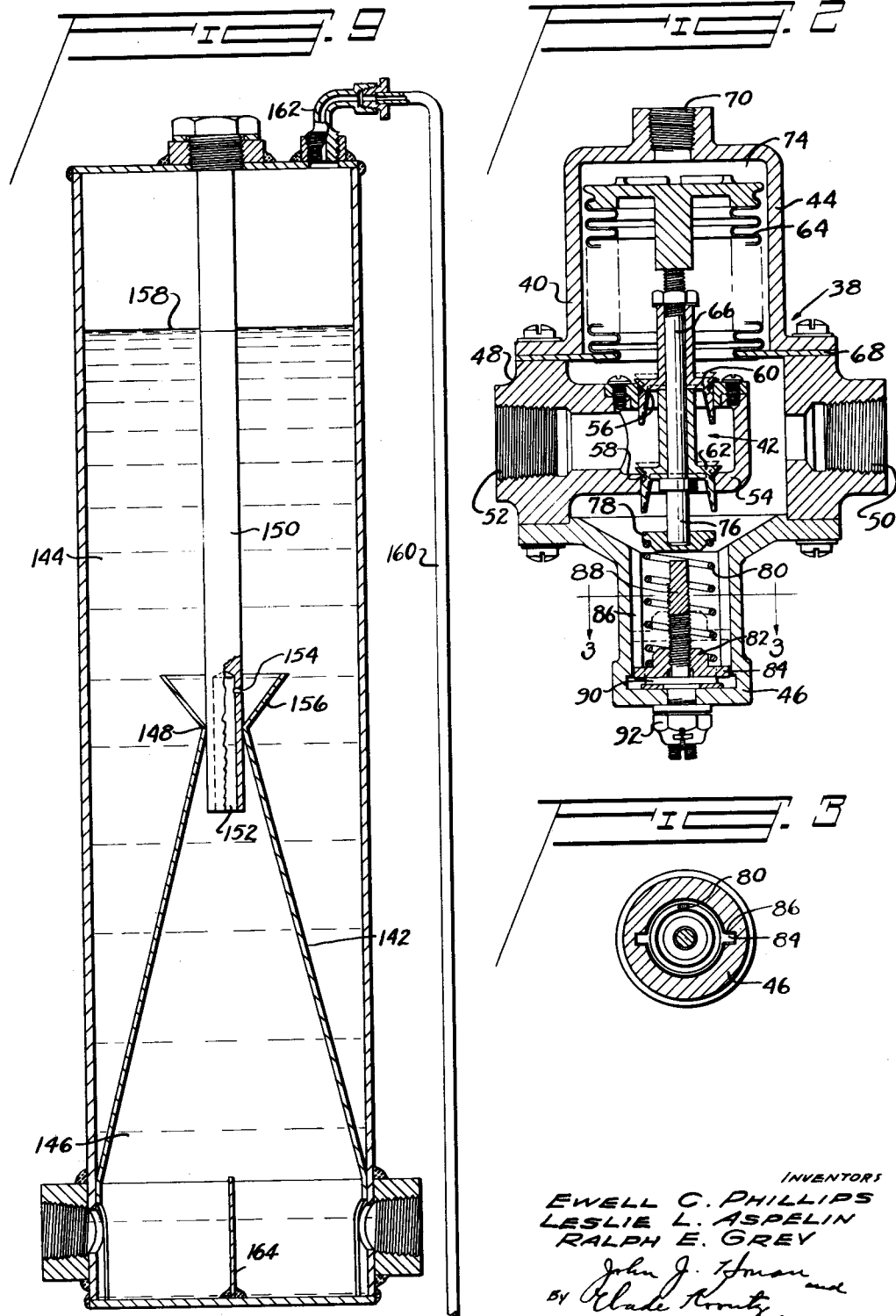
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FUEL FEEDING SYSTEM

Filed March 30, 1938

4 Sheets-Sheet 2



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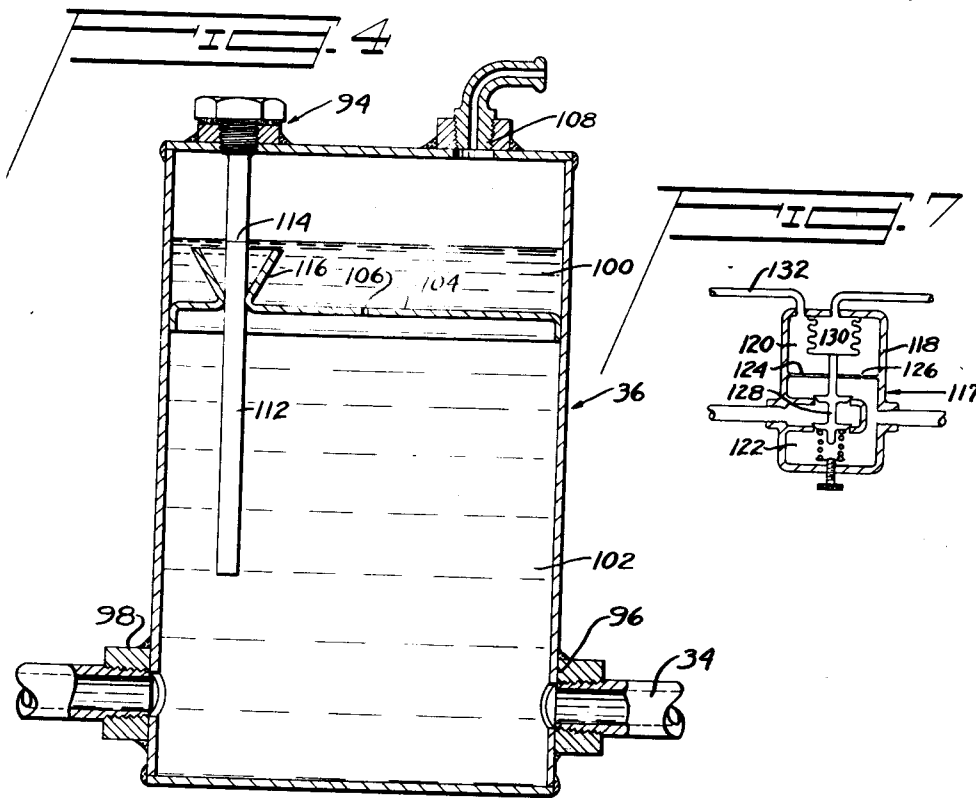
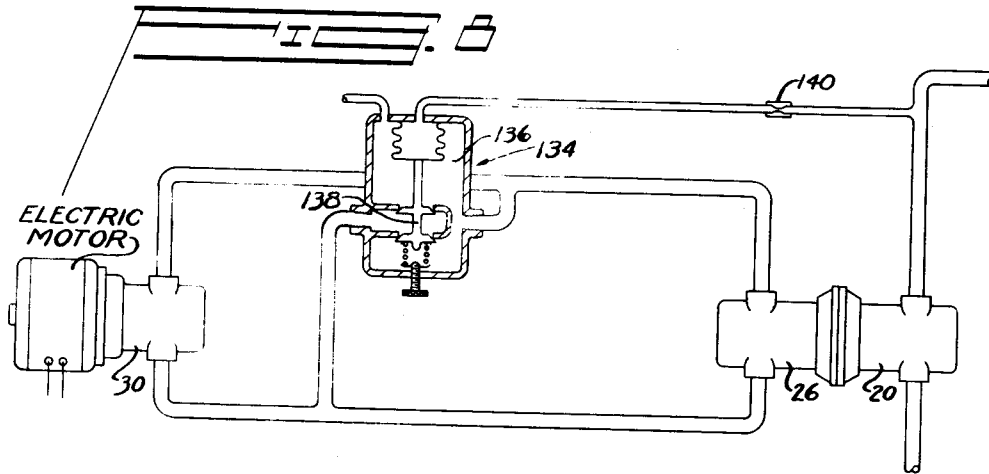
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2,183,586

FUEL FEEDING SYSTEM

Filed March 30, 1938

4 Sheets-Sheet 3



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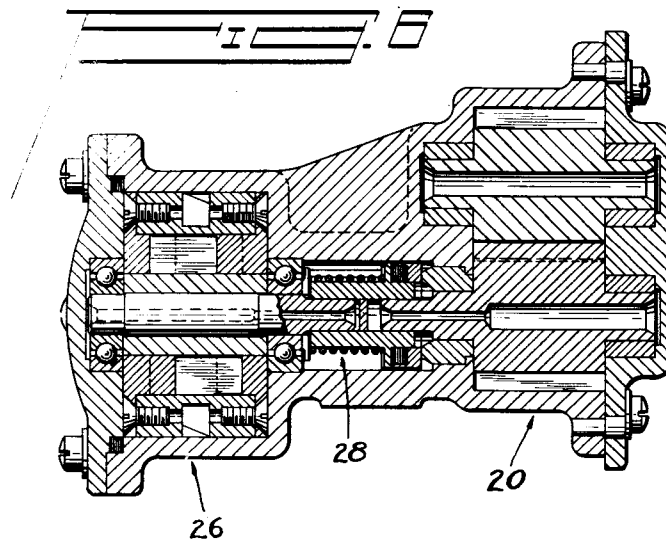
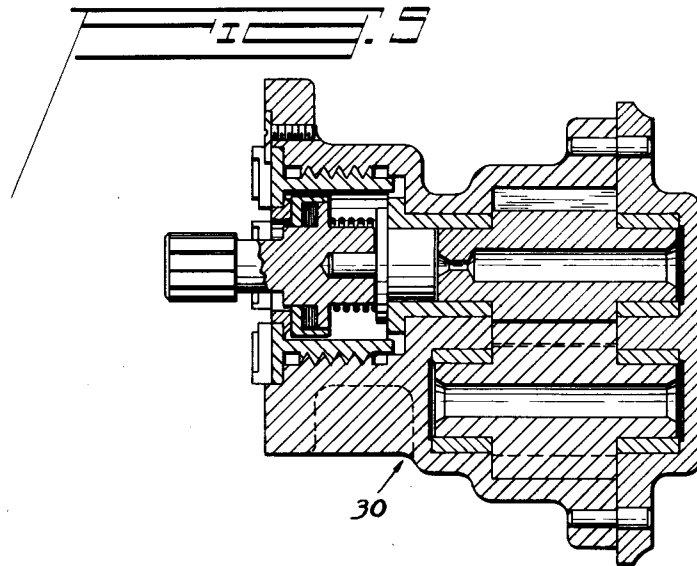
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Filed March 30, 1938

4 Sheets-Sheet 4



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2,183,586

FUEL FEEDING SYSTEM

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Application March 30, 1938, Serial No. 199,042

23 Claims. (Cl. 158—36)

(Granted under the act of March 3, 1883, as
amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to us of any royalty thereon.

5 This invention relates to a system for controlling power delivered from a source to a delivery point, and more particularly to an hydraulic system for controlling the transmission of power, and is adapted for use in connection with the
10 supplying of liquid fuel or other fluid from a source of supply to a delivery point, and is especially useful in connection with the supply of gasoline from a supply tank to an internal combustion engine remote from said tank.

15 It has been found that where, in the case of aircraft, the fuel is stored in a tank remote from the engine, supply difficulties are encountered due to vapor locks formed in the conduits. Here-
20 tofore, the fuel has been drawn from the fuel tank and fed under pressure to the engine, by means of a reciprocating air or reciprocating compression pump which is driven by a source of power and a fluid motor driven pump located at or adjacent to the source of fuel supply, the re-
25 ciprocating air or reciprocating compression pump serving to supply driving fluid under pressure to the fluid motor driven pump, and the fluid motor driven pump serving to draw fuel from the source of fuel supply and forcing, under pressure, the fuel so drawn by the fluid motor driven
30 pump to the point of delivery, provision being made for controlling the pressure and amount of the fluid supplied to the fluid motor driven pump by the pressure or amount of liquid fuel delivered
35 by the fluid motor driven pump to the point of delivery, decreasing the pressure and amount of fluid supplied to the fluid motor driven pump with increase above normal in the pressure or amount of the fuel at the point of delivery, and increasing
40 the pressure and amount of fluid supplied to the fluid motor driven pump on decrease below normal in the pressure or amount of the fuel at the point of delivery.

A further conventional method of supplying
45 fuel from a source of supply to an engine at a given pressure is that of employing a positive displacement fuel pump, driven directly by the engine, the fuel supply pressure being controlled by shunting the fuel pump by the use of a pres-
50 sure relief valve.

These known systems, however, have certain disadvantages. A reciprocating compression pump in the first mentioned system has the disadvantage that it depends for its output upon
55 the atmospheric pressure which varies with

change in altitude so that a system of this character designed for high altitude operation, where the atmosphere is less dense or rarefied, would be extremely oversize for low altitude operation.

The expansion of a compressible fluid as it
5 passes through the driving motor results in a lowering of its temperature and in the case of air would cause a condensation and freezing of the moisture in the air. In such a system, there-
10 fore, satisfactory operation makes it imperative that the air be warm. This can only be accomplished by applying heat from an external source.

Sudden changes in the demand of the fuel supply at the point of delivery require instantaneous
15 response of the fuel supply pump so that where the fluid motor driven pump is driven by a compressible fluid under pressure that is built up in the system, the change in supply of fuel to the
20 point of delivery can not be instantaneous because of the compressibility of the fluid and the consequent time lag in building up the fluid pressure by the compression pump and delivering
25 the same to the fluid driven motor.

A system of this character in which reciprocating compressors, motors, or pumps are utilized
25 in the fuel path have the further disadvantage of producing, by reason of the presence of valves, vapor lock which is brought about by the fuel undergoing a drop in pressure as it passes through the valves and particularly so through the suc-
30 tion valve where a partial vacuum is created inside the pump on the suction stroke. At high altitudes, where the pressure at the inlet of the valve is already near the boiling pressure of the
35 fuel, slight reductions in pressure in pumping the fuel through the valve will cause almost instantaneous vaporization of the more volatile fractions of the fuel and will result in vapor lock condition, rendering such a system of no practical utility in aircraft.

It is well known that the pressure of a fluid
40 pressure system will have a tendency to hunt or oscillate if, in such a system, the pressure of the fluid supplied is controlled, as a function of the change in pressure of the fluid supplied. These
45 oscillations, in the absence of provision for dampening the same, regenerate within the system and become so great as to render the system ineffective when a substantially constant pressure is
50 desired.

In the second-mentioned system, the excess
fuel being forced through the relief valve represents wasted work and horsepower. When the
inlet of the fluid pump is subjected to pressures
and temperatures near the pressure and temper-
55

ature at which the fluid changes form (gaseous to liquid or vice versa) the drop in pressure encountered by the excess liquid when passing through the relief valve causes vapor to form, which vapor when returned to the pump suction vapor locks the pump until pumping ceases. To illustrate, this drop in pressure in a present-day airplane fuel system operating at 40,000 feet altitude is from approximately 18½ pounds per square inch absolute carburetor pressure to approximately 2 pounds per square inch absolute atmospheric pressure. The relief valve controls the pressure at the point of discharge from the pump (provided it is mounted on the pump) and not at the point of consumption, therefore when the point of consumption is remote from the pump and this difference in elevation (static head) of the two changes (as in airplane maneuvering) the pressure at the point of consumption changes from the discharge pressure of the fluid pump in accordance with this change in static head.

Our invention, therefore, has for one of its objects to provide a self-contained hydraulic transmission for supplying fuel from a source of supply to a point of delivery, the speed of the transmission being made variable as a function of the pressure of the fluid supplied at the point of delivery.

It is another object of our invention to provide, in a system of this character, means for dampening the oscillations of the pressure in the system to a minimum. This is accomplished by retarding the rate of change of a pressure acting directly or indirectly on a speed control element which functions in response to the variations in the pressure of the fluid that is being supplied to the point of delivery.

It is a still further object of our invention to provide, in a system of this character, a speed control valve arrangement that is balanced both against pressure and velocity of the transmission fluid.

It is a further object of our invention to provide a system of this character in which pulsations are reduced to a minimum by the provision of positive fluid displacement devices of the rotary type.

A further object of our invention is to provide, in a system of this character, means for maintaining at all times a substantially constant differential between the carburetor air inlet pressure and the fuel pressure at the point of delivery regardless of pressure variations of the ambient atmosphere.

Other and further objects of our invention will appear from a more detailed description of our invention.

In the drawings which form a part of the specification:

Figure 1 illustrates diagrammatically one embodiment of this invention in which the speed of the hydraulic transmission is controlled by regulating the supply of motive liquid to the hydraulic generator.

Figure 2 is a sectional elevational view of the fuel pressure responsive valve regulator for regulating the supply of motive liquid to the hydraulic generator, shown in Figure 1, showing a normal predetermined operating position in dotted outline;

Figure 3 is a sectional view taken on the line 3—3 of Figure 2.

Figure 4 is a sectional elevational view of the damping means shown in Figure 1 for damping

out pressure oscillation of the pressure operated speed control valve.

Figure 5 is a sectional elevational view of the hydraulic generator shown in Figure 1 for transmitting liquid under pressure to an hydraulic motor of the hydraulic motor driven pump.

Figure 6 is a sectional elevational view of the motor pump shown in Figure 1.

Figure 7 is a diagrammatic sectional elevational view of a further embodiment of this invention showing a unitary assembly of valve regulator and pressure variation dampener.

Figure 8 is a view similar to Figure 1, illustrating a still further embodiment of this invention in which the speed of the hydraulic motor of the fluid driven pump is controlled by regulating the supply of fluid to the hydraulic motor at the output side of the hydraulic generator, and showing further a variation for damping the pressure oscillations of the valve regulator.

Figure 9 is a further variation of a detail of this invention.

In the embodiment shown in Figure 1, which illustrates the means for carrying out this invention, as applied to the supply of fuel from a fuel tank 10, which may be of manifold compartment type and conveniently located in any position on the airplane (not shown), to an internal combustion engine 12, the fuel being delivered through a multi-way cock 14, a strainer 16, from which it is delivered to the carburetor 18, through fluid driven positive displacement pump 20 by means of an hydraulic transmission 22 or by means of a hand pump 24, the hand pump being normally inoperative. The hand pump is provided with a pressure relief valve (not shown), for relieving the fuel pressure when the pressure, due to excessive pumping either manually or to failure of the transmission control, reaches a slightly higher predetermined pressure than the pressure at which the system is set to operate.

The gear pump 20 and the hydraulic motor which is preferably of the rotary vane type as described in Patent No. 2,083,560, dated June 5, 1937, are arranged in a unitary assembly and are drivingly connected together through a coupling 28 of well known construction. The motive or operating liquid is supplied to the hydraulic motor by means of an hydraulic generator 30 which, as illustrated, is of the well known gear pump type similar to that shown in Figure 6 and, as illustrated in this embodiment, is driven by the engine 12, communication between the hydraulic generator 30 and the hydraulic motor 26 being established by a pipe 32 connecting the output side of the generator to the input side of the motor, the output side of the hydraulic motor being connected to the input side of the generator through a pipe 34, a reserve supply and expansion chamber 36, and a fuel pressure responsive regulator 38 for controlling the supply of operating liquid to the input side of the generator.

The regulator, as shown in Figures 2 and 3, comprises a casing 40 and a differentially controlled valve 42. The casing 40 consists of an upper section 44, a lower section 46 and an intermediate section 48. This intermediate section has a motive fluid inlet connection 50 and an outlet connection 52, and is formed with a projection 54 provided with a pair of aligned openings formed with valve seats 56, 58 for seating two valve discs 60, 62 which are actuated by a metallic bellows 64 through a valve stem 66. The bellows 64 is confined within and constitutes with the plate 68 a closure for the upper section 44

which is provided with an inlet 70 for communicatively connecting through the conduit 72, Figure 1, the pressure chamber 74 and the fuel supply in the carburetor 18. The valve discs are also provided with a downwardly extending stem 76 that is seated in a recessed disc 78 that is yieldingly supported by an adjustable compression spring disposed within the lower section 46 of the housing, and mounted on a movable lower seat 82 that is provided with ears 84 that are received in guiding relation with guide slots 86. An adjusting screw 88 is provided for varying the tension of the spring 80. This screw is threadedly connected with the lower spring seat and is held in fixed relation to the section by means of a flange 90 and lock nut 92. The threaded portion of the adjusting screw terminates sufficiently short of the upper end of the screw to limit the tension applied to the spring. The spring, tensioned to a predetermined value determines the normal operating position of the valve. The hydraulic transmission system is self-contained and is filled through an opening 94, in the expansion chamber 36, with a liquid, preferably a light oil which serves as a lubricant for the different operating parts of the transmission system, as well as a motive fluid.

The expansion chamber shown in Figure 4 is connected in the line 34 and is provided with inlet connection 96 and an outlet connection 98 for respectively establishing communication with the output side of the hydraulic motor 26 and the inlet 50 of the motive fluid regulator. The expansion tank is divided into two chambers 100, 102 by a partition 104. Communication between the chambers is established through a relatively restricted orifice 106. The upper chamber is provided with an inlet 108 which is communicatively connected with the air inlet 110, Figure 1, to the carburetor so that the outlet side of the hydraulic transmission system between the hydraulic motor and the motive fluid regulator will be subject to approximately the same pressure as that to which the carburetor air intake may be subject.

The level of the motive liquid in the expansion chamber is at all times above the partition and at a level such that sufficient expansion space is provided within the chamber to accommodate the surplus liquid when the demand by the generator from the expansion chamber is less than the supply to the said chamber from the hydraulic motor. The level of the liquid in the chamber is measured by a sounding rod 112 that is provided with a reference mark 114 for indicating the desired level. In order to facilitate the passing of the rod into the chamber 102, the partition is provided with a funnel shaped opening 116 which serves to guide the entering end of the rod through the partition.

The motive liquid is supplied to the positive displacement engine driven hydraulic generator 30 from the expansion tank through the motor fluid regulator 38 and is in turn delivered under pressure to the hydraulic motor 26 from which it is returned to the expansion tank 36. In the operation of this system, communication is established between a preselected compartment of the fuel supply tank and the carburetor through the selector valve 14. Fuel is supplied to the carburetor and maintained at a predetermined pressure as follows: The fuel pump being a positive displacement pump, its capacity will depend directly on the speed of its rotation. Likewise, the hydraulic motor being also of the positive displacement type, its speed is dependent upon the

amount of fluid supplied thereto. Since it is desired that a predetermined pressure be maintained at the carburetor, it is obvious that, unless the speed of the fuel pump is controlled in a direct relationship to the rate of consumption of the fuel, the pressure in the carburetor will either be excessively high or excessively low. In order, therefore, to maintain a substantially constant predetermined pressure in the carburetor, the speed of the pump is varied as a function of the rate of consumption of the fuel and this is accomplished by controlling the amount of motive fluid supplied to the generator through the motive fluid regulator. When the consumption is increased the fuel delivery pressure will tend to decrease. This decrease in pressure, acting upon the bellows allows the valve to be opened by the spring, thereby delivering an increased quantity of motive fluid to the hydraulic generator which, in turn, increases the speed of the fuel pump, increasing the supply of fuel thereby raising the fuel pressure at the point of delivery which will act upon the bellows so as to prevent further opening of the valve or movement of the same towards closed position depending upon the difference in pressure between the bellows and the spring. It will be seen that, if the pressure increases in the carburetor, there will be a corresponding increase in pressure acting exteriorly on bellows which will tend to actuate the valve to restrict the flow of motive liquid through the valve, with the result that the speed of the hydraulic motor is therefore decreased and the supply of fuel to the carburetor is lessened.

By utilizing a liquid hydraulic motive fluid, the delivery of the fuel by the fuel pump will be positive in its action and rapid in its response to variations in the fuel pressure at the carburetor.

It will be seen that, as the motive fluid regulating valve is being closed and the valve opening restricted, the motive fluid generator, operating at a speed corresponding to the speed of the engine, will displace the fluid from the connecting line between the generator and the valve at a rate greater than the supply of motive fluid from the tank through the valve during the closing thereof, with the result that there will be an increased supply of fluid from the fluid motor to the tank. This increased supply of fluid is utilized to build up a pressure in that part of the system between the exposed area of the regulator valve bellows and the hydraulic motor which opposes the movement of the diaphragm so that the rate of change in the orifice opening is decreased. This built up pressure is brought about by causing the excess liquid to be forced through the restricted orifice in the partition of the expansion chamber. This built up pressure also has a retarding influence upon the speed of the fluid motor. Likewise, when the motive fluid regulator valve tends to open rapidly, the amount of motive fluid pumped by the generator is correspondingly increased and the pressure in the system between the output of the hydraulic motor and the input of the generator is diminished by reason of the fact that the supply from the supply tank is restricted to the relatively small orifice in the partition. This decrease in pressure has the effect of opposing the rapid increase of orifice opening. It will thus be seen that the pressure acting on one side of the bellows is increased when the valve is closing to oppose the increasing pressure within the bellows, and that there will be a decrease in pressure on one side to oppose the diminishing pressure in the bel-

lows when the bellows is opening and that these pressure variations are reduced by resistance to fluid flow to and from said tank.

Figure 7 shows a variation of the arrangement of the regulator and expansion chamber described above in connection with Figure 1. In this embodiment, the expansion chamber and the regulator constitute a unitary structure 117 which consists of a casing 118 that is divided into two compartments 120, 122 by a partition 124. These two chambers are communicatively connected to each other through a relatively restricted opening 126 through the partition 124. The compartment 122 is communicatively connected between the generator and the motor through a double disc regulating valve 128 that is controlled by a bellows 130 disposed within the compartment 120 which is vented through a pipe 132 that communicates with the air inlet for the carburetor (as shown in Figure 1). The arrangement of the bellows and valve differs from that shown in Figure 2 described above in that the bellows is arranged to be acted upon by the fluid pressure on the inside thereof instead of on the outside. The partition is differentiated from that of Figure 4 in that it is provided with a central opening to permit the passage of the valve stem therethrough.

The operation of this system is similar to that shown in Figure 1, in that the damping of the oscillations of the system is brought about by building up a back pressure in that part of the system between the enclosed area of the bellows and the output side of the motor by reason of the restriction of the flow of fluid through the restricted orifice 126 into the upper compartment 120 when the regulating valve is being closed, the exposed area in this embodiment being equal to the cross-sectional area of the valve stem. It will be obvious that, since the exposed area in this embodiment is less than the exposed area in the embodiment shown in Figure 1, all other conditions being the same, the magnitude of the damping effect will be less. This built up pressure has the tendency of reducing the speed of the motor, with the result that the amount of fuel supplied to the carburetor is decreased, with a consequent decrease in the controlling fuel pressure within the bellows. Damping of the oscillations of the system, when the controlling fuel pressure is less than the predetermined value as established by the predetermined loaded spring, takes place by reason of the fact that the supply of motive fluid to the generator, not shown, is less than the demand, as determined by the extent of opening of the regulating valve, due to the restricted orifice opening which controls the supply of the motive fluid from the chamber to the valve opening. Thus the motive fluid supply is gradually increased with the result that the speed of the motor is gradually changed, which in turn produces a corresponding gradual change in the controlling fuel pressure, thus reducing to a minimum the oscillations both in the motive fluid transmission system and in the fuel pressure supply system.

A further variation of our invention is shown in Figure 8. In this embodiment, the control of the speed of the motor 26 is regulated by controlling the output side of the generator 30 as a function of the fuel pressure. The control of the operating fluid pressure is accomplished by a regulator 134 that is disposed within a reserve supply chamber 136 which is communicatively connected between the input and output sides of

the generator. The regulator is identical in construction as that shown in Figure 7 except that the double discs are arranged in reverse relation. This system is further distinguished from that shown in Figure 1 in that the generator is driven by a constant speed electric motor. It will be seen that an increase in pressure in the fuel supply will cause the valve discs to open, permitting a part of the motive fluid pressure to bypass to the input side of the generator, whereby the speed of the motor 26 is decreased and conversely, when the fluid pressure decreases the regulating valve 138 will be actuated towards the closed position as the pressure in the fuel supply decreases causing a greater supply of motive fluid pressure to be transferred to the motor 26 whereby the motor speed is increased and the supply of fuel pumped by pump 20 is correspondingly increased. In this system damping of the oscillations thereof is accomplished by a restriction 140 in the fuel pressure line connecting the bellows and the carburetor. The restriction serves to prolong the time of pressure transmission from the carburetor to the bellows, decreasing the rate of movement of the regulating valve and consequently reduces oscillations of the system to a minimum.

Figure 9 shows a further variation of the expansion chamber shown in Figure 4 for use in connection with the system shown in Figure 1. In this embodiment, provision is made for the overflow of motive fluid either in the obverted or inverted position of the system. This type of expansion chamber is particularly useful in aircraft that may be subject to inverted flight. For this purpose, the expansion chamber is provided with a conical shaped partition 142 that serves to divide the expansion chamber into an upper chamber 144 and a lower chamber 146. The upper end of the cone is provided with an opening 148 to receive a sounding rod 150. The sounding rod has its inner end projecting through the opening into the lower chamber and is provided with an axial hollow 152 and an orifice 154 for establishing communication between the upper and lower compartments. The size of this restricted orifice determines the rate of change of pressure built up in the motive fluid system between the regulator (shown in Figure 2) and the output side of the motor 26, which pressure acts in opposition to the movement of the bellows 64 (Figure 2) as described above. The size of this opening is preferably determined by experiment and should be of such size as to give the most efficient pressure control. In order to facilitate the entering of the sounding rod into the opening 148, the upper end of the conical shaped partition is provided with a conical shaped guiding portion 156. By providing a conical shaped partition, the upper chamber 144 extends below the orifice 154 so that the level 158 of the fluid in the expansion chamber will be above the orifice either in the inverted or obverted position of the expansion chamber. Thus the system will be completely filled at all times and the motive fluid level will serve as a liquid seal against the entry of air into the motive fluid system and, at the same time, serve to dampen the oscillations of the system, as described in connection with Figure 1. In order to prevent the loss of the motive liquid from the expansion chamber in the inverted position thereof a vent tube 160, communicatively connected with the upper chamber at 162, extends downwardly throughout substantially the length of the expansion chamber.

Obviously the same results as described in the

various systems of our invention could be accomplished by an electrical system in which direct current is utilized as the motive energy and in which an electric generator serves in the same capacity as the hydraulic generator and an electric motor, connected for driving the fuel pump, serves in the same capacity as the hydraulic motor. An electric regulator such as a variable resistance serves in the same manner as the balanced valve of the hydraulic regulator to regulate the power supply to the motor in inverse proportion to the fuel pressure variations by use of a pressure differential means similar to that shown in the fluid systems above. The resistance may be a rheostat of the wire wound type, or carbon blocks, or a carbon granule microphone, or a crystal. The electric regulator will be employed to control the speed of the motor by use of the shunt field, or the series field, of either the electric motor or electric generator or possibly the resistance could be inserted directly in the armature circuit.

The various embodiments of our invention are to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What we claim and desire to secure by United States Letters Patent is:

1. Means for maintaining the pressure of the fuel in the carburetor substantially constant at a predetermined value, said means comprising a power actuated pump means for supplying fuel to said carburetor, means for regulating the power supplied to said pump means including a power control device and means responsive to changes in the pressure of said fuel in said carburetor for controlling said device to maintain said fuel pressure substantially constant at a predetermined value and means for damping said regulating means.

2. In combination with an internal combustion engine, a carburetor therefor, means for maintaining the pressure of the fuel in the carburetor substantially constant at a predetermined pressure, said means comprising fluid pressure actuated pump means for supplying fuel to said carburetor, means for regulating the supply of an operating fluid pressure to said pump means including a fluid pressure control valve means responsive to changes in the pressure of said fuel in said carburetor for controlling said valve to maintain said fuel pressure substantially constant at a predetermined value, and means cooperating with said regulating means for damping abrupt changes in the control of said valve with abrupt change in the demand of fuel by said engine.

3. In combination with an internal combustion engine, a carburetor therefor, an air intake for said carburetor, means for maintaining the pressure of the fuel in the carburetor substantially constant at a predetermined value in excess of air intake pressure, said means comprising fluid actuated pump means for supplying fuel to said carburetor, means for controlling the supply of an operating fluid pressure to said pump means, means responsive to changes in the pressure of said fuel in said carburetor for regulating said controlling means, and means operating to balance the effects of said air intake pressure on said pressure responsive means re-

gardless of difference in the air intake pressure and the ambient atmospheric pressure.

4. In combination, fluid pressure actuated pump means for supplying a fluid under pressure to a point of delivery, means for regulating the supply of an operating fluid pressure to said pump means, means responsive to changes in the pressure of said first mentioned supply at the point of delivery for controlling said regulating means, and means for damping the movements of said regulating control to prevent rapid change in the regulation thereof.

5. In combination, fluid pressure actuated pump means for supplying a fluid under pressure to a point of delivery, means for regulating the supply of an operating fluid pressure to said pump means, means responsive to changes in the pressure of said first mentioned supply at the point of delivery for controlling said regulating means and means to increase the time duration of the application of the fuel pressure on said pressure responsive means during any change in the fluid supply pressure to thereby damp the operation of said regulating means.

6. In combination, a pressure generator, an hydraulically driven motor pump for delivering fluid under pressure, a regulator for controlling the supply of an operating hydraulic pressure to said motor, means for establishing a predetermined operating position for said regulator, means for changing the operating position of said regulator in accordance with the differential pressure of said fluid pressure and said predetermined pressure, and means to prevent hunting of said regulator.

7. In combination, a self-contained hydraulic transmission system including a liquid pressure generator and a liquid pressure driven motor-pump for establishing another fluid pressure, a predeterminedly loaded liquid flow control means and means for regulating the speed of said motor-pump as a function of the difference in the pressure of said other pressure and the pressure of said predetermined load.

8. In combination, a self-contained hydraulic transmission system including a liquid pressure generator and a liquid pressure driven motor-pump for establishing another fluid pressure, an adjustable predeterminedly loaded liquid flow control means, means for regulating the speed of said motor-pump as a function of the difference in the pressure of said other fluid pressure and said loaded pressure, and means to prevent hunting of said regulating means.

9. Means for maintaining a substantially constant difference between the pressure of the fuel supply at a point of delivery and the inlet air pressure of the carburetor of an internal combustion engine comprising, in combination a fuel pump, a closed hydraulic transmission circuit including an hydraulic pressure generator, a motor drivingly connected to said pump and driven by an operating liquid pressure generated by said generator, means actuated by and responsive to variations in said fuel pressure for changing the speed of said fuel pump and means for balancing said last mentioned means against the effects of said inlet pressure regardless of change in pressure between the inlet pressure and the ambient atmospheric pressure.

10. Means for controlling the pressure of the fuel supply at a point of delivery to an internal combustion engine by changing the speed of a fuel pump comprising, in combination, an hydraulic generator, a motor drivingly connected to

said pump and driven by an operating liquid pressure generated by said generator, means actuated by and responsive to a variation in said fuel supply pressure for changing the speed of said fuel pump, and means to increase the time duration of the application of the fuel pressure on said pressure responsive means during any change of fuel supply pressure to thereby damp the oscillations of said pressure responsive means.

11. Means for controlling the pressure of the fuel supply at a point of delivery to an internal combustion engine by changing the speed of a fuel pump comprising, in combination, an hydraulic transmission system including an hydraulic generator driven by said engine, a motor drivingly connected to said pump and driven by an operating liquid pressure generated by said generator, means between the output of said motor and input of said generator actuated by and responsive to variations in said supply pressure from a predetermined value for controlling the liquid flow to said generator, a tank, an orifice communicatively connecting said tank with the output of said motor in parallel with said last mentioned means, said restricted orifice controlling the flow of fluid to an from said tank in a manner to reduce the amplitude of oscillations in said power transmission system with change in the liquid flow control condition, by opposing the movement thereof substantially as a function of the rate of change in the pressure of said fuel supply to thereby reduce the amplitude of oscillations in said power transmission system.

12. In a fluid transmission system a fluid pressure generator, a fluid pressure actuated device, a regulating valve for controlling the supply of fluid pressure for operating said device, said regulating valve being actuable by and responsive to variations in the speed effects of said device for changing the speed of said device, and means for producing an increasing opposition to the movement of said valve in proportion to the variation in the fluid control.

13. In an hydraulic transmission system, a liquid pressure generator, a liquid pressure actuated device, a regulating valve for controlling the supply of liquid pressure for operating said device, said regulating valve being actuable by and responsive to variations in the speed effects of said device for bypassing liquid pressure from the output side of said generator to the input side thereof and means for damping oscillations of said regulating valve with variations in the speed effects.

14. Means for maintaining a substantially constant pressure difference between the fuel pressure and the inlet air pressure of the carburetor of an internal combustion engine, comprising, a power actuated pump means for supplying fuel under pressure to said carburetor, and means for regulating the power supplied to said pump means including a power control device and a predeterminedly loaded pressure differential responsive means between the inlet air pressure and the fuel supply pressure for regulating said device in such a manner as to obtain a pressure difference between the fuel pressure and the inlet air pressure substantially corresponding to said predetermined loading.

15. Means for maintaining a substantially constant pressure difference between the fuel pressure and the inlet air pressure of the carburetor of an internal combustion engine comprising, a fluid pressure actuated pump means for supply-

ing fuel under pressure to said carburetor, and means for regulating the supply of an operating fluid pressure to said pump means including a valve and a predeterminedly loaded pressure differential responsive means between the inlet air pressure and the fuel pressure for regulating said valve in such a manner as to obtain a pressure difference between the fuel pressure and the inlet air pressure substantially corresponding to said predetermined loading.

16. Means for maintaining a substantially constant pressure difference between the fuel pressure and the inlet air pressure of the carburetor of an internal combustion engine comprising, a fluid pressure actuated pump means for supplying fuel under pressure to said carburetor, and means for regulating the supply of an operating fluid pressure to said pump means including a casing, a predeterminedly loaded pressure sensitive means providing with said casing two separate pressure chambers, one of said chambers being communicatively connected with said air inlet pressure and the other with said fuel pressure and a control device operated by said sensitive means in such a manner as to obtain a pressure difference between the fuel pressure and air pressure substantially corresponding to said predetermined loading.

17. Means for maintaining a substantially constant pressure difference between the fuel pressure and the inlet air pressure of the carburetor of an internal combustion engine comprising, a fluid pressure actuated pump means for supplying fuel under pressure to said carburetor, and means for regulating the supply of an operating fluid pressure to said pump means including a casing, an adjustable predeterminedly loaded pressure sensitive means providing with said casing two separate pressure chambers, one of said chambers being communicatively connected with said air inlet pressure and the other with said fuel pressure and a control device operated by said sensitive means in such a manner as to obtain a pressure difference between the fuel pressure and air pressure substantially corresponding to said predetermined loading.

18. In combination, a fluid pressure actuated motor pump for supplying a fluid under pressure to a point of delivery, means for generating an operating fluid pressure for said motor pump, a fluid flow control in series circuit with and between the input side of said generator and the output side of said motor, pressure sensitive means in said circuit and responsive to said means to produce pressure variations in the circuit between the output of said motor and the input of said generator in opposition to the fluid pressure variations acting on said flow control and caused by change in fluid pressure at the point of delivery and to such an extent as to prevent hunting of said flow control but to enable regulating movement thereof.

19. In combination, a fluid pressure actuated motor pump for supplying a fluid under pressure to a point of delivery, means for generating an operating fluid pressure for said motor pump, a fluid flow control in series circuit with and between the input side of said generator and the output side of said motor, pressure sensitive means in said circuit and responsive to said supply pressure for actuating said flow control, and means in said circuit between said flow control and the output of said motor to produce pressure variations that act on said pressure sensitive means in opposition to the pressure variations caused

by change in fluid pressure at the point of delivery and to such an extent as to prevent hunting of said flow control but to enable movement thereof.

- 5 20. In combination, a fluid pressure actuated motor pump for supplying a fluid under pressure to a point of delivery, means for generating an operating fluid pressure for said motor pump, a fluid flow control in series circuit with and between the input side of said generator and the output side of said motor, pressure sensitive means in said circuit and responsive to said supply pressure for actuating said flow control, and resistance means in said circuit between said flow control and the output of said motor to produce pressure variations that act on said pressure sensitive means in opposition to the pressure variations caused by change in fluid pressure at the point of delivery and to such an extent as to prevent hunting of said flow control but to enable movement thereof.

21. Means for maintaining a substantially constant pressure difference between the fuel pressure and the inlet air pressure of an internal combustion engine, comprising, a fluid pressure actuated motor pump for supplying fuel under pressure to said carburetor, means for generating an operating fluid pressure, fluid flow control means in series circuit with and between the output side of said motor and the input side of said generator, a predeterminedly loaded pressure differential responsive means between the inlet air pressure and the fuel supply pressure for regulating said fluid flow control in such a manner as to obtain a pressure difference between the fuel pressure and the inlet air pressure substantially corresponding to said predetermined loading, and means to produce the pressure variations that act on said pressure sensitive means in opposition to the pressure variations

caused by change in fluid pressure at the point of delivery and to such an extent as to prevent hunting of said flow control but to enable movement thereof.

22. Means for controlling the pressure of a fluid supply at a point of delivery by changing the speed of a fluid pump comprising, in combination, a fluid supply pump, a closed hydraulic transmission circuit including an hydraulic generator, a motor drivingly connected to said pump and driven by an operating liquid pressure generated by said generator, means actuated by and responsive to variations in said supply for changing the speed of said pump and a tank having a restricted communication with said circuit to retard the flow of liquid from said tank to said circuit and vice versa and thereby produce forces acting to reduce the speed of operation of said pressure responsive means.

23. In combination, a fluid pressure actuated motor pump for supplying a fluid under pressure to a point of delivery, means for generating an operating liquid pressure for said motor pump, a liquid flow control in series circuit with and between the input side of said generator and the output side of said motor, pressure sensitive means in said circuit and responsive to said supply pressure for actuating said flow control, and a tank having a restricted communication with said circuit at a point between said pressure sensitive means and the output of said motor to retard the liquid displacement effect of said fluid flow control and said generating means from said circuit to said tank and vice versa, thereby producing forces tending to reduce the speed of operation of said flow control with change in fluid supply pressure.

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