

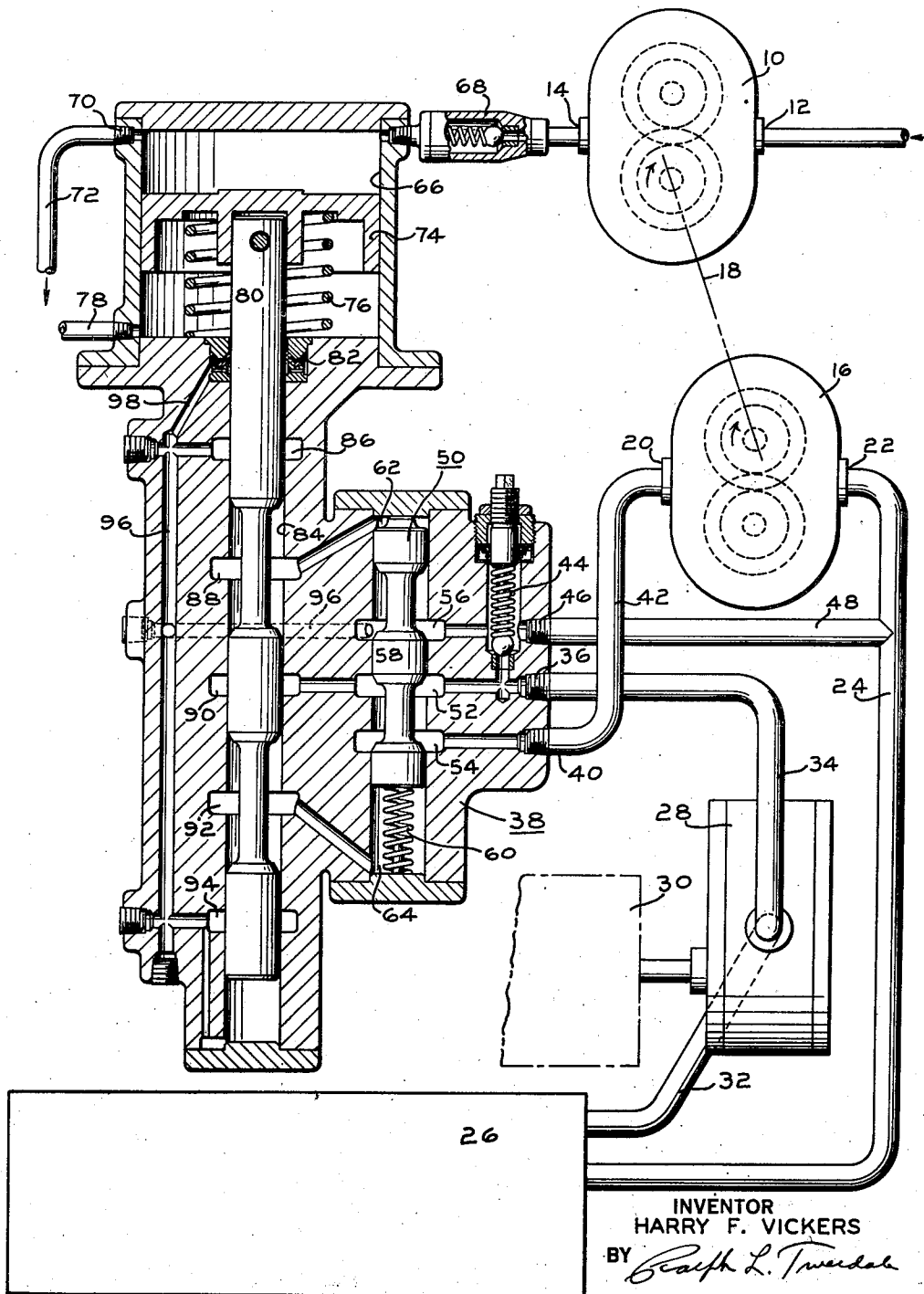
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PUMPING SYSTEM

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PUMPING SYSTEM

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This invention relates to power transmissions, particularly to those of the type comprising two or more fluid pressure energy translating devices, one of which may function as a pump and another as a fluid motor.

The invention is more particularly concerned with a power transmission for driving a fuel pumping system particularly adapted for use in aircraft. Where in aircraft the fuel tank may be located remotely from the engine and at a point below the level of the engine either in normal flight or in abnormal flight conditions, it has heretofore been difficult to satisfactorily deliver fuel to the engine under all conditions. It is desirable to locate the pump as near to the tank as possible so that a long suction line in which vapor-lock conditions may occur is avoided. This, however, complicates the driving problem for the pump since it is far more convenient to mount the fuel pump directly on the engine as far as the driving function is concerned. It is also desirable to pump only the quantity of fluid required by the engine and to avoid the use of overflow relief valves or similar systems which cause heating and vaporization of the fuel.

It is an object of the present invention to provide an improved fuel delivery system including a fuel pump which may be mounted adjacent the supply tank together with hydraulic driving means for the fuel pump capable of driving the same from a remote source of power and incorporating an improved control system whereby the fuel pump may be driven only as required to supply the fuel requirements of the engine.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred form of the present invention is clearly shown.

In the drawing the single figure is a diagrammatic view of an improved power transmission system incorporating a preferred form of the present invention.

Referring now to the drawing, 10 represents a rotary fuel pump of any suitable construction, for example, of the gear type, as illustrated, and having a suction connection 12 and a delivery connection 14. The connection 12 may lead by a short line, or may be coupled directly, to a suitable fuel tank located at a distance from the engine of the airplane. The pump 10 may be directly coupled to be driven by a rotary fluid motor 16, also of the gear type, by a shaft connection indicated diagrammatically at 18. In

actual construction the units 10 and 16 are normally mounted side by side to form a unitary motor pump but are illustrated separately for convenience and clarity of illustration. The motor 16 has an inlet connection 20 and an exhaust connection 22, the latter leading by a conduit 24 to a suitable oil reservoir 26.

A pump 28 of any suitable rotary type may be driven by the aircraft engine or other suitable prime mover indicated diagrammatically at 30. The pump has a suction conduit 32 leading from the tank 26 and a delivery conduit 34 leading to one port 36 of a control valve unit generally designated 38. From a second port 40 of the unit 38 a conduit 42 extends to the inlet port 20 of the motor 16. The unit 38 includes the customary overload relief valve 44 for limiting the pressure at port 36 to a predetermined maximum and for bypassing any excess oil delivered by the pump to the tank through a port 46 and branch connection 48.

The control unit 38 also includes a pilot-operated unloading valve 50 having three ports 52, 54 and 56 respectively communicating with the ports 36, 40 and 46. A spool 58 is slidable across the ports to selectively connect port 52 with either port 54, as illustrated, when the spool is in its upper position or with port 56 when the spool is in its lower position. A spring 60 normally biases the spool 58 upwardly. The end chambers 62 and 64 at the upper and lower ends of the spool 58 may be alternately connected to a source of pressure supply and to an exhaust point for selectively shifting the valve spool upwardly or downwardly.

At the upper end of the unit 38 there is provided an accumulator chamber comprising a cylinder 66 which communicates with the discharge port 14 of the pump 10 through a check valve 68. At the opposite side the cylinder 66 has a connection 70 which communicates by a pipe 72 with the carburetor or other fuel intake system of the aircraft engine. Slidably mounted in the cylinder 66 is a piston 74 which is normally biased upwardly by a spring 76. The lower end of the cylinder below piston 74 may be connected by a pipe 78 either with the top of the fuel tank in non-supercharged airplanes or with a point in the fuel induction system of the engine on the discharge side of the supercharging mechanism in case such is present in the airplane. The conduit 78 serves for permitting the breathing of fluid into and out of the lower end of cylinder 66 and also serves to drain any leakage of fuel that may occur past the piston 74.

The piston 74 is connected with a valve rod 80 which extends through a suitable packing 82 into the main body of the control unit 38, a bore 84 being provided for this purpose. Formed at spaced positions along the bore 84 are five ports 86, 88, 90, 92 and 94. The ports 86 and 94 are connected with the tank port 46 by means of drilled passages 96 while the central port 90 is connected with the port 52 of valve 50 and port 36. Ports 88 and 92 connect with the end chambers 62 and 64, respectively. A branch passage 98 may be provided for draining any seepage of oil along the upper end of valve rod 80 back to the tank passage 96 from a point just below the packing 82.

In operation, with the parts in the position illustrated in the drawing, it will be seen that when pump 28 is driven, power fluid will be withdrawn from the tank 26 through conduit 32 and delivered through conduit 34 to port 36 of the control unit. With the valve 50 in its upper position this fluid is directed from port 52 to port 54 and through port 40 and conduit 42 to the intake connection 20 of the motor unit 16. The latter accordingly rotates, driving the fuel pump 10 and discharging the power fluid through exhaust connection 22 and conduit 24 to tank.

Pump 10 accordingly withdraws fluid through the suction connection 12 and delivers it through connection 14 and check valve 68 to the accumulator cylinder 66. The capacity of the pump 10 when driven at the ordinary speed encountered in normal flight is sufficient to deliver fuel at a greater rate than it is consumed by the engine so that the excess fuel above the engine requirements is stored in the accumulator, and the piston 74 is accordingly moved downwardly to accommodate the ever-increasing volume of fuel thus supplied. The spring 76 applies a substantially constant bias on the piston 74 thus exerting a substantially constant pressure on the fuel in the cylinder chamber 66.

As the piston 74 moves downwardly a predetermined distance, the valve spool 80 will reach a position where port 90 opens to communication with port 88 and port 92 opens to communication with port 94. When this point is reached, fuel pressure from the main pump delivery line 34 is directed to the operating chamber 62 while the chamber 64 is exhausted so that the valve spool 58 will move downwardly against the spring 60 closing off port 52 from port 54 and thus stopping the motor 16 and pump 10. At the same time the port 52 is transferred to connect with port 56 thus bypassing the oil discharged by pump 28 back to the tank through port 46 and pipes 48 and 24. The pump 28 is thus unloaded and circulates fluid idly against negligible resistance.

When the pump 10 is stopped, pressure is no longer available at the connection 14 so that the pressure of spring 76 acting on piston 74 will act to close check valve 68, and thus piston 74 becomes the sole supply of fuel to meet the engine requirements taken off through pipe 72. Accordingly, piston 74 and valve spool 80 will move upwardly at a rate corresponding to engine fuel consumption. As the piston 74 nears the top of its stroke port 90 will be opened to port 92, and port 88 will be open to port 86. Accordingly, spring 60 will move the spool 58 upwardly discharging the oil from chamber 62 through

ports 88 and 86 and connection 96 to port 56, and through port 46, and pipes 48 and 24 to tank. As spool 58 reaches its central position, the bypass path from port 52 to port 56 will be cut off and thereafter pressure oil from the pump 34 will be admitted to chamber 64 to exert pressure and lift the spool 58 the remainder of the distance to the position shown. The pump 28 is thus reloaded, and the motor 16 and fuel pump 10 are accordingly driven again to recharge the accumulator cylinder 66, as previously described.

While the form of embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In a fuel delivery system for an internal combustion engine the combination with a fuel delivery conduit, an accumulator in the conduit, a pump for supplying fuel to the accumulator, a fluid motor connected to drive the fuel pump, a power fluid pump hydraulically connected to drive the motor, a valve for unloading the power pump, and means for alternately shifting said valve between loading and unloading position as the accumulator becomes empty and filled, respectively.

2. In a fuel delivery system for an internal combustion engine the combination with a fuel delivery conduit, an accumulator in the conduit, a pump for supplying fuel to the accumulator, a fluid motor connected to drive the fuel pump, a power fluid pump hydraulically connected to drive the motor, a means for unloading the power pump, and means for alternately shifting said unloading means between loading and unloading position as the accumulator becomes empty and filled, respectively.

3. In a fuel delivery system for an internal combustion engine the combination with a fuel delivery conduit, an accumulator in the conduit, a pump for supplying fuel to the accumulator, a fluid motor connected to drive the fuel pump, a power fluid pump hydraulically connected to drive the motor, and means responsive to changes of fuel volume in the accumulator for controlling the delivery of power fluid to said motor.

4. In a fuel delivery system for an internal combustion engine the combination with a fuel delivery conduit, an accumulator in the conduit, a pump for supplying fuel to the accumulator, a fluid motor connected to drive the fuel pump, a power fluid pump hydraulically connected to drive the motor, a pilot valve operatively connected to shift with changes of fuel volume in the accumulator, and means controlled by the pilot valve for controlling the power fluid delivered by the power pump.

5. In a fuel delivery system for an internal combustion engine the combination with a fuel delivery conduit, an accumulator in the conduit, a pump for supplying fuel to the accumulator, a fluid motor connected to drive the fuel pump, a power fluid pump hydraulically connected to drive the motor, a pilot valve operatively connected to shift with changes of fuel volume in the accumulator, and a valve controlled by the pilot valve for bypassing around the motor the power fluid delivered by the power pump.

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