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PRESSURE RESPONSIVE SYSTEM

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Fig. 2

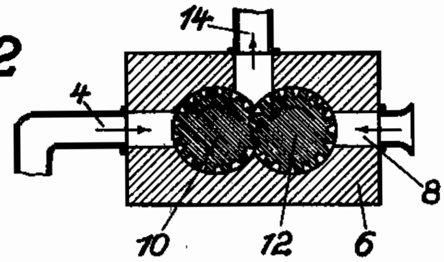
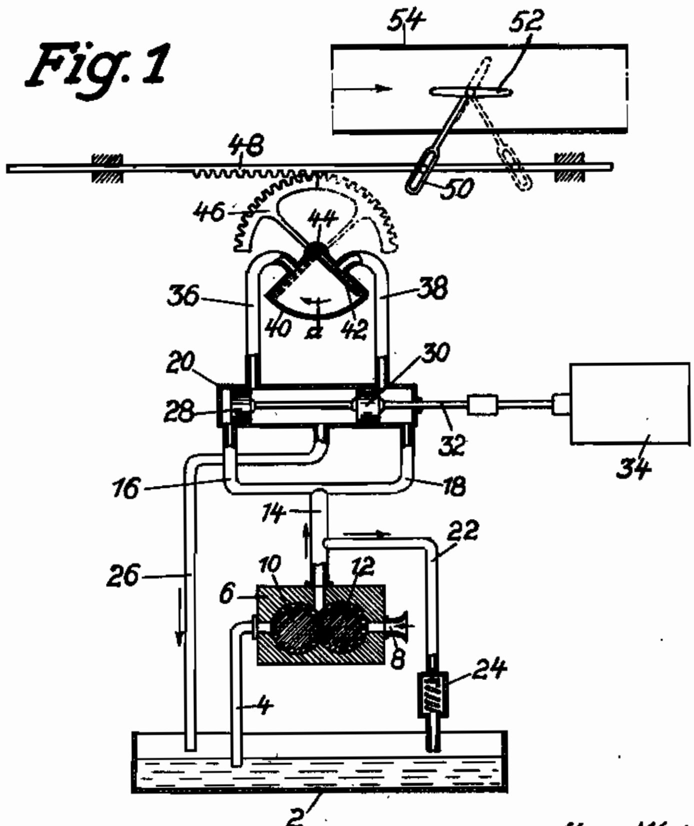


Fig. 1



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PRESSURE RESPONSIVE SYSTEM

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This invention relates to a system in which a novel hydraulic means is used to actuate a member in response to a control member.

Hydraulic control systems are old in which a fluid under pressure is applied to a member to be moved in response to a control member. In such hydraulic systems, the fluid is usually oil or water, such fluid being non-compressible. Such fluids are capable of imparting to the member to be actuated only the direct force which is given to them by a pressure producing member, and are incapable of storing energy to be expended as an additional force by themselves.

It is an object of this invention to create and apply a new medium for the transfer of forces in a hydraulic control system.

Another object of the invention is to create and apply a medium for use in hydraulic control systems, which medium has energy stored therein in addition to the force given the normal hydraulic fluid, such stored energy being expended against a member to be actuated in addition to the hydraulic thrust of the fluid alone.

Another object of the invention is to create a hydraulic control system, which, by the use of a new hydraulic medium, minimizes the lag between the initial movement of the hydraulic medium and the application of the thrust upon a member to be actuated.

A further object of the invention is to construct a hydraulic system for using a novel hydraulic medium, by reason of which the weight of the apparatus comprising the system, the power consumption, and the size of the apparatus are materially reduced over normal hydraulic control apparatus.

Another object of the invention is to create an elastic compressible medium capable of having energy stored therein for use in a hydraulic control system.

Another object of the invention is to create a hydraulic medium composed of a mixture of fluid and a gas.

Another object of the invention is to construct a hydraulic control system in which the hydraulic medium comprises a mixture of a fluid and a gas which is transmitted in response to a control member in compressed state to an actuating member, the energy of compression being expended against the actuating member.

A further object of the invention is to construct a system for actuating the throttle of an internal combustion motor, such as an aircraft motor, which system uses a novel hydraulic medium composed of a mixture of a fluid and a gas, and, as a result, a weak control impulse can be applied with a minimum of time and a surety of operation through the hydraulic system to the throttle valve.

Generally, these objects of the invention are obtained by employing a hydraulic system comprising a pump, a control member and an actuating member, the hydraulic medium being composed of a mixture of a fluid and a gas which is compressed by said pump and passed to the actuating member, the energy stored in the compressible medium by the pump being expended against the actuating member. By use of the compressible medium, the quantity of fluid used, the loss of pressure in transmission from the pump to the actuating member, and the size of the apparatus necessary for transmitting a predetermined force is materially reduced over conventional hydraulic systems in which fluid only is used. The amount of energy stored in the hydraulic medium by the compression of the gas in the fluid can be predetermined, and can be regulated by varying the quantity of gas passed to the pump.

A means by which the objects of this invention may be obtained is shown in the accompanying drawing, in which:

Fig. 1 is a diagrammatic view of an apparatus employing the novel system, the principal elements of the system being shown in section; and,

Fig. 2 is an enlarged cross sectional view of the pump shown in Fig. 1.

The novel system is shown in Fig. 1 adapted for the control of a throttle valve in the intake manifold of an internal combustion engine. Oil is taken from supply tank 2 through pipe 4 to one side of pump 6, illustrated as a gear pump. Air is introduced into the other side of pump 6 through opening 8. In the pump, the oil coming from conduit 4 is taken by gear 10, and the air entering opening 6 is taken by gear 12, the air and oil being mixed together by the engagement of the teeth of the pump, and the mixture of air and oil is discharged through conduit 14 to be compressed therein.

As air is mixed with the oil, a new hydraulic medium is created, and because of the compression of the air, energy is stored in the hydraulic medium passed into pipe 14. The amount of energy created in the medium by the compression can be regulated by the quantity of air admitted through opening 8, and, if desirable, compressed air can be admitted into opening 8, which, of course, will create a greater stored energy in the hydraulic medium discharged through pipe 14.

From pipe 14 the hydraulic medium is conveyed through branch pipes 16 and 18 to opposite ends of a control valve cylinder 20. From pipe 14 an excess pressure line 22 is returned to the supply tank, a pressure release valve 24 being contained in line 22.

From the center of control cylinder 20, a return line 28 extends back to the supply tank.

Mounted within cylinder 26 is a piston having spaced heads 28 and 30. Piston heads 28 and 30 are connected by a rod 32 which is movable to move the heads in response to variations in control member 34. Control member 34 may be responsive to changes in speed of an engine as determined by a governor, a temperature responsive device, a pressure responsive device, or any element capable of giving movement to the rod 32 in response to changes in a given condition.

From the opposite side of control cylinder 20, and from opposite sides of the cylinder heads 28 and 30, respectively, pipes 38 and 38 extend to opposite sides, respectively, of a casing 40 which houses a movable piston 42, said piston being pivoted at 44. Gear 48 is connected to the piston to be moved thereby, and, in turn, move rack 48. Rack 48 is connected by link 50 to throttle valve 82 in manifold 84.

The operation of the system is as follows: Gear pump 8 simultaneously takes fluid from the tank 2 and air through the opening 8 and mixes the two together, placing the mixture under compression. This hydraulic medium, comprising a mix of compressed air and fluid, is passed through pipe 14 to the opposite ends of control cylinder 20. Upon movement of the piston to the left in Fig. 1 in response to a change in control member 34, conduit 18 is brought into communication with conduit 38, while, at the same time, piston head 28 opens communication between return pipe 28 and conduit 36. The hydraulic medium comprising the mixture of oil and air passing through pipe 38, is discharged against piston 42 in housing 40, and movement of the piston takes place to the left in the direction indicated by the arrow *a*. By reason of the compression of the air, the movement of the piston 42 is caused both by the hydraulic thrust of the hydraulic medium and by the release of energy from the medium by the expansion of the compressed air. As the gear 40 is joined to movable piston 42, said gear is rotated to the right, and, in turn, moves rack 46 and link 50 to vary the position of throttle valve 82 in conduit 64.

It is clear that upon a reversed change of control member 34, the piston heads 28 and 30 will be moved to the right in Fig. 1 to open communication between pipes 16 and 36 and apply pressure upon piston 42 through pipe 36 to move the piston to the right.

The pipes 36 and 38 are made as short as possible so that the hydraulic medium, after passing through control cylinder 20, can act immediately upon piston 42. Therefore, the energy stored in the hydraulic medium is substantially instantly expended against piston 42, and movement of the piston 42 takes place without any lag after rod 32 has been actuated in response to changes of control device 34. A drop in pressure in housing 40 because of the expansion of the gas in the mixture is at once compensated for by the further delivery of the hydraulic medium from pump 8. This constancy of pressure maintained between the pump 8 and housing 40 is stabilized by the compression of the gas in the hydraulic medium, and thus a rupture of the pressure column between pump 6 and housing 40 is prevented, such ruptures being possible where only fluid is used as the hydraulic agent. The compression of the gas further allows a smooth and shockless operation of the piston 42 under the hydraulic medium. By reason of the expansibility of the hydraulic medium, the dimensions of pump 6 can be made smaller than the dimensions of conventional hydraulic pumps, and the force necessary to drive the pump can be smaller. Furthermore, in order to make the piston 42 responsive to a hydraulic fluid without admixed gas, the pump output must be two to three times as great as the output necessary merely to cause an actuation of the piston 42, while the excess quantity of fluid must be maintained in constant circulation between the pump and the supply tank against the pressure of valve 24.

With the use of a gas and liquid medium, the pump needs to have an output only about one-fourth of the quantity of oil which would have to be used if oil alone were used as the pressure agent. The quantity of fluid maintained in constant circulation between the pump and the supply tank is accordingly very much smaller, and therefore the weight of the pump, as well as the size and power requirements of the pump, are correspondingly less. The reduction in the amount of oil needed to be continuously circulated further reduces the undesirable additional heating of the supply tank as a result of the heat produced in recirculating the oil.

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