

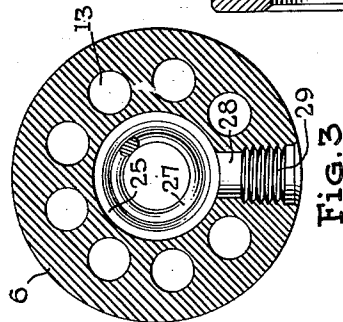
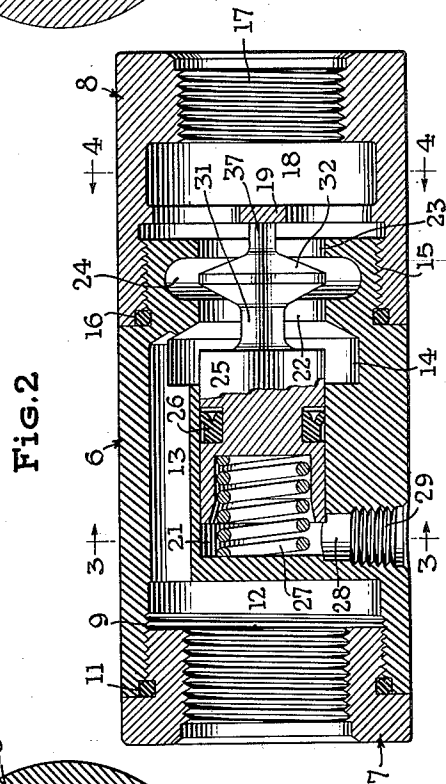
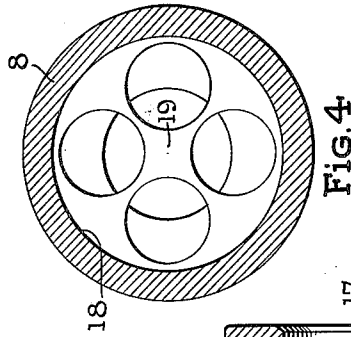
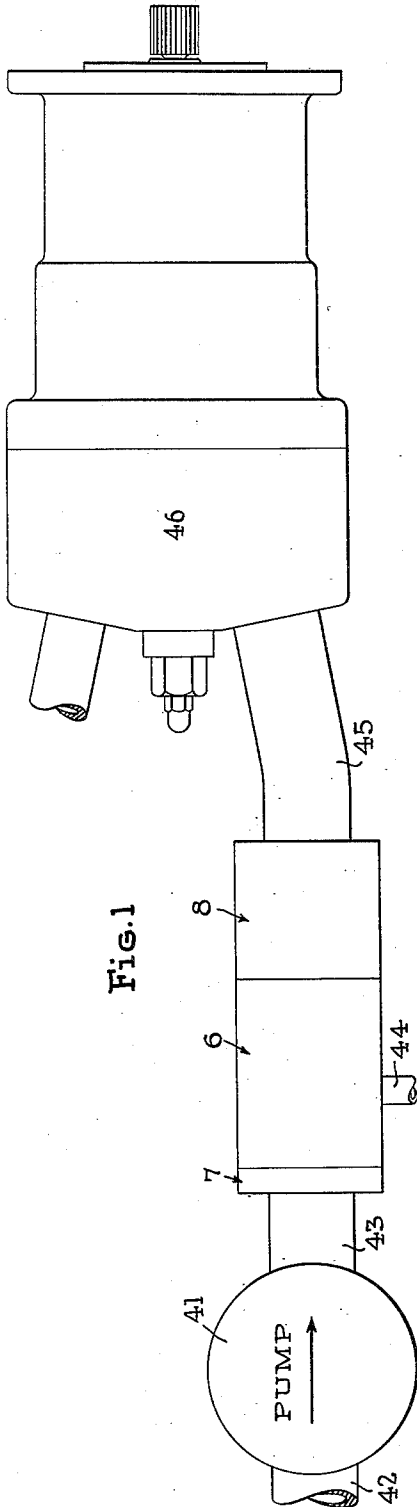
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FEEDER CONTROL FOR HYDRAULIC PUMPS

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FEEDER CONTROL FOR HYDRAULIC PUMPS

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This invention relates to hydraulic pumps particularly to such pumps as are used on airplanes as a source of motive fluid for operating secondary motors, for example, those which actuate flaps, ailerons, landing gear and the like.

Hydraulic pumps of the general type shown in the Huber Patent No. 2,433,222, issued December 23, 1947, will deliver against a head pressure of say 3500 pounds per square inch, will operate continuously at speeds of the order of 3500 R. P. M. and have gone into extensive commercial use. Because the inlet ports of this type of pump are open for extremely short intervals of time the volumetric efficiency of the pump can be increased by delivering hydraulic liquid (hereinafter called "oil") to the pump under pressure. As a practical matter, however, a pressure of 10 pounds per square inch on the inlet is approximately the maximum permissible. The inlet pressure is effective in the cam chamber, and acting on the exposed ends of the pump plungers, resists their return on the suction stroke. This return is produced by springs, and being impositive, can be delayed or even prevented.

In airplanes used under severe winter conditions, the temperature of the oil used as hydraulic liquid will be so low and its viscosity so high when the motors are first started that the oil must be put under considerable pressure by a booster pump to assure feed to the hydraulic pump. In the types of engine heretofore used there was a warm-up period during which the oil could be brought to a satisfactory working temperature. Thus the hydraulic system could be put into operating condition without delaying the take-off. Modern jet types of engine require no warm-up period. They are ready for the take-off as soon as they are started. Thus, there is no period within which the hydraulic system can be conditioned. The feeder pump must have a strong initial boosting effect, and this effect must fade out as the oil becomes increasingly fluid. When the oil is cold and viscous the boosting effect is absorbed by the work of feeding the oil to the intake of the pump, so that there is then no objectionable pressure rise in the cam chamber of the pump. However, as the oil becomes increasingly fluid, the pressure in the cam chamber rises, so that in the absence of control, a point will be reached at which operation of the pump is impaired.

The present invention provides a remedy in the form of a pressure-responsive valve of peculiar form, so contrived that it is virtually indifferent to velocity head, and tends to close in response to rising pressure in the pump intake. When viscous

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oil is fed through the valve the latter stays wide open because pressure beyond the valve does not rise. As the oil becomes more fluid a relatively minor resulting increase in pressure will produce a substantial closing movement of the valve. The closing movement is so coordinated with pressure which causes it that the pressure developed on the discharge side of the valve varies only moderately (say between five and ten pounds per square inch) while the pressure effective at the valve inlet varies widely (say between five and eighty pounds per square inch).

In this way pump inlet pressure is maintained within a reasonable operating range, without requiring that the hydraulic system be completely warmed-up before the plane takes off, and without undue limitation of the booster action.

An embodiment of the invention which has demonstrated successful operating characteristics is illustrated in the accompanying drawing, in which:

Fig. 1 shows in somewhat diagrammatic form the feeder pump, the regulatory valve means and the hydraulic pressure developing pump.

Fig. 2 is a longitudinal axial section through the regulatory valve mechanism.

Figs. 3 and 4 are sections on the lines 3—3 and 4—4 of Fig. 2 looking in the direction indicated by arrows.

Refer to Figs. 2, 3 and 4. The housing of the control valve device comprises a main body 6 and a discharge connection 8. Statements of direction which will be used in the running description are based on the parts positioned as shown in the drawing. The lefthand or entrance end of the main housing 6 is counterbored to receive the fitting 7 which is threaded into it at 9 and sealed by a soft rubber gasket 11. The fitting 7 does not extend the full length of the counterbore so that an entrance chamber 12 is afforded.

Leading from the chamber 12 are a number of bores 13. These are parallel to each other and to the axis of the fitting and extend from the chamber 12 to a second annular chamber 14. The righthand end of the housing 6 is reduced in diameter and threaded at 15 to receive the discharge fitting 8. A sealing gasket 16 is provided. The fitting 8 is pipe-threaded at 17 to receive the discharge connection and is formed with a discharge chamber 18 to the right of a spider 19 which serves as a stop to define the wide open position of the valve hereinafter described.

The body 6 is counterbored from the righthand end to provide a cylinder 21. This cylinder 21 is closed at its lefthand end and opens at its

righthand end into the chamber 14. To the right of chamber 14 are two lands 22 and 23 which desirably are of the same internal diameter as the cylinder 21. Between the lands 22 and 23 is an annular groove or channel 24. Working in the cylinder 21 is a cup-shaped piston 25 which carries a rubber sealing ring 26 and which is biased to the right by a coil compression spring 27 housed in the cup portion of the piston and reacting on the piston to force it in a valve opening direction, i. e. to the right.

The space behind the piston 25 is vented at 28. A threaded connection 29 is afforded, the purpose being to permit the attachment of a drain pipe. All that is necessary is that the space behind the piston be vented but it is convenient to afford a pipe connection to the oil sump or reservoir so that any oil leaking past the piston will be returned to the sump. The piston 25 terminates within the chamber 14 so that a clear flow passage to the land 22 is afforded.

Extending from the right end of the piston 25 is a relatively slender neck 31 which carries the valve head 32. This takes the form of two right conical surfaces connected by a peripheral cylindrical surface as clearly shown in the drawing. Extending to the right beyond the valve head 32 is a short stop stem 37 which engages the spider 10 already described in the wide open position of the valve.

This wide open position is illustrated in Fig. 2 and in that position the medial plane of the valve head 32 bisects the chamber 24, hereinafter called the reaction chamber. Since the piston 25 is inserted past the lands 22 and 23 these cannot be smaller in diameter than the piston. The outside diameter of the valve is approximately the same as the inside diameter of the two lands. Thus, if the piston 25 be forced inward to the left, the valve head 32 will restrict flow of liquid between it and land 22 which thus serves as the valve seat. Since the piston and the valve head are of substantially the same diameter, they are balanced with reference to any static pressure existing in the chamber 14. The purpose of forming the reaction chamber 24 as an annulus of approximately semi-circular cross section is to cause liquid flowing between valve head 32 and land 22 to be deflected back against the outer (right-hand) side of the valve head. In this way the effect of varying velocity head on the valve head is approximately neutralized. The purpose is to render the valve head responsive to pressure head in chamber 18, indifferent to pressure head in chamber 14 and also substantially indifferent to variations of velocity head in all the functional positions of the valve.

Referring now to Fig. 1. The feeding pump which may be of any suitable type, for example, a gear pump, is indicated at 41. It draws hydraulic liquid (oil) from any suitable source such as a sump above mentioned through a pipe 42. It discharges through the pipe 43 which is threaded in the fitting 7. The drain connection which is threaded to the housing 6 at 29 is indicated at 44. The discharge connection is shown at 45 and is connected at 17 to the outlet fitting 8 and leads to the intake passage of the hydraulic pressure-developing pump 46 which may be of the type described in the above identified Huber patent or may be of any other type in which it is desirable to limit the inlet pressure.

If the unit is started up at a very low temperature so that the oil used as a hydraulic liquid is viscous, the pressure developed by pump 41

will be largely dissipated in overcoming resistance to flow. As a consequence only a very moderate pressure will be developed in the chamber 18 and the valve head 32 will be in its wide open position or only slightly closed. As the oil warms up and becomes more fluid, the pump 41 will become effective to develop a rising pressure in chamber 18. As a consequence the valve 32 will move to the left and throttle the flow.

The valve does not maintain a uniform pressure in the chamber 18 but it does limit the pressure to a value not exceeding the maximum permissible pressure in the inlet of the pump 46. Since the valve is indifferent to variations of pressure in chamber 14 and substantially indifferent to variations in the rate of flow past the valve 32, it is possible by the use of a simple pressure-responsive valve to hold the pressure variations in chamber 18 within tolerable limits.

The configuration of the reaction chamber shown in Fig. 2 affords satisfactory operating conditions but it is anticipated that improved contours for the chamber and possibly also for the valve 32 may be developed and experiments are being conducted in an effort to avail of these possibilities. While the mechanical construction of the valve has been described in some detail and is preferred, the possibility of modifications of structure and proportion are obvious.

I claim:

1. The combination of a hydraulic pressure-developing pump having an intake in which a positive pressure below a predetermined maximum should be maintained; a feeding pump connected to deliver liquid to said intake and capable of delivering liquid at pressures above said maximum; and regulatory means interposed in the connection between the feeding pump and said intake and comprising a valve and related seat having an open position affording free flow and a graduated series of flow throttling positions, yielding means biasing the regulatory means toward open position, and pressure motor means responsive to pressure in said intake and serving to move said regulatory means away from said open position to an extent which is a function of said pressure.

2. The combination defined in claim 1 in which the valve moves from open toward closed position in a direction opposite to the direction of liquid flow, is of a diameter approximately that of its seat and is bounded by two truncated conical surfaces arranged base to base and meeting in a rim, there being on the down stream side of the seat an annular reaction channel on which the rim of the valve is approximately centered when the valve is wide open, whereby the valve is rendered substantially indifferent to the velocity head of liquid flowing between the valve and seat.

3. The combination defined in claim 1 in which the valve and the pressure motor means have substantially equal effective areas exposed in respectively opposite directions to the pressure head of liquid approaching the valve.

4. The combination defined in claim 1 in which the valve and the pressure motor means have substantially equal effective areas exposed in respectively opposite directions to the pressure head of liquid approaching the valve, the parts being so arranged that the direction of closing movement of the valve is opposite to the direction of liquid flow past the valve, said valve being approximately equal in diameter with said seat and being bounded by two truncated conical

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surfaces arranged base to base and meeting in a rim, there being on the down stream side of the seat an annular reaction channel on which the rim of the valve is approximately centered when the valve is wide open, whereby the valve is rendered substantially indifferent to pressure head of liquid approaching the valve and to velocity head of liquid flowing past the valve and hence responsive substantially exclusively to pressure in said intake beyond the valve.

5. A pressure limiting valve responsive to pressure of liquid in its discharge and substantially indifferent to variations of the pressure of liquid in its inlet and to variations in the rate of flow of liquid through the valve, said valve comprising a housing having an inlet connection at one end and a discharge connection at the other end, said housing having between its ends an axially arranged motor cylinder closed toward said entrance end, open toward said discharge end and vented to the exterior of the housing adjacent its closed end, said cylinder being surrounded by flow passages which lead from the inlet connection to an annular manifold chamber adjacent the open end of said cylinder, said housing further having, between said manifold chamber and the discharge connection, an annular reaction chamber coaxial with and located between two lands which define the margins of the reaction chamber and are of internal diameter substantially equal to the bore of said cylinder;

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der; a combined valve and motor piston comprising a piston slidable in said cylinder and having a neck which extends beyond the open end of the cylinder through the manifold chamber, and carries a valve head which has reverse convex conical faces coaxial with the piston and stem and an annular rim at the junction of said conical faces of a diameter approximating the internal diameter of said lands; a spring biasing said piston and valve toward said discharge end; and stop means serving to arrest the motion of the piston and valve under the urge of said spring, when the rim of the valve is between and approximately equi-distant from the lands.

6. The combination defined in claim 5 in which the reaction chamber is approximately semi-circular in cross section.

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