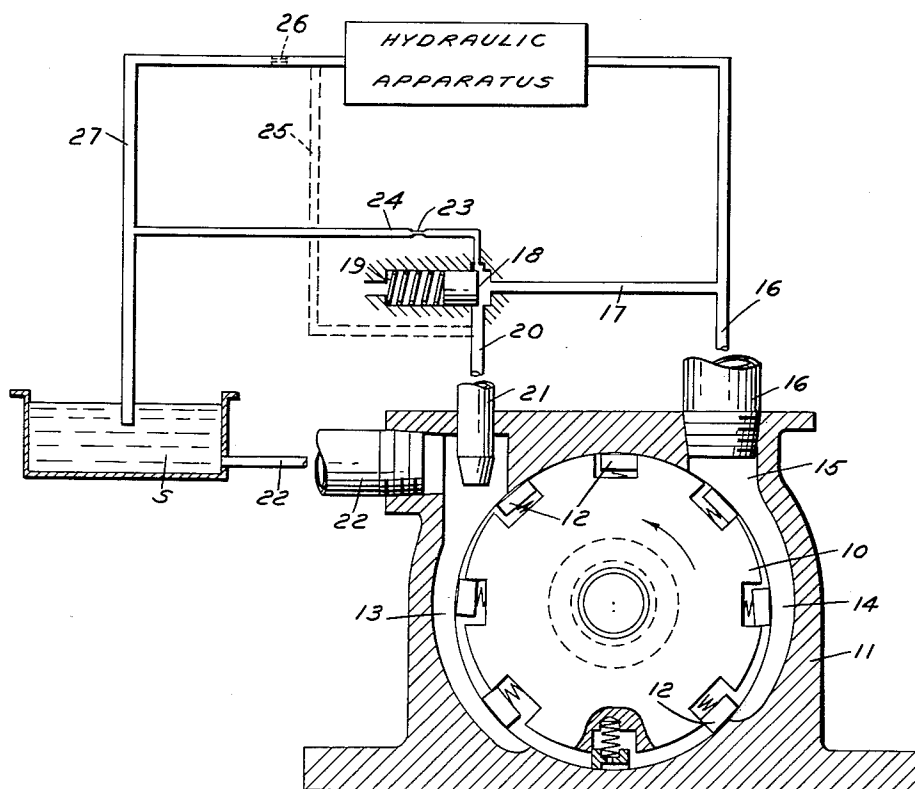


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W. T. LIVERMORE
INJECTION FILLED LIQUID PUMP
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INVENTOR.
WILLIAM T. LIVERMORE
BY
Harley Forster & Harley
ATTORNEYS

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INJECTION FILLED LIQUID PUMP

William T. Livermore, Grosse Pointe Farms, Mich.
(509 Middle River Drive, Fort Lauderdale, Fla.)

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This invention relates to a rotary hydraulic positive displacement pump of the type employed in recirculating systems wherein only a portion of the delivered fluid is required for hydraulic apparatus requirements and wherein a general supply is carried in a sump at or near atmospheric pressure.

It is customary in such systems to provide a by-pass to sump for excess pump discharge not required for service operations, as well as a return to sump for fluid exhausted from the hydraulic apparatus. It has been found in pumping systems of this type, particularly where the pump is run at high speed, that cavitation may result from incomplete filling of pumping elements at the intake side of the pump when atmospheric pressure alone is depended upon to produce such filling. Such cavitation may result in noisy operation of the pump as well as inefficiency and undue wear of the elements.

In accordance with the present invention, at least a substantial portion of the delivered fluid is caused to flow directly back into the intake chamber of the pump, preferably through a jet nozzle or aperture which feeds such fluid under a high velocity directly to the pumping elements at the intake chamber, instead of passing all of the delivered fluid to the sump as in conventional practice. Such injection filling has been found in practice to assure complete filling of the pumping elements, substantially eliminate cavitation, and produce exceptionally quiet and efficient operation.

When the pump is run at very high speeds, the centrifugal force imparted to the liquid moved by impellers at the intake chamber produce a considerable force, tending to throw the fluid radially outwardly before the impeller reaches the sealing edge of the pumping intake chamber and thus produces a considerable tendency toward cavitation. By injecting hydraulic fluid at high speed tangentially, or at a slight angle to the tangent of the rotor, the work required to speed the intake fluid up to rotor speed is eliminated or substantially reduced, a smoother flow into the working chamber with minimized turbulence is effected, and/or a substantial pressure in the immediate area of the cut-off edge of the intake chamber may be created to resist the centrifugal forces tending to produce cavitation.

Accordingly, it is the principal object of the present invention to provide a simple and effective means of assuring complete filling of the pumping elements at the intake chamber to an extent not permitted by reliance on total intake supplied from sump at atmospheric pressure.

Another object is to use direct return of at least a substantial portion of the discharge of the pump to the intake chamber per se instead of to the sump.

Another object is to return such discharge under a velocity and in a direction which will assist the filling of the pumping elements, either through imparting at least a portion of the required rotor velocity to the liquid moving into the pump impeller chambers, or in building

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an effective super atmospheric pressure head in the final area of intake fluid engagement by the pump impellers.

Another object is to provide a tangential jet feed for such directly returned liquid in the direction of impeller movement at the inlet chamber.

Another object is to provide means for directing a limited portion of the pump discharge to the sump to provide necessary cooling in cases where continuous direct recirculation would result in undue heating of the hydraulic fluid.

These and other objects will be apparent from the following detailed description of a typical embodiment and from an examination of the drawing thereof.

The drawing comprises a sectional elevation of a slipper type rotary pump incorporating provision for injection filling in a schematically shown recirculating hydraulic system.

Referring to the drawing, it will be seen that a pump rotor 10 is adapted to rotate in a counterclockwise direction within a pump housing 11, driving slipper impellers 12 through an eccentric arc in the housing to provide pumping action between an inlet chamber 13 and an outlet chamber 14 in the housing. Hydraulic pressure from an outlet port 15 is delivered to outlet passage 16 supplying hydraulic apparatus from which the hydraulic fluid is exhausted to a sump S. Hydraulic fluid delivered in excess of apparatus requirements also communicates through passage 17 with a by-pass valve 18 which may operate as a pressure regulator and safety valve controlled by the strength of the spring 19.

After fluid pressure is built up to overcome the spring, the by-pass valve is opened and the surplus discharge from the pump is directed through the passage 20 and nozzle 21 directly to the intake chamber 13 of the pump. Such directly returned fluid is preferably delivered under velocity in the general direction of the peripheral movement of the slippers passing through the intake chamber and may be tangential to the rotor. Such velocity delivery of fluid directly to the rotors avoids at least part of the necessity for acceleration of the fluid in filling the expanded slipper chambers in the intake arc, thereby assisting smooth flow into such chambers and minimizing the possibility of turbulence and cavitation. It will also be seen that fluid delivered under velocity into the intake chamber 13 may build up an effective pressure head in any portion of the intake chamber where the form is such as to reduce velocity. This pressure can be utilized to overcome centrifugal effects of high speed operation which might otherwise prevent the hydraulic fluid from completely filling the slipper chambers.

While it is preferred to deliver the fluid under velocity in the direction of perimeter travel, it will be understood that at least a substantial portion of the benefit of direct return may be obtained through the development of an effective superatmospheric pressure head in the intake chamber. For example, if the nozzle 21 were to direct fluid toward the rotor in a radial rather than tangential direction, such velocity might be utilized to build up an effective pressure head which would materially assist in avoiding cavitation even though such velocity injection did not directly impart required acceleration to the fluid in the direction of impeller travel.

It is important, however, that whatever direction the velocity injection takes relative to the rotor, it must be so arranged as to prevent interference with low pressure flow from the sump. Thus, in the present embodiment, the intake 22 from sump S is arranged to enter laterally at the side of the nozzle 21 when the velocity is high and pressure therefore is at a minimum so that velocity flow from the nozzle, which may be made high by making the nozzle small, will not oppose flow from the sump

but will actually assist such flow utilizing the principle of jet pump action.

Where delivery requirements for hydraulic apparatus are intermittent or very small compared to total pump delivery, it may be desirable to lead a portion of the surplus delivery to the sump, as by an orifice 23 and passage 24, to any extent necessary to avoid overheating of the fluid through direct recirculation. On the other hand, where the flow to the hydraulic apparatus is continuous and comprises a relatively large portion of the total output of the pump, it may be desirable to direct a portion of the fluid returned from the hydraulic apparatus directly to the velocity injector, as by an optional passage 25 under a partial pressure head maintained by orifice 26 rather than passing it all to sump through return passage 27.

While a particular embodiment has been described above in detail, it will be understood that numerous modifications may be resorted to within the scope of my invention as defined in the following claims.

1. In a recirculating hydraulic pressure system, a rotary positive displacement hydraulic pump having a pump rotor and an inlet and an outlet communicating with said rotor, a reservoir for storing hydraulic fluid connected to said inlet, and means for minimizing cavitation in the filling of the pump during the intake cycle of operation, said means being characterized by fluid passage means for recirculating a portion of the pump output back to the inlet without passing through said reservoir, said passage means directing fluid toward said inlet and including a restricted discharge opening to provide a jet action at a velocity exceeding the inlet flow from said reservoir and in a direction substantially tangential to the perimeter of the pump rotor thereby effectively supercharging the inlet of said pump.

2. In a hydraulic pressure system, a rotary positive displacement hydraulic pump having a pump rotor communicating with an outlet adapted to discharge hydraulic fluid for meeting hydraulic pressure requirements and an inlet for receiving hydraulic fluid passing through said pump, a reservoir connected to said inlet for supplying said pump with hydraulic fluid, and a branch hydraulic circuit between the outlet and inlet of said pump terminating in a restricted discharge opening directed substantially tangential to the perimeter of said rotor

to assist the filling of said pump through jet action at a velocity exceeding the inlet flow from said reservoir and effective to supercharge the inlet of said pump.

3. In a recirculating hydraulic pressure system having a reservoir and hydraulic pressure actuated apparatus discharging into said reservoir, a positive displacement rotary pump having a pump rotor with fluid impeller elements and an inlet and an outlet communicating with said rotor, a by-pass valve connected to said outlet for venting a portion of the discharge of said pump, and means for minimizing cavitation in the filling of the pump in advance of said impeller elements during the intake cycle of operation characterized by fluid passage means for delivering at least a portion of by-passed discharge directly to said inlet without passing through said reservoir, said passage means including a restricted discharge opening to provide a jet action at a velocity exceeding the inlet flow from said reservoir directing fluid to said inlet in a direction generally tangential to the path of said impeller element in said intake cycle of operation thereby effectively supercharging the inlet of said pump.

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