Dec. 8, 1931. H. ERNST ET AL 1,835,977

HYDRAULIC SYSTEM

Filed May 11, 1929

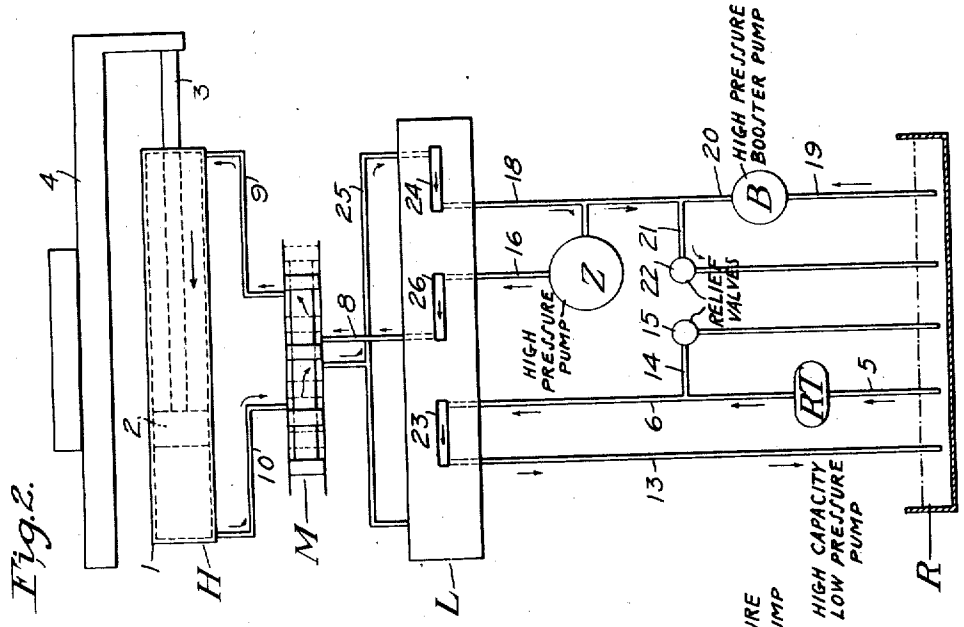


Fig. 2.

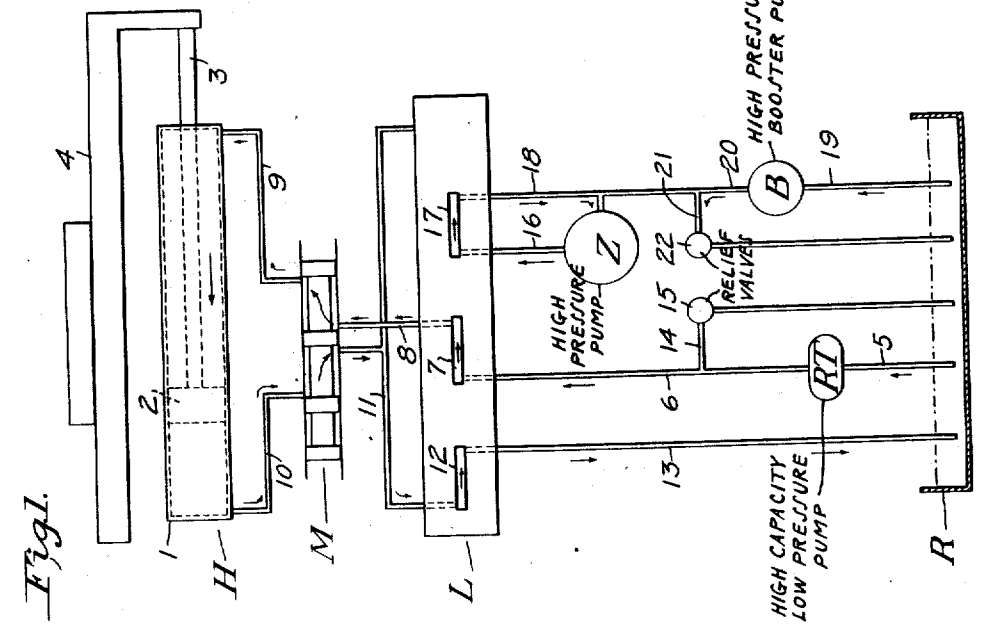


Fig. 1.

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UNITED STATES PATENT OFFICE

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HYDRAULIC SYSTEM

Application filed May 11, 1929. Serial No. 362,414.

Hydraulic propulsions, as heretofore provided, are of two distinct types, to wit:— one which seeks to produce a uniform rate of advance of an actuated member by delivering into an hydraulic motor, at a volumetrically uniform rate, what may be termed "pushing" oil, and the other in which a uniform rate of movement is obtained by diminishing, at a volumetrically constant rate, a supply of "movement-resisting" oil which serves to oppose the movement of the actuated member under the influence of the "pushing" oil.

The present invention relates primarily to systems of the former type and it seeks to render such systems more efficient under varying conditions such, for example, as are encountered when they are employed to effect, selectively, fast and slow movements of a milling machine work-table or other translatable element.

The hydraulic system provided by this invention satisfies a number of desiderata. First, it effects a relatively rapid movement of the translated element in either direction. Second, it maintains a high back pressure on the exhaust end of the hydraulic motor, thereby precluding jumping of the piston and its connected parts by irregular action of the tool on the work, and:—third, it insures the delivery of "pushing" oil into the intake end of the hydraulic motor at a volumetrically uniform rate.

This invention proposes an improved system in which each of these three functions is performed by an individual pump, each of which is adapted to perform its function in a most efficient manner and with a minimum amount of power; the exhausting of large quantities of oil against high back pressures, as in certain prior systems, being wholly obviated.

In the annexed drawings, forming a part of this disclosure, Figure 1 is a diagrammatic view of the improved hydraulic system, the controlling valves thereof being so set as to effect rapid traverse movement of the actuated element to the left. Fig. 2 is a similar view with the valves set in a different position thereby to effect slow feeding movement of the actuated element to the left, the rate of feed being determined by the action of a variable delivery pump connected with the intake end of the hydraulic motor.

Referring more specifically to the drawings the improved hydraulic system is disclosed as comprising a reservoir R adapted to contain a supply of actuating liquid, preferably oil; an hydraulic motor H comprising a cylinder 1 and piston 2, and a plurality of pumps, valves and conduits, later to be described, connecting the reservoir and the motor. The motor is, of course, intended to do work and this may be effected by having the piston 2 connected, as by a piston rod 3, with a reciprocatory element or table 4.

For the purpose of this disclosure the element 4 may be considered to be the work-table of a milling machine inasmuch as the features of this invention may be employed to advantage when embodied in that type of machine tool.

The pumps embodied in this system comprise a low pressure high capacity pump RT, adapted to effect rapid traverse movements of the reciprocatory table 4; a low capacity high pressure booster pump B adapted to be connected to the exhaust end of the cylinder 1, to build up in said end a high resisting pressure; and a high pressure pump Z having its discharge port connected with the intake end of said cylinder and serving to inject oil thereinto at a volumetrically uniform rate. The pump Z may receive oil from any suitable source but preferably it is connected to receive oil from the exhaust end of the hydraulic motor. To enable the table to be moved at any desired uniform rate, the pump Z is preferably of the variable delivery type which, by means of adjustment may be caused to deliver oil into the intake end of the motor at any desired volumetrically uniform rate from zero to the maximum capacity of the pump.

Intermediate the pumps RT, B and Z and the hydraulic motor H, are two valves, one L, which serves as a selector or main control valve and other, M, which serves as a supplemental or stop valve. The valve L is adapted to control the direction of flow of oil to and from the motor H and to determine

which of the pumps RT or Z may be effective to actuate said motor. The valve M serves either to connect the motor H with the valve L, as shown in full lines in the drawings, or to isolate the motor from the valve L and the pumps, as shown in dotted lines in Fig. 2, thereby to trap the oil in the opposite ends of the motor H when it is desired to lock the table 4 against movement in either direction. The constructon and operation of the valves L and M are clearly shown and described in our application, Serial Number 220,721, filed September 15, 1927, and also in British Patent No. 297,104. Detailed illustration and description thereof, in this application, is therefore deemed unnecessary.

Fig. 1 shows the valves L and M so set that the pumps B and Z are isolated from the motor H and the rapid traverse pump RT is connected to effect rapid movement of the piston 2 and table 4 to the left. In this setting of the valves the rapid traverse pump draws oil from the reservor R through conduit 5 and discharges it through conduit 6, port 7 in valve L, conduit 8, through valve M and conduit 9 into the right end of the cylinder 1. At the same time oil in the left end of the cylinder escapes freely through conduit 10, valve M, conduit 11, port 12, in valve L, and through conduit 13 to the reservoir.

A relief line 14, controlled by a relief valve 15, connects the discharge side of the pump RT with the reservoir and thereby limits the pressure which that pump may build up in the motor and returns to the reservoir any excess oil delivered by the pump.

As shown in Fig. 1 the pump Z is short circuited. In other words, oil passed by the pump flows outwardly through the conduit 16, through a port 17 in the valve L and back through a conduit 18 to the intake port of the pump, thereby maintaining a free circulation of oil. The low capacity high pressure booster pump B draws small quantities of oil from the reservoir through a conduit 19 and discharges it through a conduit 20 connected with the intake port of the pump Z. In this setting of the valves the output of the pump B is required only to maintain the pump Z and conduits connected therewith filled with oil. The excess oil delivered by the pump B is exhausted back into the reservoir through an exhaust line 21 controlled by a high pressure relief valve 22.

From the position shown in Fig. 1, the valve L may be shifted, as described in the application above referred to, to connect the left end of the motor H with the rapid traverse pump RT and to connect the right end of the motor with the reservoir, thereby to effect rapid traverse movement of the piston 2, and parts connected therewith, to the right. Likewise the valve L may be shifted to the position shown in Fig. 2, in which the pump RT is short circuited, having its outlet conduit 6 connected, as by port 23 in the valve L, with the drain conduit 13. In this position of the valve, the booster pump B is connected through conduit 18, port 24, conduit 25, through valve M and conduit 10 with the left end of the hydraulic motor H, thereby maintaining a high resisting pressure therein, the value of which is determined by the relief valve 22. The pump Z has its discharge port connected, by conduit 16, port 26 in valve L, conduit 8, through valve M and conduit 9, to the right end of the motor H. As hereinbefore stated the pump Z might receive its fluid from any suitable source, such for example, as by being connected directly with the reservoir R. Preferably, however, it has its intake port connected with the conduit 18 which serves as a discharge for the oil in the exhaust end of the cylinder 1. Thus the oil exhausted from the left end of the motor passes through the pump Z and is forcibly injected into the right end thereof thereby forming, in effect, a closed circuit.

The office of the pump B is, as previously stated, to maintain a high pressure in the exhaust end of the motor H and also to maintain the system completely filled with oil. It will readily be perceived that by having the intake end of the pump Z connected with the exhaust end of the cylinder 1 and the high pressure pump B also connected with the same end the pump B may perform its required function by passing only a very small quantity of oil.

In certain applications of hydraulic systems, such for example, as where they are utilized to effect feeding movements of the work-table of a milling machine in which the action of the cutter on the work tends to move the table in the direction of feed, in order to produce the required margin of safety it is necessary that the relief valve, which controls the exhaust of fluid from the motor, be set to withstand a pressure up to 400 lbs. per square inch. It will, therefore, be perceived that the exhaust of any substantial amount of oil through this valve would result in the consumption of a substantial amount of power and likewise would result in the undesirable heating of the oil. These objections have been particularly noticeable in prior systems in which a single high capacity pump has been utilized to effect rapid traverse and to produce the required back pressure on the system. The present invention overcomes these objections by short circuiting the rapid traverse pump when traverse is not required and by utilizing a separate low capacity high pressure pump to produce the required back pressure. With this construction and arrangement all of the advantages are obtained and the dis-

advantages incident to the exhausting of great quantities of oil against a high back pressure are obviated.

From the position shown in Fig. 2 the valve L may be shifted to connect the intake port of the pump Z with the right end of the cylinder 1 and the discharge port thereof with the left end of said cylinder, thereby to effect feeding movements of the table 4 to the right.

Under certain conditions it may be desirable to discontinue the feed of the table and to lock it against movement in either direction. This may be effected by shifting the valve M to the position shown in dotted lines in Fig. 2 whereby the conduits 9 and 10 are both closed against exhaust and the pump Z is short circuited by having its discharge conduit 8 connected with the return conduit 25.

Without further analysis, the foregoing will so fully reveal the gist of this invention that others can, by applying current knowledge, readily adapt it for various utilizations by retaining one or more of the features that, from the standpoint of the prior art, fairly constitute essential characteristics of either the generic or specific aspects of this invention and, therefore, such adaptations should be, and are intended to be, comprehended within the meaning and range of equivalency of the following claims.

Having thus revealed this invention, we claim as new and desire to secure the following combinations and elements, or equivalents thereof, by Letters Patent of United States:—

1. An hydraulic system combining a motor; a reservoir; a high capacity pump adapted to be connected with said motor and to draw oil from said reservoir and to deliver it into said motor to effect relatively rapid actuation thereof; a second pump adapted to be connected with an intake side of said motor to deliver oil thereinto when the first mentioned pump is disconnected from said motor, thereby to effect relatively slow actuation thereof; and a third pump adapted to have its discharge port connected with the exhaust side of said motor when said second pump is connected to the pump thereby to maintain therein a pressure counter to the pressure built up in the intake side thereof by said second pump.

2. An hydraulic system combining a motor; a reservoir; a first pump of high capacity adapted to be connected with said motor and to draw oil from said reservoir and to deliver it to said motor to effect relatively rapid actuation thereof; a second pump adapted to be connected with one side of said motor to deliver oil thereinto, thereby to effect relatively slow actuation thereof; a third pump adapted to have its discharge port connected with the exhaust side of said motor when said second pump is connected with the intake side thereof thereby to maintain therein a pressure counter to the pressure built up in the intake side by said second pump; and a valve for connecting one of the first two mentioned pumps with said motor and for short circuiting the other of said two pumps.

3. An hydraulic system combining a motor; a reservoir; a first pump of high capacity adapted to be connected with said motor and to draw oil from said reservoir and to deliver it to said motor to effect relatively rapid actuation thereof; a second pump adapted to be connected with the intake side of said motor to deliver oil thereinto, thereby to effect relatively slow actuation thereof; a third pump adapted to have its discharge port connected with the exhaust side of said motor when said second pump is connected with the intake side thereof thereby to maintain therein a pressure counter to the pressure built up in the intake side by said second pump; and a valve for selectively connecting either of said first and second pumps with either side of said motor to effect forward or reverse actuation thereof and for simultaneously therewith short circuiting the other of said two pumps.

4. An hydraulic system combining a motor; a reservoir; a first pump of high capacity adapted to be connected with said motor and to draw oil from said reservoir and to deliver it to said motor to effect relatively rapid actuation thereof; a second pump of high pressure adapted to have its discharge port connected with the intake side of said motor to deliver oil thereinto when said first pump is disconnected from said motor; a discharge conduit connected with the exhaust side of said motor and extending to said reservoir; a high pressure relief valve embodied in said conduit; and a third pump of high pressure and low capacity receiving oil from said reservoir and connected with the exhaust side of said motor when said second pump is connected with the intake side thereof.

5. An hydraulic system combining a motor; a reservoir; a first pump of high capacity adapted to be connected with said motor and to draw oil from said reservoir and to deliver it into said motor to effect relatively rapid actuation thereof; means to short circuit said pump; a second pump of high pressure having its discharge port connected with the intake side of said motor to deliver oil thereinto when the first pump is short circuited; a discharge conduit connected with the exhaust side of said motor and with the intake port of said second pump; a third pump of high pressure receiving oil from said reservoir and injecting it into said discharge conduit; and a high pres-

sure relief valve in said discharge conduit to limit the maximum pressure therein.

6. An hydraulic system combining a motor; a reservoir; a high capacity low pressure pump adapted to draw oil from said reservoir and to deliver it into either end of said motor; conduits, and valve means therein, to determine which end of said motor shall receive the oil from said pump and to connect the other end thereof with said reservoir; said valve means also serving at another time to short circuit said pump; a second pump of the variable delivery type having its discharge port connected with one end of said motor and its intake port connected with a discharge conduit extending from the exhaust end of the motor when the first pump is short circuited, said valve means also serving to determine which end of the motor shall be connected with the discharge port of the second pump; and a third pump of high pressure and low capacity delivering oil into said discharge conduit thereby to maintain the exhaust end of said motor and said discharge conduit filled with oil under high pressure.

7. An hydraulic system as set forth in claim 5 embodying an auxiliary valve intermediate said main valve and said motor and adapted to isolate both sides of said motor from said pumps and from said discharge conduit to lock the piston of said motor against movement in either direction.

8. An hydraulic system combining a motor; a first pump adapted to be connected to deliver oil into said motor to effect rapid actuation thereof; a second pump adapted to have its intake and discharge ports connected respectively with the opposite sides of said motor to effect slow actuation thereof; and a third pump connected with the intake side of the second pump and thereby adapted to maintain a high pressure on the exhaust side of said motor.

In witness whereof, we have hereunto subscribed our names.

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CERTIFICATE OF CORRECTION.

Patent No. 1,835,977. **Granted December 8, 1931, to**

HANS ERNST ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, line 51, claim 1, for the word "pump" second occurrence read motor; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 9th day of February, A. D. 1932.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)

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