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HYDRAULIC PUMP FOR MACHINE TOOL DRIVES

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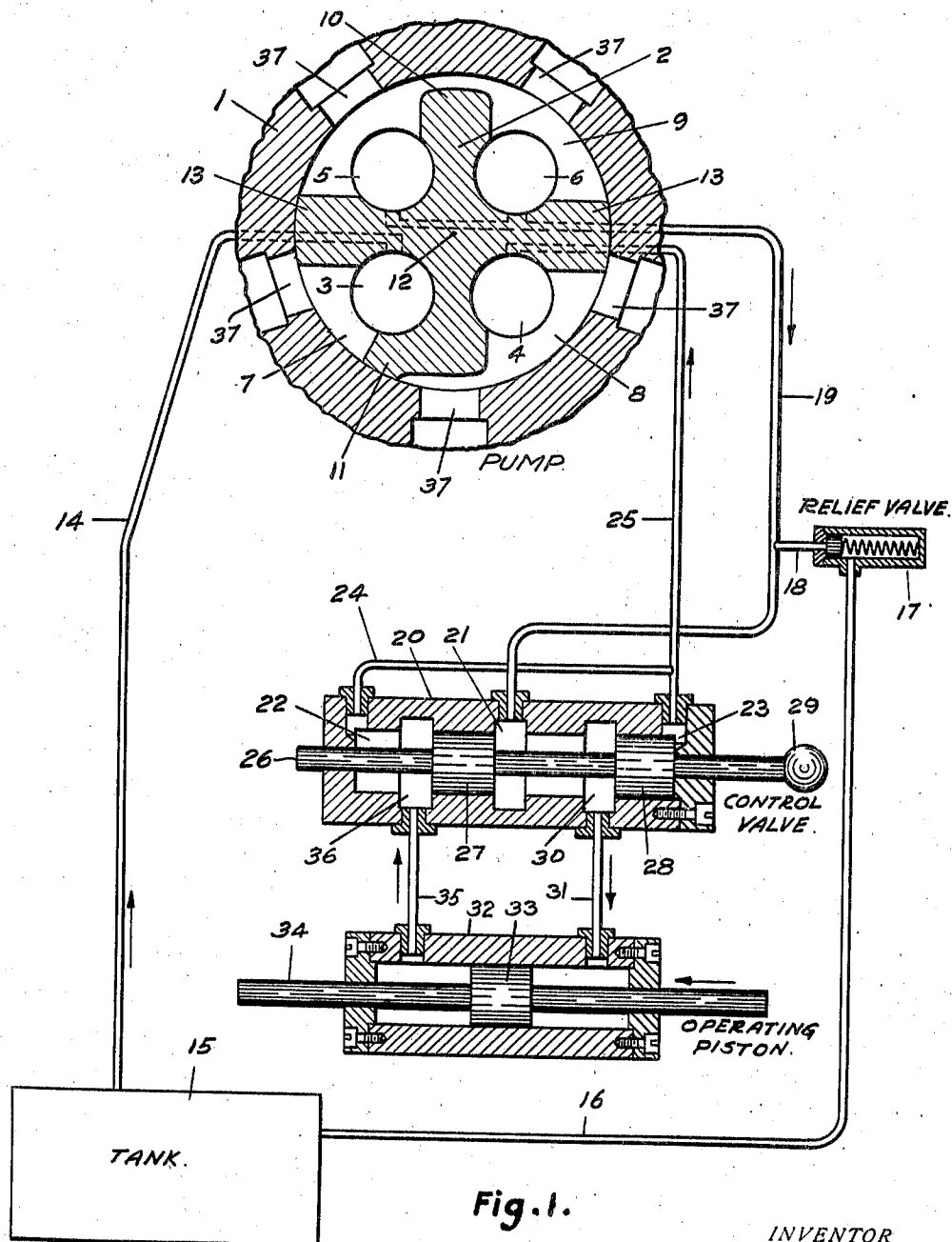


Fig. 1.

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HYDRAULIC PUMP FOR MACHINE TOOL DRIVES

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9 Claims. (Cl. 60—52)

This invention relates to hydraulic pumps and circuits and, in particular, to such pumps and circuits as are adaptable to the driving of machine tool feeds and other similar drives.

One object of my invention is to provide a hydraulic pump with a bored pintle so constructed as to provide a back pressure to the double-acting motive piston which operates the machine tool feed or other suitable devices.

Another object is to provide a hydraulic pump having a pintle with intake and discharge bores, the pintle being so constructed that the pump tends to discharge a greater amount of fluid to one side of a double acting motive piston, than can be returned to the inlet of the pump from the opposite side of the piston, so as to provide a back pressure on the piston in order to prevent "creeping" or uneven motion due to variations in the load.

Another object is to provide such a circuit wherein the pintle has twin discharge passages and twin intake passages, the partition between the intake passages being asymmetrically placed, one intake passage communicating with a fluid tank for supplying make up fluid, whereas the other intake passage and the discharge passages communicate with opposite sides of the motive or operating piston, the latter being used to operate any suitable devices; the pump thus discharging more fluid toward the one side of the piston than can be returned from the opposite side of the piston to the intake passage connected thereto, the excess fluid being discharged through any suitable means, as through a relief valve.

In the drawings:

Figure 1 is a diagrammatic representation of the hydraulic circuit of my invention, showing in cross section the pintle construction and connections thereof to the double-acting operating or servo-piston by way of a control valve.

Figure 2 is a central vertical cross section through the pump shown in part in Figure 1, and showing the pintle construction thereof.

The problem faced by the applicant was to devise a hydraulic circuit whereby a servo-piston could be moved smoothly or firmly locked in a given position, this servo-piston being particularly used for feeding tools. In previous arrangements of this sort, employing a single-acting piston, the piston has had a tendency to "creep" under varying resistance, as well as to "jump" when the cutter or drill breaks through the work piece. This is liable to break the tool or produce chatter marks on the work piece. Double-acting pistons have been devised in the prior art to over-

come this difficulty, but resulted in very complex and costly apparatus or else in unsatisfactory operation. The attempt to create back pressure against one side of the servo-piston by throttling the fluid discharged therefrom has, for example, resulted in excessive heating and waste of power due to the motion of the high velocity fluid through the throttling valve.

The provision of a constant delivery pump to feed fluid to one side of the operating or servo-piston and a variable delivery pump with a bypass arrangement to feed the other side thereof results in a complex and costly mechanism, as well as in the waste of a large amount of the fluid pressure developed, because of the fact that at slow feeding speeds, much of the pump discharge must be by-passed.

In the applicant's solution of the problem, as shown in detail in the drawing of Figure 1, a single variable delivery pump suffices to provide fluid pressure for both sides of the double-acting piston. The applicant's arrangement consists, in general, of a variable delivery pump, represented diagrammatically in Figure 1, and having a rotary cylinder barrel 1, and a pintle 2 of special construction. The detailed construction of the pump is immaterial, since any suitable type of cylinder and piston construction may be used in combination with the pintle 2, such as that shown in Figure 2, and disclosed in the United States Patent to Ernst No. 2,041,172 of May 19, 1936. The radial piston type of variable delivery pump is preferably employed, the pistons being engaged by a shift ring which rotates on an axis eccentric to that of the cylinder barrel, thereby imparting reciprocation to the pistons in a manner well known to the art.

In the hydraulic pump of my invention, the pintle 2 is provided with longitudinal intake bores 3 and 4 and longitudinal discharge bores 5 and 6. In the central plane of the pump, that is the plane passing through the axis of the cylinder bores, the intake bores 3 and 4 open respectively into pintle cut-outs 7 and 8. The discharge bores 5 and 6, on the other hand, open into a pintle cut-out 9. As the cylinder barrel 1 of the pump rotates in the usual manner, its cylinder ports 37 are presented successively to the pintle cut-outs 7, 9 and 8, assuming a clockwise rotation of the cylinder barrel.

It will be observed that both of the discharge bores 5 and 6 impart their contents into the common discharge cut-out 9, the partition 10 being spaced away from the cylinder barrel. In contrast to this, the intake bores 3 and 4 open into

separate intake cut-outs 7 and 8, these being separated by the partition 11, the latter being placed in an eccentric position so as to make the angular extent of the intake cut-outs 7 and 8 decidedly unequal as measured from the axis of rotation 12 of the cylinder barrel. The exhaust and intake cut-outs are separated from one another by the transverse partition member 13 which completely separates the opposite sides of the pump.

The angular extent of the intake port 8 as shown in Fig. 1 amounts to approximately 95°. The governing feature of the return to the inlet 8 resides in the fact that the amount of fluid returned to the inlet will depend upon what portion of a revolution an inlet 37 will remain in communication with the inlet 8. If in Fig. 1 measuring from a point at which an inlet 37 begins to communicate with inlet 8 until the same just passes the portion 11 it will be found that the extent of communication of an inlet 37 with inlet 8 amounts to about 119°. These figures are only approximate, since the partitions 11 and 13 themselves have a certain amount of angular extent, measured from the axis of rotation 12 of the primary rotor. It will be understood that the pintle 2 is stationary.

At its outer end the intake port 3 of the pintle 2 is connected to the conduit 14 leading to the fluid tank 15, from which the conduit 16 leads to the discharge side of the relief valve 17. The intake pipe 18 of the latter is connected to the discharge conduit 19 of the pump. The latter runs from the discharge bores 5 and 6 at the end of the pintle 2 to the middle chamber 21 of the control valve 20. The end chambers 22 and 23 of the latter are interconnected by the conduit 24, which in turn is connected to the intake conduit 25 leading to the intake bore 4 at the end of the pintle 2.

The control valve 20 serves to reverse the direction of the fluid discharged by the pump, and contains a reciprocable valve rod 26 having spaced heads 27 and 28 which are shifted to and fro by the hand knob 29. The intermediate chamber 30 of the control valve 20 is connected by the conduit 31 to one end of the operating piston cylinder 32. The latter is provided with the double-acting piston 33 having the piston rod 34 movable in either direction according to the direction of the fluid admitted to its cylinder 32. The opposite end of the cylinder 32 is provided with the conduit 35 leading to the intermediate chamber 36 of the control valve 20.

The pump shown in part in Figure 1 is shown in greater detail in Figure 2. In addition to the pintle 2, previously described in detail, the cylinder barrel 1 contains the cylinder ports 37 leading to the radial cylinder bores 38, within which the pistons 39 are arranged to reciprocate. The latter are provided with crossheads 40, engaging grooved guideways 41 in tangential guide blocks 42 which are clamped, as by the bolts 43, to the secondary rotor 44. The latter is rotatably mounted in anti-friction bearings (not shown) supported by the shift ring 45.

The shift ring 45 is provided with threaded bores 46 into which are inserted the threaded ends 47 of the shift rods 48. These pass loosely through bores 49 in the sides of the pump casing 50, which is provided with pads 51 and 52 with flattened portions 53 engaging the correspondingly flattened portions 54 upon the upper and lower sides of the shift ring 45. The shift rods 48 may be moved to and fro either by hand or by suitable servomotor mechanism, known to those skilled in the art, thereby varying the separation of the

axis of rotation 12 of the cylinder barrel 1 from the axis of rotation of the secondary rotor 44. This rotation of the two rotors 1 and 44 upon independent and separated axes causes the pistons 39 to reciprocate by reason of the engagement of their crossheads 40 with the guide blocks 42, in a manner well known to those skilled in the art.

In the position of the valve heads 27 and 28 shown in Figure 1, the fluid will be discharged into the righthand end of the operating cylinder 32, in the direction of the arrow, and withdrawn from the lefthand end thereof through the conduit 35. This causes the piston rod 34 to move to the left, in the direction shown by the arrow. By shifting the control valve 20, the direction of flow may be reversed, thus causing the operating piston 33 and the piston rod 34 to move to the right.

In the circuit shown in Figure 1, the feature of separating the intake ports 3 and 4 by the partition 11 and the connection thereof to the tank 15 and control valve 20 respectively through the conduits 14 and 25, results in a tendency for a greater amount of fluid to be discharged into one side of the operating cylinder 32 through the pipe 19 than is withdrawn from the other side through the pipe 25. The intake pipe 14 serves as a "make-up" pipe for the admission of fluid to supply any deficiency which may occur in the various cylinders.

This inequality of pressure on opposite sides of the operating piston head 33 causes the latter to move until the pressures are balanced on opposite sides thereof, or until the resistance encountered balances this pressure. Excess pressure is taken care of by the discharge of fluid through the pipe 18 and relief valve 17 into the tank 15 by way of the discharge pipe 16.

In the operation of the pump and circuit of my invention, the fluid will travel in the direction shown by the arrows when the parts are arranged as shown in Figure 1. Under these conditions the rotating cylinders will discharge more fluid into the discharge cut-out 9 and discharge pipe 19 than they will withdraw from the intake cut-out 8 or from the intake cut-out 7, since the angular travel is much greater in the former case than in the latter. With this arrangement, the operating piston 33 is "crowded" in such a manner that a positive back pressure is created on its exhaust side, since the pump does not take as much fluid out of the operating cylinder 32, as it attempts to put into this cylinder, owing to the additional make-up fluid received from the tank 15 through the conduit 14.

It will be understood that I desire to comprehend within my invention such modifications as may be necessary to adapt it to varying conditions and uses.

Having thus fully described my invention what I claim as new and desire to secure by Letters Patent is:

1. In combination, a hydraulic pump having pumping means therein and a pintle with an outlet port and two inlet ports, a hydraulic motor having its opposite fluid connections to said outlet port and to one of said inlet ports respectively, a source of working fluid connected to the other of said inlet ports, the discharge capacity of the pumping means connected to said outlet port being greater than the intake capacity of the pumping means connected to said first-mentioned inlet port, whereby said pump will tend to supply a greater amount of fluid to one side of said motor than is withdrawn from the other side thereof,

and relief means connected to discharge the excess fluid from said outlet port.

2. In combination, a hydraulic pump having pumping means therein and a pintle with an outlet port and a pair of inlet ports, a double-acting motive piston having its opposite sides connected to said outlet port and to one of said inlet ports respectively, relief means connected to said outlet port, a source of fluid connected to the other of said inlet ports, the discharge capacity of the pumping means connected to said outlet port being greater than the intake capacity of the pumping means connected to said first-mentioned inlet port, whereby said pump will tend to supply a greater amount of fluid to one side of said piston than is withdrawn from the other side thereof.

3. In combination, a hydraulic pump having pumping means therein and a pintle with an outlet port and a pair of inlet ports of unequal circumferential extent, a double-acting motive piston having its opposite sides connected to said outlet port and to one of said inlet ports respectively, means for supplying fluid to the other inlet port, the discharge capacity of the pumping means connected to said outlet port being greater than the intake capacity of the pumping means connected to said first-mentioned inlet port, whereby a back pressure will be built up against said double-acting piston, and relief means connected to discharge the excess fluid from said outlet port.

4. In combination, a variable delivery hydraulic pump having pumping means therein and a pintle with an outlet port and a pair of inlet ports, a double-acting motive piston having its opposite sides connected to said outlet port and to one of said inlet ports respectively, means for supplying fluid to the other inlet port, the discharge capacity of the pumping means connected to said outlet port being greater than the intake capacity of the pumping means connected to said first-mentioned inlet port, whereby said pump will tend to supply a greater amount of fluid to one side of said piston than is withdrawn from the other side thereof, and means responsive to the attainment of a predetermined pressure for discharging the excess fluid when said predetermined pressure is exceeded.

5. In combination, a hydraulic pump having pumping means therein and a pintle with an outlet port and a pair of inlet ports of unequal circumferential extent, a double-acting motive piston having its opposite sides connected to said outlet port and to one of said inlet ports respectively, a source of working fluid connected to the other of said inlet ports, the discharge capacity of the pumping means connected to said outlet port being greater than the intake capacity of the pumping means connected to said first-mentioned inlet port, whereby said pump will tend to supply a greater amount of fluid to one side of said piston than is withdrawn from the other side thereof, and pressure-responsive relief means adapted to discharge the excess fluid from the circuit of said piston when the pressure in said circuit exceeds a predetermined amount.

6. In combination, a hydraulic pump having pumping means therein and a pintle with an outlet port and a pair of inlet ports separated from

one another and of unequal angular extent, a double-acting motive piston having its opposite sides connected to said outlet port and to the larger of said inlet ports respectively, relief means connected to said outlet port, means for supplying fluid to the smaller inlet port, the discharge capacity of the pumping means connected to said outlet port being greater than the intake capacity of the pumping means connected to said first-mentioned inlet port, whereby said pump will tend to supply a greater amount of fluid to one side of said piston than is withdrawn from the other side thereof, and means for reversing the direction of flow of said fluid between said pump and said piston.

7. In combination, a variable delivery hydraulic pump having pumping means therein and a pintle with an outlet port and a pair of inlet ports, separate longitudinal bores communicating with said outlet port and each of said inlet ports respectively, a double-acting motive piston having its opposite sides connected to said outlet port and to one of said inlet ports respectively through said bores, means for supplying fluid to the other inlet port, the discharge capacity of the pumping means connected to said outlet port being greater than the intake capacity of the pumping means connected to said first-mentioned inlet port, whereby a back pressure will be built up against said double-acting piston, and relief means connected to discharge the excess fluid from said outlet port.

8. In combination, a variable delivery hydraulic pump having pumping means therein and a pintle with an outlet port and a pair of inlet ports, separate longitudinal bores communicating with said outlet port and each of said inlet ports respectively, a double-acting motive piston having its opposite sides connected to said outlet port and to one of said inlet ports respectively through said bores, means supplying fluid to the other inlet port, the discharge capacity of the pumping means connected to said outlet port being greater than the intake capacity of the pumping means connected to said first-mentioned inlet port, whereby a back pressure will be built up against said double-acting piston, and pressure-responsive relief means adapted to discharge the excess fluid delivered to said piston when the pressure thereof exceeds a predetermined amount.

9. In a pumping combination, a hydraulic pump circuit including pumping means connected to two inlet ports and an outlet port, a control valve interposed between the outlet port and one inlet port of said pump, a fluid supply tank connected to the other inlet port, an operating piston connected to said control valve, and a return line with a relief valve therein extending between the outlet port and the supply tank, the discharge capacity of the pumping means connected to said outlet port being greater than the intake capacity of the pumping means connected to said first-mentioned inlet port, whereby the operating piston is crowded and a positive back pressure is created on its exhaust side by reason of the fact that the pump takes less fluid away from the piston than it attempts to supply thereto.