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CONTROL APPARATUS FOR PUMPS

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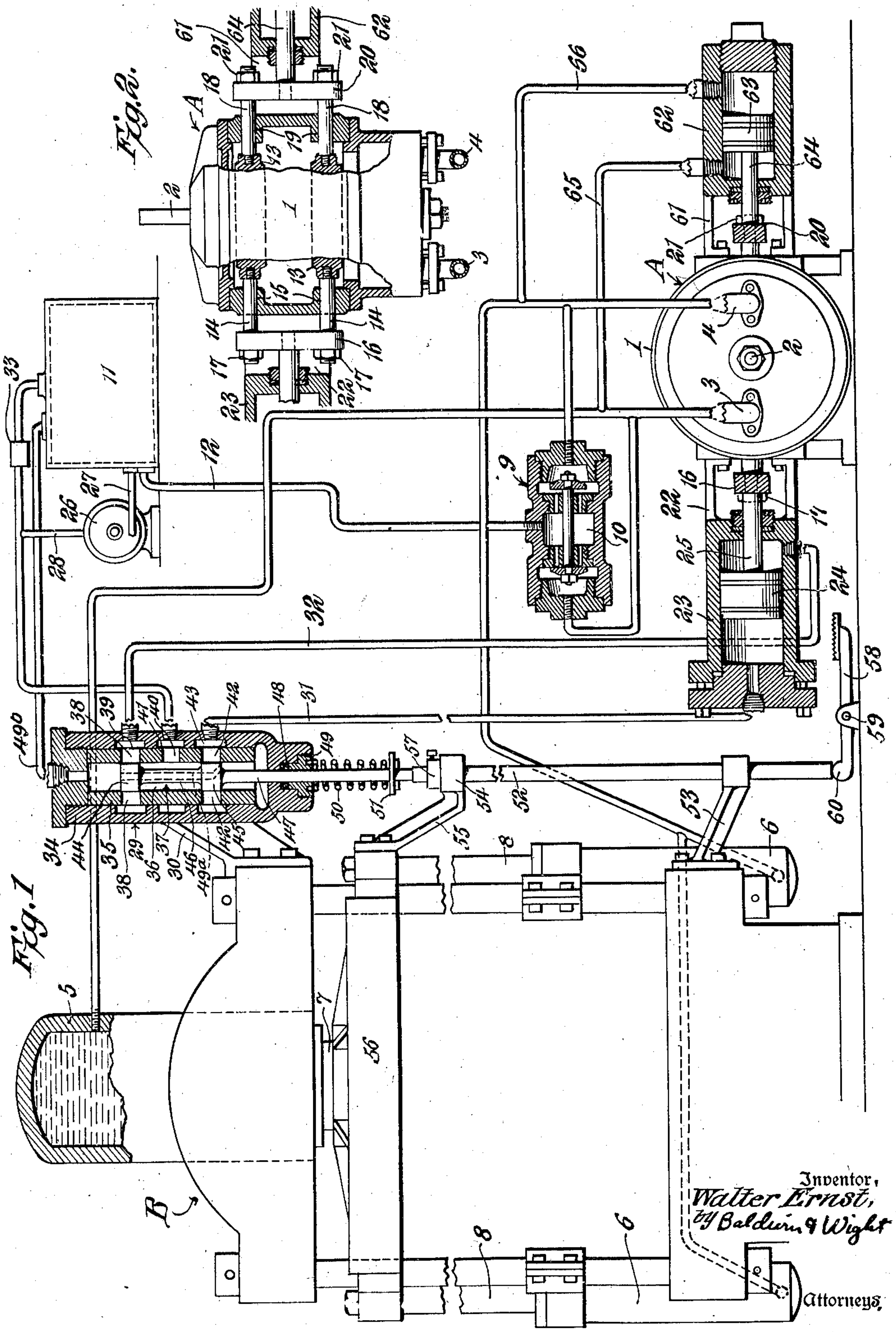

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CONTROL APPARATUS FOR PUMPS

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This invention relates to control apparatus for pumps and more particularly to mechanism for controlling the direction and rate of discharge of reversible variable discharge pumps.

Pumps of this general description are of various constructions, and, generally stated, the present invention relates to control mechanism adapted for use in connection with a number of different types of variable discharge pumps. For the purposes of illustration one embodiment of the invention will be disclosed in connection with a pump of the radial, reversible, variable discharge kind now well known in the art.

Pumps of this kind are exemplified by the pump disclosed in United States Letters Patent 1,250,170, granted to Hele-Shaw et al., December 18, 1917. Briefly stated, such pumps include assemblies comprising a plurality of radially arranged cylinders and pistons, the rate and direction of discharge effected by which depend upon the eccentricity of the cylinder and piston assembly relative to a drive shaft. The cylinders are usually carried by a floating ring or the like, which, by means of a cross head or other control element, may be shifted to vary the eccentricity of the cylinders and thereby to effect control of the pump discharge. Various other kinds of variable discharge pumps are known in the art, and it will be understood that the present invention relates to control mechanism for use in connection with pumps differing in some respects from the pump illustrated herein.

An object of the invention is to improve generally the construction and operation of control mechanism for pumps of this general character.

Another object is to provide, in such a control mechanism, means for limiting the maximum discharge pressure of the pump to any desired value. A further object of the invention is to provide a pump control apparatus including a piston connected to the pump flow control element for shifting the latter to control the direction of flow through the pump, and means mounted independently of the pump and remote therefrom for controlling the application of pressure on said piston. Other objects will become apparent from a reading of the following description, the appended claims, and the several views of the drawing, in which:

Figure 1 is a view partly in front elevation and partly in vertical section of a pump and control mechanism embodying the invention, a hydraulic motor and circuit to which the pump is connected being shown somewhat diagrammatically; and

Figure 2 is a fragmentary top plan view of the pump shown in Figure 1, parts being shown in section.

A practical embodiment of the invention is illustrated in the accompanying drawing as being connected to a pump A of the radial, reversible, variable discharge type, the pump being connected in hydraulic circuit with a hydraulic motor or press B.

As shown, the pump A includes a casing 1, a shaft 2 which may be driven from any suitable source of power, and combined intake and discharge pipes 3 and 4. The pipe 3 is connected to the upper or pressing cylinder 5 of the press B and the pipe 4 is connected to the lower or push back cylinders 6 thereof. When the pump is discharging through the pipe 3, the ram 7 of the press will be moved downwardly to perform a pressing or other like operation, the pump at this time receiving its intake principally from the cylinders 6. When the pump is reversed so as to discharge in the opposite direction, that is, through the pipe 4, fluid will be drawn from the cylinder 5 and delivered under pressure to the cylinders 6 to move the push back rams 8 and ram 7 to their upper positions. A compensating valve 9 of the kind fully disclosed in the United States Patent to Walter Ernst 1,653,350, dated December 17, 1927, is connected across the pipes 3 and 4 and has its central chamber 10 connected to a tank 11 by means of a pipe 12 for compensating for the unequal effective cross sectional areas of the cylinder 5 and the cylinders 6 in a manner well understood in the art.

The pump A includes a pair of floating rings 13—13 mounted in the casing 1, these rings comprising part of a piston and cylinder assembly which is movable radially with respect to the pump shaft for varying the pump discharge. Rods 14—14 are connected to the rings 13—13 and extend through the casing at 15—15, the outer ends of the rods being connected by a cross head or pump flow control element 16 secured to the rods by nuts 17—17. Rods 18—18, also connected to the rings 13—13, extend through the opposite side of the casing at 19—19, the outer ends of these rods being connected by a cross head 20 secured to the rods by nuts 21.

Referring now to the control apparatus forming the subject matter of the present invention, a bracket 22 is mounted on one side of the pump casing and serves to support a control cylinder 23 thereon. A double acting pump control piston 24 is mounted for reciprocation in the cylinder 23 and is connected to the cross head 16 by means of a piston rod 25 extending through the inner end of the cylinder. When the piston 24 is shifted either to the right or to the left in a manner to be described, the floating rings 13—13 of the pump will be shifted so as to vary the pump discharge or to reverse the direction of discharge.

For moving the piston 24 to shift the cross head 16 so as to vary or reverse the discharge of the pump, means are provided for applying fluid pressure to either side of the piston. In the embodiment shown, this pressure-applying means includes a low pressure auxiliary pump 26 arranged to receive fluid from the tank 11 through the medium of a suction pipe 27, and to discharge fluid under relatively low pressure through a pipe 28 to a pilot valve generally designated 29 carried by a bracket 30 secured to the press B, the pilot valve serving to control the application of pressure on the respective sides of the piston 24 through pipes 31 and 32. A relief valve 33, which may be of a conventional pressure responsive type, is interposed between the pipe 28 and the tank 11 to permit by-passing of the low pressure fluid to the tank when fluid is not being delivered through either of the pipes 31 or 32.

The pilot valve includes a casing 34, a liner 35 mounted in the casing and defining a valve chamber 36, and a piston valve generally designated 37. The liner 35 is provided with ports 38 adjacent its upper end which register with an annular chamber 39 formed in the valve casing 34, with a passage 40 at the central part of the liner registering with an annular chamber 41 in the valve casing, and with ports 42 adjacent the lower end of the liner and registering with an annular chamber 43 formed in the valve casing.

The piston valve 37 includes a pair of spaced heads 44 and 45 connected by an intervening reduced portion 46 and a stem 47 which extends downwardly from the head 45 through the lower end of the valve casing, leakage around the stem being prevented by a packing 48 held in place by a gland nut 49. The piston valve is formed with an internal passage 49*a* which provides communication between the valve chamber at the opposite ends of the piston valve and serves to maintain equal unit pressures in the opposite ends of the chamber to facilitate shifting of the valve. A pipe 49*b* provides constant communication between the upper end of the valve casing and the tank 11 for a purpose to be described later.

The heads 44 and 45 are so spaced that, when the head 44 is disposed to cover the ports 38, the head 45 will cover the ports 42. There is sufficient clearance between the valve heads and the inside of the liner to permit a slight leakage through the ports 38 and 42 when the valve heads cover the ports for a purpose to be explained later.

A spring 50 surrounding the valve stem 47 and interposed between the gland nut 49 and a washer 51 secured to the lower end of the stem serves to urge the piston valve 37 downwardly from the position shown in Figure 1. For moving the valve upwardly, I have provided a ram-operated rod 52 which is maintained in alignment with the valve stem 47 by means of a bracket 53 secured to the press base and a boss 54 at the end of an arm 55 connected to the press platen 56, the rod 52 being arranged for free sliding movement within the bracket 53 and the boss 54. A collar 57 secured to the rod 52 is adapted to be engaged by the boss 54 when the rams move upwardly so as to lift the rod 52 to bring the upper end of the latter into engagement with the stem 47 and to raise the piston valve 37. In order to raise the piston valve upwardly from its Figure 1 position when the parts are at rest, I have provided a treadle 58 pivotally supported on a bracket 59 and having a rounded head 60 disposed for engagement with the lower end of the rod 52.

In operation, assuming that the parts are in the positions shown in Figure 1 and that the pumps A and 26 are running, there will be no movement of the press parts until the piston valve 37 has been shifted, since the floating rings 13 of the pump A are in neutral position and the pump is not discharging. Fluid discharged by the pump 26 will be by-passed through the relief valve 33 to the tank 11. In order to initiate a downward movement of the press rams, the treadle 58 will be depressed so as to lift the rod 52 and the valve 37. Fluid delivered by the auxiliary pump will now flow through the pipe 28, the annular chamber 41, the passage 40, the valve chamber 36, the ports 38, the passage 39, and the pipe 32 to the inner end of the control cylinder 23 on the pump. The fluid entering the inner end of the control cylinder will act upon the piston 24 and move the latter and the floating rings 13 toward the left so as to cause the pump A to discharge through the pipe 3 into the pressing cylinder 5 and to drive the ram 7 downwardly. During movement of the piston 24 to the left, fluid contained in the outer end of the cylinder 23 will be discharged therefrom through the pipe 31, the annular chamber 43 in the pilot valve casing, the ports 42, the passage 49*a* in the piston valve 37, the upper end of the pilot valve chamber, and the pipe 49*b*. When the piston 24 has moved the floating rings to the left to an extent which causes the pump A to discharge at the desired rate, the operator will release pressure on the treadle 58 so as to permit the spring 50 to return the piston valve 37 to its Figure 1 position, wherein flow of fluid from the pump 26 to the control cylinder 23 is arrested, and the piston 24 will be maintained in its new position. The pump A will continue to discharge through the pipe 3 until the pressing operation has been performed, and the operator will then release the treadle 58 entirely, so as to permit the spring 50 to move the piston valve 37 down below its Figure 1 position. Fluid from the auxiliary pump will then flow through the pipe 28, the annular chamber 41 and passage 40 in the pilot valve, the valve chamber 36, the ports 42, the annular passage 43, and the pipe 31 into the outer end of the control cylinder 23. Fluid thus introduced into the control cylinder will act upon the outer end of the piston 24 to move the latter and the floating rings 13 to the right so as to reverse the pump and cause it to discharge through the pipe 4 into the push back cylinders 6 of the press. When the piston 24 and floating rings of the pump have been moved to the right to an extent causing the pump to discharge through the pipe 4 at the desired rate, the operator will depress the treadle 58 until the rod 52 has lifted the piston valve 37 to its Figure 1 position, wherein there will be no further flow of fluid from the auxiliary pump to the cylinder 23. However, if it is desired that the pump A deliver fluid through the pipe 4 at the maximum discharge rate during the upward movement of the press rams, the operator need not return the piston valve 37 to its Figure 1 position, and the floating rings 13 will be moved to their extreme right hand positions. When the rams approach the limit of their upward travel, the boss 54 will engage the collar 57 on the rod 52 so as to raise the latter and the piston valve 37 against the urge of the spring 50. The rams will continue to move upwardly until the piston valve 37 has been moved to a position above its Figure 1 position, after which fluid will be delivered to the inner end of the control cylinder 23 in the manner previously described.

This will cause the piston 24 and the floating rings to be moved to the left so as to cause the pump to discharge through the pipe 3 and to start the rams moving downwardly. As soon as the rams have moved downwardly enough to allow the spring 50 to move the piston valve 37 to a position slightly below its Figure 1 position, fluid will be delivered to the outer end of the control cylinder 23, which, as previously stated, will move the piston 24 and the floating rings to the right so as to cause the pump to discharge through the pipe 4. There will be several back and forth movements of the piston 24 and the floating rings, and corresponding movements of the press rams for a short time, until finally the floating rings of the pump will come to rest in a neutral position and fluid will no longer be delivered through either of the pipes 3 and 4, the press rams being thereby brought to rest.

Means are also provided for limiting the maximum pressure of fluid discharged by the pump in either direction. The means shown includes a bracket 61 secured to the pump on the side opposite the control cylinder 23 and serving to mount an overload cylinder 62 on the pump. A double-acting overload piston 63 is mounted in the cylinder 62 and is connected to the cross head 20 by means of a piston rod 64. A pipe 65 provides communication between the pipe 63 and the inner end of the overload cylinder, and a pipe 66 provides communication between the pipe 4 and the outer end of the cylinder. If, during downward movement of the press rams, pressure builds up in the pipe 3 to a predetermined point, this pressure, acting through the pipe 65 and in the inner end of the overload cylinder, will move the overload piston 63 and the cross head 20 to the right so as to reduce the rate of discharge by the pump. During this movement of the piston 63 and the cross head 20, the piston 24 will also necessarily move to the right. Fluid contained in the inner end of the control cylinder 23 will be forced out through the pipe 32 and will leak past the valve head 44 into the upper end of the valve chamber, and then will flow through the pipe 49*b* to the tank 11. Similarly, if, during a return movement of the press rams while the pump is discharging through the pipe 4, pressure should build up beyond a predetermined amount, this pressure, acting through the pipe 66 and in the outer end of the overload cylinder 62, will force the piston 63 and the cross head 20 to the left to move the floating rings toward their neutral position and to reduce the rate of discharge of the pump. During this movement of the piston 63 to the left the piston 24 also must be moved to the left, and the fluid contained in the left hand end of the cylinder 23 will be discharged through the pipe 31 and will leak past the valve head 45 into the lower end of the valve chamber, after which it will flow through the internal passage 49*a* in the piston valve, the pipe 49*b*, and thence to the tank 11.

From the foregoing it will be apparent that my improved control apparatus is extremely simple in that the piston 24 is connected directly to the shiftable flow control elements of the pump, and there are no mechanical connections between the pump and the hydraulic motor served by the pump. The movable element 37 of the pilot valve is free from mechanical connection with the flow control element of the pump, so that the pilot valve may be mounted conveniently on the press, and the pump may be located at some distance from the press, as is often desirable. The control apparatus disclosed herein may be used in connection with various specific kinds of pumps other than that illustrated, and it will be understood that various changes may be made in the specific construction and relative arrangement of the parts without departing from the spirit of the invention as defined in the claims.

I claim:

1. In combination a reversible pump of the type provided with a shiftable piston and cylinder assembly for controlling the direction of flow of fluid through the pump; a hydraulic motor having reciprocable ram means; hydraulic connections between the pump and motor; a pump control cylinder; a hydraulic pump control piston mounted therein and connected to said piston and cylinder assembly; means for supplying fluid under pressure to said control cylinder including a pilot valve mounted on said hydraulic motor independently of said pump and having a movable element free from mechanical connection with said piston and cylinder assembly, an auxiliary pump for supplying fluid under pressure to said pilot valve, and a hydraulic connection between said pilot valve and said control cylinder; means for biasing the movable element of said pilot valve in one direction and ram operated means for automatically shifting the movable element of said pilot valve in the opposite direction.

2. In combination, a reversible variable discharge pump of the type including a shiftable flow control element; a hydraulic motor having reciprocable double acting ram means; hydraulic circuit connections between the opposite sides of said pump and the opposite sides of said ram means respectively; a hydraulic overload cylinder; a double acting overload piston mounted therein and connected to said flow control element; hydraulic connections between the opposite ends of said overload cylinder and said hydraulic circuit connections respectively; a pump control cylinder; a hydraulic pump control piston mounted therein and connected to said flow control element; means for supplying fluid to said control cylinder including a pilot valve mounted on said hydraulic motor independently of said pump and having a movable element free from mechanical connection with the flow control element of said pump, and a hydraulic connection between said pilot valve and said control cylinder; means for biasing the movable element of said pilot valve in one direction and ram operated means for automatically shifting the movable element of said pilot valve in the opposite direction.

3. In combination a reversible pump of the type provided with a shiftable flow control element; a hydraulic motor having reciprocable ram means; hydraulic connections between the pump and motor; a pump control cylinder; a hydraulic pump control piston mounted therein and connected to said flow control element; means for supplying fluid under pressure to said control cylinder including a pilot valve mounted on said hydraulic motor independently of said pump and having a movable element free from mechanical connection with the flow control element of said pump, and a hydraulic connection between said pilot valve and said control cylinder; means for biasing the movable element of said pilot valve in one direction; and ram operated means for shifting the movable element of said valve in the opposite direction.

WALTER ERNST.