June 3, 1941. R. W. READER 2,243,978

ROTARY HYDRAULIC INTENSIFIER

Filed Aug. 14, 1939 2 Sheets-Sheet 1

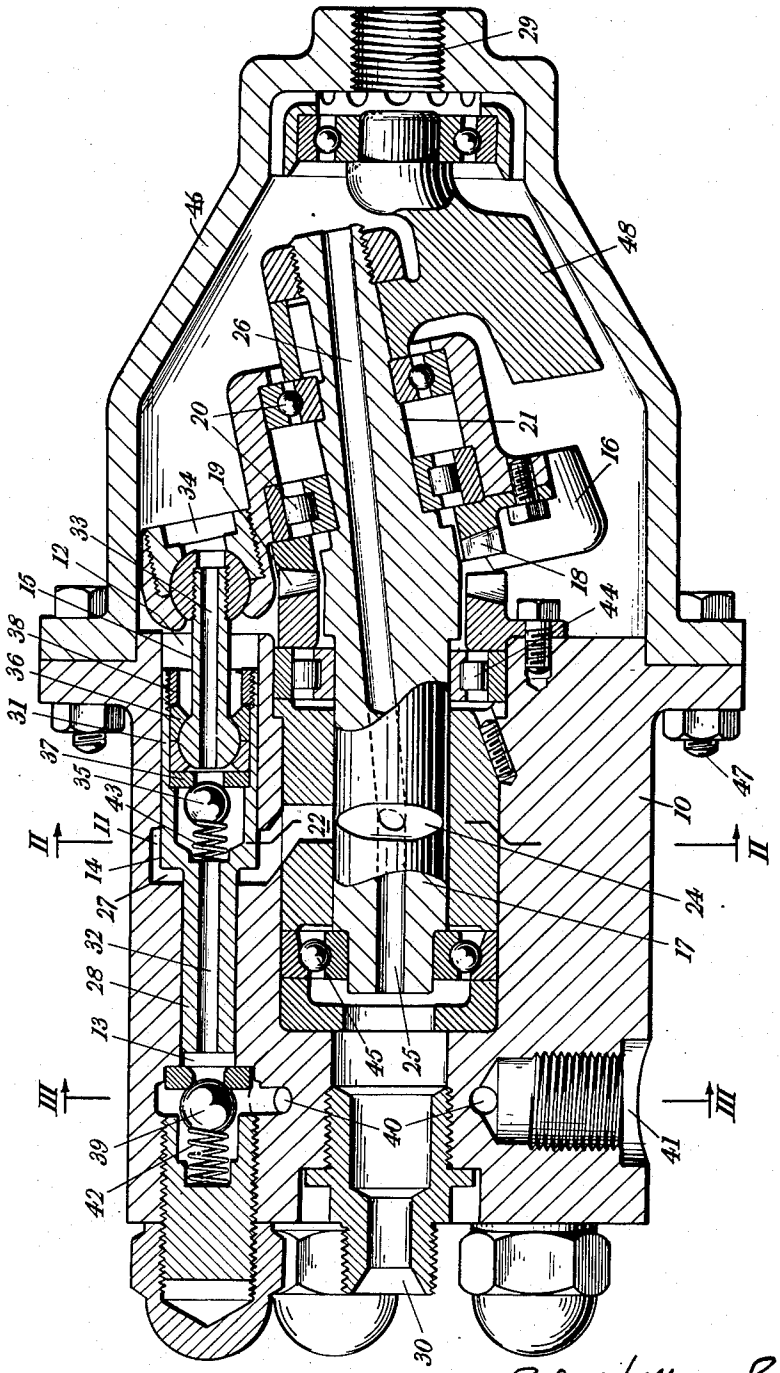


Fig. 1.

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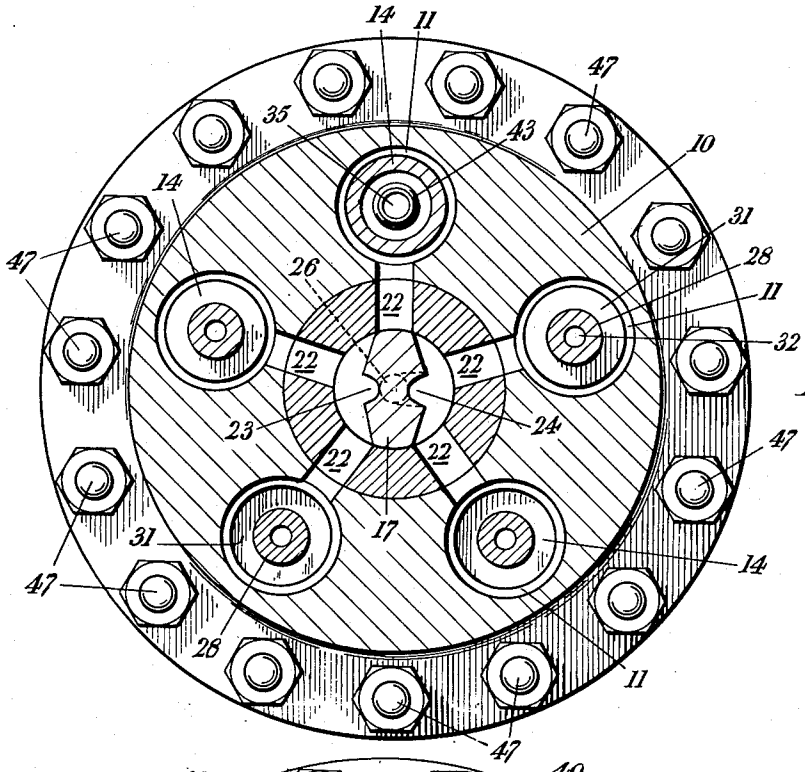


Fig. 2.

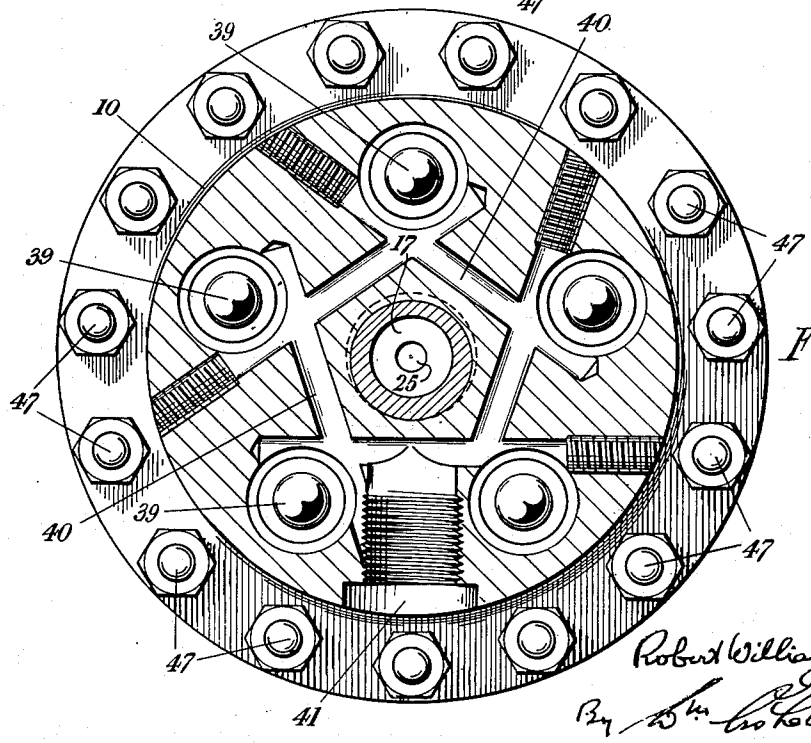


Fig. 3.

Robert William Reader
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UNITED STATES PATENT OFFICE

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ROTARY HYDRAULIC INTENSIFIER

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7 Claims. (Cl. 103—49)

This invention provides a rotary hydraulic intensifier, which, when supplied with liquid under pressure, will be driven to deliver a continuous flow of the liquid at a higher pressure.

The intensifier comprises an inlet for connection to the source of pressure, an exhaust outlet and a high pressure outlet, a shaft arranged to be rotated by the pressure of the liquid supplied to the intensifier and a plurality of cylinders each containing a piston, the pistons being coupled to the shaft so as to be reciprocated in their respective cylinders in cyclical order as the shaft rotates, the arrangement being that on the suction stroke of each piston pressure liquid from the source is drawn into its associated cylinder, while on the delivery stroke a part of said liquid is expelled through the high pressure outlet at an intensified pressure and the remainder is expelled through the exhaust outlet.

In the preferred form of the invention, each cylinder is formed in two portions, one of a smaller cross section than the other, and its piston is similarly formed of two portions of appropriate different cross section, the portion of the cylinder of smaller section being filled with liquid from the source on the suction stroke, and this liquid being subsequently expelled on the delivery stroke by the pressure from the source acting on the portion of the piston of larger cross section.

The larger ends of the pistons may conveniently be coupled to the shaft by means of a swash plate, and the flow of liquid to the cylinders is preferably effected by means of valve-controlled through passages in the pistons which communicate at the larger ends of the pistons with the inlet, and by means of a rotary valve associated with the shaft, which valve is arranged to place the annulus in each cylinder in alternate communication with the inlet and the exhaust outlet. By the term "annulus" is meant that part of the enlarged portion of the cylinder in which lies the smaller portion of the piston.

One form of rotary hydraulic intensifier constructed in accordance with the present invention will now be described in detail, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a longitudinal section through the apparatus, and

Figures 2 and 3 are sections taken respectively along the lines II—II and III—III in Figure 1.

A number of cylinders 11, in this particular instance five, are arranged in a fixed cylinder block 10 with their axes parallel and equidistant from a common axis, the outer end 12 of each cylinder being bored to one diameter, and the inner end 13 to a reduced diameter of such a dimension that the ratio of piston areas corresponds with the increase of hydraulic pressure desired. The cylinders are fitted with suitable pistons 14, each piston having the portions of larger and smaller diameter formed in one piece. The pistons are arranged to reciprocate in cyclical order by connecting their outer ends by means of ball ended connecting rods 15 to a swash plate 16 mounted on a central shaft 17 which is free to rotate about the common axis of the cylinders.

The swash plate itself is restrained from rotation by means of a bevel gear 18 fixed to the swash plate engaging with a similar bevel gear 19 fixed to the cylinder block. The swash plate is mounted in suitable bearings 20 on a portion 21 of the central shaft inclined to its axis of rotation at the correct swash plate angle.

Ports 22 connected to the inner ends of the large portions 12 of the cylinders are formed in the cylinder block and communicate in succession as the shaft rotates with two ports 23, 24 in the shaft which are connected respectively with long holes 25, 26 drilled to the inner and outer end of the shaft. The inner end 27 of the large portion of each cylinder will, as will readily be understood, constitute an annulus surrounding the small diameter portion 28 of the piston 14.

Pipe connections 29, 30 are arranged at the two ends of the cylinder block, that 29 at the outer end being connected to the source of pressure and that 30 at the inner end being connected to an exhaust or return pipe leading to a liquid reservoir. The inlet connection 29 is formed in a casing 46 surrounding the swash plate and bolted to the cylinder block 10 by bolts 47. The arrangement is such that the outer or large diameter end 31 of each piston is always under pressure while the annulus in each cylinder is alternately in connection with pressure and exhaust through the port 22 so that the pressure of the liquid will effect rotation of the shaft and cyclical reciprocation of the pistons.

The small diameter portion 13 of each cylinder is filled with pressure liquid on the suction stroke through an internal passage 32 in the piston com-

municating with another passage 33 along the axis of the connecting rod 15, which passage communicates in turn with a hole 34 formed in the swash plate 16. The passage so formed contains a non-return valve constituted by a ball 35 disposed inside the large portion of the piston between the inner ball socket 36 of the connecting rod and the small end of the piston. The valve seat is formed by a disc 37 of hardened material inserted in the piston, the disc 37, the valve 35 and the ball socket 36 being secured in position by an annular nut 38 screwed into the end of the piston. The end of the small diameter portion of each cylinder is connected through a non-return valve 39 to a high pressure discharge passage 40 in the cylinder block, the five discharge passages being connected to a pipe connection 41 and thence to the pipe conveying the high pressure liquid to the work.

On the outward stroke of the piston the valve 39 is held closed by its spring 42, but the pressure of the liquid opens the valve 35 against the action of its spring 43. Consequently the small end 13 of the cylinder is filled with pressure liquid entering through the passages 33, 32. The large end 12 of the cylinder is also filled with pressure liquid through the passage 26 and ports 24, 22. On the inward stroke the rotary valve constituted by the ports 23, 24 in the shaft cuts off the annulus 27 from the pressure liquid and connects it to exhaust through the passage 25. The original pressure on the large end of the piston then creates an intensified pressure on the small end, and the liquid under the intensified pressure is discharged through the non-return valve 39 into the high pressure pipe.

The portion of the shaft forming the rotating member of the rotary valve is mounted at its outer end in a roller bearing 44 and at its inner end in a ball bearing 45 arranged to carry the end thrust caused by the pressure of the liquid entering the apparatus from the source acting on the area of cross section of the shaft.

A counterweight 48 is attached to the shaft to counteract the out of balance caused by the weight of the swash plate.

What I claim as my invention and desire to secure by Letters Patent is:

1. A rotary hydraulic intensifier, comprising a cylinder block, a shaft mounted for rotation in the cylinder block, a plurality of cylinders disposed in the cylinder block around said shaft each cylinder embodying a high pressure portion and a low pressure portion, a differential piston in each cylinder, connections between the pistons and the shaft for coordinating rotation of the shaft with reciprocation of the pistons in their respective cylinders in cyclical order, an inlet for connection to a source of pressure liquid, an exhaust outlet, a high pressure outlet, conduits connecting the inlet and outlets with the cylinders, and valves for controlling the flow of liquid through said conduits, the valves being arranged to admit pressure liquid from the inlet to each cylinder during the suction stroke of its piston and to discharge on the delivery stroke part of said liquid through the exhaust outlet and the remainder thereof through the high pressure outlet.

2. A rotary hydraulic intensifier, comprising a cylinder block, a shaft mounted for rotation in the cylinder block, a plurality of cylinders disposed in the cylinder block around said shaft, each cylinder being formed of two portions of different cross-section, a piston having portions of correspondingly different cross-section in each cylinder, connections between the pistons and the shaft for coordinating rotation of the shaft with reciprocation of the pistons in their respective cylinders in cyclical order, an inlet for connection to a source of pressure liquid, an exhaust outlet, a high pressure outlet, conduits connecting the inlet and outlets with the cylinders, and valves for controlling the flow of liquid through said conduits, said valves being arranged to admit pressure liquid to both portions of each cylinder during the suction stroke of its piston, and to discharge on the delivery stroke the liquid in the larger portion of the cylinder to the exhaust outlet and the liquid in the smaller portion of the cylinder to the high pressure outlet.

3. A rotary hydraulic intensifier, comprising a cylinder block, a shaft mounted for rotation in the cylinder block, a plurality of cylinders disposed in the cylinder block around said shaft, each cylinder being formed of two portions of different cross-section, a piston having portions of correspondingly different cross-section in each cylinder, a swash plate connection between the shaft and the pistons, an inlet for connection to a source of pressure liquid, an exhaust outlet, a high pressure outlet, conduits connecting the inlet and outlets with the cylinders, and valves for controlling the flow of liquid through said conduits, said valves being arranged to admit pressure liquid to both portions of each cylinder during the suction stroke of its piston, and to discharge on the delivery stroke the liquid in the larger portion of the cylinder to the exhaust outlet and the liquid in the smaller portion of the cylinder to the high pressure outlet.

4. A rotary hydraulic intensifier, comprising a cylinder block, a shaft mounted for rotation therein, an inlet for pressure liquid, an exhaust outlet, a high pressure outlet, a plurality of cylinders disposed in the cylinder block around the shaft and each formed of two portions of different cross-section, a piston in each cylinder having two portions of correspondingly different cross-section, each piston being formed with a through passage communicating at the larger end of the piston with the inlet, a valve in each passage arranged to open on the suction stroke of the piston to admit pressure liquid from the inlet to the smaller portion of the cylinder, a conduit connecting the smaller portion of each cylinder with the high pressure outlet, a valve in each of said conduits arranged to open on the delivery stroke of the associated piston, conduit connections between the annulus in each cylinder and the inlet and exhaust outlet, a rotary valve associated with the shaft for controlling the flow of liquid through said conduit connections and arranged to place each annulus alternately in communication with the exhaust outlet and with the inlet, thereby permitting the pistons to be driven in cyclical order by the entering pressure liquid, and connections between the pistons and the shaft for coordinating cyclical reciprocation of the pistons with rotation of the shaft.

5. A rotary hydraulic intensifier, comprising a cylinder block, a shaft mounted for rotation therein, an inlet for pressure liquid, an exhaust outlet, a high pressure outlet, a plurality of cylinders disposed in the cylinder block around the shaft and each formed of two portions of

different cross-section, a piston in each cylinder having two portions of correspondingly different cross-section, each piston being formed with a through passage communicating at the larger end of the piston with the inlet, a valve in each passage arranged to open on the suction stroke of the piston to admit pressure liquid from the inlet to the smaller portion of the cylinder, a conduit connecting the smaller portion of each cylinder with the high pressure outlet, a valve in each of said conduits arranged to open on the delivery stroke of the associated piston, conduit connections between the annulus in each cylinder and the inlet and exhaust outlet, a rotary valve associated with the shaft for controlling the flow of liquid through said conduit connections and arranged to place each annulus alternately in communication with the exhaust outlet and with the inlet, thereby permitting the pistons to be driven in cyclical order by the entering pressure liquid, and a swash plate connection between the pistons and the shaft.

6. A rotary hydraulic intensifier as claimed in claim 4, in which the shaft is formed with through passages communicating respectively with the inlet and the exhaust port, and in which radial ports in the shaft communicating with said passages serve as the rotary valve for placing the passages in alternate communication with the annulus in each cylinder.

7. A rotary hydraulic intensifier, comprising a rotary member, a plurality of cylinders each embodying a high pressure portion and a low pressure portion, a differential piston in each cylinder, valve means under the control of the rotary member for operating in succession on the low pressure portions of the cylinders to connect them alternately to a source of pressure liquid and to exhaust, thereby causing the pistons to be successively displaced by the pressure of the liquid, means cooperating with the pistons for driving the rotary member on displacement of the pistons as aforesaid and for effecting positive return movement of the pistons, and valves arranged to admit pressure liquid to the high pressure portions of the cylinders on the suction stroke of their respective pistons and to permit of the discharge of said liquid at an intensified pressure on the delivery stroke.

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