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W. R. TUCKER ET AL

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FLUID PRESSURE INTENSIFIER

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FIG. 1

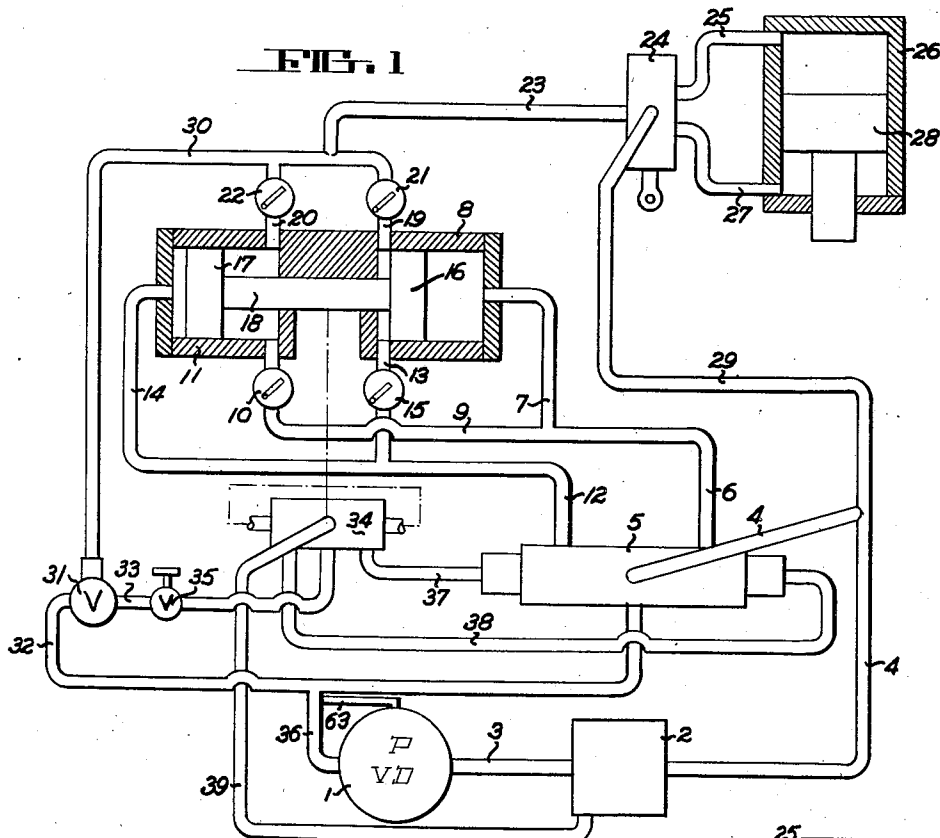
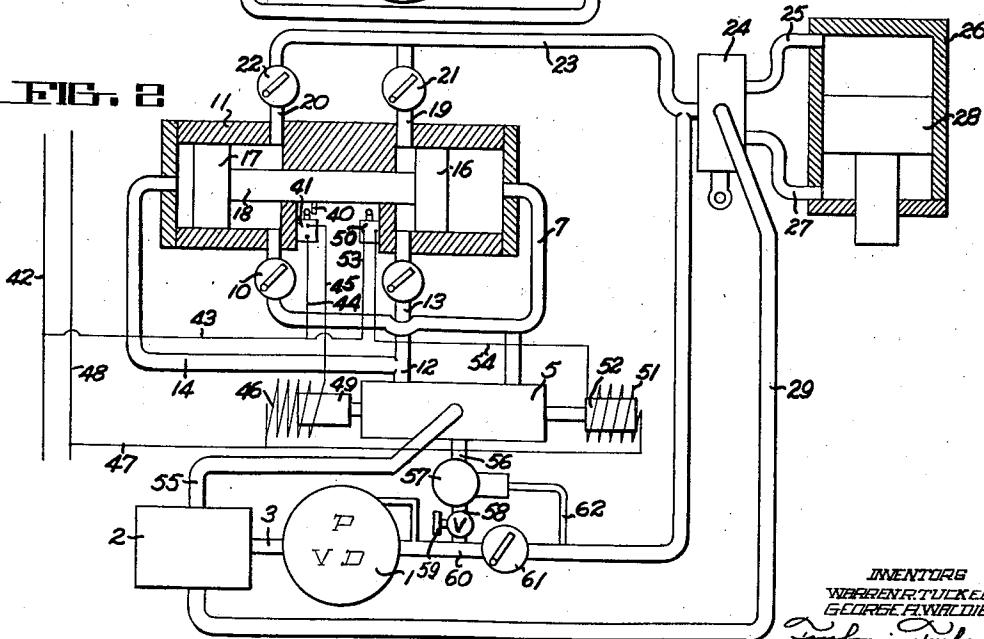


FIG. 2



INVENTORS
WARREN TUCKER
GEORGE F. WALSH
BY *W. R. Tucker*
ATTORNEYS

UNITED STATES PATENT OFFICE

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FLUID PRESSURE INTENSIFIER

Warren R. Tucker, Dayton, and George A. Waldie,
 Miamisburg, Ohio, assignors to The Hydraulic
 Development Corporation, Inc., Wilmington,
 Del., a corporation of Delaware

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7 Claims. (Cl. 103—52)

This invention relates to intensifiers and, in particular, to intensifiers for boosting the pressure output of fluid pressure sources as, for instance, pumps.

It is an object of the invention to provide intensifiers which may be used in connection with pumps for boosting the pressure delivered by the latter, without imposing any material changes upon the flow characteristics of the pumps.

It is another object of the invention to provide intensifier means which will make it possible selectively to use the fluid delivered by a pressure fluid source at its actual delivery pressure or to boost the pressure while maintaining a substantially continuous flow of the thus treated pressure fluid.

A further object of the invention consists in the provision of intensifier means in connection with a fluid pressure source, in which the operation of the intensifier means is controlled by fluid pressure established by the fluid pressure source.

Still another object of the invention consists in the provision of an intensifier for boosting the pressure of a fluid pressure source, in which the intensifier comprises at least two operatively connected differential pistons.

It is a still further object to provide an intensifier system for increasing the pressure of a fluid pressure pump, in which hydraulic connection of the said fluid pressure pump with a plurality of differential pistons is controlled by a common distributing valve in accordance with the movement of said differential pistons.

These and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawing, in which:

Figure 1 diagrammatically illustrates an intensifier according to the invention in connection with a variable delivery pump in a hydraulic circuit.

Figure 2 is a diagrammatic illustration of an intensifier system similar to that of Figure 1, but with a modified intensifier control.

General arrangement

The intensifier according to the invention substantially comprises a plurality of differential pistons which are so arranged in a hydraulic circuit comprising a pump, the pressure of which is to be boosted, that the said pistons automatically start their intensifying or boosting action

as soon as the pump has established a predetermined pressure.

According to the first and second embodiments of the invention, the reversing control of the intensifier pistons is effected by a plurality of reciprocatory valves.

Structural arrangement

Referring now to the drawing in detail and, in particular, to the arrangements of Figures 1 and 2, the system shown in the said figures comprises a variable delivery pump with servo-motor means which, at the establishment of a predetermined pressure at the pressure side of the pump 1, moves the latter to neutral or substantially no delivery position. Such pumps are well known to those skilled in the art and may, for instance, be of the same type as the pump described in Patent No. 2,039,893 to Ernst.

One side of the pump 1 is connected with a fluid reservoir or tank 2 through the suction line 3. The tank 2 is adapted to communicate through conduit 4 with a four-way valve 5, which may be of a standard type. The four-way valve 5 communicates with a conduit 6 having two branches, of which the line 7 leads to the right side of the intensifier cylinder 8, while the branch line 9 comprising a check valve 10 leads to the right side of the intensifier cylinder 11. Similarly, a conduit 12 connected to the four-way valve 5 has two branch lines 13 and 14, of which the line 13 comprising a check valve 15 leads to the left end of the intensifier cylinder 8, whereas the line 14 leads to the left end of the intensifier cylinder 11.

Reciprocally mounted in the intensifier cylinders 8 and 11 are differential pistons 16 and 17 respectively, which are operatively interconnected by a piston rod 18. Hydraulically connected with the smaller piston areas of the intensifier pistons 16 and 17 are conduits 19 and 20 with check valves 21 and 22 respectively, which conduits 19 and 20 are in hydraulic communication through conduit 23 with a four-way valve 24 adapted to direct the control of pressure fluid from conduit 23 selectively through conduit 25 to the upper portion of the cylinder 26, or through conduit 27 to the lower portion of cylinder 26, having reciprocally mounted therein a piston 28. The four-way valve 24 is furthermore connected through line 29 with the tank 2.

According to the embodiment of Figure 1, the conduits 19 and 20 communicate through conduit 30 with a pressure controlled valve 31 adapted to establish hydraulic communication be-

tween conduit 32 leading to the four-way valve 5 and conduit 33 leading to shift valve 34 as soon as a predetermined pressure has been established in conduit 30. Such pressure controlled valves are well known in the art and for a more detailed description thereof reference may be had to Patent No. 2,086,295 to Ernst.

The conduit 33 also comprises a shutoff valve 35 which, when closed, enables operation of the piston 28 at the delivery pressure of the fluid delivered by pump 1, whereas when valve 35 is open the piston 28 will automatically be operated at an intensified pressure as created by the intensifier cylinder-piston-assembly 8, 16; 11, 17.

The shift valve 34 is mechanically connected to the piston rod 18 so that, at the end of the strokes of pistons 16 and 17 in one direction, the shift valve 34 causes fluid delivered by pump 1 through lines 36, 32 and 33 to flow through conduit 37 for shifting the four-way valve 5 in one direction, whereas at the end of the strokes of pistons 16 and 17 in the opposite direction, fluid delivered by the pump 1 will pass through conduit 38 to the four-way valve 5 to shift the latter in the opposite direction. The shift valve 34 is furthermore connected through conduit 39 with the fluid tank 2.

The intensifier system of Figure 2 differs from that of Figure 1 primarily in that the four-way valve 5 is electrically shifted instead of being hydraulically shifted as in Figure 1. To this end, the piston rod 18 of Figure 2 is provided with a switch actuating arm 40 adapted, at one end position of the pistons 16 and 17, to actuate a switch 41 for closing an energizing circuit comprising the main supply line 42, lines 43 and 44, switch 41, line 45, coil 46, line 47 and main supply line 48. Energization of the coil 46 causes movement of the armature 49 connected to the valve member of valve 5 toward the left.

When the pistons 16 and 17 have reached their other end position, the switch actuating arm 40 closes the switch 50 so as to energize the solenoid 51, which causes rightward movement of the armature 52 and the valve member of the four-way valve 5. The energizing circuit for solenoid 51 comprises the main supply line 42, line 53, switch 50, line 54, solenoid 51, line 47 and main supply line 48.

The four-way valve 5 communicates through conduit 55 with the tank 2 and through conduit 56 with a pressure controlled valve 57 similar to the valve 31 of Figure 1. The valve 57 is connected with a conduit 58 comprising a shutoff valve 59 performing the same function as the shutoff valve 35 in Figure 1, and connected with the pressure line 60 of pump 1. The pressure line 60 comprises a check valve 61 and leads to conduit 23. Branching off from conduit 60 is a pilot line 62 connected to the valve 57 and performing the same function as line 30 in Figure 1.

Operation of first and second embodiments

Referring first to Figure 1 and supposing that the pump 1 is running and it is desired to operate the piston 28 at intensified pressure, the operator opens the valve 35, and assuming that piston 28 is in its uppermost position, shifts the valve 24 so as to effect hydraulic communication between conduits 23 and 25. Fluid pressure delivered by pump 1 then passes through conduit 36, line 32, valve 5 and either conduit 6 or 12 and, consequently, either check valve 10 or 15 to the left portion of intensifier cylinder 8, or right portion of intensifier cylinder 11 to conduit

23 and from there through the four-way valve 24 and conduit 25 into the upper portion of the cylinder 26 so as to move the piston 28 downwardly.

If the piston 28 moves downwardly by gravity, the fluid entering the upper portion of the cylinder 26 merely fills the increasing space. The fluid expelled from the lower part of cylinder 26 passes through conduit 27, four-way valve 24 and conduits 29 and 4 to the tank 2. As soon as the piston 28 encounters resistance exerted by a work piece, for instance, when the piston 28 has reached the position shown in Figure 1, pressure starts to build up in the upper portion of cylinder 26 and is conveyed through conduit 25, four-way valve 24 and conduit 23 to conduit 30, causing check valves 21 and 22 to close and acting upon valve 31 so as to effect hydraulic communication between conduits 32 and 33.

Fluid pressure delivered by pump 1 then passes from conduit 36 through conduits 32 and 33, shift valve 34 and conduit 38 to the four-way valve 5, shifting the latter so as to establish hydraulic connection between conduit 32 and conduit 12, if the valve 5 should not already be in the said position. Pressure will then build up in the left portion of cylinder 11 and the left portion of cylinder 8 and, due to the difference in areas on both sides of pistons 16 and 17 respectively, the pistons 16 and 17 will move toward the right, pressing the fluid through conduit 20 and check valve 22 into conduit 23 at an increased pressure, and the thus boosted pressure is conveyed through four-way valve 24 and conduit 25 into the upper portion of cylinder 26 where it actuates the piston 28 at increased pressure.

The fluid expelled from the lower portion of cylinder 26 is exhausted to tank 2 in the manner described above.

The increasing space on the left side of piston 16, during its rightward stroke, is filled with fluid passing through conduit 12, check valve 15 and conduit 13, whereas the fluid expelled during this rightward stroke by piston 16 from the right portion of cylinder 8 passes through conduits 7 and 6, four-way valve 5 and conduit 4 to the tank 2.

When the pistons 16 and 17 have reached the end of their rightward stroke, the piston rod 18, due to its operative connection with the shift valve 34, shifts the latter into opposite direction so as to effect hydraulic communication between the conduit 33 and the conduit 37. This in turn causes hydraulic shifting movement of the four-way valve 5 so as to establish hydraulic communication between the conduits 32 and 6.

Pressure fluid delivered by pump 1 then passes through conduits 36 and 32 to conduit 6. From here part of the fluid passes into the right portion of cylinder 8 and another part into the right portion of cylinder 11. Due to the differential pressure areas of the pistons 16 and 17 respectively, the said pistons now move toward the left so that fluid is expelled from the left portion of cylinder 8 by piston 16 at an increased pressure, and passes through conduit 23, four-way valve 24 and conduit 25 into the upper portion of cylinder 26 acting upon piston 28 so as to move the latter in the same direction as previously. The fluid expelled from the left portion of cylinder 11 passes through conduit 12, valve 5 and conduit 4 into the tank 2. When the pistons 16 and 17 have again reached their left end position, the piston rod 18 again shifts the shift valve 34 in the manner previously

described and the delivery of boosted pressure fluid to conduit 23 continues.

When the piston 28 has reached the end of its downward stroke, so that a predetermined pressure is established in the upper portion of cylinder 26, this pressure will be conveyed through the intensifier proper, four-way valve 5, conduit 32 and conduits 36 and 63 to the servomotor of pump 1 so as to shift the latter to neutral or substantially no delivery position. The piston 28 is then held in its lower position at a predetermined pressure.

If an upward stroke of piston 28 at boosted pressure is now desired, all that it is necessary to do is to shift the valve 24 so as to establish hydraulic connection between the conduits 23 and 27, while establishing hydraulic communication between the conduits 25 and 29. The pump 1 will then again move to delivery position and lift the piston 28 at its actual delivery pressure if no resistance is encountered by piston 28. If resistance is encountered by piston 28, fluid pressure will build up in the lower portion of the cylinder 26 and the intensifier will be actuated in the same manner as previously described in connection with the downward stroke of the piston 28. At the end of the upward stroke of piston 28, the latter will come to a halt and the pump 1 will move to neutral or substantially no delivery position until the valve 24 is reversed.

The operation of the circuit shown in Figure 2 is substantially the same as that described in connection with Figure 1, the only exception being that the valve 5 is not hydraulically shifted but is electrically shifted by means of the solenoids 46 and 51, the circuits of which are closed by actuation of the switches 41 and 50 by means of arm 45 connected to the piston rod 18.

As long as no pressure is built up in the cylinder 26, fluid delivered by pump 1 passes through conduit 60 and check valve 61 to the four-way valve 24, but as soon as pressure is built up in the cylinder 26 and, therefore, also in conduit 23, this pressure closes the check valve 61 and, passing through pilot line 62, causes valve 57 to effect hydraulic communication between conduits 58 and 56. The operation of the system of Figure 2 will then be carried out similar to that of Figure 1.

It will be understood that we desire to comprehend within our invention such modifications as come within the scope of the claims.

Having thus fully described our invention, what we claim as new and desire to secure by Letters Patent is:

1. In an intensifier system, two cylinders, two synchronically movable differential pistons respectively reciprocable in said cylinders, means for connecting said pistons with each other, each of said pistons having a large and an opposed smaller piston area, means for supplying fluid to one of said smaller piston areas, and means for supplying pressure fluid to the other smaller piston area and substantially simultaneously to one of said larger piston areas for imparting upon the fluid adjacent said first mentioned smaller piston area an intensified pressure corresponding to the ratio of said last mentioned smaller area to the total of the other smaller piston area and the large piston area acted upon by pressure fluid.

2. In an intensifier system, a pair of intensifier cylinders, each of said cylinders having reciprocably mounted therein a piston with a large and an opposed smaller differential piston area, means for operatively interconnecting said pistons, first valve means for selectively supplying

pressure fluid to one large piston area and simultaneously therewith to one smaller piston area, to thereby impart intensified pressure on the fluid adjacent the other smaller piston area, and second valve means hydraulically connected with said first valve means and operatively connected with said pistons for controlling the position of said first valve means.

3. In an intensifier system, a pair of oppositely directed differential pistons, each having a large piston area and an opposed smaller piston area, means positively interconnecting said pistons, valve means for controlling the supply of pressure fluid to said piston areas, means for simultaneously supplying pressure fluid to the larger piston area of one piston and the smaller piston area of another piston to impart an increased pressure on the fluid adjacent the smaller area of said first mentioned piston, and means controlled by said pistons for controlling said valve means.

4. In a hydraulic system, two spaced oppositely directed intensifier pistons, each having a large and a smaller piston area, said pistons being rigidly connected with each other and being reciprocable in two separate cylinders, inlet and outlet means adjacent the inner ends of said intensifier cylinders, a pressure fluid source adapted to supply pressure fluid to said areas, valve means interposed between said pressure fluid source and said intensifier cylinders and operable to admit pressure fluid simultaneously to the large piston area of one piston and the smaller piston area of the other piston, to thereby impart intensified pressure on fluid adjacent the other smaller piston area, and means operable by said intensifier pistons for controlling said valve means.

5. In an intensifier system, a pair of cylinders, a pair of fluid operable pistons reciprocable in said cylinders, each piston having a large and an opposed smaller piston area, means positively interconnecting said pistons, a fluid source for supplying pressure fluid to said piston areas, a fluid operable valve hydraulically connected with said cylinders and operable to selectively convey pressure fluid from said fluid source to the large piston area of one piston and simultaneously to the smaller piston area of the other piston, means responsive to the building up of pressure at the pressure side of said fluid source for automatically initiating operation of said differential pistons, and means responsive to the travel of said differential pistons for controlling said valve means.

6. In an intensifier system, a pair of oppositely directed differential pistons with the smaller piston areas directed toward each other and with the larger piston areas directed away from each other, two spaced intensifier cylinders having reciprocably mounted therein said pistons, a pressure fluid source for supplying pressure fluid selectively to the larger piston area of one piston and simultaneously to the smaller piston area of the other piston, or to the larger area of said last mentioned piston and simultaneously to the smaller area of said first mentioned piston, valve means interposed between said pressure fluid source and said cylinders for controlling the supply of pressure fluid to said piston areas, and a control valve operable by said pistons and in response to the establishment of a predetermined pressure at the pressure side of said fluid source for controlling the position of said valve means.

7. In an intensifier system, two synchronically movable oppositely directed differential pistons, each having a large and an opposed smaller area, a pressure fluid source for supplying pressure fluid to said pistons, a fluid operable valve for controlling the supply of pressure fluid from said fluid source to said pistons so as to admit pressure fluid simultaneously to the larger piston area of one piston and the smaller piston area

of another piston, control valve means for controlling the supply of control fluid to said fluid operable valve, and means responsive to a predetermined pressure at the pressure side of said fluid source for admitting control fluid to said control valve means.

WARREN R. TUCKER.
GEORGE A. WALDIE.