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HYDRAULIC PRESSURE BOOSTER

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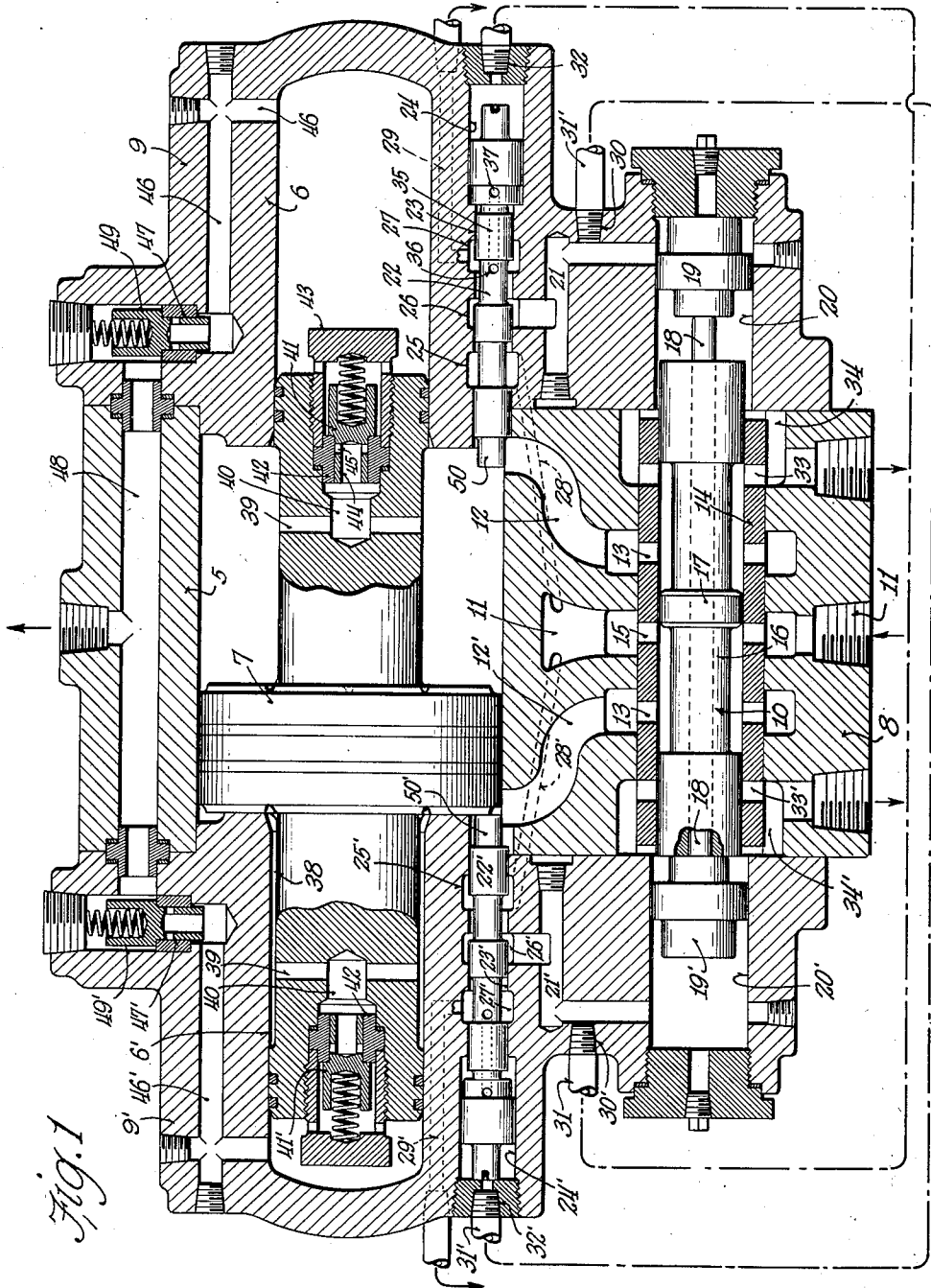


Fig. 1

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HYDRAULIC PRESSURE BOOSTER

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4 Claims. (Cl. 121—157)

The invention relates to hydraulic pressure boosters.

The general object of the invention is to provide a combined pump and motor device of the differential piston type in which a pressure fluid at low pressure acting against the larger diameter of the piston is used to raise the pressure of an operating fluid, preferably a portion of the low pressure fluid, to the desired higher pressure. The pump and motor device of the present invention is double acting, and the pressure of the higher pressure fluid is practically continuous through the operation of an automatically operated reversing valve whose movements are positively controlled by auxiliary valves which are in turn controlled both by each other, by the piston, and by the pressure of the motive fluid.

A further object of the invention is to provide a pump and motor of the type above described in which the entire area of the high and low pressure pistons may be used to drive the piston.

The invention further consists in the several features hereinafter set forth and more particularly defined by claims at the conclusion hereof. In the drawings:

Fig. 1 is a vertical sectional view of a device embodying the invention in one of its operating positions;

Fig. 2 is a vertical sectional view similar to Fig. 1 showing certain modifications.

The combined motor and pump comprises a low pressure cylinder 5 and high pressure cylinders 6, 6' aligned therewith and with a double acting differential piston 7 having parts reciprocating in said cylinders. The cylinder 5 is formed in a casing 8 and the cylinders 6 in end plates 9 and 9' secured in a fluid-tight manner to the casing 8.

A main piston type reversing valve 10 works in the casing 8 having a low pressure supply conduit 11, and passages 12, 12' respectively connecting opposite ends of the cylinder 5 with passages or holes 13 in the cylindrical valve liner 14. The conduit 11 connects with holes 15 in said liner. The valve 8 has annular recesses 16 therein on opposite sides of a central part 17 whereby the conduit 11 will connect with either the passage 12 or the passage 12'. Instead of being directly operated by the hydraulic fluid, the valve 8 has a lost motion connection through a rod 18, loosely mounted in it and of greater length, with hydraulically operated rams 19, 19' working in bores 20, 20' formed in the end plates 9 and 9' and aligned with the bore in the liner 14.

Passage of hydraulic fluid to the bores 20 and

20' is through passages 21 and 21' formed in the respective end plates and each controlled by its own differential piston type control valve 22 or 22'.

The control valves 22 and 22' work respectively in differentially aligned bores 23, 24 and 23', 24', the bores 23 and 23' being of smaller diameter and having annular enlargements 25, 26, and 27 and 25', 26', and 27' therein, respectively. The enlargements 25 and 25' connect by cored passages 28 and 28' in the casing 8 with the inlet passage 11, the enlargements 26 and 26' connect with the passages 21 and 21' and the enlargements 27 and 27' connect with passages 29 and 29' which are connected with the exhaust or return connection to the fluid supply tank. A port 30' from the passage 21' connects through exterior piping 31 with a port 32 communicating with the bore 24, and a port 30 connects through exterior piping 31' with a port 32' communicating with the bore 24'. The liner 14 has exhaust ports 33 and 33' which connect with permanent exhaust chambers 34, 34' that in turn are connected by suitable piping with the supply tank.

For allowing any leakage from the larger diameter parts of the valves 22 and 22' to quickly escape to exhaust each of these valves has a longitudinal passage 35 connected by ports 36 and 37 whereby leakage from the space adjacent bores 23 or 23' may escape through port 37, passage 35, and port 36 to the exhaust including the enlargement 27 or 27' and passage 29 or 29'.

In order to allow the low pressure fluid to act on the entire area of each end of the piston 7, the back end of each high pressure end is relieved to provide a space 38 which is connected by a diametrically disposed passage 39 with a centrally disposed passage 40 leading to the high pressure bore of the cylinder 6 or 6' whose outer end is controlled by a flat seated spring closed check valve 41 or 41', each mounted to cooperate with a removable seat member 42 in the passage 40 secured in position by a sleeve nut 43. Each check valve has a sleeve guide extension 44 provided with passages 45 adjacent the seating portion of said valve.

The high pressure bore 6 has passages 46 and 47 connected to a high pressure outlet passage 48, and the high pressure bore 6' has passages 46' and 47' connected to the high pressure outlet passage 48. A spring seated discharge check valve 49 controls the discharge from the passage 47 to the passage 48, and a similar valve 49' controls the discharge from the passage 47' to the passage 48.

The drawing shows the device about to start on its pumping stroke toward the right, the space 38 in front of the left hand face of the piston 7 being filled with low pressure oil, some of which has passed by the check 41' to fill the cylinder space 6' in front of the high pressure portion of the piston 7. This low pressure oil is being admitted to the device through the low pressure inlet 11, holes 15, recess 16 in valve 10, ports 13, passage 12', space 38, and through passages 39 and 40 past check valve 41' to cylinder space 6' and its connecting passages which are under these conditions cut off from the high pressure outlet 48. At the same time low pressure oil passes from the inlet 11 and passage 28' to enlargement 25' from which it proceeds through part of bore 23 and enlargement 26' to passage 21' and bore 20', thereby acting on ram 19' and valve 10 while the ram 19 and the opposite end of said valve are at exhaust pressure to retain the same in this position of adjustment until the pressure on said ram 19' and valve 22 are relieved. At the same time the valve 22 is positively hydraulically held in its leftward shifted position by oil at low pressure from passage 21' passing through pipe 31 to bore 24 acting on the part of said valve 22 of larger diameter and also connecting the smaller diameter portion of this valve 22 through enlargements 26 and 27 and passage 29 with the exhaust or supply tank. At the same time the forward end of bore 24' is connected to the exhaust through piping 31', passage 21', enlargements 26 and 27 and passage 29. Under the conditions mentioned above the piston 7 proceeds to move to the right forcing the fluid at the low pressure side of cylinder 5 adjacent the cylinder 6 out the exhaust through the passages 12, 13, and 33 and forcing the fluid in the high pressure cylinder 6 into the passages 46 and 47 past the discharge valve 49 and into the discharge passage 48 until said piston strikes the inner end 50 of the valve 22 and shifts this valve to the right. When this occurs, the valve 22 moves to the same position relative to the cylinder 6 as is shown in connection with the valve 22' and cylinder 6'. Under these conditions the enlargements 25 and 26 are connected to the low pressure oil through the passage 28 and inlet 11, so that some of this oil may flow into the passage 21 to the bore 20 in front of the ram 19, and also some of it will flow through pipe 31' to the larger diameter bore 24' and act upon the larger diameter part of the piston of the valve 22' causing it to be shifted from its leftward position shown in the drawings toward the right so as to bring its smaller inner end 50' into position to be struck by the piston as it nears the end of its stroke toward the left and also connect the passage 21' and enlargement 26' with enlargement 27' and passage 29' to the exhaust or supply tank, thus relieving the oil pressure ahead of ram 19' and permitting the low pressure oil flowing into the forward part of bore 20 to act on ram 19 and pin 18 so as to shift the reversing valve 10 toward the left. It is also to be noted that the connection of the valve 22' with the exhaust also connects the bore 24 through piping 31 with the exhaust or supply tank, so that there is no tendency for the valve 22 to change the position into which it has been shifted by the piston. As soon as the reversing valve 10 reaches its leftward position, the low pressure oil from passage 11 is admitted by valve 10 to passage 12 while passage 12' is connected with the exhaust with the result that the piston 7 in its right hand position has its right end acted upon by low pressure oil in the

same way as that shown in the drawing on its left end, and its left end is relieved of pressure with the result that the piston is pushed from the right to the left, and the oil in the bore 6' in front of the smaller diameter left end part of the piston 7 is forced through passages 46' and 47' past opened check valve 49' to the high pressure passage 48, and when the piston 7 completes its movement to the left, it shifts the valve 22' to the left to the position shown in the drawing to connect the bore 20' with the low pressure oil so as to shift the valve 10 to the position shown, and the cycle of operations is then repeated.

From the foregoing it will be noted that it is necessary to effect a complete movement of one of the auxiliary valves 22 or 22' before the other is moved and that this latter valve is hydraulically moved and hydraulically held in a position to be struck and moved by the piston 7 before the reversal of the reversing valve can take place, and that while one auxiliary valve is hydraulically held in a tripping position by low pressure oil, the other auxiliary valve is held in a non-tripping position by suction or exhaust pressure on its larger diameter end. It will, therefore, be noted that the arrangement provides a hydraulic interlocking action between the two auxiliary valves 22, 22' and the reversing valve 10.

In some instances it is desired to use different hydraulic fluids for the low pressure motor and the high pressure pump, and under these conditions the low pressure oil is separate from the high pressure fluid, such as water, as shown in the apparatus of Fig. 2 in which the numeral 105 designates the low pressure cylinder and 106 and 106' the high pressure cylinders with the differential piston 107 working in these cylinders, there being suitable packing glands 108 through which the high pressure end 109 and 109' of the piston 107 passes in order to prevent leakage between the high and low pressure cylinders. In this modified form the high pressure ends function as ordinary plunger type pumps, the suction stroke of the piston 107 drawing water or other press operating fluid past suction inlet check valve 60' into the pump chamber including the short pipe 61' and the delivery stroke of this piston 107 forcing the fluid in the cylinder 106' past a discharge check valve 62' into the high pressure pipe line 63. Similarly, the suction stroke of the piston 107 drawing water or other operating fluid past suction inlet check valve 60 into the pump chamber including the short pipe 61 and the delivery stroke of this piston 107 forcing the fluid in the cylinder 106 past a discharge check valve 62 into the high pressure pipe line 63.

The action of the high pressure ends of the differential piston is, of course, dependent directly on the movement of the low pressure end by the low pressure hydraulic fluid which is effected in substantially the same manner as the first described construction through the operation of a main reversing valve 110 and auxiliary differential piston type valves 122 and 122' working in the bores 123, 124 and 123', 124', respectively. The main reversing valve 110 works in a ported liner 114 and acts to direct the flow of low pressure hydraulic fluid from pipe 111 either to pipe 112 connected with the right hand end of the cylinder 105 or to pipe 112' connected to the left hand end of said cylinder 105 and at the same time connect the other of these pipes 112, 112' with the exhaust passage 134 connected to the hydraulic fluid supply tank through any suitable piping not shown. The bore 123 has a low

pressure port 128, a transfer port 126, and an exhaust port 129 communicating therewith. The valve 122 is adapted to connect the port 126 with the exhaust port 129 in its leftward shifted position or to connect port 126 with the port 128 in its rightward shifted position. Similarly, the bore 123' has a low pressure port 128', a transfer port 126', and an exhaust port 129' communicating therewith. The valve 122' is adapted to connect the port 126' with the low pressure port 128' as shown in its leftward shifted position or to connect said port 126' with exhaust port 129' in its rightward shifted position.

As in the first described construction, the reversing valve has a lost motion connection with the rams 119 and 119' working in bores 120 and 120' in the valve casing 150 engaging the ends of a rod 118 which runs loosely through an axially extending bore in the valve 110, said rams having stem extensions passing through stuffing boxes 101 at the ends of said casing. The bore 120 connects by a pipe 121 with the port 126', and a branch pipe 131 leads from an intermediate point of this pipe to the front end of the bore 124. The bore 120' connects by a pipe 121' with the port 126, and a branch pipe 131' leads from an intermediate point thereof to the front end of the bore 124'.

The ports 128 and 128' lead into a common passage connected with a pipe 111 of low pressure oil or other suitable hydraulic fluid.

With the above arrangement, the piston 107 on the last part of its movement toward the left engages the projecting end of the valve 122' and shifts it to the left into the position shown in Fig. 2, thereby connecting ports 128' and 126' together, so that the driving low pressure hydraulic fluid from pipe 111' will flow through pipes 121 and 131, thus bringing pressure fluid against the ram 119 to move the reversing valve 110 from the position shown in Fig. 2 toward the left and bringing pressure fluid into the bore 124 to shift the valve 122 to the left to the position shown in the drawing. When this valve 122 is so shifted, the port 126 is connected with the exhaust port 129, and hence the bores 124' and 120' are connected to the exhaust through pipes 131' and 121' with the result that there is nothing interfering with the shifting of the reversing valve 110 toward the left and the continued positioning of the valves 122' and 122 in the positions shown in the drawing until the piston 107 moves from the position there shown to the right until it strikes the projecting end of the valve 122. The piston is so moved to the right by the movement of the reversing valve 110 to the left so as to connect pipes 112' and 111 together while pipe 112 is connected to the exhaust passage 134 and the supply tank connected therewith. During the movement of the piston 107 toward the right, the hydraulic fluid in cylinder 106 drawn in past check valve 60 during the preceding leftward stroke is forced out of said cylinder past the check valve 62 to the pipe 63 at the desired high pressure which is determined by the ratio of the diameters of the small and large pistons of the differential piston 107. On this movement to the right the piston 109' draws in a new charge of hydraulic operating fluid past check valve 60' into cylinder 106'. At the end of the travel of the piston 107 to the right the positions of the control valves 122 and 122' are reversed from that shown in the drawing while the reversing valve 110 is shifted to the right to the position shown in Fig. 2 since shifting of the valve 122 to

the right connects ports 126 and 128 together and to pipes 121' and 131' which then connect the bore 120' of the reversing valve mechanism and the bore 124' of the pilot valve 122' with the low pressure motive fluid from pipe 111', thereby first causing a shift of the valve 122' toward the right to connect the port 126' to the exhaust port 129' and through pipe 121 and 131 connect the forward end of bore 120 of the reversing valve mechanism and the bore 124 for the pilot valve 122 with exhaust, so that there is then nothing to stop the shifting of the reversing valve 110 from the left to the right to the position shown, and at the same time holding the valve 122 in its rightward position. Shifting of the valve 110 to the position shown connects the pipe 112 with the pressure fluid supply pipe 111 and the pipe 112' with the exhaust passage, so that the piston 107 is driven to the left to the position shown in Fig. 2 while the right high pressure piston 109 is on its suction and the left high pressure piston 109' is on its delivery stroke. Thereafter, the cycle of operation is repeated.

In this form of the invention it is to be again noted that the reversing valve 110 cannot be operated to cause a reversal of the piston 107 until said piston reaches the end of its movement and the control or auxiliary valves are operated and that neither pilot valve 122 or 122' can be shifted during the intermediate travel of the piston and that the shifting of one controls the shifting to what may be termed the "cocked" position of the other.

It is also to be noted that the lost motion connections between the reversing valve and its small operating rams aid in the shifting of the reversing valve, as either one of them is in motion when it engages this valve and thus acts to overcome the inertia of the heavier reversing valve and promptly shift it to its reversed position. The lost motion connections also provide a certain time delay or lag in the operation of the reversing valve, so that the control valves will be in their desired positions when the movement of the reversing valve occurs.

The hydraulic pressure booster above described corresponds in its operation with that of the actuating pump for furnishing the low pressure fluid, so the booster's operation may be of variable or constant volume depending upon the actuating pump.

I desire it to be understood that this invention is not to be limited to the details of construction hereinbefore described except only in so far as such limitations are included in the appended claims.

What I claim as my invention is:

1. In a hydraulic booster having a cylinder, a motor piston operating in said cylinder and a reversing valve for alternately respectively connecting opposite ends of said cylinder with a source of hydraulic pressure fluid and exhaust, the combination with said piston and said valve of a pair of control valves for said reversing valve, means for operating said control valves alternately by the piston as it reaches the end of its stroke, hydraulically operated means for returning said control valves, and means for hydraulically interlocking said control valves to prevent their movement except at the end stroke positions of the movement of the piston, said valves in turn preventing movement of the reversing valve until one of said valves has been operated and the other has been moved to a position for actuation by the piston on its return stroke.

2. In a hydraulic booster having a pressure cylinder, a motor piston operating in said cylinder and a reversing valve for alternately connecting the opposite ends of the cylinder with a source of hydraulic pressure fluid and an exhaust, the combination with said piston and said valve of a pair of control valves for said reversing valve, said control valves being disposable at the ends of the cylinder in position to be alternately engaged and moved by the piston as it reaches the end of its stroke, hydraulically operated means for returning said control valves and means for hydraulically interlocking said control valves to prevent their movement except at the end stroke positions of movement of the piston, said valves in turn preventing movement of the reversing valve until one of said valves has been operated and the other has been moved to a position for actuation by the piston on its return stroke.

3. In a hydraulic booster having a cylinder, a motor piston operating in said cylinder, and a reversing valve for alternately respectively connecting the opposite ends of the cylinder with a source of hydraulic fluid under pressure and an exhaust, the combination with said reversing valve of actuating rams for shifting said valve having a lost motion connection therewith so as

to control the inlet and exhaust of pressure fluid to opposite ends of the cylinder, and control means controlled by the piston at the end of its stroke in both directions for controlling the operation of said rams.

4. In a hydraulic booster having a cylinder, a motor piston operating in said cylinder, and a hydraulically operated reversing piston type valve for alternately respectively connecting the opposite ends of the cylinder with a source of hydraulic pressure fluid and an exhaust, the combination with said piston and valve of a pair of oppositely disposed differential piston type control valves mounted to have a part of their reduced inner end project inwardly into the cylinder in the path of the piston for shifting movement thereby in one direction, said control valves provided with hydraulically operated rams for shifting said valves in the opposite direction, differential diameter bores for said valves, passages interconnecting the larger diameter bore of one of the valves with the smaller diameter bore of the other valve, and passages controlled by said control valves under the action of the piston for controlling the supply of hydraulic pressure fluid to operate said reversing valve.

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CERTIFICATE OF CORRECTION.

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September 22, 1942.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 16, for "bore 23" read --bore 23'--; page 4, first column, line 1, strike out "pressure"; 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 27th day of October, A. D. 1942.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)