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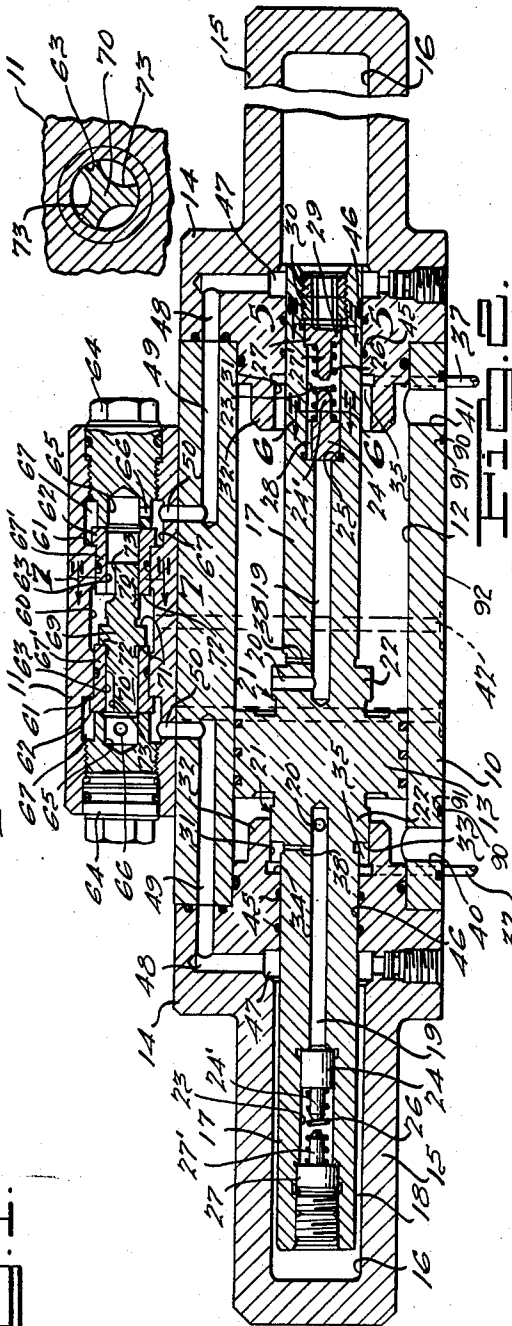
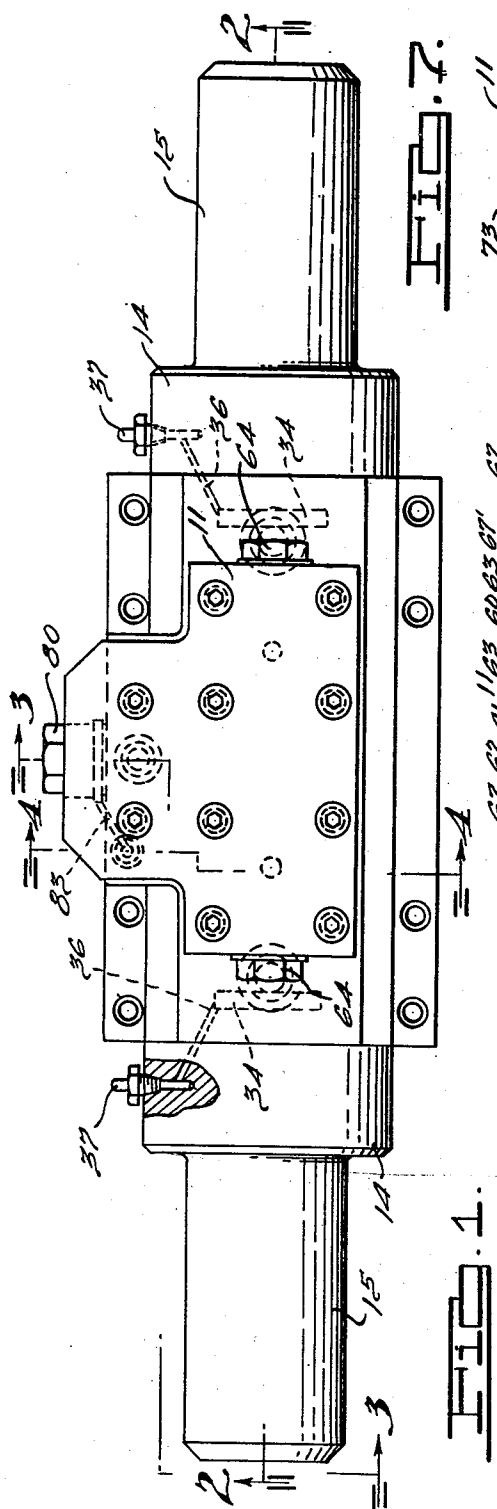
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BOOSTER FOR INCREASING DELIVERED HYDRAULIC PRESSURE

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2 Sheets-Sheet 1



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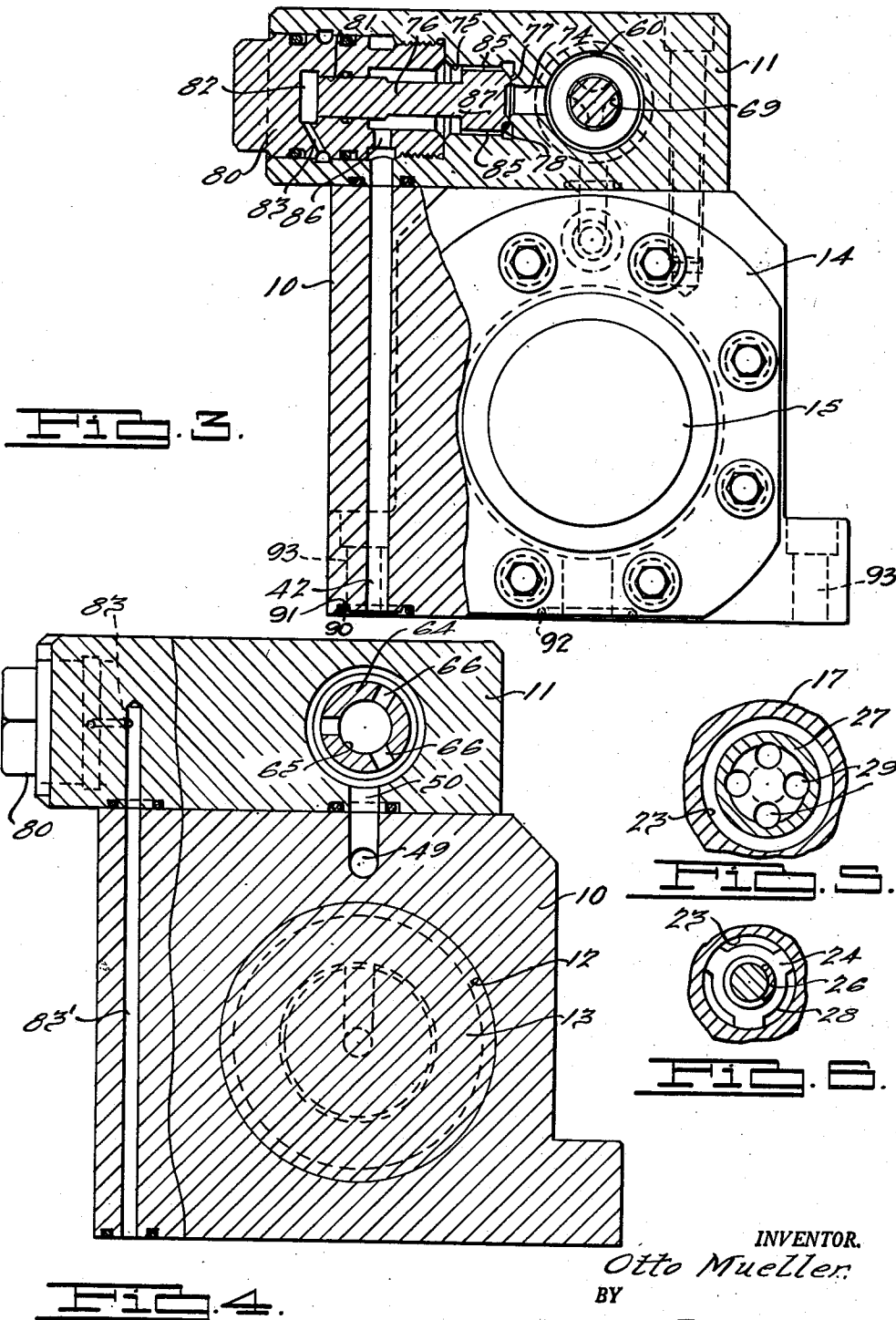
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BOOSTER FOR INCREASING DELIVERED HYDRAULIC PRESSURE

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BOOSTER FOR INCREASING DELIVERED HYDRAULIC PRESSURE

Otto Mueller, Dearborn, Mich.

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12 Claims. (Cl. 103—51)

This invention relates to boosters for hydraulic pressure systems, and more particularly to a booster adapted to provide a high ratio of pressure increase in the hydraulic medium passing through the booster for use in the pressure system.

An object of the present invention is to provide a simple, dependable and automatically operable booster for use in connection with hydraulic pressure systems.

Another object of the invention is to provide a hydraulic booster device adapted to be actuated by the primary pressure of the system and designed to step up the hydraulic pressure to any desired ratio, such as that in the order of five to one, for example.

The various objects, advantages and novel details of construction of the invention will be made more apparent as this description proceeds, especially when considered in connection with the accompanying drawings, wherein:

Figure 1 is an elevational view of a booster device constructed in accordance with this invention;

Fig. 2 is a longitudinal, sectional view, taken substantially on the plane indicated by line 2—2 of Fig. 1;

Fig. 3 is a transverse sectional, end elevational view taken substantially on the plane indicated by line 3—3 of Fig. 1;

Fig. 4 is a transverse sectional view, taken substantially on the plane indicated by line 4—4 of Fig. 1;

Fig. 5 is a detail sectional view, taken on the plane indicated by line 5—5 in Fig. 2;

Fig. 6 is a detail sectional view, taken on the plane indicated by line 6—6 in Fig. 2, and

Fig. 7 is a detail sectional view, taken on the plane indicated by line 7—7 in Fig. 2.

In the drawings, wherein a preferred embodiment of the invention is illustrated, the reference character 10 indicates generally the body of the booster and 11 a housing enclosing certain control parts therefor. The body is formed with a cylindrical chamber 12 of relatively large diameter constituting the main cylinder in which an actuating piston 13 is adapted to reciprocate. Secured to the body 10, at opposite ends thereof, are members 14 forming the closures or end portions for the main cylinder 12. The members 14 are formed with tubular extensions 15 providing cylinders 16 in which the hydraulic medium supplied by the booster is stepped up in pressure.

Working in the pressure cylinders 16 are elongated pistons 17. These pistons 17 extend from opposite sides of the main piston 13 and reciprocate therewith and, as shown, may be made integral with the piston 13. The pistons 17 have a loose fit within the cylinders 16 providing a clearance 18 therebetween through which the hydraulic medium is forced on the pressure stroke of the piston. The closed pressure end of each cylinder 16 is connected to the adjacent end of the main cylinder 12 by a passage 19 extending through the piston 17 connecting with radial ports 20. These ports 20 extend through the annular surfaces 21 of drum portions 22 located at the ends of pistons 17 adjacent the piston 13.

Each passage 19 is provided with an enlarged cylin-

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drical chamber 23 in which a spring biased valve piston 24 is located. The piston 24 in closed position seats on the annular shoulder 25 located at the junction of the passage 19 and chamber 23. The valve piston 24 is normally held in closed position by means of a spring 26 engaging the piston 24 and a plug 27 seated on a shoulder at the end of chamber 23. The spring 26 surrounds stemlike projections 24' and 27' formed respectively on piston 24 and plug 27. Engagement of projection 24' with projections 27' limits movement of piston 24 in open position. The valve piston 24 is provided with a plurality of axially extending slots 28 and the plug 27 is formed with axial openings 29 to permit the flow of hydraulic medium therethrough into the pressure cylinder 16 during the open position of the valve piston 24. Each plug 27 is held in place by a pair of hollow lock nuts 30 secured in the ends of the pistons 17. Each valve piston 24 closes its related passage 19 during the pressure stroke of the associated piston 17 and opens on the return stroke against the action of its spring 26 due to pressure in the cylinder 12 flowing through port 20 and passage 19.

Near the end of the pressure stroke of each piston 17, passage of fluid through ports 20 and passage 19 is additionally interrupted by the engagement of the annular surface 21 of the drum portion 22 with the inner annular surface 31 of flange extensions 32 carried by the members 14. This covers the ports 20 when the drum portion 22 moves therein, as shown at the left in Fig. 2. Also, upon engagement of the surface 21 of a drum portion 22 with an annular surface 31, fluid will be trapped and compressed in chambers 35 formed between the shoulder 33 of drum 22 and the surface 34 formed at the juncture of the flange 32 and member 14 to cushion the end of the pressure stroke of each piston 17. The degree of this cushioning action is controlled by the bleed port 38 communicating with the passageway 19.

This booster device is adapted, in the hydraulic pressure system of which it forms a part, to be supplied with fluid under pressure alternately at inlet ports 40 and 41. Fluid under the stepped-up working pressure leaves the booster at outlet port 42 and is conducted by means (not shown) to the power cylinder or cylinders for performing the work. The fluid trapped and compressed in chambers 35 may be conducted through ports 36 and conduits 37 to control valve means (not shown) for alternately admitting fluid pressure to inlet ports 40 and 41 for the purpose previously described. This alternate shifting of the control valve means may be effected by suitable timing means, but to obtain the full movement of the pistons 17 during each of their strokes, the pressure in the chambers 35 is preferably utilized for the purpose. Thus, the fluid compressed in the chamber 35 at the left of Fig. 2 will, at the end of the movement of piston 13 to the left, actuate a control valve to admit fluid pressure from the hydraulic system to inlet port 40, and fluid compressed in the other chamber 35 at the end of the movement of the piston to the right will actuate a control valve to admit fluid pressure from the hydraulic system to the inlet port 41.

The open end of each cylinder 16 is sealed by sealing rings 45 located in the wall portion 46 of the member 14 which surrounds and slidably supports the associated piston 17. Each wall portion 46 is provided with an annular groove 47 adjacent the sealing rings 45 connected by a passage 48 with a passage 49 provided in the body 10. These passages connect with ports 50 in the housing 11.

The housing 11 is formed with a cylindrical recess 60 provided with spaced opposed shoulders 61 engaged by the flange 62 of sleeves 67' forming valve cylinders 63. The open ends of the cylindrical recess 60 are closed by plugs 64 having recesses 65 forming continuations of the valve cylinders 63. The ends of the plugs 64 engage

these sleeves 67' and hold the same in place against the shoulders 61. The walls of the recesses 65 are provided with a plurality of openings 66 communicating with annular grooves 67 in the housing 11 into which the ports 50 open.

A control valve piston or spool 69 has terminal portions 70 fitting snugly but slidably within the valve cylinders 63. The central portion of the valve piston is provided with spaced annular opposed shoulders 71 which alternately engage the ends 72 of the sleeves of cylinders 63 to limit movement of the valve piston 69 in both directions. The terminal portions 70 of the valve piston are formed with longitudinal grooves 73 at their extremities which provide passages for fluid through and past the valve piston whenever it is shifted to either of its extreme left- or right-hand positions, as viewed in Fig. 2. The length of the grooves 73 is such that passage of fluid through the grooves and past the piston is cut off at one end before it is opened at the other end.

Fluid flowing through the grooves 73 enters the cylindrical recess 60 of the housing 11 and through a laterally extending port 74 (see Fig. 3) into a check valve chamber 75 to which the outlet port 42 is connected. Slidably mounted in the chamber 75 is a check valve 76 having an annular valve surface 77 adapted to seat on a corresponding valve surface 78 surrounding the port 74. A plug 80, which forms a part of the check valve chamber, is provided with a bore 81 which slidably supports the adjacent end of the check valve 76 and is further provided with a chamber 82 into which pilot pressure is constantly introduced through a pilot inlet port 83 connected to a passage 83'. This pilot pressure acts on the end of check valve 76 to urge the same into closed position, as illustrated in Fig. 3, to prevent back pressure in outlet port 42 from flowing back into the booster. When the check valve has moved away from its seat 78, the fluid may flow through grooves 85 formed in the piston portion 87 of the check valve and into the chamber 75 and thence through port 86 to outlet port 42.

The size of the piston 13 to the pistons 17 is so selected that the pressure of the fluid entering cylinder 12 is stepped up or increased in the structure illustrated, in the ratio of five to one. Thus, if fluid of 1000 lb. pressure is delivered to inlet ports 40 and 41, the pressure of this fluid will be stepped up and discharged through the outlet port 42 at 5000 lb. pressure. With pressures of this order, a pilot pressure of approximately 400 lbs. is maintained in the chamber 82.

The operation is, briefly, as follows: With the parts as shown in Fig. 2, the piston 13 is just starting its movement toward the right under the pressure of fluid entering inlet port 40. Fluid pressure to inlet port 41 has been cut off. Cylinders 12 and 16 to the right of piston 13 are charged with fluid from the preceding stroke of the piston to the left. Upon internal movement of piston 13 to the right, piston valve 24 in right-hand piston 17 closes under influence of its spring 26 and the pressure building up in cylinder 16. At the same time, valve piston 69 is moved toward the left by reason of the pressure being built up in cylinder 16. This opens communication between right-hand cylinder 16 through passages 48 and 49, port 50, valve cylinder 63, past piston 69, to recess 60 and closes communication between the left-hand cylinder 16 and the valve recess 60.

The fluid under, for instance, 1000 lb. pressure, acting on the left-hand side of piston 13, moves right-hand piston 17 into its cylinder 16 to compress the fluid therein. By reason of the relatively large area of pistons 13 exposed to the fluid pressure from inlet 40 compared to the area of piston 17 in cylinder 16, the fluid in cylinder 16 is compressed to five times that of the pressure acting on the piston 13.

From valve recess 60 the high pressure fluid passes to port 74 and when sufficient pressure is attained to unseat check valve 76, the high pressure fluid flows past this

check valve into chamber 75 and through port 86 and outlet passage 42 to the power cylinder or cylinders (not shown) performing the work. After delivery of the high pressure fluid past check valve 76 to the work cylinders, the check valve seats under the influence of the pilot pressure in chamber 82 which, as stated, is maintained at substantially 400 lbs. This check valve acts to prevent the back pressure in the outlet 42 from flowing back into booster, as will be obvious. The area of piston 87 of the check valve exposed to the pressure of fluid at port 74 overcomes the pilot pressure in the chamber 82 as the pressure builds up and the valve surface 77 leaves valve seat 78 as the check valve 76 is moved toward the left, as viewed in Fig. 3, to permit the discharge of the high pressure fluid to the working cylinders. The pilot pressure in chamber 82 acting on the end of the check valve 76 shifts the valve to closed position upon the reversal of the pressure strokes of the pistons 17. Upon movement of piston 13 to the left, the cycle of operations is repeated, the valve piston 69 being shifted to the position opposite to that shown in Fig. 2.

During the pressure stroke of the right-hand piston 17, just described, fluid in cylinder 12 at the left of piston 13 will flow through ports 20 and passage 19 and will unseat piston valve 24 against the action of its spring 26. The fluid will then flow through grooves or slots 28, chamber 23, opening 29 in plug 27 and into the left-hand cylinder 16. Thus, upon the next pressure stroke of the left-hand piston 17, its cylinder 16 will be charged with fluid at primary pressure setting.

It will be understood that the ports 20 are closed near the end of the pressure stroke of the associated piston 17 and are opened shortly after the beginning of the return stroke of the associated piston. This valving of the ports 20, in the order described, is effected by engagement of the annular surface 21, into which the ports 20 open, with the annular surface 31 of flange 32. This additional valving of the passages and ports 19 and 20 insures against leakage of the high pressure fluid back past the piston at the end of the pressure stroke and during the initial movement of the piston during its return stroke.

As previously described, fluid is trapped in one of the chambers 35 at the end of each pressure stroke of each piston 17. This trapped fluid, as it is bled through the port 38, acts to cushion the pistons at the ends of their pressure strokes and the fluid under pressure in these chambers 35 may be used to actuate any suitable means (not shown) for controlling the flow of fluid to inlets 40 and 41. This arrangement provides means whereby the control of the fluid to the inlets 40 and 41 can be timed with the movement of the piston 13 without the aid of independent timing means as heretofore employed.

The ports 40, 41 and 42 may be connected to their respective conduits (not shown) by sealing connections such as shown in the copending application of Otto Mueller, Serial No. 43,914, filed August 12, 1948, now Patent No. 2,679,377, or in any other suitable manner. In such an arrangement, O-rings 90 are provided in recesses 91 in the flat surface 92 of the body 10 of the booster about the ports 40, 41 and 42, the depth of the recesses 91 being such that the O-rings project beyond the surface 92 so as to seal the ports in a fluid delivering plate with the ports 41 and 42 when the body 10 is secured to the flat surface of the plate by bolts extending through the apertures 93 of the body.

What is claimed is:

1. A booster for hydraulic pressure systems comprising a body provided with a main cylinder and a pair of pressure cylinders, fluid pressure inlets adjacent the ends of said main cylinder, a piston assembly comprising an actuating piston and a pair of pressure pistons working respectively in said main and pressure cylinders, high pressure passageways in said body connected to said pressure cylinders, said body having a high pressure outlet,

valve piston means between said high pressure passageways and outlet and shiftable to initially establish communication between the operative pressure cylinder and said outlet, and a pressure-loaded piston check valve between said valve means and said outlet operable upon predetermined pressure for opening communication to said outlet.

2. A booster for hydraulic pressure systems comprising a body provided with a main cylinder and a pair of pressure cylinders, fluid pressure inlets adjacent the ends of said main cylinder, a piston assembly comprising an actuating piston and a pair of pressure pistons working respectively in said main and pressure cylinders, high pressure passageways in said body connected to the inner ends of said pressure cylinders, said body having a high pressure outlet, valve means in said high pressure passageways operable by pressure in said pressure cylinders for alternately connecting said passageways to said outlet, and a pressure-loaded differential piston valve between said valve means and said outlet operable upon a predetermined pressure to open communication to said outlet.

3. A booster for hydraulic pressure systems comprising a body provided with a main cylinder and a pair of pressure cylinders, fluid pressure inlets adjacent the ends of said main cylinder, a differential piston assembly comprising a relatively large main piston sealed to said main cylinder for movement between said inlets and smaller pressure pistons in said pressure cylinders actuated by said main piston, said pressure pistons being of smaller diameter than said pressure cylinders to permit the fluid to pass therebetween, high pressure passageways in said body connected to said pressure cylinders near the inner ends thereof, said body having a high pressure outlet passageway, a control valve between said high pressure passageways and said outlet passageway operable by pressure in one of said pressure cylinders to initially establish communication between said cylinder and said outlet passageway, and a pressure-loaded piston check valve beyond said valve means and in said outlet passageway operable upon predetermined pressure for opening communication through said outlet passageway.

4. A booster for hydraulic pressure systems comprising a body having a main cylinder and a pair of pressure cylinders, a piston assembly comprising a main piston in said main cylinder and opposed pressure pistons connected thereto and operating in said pressure cylinders, fluid pressure inlets in opposite ends of said main cylinder for admitting fluid pressure to opposite ends of said main cylinder to reciprocate said main piston and actuate said pressure pistons, said main piston being larger and the pressure pistons being smaller in diameter than said pressure cylinders, means for supplying fluid to one pressure cylinder during the pressure stroke in the other pressure cylinder, said body having a single high pressure outlet, means in said body for alternately connecting a pressure cylinder to said outlet, and means for preventing a reverse flow of fluid from said outlet and a delivery of fluid thereto until the pressure thereof has reached a predetermined amount.

5. A booster for hydraulic pressure systems comprising a body having a main cylinder and a pair of pressure cylinders, a differential piston assembly comprising a large main piston in said main cylinder and opposed smaller pressure pistons connected thereto and operating in said pressure cylinders, fluid pressure inlets in opposite ends of said main cylinder for admitting fluid pressure to opposite ends of said main cylinder to reciprocate said main piston and actuate said pressure pistons, means for supplying fluid to one pressure cylinder during the pressure stroke in the other pressure cylinder, said body having passageways from the inner ends of said pressure cylinders and a single high pressure outlet passageway connected thereto, means in said body for alternately connecting a pressure cylinder to said outlet passageway through said passageways including a shiftable piston valve operable by pressure in said pressure cylinders,

and means in said body preventing a reverse flow of fluid from said outlet.

6. A booster for hydraulic pressure systems comprising a body having a main cylinder and a pair of pressure cylinders, a differential piston assembly comprising a large main piston in said main cylinder and opposed smaller pressure pistons connected thereto and operating in said pressure cylinders in spaced relation thereto, sealing means between said cylinders, fluid pressure inlets in opposite ends of said main cylinder for admitting fluid pressure to opposite ends of said main cylinder to reciprocate said main piston and actuate said pressure pistons, pressure actuated means for supplying fluid to one pressure cylinder during the pressure stroke in the other pressure cylinder, said body having a single high pressure outlet, means in said body for alternately connecting a pressure cylinder to said outlet, and a fluid biased valve for closing said outlet until pressure has been built up on the fluid from the pressure cylinders to a predetermined amount.

7. A booster for hydraulic pressure systems comprising a body having a main cylinder and a pair of pressure cylinders, a differential piston assembly comprising a large main piston in said main cylinder and opposed smaller pressure pistons connected thereto and operating in said pressure cylinders in spaced relation thereto, sealing means between said cylinders, fluid pressure inlets in opposite ends of said main cylinder for admitting fluid pressure to opposite ends of said main cylinder to reciprocate said main piston and actuate said pressure pistons, valve means in said pressure pistons in passageways therein which extend to said main piston permitting flow of fluid from said main cylinder to a pressure cylinder during the pressure stroke of the piston in the other pressure cylinder, said body having a single high pressure outlet, means in said body for alternately connecting a pressure cylinder to said outlet, and means in said body effective during the time of changing the connections of the pressure cylinders to said outlet for preventing a reverse flow of pressure fluid from said outlet.

8. A booster for hydraulic pressure systems comprising a body having a main cylinder and a pair of pressure cylinders, a piston assembly comprising a main piston and opposed pressure pistons operating in said main and pressure cylinders respectively, said pressure pistons being of smaller diameter than said pressure cylinders to permit a flow of fluid therebetween, sealing means between said cylinders, said body having passageways from said pressure cylinders located adjacent to said sealing means, said main and pressure pistons having a differential ratio of the order of five to one, fluid pressure inlets in opposite ends of said main cylinder for admitting fluid pressure to opposite ends of said main cylinder to reciprocate said main piston and actuate said pressure pistons, means for supplying fluid to one pressure cylinder during the pressure stroke in the other pressure cylinder, said body having a single high pressure outlet, and means in said body for alternately connecting a pressure cylinder to said outlet while preventing a reverse flow of pressure therefrom.

9. A booster for hydraulic pressure systems comprising a body having a main cylinder and a pair of pressure cylinders, a differential piston assembly including a large main piston working in said main cylinder, a pair of elongated pistons extending from opposite faces of said main piston and working in said pressure cylinders but of smaller diameter than said cylinders, means sealing the pressure cylinders from the main cylinder, fluid pressure inlets in opposite ends of said main cylinder for admitting fluid pressure to opposite ends of said main cylinder to reciprocate said main piston and actuate said pressure pistons, passages extending through each pressure piston, one end of each passage terminating in a radially outwardly open port in an annular portion of said piston adjacent to the main cylinder, an annular recess formed in said main cylinder at each end adapted to engage said

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annular portions to close said ports near the end of the movement of said pistons in each direction, means for supplying fluid to one pressure cylinder during the pressure stroke in the other pressure cylinder, said body having a high pressure outlet, and means for alternately connecting a pressure cylinder to said outlet.

10. A booster for hydraulic pressure systems comprising a body having a main cylinder and a pair of pressure cylinders, a differential piston assembly including a large main piston working in said main cylinder, a pair of elongated pistons extending from opposite faces of said main piston and working in said pressure cylinders, fluid pressure inlets in opposite ends of said main cylinder to reciprocate said main piston and actuate said pressure pistons, passages extending through each pressure piston, one end of each passage terminating in a radially outwardly open port in an annular portion of said piston, an annular recess formed in said main cylinder at each end adapted to engage said annular portions to close said ports near the end of the movement of said pistons in each direction, said piston and annular recess when engaged providing a chamber in which fluid is trapped and compressed, means for conducting said trapped fluid under pressure to a point remote from said body, means for supplying fluid to one pressure cylinder during the pressure stroke in the other pressure cylinder, said body having a high pressure outlet, and means for alternately connecting a pressure cylinder to said outlet.

11. A booster for hydraulic pressure systems comprising a body having a main cylinder and a pair of pressure cylinders, a differential piston assembly including a large main piston working in said main cylinder, a pair of elongated pistons extending from opposite faces of said main piston and working in said pressure cylinders, fluid pressure inlets in opposite ends of said main cylinder for admitting fluid pressure to opposite ends of said main cylinder to reciprocate said main piston and actuate said pressure pistons, a passage extending through one of said pressure pistons, a pressure biased

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check valve normally closing one end of said passage, the other end of said passage terminating in a radially outwardly open port in an annular portion of said piston, the wall of said main cylinder having an annular recess adapted to receive said annular piston portion and close said port at a predetermined point in the movement of said pressure piston, said body having a high pressure outlet, and pressure operated valve means for closing communication between the pressure cylinder and said outlet and subsequently opening communication between the other pressure cylinder and said outlet.

12. A booster for a hydraulic pressure system comprising a body having a main cylinder and a pair of pressure cylinders, a differential piston assembly including a large main piston working in said main cylinder and a pair of elongated pistons extending from said main piston and working in said pressure cylinders, said body having a flat surface through which extend fluid pressure inlets which communicate with opposite ends of said main cylinder for admitting fluid pressure thereto for reciprocating said main piston and actuating said elongated pistons, said flat surface having annular recesses therein about said inlets, and O-rings in said annular recesses projecting beyond said flat face of the surface.

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