Jan. 23, 1951 A. F. McFARLAND **2,538,842**

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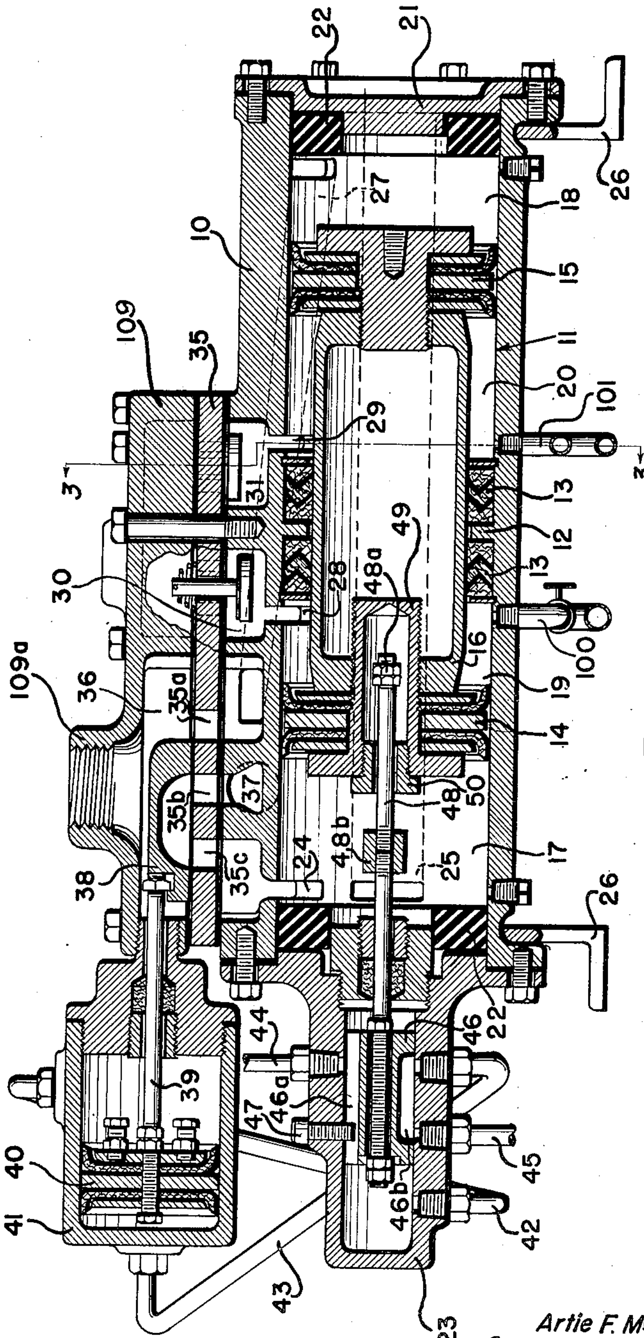

Fig. 1

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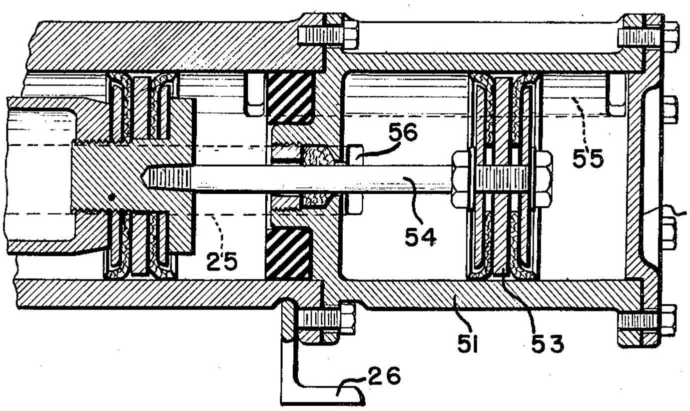

Fig. 2

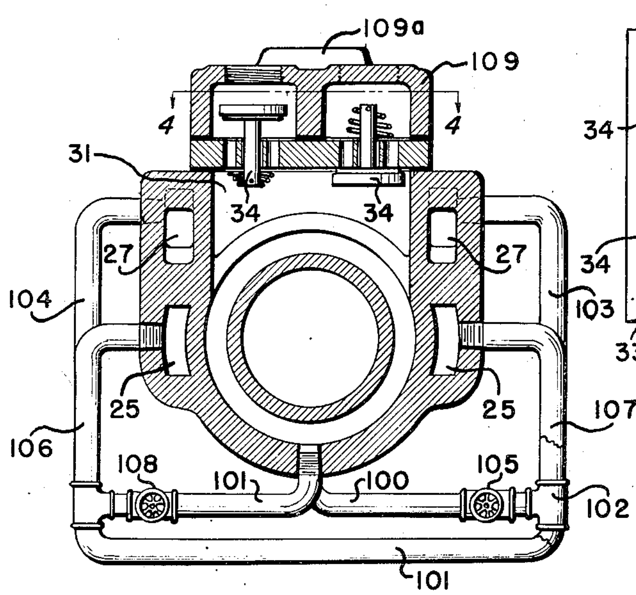

Fig. 3

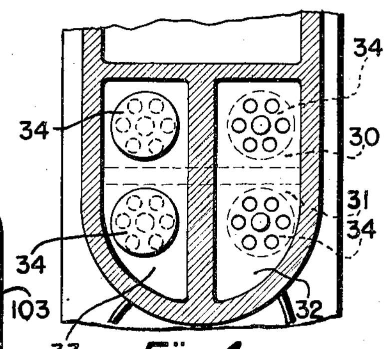

Fig. 4

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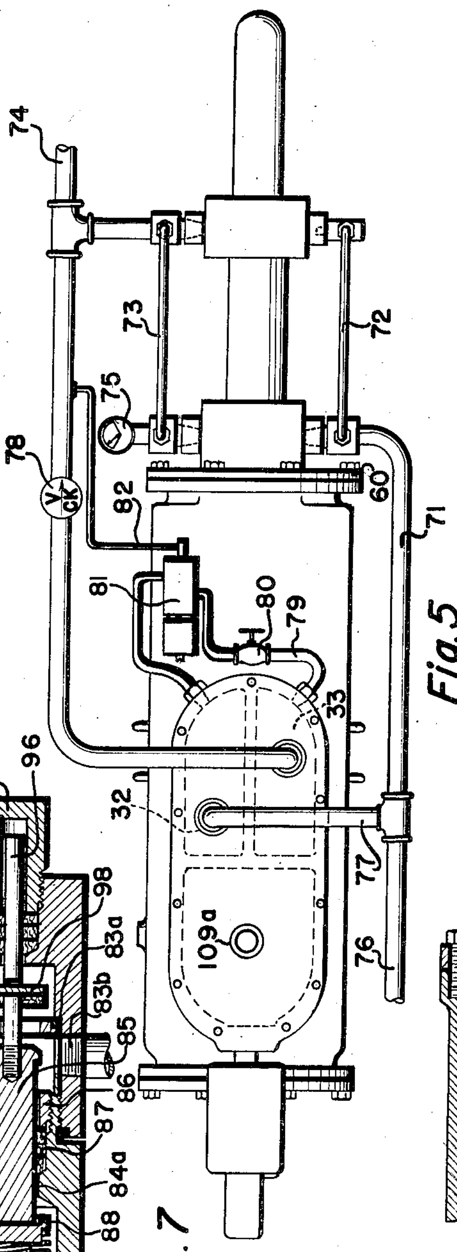

Fig. 5

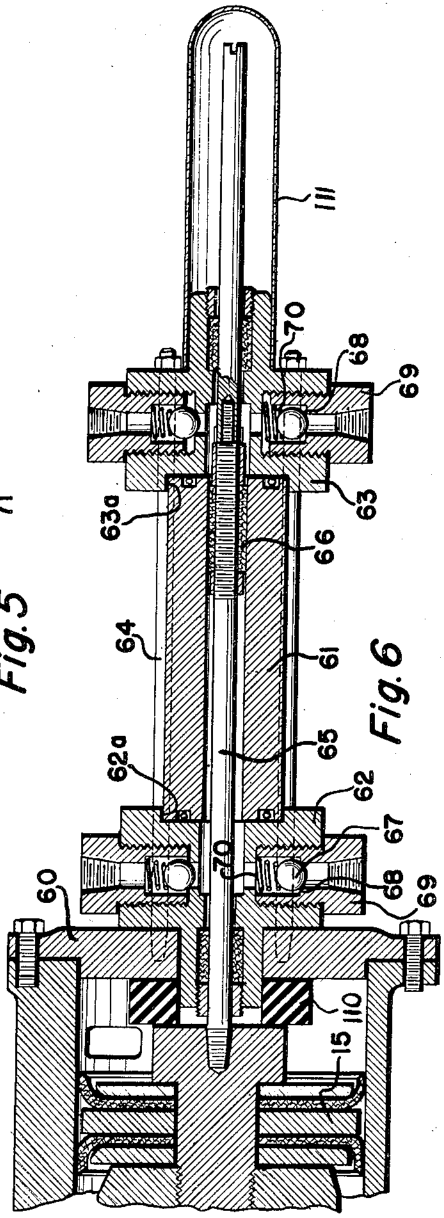

Fig. 6

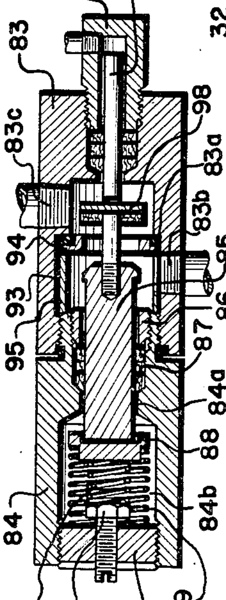

Fig. 7

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UNITED STATES PATENT OFFICE

2,538,842

PUMP

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Application November 21, 1946, Serial No. 711,383

21 Claims. (Cl. 103—49)

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This invention relates to improvements in fluid actuated pumps and refers more particularly to the arrangement of ports and passages for both the power fluid and fluid to be pumped and to means for increasing the discharge pressure of the pumped fluid.

An object of this invention is to provide a pump in which the surging of fluid during the operation of the pump does not impart forces to the pump body tending to produce lateral movement of the body on its mounting.

Another object is to provide a pump which may be used in numerous manners to pump fluid at varying pressures.

A further object is to provide a pump having low pressure and high pressure booster sections, which is particularly adaptable for use in testing boilers, tanks, well heads, Christmas trees and the like, wherein the container to be tested may be filled by the high volume low pressure section and tested by the high pressure booster section.

Yet another object is to provide a pump having low pressure and high pressure booster sections communicating with common inlet and discharge lines in which the sections may be selectively utilized by manipulation of a single valve.

Yet a further object is to provide a pump having low pressure and high pressure booster sections wherein an automatic valve is operable to selectively actuate the sections individually in response to the pressure in the discharge line.

Other and further objects will appear from the following description:

In the accompanying drawings which form a part of the instant specification and are to be read in conjunction therewith and wherein like numerals are used to indicate like parts in the various views:

Fig. 1 is a vertical sectional view of a pump embodying this invention,

Fig. 2 is a fragmentary sectional view of the pump in Fig. 1 showing an auxiliary power attachment,

Fig. 3 is a view taken along the line 3—3 in Fig. 1 in the direction of the arrows,

Fig. 4 is a fragmentary view taken along the line 4—4 in Fig. 3 in the direction of the arrows,

Fig. 5 is a top plan view of the pump shown in Fig. 1, having a booster section mounted thereon,

Fig. 6 is an enlarged horizontal section through the booster section and a part of the low pressure section of the pump illustrated in Fig. 5, and

Fig. 7 is an enlarged sectional detail of the regulator shown in Fig. 5.

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Referring to the drawings, the pump illustrated in Fig. 1 will be first described. The pump comprises a body 10 having a cylinder bore 11 therethrough. The body has an internal boss 12 formed in the cylinder bore intermediate its ends. The boss 12 carries an annular packing assembly 13. A double element piston with piston heads 14 and 15 connected by cylindrical member 16 extends through packing 13.

Packing 13 and the double element piston divide the cylinder bore into power cylinders 17 and 18 at the ends of the piston heads and intermediate pump chambers 19 and 20 for fluid to be pumped. An end plate 21 is removably secured to the right end of the cylinder bore and carries an annular bumper 22 of resilient material such as synthetic rubber or the like to limit movement of the piston in one direction. The other end of the cylinder bore is closed by a removable cap 23, which also carries a bumper 22. The cap will be hereafter more fully described in connection with means for controlling the introduction of power fluid to the power chambers.

Ports and passages are provided in body 10 for introduction of power fluid to the power cylinders and fluid to be pumped to the chambers 19 and 20. A port 24 communicates with cylinder 17. This cylinder also communicates with passages 25, which extend longitudinally of body 10 to the right end of the cylinder and are closed by plate 21. Preferably, two of these passages 25 are provided in the body. These passages are substantially of equal cross sectional area throughout their length. Two passages 27 are provided in body 10 for supplying and exhausting power fluid to cylinder 18. Ports 28 and 29 in body 10 communicate with chambers 19 and 20, respectively.

Ports 24, 28 and 29 are arranged at the top of body 10 and are centered on a vertical plane including the cylinder bore axis. Each of the passages 25 and each of the passages 27 are spaced equally from a vertical plane including the cylinder bore axis. This arrangement of ports and passages is such that the forces due to surging of fluid therethrough are counterbalanced and do not tend to move the pump body 10 laterally or rotate the pump body 10 on its base supports 26. Preferably, the body 10 is a casting having ports 24, 28 and 29 and passages 25 and 27 formed therein at the time of the casting.

Referring now to the valves for the introduction of fluid to be pumped to chambers 19 and 20, it is seen that reservoirs 30 and 31 are provided at the top of body 10 communicating with ports 28 and 29, respectively. These reservoirs communicate with intake and exhaust fittings 32 and 33, respectively, provided in cap plate 109 as shown in Figs. 3 and 4. Spring pressed poppet valves 34 control the flow of fluid between the reservoirs and fittings. The intake valves have their stems pointing upwardly and are unseated by pressure differential drop across the divider plate or partition 35 and are seated when the reservoir pressure exceeds that of the intake fitting pressure. The discharge valves 34 have their stems pointing downwardly and are unseated when the reservoir pressure exceeds the discharge pressure and are seated by excess discharge pressure relative to the reservoir pressure.

With reference to the control of power fluid to the power cylinders, a valve cage 36 is provided in cap 109 above divider plate 35. The cap has a power fluid inlet connection 109*a*. The divider plate has three ports 35*a*, 35*b* and 35*c*. Port 35*a* communicates between cage 36 and passages 27. Port 35*c* communicates between cage 36 and port 24. The middle port 35*b* communicates with exhaust 37. A slide valve 38 is mounted for reciprocal sliding movement within cage 36 and has a recess which in one position of the valve makes connection between ports 35*c* and 35*b* whereby expended power fluid from cylinder 17 may be exhausted through port 37. Slide valve 38 in its other extreme position places port 35*a* in communication with port 35*b* whereby expended power fluid from cylinder 18 may be discharged.

Valve member 38 is shifted in response to the position of the double element piston within the cylinder bore. This is accomplished by means of a mechanical tripped valve which controls a fluid actuating mechanism for valve 38. Valve 38 is attached by stem 39 to piston 40. The piston is reciprocally mounted in cylinder 41. The cylinder aperture through which stem 39 extends has a stuffing box to prevent leakage of fluid from the cylinder. Power fluid may be introduced to cylinder 41 on opposite sides of piston 40 to shift the position of the piston and thereby shift slide valve 38.

Power fluid flow to cylinder 41 is controlled by the mechanically tripped valve housed within cap 23. Cap 23 has connections 42 and 43 with cylinder 41 communicating on opposite sides of piston 40. The cap also has an inlet connection 44 for power fluid and a discharge connection 45. A valve member 46 is mounted within the cap 23 and controls the flow of power fluid and expended power fluid through connections 42 and 43. This valve member 46 is cylindrical in shape with a longitudinally extending groove 46*a* in its periphery. This groove is engaged by aligning screw 47 and communicates with the inlet connection 44 whereby power fluid may flow past member 46 to both ends of the valve member. Thus with the valve in the position shown in Fig. 1 the fluid passes from connection 44 through groove 46*a* and connection 42 to cylinder 41, driving the piston 40 to the position shown. Valve 46 has a recess 46*b* in its periphery. This recess makes communication between connection 43 and discharge 45 so that expended power fluid in cylinder 41 is exhausted when piston 40 moves to the position shown in Fig. 1.

The arrangement of valve 46 is such that when shifted in the cylinder of cap 23 to the left end of the cylinder the recess 46*b* makes communication between connection 42 and discharge 45, and the connection 43 is exposed. Thus with the valve 46 in its shifted position power fluid is introduced through line 43 to the left end of cylinder 41 to move piston 40 to the right. During movement of the piston expended power fluid is discharged through line 42, recess 46*b* and discharge line 45.

A connection is provided between valve 46 and the double element piston whereby the valve is mechanically tripped by the travel of the power piston as it reaches predetermind positions (usually the ends of the cylinder bore) within the cylinder bore. This connection includes the rod 48 attached to valve 46 and extending into the well of member 49 of cylinder head 14. The rod carries a stop 48*a* at its end within the well and a stop 48b intermediate its ends. Rod 48 extends through apertured plug 50 threaded in the well of member 49. The aperture of plug 50 is smaller than the diameter of stops 48*a* and 48*b* whereby the plug engages these stops as the piston travels within the bore.

With the parts arranged as illustrated in Fig. 1, power fluid is introduced through passages 27 to cylinder 18 to drive the double element piston toward the left. As the piston continues to move to the left, plug 50 will engage stop 48*b*, and continued movement of the piston will move valve 46 to the left until recess 46*b* covers the connections 42 and 45. When this is accomplished power fluid passes from cap 23 through connection 43 to cylinder 41 to drive piston 40 to the right. With piston 40 in its extreme right position, valve 38 has been shifted so that its recess covers ports 35*a* and 35*b* in the divider plate, and power fluid is then introduced to cylinder 17, whereby the double element piston is driven to the right. As the movement of the piston to the right continues, plug 50 engages stop 48*a* to shift valve 46 to position shown in Fig. 1. This again reverses flow of power fluid to cylinder 41 to shift valve 38, whereby power fluid is again introduced to power cylinder 18, changing the direction of travel of the double element piston.

It will be understood that the area of each of the piston heads 14 and 15, which is exposed to fluid to be pumped, is small relative to the outer faces of the piston heads exposed to the power fluid. For this reason the pressure of the fluid to be pumped is great relative to the pressure of the power fluid. Obviously, the diameter of the cylinder connection 16 between the piston heads 14 and 15 may be varied to change the pressure ratio of the pumped fluid to the power fluid. However, as the diameter of connection 16 is increased to increase the pressure, the volume capacity of the pump is decreased proportionately. Therefore, it is often desirable to increase the pressure of the pumped fluid without at the same time decreasing the volume capacity of the pump.

The auxiliary power attachment shown in Fig. 2 is provided to increase the discharge pressure of the pump. The attachment comprises a cylinder housing 51 with an end plate 52. A piston 53 is mounted within the housing and is attached by rod 54 to piston head 15. The rod 54 extends through a stuffing box to prevent intermingling of fluids. The housing 51 has passages 55 corresponding in number and communicating with passages 27 to supply power fluid to the right side of piston 53 at the same time power fluid is supplied to cylinder 18. Ports 56 communicate through passages formed in housing 51 with passages 25 of the body 10. Thus, power fluid is introduced to the left side of piston 53 through ports 24, passages 25 and ports 56. The expended power fluid is exhausted from either side of the piston through the same passages and ports through which it was supplied. By this expedient, the pressure of the pumping fluid may be substantially doubled without decreasing the volume capacity of the pump.

While the diameter of the bore of the cylinder housing 51 is substantially the same as the cylinder bore of body 10, it is contemplated that the diameter of the bore of the auxiliary housing may be varied to either increase or decrease the degree of pressure step-up.

Referring to the modification shown in Figs. 5 and 6, it will be seen that there is provided a high pressure booster section which may be utilized in conjunction with the relatively low pressure pump section shown in Fig. 1. The booster section is attached to body 10 by removing end plate 21 and securing in its place end plate 60 of the booster section.

The booster cylinder is made up of the cylindrical member 61 and the cylinder heads 62 and 63. Cylinder heads 62 and 63 are annular in shape and have large diameter bores 62*a* and 63*a* which receive the ends of member 61. O-rings or other sealing means are disposed between the ends of member 61 and the abutting shoulders of the cylinder heads to form a seal therebetween. The cylinder heads and cylinder member are held together as a unit by through bolts 64. These bolts also secure the booster unit to plate 60. The bumper 110 surrounds the male portion of cylinder 62 and limits the stroke of the double element piston.

The cylinder heads have bores of reduced diameter which are of substantially the same diameter as the bore of member 61. The bores of the cylinder heads and member 61 are coaxial with the cylinder bore of body 10. A booster rod 65 extends through the cylinder heads, and one end is secured to piston element 15 of the double element piston. The other end of rod 65 serves as a guide and is housed within dome 111. Each of the cylinder heads carries a packing gland surrounding rod 65. Rod 65 carries suitable packing 66, which serves as a piston on plunger within the cylinder bore of member 61.

Each of cylinder heads 62 and 63 has radial bores communicating with the reduced diameter bores. These radial bores serve as inlet and outlet ports for the booster cylinder. Check valves are provided for these ports. In the case of the inlet ports, the check valve balls 67 seat against shoulder 68 of fittings 69. The balls are urged against their seat by springs 70. In the outlet or discharge ports, the ball valves and springs are reversed whereby the springs urge the valves into seating position against the cylinder head port. The inlet ports communicate with the supply line 71 for fluid to be pumped. Line 72 provides a connection with one of the inlet ports and line 71. Line 73 forms a part of the connection for the outlet ports to the discharge line 74. A pressure gauge may be incorporated in the discharge from the booster.

A fluid to be pumped may be supplied to the low pressure section and the booster section by a common supply line 76 through branches 71 and 77. A common discharge line 74 may also communicate with the exhaust of both sections. It is preferred to place a check valve 78 in the discharge line between the two sections.

In order that the low pressure section and high pressure booster section can be selectively and interchangeably used, a pipe 79 is provided between the inlet and exhaust fittings 32 and 33. This pipe may be equipped with a manually operated valve 80, and preferably has disposed therein a combination valve and regulator 81. The regulator 81 has a connection with the discharge line 74 on the downstream side of check valve 78 through conduit 82.

The valve and regulator is detailed in Fig. 7 and comprises a cylindrical casing made up of two parts 83 and 84 having a threaded engagement. Part 84 has a bore 84*a* which slidingly receives the stem of valve member 85. Packing gland 86 retains packing material 87 in an enlarged diameter bore surrounding the valve stem. The stem of valve 85 extends into a chamber formed by an enlarged diameter bore 84*b* of part 84 and abuts shoe 88. Shoe 88 has a flange which engages one end of coil spring 89, the other end of the spring engaging a threaded plug 90. A second spring 91 is carried by the head of bolt 92 in the line of travel of shoe 88. Bolt 92 has a threaded engagement with plug 90 and may be advanced toward or retracted from shoe 88 to adjust the pressure exerted by the spring against valve 85.

Part 83 has an enlarged cylinder bore 93 in which fits seat ring 94. Packing material is disposed between ring 94 and shoulder 83*a* of part 83. A sleeve insert 95 holds seat ring 94 securely in position when parts 83 and 84 are assembled. Ports 83*b* and 83*c* are provided for connection in conduit 79.

Valve 85 is urged by spring 89 against seat 94 to close the passage through the cylindrical casing. In order that the valve may be opened in response to pressure within the discharge line, a plunger stem 96 is secured to valve 85 and extends through the seat ring into the bore of fitting 97. This fitting in turn is connected to the discharge line 74 through the conduit 82. Thus the end of plunger 96 is exposed to pressure within the bore of fitting 97 equal to the discharge pressure. When this pressure is great enough to collapse spring 89, valve 83 is opened, and the intake and exhaust fittings 32 and 33, respectively, are placed in communications with each other. Spring 91 does not engage shoe 88 until valve 83 has been unseated. This spring is stiffer than spring 89 and when it is engaged retards further movement of valve 85 until the discharge pressure is sufficient to overcome the combined springs 89 and 91. A second valve member 98 is carried by plunger rod 96 and seats against ring 94 when the discharge line pressure exceeds a certain value. By rotation of bolt 92, the upper pressure at which the valve is closed may be adjusted.

In operation of the low pressure and high pressure booster sections, the pump sections are assembled as illustrated in Fig. 5. The pump then may be used for any normal pumping purpose, but is especially adapted for use in testing apparatus such as boilers, well heads, Christmas trees and the like. When a testing job is to be performed, it is usually preferable to use a hydraulic fluid as the test fluid. The low pressure section is utilized as the pumping means until the container to be tested has been filled. This is desirable because of the greater capacity of the low pressure pump as compared with the booster. Spring 89 of regulator 81 is set so that valve 85 will open when the pressure within discharge line 74 approaches the pressure output of the low pressure section. With valve 85 open, inlet and outlet fittings 32 and 33, respectively, are placed in communication, and the low pressure section ceases to act as a pump because of the equalization of the pressures. With valve 85 seated, the volume capacity of the low pressure section is so great as compared with the volume capacity of the booster section that the booster section is substantially ineffectual. However, with valve 85 unseated, the low pressure section becomes ineffectual, and all the fluid pumped must pass through the booster section. Back pressure valve 78 is seated by the pressure developed by the booster section, and the pump continues in operation until the discharge pressure is great enough to move plunger 96 against the springs 89 and 91 to the point that valve member 98 seats against seat ring 94. When this occurs, conduit 79 is again closed, and the pump immediately locks and remains ineffective until the pressure in the discharge line has been released.

By this arrangement high volume pumping may be accomplished at pressures in the neighborhood of 200 pounds per square inch by utilizing the ordinary water pressure in most city mains, which is usually about 60 pounds per square inch. The area ratio between the double element piston and piston or plunger 66 of the booster section is such that pressures in the neighborhood of 12,000 pounds can be developed by the pump utilizing ordinary city water as the power source.

In the event additional pressure is desired from the booster section, it may be readily obtained by utilizing the pump chambers 19 and 20 as auxiliary power cylinders. For this purpose conduits 100 and 101 are provided in communication with chambers 19 and 20, respectively. Conduit 100 communicates with passages 27 through T connection 102 and conduits 103 and 104. A valve 105 controls flow through these conduits. Conduit 101 communicates with passages 25 through conduits 106 and 107, and flow is controlled through these conduits by valve 108. By opening valves 105 and 108, power fluid is introduced to and exhausted from chambers 19 and 20. The arrangement is such that chamber 19 is energized simultaneously with power cylinder 18 and chamber 20 is energized simultaneously with power cylinder 17. Thus the active area of the double element piston which is exposed to power fluid at any one time is increased by the area of pistons 14 and 15 that are exposed to chambers 19 and 20, respectively.

When the valves 105 and 108 are opened, the pressure within reservoirs 30 and 31 is greater than the pressure in intake line 77, and the poppet intake valves are held seated by the pressure within the reservoirs. Pressure in discharge line 74 down stream from check valve 78 is greater than the pressure within the exhaust fitting 33, and the check valve is seated by this pressure. It is then apparent that with valves 104 and 108 open the poppet intake and exhaust valves are held closed automatically and the chambers 19 and 20 become a part of the power system whereby the entire low pressure section is utilized as a motor for actuating the booster piston 66.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the structure.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having described the invention, what is claimed is:

1. In a fluid actuated pump having a body having a support and with a cylinder bore, means including a piston mounted within the bore dividing it into two power cylinders at the ends of the piston and intermediate chambers for fluid to be pumped, the capacities of the cylinders and chambers variable individually with reciprocation of the piston, the improvement which resides in the combination therewith of a valve cage adjacent one end of the body having intake and exhaust connections for power fluid and an even number of passages communicating between the power fluid connection and the power cylinder remote from the cage, said passages spaced equally from a plane normal to the support and including the longitudinal axis of the bore and of equal cross-sectional area and valve means simultaneously controlling flow through said passages, whereby surging effects of fluid passing through the passages are substantially counterbalanced.

2. A pump as in claim 1 wherein the intermediate pump chambers each have ports to establish communication between both the chambers and a source of fluid to be pumped and a discharge for pumped fluid, said ports having equal areas similarly disposed on each side of a plane normal to the support and including the longitudinal axis of the bore, whereby the forces produced by surging of fluid through the ports does not tend to effect lateral movement or rotation of the pump.

3. A pump as in claim 1 wherein the body is a casting with said fluid passages formed therein.

4. In a fluid actuated pump having a cast body with a cylinder bore, means including a double element piston and packer within the bore dividing it into two power cylinders at the ends of the piston and intermediate chambers for fluid to be pumped, the capacities of the cylinders and chambers variable individually with reciprocation of the piston, the improvement which resides in the combination therewith of power fluid passages formed in the body communicating with the ends of the cylinders, said passages extending through one end of the body and adapted to supply power fluid to the piston and to an auxiliary power attachment.

5. A fluid actuated pump comprising a cast body with a cylinder bore and a support, means including a double element piston and packer within the bore dividing it into power cylinders at the ends of the piston and intermediate chambers for fluid to be pumped, the capacities of the cylinders and chambers variable individually with reciprocation of the piston, an auxiliary cylinder housing removably mounted on one end of the body with a bore axially aligned with the bore of the body, a second piston reciprocally mounted in the bore of the housing and rigidly interconnected with the first piston, and passages communicating with the cylinders for supplying and exhausting power fluid to and from the cylinders on corresponding sides of the pistons simultaneously, the passages for supplying power fluid to the auxiliary cylinder being even in number and provided in the cast body spaced equally from a plane normal to the pump support and including the longitudinal axis of the bore, said passages each being of equal cross-sectional area.

6. The pump of claim 5 wherein the auxiliary cylinder housing is a casting and has passages for supplying power fluid thereto communicating with the passages for this fluid formed in the body, the passages in the auxiliary cylinder housing also being spaced equally from a plane normal to the pump support and including the longitudinal axes of the body and auxiliary cylinder housing bores, and each being of equal cross-sectional area.

7. A fluid actuated pump comprising a body with a cylinder bore therein, a double element piston operably mounted within the bore to provide power cylinders at each end of the piston with pumping chambers therebetween, a pressure booster including a cylinder with a bore axially aligned with the body bore, a plunger within the booster bore rigidly interconnected with the piston, the active area of the plunger being small relative to that of the power faces of the piston, means for selectively supplying fluid to be pumped to the pumping chambers and the booster cylinder and operable discharge connections from said pump chambers and booster cylinder whereby the pump may be selectively operated as a high volume and a high pressure pump.

8. In a fluid actuated pump having a cylinder with a piston operably mounted therein to provide power cylinders and chambers for fluid to be pumped, a pressure booster including a second cylinder co-axial with the first cylinder, a plunger reciprocally mounted within the second cylinder and having a rigid connection with the piston, valve controlled ports for the second cylinder providing for alternate intake and exhaust of fluid to and from the cylinder on both sides of the plunger dependent upon the direction of travel of the plunger, reservoirs for fluid to be pumped having ports communicating with the chambers of the first cylinder, a common inlet connection and common exhaust connection for the reservoirs, a conduit for supplying fluid to be pumped to the intake connection and the intake ports of the second cylinder, and means for selectively placing the intake and exhaust connections for the reservoir in communication whereby the unit serves as a high volume pump with said intake and exhaust connections out of communication and as a high pressure pump with said connections in communication.

9. A pump as in claim 8 wherein a discharge line communicates with the exhaust connection for the rservoirs and the exhaust ports of the second cylinder and has a back pressure check valve therein intermediate said points of communication.

10. In a fluid actuated pump having a cylinder with a piston operably mounted therein to provide power cylinders and chambers for fluid to be pumped, a pressure booster including a second cylinder co-axial with the first cylinder, a plunger reciprocally mounted within the second cylinder and having a rigid connection with the piston, valve controlled ports for the second cylinder providing for alternate intake and exhaust of fluid to and from the cylinder to supply fluid to the cylinder on the suction side of the plunger and to exhaust fluid from the cylinder on the compression side of the plunger, reservoirs for fluid to be pumped having ports communicating with the chambers of the first cylinder, a common inlet connection and common exhaust connection for the reservoirs, a conduit for supplying fluid to be pumped to the intake connection and the intake ports of the second cylinder, a pipe communicating between the intake and exhaust connections for the reservoirs and a valve controlling flow through said pipe whereby the unit serves as a high volume pump with said intake and exhaust connections out of communication and as a high pressure pump with said connections in communication.

11. In a fluid actuated pump having a cylinder with a piston operably mounted therein to provide power cylinders and pump chambers, a pressure booster including a second cylinder co-axial with the first cylinder, a plunger reciprocally mounted within the second cylinder and having a power transmitting connection with the piston, valve controlled ports for the second cylinder providing for alternate intake and exhaust of fluid to and from the cylinder on both sides of the plunger supplying fluid to the cylinder on the suction side of the plunger and exhausing fluid from the cylinder on the compression side of the plunger, reservoirs for fluid to be pumped having ports communicating with the chambers of the first cylinder, a common inlet connection and a common exhaust connection for the reservoirs, a conduit for supplying fluid to be pumped to the intake connection and the intake ports of the second cylinder, a discharge line communicating with the exhaust connection and the exhaust ports with a back flow check valve between the exhaust connection and the exhaust ports, a connection between the intake and exhaust connections for the reservoirs, a valve in said connection and a regulator for said valve, said regulator responsive to the pressure of said discharge line and operative to close said valve in said pipe when the discharge pressure is less than a predetermined amount and higher than a greater predetermined amount and to open said valve when the discharge pressure is intermediate said predetermined amounts.

12. A fluid actuated pump comprising a low pressure section and a high pressure booster section, said low pressure section having a cylinder with a piston operably mounted therein to provide power cylinders at both ends of the piston with two intermediate pumping chambers and common intake and exhaust fittings for the pump chambers for separately and alternatively supplying fluid to be pumped thereto, said booster section including a cylinder with a piston therein, means for actuating the piston, said piston. cylinder and actuating means so proportioned as to be capable of developing a high pressure relative to that of the low pressure section, a supply line communicating with the intake fitting of the low pressure section and having an operable valve controlled connection with the booster cylinder, a discharge line communicating with the exhaust fitting of the low pressure section and having an operable valve controlled connection with the booster cylinder, a back flow check valve in the discharge line between the sections, and means responsive to the pressure in the discharge line downstream from the check valve for placing the exhaust and intake fittings in communication with one another when the discharge line pressure downstream from the check valve exceeds a predetermined low pressure but is less than a greater predetermined pressure.

13. A combination as in claim 12 wherein the pressure responsive means includes a valve and a regulator in which the regulator is adjustable as to its maximum pressure for closing the valve.

14. A fluid actuated pump assembly comprising a low pressure section and a high pressure booster

section; the low pressure section having pump chambers and intake and exhaust fittings, said fittings each having separate valve connections with each pump chamber; the booster section having low volume capacity relative to the low pressure section and valved intake and exhaust ports for fluid to be pumped; a common discharge line connected to the exhausts of both pump sections with a back pressure check valve in the discharge line intermediate its connections to the pump sections; a connection between the intake and exhaust fittings of the low pressure section and a valve for the connection, a regulator for the valve responsive to the pressure in the discharge line downstream from the check valve for closing the valve when the discharge pressure in below a predetermined low pressure and exceeds a predetermined high pressure and to open the valve when the discharge pressure is an intermediate amount.

15. A fluid actuated pump comprising a low pressure section and a high pressure booster section, the low pressure section including a cylinder, a double element piston therein dividing it into power cylinders at the ends of the piston and intermediate pumping chambers, said booster section having a pump cylinder with a piston therein, a power transmitting connection between the pistons of both sections whereby actuation of the low pressure piston actuates the booster piston, means for selectively supplying and discharging fluid to be pumped to the pump chambers of both sections separately, and means for supplying and discharging power fluid to the power cylinders of the low pressure section to reciprocally drive the double element piston therein.

16. A fluid actuated pump comprising a low pressure section and a high pressure booster section, the low pressure section including a cylinder, a double element piston therein dividing it into power cylinders at the ends of the piston and intermediate pumping chambers, said booster section having a pump cylinder with a piston therein, a power transmitting connection between the pistons of both sections whereby actuation of the low pressure piston actuates the booster piston, means for selectively supplying and discharging fluid to be pumped to the pump chambers of both sections separately, means for supplying and discharging power fluid to the power cylinder of the low pressure section to reciprocally drive the double element piston therein, and means to selectively introduce and exhaust power fluid to the pump chambers alternately whereby corresponding faces of both elements of the piston of the low pressure section may be simultaneously exposed to power fluid to increase the pressure that may be developed in the booster section when fluid to be pumped is supplied to the booster section.

17. A fluid actuated pump comprising a pump section including a cylinder, a double element piston therein dividing it into power cylinders at the ends of the piston and intermediate pumping chambers, means for selectively supplying and discharging fluid to be pumped to the pump chambers, means for supplying and discharging power fluid to the power cylinder to reciprocally drive the piston and means to selectively introduce exhaust power fluid to the pump chambers alternately whereby corresponding faces of both elements of the piston may be simultaneously exposed to power fluid whereby the section may be selectively used as a pump or a power unit.

18. A fluid actuated pump comprising cylinder means with piston means therein to provide power cylinders and low pressure pump chambers, means for alternately supplying and exhausting power fluid to the power cylinders to actuate the piston means, valve controlled inlet and outlet ports for supplying and discharging fluid to be pumped to the pump chambers, a pressure booster including another cylinder of substantially smaller diameter than the pump chambers, a plunger reciprocally mounted within the second cylinder and having a power transmitting connection with the piston means, inlet and discharge ports for the booster cylinder with check valves controlling them providing for pumping of fluid upon each half cycle of the plunger, a main discharge conduit, the sole connections between the conduit and the pump being connections with the discharge ports of the pump chambers and booster cylinder, and means in the conduit preventing backflow from the booster discharge to the pump cylinders.

19. A fluid actuated pump comprising cylinder means with piston means therein to provide power cylinders and low pressure pump chambers, means for alternately supplying and exhausting power fluid to the power cylinders to actuate the piston means, valve controlled inlet and outlet ports for supplying and discharging fluid to be pumped to the pump chambers, a pressure booster including another cylinder of small diameter relative to the pump chambers, a plunger reciprocally mounted within the second cylinder and having a power transmitting connection with the piston means, inlet and discharge ports for the booster cylinder with check valves controlling them providing for pumping of fluid upon each half cycle of the plunger, a main discharge conduit, the sole connections between the conduit and the pump being connections with the discharge ports of the pump chambers and booster cylinder, means in the conduit preventing backflow from the booster discharge to the pump cylinders, and fittings connected between the inlet and discharge ports for the pump chambers to selectively place them in communication for circulating fluid.

20. A fluid actuated pump comprising cylinder means with piston means therein to provide power cylinders and low pressure pump chambers, connection means for alternately supplying and exhausting power fluid to the power cylinders to actuate the piston means, valve controlled inlet and outlet ports for supplying and discharging fluid to be pumped to the pump chambers, a pressure booster including another cylinder of small diameter relative to the pump chambers, a plunger reciprocally mounted within the second cylinder and having a power transmitting connection with the piston means, inlet and discharge ports for the booster cylinder with check valves controlling them providing for pumping of fluid upon each half cycle of the plunger, a main discharge conduit, the sole connections between the conduit and the pump being connections with the discharge ports of the pump chambers and booster cylinder, means in the conduit preventing flow from the booster discharge to the pump cylinders, and means for selectively establishing communication between the pump chambers whereby they may be selectively rendered ineffective as a pump.

21. In a pump, a fluid operated actuator, cylinder means with piston means therein providing a pump chamber, said piston means having a power transmitting connection with the actuator,

inlet and outlet ports for supplying and discharging fluid to be pumped to and from the chamber, a booster cylinder of smaller area than that of the pump chamber with plunger means therein providing a booster pump chamber therein, said plunger means having a power transmitting connection with the actuator, means for supplying and discharging fluid to be pumped to and from the booster chamber, a common main discharge conduit, the sole connections between the conduit and the pump being connections with the discharge ports of the pump chambers and booster cylinder, check valve means in the conduit preventing backflow of fluid from the booster discharge into the low pressure discharge and means for selectively establishing communication between the inlet and outlet ports of the first chamber to establish circulation through the chamber and said ports.

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