Aug. 13, 1929. G. B. SMALL 1,724,855

PNEUMATIC PUMPING APPARATUS

Filed Nov. 16, 1927 3 Sheets-Sheet 1

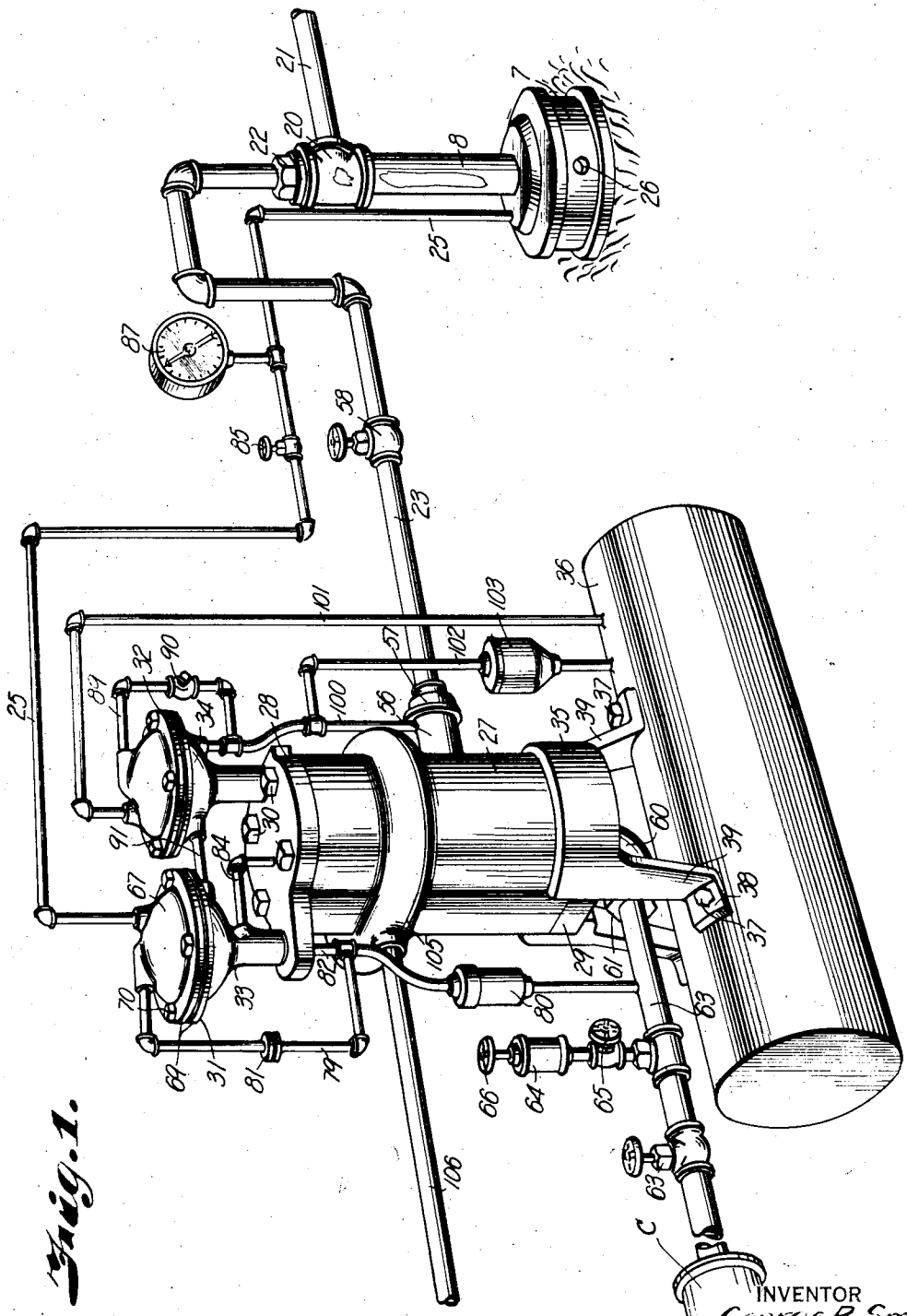


Fig. 1.

INVENTOR
George B. Small
BY
Arthur O. Brown
ATTORNEY

Aug. 13, 1929. G. B. SMALL 1,724,855

PNEUMATIC PUMPING APPARATUS

Filed Nov. 16, 1927 3 Sheets-Sheet 2

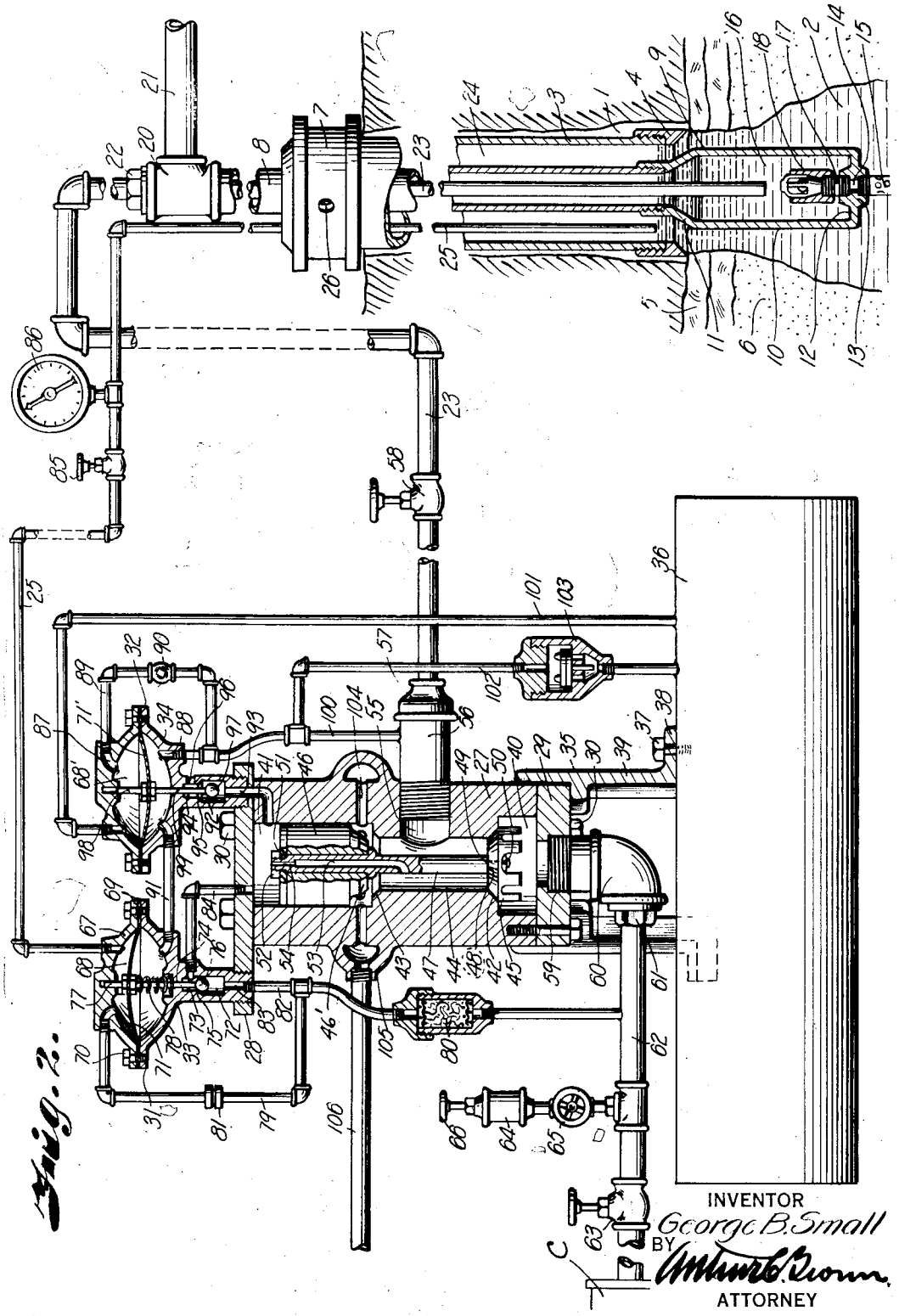


Fig. 2.

INVENTOR
George B. Small
BY
Arthur C. Brown
ATTORNEY

Aug. 13, 1929. G. B. SMALL 1,724,855

PNEUMATIC PUMPING APPARATUS

Filed Nov. 16, 1927 3 Sheets-Sheet 3

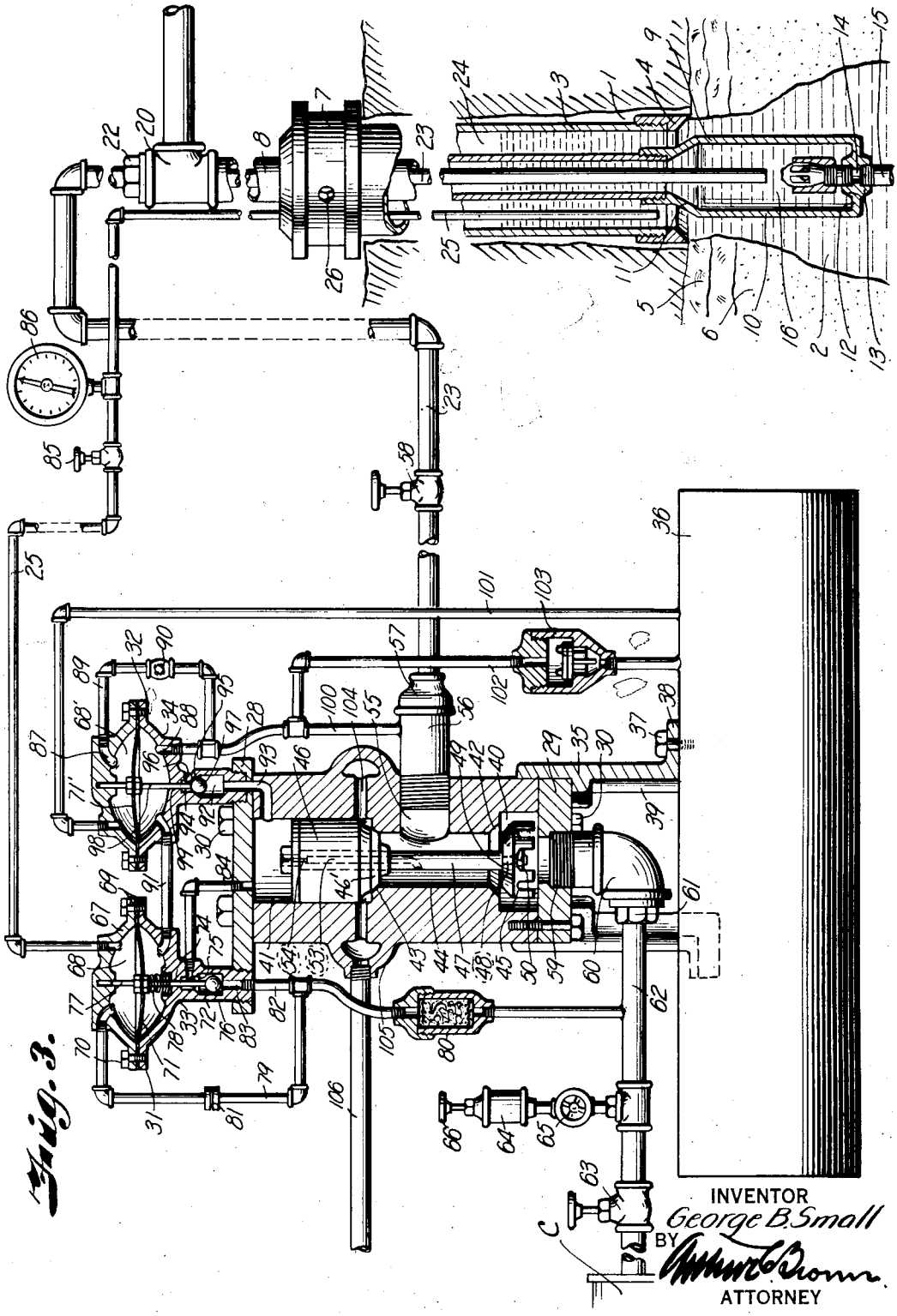


Fig. 3.

INVENTOR
George B. Small
BY
ATTORNEY

Patented Aug. 13, 1929. 1,724,855

UNITED STATES PATENT OFFICE.

GEORGE B. SMALL, OF TULSA, OKLAHOMA, ASSIGNOR OF THREE-FOURTHS TO TIDAL OIL COMPANY, OF TULSA, OKLAHOMA, A CORPORATION OF OKLAHOMA.

PNEUMATIC PUMPING APPARATUS.

Application filed November 16, 1927. Serial No. 233,656.

My invention relates to pneumatic apparatus for pumping wells and constitutes an improvement on my pending application for United States Letters Patent Serial No 229,414; the principal objects of the present invention being to effect more sensitive operation of the valves controlling flow of pressure medium to and from the well and to provide for individual removal of valve units for repair or replacement.

In accomplishing these and other objects of the invention I have provided improved details of structure, the preferred forms of which are illustrated in the accompanying drawings, wherein:

Fig. 1 is a perspective view of apparatus embodying my improvements, illustrating its application to a well.

Fig. 2 is a side elevation of the apparatus, illustrating parts of the valve mechanism and well in central vertical section, the parts appearing as when the displacing flow is interrupted to permit accumulation of oil in the well.

Fig. 3 is a similar view, illustrating the parts as they appear immediately following opening of the valve to permit flow for displacing oil from the well.

Referring more in detail to the drawings: 1 designates a well hole terminating in the usual shot hole 2, and 3 a well casing comprising a shoe 4 seated on cap rock 5 above the oil sand 6, and provided at its upper end with a vent 7, in accordance with common practice except as hereinafter stated. Extending through the head 7 is tubing 8, preferably equipped at its lower end with a liquid trap 9, comprising a cylindrical body 10 of larger diameter than the tubing, a reduced neck 11 at its upper end threaded onto the tubing, and a closed bottom 12 having a built-up boss 13, provided with a port 14.

Threaded into the port 14 and depending into the well pocket is a strainer pipe 15, and threaded into the port 14 and extending into the trap chamber 16 is a nipple 17 carrying a downwardly seating check valve 18, through which oil admitted to the strainer pipe is passed to the trap chamber, but prevented from return, to thereby effect collection of a charge in the trap.

A fitting 20 on the tubing above the casing head provides connection for a flow line 21 through which displaced oil is delivered to a pipe line, or storage, and extending through a reducing coupling 22 on the T fitting and through the tubing into trap 9 is a conduit 23 for conducting a major flow of artificial pressure medium, hereafter referred to as air, into the trap for release within oil accumulated in the trap.

The conduit 23 is of sufficiently less diameter than the tubing 8 to provide an annular channel 24 between the conduit and tubing through which oil displaced from the trap is delivered into the flow line 21.

Leading through the casing head and to near the bottom of the casing, exteriorly of the tubing 23 is a conduit 25 for a minor, or pilot, flow of air, and opening through the casing head is a vent 26 for relief of air delivered through the pilot line to delay back pressure in the line until the line is submerged and obviate back pressure on the oil inflowing from the sand.

Referring now to the mechanism for controlling flow of air to the well, 27 designates a master valve housing having an upper cover plate 28 and a lower cover plate 29, secured thereon by bolts 30; secondary valve units 31 and 32 including valve and diaphragm housings 33 and 34 being mounted on the upper plate 28 as and for the purpose presently described.

The assembled housings 27, 33 and 34 are supported by a chair 35 from a suitable base, here shown to consist of a pressure tank 36, forming part of the apparatus, and to which the seat is attached by bolts 37, extended through feet 38 on the chair legs 39.

The master valve chest 27 includes spaced chambers 40 and 41, having inwardly facing seats 42, 43, connected by a throat 44, and contained within the respective chambers is a valve 45 and a piston 46 of differential areas, rigidly connected by a stem 47, having a reduced shank 48 at one end extended through the valve 45 and forming a shoulder 49 to which the valve is held by a nut 50; the other end of the stem extending through the piston 46 and having a shoulder 51 to which the valve is held by a nut 52.

A channel 53 opening laterally through the stem and extending through the upper part thereof, provides open communication between the throat 44 and the part of the chamber 41 above the piston 46, the end of the channel opening into the upper portion of the chamber 41 being restricted as at

54, for a purpose presently described. The inner end of the piston 46 constitutes a valve head 46′ having an inner face exposed to the throat 44 when the head is on its seat 43, and which is of less area than the top of the piston so that when pressures are equal in chamber 41 and throat 44, the valve head will be held to its seat.

Opening laterally from the throat 44 is a port 55, and threaded into said port is a nipple 56 having a reducing coupling 57 for the conduit 23, through which the major flow of air is delivered to the well; the conduit 23 being equipped with a hand valve 58 for manually controlling the flow.

Opening through the cover plate 29 at the lower end of the valve chest is a port 59 into which is threaded an L fitting 60 having a reducing coupling 61 for a line 62 leading from a compressor, or other source of supply of air under pressures indicated by the cylinder C; the line being provided with a hand valve 63 for manually controlling flow to the valve mechanism and with a lubricator 64 controlled by a valve 65 from which lubricant is supplied to the line by a press, indicated by hand wheel 66.

It is apparent that air admitted through the line 62 to the chamber 40 will force the valve 45 to its seat and retain it there to cut off flow to the well until the valve is opened by means presently described.

The valve housing member 33 of the secondary valve unit 31 has a neck 33′ threaded onto the cover plate 28 and enlarged to cooperate with a cover member 67 in forming a diaphragm chamber 68, the enlargement and cover member having flanges 69 connected by bolts 70, a diaphragm 71 being extended across the chamber 68 with its periphery located between the flanges 69 and clamped in place by the bolts 70.

Located in the neck 33′ is a valve chamber 72 connecting with the diaphragm chamber 68 through a throat 73 and bore 74, the valve chamber having a downwardly facing seat 75 for a valve 76, having a stem 77 extended through the throat and bore into the diaphragm chamber and there connected with the diaphragm 71 which is adapted for actuation within the chamber 67. A spring 78 seated on the bottom of chamber 68 about the stem 77 normally supports the diaphragm to retain the valve 76 closed.

79 designates a bypass, or pilot supply line, leading from a point in the main supply line 62 between the valve 63 and piston valve chamber 40 to the piston chamber 68 above the diaphragm 74 and equipped with a filter 80 and orifice fitting 81.

82 designates a branch leading from the pilot line 79 between the filter and orifice fitting, to a channel 83 in the valve neck 33′ which connects with the bottom of valve chamber 72, and 84 designates a pipe leading from the throat 72 to the top of the piston valve chamber 41.

The minor flow, or pilot line 25, heretofore mentioned, leads from the top of the diaphragm chamber 68 to a point in the well considerably below the head level of the well, and is equipped with a hand valve 85 and pressure indicator 86.

With the parts above mentioned constructed and assembled as described, and, assuming the oil in the well to be below its head level (Fig. 2), as after preliminary swabbing or following a blowoff with the present apparatus, air admitted through the line 62 passes in major flow to the chamber 40 and forces the piston valve 45 to its seat, under which conditions no air is admitted to the well in major flow, but is passed in minor flow through the pilot line 79 into chamber 68 above the diaphragm 71 and from said chamber through the line 25, past the manual valve 85 into the well, escaping through the vent 26 in the casing head.

Oil flowing into the well from the sand rises into the trap past the check valve and within the well about the trap, finally submerging the outlet end of the pilot line to liquid seal the line. When this sealing occurs, air entering chamber 68 builds up a pressure sufficient to lower the diaphragm 71 against tension of the spring 78 and unseat the valve 76. When the valve 76 is unseated, a minor flow of air passes from line 79 through branch 82, channel 83, throat 73 and pipe 84, into the chamber 41 above the piston 46, thrusting the vent valve 97 (presently described) to its seat to prevent loss of the pressure medium and building up a pressure in chamber 41 equal to the pressure in chamber 40. When this equalization of pressure occurs, the piston, 46, being of greater area than the valve 45, is shifted downwardly to unseat the valve 45, seat the valve head 46′ and admit a major flow of air to the well through throat 44, nipple 56 and line 23; such flow acting to expel oil from the trap through tubing 8 and continuing until the trap is emptied and the major flow cut off, as I will now describe.

Mounted in the chamber 68′ of the secondary valve unit 2 is a diaphragm 71′. Connecting ports 87 and 88 leading from portions of the chamber 68′ on opposite sides of the diaphragm is a pipe 89 provided with a downwardly seating check valve 90 for controlling flow of air from one side of the diaphragm to the other, the chamber 78′ having connection near its bottom with the lower portion of the chamber 68 through a pipe 91. Located in the housing 34 below the chamber 68′ is a valve chamber 92 connected with the upper portion of the master piston chamber 41 through a channel 93 and having a throat 94 above its seat 95 provided with a vent 96.

97 designates a valve located in chamber 92 and having a stem 98 extended through the throat 94 and through a bore 99 in the valve housing leading from the throat 94 into the diaphragm chamber 68′, where it is rigidly connected with the diaphragm 71′. Weight on the diaphragm 71′ normally retains the valve 97 below its seat, so that air may be drained from the major flow chambers and lines through the vent port 96 when supply of major flow is cut off.

Leading from the nipple 56 in the major flow line to the port 88 in the housing 34 and communicating with the lower portion of diaphragm chamber 68′ is a branch 100 through which part of the major flow is diverted to chamber 68′ below the diaphragm 71′, and leading from the top of chamber 68′ to storage tank 36 is a line 101 through which part of the air from the major flow passing through the line 100, chamber 68′ and pipe 89 is directed to the storage tank to build up a pressure therein equal to that of the major flow.

102 designates a return line from the tank 36 to the branch 100, including a back check valve 103 for preventing flow of pressure medium from the line 100 to the tank 36 but permitting relief of the tank through the nipple 56, the master valve throat 44 and vent ports 104, which open from the piston valve chamber 41 directly above the valve seat 43 into a manifold 105. A line 106 is connected with the manifold for conducting the vented medium to a point of discharge.

When major flow to the well is established, as heretofore described, a part of the flow is diverted through the line 100 to the lower portion of chamber 68′, and through pipe 89 past the check valve 90 to the upper part of the chamber 68′ and through line 101 to the tank 36 to build up pressure in the tank equal to that of the major flow. Some of the air admitted to chamber 68′, through line 100 is delivered through pipe 91 into the bottom of chamber 68, balancing pressure on the diaphragm 71 and permitting spring 78 to lift the diaphragm and close valve 76, thereby cutting off minor flow of air to the chamber 41, above the piston valve 46. Cutting off supply of air to chamber 41 by minor flow does not, however, affect the master valve, as the chamber 41 is in communication with the throat 44 through the channel 53 in the piston valve stem, so that the pressure is equalized above and below the piston and the piston forced downwardly because of greater area of the top of the piston flow has passed through the channel in the stem 47 to balance pressure on the piston 46 so that it may retain its position.

Air passing to the well trap in major flow under these conditions closes the check valve in the trap and lifts the oil, as heretofore mentioned. When the trap has been emptied, air from the major flow escapes through the flow line, reducing pressure in the line 23 below that in the tank 36, and back pressure from the tank returns diaphragm 71′ to its lower position, unseating valve 97 so that pressure on the piston 46 is relieved and the master valve returned to initial position by pressure of the major flow on the piston valve 45, air escaping from the upper portion of chamber 41 through vent 96 more rapidly than it is admitteed through the restricted terminal 54 of the channel 53 in stem 47, to unbalance the pressure and permit lift of the piston.

The piston 46, when raised, exposes the vents 104 permitting air to escape therethrough from the storage tank into the manifold chamber 105, which encircles the valve housing member, to pass off through pipe 106.

The exhausting of the pressure continues until the parts again assume their original position, when major flow of air to the trap is cut off and the standing check valve is relieved and may open to permit the trap to be recharged, the operations heretofore described being repeated when the oil has reached the proper level in the well.

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

1. A pressure flow control device including in combination with an accumulator, primary piston and valve chambers having a connecting throat provided with an outlet line, connected primary piston and valve members mounted for reciprocation in said chambers, means for supplying air to the valve chamber in major flow, means including a valve controlling supply of air to the primary piston chamber in minor flow for opening the primary valve, means controlling relief of the primary piston chamber including diaphragm and valve chambers, a valve in the relief valve chamber, a diaphragm in the diaphragm chamber connected with said valve and dividing said chamber into inner and outer portions, a conduit connected with said outlet line and with the inner portion of said diaphragm chamber, and having a branch provided with a back-check valve leading to the accumulator through the outer portion of said diaphragm chamber, and means whereby the relief valve is opened by pressure from the accumulator in response to drop in pressure in the outlet line.

2. A pressure flow control device including in combination with an accumulator, primary piston and valve chambers having a connecting throat provided with an outlet line, connected primary piston and valve members mounted for reciprocation in said chambers, means for supplying air to the valve chamber in major flow, means including a valve controlling supply of air to the

primary piston chamber in minor flow for opening the primary valve, means controlling relief of the primary piston chamber including diaphragm and valve chambers, a valve in the relief valve chamber, a diaphragm in the diaphragm chamber connected with said valve and dividing said chamber into inner and outer portions, a conduit connecting said outlet line with the inner portion of said diaphragm chamber, and having a branch provided with a back-check valve leading to the accumulator from the outer portion of said diaphragm chamber and means whereby the relief valve is opened by pressure from the accumulator in response to drop in pressure in the outlet line, and means responsive to drop in pressure in the outlet line for venting the accumulator.

3. A pressure flow control device including in combination with an accumulator, primary piston and valve chambers having a connecting throat provided with an outlet line, connected piston and valve members mounted for reciprocation in said chambers, means for supplying air to the valve chamber in major flow, a line for supplying air to the primary piston chamber in minor flow, means controlling flow through said minor flow line including a valve, a diaphragm chamber, a diaphragm dividing said chamber into inner and outer portions and connected with said valve, means for supplying air in minor flow to the upper portion of said diaphragm chamber to open the valve, means for venting the primary piston chamber, means controlling said venting means including a valve, a second diaphragm chamber and a diaphragm dividing said second chamber into inner and outer portions and connected with said vent valve, a line communicating with said outlet line and with the lower portion of the minor flow supply and relief control diaphragm chambers, a back-checked branch leading from said communicating line through the upper portion of said relief diaphragm chamber, and a back-checked line communicating with the outlet line and with the accumulator for venting the accumulator in response to drop in pressure in the outlet line.

4. A pressure flow control device including in combination with an accumulator, a primary valve housing including spaced piston and valve chambers having a connecting throat provided with an outlet line, means for supplying air in major flow to the valve chamber, connected piston and valve members mounted for reciprocation in said chambers, a minor flow air line leading to the piston chamber including a valve chamber, a valve in said chamber, a diaphragm chamber, a diaphragm dividing said diaphragm chamber into upper and lower portions and connected with said minor flow control valve, a vent line leading from the primary piston chamber including a valve chamber, a valve in said chamber, a vent diaphragm chamber, a diaphragm dividing the vent diaphragm chamber into upper and lower portions and connected with the vent valve, a line providing communication between the inner portions of the minor flow supply and vent diaphragm chambers, a line leading from the outlet line to the lower portion of the vent diaphragm chamber, a branch on said line leading to the upper portion of said vent diaphragm chamber and provided with a back-check valve, a line leading from the outer portion of the vent diaphragm chamber to the accumulator, a line leading from the line connecting the outlet line with the vent diaphragm chamber to the accumulator provided with a back-check valve, and means for supplying air in minor flow to the outer portion of the minor flow control diaphragm chamber.

In testimony whereof I affix my signature.

GEORGE B. SMALL.