

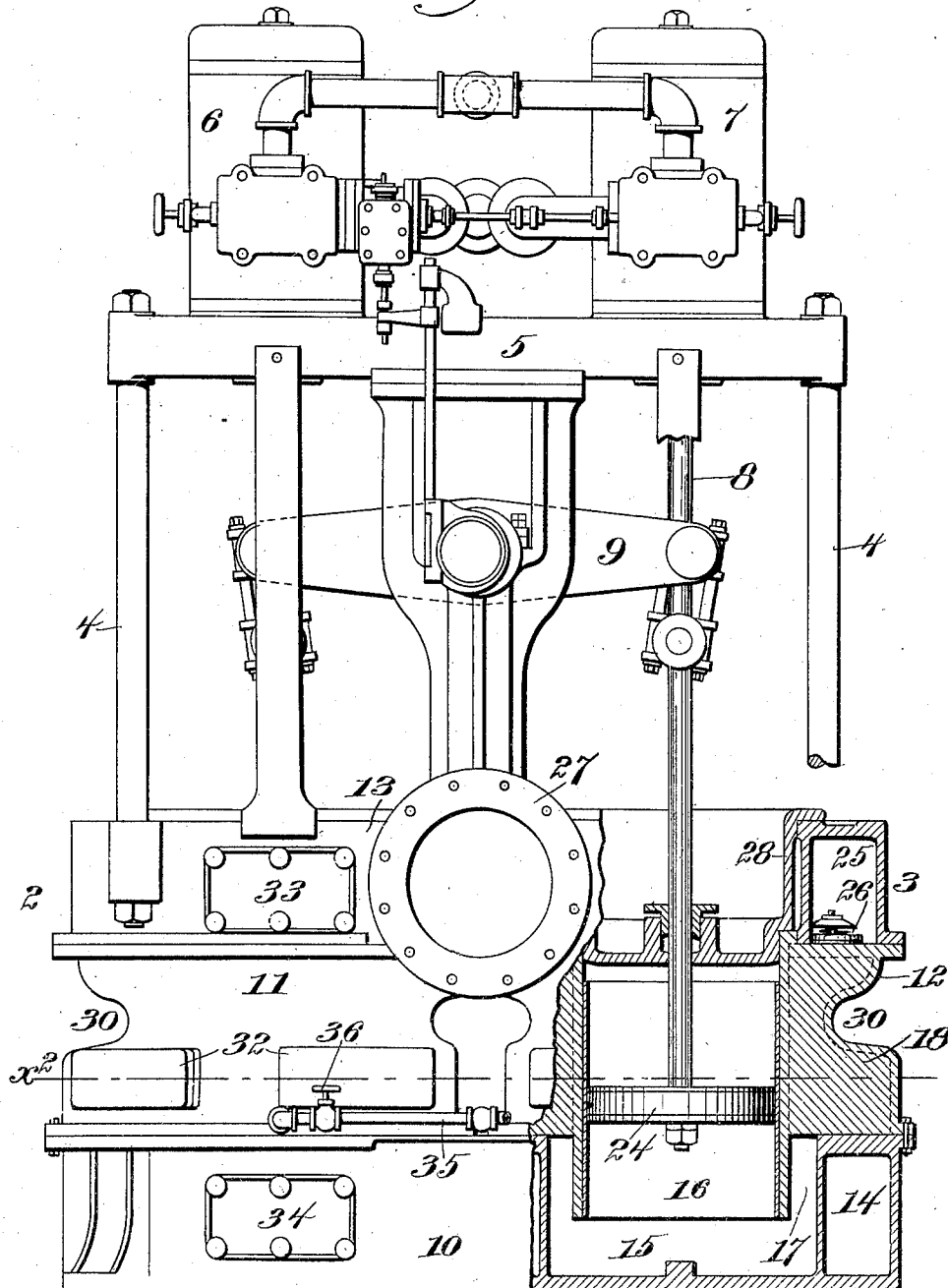
B. O. GAGE.
PUMPING ENGINE.
APPLICATION FILED DEC. 16, 1908.

972,357.

Patented Oct. 11, 1910.

2 SHEETS—SHEET 1.

Fig. 1.



Witnesses:

James Maloney.
Wm. Brown.

Inventor:

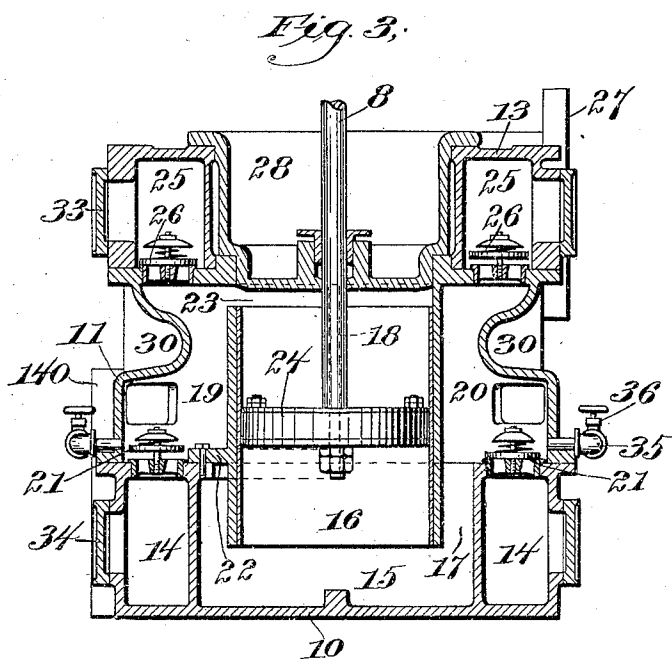
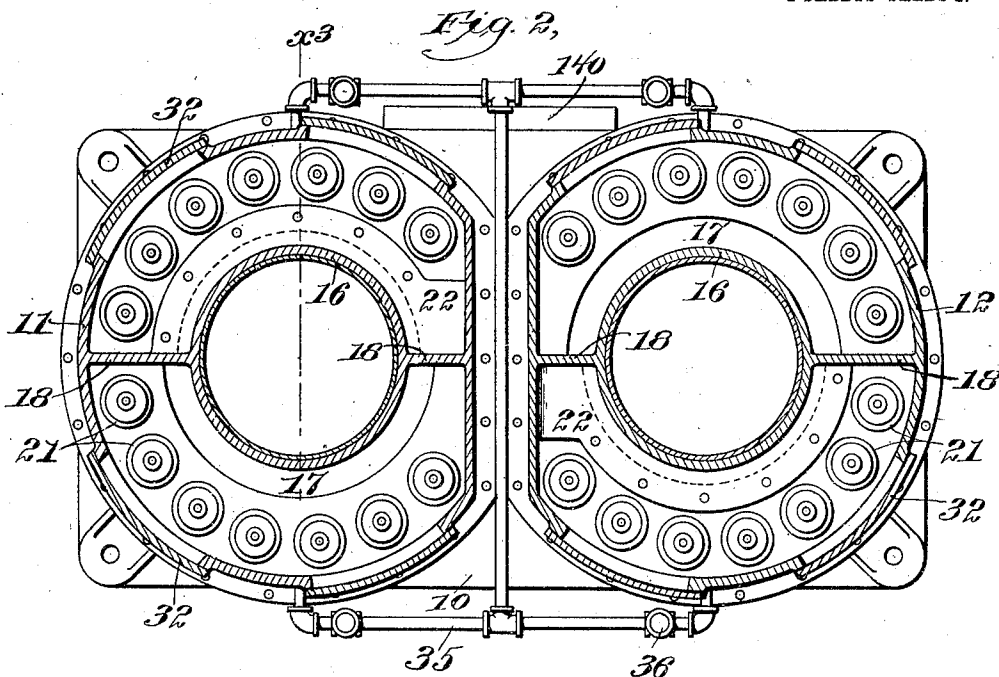
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by J. P. & H. J. Lummie
Attys.

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2 SHEETS-SHEET 2.



Witnesses
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UNITED STATES PATENT OFFICE.

BURT O. GAGE, OF WARREN, MASSACHUSETTS, ASSIGNOR TO WARREN STEAM PUMP COMPANY, A CORPORATION OF MASSACHUSETTS.

PUMPING-ENGINE.

972,357.

Specification of Letters Patent.

Patented Oct. 11, 1910.

Application filed December 16, 1908. Serial No. 467,883.

To all whom it may concern:

Be it known that I, BURT O. GAGE, a citizen of the United States, residing in Warren, in the county of Worcester and State of Massachusetts, have invented an Improvement in Pumping-Engines, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

This invention relates to a pumping engine, and especially to the pump proper of a double acting, independent air pump for use in connection with condensing steam engines.

The peculiar nature of the operation of an air pump for discharging the contents of a condenser of a steam engine and maintaining a high vacuum therein is such as to call for special construction of the pump proper, and it has been found, heretofore, that for an independent air pump, especially of the twin type, a single acting bucket pump is most effective, and such construction has been most commonly adopted for independent twin air pumps.

I have devised a double-acting piston pump capable of producing and maintaining a high vacuum, and being more compact and economical of space than the bucket pumps heretofore commonly used, and having the advantages of easy maintenance and ready accessibility of parts for repair or replacement, when required.

Figure 1 is a front elevation of a double acting twin air pump embodying this invention, one of the pumps being shown partly in section; Fig. 2 is a sectional plan thereof on line x^2 , Fig. 1; and Fig. 3 is a vertical, longitudinal section through one of the pumps on line x^3 of Fig. 2.

The invention is shown embodied in a twin pumping engine, and the general arrangement is the same as in twin air pumps heretofore used, the engine comprising a pair of pumps 2, 3 (see Fig. 1) having suction and discharge chambers common to both, and connected by uprights 4 with a base plate 5 for the actuating engine or steam cylinders 6, 7, corresponding to, and in line with the pump cylinders, the pistons of the steam cylinders being each connected by a piston rod 8 with the piston of the corresponding pump, so that each steam cyl-

inder and piston with the corresponding pump constitutes a direct acting pumping engine. The piston rods of the two pumping engines are connected by a rocking beam 9 which causes the pumps to operate in unison, but to make their strokes in opposite directions, the power of both steam cylinders thus being exerted in each stroke, and transmitted to the pump pistons in accordance with the load on each, at any given stroke or time in the stroke.

The organization thus far considered, except for the construction of the pumps, which will be hereinafter described, and the fact that pistons, instead of buckets or valved pistons, are used in the pumps proper, is substantially the same as has been heretofore used in independent twin air pumps, and the construction of the steam cylinders and their appurtenances, including the valve mechanism, may be of any suitable or usual construction, and, if desired, a single steam cylinder might be used connected directly to the piston of one of the pumps, and through the rocking beam 9 to the piston rod of the other pump, so as to operate the pump pistons in unison but in opposite directions, the same as when two steam cylinders are employed.

The structure of the pump comprises four principal components, viz., the base portion 10 containing the suction chamber common to both pumps, and the two cylinder pieces or sections 11, 12, and the discharge chamber 13, common to both cylinders, and mounted upon the cylinder pieces 11, 12, and constituting the direct support for the frame work of the actuating cylinders or steam end of the pump.

The construction of the individual pumps is best shown in Fig. 3. The base 10 contains the suction chamber 14, provided with a suitable inlet passage, as indicated at 140, Figs. 2 and 3 (being structurally similar to the outlet passage 27 shown in Fig. 1, but at the rear of the pump), said suction chamber being of annular form where it is adjacent to the end of the cylinder proper, the base portion 10 containing a recess 15 within the suction chamber 14, corresponding in position to the cylinder proper 16 and of larger diameter or sectional area, so as to afford a space between the wall of the cylinder proper and the inner wall of the suc-

tion chamber 14, as shown at 17, Figs. 2 and 3, the lower end of the cylinder proper 16 extending down into the recess 15 in the base portion, and having its lower end a substantial distance below the level of the top of the suction chamber 14.

Each cylinder piece contains the cylinder proper 16 and a surrounding wall or casing extending to the outer wall of the suction chamber 14, and having a space between it and the cylinder proper divided by a vertical partition 18, as best shown in Fig. 2, thus forming two separate intermediate chambers 19, 20, which together surround the cylinder 16, above the base casting and suction chamber, which latter communicates with both of the said intermediate chambers through openings controlled by upwardly opening valves 21 which may be such as commonly employed between the suction chamber and cylinder or barrel of a pump.

The cylinder piece is provided with a flange 22 extending around one side of the cylinder 16, from one to the other of the partitions 18, which flange seats upon the base piece above the inner wall of the suction chamber 14, as shown at the left hand in Fig. 3, and thus cuts off communication between the intermediate chamber 19 at that side of the vertical partitions 18 and the chamber 15 communicating with the lower open end of the cylinder proper 16, while the intermediate chamber 20 at the other side of said partitions 18 is in free communication through the space 17 (see Figs. 2 and 3) with the recess 15 in the base piece and with the lower end of the cylinder 16 which opens directly into said recess.

The wall of the cylinder proper 16 is extended at one side of the vertical partitions 18 to the top of the cylinder piece, thus cutting off communication between the intermediate chamber 20 and the upper end of the cylinder, as is clearly shown in Fig. 3, while at the other side of the said partition 18, the cylinder wall terminates a little below the upper end of the cylinder chamber, thus leaving a passage or space 23 which affords communication between the intermediate chamber 19 and the upper end of the cylinder. The piston 24 may be of any suitable or usual construction, and by reason of the construction thus far described, it will be seen that the cylinder 16 communicates at its lower end only with the intermediate chamber 20, and at its upper end only with the intermediate chamber 19, and that the upper end of the cylinder communicates with the upper end of the intermediate chamber 19 near the top wall of said chamber, and the lower end of the cylinder communicates through the passage 17 with the intermediate chamber 20 at the bottom of the latter.

The discharge chamber 25 in the top sec-

tion of the pump portion of the engine overlies both of the cylinder pieces 11 and 12 substantially to the outer wall, and thus lies above both intermediate chambers 19, 20 of both pumps, and communicates with said intermediate chambers through openings controlled by upwardly opening valves 26 which are opened to permit the flow of fluid from the intermediate chambers into the discharge chamber to prevent the reverse movement of the fluid, as is usual in pumps. The top section 13 is provided with a suitable discharge outlet 27 common to both pumps, as best shown in Fig. 1.

The upper section 13 has openings completely through it above the cylinders, each opening receiving the corresponding cylinder head 28 which is made cup-shaped, as best shown in Fig. 3, so as to afford a cup-like or open top chamber or recess above the piston head, and surrounded by the discharge chamber, which recess in the cylinder head receives any liquid which may leak through the stuffing box so that the said liquid tends to prevent the passage of air or vapor through the stuffing box.

The outer wall of the cylinder sections 11 and 12 is contracted toward the cylinders 16 contained therein in the space between the suction and discharge chambers, as shown at 30, which reduces the capacity of the intermediate chambers 19 and 20, and gives comparatively small clearance space between the piston and the inlet and outlet valves.

Hand holes with removable covers are provided in the cylinder pieces and in the top and base sections, as shown at 32, 33, 34, Fig. 1, for affording access to the valves which may thus be repaired or replaced, without having to obtain access to the interior of the cylinder, as is the case with reference to the valves in the bucket of a single acting bucket pump.

While the invention has been herein shown and described as embodied in a twin pump or pair of pumping engines connected for simultaneous and equalized operation by a rocking beam, the invention, so far as it relates to the novel construction of the pump cylinder and parts directly cooperating therewith, is embodied in a single one of the pumps and cooperating parts, and Fig. 3, for example, may be understood as representing the pump end of a complete pump embodying the invention, it being understood that there is a suitable inlet to the suction chamber 14 and outlet from the discharge chamber 25, whether the cylinder works alone or in combination with the other cylinder of a twin pump.

By reason of the nature of the material being pumped, part being liquid, and part being vapor or gaseous, the operation is somewhat different at the two ends of the cylinder, and the operation of the parts in

communication with the lower end of the cylinder during a stroke is as follows: When the piston has completed its down stroke which extends clear to the bottom of the cylinder 16, under usual conditions when the pump is in continuous operation, the gaseous material and a part of the liquid will have been expelled through the discharge valves 26 and the intermediate chamber 20 which is in communication with the lower end of the cylinder, as well as the space 15 below the cylinder, and the connecting passage 17 will be full of liquid. When the piston makes its upstroke, the liquid will follow it through the open, lower end of the cylinder, and will descend in the intermediate chamber 20, the liquid following the piston from the intermediate chamber into the cylinder. During or toward the latter part of the upstroke of the piston, the pressure in the intermediate chamber will have been so reduced that the slight pressure in the suction chamber 14 is sufficient to open the valves 21, and the air and vapor from the suction chamber will pass through the said valves into the intermediate chamber 20, and if liquid begins to pass before the liquid in the chamber has been drawn down to the level of the lower end of the cylinder, no air will pass into the cylinder, but the air and vapor will accumulate in the intermediate chamber 20 above the level of the liquid therein. In the down stroke of the piston, the liquid will be forced from the cylinder through the passage 17 into the intermediate chamber 20, and rising therein will expel the air and vapor through the discharge valves 26, and finally if there is more than enough liquid to fill the intermediate chamber or clearance space between the piston and the discharge valves 26, some liquid will be discharged through the said valves 26, leaving the said clearance space entirely filled with liquid at the end of the stroke. Thus, in the usual operation, the level of the liquid outside the cylinder will not at any time descend below the level of the lower end of the cylinder, and the vapor will not enter the cylinder, so that the piston, for the most part, acts directly against liquid rather than gaseous material. If, however, the liquid in the intermediate chamber, together with that entering the same in the upstroke of the piston is insufficient completely to fill the lower part of the cylinder, its level outside the cylinder would descend, and when it arrived at the lower end of the cylinder, the gaseous material would pass into the cylinder and accumulate between the piston and the column of liquid therein. In the next down stroke of the piston, however, the gaseous material would be entirely expelled from the cylinder, and rising to the top of the chamber would pass out through the discharge valves 26, or remain above the liquid

in the intermediate chamber 20, and at the next upstroke the piston would be followed by the liquid material entering the cylinder, as previously described. In the case of the other intermediate chamber 19 which communicates with the upper end of the cylinder, the said chamber will, in the usual operation, remain filled with liquid at all times up to the level of the upper end of the cylinder. When the piston has completed its upstroke, the slight space above it and the intermediate chamber 19 communicating with it will usually be filled with liquid up to the level of the valve 26 through which some of the liquid has been discharged after the gaseous material has been discharged. When the piston makes its down stroke, the liquid above the level of the top of the cylinder will lie upon the piston and travel down with it in creating the vacuum in the upper part of the cylinder, and in the slight space above the level of the upper end thereof, until the pressure is sufficiently reduced to cause the pressure in the suction chamber 14 to open the valves 21 when the vapor or gaseous material will first pass up through the liquid from the chamber 19 into the space in and above the cylinder above the piston. When more liquid follows through the suction valves 21 from the suction chamber it will flow over the upper edge of the cylinder and down into the cylinder upon the liquid already resting on the piston therein. When the piston makes its upstroke, it will first discharge all the gaseous material through the discharge valves 26, and thereafter if the liquid contents are greater than the clearance space, will discharge liquid through the discharge valve 26, the entire space between the suction and discharge valves being full of liquid at the end of the stroke in the usual operation.

It sometimes happens, especially in starting the pump, that sufficient liquid does not enter or accumulate in one of the chambers, and, at the suction stroke of the piston, the rarefaction of the air by expansion from the intermediate chamber into the cylinder does not reduce the pressure to that in the suction chamber, or enough below it to cause the valves 21 to be lifted, and in such event the air would merely be compressed to about atmospheric pressure at the next forcing stroke, and again expanded at the next suction stroke of the piston, without causing any draft from the suction chamber. In such event, others of the intermediate chambers will have become wholly or partially filled with the liquid as the operation continues, and the equalizing connecting duct will permit some of the liquid to flow from the chambers relative to which the piston is making its forcing stroke to the chamber relative to which the piston is making its suction stroke, so that the liquid will enter

the latter and thus reduce the clearance space for the gaseous material, so that on the suction stroke it will be sufficiently rarefied to cause the suction valves to open and the pumping action to go on properly. This equalizing, connecting passage or duct should be of relatively small capacity, and when all of the chambers contain sufficient liquid to insure the proper working, the flow through said equalizing duct will be very slight, and may, if desired, be entirely shut off by valves provided for that purpose, as shown at 36.

As the piston operates to discharge the fluid at both strokes, it may be made of half the sectional area required for the bucket piston of a single acting pump of otherwise equal dimensions, and the setting of the cylinder so that its lower end is well below the upper part of the suction chamber permits the height of the pump portion or pump end of the pumping engine to be correspondingly reduced, so that a relatively compact structure is produced, which is an extremely desirable feature for pumps of this character, which are frequently used where the greatest economy of space is a requisite. The reduction of the sectional area of the piston thus made possible by utilizing its complete pumping action, (suction and discharge) at both strokes, admits of the piston itself, and the piston rod and moving parts associated therewith, being made much lighter than in a single acting pump of equal speed in strokes per minute, and of equal capacity, which lightening of the moving parts affords a substantial advantage in construction and operation, as the momentum of heavy moving parts is objectionable in the operation of pumps of this character.

The construction and arrangement of the pump cylinder, suction and discharge chambers, and intermediate chambers, are such that the valve controlled openings, through which the fluid is discharged, are at the highest point relative to the space from which the fluid is discharged, so that no air or gaseous material is trapped at any point, and, furthermore, the construction is such that, in the continuous regular operation, the piston is at all times in direct contact with the liquid, and there is always a complete separation of the liquid and gaseous contents, with the gaseous portion when present always in the upper part of the intermediate chambers and adjacent to the discharge valves, so that if there is liquid enough to fill the clearance space, the gaseous material will be entirely expelled at each forcing stroke of the piston. The fact that the piston works in contact with the liquid contents tends to prevent or reduce leakage past it, and that fact coupled with the relatively small piston area and momentum of the moving parts, reduces the ob-

jectionable shock such as is experienced when a bucket or plunger or piston makes the first part of its stroke in the gaseous material, and encounters the surface of the liquid below the gaseous material when said piston is at mid-stroke and in rapid movement, so that a violent blow is struck upon the surface of the liquid.

In the present construction, there is no impact or blow struck by the piston against the liquid, even when the amount of liquid in the clearance space is insufficient to fill the cylinder. In that event, gaseous material will enter the cylinder at its lower end, and will lie between the piston and the liquid when the piston has arrived at the end of its upstroke, but, in the next down stroke, the gaseous material between the piston and the liquid will force the liquid downward out of the cylinder in advance of the piston, and will then itself be discharged from the lower end of the cylinder, and will rise through the liquid in the intermediate chamber and be expelled through the discharge valve, and the piston will encounter the surface of the liquid only at the moment when the piston is practically at the end of its downward stroke, so that no appreciable impact will be experienced.

I claim:

1. A pumping engine comprising, in combination with an actuating cylinder and piston, a pump cylinder and piston; and a base for said pump cylinder, having a suction chamber surrounding the lower end of said cylinder, and forming therewith a recess surrounded by and normally cut off from said suction chamber and communicating with the lower end of said cylinder; and separate intermediate chambers one communicating with the lower end only, and the other with the upper end only of said pump cylinder; and a discharge chamber above said intermediate chambers; and valves controlling communication between the suction chamber and intermediate chambers, and located substantially at the junction of said chambers and said recess, and valves controlling communication between the intermediate chambers and discharge chamber, substantially as described.

2. A pumping engine comprising, in combination with an actuating cylinder and piston, a pump cylinder and piston; and a base for said pump cylinder, having a suction chamber surrounding the lower end of said cylinder, and forming therewith a recess surrounded by and normally cut off from said suction chamber and communicating with the lower end of said cylinder; and separate intermediate chambers one communicating with the lower end only, and the other with the upper end only of said pump cylinder; and a discharge chamber above said intermediate chambers; and

valves controlling communication between the suction chamber and intermediate chambers, and located substantially at the junction of said chambers and said recess, and valves controlling communication between the intermediate chambers and discharge chamber, said pump cylinder having its lower end open in said recess of the base below the level of the top of the suction chamber, substantially as described.

3. A pumping engine comprising, in combination with an actuating cylinder and piston, a pump cylinder and piston; and a base for said pump cylinder, having a suction chamber surrounding the lower end of said cylinder, and forming therewith a recess surrounded by and normally cut off from said suction chamber and communicating with the lower end of said cylinder; and separate intermediate chambers one communicating with the lower end only, and the other with the upper end only of said pump cylinder; and a discharge chamber above said intermediate chambers, and valves controlling communication between the suction chamber and intermediate chambers, and located substantially at the junction of said chambers and said recess, and valves controlling communication between the intermediate chambers and discharge chamber, said intermediate chambers surrounding the pump cylinder and having their outer walls contracted toward the pump cylinder which constitutes the inner wall thereof, substantially as and for the purpose described.

4. A pumping engine comprising, in combination with an actuating cylinder and piston, a pump cylinder and piston; and a base for said pump cylinder, having a suction chamber surrounding the lower end of said cylinder, and forming therewith a recess surrounded by and normally cut off from said suction chamber and communicating with the lower end of said cylinder; and separate intermediate chambers one communicating with the lower end only, and the other with the upper end only of said pump cylinder; and a discharge chamber above said intermediate chambers; valves controlling communication between the suction chamber and intermediate chambers, and located substantially at the junction of said chambers and said recess, and valves controlling communication between the intermediate chambers and discharge chamber; and a cup-like cylinder head, closing the upper end of the cylinder and surrounded by the discharge chamber, substantially as described.

5. A pumping engine comprising, in combination with an actuating cylinder and piston, a pump cylinder and piston; and a base for said pump cylinder, having a suction chamber surrounding the lower end of

said cylinder, and forming therewith a recess surrounded by and normally cut off from said suction chamber and communicating with the lower end of said cylinder; and separate intermediate chambers one communicating with the lower end only, and the other with the upper end only of said pump cylinder; and a discharge chamber above said intermediate chambers; valves controlling communication between the suction chamber and intermediate chambers, and located substantially at the junction of said chambers and said recess, and valves controlling communication between the intermediate chambers and discharge chamber; and an equalizing duct affording communication between said intermediate chambers, substantially as and for the purpose described.

6. A twin pumping engine, comprising, in combination, two pump cylinders and pistons and piston rods connected therewith, and a rocking beam connecting said piston rods for simultaneous operation in opposite directions; a steam cylinder and piston connected with one of said rods; a base having a suction chamber common to both pump cylinders, and separate intermediate chambers coöperating with each cylinder, one communicating with the lower end only, and the other with the upper end only of said cylinder; a discharge chamber common to both pump cylinders located above the intermediate chambers; and valves in the upper wall of the suction chamber around the cylinder, controlling communication between the suction chamber and intermediate chambers, and valves at the upper ends of the intermediate chambers around the cylinder head, controlling communication between the intermediate chambers and the discharge chamber, substantially as described.

7. A twin pumping engine, comprising, in combination, two pump cylinders and pistons and piston rods connected therewith, and a rocking beam connecting said piston rods for simultaneous operation in opposite directions; a steam cylinder and piston connected with one of said rods; a base having a suction chamber common to both pump cylinders and surrounding the same to form recesses between said suction chamber and the lower ends of said cylinders, and separate intermediate chambers coöperating with each cylinder, one communicating with the lower end only, and the other with the upper end only of said cylinder; a discharge chamber common to both pump cylinders; automatic valves controlling communication between the suction chamber and intermediate chambers and located substantially at the junction of said chambers and said recess, and automatic valves controlling communication between the intermediate chambers and discharge chamber; and an equalizing

duct affording communication between all of said intermediate chambers, substantially as and for the purpose described.

8. In a pump of the class described, in combination, a casing provided within it at its lower end with an annular suction chamber whose inner wall forms a well within said casing normally disconnected from said suction chamber, and having at its upper end an annular discharge chamber, a cylinder located in said casing and extended from near the discharge chamber into said well to form with the inner wall of the suction chamber an annular space or recess about the lower end of said cylinder, means extended longitudinally of the cylinder to separate the space between the cylinder and the casing between the suction and discharge chambers into intermediate chambers, means to cut off one of said intermediate chambers from said well, automatic valves for said suction and discharge chambers, the automatic valve for said suction chamber being located substantially on a level with the junction of the said recess with one of said intermediate chambers and a piston in said cylinder of the internal diameter of the latter, substantially as described.

9. In a pump of the class described, in combination, a cylinder open at its upper and lower ends, a piston therein, a casing surrounding said cylinder and provided with means for reducing the width of the space between the cylinder and casing between the top and bottom of the latter, a suction chamber communicating with said space below the reduced portion and surrounding the lower end of said cylinder to form therewith a recess, a discharge chamber communicating with the said space above the reduced portion, automatic valves located substantially on a level with the junction of said recess with one of the intermediate chambers and controlling communication between said suction chamber and said intermediate chamber, automatic valves controlling communication between the intermediate chambers and the discharge chamber, means for separating said space into chambers between said suction and discharge chambers, and means for cutting off one of said intermediate chambers from the lower end of said cylinder, substantially as described.

10. In a pump of the class described, in combination, a cylinder open at its upper and lower ends, a piston therein, a casing surrounding said cylinder, a suction chamber within said casing whose inner wall forms a well normally cut off from said suction chamber and within which the lower end of the cylinder is extended to form a recess about said cylinder, said suction chamber having a fluid inlet, and a fluid outlet in close proximity to the upper end of said fluid inlet and substantially on a level with

the upper end of said recess, an automatic valve controlling said fluid outlet, a discharge chamber communicating with the casing above the open upper end of said cylinder, and provided with a fluid inlet from said casing, an automatic valve controlling the fluid inlet for said discharge chamber, means extended longitudinally of said cylinder between said suction chamber and said discharge chamber to form intermediate chambers with one of which only the upper end of the cylinder communicates near the bottom of the discharge chamber, and with the other of which only the lower end of the cylinder communicates near the bottom of said intermediate chamber, and means to cut off said well from the intermediate chamber with which the upper end of the cylinder communicates, substantially as described.

11. In a pump of the class described, in combination, a cylinder open at its upper and lower ends, a piston therein, a casing surrounding said cylinder, a suction chamber within said casing whose inner wall forms a well which is normally cut off from said suction chamber and into which the lower end of said cylinder is extended to form a recess about said cylinder, a discharge chamber within said casing, located above the cylinder in proximity to its upper end, means for separating the space between the said cylinder and casing into intermediate chambers, means to cut off one of said chambers from the said well and leave the other of said chambers in open communication with said well at the bottom of the said intermediate chamber, automatic valves located substantially on a level with the junction of said chambers and said recess, and automatic valves controlling communication between said intermediate chambers and said discharge chamber, substantially as described.

12. In a pump of the class described, in combination, a cylinder open at its upper and lower ends, a piston therein, a casing surrounding said cylinder and provided at its lower end with a suction chamber having a fluid inlet in the casing and provided with an annular inner wall within the casing forming a well and an annular upper wall located in close proximity to the upper part of the said fluid inlet, the lower end of said cylinder being extended into said well to form an annular space or recess between the cylinder and the inner wall of said suction chamber, an annular discharge chamber supported by said casing above the upper end of the said cylinder, automatic valves located in the upper wall of said suction chamber and the bottom wall of said discharge chamber substantially on a level with the upper end of said recess, means to separate the space between said suction and discharge chambers into intermediate chambers, one of

which is in open communication at its bottom with said well by said annular space, means cooperating with said cylinder and the inner wall of said suction chamber to
5 close a portion of said annular space and thereby cut off the other of the intermediate chambers from said well, means to restrict the diameter of the intermediate chambers between said suction and discharge chambers, and means for connecting one interme-

mediate chamber in open communication with the other, substantially as described.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

BURT O. GAGE.

Witnesses:

JOS. P. LIVERMORE,
M. E. COVENY.