

J. J. REXROTH.
DOUBLE ACTING PUMP.
APPLICATION FILED FEB. 5, 1909.

940,192.

Patented Nov. 16, 1909.

Fig. 1.

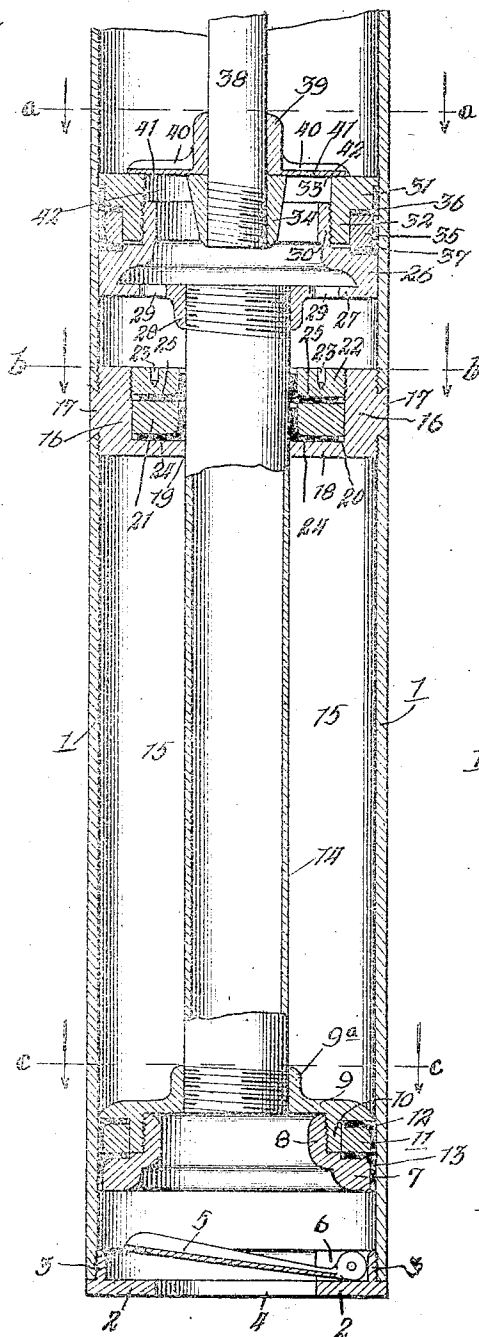


Fig. 2.

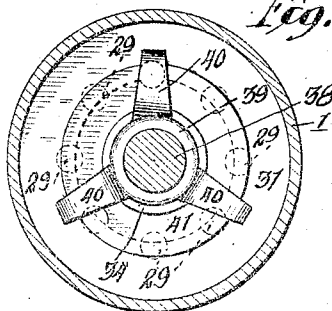


Fig. 3.

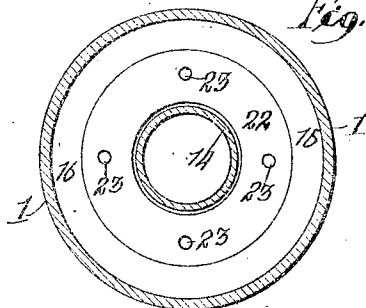
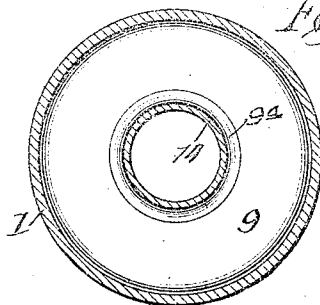


Fig. 4.



Witnesses:

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DOUBLE-ACTING PUMP.

940,192.

Specification of Letters Patent.

Patented Nov. 16, 1909

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To all whom it may concern:

Be it known that I, JOHN J. REXROTH, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Double-Acting Pumps, of which the following is a specification.

The objects of the present invention are to obtain, in a pump barrel or cylinder having a uniform diameter from end to end and by the use of one pump rod and an upper and lower piston, both pistons of the same diameter, a lift or raise of water with each up and down stroke of the pump rod and pistons under conditions by which the volume of water raised and discharged with each upstroke, will equal in amount the full capacity of the barrel or cylinder, and the volume of water raised and discharged at each downstroke, will equal in amount, approximately, the full capacity of the barrel or cylinder.

A further object is to furnish a space in the pump barrel or cylinder between a lower piston and a fixed cross-head or wall, in which space the lower piston travels and by its travel creates and maintains a vacuum, thereby forming a cushion to carry a weight of pump rod equal in amount to the air pressure.

A further object is to furnish a lower inducing and educing chamber for water, located below a lower piston and from which the water can be drawn or sucked into a twin upper inducing and educing chamber for water, located above a cross-head or wall and below an upper piston and valve,—the water passing from the lower inducing and educing chamber through a hollow imperforate piston rod or transmission tube into the twin upper inducing and educing chamber and out of the barrel or cylinder of the pump at the point of discharge.

A further object is to connect an upper and a lower piston, each of the same diameter, by a hollow imperforate piston rod or transmission tube, and thereby draw or suck water into both a lower and an upper inducing and educing chamber on the upstroke or ascent of the pistons, and on the downstroke or descent of the pistons discharge water from both the lower and upper inducing and educing chambers, for the water to pass above the upper piston, and valve and an equal amount be finally dis-

charged with each up and down stroke of the pistons.

A further object is to furnish a lower induction and eduction chamber into and from which water is induced and educed by a packed and sealed lower piston and a hollow imperforate piston rod or transmission tube and an upper twin or companion induction and eduction chamber into and from which water is induced and educed by an upper packed and sealed piston and the hollow imperforate piston rod or transmission tube, thus inducing into the pump barrel or cylinder, at the same time and with the same movements of the pistons, two approximately equal volumes of water, which are educed with the up and down stroke of the pistons, one volume on the upstroke and one volume on the downstroke.

A further object is to create a perfect suction and seal between a lower piston and an upper piston, both of the same diameter, and an inclosing pump barrel or cylinder, consisting of an upper section and a lower section, separated by a sealed cross-head or wall, by which water will be drawn or forced into and from an endwise expansible and contractible lower induction and eduction chamber by the lower piston, to be drawn or forced by the upper piston, through a hollow imperforate piston rod or transmission tube, connecting the two pistons, into an endwise expansible and contractible chamber between the upper piston and above the fixed cross-head or wall.

Other objects are to effectively seal and separate the lower chamber and the upper chamber by a fixed cross-head or wall, and thereby cause the water to pass from the twin lower chamber to the twin upper chamber, without passing into the space below the fixed cross-head or wall above the lower piston; and to improve generally the construction and operation of the pump as a whole.

The invention consists in the features of construction and combinations of parts hereinafter described and claimed.

In the drawings Figure 1 is a sectional elevation of a pump barrel or cylinder broken off at its upper end and showing the construction and arrangement of the fixed head or cross-wall, the upper and lower induction and eduction chambers, the upper and lower pistons and their connecting hol-

low piston rod or transmission tube, and the lower induction and upper eduction valve. Fig. 2, a cross-section on dotted line *a a* of Fig. 1, looking in the direction of the arrow. Fig. 3, a cross-section on dotted line *b b* of Fig. 1, looking in the direction of the arrow; and, Fig. 4, a cross-section on dotted line *c c* of Fig. 1, looking in the direction of the arrow.

10 The pump has a barrel or cylinder 1, which, as shown, is formed of an upper section and a lower section. At the lower end of the barrel or cylinder 1 is a cross-plate or wall 2, with an annular rim or flange 3 threaded into the end of the barrel or cylinder or otherwise secured in position. The bottom plate or cross-wall 2 has an opening or inlet 4 for admitting water, which opening, as shown, is controlled by a flap valve 5, pivoted at one side to ears 6 on the bottom or cross-wall 2, and constituting the induction valve for the lower section of the barrel or cylinder; but this induction valve could be of any other suitable form of construction.

25 Above the induction valve in the pump barrel or cylinder is located and operates the lower piston, the space between the piston and the induction valve forming the lower induction and eduction chamber. The lower piston consists of an annular ring 7, having an upwardly extending annular rim or wall 8 with an exterior screw thread, and a top plate 9, having a depending annular rim 10 with an interior screw thread engaging the exterior screw thread of the rim or wall 8 and uniting the ring 7 and top wall 9 to each other. An annular ring 11 is located in the space or recess formed between the top wall 9 and lower ring 7, and between the depending wall or flange 10 and the wall of the pump barrel; and on the upper side of this interposed ring 11 is a packing 12, preferably of cup leather; and below the interposed ring 11 and around the upper side of the ring 7 is a packing 13, also preferably of cup leather—which two packings are compressed and held in place by and between the interposed ring and the bottom ring and top plate, so as to furnish a close joint and seal around the periphery of the piston, between the piston and barrel or cylinder on the downstroke of the piston, thereby sealing the periphery of the piston, when the pump is primed with water, against the passage of water and air, as the piston moves down in the barrel or cylinder.

The top plate 9 has a central upwardly projecting rim or neck 9^a with an interior screw thread into which is threaded the lower end of a hollow imperforate piston rod or transmission tube 14, with a space 15 between the exterior of the hollow imperforate piston rod or transmission tube and the wall of the pump barrel or cylinder, in which space, below a fixed cross-head or wall, the

lower piston travels. The fixed cross-head or wall 16, as shown, has a central circumferential flange or bead 17, above and below which is an exterior screw thread, and a bottom plate or wall 18 having a central hole 19 for the passage of the hollow piston rod or transmission tube. The fixed cross-head or wall 16 has an interior annular chamber 20, the upper part of the wall of which has an interior screw thread. The chamber 20 has located in its lower portion a loose or free annular ring 21, and the upper part of the chamber 20 receives a ring follower 22, having an exterior screw thread to engage the interior thread of the wall of the chamber in the fixed cross-head or wall 16; and, as shown, the top of the ring follower 22 has holes 23 for a turn key or wrench, by means of which the ring follower 22 can be entered into position. The loose or free ring 21 has on its under and inner side a packing 24, preferably cup leather, and the ring follower 22 has on its under and inner side a packing 25, preferably cup leather, which packings 24 and 25 are compressed, so as to make a tight joint around the hollow piston rod or transmission tube, by advancing the ring follower 22 as required.

The lower portion of the cross-head or wall is threaded into the upper end of the lower section of the pump barrel or cylinder, until the end of the barrel or cylinder and the circumferential flange or bead 17 abut, and the upper section of the pump barrel or cylinder is threaded on to the upper portion of the fixed cross-head or wall, until its end abuts the flange or bead 17; so that when the sections are united to the cross-head or wall, the cross-head or wall will be held in a fixed position within the pump barrel or cylinder, with a tight close joint for the chamber below and the chamber above the fixed cross-head or wall, which chambers, when the pump is primed with water, are sealed against the passage of air and water around the outer circumference of the fixed cross-head or wall, while the cup leather packings 24 and 25 seal the chambers against the passage of air and water around the exterior of the hollow imperforate piston or transmission tube, when the pump is fully primed and in operation.

The upper piston is located above the fixed cross-head or wall; and between this piston and the fixed cross-head or wall is the upper induction and eduction chamber for the water, corresponding to and having the same capacity as the lower induction and eduction chamber. The upper piston consists of an annular lower ring 26, fitting the interior of the pump barrel or cylinder and having a bottom plate or wall 27, with a depending boss or hub 28 having an interior screw thread into which is entered the up-

per end of the hollow piston rod or transmission tube; and the bottom plate or wall has a series of holes or passages 29, furnishing an inlet into the chamber of the upper piston. The outer lower peripheral ring 26 has an upwardly extending annular rim or wall 30, with an exterior screw thread and of a less diameter than the diameter of the lower ring. An upper annular ring 31 is located above the bottom or lower annular ring; and this upper ring has a depending annular rim or wall 32, with an exterior screw thread engaging the exterior screw thread of the wall or rim 30 and uniting the two rings one to the other. The upper ring 31 has inwardly extending arms 33, uniting the ring to a central boss or hub 34, so as to leave openings between the ring and the boss or hub for the passage of water from inside of the hollow piston as a whole. A free or loose annular ring 35 is located in the space between the upper and lower outer rings and the wall of the pump barrel or cylinder; and between this intermediate ring 35 and the under face and outer side of the upper ring 31 is a packing 36, preferably a cup leather packing. A packing 37, also, preferably a cup leather packing, is located between the upper face of the lower annular ring and the under and outer face of the intermediate ring. The two packings 36 and 37 are compressed and held in place by advancing the outer upper ring 31; and these packings furnish a tight joint between the piston, as a whole, and the wall of the pump barrel or cylinder, which joint effectually prevents the escape of water and air around the periphery of the piston, on its upstroke. A pump rod 38 is threaded at its lower end into the central boss or hub 34 of the upper ring 31 of the upper piston; and this pump rod at its upper end is to be connected to a handle, or other operating means, in any usual and well known manner. An upper eduction valve is located above the upper piston. As shown this upper eduction valve is a flat faced disk valve, having a boss or hub 39 with spokes 40 encircling and free to slide up and down on the pump rod; and having a body or plate 41 attached to the spokes 40 of a diameter to cover and close the eduction openings or passage 42 between the arms 33 of the upper ring 31, when the valve is down, and to unclose these openings or passages, when the valve is raised.

The pump is assembled by attaching the lower or induction valve to the lower end of its section of the pump barrel or cylinder; the lower piston, with its sections united to compress the cup leather packings, is attached to the lower end of the hollow imperforate piston rod or transmission tube, and the lower piston and the hollow imperforate piston rod or transmission tube are

entered into the lower section of the pump barrel or cylinder, for the cup leather packings to make an air and water tight joint between the piston and the pump barrel or cylinder, and when entered the piston will form an endwise expansible and contractible lower induction and eduction chamber for the water within the barrel or casing, between the lower piston and the lower or induction valve. The fixed cross-head or wall is entered on to the upper end of the hollow imperforate piston rod or transmission tube, and then threaded or otherwise secured in the upper end of the lower section of the pump barrel or cylinder, so as to tightly close the upper end of said section of the barrel or cylinder. The upper piston, with its sections united to compress the cup leather packings, is attached to the projecting upper end of the hollow imperforate piston rod or transmission tube. The pump rod is connected to the upper piston, and the upper or eduction valve is slipped on to the pump rod to rest on the top face of the upper piston. The upper section of the pump barrel or cylinder is threaded or otherwise secured to the fixed cross-head or wall, so as to tightly close the lower end of said section of the barrel or cylinder; and when the upper piston is in place the cup leather packings make an air and water tight joint between the piston and the pump barrel or cylinder, and form an endwise expansible and contractible upper induction and eduction chamber, between the upper piston and the fixed cross-head or wall, corresponding to and the twin as to capacity of the lower induction and eduction chamber, when the pump is assembled.

The space above the upper piston, within the pump barrel or cylinder, forms a receiving and discharging chamber into which the water is lifted or raised and from which the water is discharged, through a suitable spout or nozzle (not shown), with each up and down stroke of the piston; and when the pump is primed the space between the sealed fixed cross-head or wall and the sealed lower piston, within the pump barrel or cylinder, has therein a vacuum, created and maintained by the sealed lower piston, which vacuum furnishes a cushion for the pump rod.

The operation is as follows: The initial up and down strokes of the pistons will prime or charge the pump barrel or cylinder with water, the priming or charging continuing until the upper receiving chamber is filled to a point for discharge of the next succeeding volume of water raised and projected thereinto; and when the pump is fully primed or charged, the upper and lower inducing and educing chambers are sealed by their respective pistons against peripheral escape of air and water around

the pistons, so that each up and down stroke will discharge a volume of water from the pump of approximately the same amount. The lower piston acts on each upstroke and sucks or draws the lower induction and eduction chamber full of water; and at the same time the upper piston acts on each upstroke and sucks or draws the twin upper induction and eduction chamber full of water, the water for the upper induction and eduction chamber being drawn through the hollow imperforate piston rod or transmission tube between the two pistons and passing into the interior of the upper piston and out through the openings in the bottom wall or plate of the piston into the chamber above the fixed cross-head or wall. It will thus be seen that with each upstroke of the pistons two volumes of water of approximately the same amount are simultaneously drawn into the pump barrel or cylinder—the amount entering or drawn into the sealed upper chamber being slightly less than the amount entering or drawn into the sealed lower chamber, owing to the presence of the hollow piston rod or transmission tube. The induction or lower valve is opened with each upstroke of the pistons, so as to admit water into the twin upper and lower induction and eduction chambers; and the eduction or upper valve is closed with each upstroke of the piston so that with each upstroke a volume of water will be raised in and discharged from the receiving chamber above the upper piston by the upstroke of said piston, thus discharging a volume of water at the same time that two volumes are sucked or drawn into the pump barrel or cylinder with and by the upstroke of the pistons.

The induction or lower valve is closed and the eduction or upper valve is opened with the downstroke of the pistons; and with each downstroke of the pistons, the volume of water sucked or drawn into the upper induction and eduction chamber is forced therefrom into the receiving chamber above the upper piston; and, at the same time, the volume of water sucked or drawn into the lower induction and eduction chamber is forced therefrom, through the hollow imperforate piston rod or transmission tube, into and through the upper piston to pass into the receiving chamber above the upper piston. It will thus be seen that, inasmuch as two volumes of water of practically the same amount are forced into the receiving chamber at one and the same time, it follows, owing to the receiving chamber having discharged but one volume of water on the upstroke, that one volume of the two volumes forced into the receiving chamber on the downstroke of the piston, must displace or pass the other and be discharged from the pump, thus making the pump a double acting one with but a

single pump barrel or cylinder and but one pump rod, but discharging water both on the upstroke and on the downstroke. This result of a full discharge on both the upstroke and on the downstroke of the pistons in a single pump barrel or cylinder, and with a single pump rod is obtained by the sealed fixed cross-head or wall, and the sealed upper and lower pistons, both of the same diameter and connected by the hollow imperforate piston rod or transmission tube, which furnishes a free communication between the twin upper and lower induction and eduction chambers, each of the same capacity, and the receiving or final discharge chamber.

The first upstroke of the pistons will exhaust or educe any air or water in the space between the sealed fixed cross-head or wall and the sealed lower piston—the air and water escaping around the hollow imperforate piston rod or transmission tube, at the point of passage through the sealed fixed cross-head or wall, or between the sealed lower piston and pump barrel or cylinder or both, until the pump has been fully primed with water making a water seal, which effectually closes the space between the sealed cross-head or wall and the sealed lower piston, producing a vacuum in said space, for the reason that the packing around the pistons will prevent any air from entering this space with the succeeding downstroke of the pistons, the result being the production of a practically perfect vacuum in the space between the sealed cross-head or wall and the sealed lower piston; and this vacuum will furnish a cushion to carry a weight of pump rod to an amount equal to the air pressure; and this carrying of the weight of the pump rod is of great assistance in operating the pump. It will be understood that the vacuum is created and maintained shortly after the beginning of the downstroke and until at or near the completion of the upstroke of the piston.

After the pump is once primed or charged, the upstroke or ascent of the sealed upper piston creates a suction, between the piston and the sealed fixed cross-head or wall, by which a volume or quantity of water, approximately equal to the area of the pump barrel or cylinder multiplied by the length of stroke of the pistons, will be drawn or sucked into the chamber above the fixed cross-head or wall, through the hollow imperforate piston rod or transmission tube. At the same time or simultaneously, the upstroke or ascent of the lower piston creates a suction, between such sealed piston and the lower or induction valve, by which a volume or quantity of water, equal to the area of the pump cylinder multiplied by the length of stroke of the pistons, will be drawn or sucked into the chamber below the lower piston. Each upstroke of the piston thus

induces into the pump barrel or cylinder, as a whole, two volumes or quantities of water, each of approximately the capacity of the area of the barrel or cylinder multiplied by the length of stroke of the pistons, for the simultaneous discharge of the two volumes from the respective chambers with each downstroke of the pump rod and pistons. The two volumes will pass into the pump barrel or cylinder above the upper piston, and one volume will be discharged at the exit of the pump, while the other volume will remain in the pump barrel or cylinder above the upper piston and be discharged with the next succeeding upstroke.

It will be seen that a discharge of approximately a full volume of water is obtained at each up and down stroke of the pump rod and pistons. The downstroke of the sealed upper piston will force into the chamber of the pump barrel or cylinder, above such upper piston and valve, the full volume of water, sucked or drawn into the upper chamber above the fixed cross-head or wall by means of the upper piston and the upper induction valve. At the same time or simultaneously, the downstroke of the sealed lower piston will force upwardly the full volume of water, drawn or sucked by the preceding upstroke of the pistons into the lower chamber above the induction or bottom valve, for such volume of water to pass above the fixed cross-head or wall and through the upper piston and the induction or top valve into the receiving and discharging chamber of the pump barrel or cylinder, above the upper piston and the induction valve. The two volumes of water thus brought together in the receiving and discharging chamber of the pump barrel or cylinder, will effect a final discharge of one volume by adding the lower volume of water to the upper volume of water, in the chamber above the upper piston, thereby forcing out one volume at the discharge of the pump with each downstroke of the pistons, leaving a volume still in the receiving and discharging chamber to be discharged with each upstroke of the pistons.

The volume of water in the upper induction and eduction chamber, which is transferred therefrom to pass above the upper piston and valve, constitutes one column of water; and the volume of water, passing through the hollow piston rod or transmission tube and transferred from the lower induction and eduction chamber to the chamber above the upper piston and valve, also constitutes a column of water, with the result that the lowermost column acts and forces the uppermost column to be discharged from the pump with each downstroke of the two pistons, so that in effect two volumes of water of approximately the same amount are forced at one and the same

time into a common receiving and discharging chamber, for one volume to be discharged from the receiving and discharging chamber by passing the other volume, as two volumes cannot occupy the same space at the same time.

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

1. In a double acting pump, the combination of a cylinder having an imperforate wall and of uniform interior diameter from end to end, a fixed cross-head dividing the interior of the cylinder into a lower section closed at its upper end and an upper section closed at its lower end, a piston having a central chamber and operative below the fixed cross-head in the lower section of the cylinder and creating and maintaining a vacuum between the piston and cross-head, the piston having downwardly extending circumferential packing rings, a piston having a central chamber and operative above the fixed cross-head in the upper section of the cylinder, the piston having upwardly extending circumferential packing rings, the fixed cross-head furnishing a lower and an upper induction-eduction chamber, each endwise expansible and contractible by and with the strokes of the pistons and of the same capacity approximately, and a hollow imperforate piston rod connecting the central chambers of the two pistons and slidable through the fixed cross-head, the hollow piston rod or transmission tube and the chambers of the two pistons furnishing a conduit between the induction-eduction chambers of the sections of the cylinder below and above the fixed cross-head, substantially as described.

2. In a double acting pump, the combination of a cylinder having an imperforate wall and of uniform interior diameter from end to end, a fixed cross-head having a central packing and dividing the interior of the cylinder into a lower section closed at its upper end and an upper section closed at its lower end, a piston having a central chamber and operative below the fixed cross-head in the lower section of the cylinder and creating and maintaining a vacuum between the piston and cross-head, the piston having around its periphery downwardly extending cup leather packing rings, a piston having a central chamber and operative above the fixed cross-head in the upper section of the cylinder, the piston having around its periphery upwardly extending cup leather packing rings, the fixed cross-head furnishing a lower and an upper induction-eduction chamber, each endwise expansible and contractible by and with the stroke of the pistons and of the same capacity approximately, and a hollow imperforate piston rod connecting the two pistons and slidable through the fixed head and its pack-

ing, the hollow piston rod or transmission tube and the chambers of the two pistons furnishing a conduit between the induction-education chambers of the sections of the cylinder below and above the cross-head, substantially as described.

3. In a double acting pump, the combination of a cylinder having an imperforate wall and of uniform diameter from end to end, a fixed cross-head having a central packing and dividing the interior of the cylinder into a lower section closed at its upper end and an upper section closed at its lower end, a peripheral packed piston having a central chamber and operative below the fixed head in the lower section of the cylinder and creating and maintaining a vacuum between the piston and cross-head, a peripheral packed piston having a central chamber and operative above the fixed head in the upper section of the cylinder, the fixed cross-head furnishing a lower and an upper induction-education chamber, each endwise expansible and contractible by and with the stroke of the pistons and of the same capacity approximately, a hollow imperforate piston rod connecting the two pistons and slidable through the fixed head and its packing, the hollow piston rod or transmission tube and the chambers of the two pistons furnishing a conduit between the induction-education chambers of the two sections of the cylinder above and below the fixed cross-head, an induction valve below the lower piston, a pump rod connected to the upper piston, and an eduction valve above the upper piston and carried by the pump rod, substantially as described.

4. In a double acting pump, the combination of a cylinder having an imperforate wall and of uniform diameter from end to end and having its interior divided into upper and lower twin sections, the lower section closed at its upper end and the upper section closed at its lower end, each section having an induction-education chamber of the same capacity approximately, a peripheral sealed piston for each section of the cylinder, each piston having an upper and lower peripheral packing ring, the ring of the lower piston extending downwardly and the ring of the upper piston extending upwardly, for sealing the lower piston on the downstroke and the upper piston on the upstroke, each piston having a central chamber and the lower piston operative in the lower section of the lower cylinder and creating and maintaining a vacuum between the piston and cross-head, a hollow imperforate piston rod connecting the two pistons and furnishing, in connection with the chambers of the two pistons, communication between the induction-education chambers of the twin sections of the cylinder, for simultaneously drawing into the induction-education cham-

ber of each section of the cylinder an approximately equal volume of water with each upstroke of the pistons and discharging a single equal volume of water from the chamber of the upper section of the cylinder with each up and with each down stroke of the pistons, substantially as described.

5. In a double acting pump, the combination of a cylinder having an imperforate wall and of uniform diameter from end to end, and having its interior divided into separate twin sections closed at their adjoining ends against communication with each other, each section having an induction-education chamber of the same capacity approximately, a peripheral packed and sealed piston for each section, each piston having two peripheral packings, one packing above the other, and each packing formed of cup leather, both cup leathers of the lower piston downwardly extending and both cup leathers of the upper piston upwardly extending, each piston having a central chamber and the lower piston-operative in the lower section of the cylinder and creating and maintaining a vacuum between the piston and cross-head, a hollow imperforate piston rod connecting the two pistons and furnishing, in connection with the chambers of the two pistons, communication between the induction-education chambers of the twin sections of the cylinder, and valves controlling the induction and eduction of water into and from the sections of the cylinder, substantially as described.

6. In a double acting pump, the combination of a cylinder having a uniform interior diameter from end to end, a fixed cross-head having a central packing and dividing the chamber of the cylinder into lower and upper twin sections, closed against communication at their adjoining ends by the cross-head, each section having an induction-education chamber of the same capacity approximately, a piston having a central chamber and operative in the lower section of the cylinder chamber below the cross-head, and creating and maintaining a vacuum between the piston and cross-head, the piston consisting of a lower annular ring having an upwardly extending inner flange, a top plate having a depending flange, an annular ring interposed between the top plate and the lower annular ring outside of the depending flange of the top plate, and a packing above and below the interposed annular ring, each packing having an exterior rim downwardly extending, a piston having a central chamber and operative above the fixed cross-head in the upper section of the cylinder chamber, the piston consisting of a lower annular ring having a perforated bottom plate and an upwardly extending inner flange with inwardly extending arms and openings between the arms, an upper annular ring having a de-

pending flange, an annular ring interposed between the lower and upper rings, and a packing above and below the interposed annular ring, each packing having an exterior rim upwardly extending, and a hollow imperforate piston rod entered into the top plate of the lower piston and the bottom plate of the upper piston centrally of both plates and connecting the two pistons, and slidable through the fixed head and its packing, the hollow piston rod and the chambers of the two pistons furnishing a conduit between the induction-education chambers of the twin sections of the cylinder below and above the cross-head, substantially as described.

7. In a double acting pump, the combination of a cylinder having a uniform interior diameter from end to end, a fixed cross-head having a central chamber and dividing the chamber of the cylinder into upper and lower twin sections, the upper section closed at its lower end and the lower section closed at its upper end, each section having an induction-education chamber of the same capacity approximately, a packing in the chamber of the fixed cross-head, the packing formed of a loose ring at the bottom of the chamber, a ring follower for the upper part of the chamber, a packing ring on the under and inner side of the loose ring and a packing ring on the under and inner side of the ring follower, a piston having a central chamber and operative in the lower section of the cylinder chamber below the cross-head and creating and maintaining a vacuum between the piston and cross-head, the piston consisting of a lower annular ring having an upwardly extending inner flange, a top plate having a depending flange, an annular ring interposed between the top plate and the lower annular ring outside of the depending flange of the top plate, and a packing above and below the interposed annular ring, each packing having an exterior rim downwardly extending, a piston having a central chamber and operative above the fixed cross-head in the upper section of the cylinder chamber, the piston consisting of a lower annular ring having a perforated bottom plate and an upwardly extending inner flange with inwardly extending arms and openings between the arms, an upper annular ring having a depending flange, an annular ring interposed between the lower and upper rings, and a packing above and below the interposed annular ring, each packing having an exterior rim upwardly extending, and a hollow imperforate piston rod entered into the top plate of the lower piston and the bottom plate of the upper piston centrally of both plates and connecting the two pistons, and slidable through the fixed head and its packing, the hollow piston rod or tube and the chambers of the two pistons

furnishing a conduit between the induction-education chambers of the twin sections of the cylinder below and above the cross-head, substantially as described.

8. In a double acting pump, the combination of a cylinder having a uniform interior diameter from end to end, a fixed cross-head having a central packing and dividing the chamber of the cylinder into upper and lower twin sections, the upper section closed at its lower end and the lower section closed at its upper end, a hollow piston operative in the induction-education chamber of the cylinder below the fixed cross-head and creating and maintaining a vacuum between the piston and cross-head, the piston having a central chamber open at the bottom for the induction and education of water, a hollow piston operative above the fixed head, the piston having a central chamber open at the top for the induction and education of water, and a hollow imperforate piston rod connecting the two pistons and in communication with the central chambers of both pistons, and furnishing with the chambers of the two pistons a conduit between the induction-education chambers of the twin sections of the cylinder above and below the fixed cross-head, substantially as described.

9. In a double acting pump, the combination of a cylinder having a uniform interior diameter from end to end, a fixed cross-head having a central packing and dividing the chamber of the cylinder into upper and lower twin sections, the upper section closed at its lower end and the lower section closed at its upper end, each section having an induction-education chamber of the same capacity approximately, a hollow piston operative in the induction-education chamber of the cylinder below the fixed cross-head and creating and maintaining a vacuum between the piston and cross-head, the piston having a central chamber open at the bottom for the induction and education of water, a hollow piston operative above the fixed cross-head, the piston having a central chamber open at the top for the induction and education of water, a hollow imperforate piston rod connecting the two pistons and in communication with the central chambers of both pistons, and furnishing with the chambers of the two pistons a conduit between the induction-education chambers of the twin sections of the cylinder above and below the fixed cross-head, an induction valve below the lower piston, opened and closed by the strokes of the piston, and an education valve above the upper piston, opened and closed by the strokes of the piston, substantially as described.

10. In a double acting pump, the combination of a cylinder having a uniform interior diameter from end to end, a fixed cross-head having a central packing and dividing the

chamber of the cylinder into upper and lower twin sections, the upper section closed at its lower end and the lower section closed at its upper end, each section having an induction-education chamber of the same capacity approximately, a hollow piston operative in the induction-education chamber of the cylinder below the fixed cross-head and creating and maintaining a vacuum between the piston and cross-head, the piston having a central chamber open at the bottom for the induction and education of water, a hollow piston operative above the fixed head, the piston having a central chamber open at the top for the induction and education of water, a hollow imperforate piston rod connecting the two pistons and in communication with the central chambers of both pistons, and furnishing with the chambers of the two pistons a conduit between the induction-education chambers of the twin sections of the cylinder above and below the fixed cross-head, an induction valve below the lower piston, opened and closed by the strokes of the piston, an education valve above the upper piston, opened and closed by the strokes of the piston, and a pump rod connected with the upper piston and on which the education valve is mounted and operates, substantially as described.

11. In a double acting pump, the combination of a cylinder consisting of an upper section and a lower section, each section having an imperforate wall and the same interior diameter from end to end, a fixed cross-head having a central packing and on to which the adjacent ends of the cylinder sections are threaded, closing and sealing the lower section at its upper end and closing and sealing the upper section at its lower end, each section of the cylinder above and below the cross-head having an induction-education chamber both chambers of the same dimensions and capacity, and a piston having a central chamber and operative in the section of the cylinder below the fixed cross-head, the piston having around its periphery cup leather packing rings, each packing ring downwardly extending, the piston creating and maintaining a vacuum in the lower section of the cylinder below the fixed cross-head, substantially as described.

12. In a double acting pump, the combination of a cylinder consisting of an upper section and a lower section, each section having an imperforate wall and the same interior diameter from end to end, a fixed cross-head having a central packing and on to which the adjacent ends of the cylinder sections are threaded, closing and sealing the lower section at its upper end and closing and sealing the upper section at its lower end, each section of the cylinder above and below the cross-head having an induction-education chamber both chambers of the same

dimensions and capacity, and a piston having a central chamber and operative in the section of the cylinder below the fixed cross-head, the piston having around its periphery cup leather packing rings, each packing ring downwardly extending, the piston creating and maintaining a vacuum in the lower section of the cylinder below the fixed cross-head, substantially as described.

13. In a double acting pump, the combination of a cylinder consisting of an upper section and a lower section, each section having an imperforate wall and the same diameter from end to end, a fixed cross-head having a central packing and on to which the adjacent ends of the cylinder sections are threaded, closing and sealing the lower section at its upper end and closing and sealing the upper section at its lower end, each section of the cylinder above and below the cross-head having an induction-education chamber both chambers of the same dimensions and capacity, and a peripheral packed piston having a central chamber and operative in the section of the cylinder below the fixed head, the piston creating and maintaining a vacuum in the lower section of the cylinder below the fixed cross-head, substantially as described.

14. In a double acting pump, the combination of a cylinder consisting of an upper section and lower section, each section having an imperforate wall and the same diameter from end to end, a fixed cross-head on to which the adjacent ends of the cylinder sections are threaded, closing and sealing the lower section at its upper end and closing and sealing the upper section at its lower end, a peripheral sealed piston for each section of the cylinder, on opposite sides of the cross-head, both pistons of the same diameter, and each piston having an upper and lower peripheral packing ring, both rings of the lower piston extending downwardly and both rings of the upper piston extending upwardly, for sealing the lower piston on the down stroke and the upper piston on the up stroke, each piston having a central chamber and the lower piston creating and maintaining a vacuum between the piston and the cross-head, and a hollow imperforate piston rod connecting the two pistons and furnishing, in connection with the chambers of the two pistons, communication between the two sections of the cylinder, for simultaneously drawing into each section of the cylinder an approximately equal volume of water with each upstroke of the pistons and discharging a single equal volume of water from the upper section of the cylinder with each up and with each down stroke of the pistons, substantially as described.

15. In a double acting pump, the combination of a cylinder consisting of an upper

section and a lower section; each section having an imperforate wall and the same diameter from end to end, a fixed cross-head on to which the adjacent ends of the cylinder sections are threaded, closing and sealing the lower section at its upper end and closing and sealing the upper section at its lower end, a peripheral double packed piston for each section of the cylinder on opposite sides of the cross-head, both pistons of the same diameter, and each piston having a central chamber; the lower piston creating and maintaining a vacuum formed in the lower section of the cylinder below the cross-head, each piston having an upper and lower cup packing, both packings of the lower piston downwardly extending and acting on the downstroke of the piston and both packings of the upper piston upwardly extending and acting on the upstroke of the piston, an imperforate hollow piston rod connecting the two pistons and furnishing, in connection with the chamber of the two pistons, communication between the two sections of the cylinder, an induction and eduction chamber for each piston, an induction valve for the lower section of the cylinder, and an eduction valve for the upper section of the cylinder, for simultaneously drawing into each section of the cylinder an approximately equal volume of water with each upstroke of the pistons and discharging, from the upper section of the cylinder, a single equal volume of water with each up and each down stroke of the pistons, substantially as described.

16. In a double acting pump, the combination of a cylinder consisting of an upper

section and a lower section, each section having an imperforate wall and the same interior diameter from end to end, a fixed cross-head having a central packing and on to which the adjacent ends of the cylinder sections are threaded, closing and sealing the upper section at its lower end, and closing and sealing the lower section at its upper end, a hollow piston operative in the section of the cylinder below the fixed cross-head and creating and maintaining a vacuum between the piston and the fixed cross-head, the piston having a central chamber open at the bottom for the induction and eduction of water, a hollow piston operative in the section of the cylinder chamber above the fixed cross-head, the piston having a central chamber open at the top for the induction and eduction of water, a hollow imperforate piston rod or transmission tube connecting the two pistons and in communication with the central chambers of both pistons, and furnishing with the chambers of the two pistons a conduit between the sections of the cylinder above and below the fixed cross-head, an induction valve below the lower piston, opened and closed by the strokes of the piston, an eduction valve above the upper piston, opened and closed by the strokes of the piston, and a pump rod connected with the upper piston and on which the eduction valve is mounted and operates, substantially as described.

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Witnesses:

F. R. FARMER,
A. J. GROVAIRE.