April 17, 1928.

1,666,463

D. H. McGOGY

PUMP

Filed May 7, 1926

3 Sheets-Sheet 1

Fig. 1.

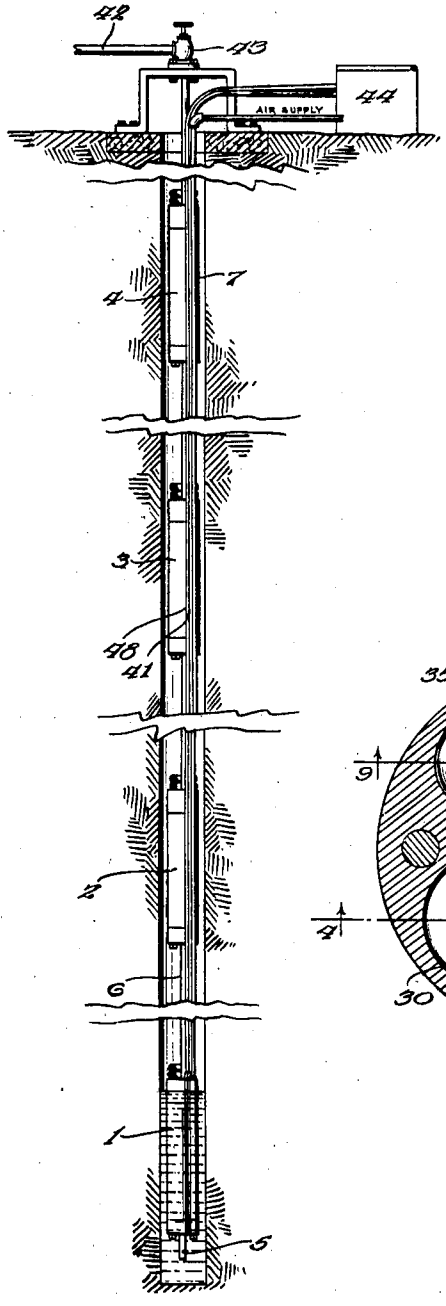


Fig. 2.

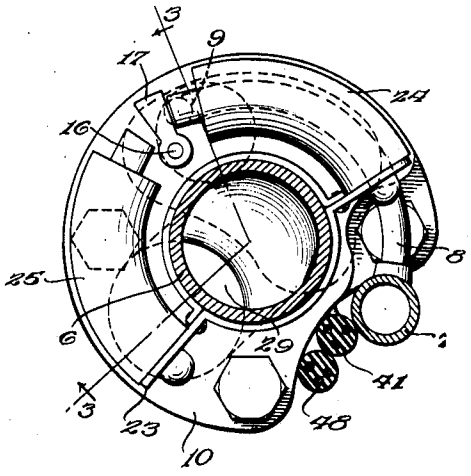
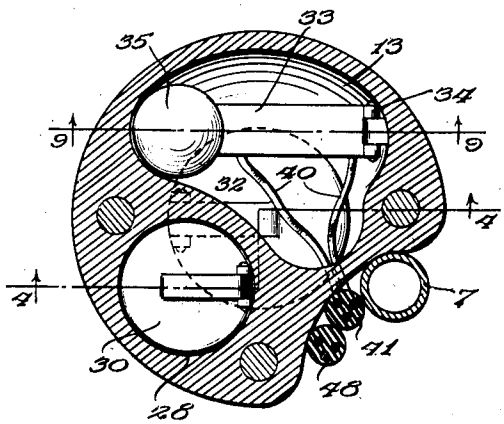


Fig. 5.



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Fig. 3.

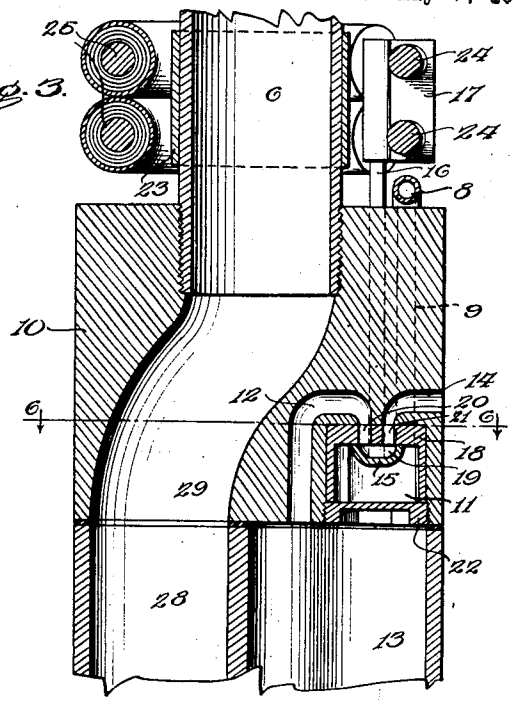


Fig. 6.

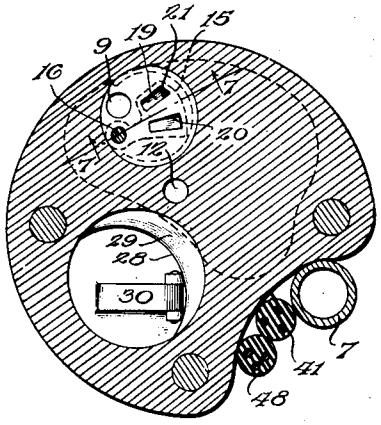


Fig. 7.

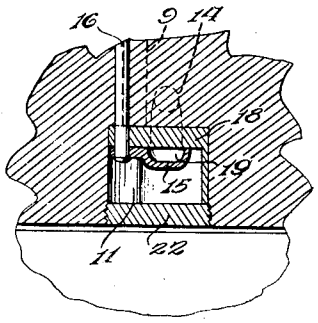
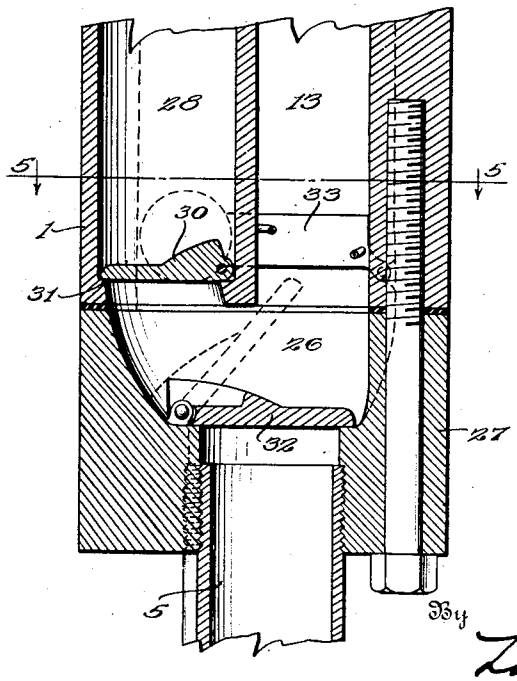


Fig. 4.



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Fig. 10.

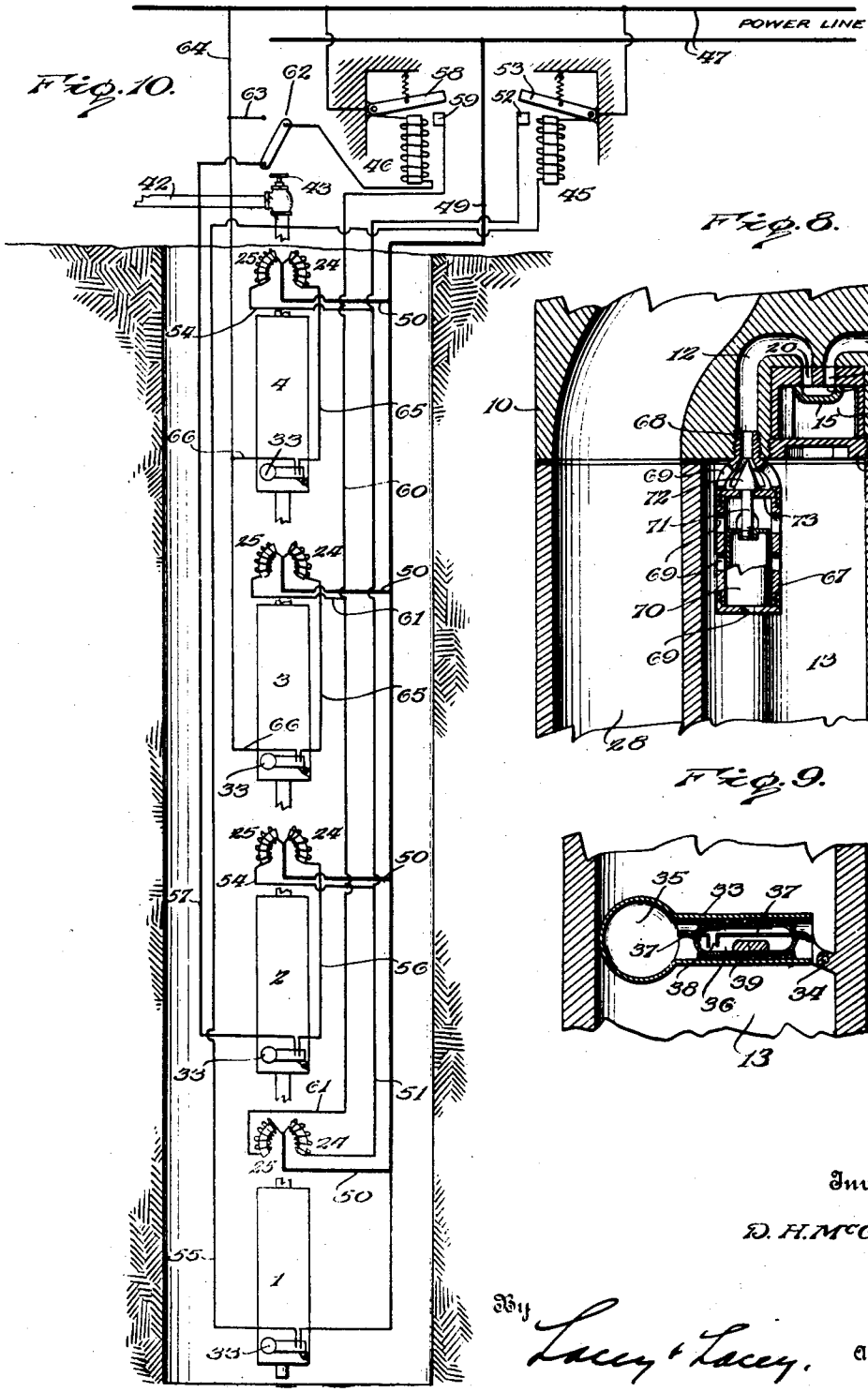


Fig. 8.

Fig. 9.

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Patented Apr. 17, 1928. 1,666,463

UNITED STATES PATENT OFFICE.

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PUMP.

Application filed May 7, 1926. Serial No. 107,508.

This invention relates to pumps of that type in which fluid pressure is utilized to lift liquid step by step through a series of connected cylinders, the object of the invention being to simplify the construction and provide an inexpensive apparatus which will operate efficiently to raise the liquid and will be automatic in its action after having been once started. The device is intended more particularly for use in deep wells but it may, of course, be used in relatively shallow wells, the number of the cylinders employed and the distance between the cylinders being determined by the depth of the well and the pressure to be utilized. The invention is illustrated in the accompanying drawings and will be hereinafter fully set forth, the novel features being subsequently particularly pointed out in the appended claims.

In the drawings:

Figure 1 is an elevation showing an apparatus embodying the invention;

Fig. 2 is an enlarged top plan view of one of the cylinders with the water outlet pipe, the air supply pipe and the electrical cables in section;

Fig. 3 is an enlarged detail vertical section of the upper end of a cylinder on the line 3—3 of Fig. 2;

Fig. 4 is a vertical section of the lower portion of a cylinder;

Fig. 5 is a horizontal section on the line 5—5 of Fig. 4, the line 4—4 in this figure indicating the plane in which Fig. 4 is taken;

Fig. 6 is a horizontal section on the line 6—6 of Fig. 3;

Fig. 7 is a detail section on the line 7—7 of Fig. 6;

Fig. 8 is a view similar to Fig. 3 but showing a float check valve which is employed in the upper end of the lowermost cylinder;

Fig. 9 is a detail section on the line 9—9 of Fig. 5, and

Fig. 10 is a diagram illustrating the electric circuits.

As has been stated, any number of cylinders may be employed, but in the accompanying drawings I have illustrated four cylinders and have numbered the same 1, 2, 3 and 4, respectively for convenience, in setting forth the operation. The lowermost cylinder 1 is located at such a depth that it will be submerged, as shown in Fig. 1, and will fill with the water or other liquid to be raised by the action of gravity. An inlet pipe 5 is fitted in the lower end of the cylinder 1 and from the upper end of said cylinder a pipe 6 extends into the lower end of cylinder No. 2, each cylinder being, in turn, likewise connected with the next cylinder above by a pipe extending between the two cylinders and constituting the outlet of the lower cylinder and the inlet of the upper cylinder, as will be understood. An air pipe 7 is also provided and is connected at its upper end with any convenient air compressor or other source of supply for pressure fluid. This air pipe 7 is provided adjacent each cylinder with a branch 8 leading laterally over the cylinder and then down to communicate with a port or passage 9 leading through the top cap 10 of the cylinder into an air chamber 11 formed in the lower end of the cap. A port or passage 12 leads from the top of the air chamber 11 through the cap into the upper end of the pumping chamber 13 of the cylinder. An exhaust port or passage 14 is also formed in the cap 10 and this exhaust port leads from the top of the chamber 11 to the outside air in the well, as will be understood upon reference to Fig. 3. To control the flow of air to and from the pumping chamber, a rocking valve 15 is provided, the said valve being secured upon the lower end of a rock shaft 16 which is journaled in the cap 10 of the pump cylinder and extends vertically through the same, the upper end of the said rock shaft being equipped with an armature 17 of any approved construction. The valve 15 is in the form of a plate fitting closely but slidably against the under side of a ported cage 18 fitted in the air chamber, a recess or groove 19 being formed in the upper side of the valve to register at times with the ports 20 or 21 in the said cage so that the flow of air will be directed to or cut off from the exhaust according to the position of the valve. The cage 18 is secured within the air chamber 11 by a plug or other closure 22 threaded into the lower end of the said chamber, as clearly shown in Figs. 3, 7 and 8. When the valve is in the position shown in Figs. 3 and 8, the passage 12 will be connected with the exhaust passage or port 14 and the air within the pump cylinder may escape, thereby permitting the entrance of liquid but when the valve is shifted to the position shown in Fig. 7, the exhaust port or passage will be closed and the passage 12 will be in communication with the inlet port 9 through the

air chamber 11, it being understood that the said port 9 discharges directly into the air chamber so that there is always pressure within said chamber which holds the valve up so that it will be seated snugly against the under side of the top plate of the cage 18.

A bracket 23 or other suitable support is secured around the pipe 6 above the cylinder, and this bracket carries a pair of electro-magnets 24 and 25 which are disposed adjacent to but at opposite sides of the armature 17 and serve to attract the said armature and thereby rock the shaft 16 and set the valve 15 in open or closed position according to which magnet is energized.

The pumping chamber 13 is of an irregular form, as shown most clearly in Fig. 5, so as to attain the greatest possible capacity within a given dimension of the cylinder. The said chamber communicates at its lower end with an inlet chamber 26 in the cap 27 at the lower end of the cylinder, and the liquid passes from the cylinder through an outlet or by-pass 28 which extends longitudinally of the cylinder at one side of the pumping chamber and communicates at its lower end with the said chamber 26 and at its upper end with a passage or port 29 through the upper cap which leads directly into the pipe 6. In the lower end of the outlet or by-pass 28 is a flap check valve 30 which is normally seated upon a shoulder 31 provided in the said passage 28. Over the inlet 5 of the lowermost cylinder and over the upper end of the pipe 6 in each of the upper cylinders is a flap check valve 32 which is normally closed across the upper end of the inlet port, as shown clearly in Fig. 4. It will also be noted that this check valve 32 is larger than the valve 30 and, consequently, when it is raised its free edge will impinge against the lower end of the wall of the cylinder between the pumping chamber 13 and the by-pass or outlet 28, thereby cutting off the liquid from access to the said passage 28 and directing it positively into the pumping chamber. It will also be readily understood from the description thus far given that the entering liquid flows into and fills the pumping chamber 13, and fluid under pressure is then admitted through the passage 12 into the top of the pumping chamber, whereupon the pressure exerted upon the liquid by the said fluid will expel the liquid so that it will flow from the lower end of the chamber 13 into the by-pass 28 and will pass directly therefrom into the next cylinder above or be held therein by the check valve 30 until the next stage of operation of the apparatus. When the pumping chamber 13 is filled with liquid, the pressure upon the check valve 32 will be neutralized so that the weight of the valve will then cause it to again be seated.

Mounted in the lower end of the pumping chamber 13 is an automatic switch consisting of a tubular body 33 which may be of metal or any other material having sufficient durability. This body 33 is hinged, as shown at 34, to one side of the pumping chamber and at its free end is provided with a hollow spherical head 35 so that sufficient buoyancy will be imparted to the device to permit it to readily swing upwardly as the water enters the cylinder. Within the tubular body 33 is secured a hollow glass bulb 36 having wires 37 fused in its respective ends with their own ends spaced apart to form a gap 38. A ball 39 of mercury is contained in the bulb 36 and is free to move therein so that in one position of the float it will extend across the gap 38 and establish electric connection between the two wires 37, while in another position, which is the position illustrated in Fig. 9, it will be away from the said gap and the electric circuit will be broken. Conductors 40, which are suitably insulated, are attached to the respective wires 37 and extend through the wall of the cylinder to be carried in a cable 41 suitably supported on the side of the cylinder.

The uppermost cylinder is connected directly with a discharge pipe 42 which extends to any desired point of use and is equipped with a cut-off valve 43 so that the outflow may be regulated or entirely cut off when desired so that the operation of the pump may be controlled.

Above the ground and at the mouth of the well or at a point remote therefrom, as may be preferred, is disposed a housing 44 in which are mounted solenoids 45 and 46 which constitute part of the controlling mechanism, current being supplied from a local generator or from trunk lines, indicated at 47 in Fig. 10. The cable 41 and a similar cable 48 carry the wires whereby the current is led from the feeding trunk line through the electro-magnets 24 and 25 and the solenoids 45 and 46 back to the outlet trunk line as well as the wires which are connected with the float switches 33. Referring particularly to Fig. 10, it will be noted that a conductor 49 extends downwardly through the well and has a branch 50 leading to the electro-magnets 24 and 25 over the respective cylinders. Each branch 50 is divided so that it serves as part of the energizing circuit for each of the electro-magnets. The return from the magnet 24 of the cylinder 1 is through a conductor 51 which extends to the mouth of the well and thence to a terminal 52 which is adapted to be engaged by the switch arm 53 extending across the core of the solenoid 45. This return wire 51 is also connected with the return conductors 54 of the magnets 25 at the cylinders 2 and 4. The conductor 49 is ex-

tended to the lower end of cylinder 1 and is there connected to one terminal of the float switch 33, the other terminal of said switch being connected by the conductor 55 to the winding of the solenoid 45, which is connected to the power line. Should the water be forced from cylinder 1, the float switch 33 will swing downwardly so that the circuit therethrough will be closed and the solenoid 45 energized to attract the switch arm 53 and thereby close the circuit through the conductor 51. The electric connection between the wires 37 in the float switch, it will be seen at once, serve to complete the initial circuit through the conductors 49 and 55 which are connected directly with the trunk lines. When the solenoid 45 is energized and the switch 52, 53 thereby closed, a circuit is also completed through the conductors 51 and 49 so that the closing magnet 24 of the cylinder 1 and the opening magnets 25 of the cylinders 2 and 4 will be energized, the air being consequently caused to exhaust from cylinder 1 and being admitted to the cylinder 2, whereupon liquid may again flow into and fill the cylinder 1 and the liquid which has been admitted to the cylinder 2 will be expelled and driven into the cylinder 3. When the liquid enters the cylinder 1, the float switch 33 will, of course, be raised and the circuit through the same broken and this condition will exist until the water is driven from the cylinder 2, whereupon the float switch in said cylinder will drop and a circuit will be closed through the conductor 56 connecting said float switch with the closing magnet 24 of said cylinder and the conductor 57 connecting said switch with the winding of the solenoid 46, which winding is connected with the outgoing trunk line in the same manner as the winding of the solenoid 45 is so connected. When the solenoid 46 is energized, the switch arm 58 is caused to engage the contact 59 and thereby close a circuit through the conductor 60 which is connected by branches 61 with the opening magnets 25 of the cylinders 1 and 3, whereupon the fluid under pressure will be admitted to cylinders 1 and 3 and the liquid expelled from said cylinders into the cylinders 2 and 4, respectively. This action, of course, is dependent on the hand switch 62 being in the position illustrated in Fig. 10. If the said switch be in contact with the terminal 63, the conductor 57 will be connected through the conductor 64 directly with the trunk line instead of with the winding of the solenoid 46 and, consequently, the said solenoid will not be energized. The float switches 33 of the cylinders 3 and 4 are both connected by conductors 65 with the closing magnet 24 of the respective cylinders and are connected by branches 66 directly with the conductor 64. When these float switches of the cylinders 3 and 4, therefore, are lowered, the solenoid 46 will not be energized. It will thus be seen that cylinders 1 and 2 are the controlling cylinders and that all cylinders above cylinder No. 2 may be equipped in the same manner as the cylinders 3 and 4.

In the lowermost cylinder, which is No. 1 in the present illustration, I provide an air check valve which will operate automatically to admit the air when the liquid is to be discharged but will seat when liquid is entering so that the inflow of liquid will not be retarded or checked by the pressure fluid. This valve is shown in Fig. 8 and includes a cage 67 provided at its upper end with a nipple 68 whereby it may be threaded into the end of the passage 12 and provided at its lower end and in its sides with openings 69 to permit the liquid to reach the float 70 constituting the body of the valve. This float 70 has a valve stem 71 secured in and projecting from its upper end and the upper extremity of this stem is formed with or secured to a cone 72 adapted to seat in the nipple 68 and thereby cut off inflow. The cage 67 is furnished with a top plate 73 which serves as a guide for the stem 71 and also as a support for the conical valve head 72 when the latter is in its lowered open position. Some of the openings 69 are arranged in the extreme upper end of the cage above the plate 73 so that the outflowing air will not act upon the float 70 to prematurely seat the valve but may pass around the valve head and by its pressure thereon maintain the same in open position until the pressure fluid has all escaped. The rising liquid, however, will have ready access through the bottom of the cage to the float 70 and will lift the float so that the valve head 72 will be driven into engagement with its seat and the liquid thereby prevented from filling the passage 12, air chamber 11 and exhaust port 21. When the controlling valve 15 is shifted to admit air from the air supply, the valve head 72 will be unseated and the desired outflow of liquid will be effected. This air check valve is not needed in any cylinder, except the lowest which fills by gravity, inasmuch as the float switches 33 so operate that only a measured quantity of liquid can be delivered at any one stroke from any cylinder and, therefore, no upper cylinder will receive an overload. Each float switch drops to close its circuit when the pumping chamber in which it is mounted is exhausted of liquid, so that a measured charge is delivered on each discharge stroke in the cylinder.

From the foregoing description, taken in connection with the accompanying drawings, it will be seen that I have provided an exceedingly simple apparatus which will operate automatically after having been primed and will be highly efficient for delivering a

supply of liquid. The admission and discharge of liquid in the alternate cylinders is synchronized throughout the system so that the lifting of the liquid will proceed efficiently, and no cylinder will choke the operation of any other cylinder nor be choked thereby. By the proper use of the switch 62 the apparatus may be easily primed after installation has been completed, because of the presence of the float switches 33 in each cylinder and the fact that the switch arms 53 and 58 may be manually manipulated until enough liquid is pumped to fill the cylinders 1 and 2. When priming, the switch 62 is moved over to the contact 63 until the cylinder 2 is filled, whereupon said switch is moved to the position shown in Fig. 10.

Having thus described the invention, I claim:

1. A pumping apparatus comprising a vertical series of cylinders, each cylinder having a liquid inlet in its bottom and a liquid outlet in its top, the outlet of each cylinder communicating directly with the inlet of the superposed cylinder, means for admitting fluid under pressure to the upper ends of the cylinders, a switch in the lower end of each cylinder arranged to be raised to inoperative position by the inflowing liquid and to move downwardly to operative position when the liquid is discharged, a valve at the upper end of each cylinder controlling the in-flow and exhaust of fluid under pressure thereto, and electric means controlled by the respective switches for actuating the said valves when said switches are lowered whereby the pressure fluid will be admitted to a lower cylinder and simultaneously exhausted from an upper cylinder to cause the liquid to flow from the lower cylinder into the upper cylinder.

2. In a pumping apparatus of the character described, the combination of a cylinder, a pumping chamber therein, an outlet passage for liquid through the cylinder at the side of the pumping chamber, a check valve disposed at the lower end of said outlet passage, a second check valve arranged below the first-mentioned check valve and controlling flow of liquid to the pumping chamber, said second valve being arranged to close the liquid outlet passage when admitting liquid to the pumping chamber and permit flow to the outlet passage when cutting off liquid flow to the pumping chamber, and means at the upper end of the pumping chamber for admitting and exhausting fluid under pressure whereby to effect inflow and outflow of liquid at the lower end of the pumping chamber and discharge of liquid through the said outlet passage.

3. In a pumping apparatus of the character described, the combination of a plurality of superposed communicating pumping cylinders, each cylinder being constructed to receive liquid at its lower end and discharge the same at its upper end into the lower end of the superposed cylinder, means for supplying fluid under pressure to the upper ends of the several cylinders, valves mounted in the upper ends of the several cylinders to control the inflow and outflow of the fluid under pressure, a pair of electro-magnets on the upper end of each cylinder, a stem rising from each of said valves through the upper end of the respective cylinder, an armature on said stem between and common to the electro-magnets and means controlled by the inflow and outflow of liquid to selectively energize the said magnets whereby to set the valve for controlling the flow of pressure fluid.

4. In a pumping apparatus of the character described, the combination of a series of cylinders each having a pumping chamber extending longitudinally thereof and provided with an outlet passage at the side of said chamber, valves at the lower ends of the several cylinders controlling the flow of liquid into and from the pumping chamber, a float mounted for swinging movement at the lower end of the pumping chamber, a circuit closer carried by said float and arranged to close a circuit when the float is lowered and break the circuit when the float is raised, means for admitting fluid under pressure to the upper end of the pumping chamber, a valve controlling the flow of said fluid under pressure, and means mounted on the several cylinders whereby when the float in a lower cylinder closes a circuit fluid pressure will be exhausted from the said cylinder and admitted to the pumping chamber of a superposed cylinder.

5. In a pumping apparatus of the character described, the combination of a cylinder having a pumping chamber extending longitudinally thereof and an outlet passage at the side of the pumping chamber, means for admitting liquid to the lower end of the said chamber, an air chamber in the upper end of the cylinder communicating with the upper end of the pumping chamber, a rocking valve in the upper end of said chamber arranged in one position to establish communication with the pumping chamber and the exhaust of the air chamber and in another position to establish the communication between the inlet of the air chamber and the pumping chamber, and electro-magnetic means for shifting said valve.

6. A pumping apparatus comprising a series of communicating cylinders, each having a liquid inlet in its bottom and a liquid outlet in its top, means for admitting fluid pressure to and exhausting it from the tops of the cylinders whereby to expel and admit liquid successively, and electro-magnetic means for synchronizing the inflow and out-

flow of pressure fluid in alternate cylinders, said means including a pivotally mounted switch member in the lower end of each cylinder actuated by the rise and fall of liquid in the cylinder, and a gravitating circuit closer carried by said switch member operable to actuate said electro-magnetic means only when the switch member is in lowered position.

7. A pumping apparatus comprising a plurality of cylinders arranged in a vertical series each having a liquid inlet in its bottom and a liquid outlet in its top with the outlet of one cylinder in direct communication with the inlet of the superposed cylinder, means for admitting fluid under pressure into the upper end of each cylinder and exhausting it therefrom, the lowest cylinder receiving liquid by gravity, a floating valve in the upper end of the lowest cylinder operated by liquid to close the air inlet, and means in the lower end of each cylinder operated by the inflow and outflow of liquid to control the means for admitting and exhausting fluid under pressure.

In testimony whereof I affix my signature.

DONALD H. McGOGY. [L. S.].