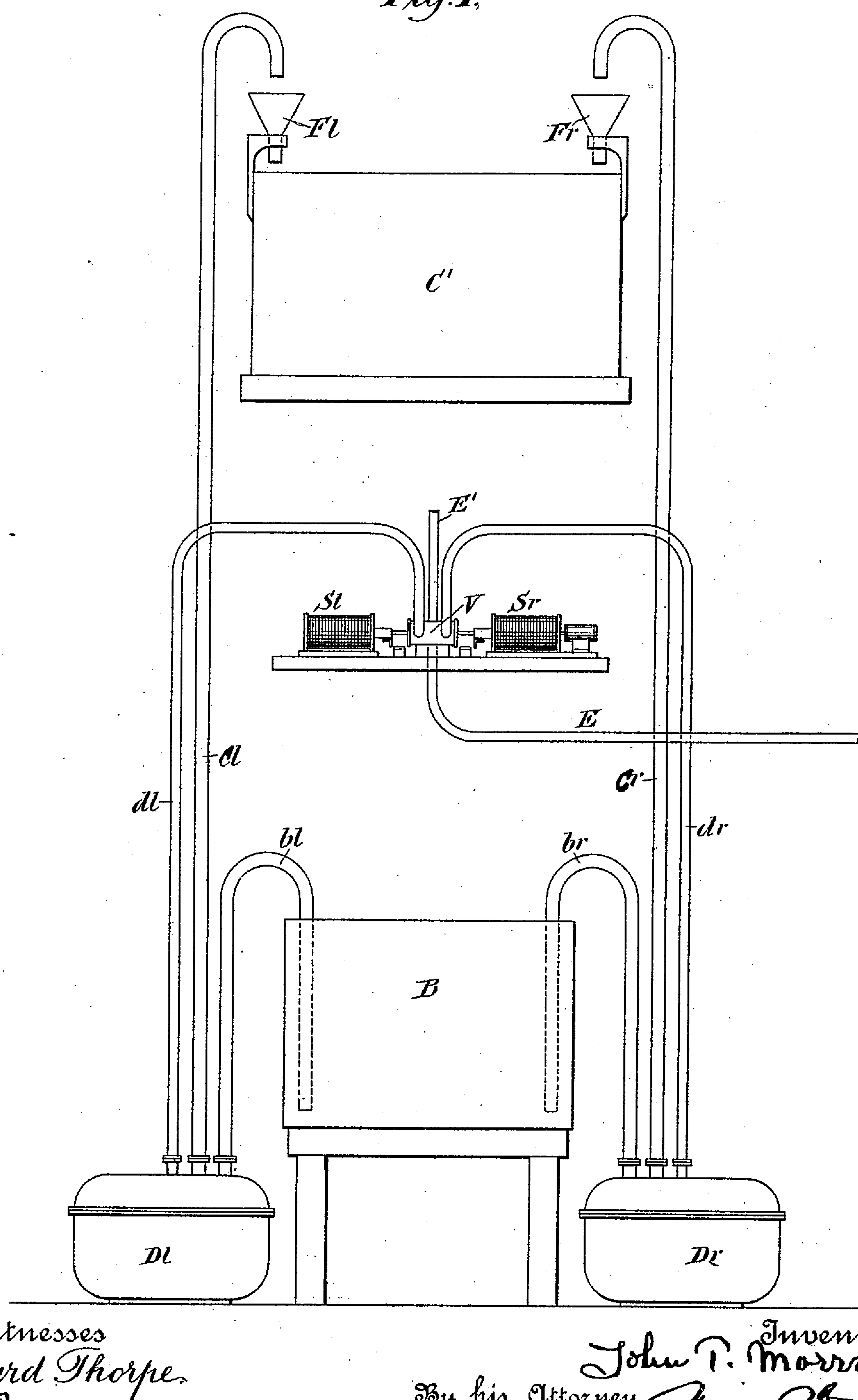
(No Model.) 3 Sheets—Sheet 1.

J. T. MORROW.

DEVICE FOR CIRCULATING OR PUMPING LIQUIDS.

No. 539,074. Patented May 14, 1895.

Fig. 1.



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(No Model.) 3 Sheets—Sheet 2.

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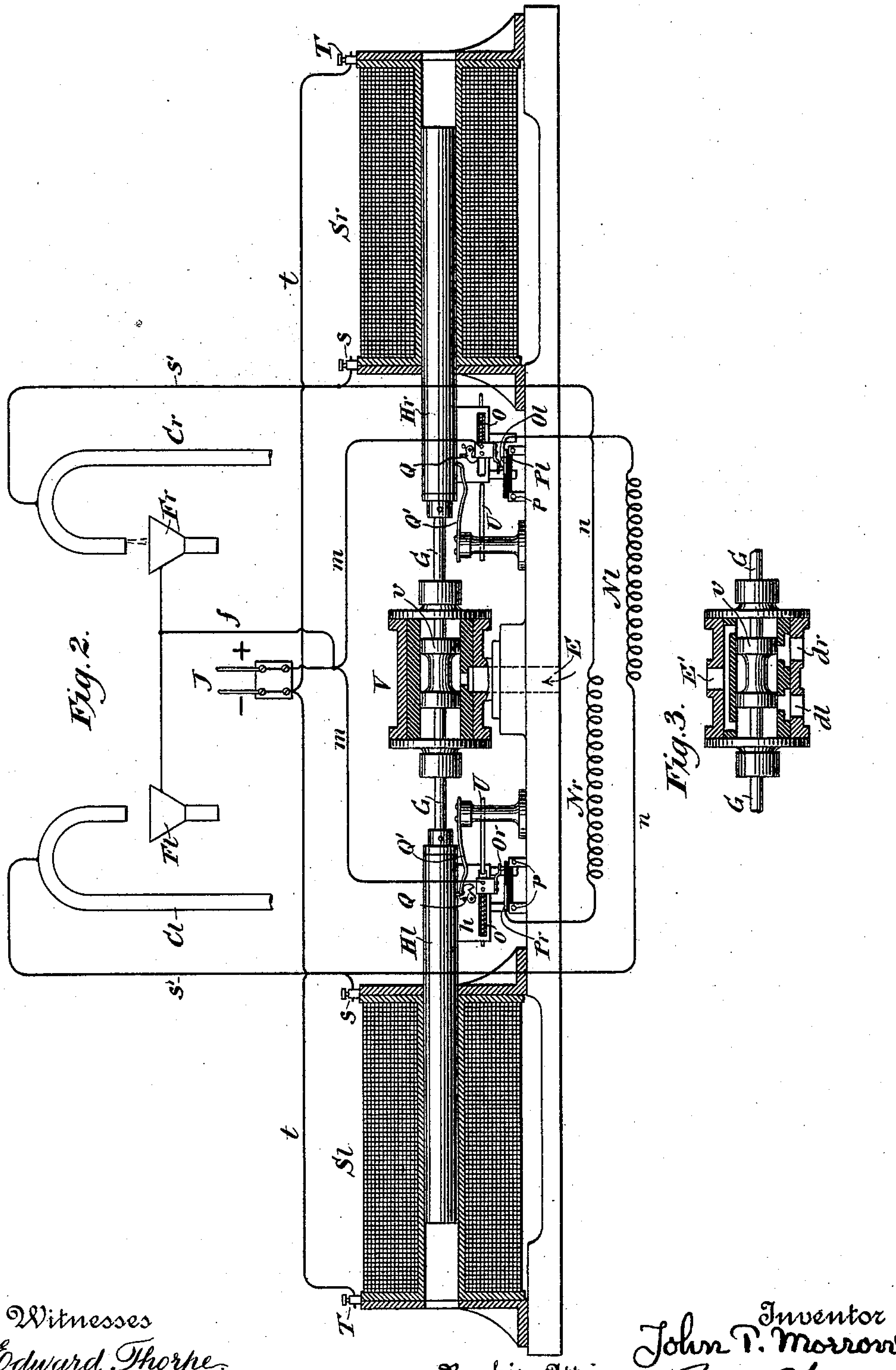

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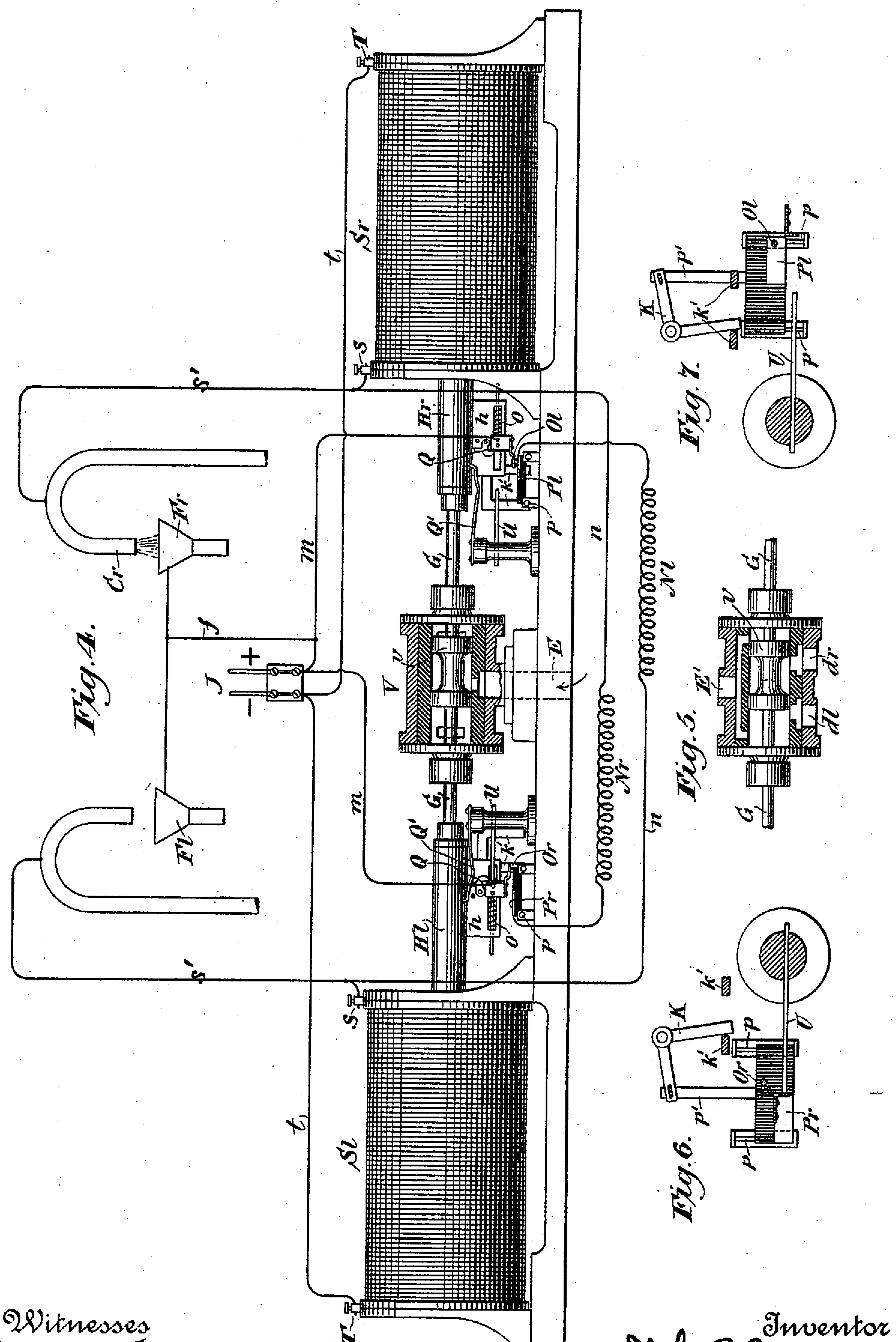

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UNITED STATES PATENT OFFICE.

JOHN T. MORROW, OF GREAT FALLS, MONTANA.

DEVICE FOR CIRCULATING OR PUMPING LIQUIDS.

SPECIFICATION forming part of Letters Patent No. 539,074, dated May 14, 1895.

Application filed October 9, 1894. Serial No. 525,385. (No model.)

To all whom it may concern:

Be it known that I, JOHN T. MORROW, of Great Falls, Montana, have invented a new and useful Device for Circulating or Pumping Liquids, of which the following is a description, referring to the accompanying drawings, which form a part of this specification.

The object of the invention is to pump or circulate liquids, especially liquids of an acid nature where a regular discharge or circulation is desired; and while in the drawings I have shown one arrangement of tanks through which the circulation is carried it must not be understood that my invention is in any way restricted to such an arrangement, which I show merely to indicate one of the many applications of my invention.

Briefly my invention effects the continuous and almost uniform flow of liquid from one tank to another by means of two reservoirs which are alternately filled and discharged by means of an electrically controlled automatic valve which supplies compressed air to the reservoirs or tanks. The valve is actuated by means of two or more solenoids, or series of solenoids, drawing upon coils or plungers secured to the valve stem.

The pumping reservoirs are placed somewhat below the level of the liquid to be pumped so that they fill freely when the air is allowed to escape. When the valves are at one limit of travel air pressure is admitted to one of the pumping reservoirs, driving the liquid therein through the proper channel into the tank to which the liquid is to be pumped,—a check valve closing and preventing the back flow of the liquid into the tank from which the liquid was originally drawn. In this position of the valves and solenoids the circuit is closed across a space traversed by the flow of liquid, and the current so passing controls the position of the valve, holding it wide open. At the same time, however, the opposing solenoid is closed through a suitable resistance permitting the flow of a current too weak to overcome the pull of the other. When, however, the flow from the pumping reservoir or tank is exhausted the circuit formed by the flowing liquid is broken and then the opposing solenoid being free to act closes the valve of that reservoir and opens slightly the valve into the other reservoir starting the pulsation in the second reservoir. When the liquid has filled the pipe leading to the receiving tank, the circuit is closed directly through the flowing liquid as before, and the second solenoid in turn acts to open the valve wide and at the same time open the exhaust from the first pumping reservoir.

Such briefly is an indication of the general operation of my invention.

The details of the invention as illustrated in one preferred embodiment, together with certain minor features and objects of the invention, will be more clearly apparent from the following description and the accompanying drawings.

Figure 1 is a diagrammatic view showing the general arrangement of the tanks and apparatus for controlling the discharge or circulation of the liquid, though, as above stated, it must not be understood that my electromagnetic valve-controlling apparatus for pumping or circulating liquids is in any way restricted to precisely such an arrangement. Fig. 2 is an elevation, partly in section, showing the electromagnetic reversing mechanism for the valves, together with the valves, including a diagrammatic illustration of the electric connections, the whole being shown in the position when the right-hand pumping-reservoir is commencing its pulsation. Fig. 3 is a horizontal cross-section of the valves, shown in the same position as in Fig. 2. Figs. 4 and 5 are elevation and cross section corresponding to Figs. 2 and 3, but showing the apparatus in the extreme right-hand position when the right-hand tank or reservoir is in full operation. Figs. 6 and 7 are detail plan views of movable switch-contacts for effecting some of the electric connections.

Throughout the drawings like letters of reference indicate like parts.

Referring to the general arrangement shown in Fig. 1 B is the tank from which the liquid is to be drawn or discharged into the receiving tank C'. I will refer to these tanks hereinafter as the discharge tank and receiving tank respectively.

D*l* and D*r* are respectively the left and right hand pump reservoirs or tanks which for convenience of description and greater distinction, I will call eggs without intending in any way to limit myself by the expression to any precise form.

bl and *br* are respectively the left and right-hand passages for the liquid from the tank B to the eggs D.

Throughout the description I will use the small letters *l* and *r* to designate the parts belonging particularly to the right and to the left-hand eggs D;—using other reference letters, either with or without those, to indicate the other parts either generally or with particular reference to the egg with which they are associated.

The intake pipes *b* have check valves permitting the flow of the liquid from the tank into the eggs but checking any return flow. The eggs are air tight and connect with the valve mechanism V by means of the pressure pipes *d* through which air pressure is supplied from a suitable source E, and through which also the air within the eggs is allowed to exhaust at the proper time into the exhaust passage E'. Uptake passages C extend from the bottom of the eggs to the receiving tank C' in a position to discharge into the metallic funnels F through a short air space. The uptakes C and the funnels F are electrically connected with a source of current and with the respective solenoids so that the discharge of the liquid across the space between the mouth of the uptake pipe and its corresponding funnel closes the electric circuit and energizes the solenoid, as will more fully appear from the other figures. From Fig. 1, however, it will be seen that when the exhaust is open from one of the eggs it will be filled from the tank B, and while so filling the other egg previously filled may be discharged by pressure through its pressure pipe and the liquid pass through the corresponding uptake into the tank C'.

In Figs. 2 and 3 details of the valves and electrical connections are clearly apparent. The valve proper *v* may be a slide valve as shown, the admission passage being indicated at E and the exhaust at E'. The right and left hand pressure connections are shown respectively at *dl* and *dr*. The valve stem is indicated at G and the solenoid cores or plungers by H. At J are shown a pair of terminals or leading-in wires from a battery or any convenient source of electric energy. One terminal, which for convenience I will call the positive, is connected to the funnels F by means of the conductors *f*, and to the two snap switches, which will be presently described, by means of the conductors *m*. From these switches the conductors *m* lead through resistance N to one terminal *s* of each of the respective solenoids S. The same terminals *s* are connected with the uptake pipes C. The other terminals T of the solenoids are connected by *t* directly to the negative conductor J. When the valves are in the position shown in Figs. 2 and 3, it is clear that the compressed air will be admitted from the supply pipe E through the port *dr* and into the right hand egg D*r*. This will force the liquid through the uptake C*r*. It will be noticed that the port *dr* is very slightly opened, thereby preventing a rush of the liquid until the pressure of the column within the uptake has been established. When, however, the liquid begins to flow from the mouth of the uptake into the funnel F*r* the electrical connection is completed between the uptake and the funnel and the full force of the current flows through the right-hand solenoid S*r*. The electric circuit is from the positive wire J through the conductor *f* to the funnel F*r*, thence through the flowing liquid to the uptake C*r* and by the conductor *s'* into the terminal *s* of the solenoid S*r* and thence back to the negative conductor J by way of terminal T and conductor *t*. There being no resistance save that of the solenoid core and of the conductors, the maximum current flows and the solenoid core H*r* is drawn to the right opening the valve *v* wide and admitting the full pressure to the right-hand egg D*r*.

I will now describe the switching mechanism by which the circuit is made and broken through the resistance N.

Fig. 4, as already described, illustrates the extreme right-hand position of all the parts.

Figs. 6 and 7 are plan views of certain details of shifting mechanism by which the switch plates P are shifted laterally into and out of the path of the snap switch contacts O.

At *h* are shown the brackets or standards carrying the right and left-hand snap switches O*l*, O*r*. The actuating springs for the snap switches are shown at *o*, the controlling triggers at Q, the releases for the triggers at Q', and the cocking rods at U. In the figure the snap switch O*r* has just been cocked by coming into contact and compressing its spring against the cocking rod U. The extreme motion to the right causes the stationary release Q' to clear the trigger Q allowing it to fall and catch the switch. The other switch O*l* is shown at the other limit of its motion, the trigger still holding the spring compressed and ready to release when moved sufficiently to the left to come into contact with its release Q'. The switch plates P are each mounted upon a piece of ebonite, or other insulation, and travel laterally or transversely upon the slides *p*. The transverse sliding movement is effected by means of the bell crank levers K, the free ends *k* being alternately brought in contact with the tappets *k'* which move with the brackets *h* and the solenoid cores, turning the bell cranks and giving a transverse motion to the other arms. This transverse movement is transmitted to the respective switch plates P by means of the projecting rods or arms *p'* connected by a pin-and-slot or other loose connection with the bell crank levers and carried by the blocks of insulating material. When the valves are in the extreme right-hand position, as in Fig. 4, the plate P*l* is drawn into line with the snap switch contact Ol, the tip of the contact Ol being clearly indicated in Fig. 7. With the other switch plate Pr, however, the reverse action takes place the plate being moved out of the line of travel of the snap switch contact Or. Thus at the extreme right-hand travel of the valves the switch plate Pl is thrown into contact with the snap switch contact Ol and the circuit of the left-hand solenoid Sl closed through the resistance Nl. At the same time the switch contact plate Pr is moved out of line with its snap switch contact Or so that the returning movement of the valves toward the central position will not close the switch. Of course in the extreme left-hand position the plate Pr is shifted in turn into line with its contact, closing the circuit through the resistance Nr and the right-hand solenoid, while the plate Pl is drawn out of line with its switch contact so that when the valve action moves again to the right toward the central position its contact will not be closed.

Figs. 6 and 7 correspond on a larger scale and in plan view to the position shown in Fig. 4 in elevation, but the bell cranks K and their connections, which would appear in the background of Fig. 4, are omitted thereform for the sake of clearness, the movable tappets k' being however shown dependent from the brackets h.

As my whole valve apparatus and electro-magnetic reverser is symmetrical, I have only shown the positions as it is just opening the right-hand valve and as the right-hand valve is wide open, the position for the left-hand valve just opening and the left-hand valve wide open would be in all respects but an inversion of the views shown and are therefore superfluous. In describing the operation of the snap switches, however, I will start from the extreme left-hand position of all the parts following their action and tracing out their successive motions into the two positions shown respectively in Figs. 2 and 3 and in Figs. 4, 5, 6 and 7.

When the current flowing through the left-hand funnel Fl breaks and de-energizes the left-hand solenoid, the weaker current flowing in the right-hand solenoid through its resistance Nr in a manner exactly similar to that described in connection with the left-hand solenoid Sl, draws the parts to the right toward the position shown in Figs. 2 and 3. Upon reaching the position shown in Figs. 2 and 3 the snap switch Or is released by its trigger Q coming into contact with the stationary release Q′ and the switch snaps from its contact plate Pr breaking the circuit through the resistance Nr and the right-hand solenoid and leaving both solenoids de-energized. At this position, however, which is slightly to the right of the central position of the valves, the admission of air from the supply pipe E into the port dl of the left-hand egg Dl is checked and the right-hand port dr slightly opened, as clearly shown in Fig. 3. The pressure of the air flowing down the corresponding passage d into the right-hand egg dr closes the check valve in the intake br and forces the liquid within Dr gently through the uptake Cr and funnel Fr into the tank C′. As soon as the flow is established between the intake Cr and its funnel Fr the circuit is thereby closed directly through the right-hand solenoid and the valve drawn strongly to the right to its extreme position, as shown in Figs. 4 and 5. This clearly opens wide the port dr and permits the exhaust of the air within the left-hand egg dl through its pressure pipe and port dl into the exhaust passage El. At the same time this extreme motion to the right has brought the switch Ol (which was cocked in its extreme left-hand position) to its right-hand limit; and brought the corresponding contact plate Pl into contact with it by shifting the bell crank lever K by means of the tappet kl, all clearly shown in Fig. 7. The closing of the switch Ol, Pl, establishes the minimum current in the left-hand solenoid Sl, the circuit being through the conductor m, switch and switch plate Ol, Pl, resistance Nl, solenoid, and conductor t. At the same time the switch Or has been cocked by coming into contact with its cocking rod U, and its hammer becoming clear of the release Ul drops into place, ready for the left-hand cycle. Upon the cessation of flow into the funnel Fr the circuit through the right-hand solenoid is again broken and by the pull due to the minimum current in Sl the other half of the complete cycle repeats itself in a manner substantially similar but of course the reverse of that already described while the valve was being moved successively to the right. When, therefore, the liquid is blown out of one of the eggs, the air pressure is at once shut off from it and the admission to the other egg slightly opened. As soon as the electric circuit is closed by the flow of the liquid into the funnel of this second egg, the admission is opened wide and the exhaust from the first egg takes place, such egg being filled (either by the gravity of the liquid or by the application of a vacuum exhaust) from the discharge tank B. The maximum pull of one solenoid, when energized through the flowing liquid, need not exceed the minimum of the other by any great amount; so that the resistance N may be small. Any electrical equivalent for the resistance may of course be introduced, such, for instance, as using separate coils upon the solenoid of less ampère turns than those energized directly through the funnels and flowing liquid. So also many other equivalents, both electrical and mechanical, may be substituted in my invention without in any way interfering with its principles, and I have purposely omitted the enumeration of these, as well as many details of construction, because to set these forth at lengtn would obscure rather than make clear the more essential features of my device.

I believe I am the first to accomplish certain of my results, as well as the first to construct my apparatus for accomplishing them, and therefore I claim, broadly, and desire to secure by these Letters Patent, together with all such modifications, substitutions, and additions as may be made by mere skill, electrical or mechanical, and with only the limitations expressed or by law implied in view of the related art, the following:

1. In a device for pumping liquids, the pair of eggs D, the intake and uptake passages therefor, the pressure connections *d*, controlling valve or valves and exhaust and supply pipes, the receiving reservoir or tank C', in combination with the oppositely acting solenoids and cores, the snap switches, and connections with a suitable current source, and the controlling circuits completed through the liquid flowing in or from the respective uptakes and broken when such flow ceases, substantially as described.

2. In combination in or with an electro-magnetic device for pumping or controlling the pumping of liquids, a controlling circuit therefor completed through the flowing liquid and broken upon the cessation of flow, substantially as set forth.

3. The electro-magnetic shifting mechanism for governing the circulation of liquids, consisting of oppositely acting solenoids and cores, and controlling circuits therefor, one circuit of each solenoid being completed through a switch actuated by the movement of the solenoid cores, and a second incomplete circuit for each solenoid arranged to be closed by the passage of the liquid across the break in such circuit, substantially as set forth.

4. The electro-magnetic shifting mechanism for governing the circulation of liquids consisting of oppositely acting solenoids and cores, and controlling circuits therefor, one circuit of each solenoid being completed through a switch actuated by the movement of the solenoid cores, and a second incomplete circuit for each solenoid arranged to be closed by the passage of the liquid across the break in such circuit, the said switches being arranged to be closed when the cores are drawn farthest out from the corresponding solenoid and opened by the return movement of the cores somewhat more than half way, and means controlled by the said solenoid cores for alternately forcing the said liquid through passages and across the breaks in the said incomplete circuits whereby alternate pulsations of the liquid may take place at first gently and then full force, and the reversal of the said device occur upon the cessation of each pulsation or flow, substantially as set forth.

5. The electro-magnetic shifting mechanism for governing the circulation of liquids, consisting of oppositely acting solenoids and cores, and controlling circuits therefor, one circuit of each solenoid being completed through a switch actuated by the movement of the solenoid cores, and a second incomplete circuit for each solenoid arranged to be closed by the passage of the liquid across the break in such circuit, the circuits through the said switches being of weaker effect upon the solenoid cores than the other circuits, substantially as set forth.

6. The pair of solenoids and cores for actuating a shifting device, and electric circuits for drawing the said cores toward one or the other of the said solenoids alternately, in combination with the second circuits for the said solenoids containing the switches and resistances, the said switches being actuated by the motion of the solenoid cores, substantially as set forth.

7. The movable switch plate P, co-operating snap switch contact O, and solenoid circuit controlled thereby, in combination with means actuated by the said solenoid for snapping and cocking the said switch and for giving travel to the said movable switch plate, substantially as set forth.

8. The double valve for controlling the admission and exhaust to and from two ports *dr*, *dl*, the pair of solenoids acting upon the said valve, and connections and means for energizing the said solenoids alternately weakly and then strongly, thereby opening the admission slightly and then fully to each of the said ports and exhausting from the other, substantially as set forth.

In testimony whereof I have hereunto set my hand, at Great Falls, Montana, this 20th day of September, 1894.

JOHN T. MORROW.

Witnesses:
R. H. OLIVER,
C. P. HADLEY.