R. CONRADER.

APPARATUS FOR ACTUATING LIQUIDS.

APPLICATION FILED OCT. 2, 1903. RENEWED JAN. 31, 1910.

969,940. **Patented Sept. 13, 1910.**

8 SHEETS—SHEET 1.

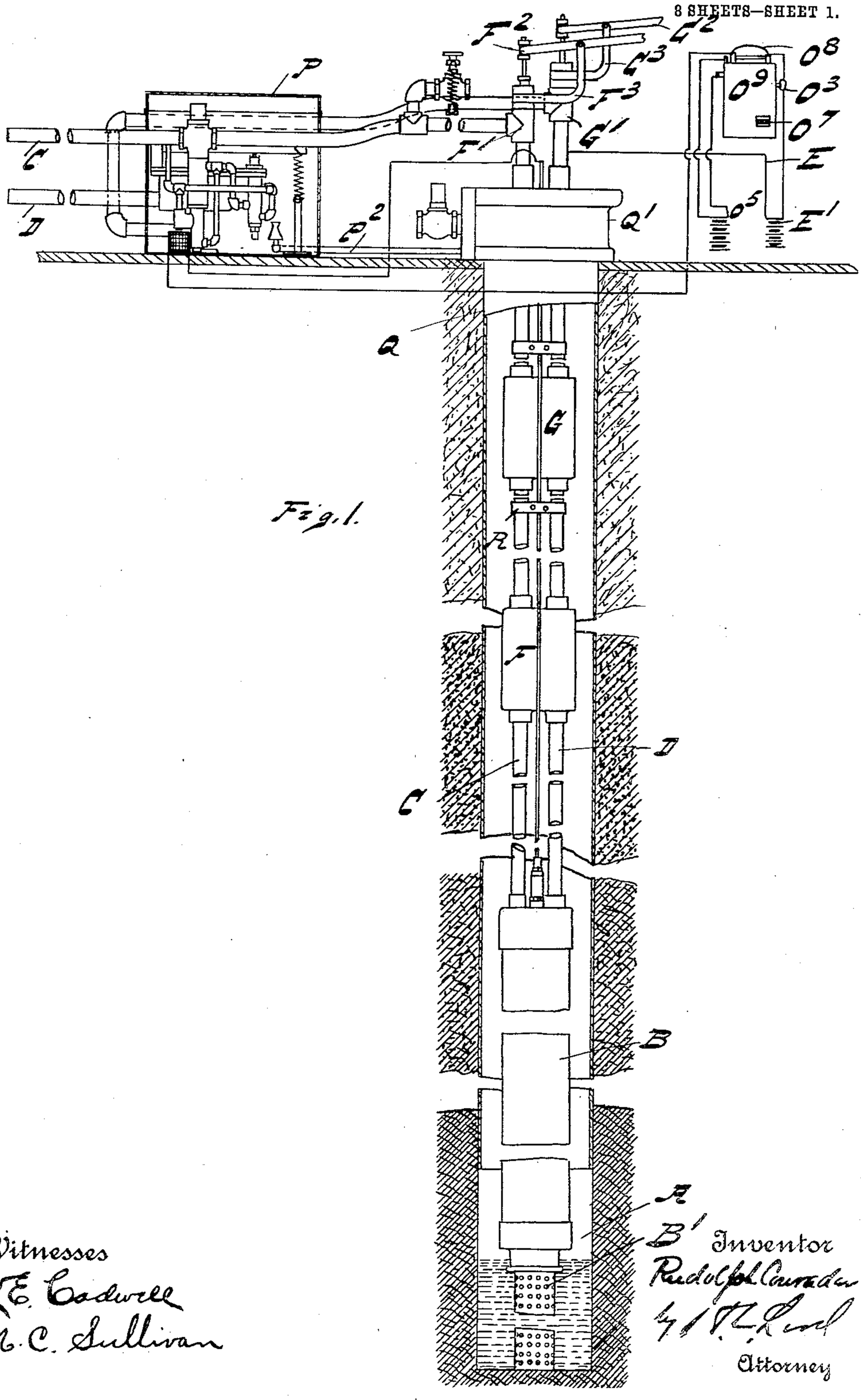


Fig. 1.

Witnesses
W. E. Caldwell
M. C. Sullivan

Inventor
Rudolph Conrader
by V. Z. Lee
Attorney

R. CONRADER.

APPARATUS FOR ACTUATING LIQUIDS.

APPLICATION FILED OCT. 2, 1903. RENEWED JAN. 31, 1910.

969,940. **Patented Sept. 13, 1910.**

8 SHEETS—SHEET 2.

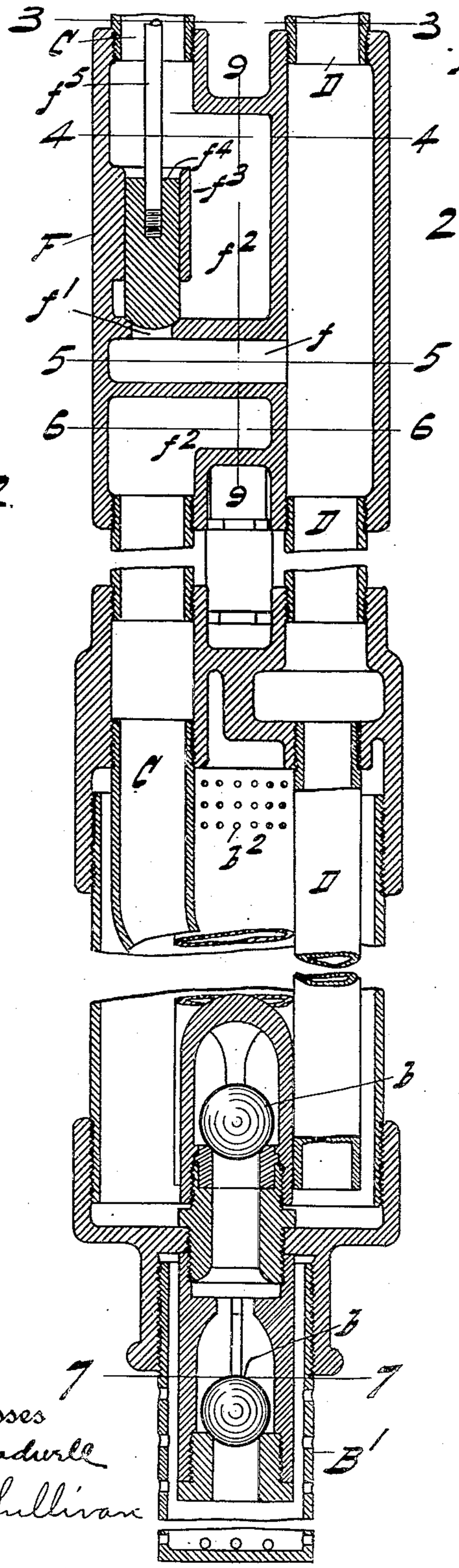


Fig. 2.

Fig. 3.

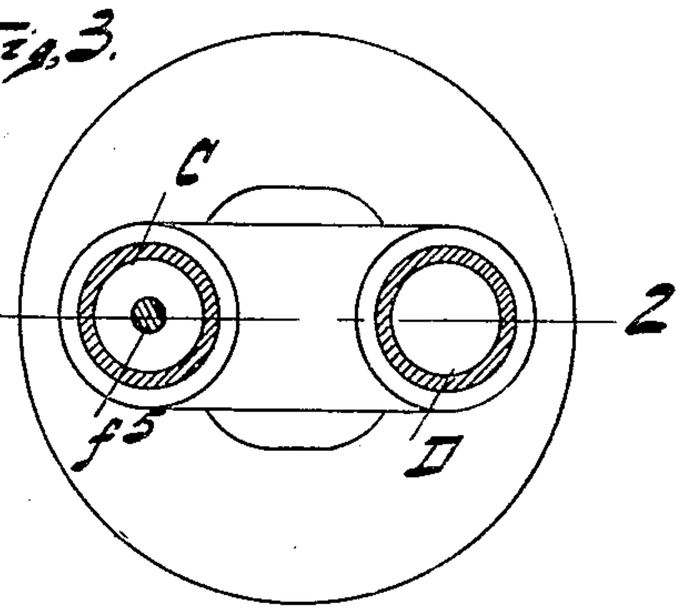


Fig. 4.

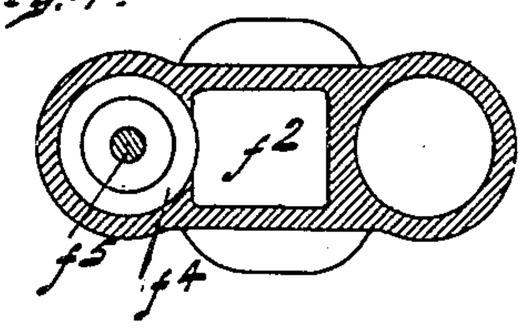


Fig. 5.

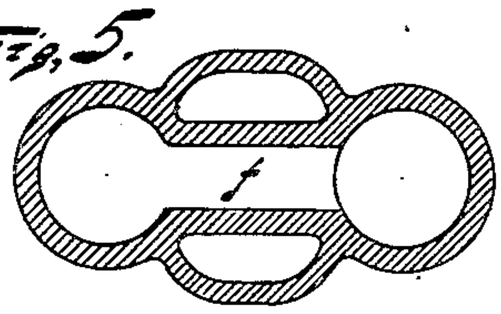


Fig. 6.

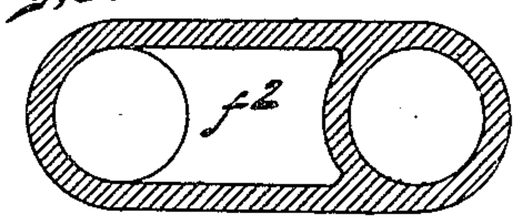


Fig. 7.

Witnesses
E. Caldwell
M. C. Sullivan

Inventor
Rudolph Conrader
by R. Z. Lord.
Attorney

R. CONRADER.

APPARATUS FOR ACTUATING LIQUIDS.

APPLICATION FILED OCT. 2, 1903. RENEWED JAN. 31, 1910.

969,940.

Patented Sept. 13, 1910.

8 SHEETS—SHEET 3.

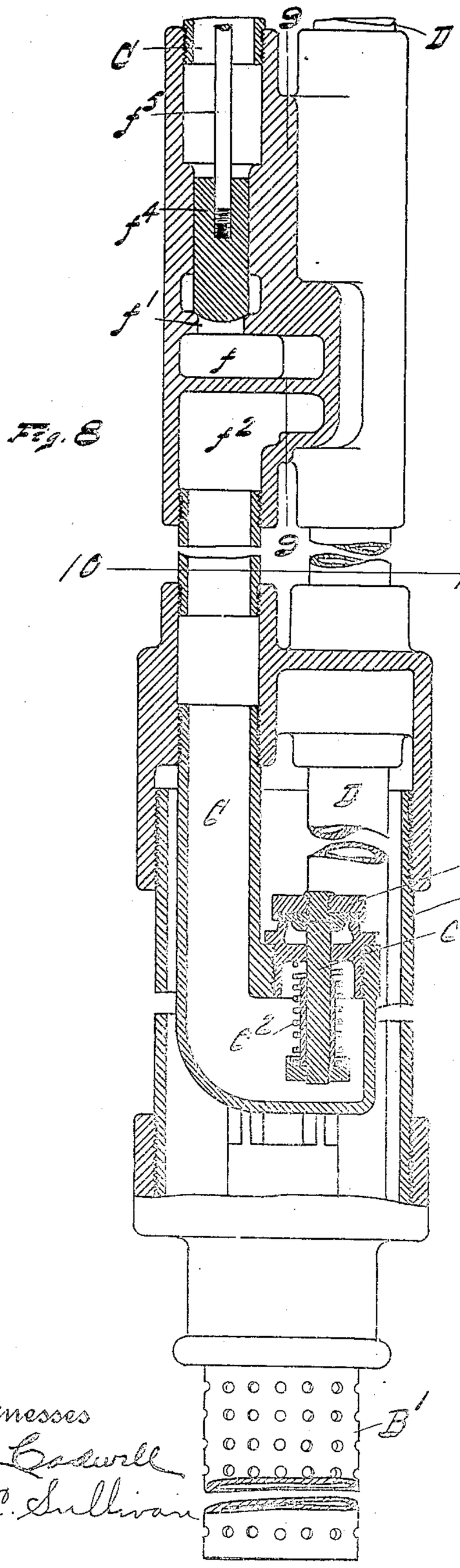


Fig. 8.

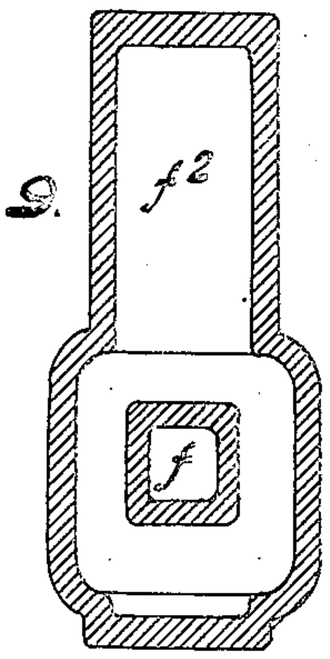


Fig. 9.

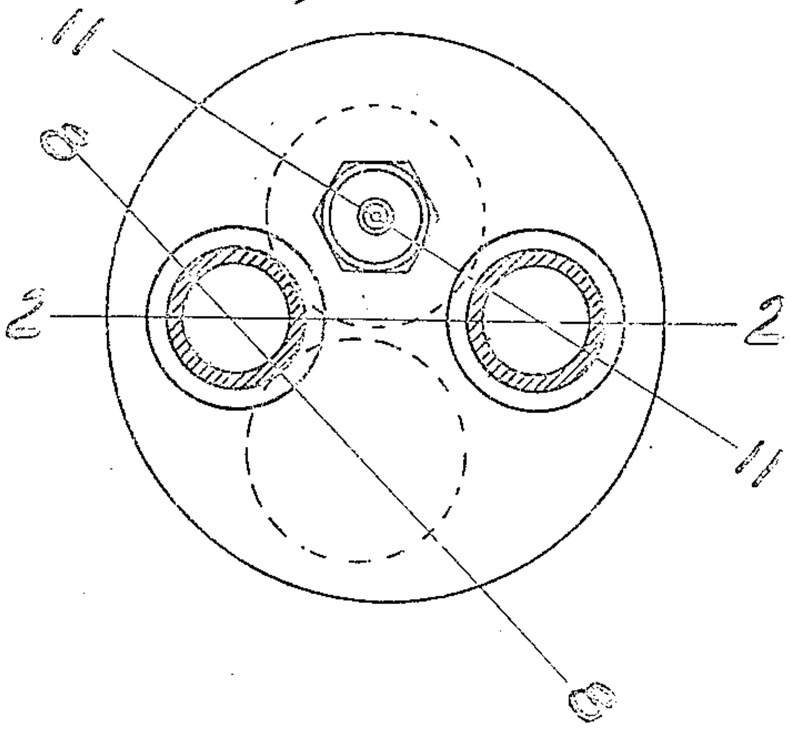


Fig. 10.

Witnesses
H. E. Boswell
M. C. Sullivan

Inventor
Rudolph Conrader
by H. C. Lord
Attorney

R. CONRADER.

APPARATUS FOR ACTUATING LIQUIDS.

APPLICATION FILED OCT. 2, 1903. RENEWED JAN. 31, 1910.

969,940.

Patented Sept. 13, 1910.

8 SHEETS—SHEET 4.

Fig. 11

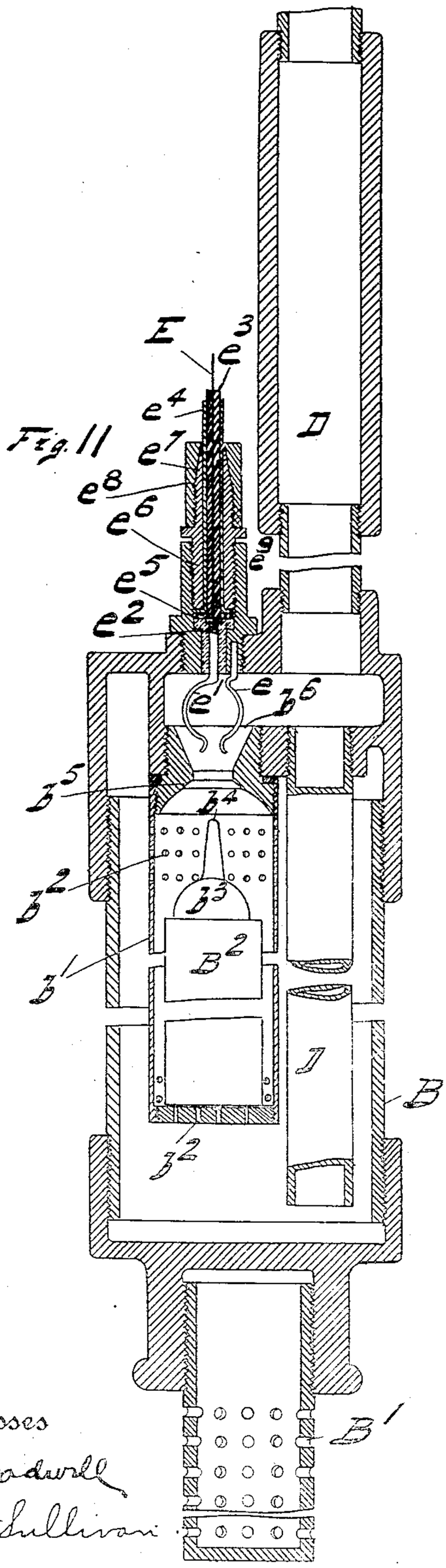
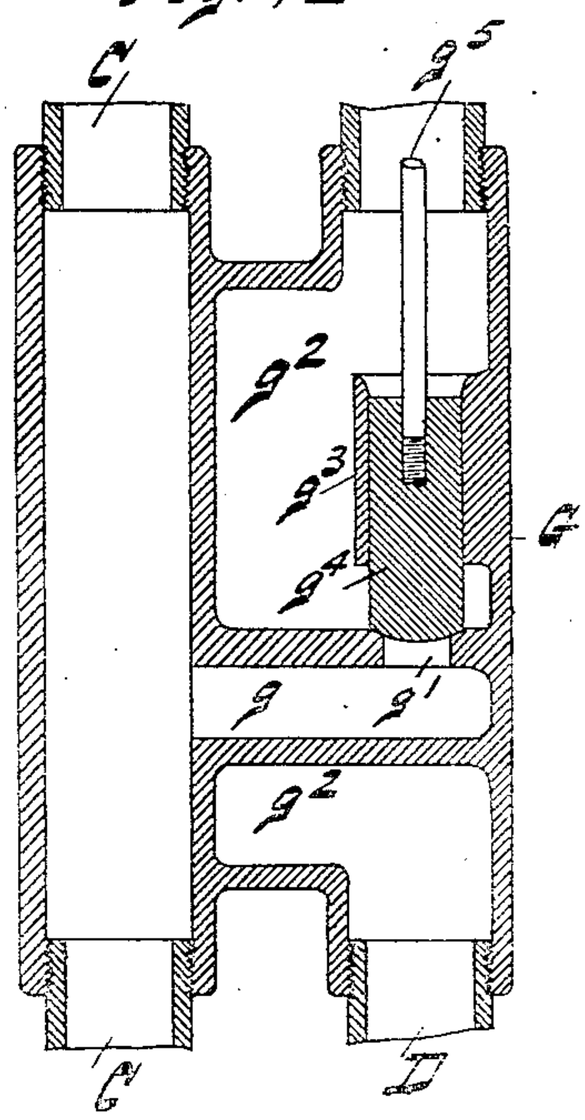


Fig. 12



Witnesses

W. E. Coldwell

M. C. Sullivan

Inventor

Rudolph Conrader

by W. C. Lund

Attorney

R. CONRADER.

APPARATUS FOR ACTUATING LIQUIDS.

APPLICATION FILED OCT. 2, 1903. RENEWED JAN. 31, 1910.

969,940.

Patented Sept. 13, 1910.

8 SHEETS—SHEET 5.

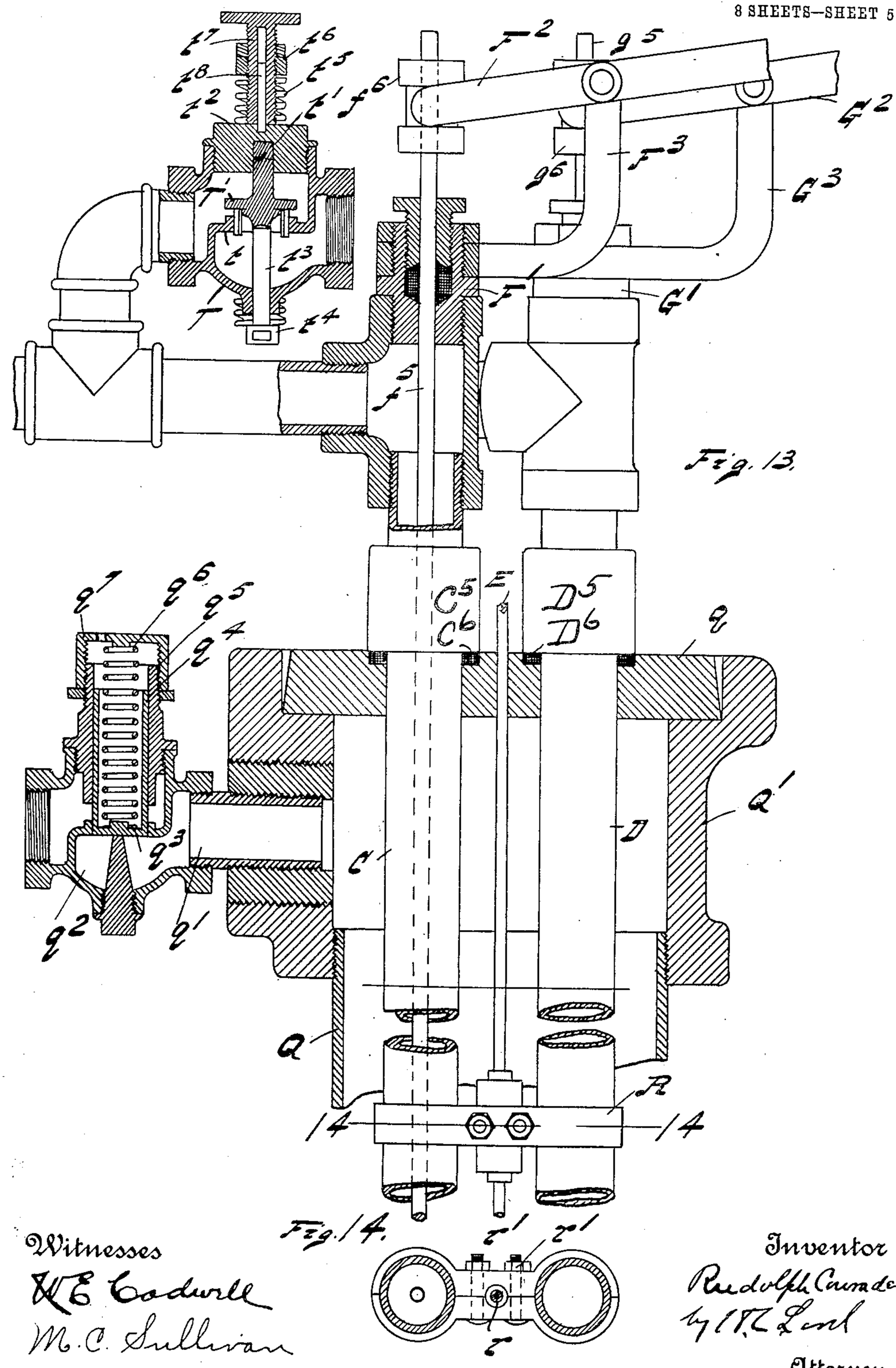


Fig. 13.

Fig. 14.

Witnesses

W E Coulwell

M. C. Sullivan

Inventor

Rudolph Conrader

by R. C. Lord

Attorney

R. CONRADER.

APPARATUS FOR ACTUATING LIQUIDS.

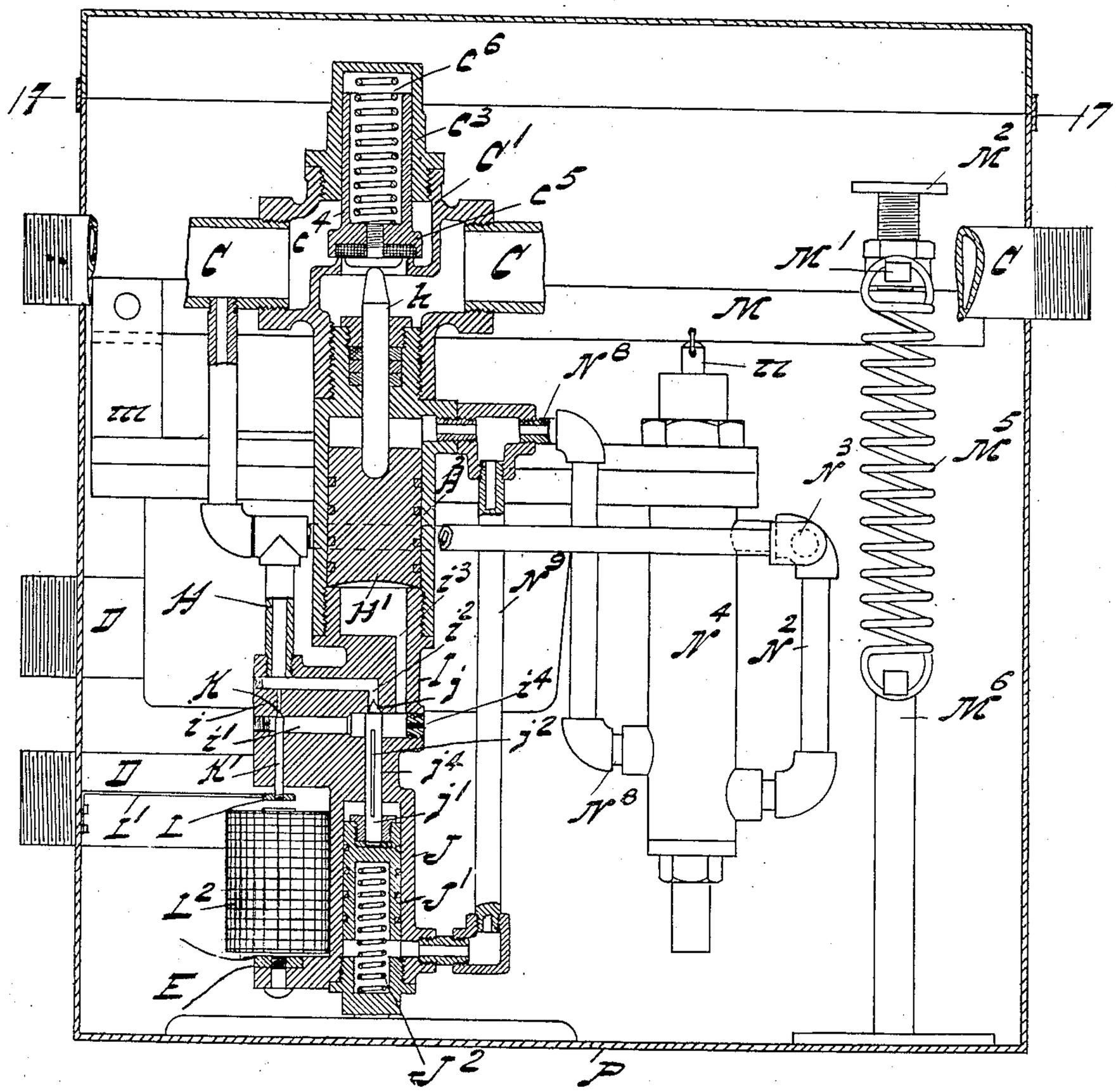
APPLICATION FILED OCT. 2, 1903. RENEWED JAN. 31, 1910.

969,940.

Patented Sept. 13, 1910.

8 SHEETS—SHEET 6.

Fig. 15.



Witnesses

W. E. Caldwell.

M. C. Sullivan.

Inventor

Rudolph Conrader

by T. C. Lord.

Attorney

R. CONRADER.

APPARATUS FOR ACTUATING LIQUIDS.

APPLICATION FILED OCT. 2, 1903. RENEWED JAN. 31, 1910.

969,940.

Patented Sept. 13, 1910.

8 SHEETS—SHEET 7.

Fig. 17.

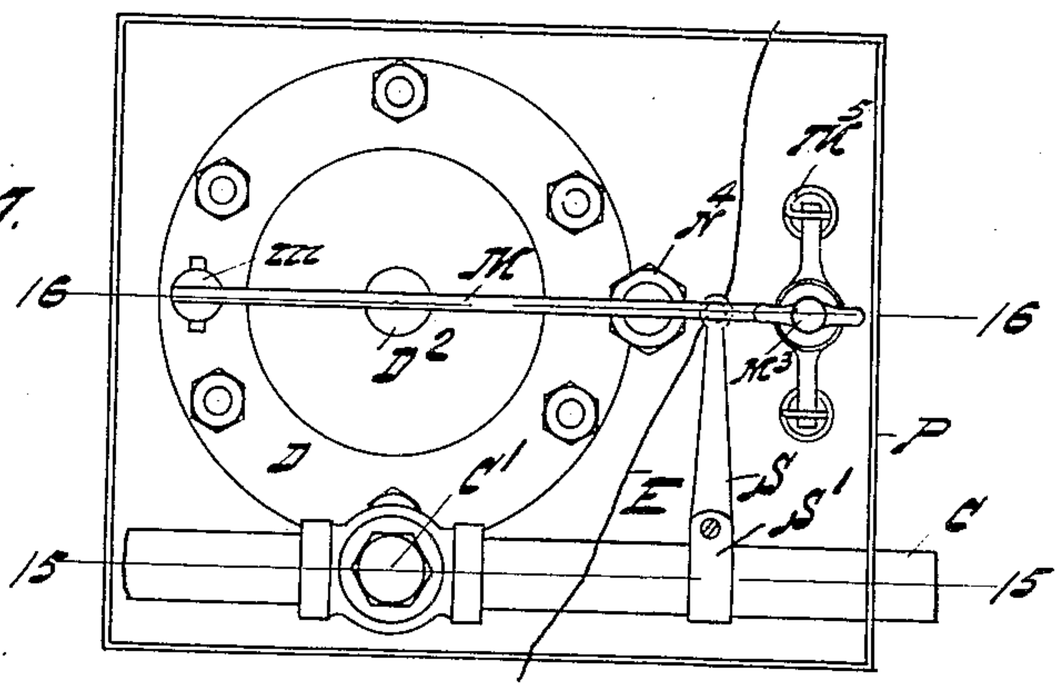
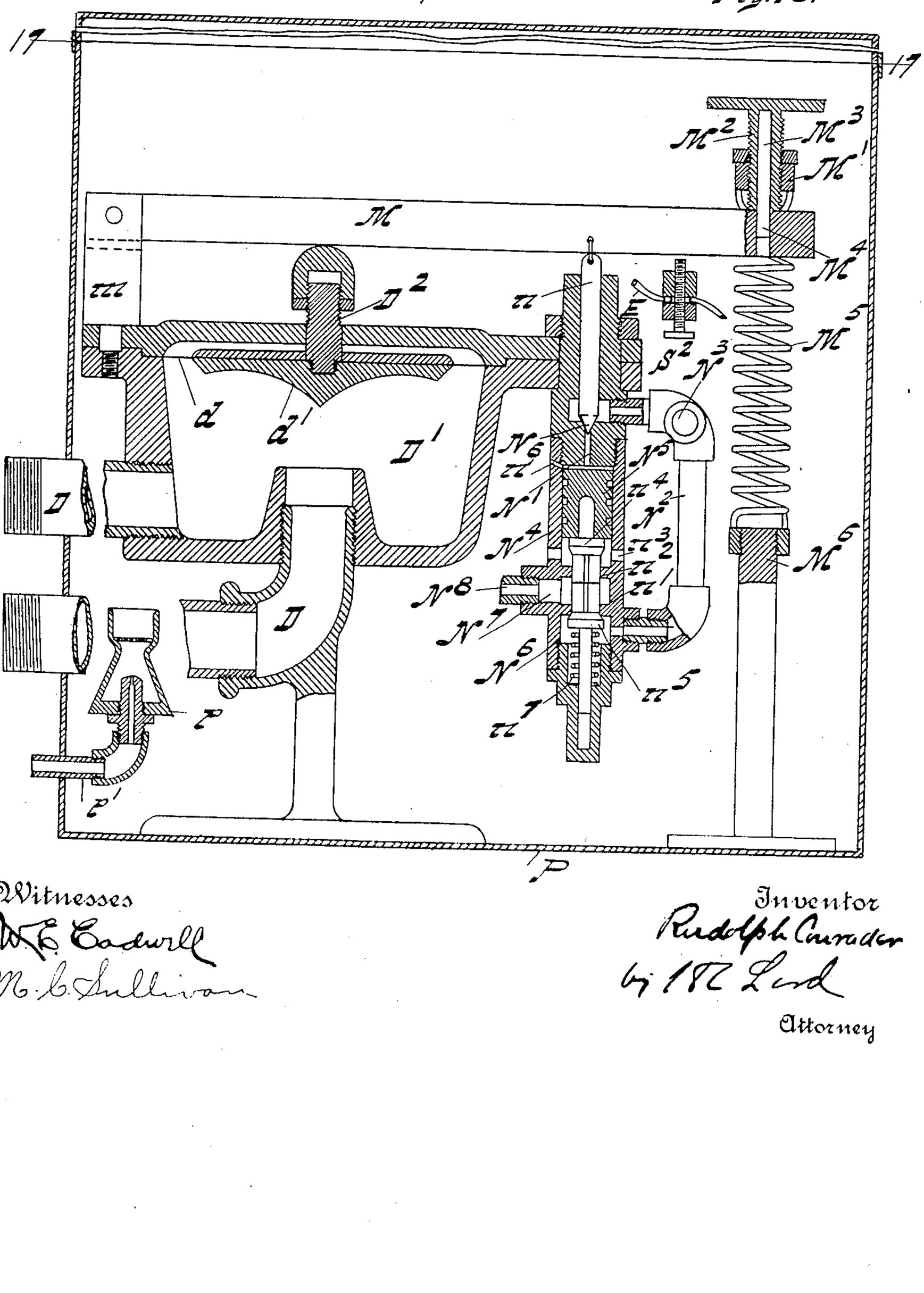


Fig. 16.



Witnesses

W. E. Cadwell

M. C. Sullivan

Inventor

Rudolph Conrader

by H. C. Lord

Attorney

R. CONRADER.

APPARATUS FOR ACTUATING LIQUIDS.

APPLICATION FILED OCT. 2, 1903. RENEWED JAN. 31, 1910.

969,940.

Patented Sept. 13, 1910.

8 SHEETS—SHEET 8.

19

Fig. 18.

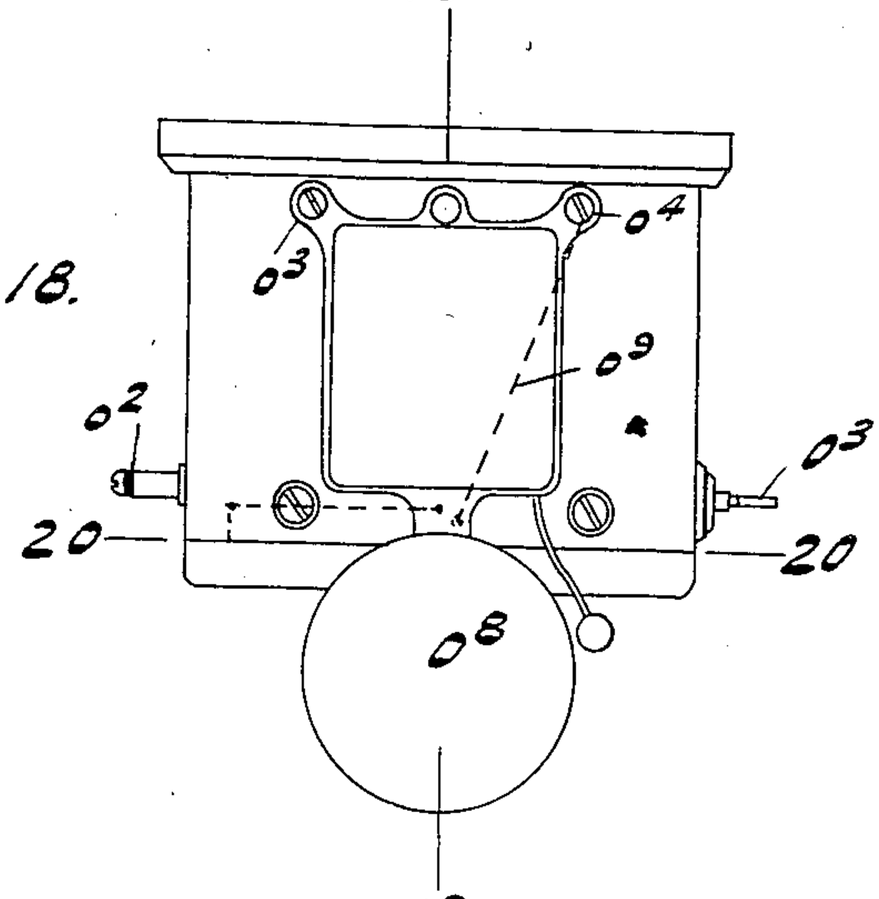


Fig. 19.

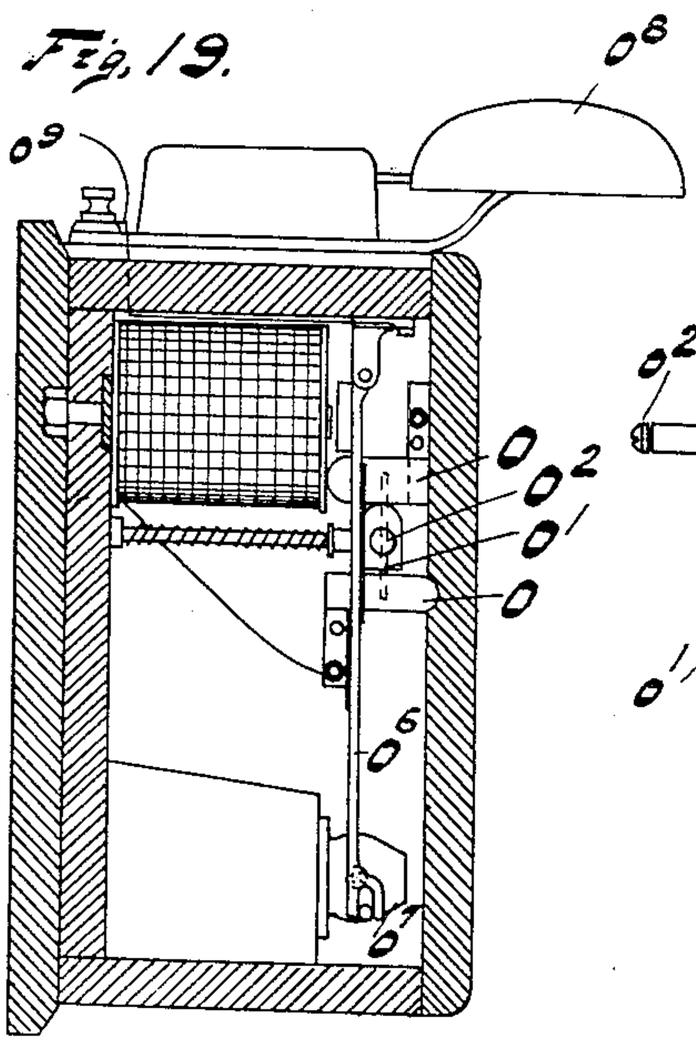
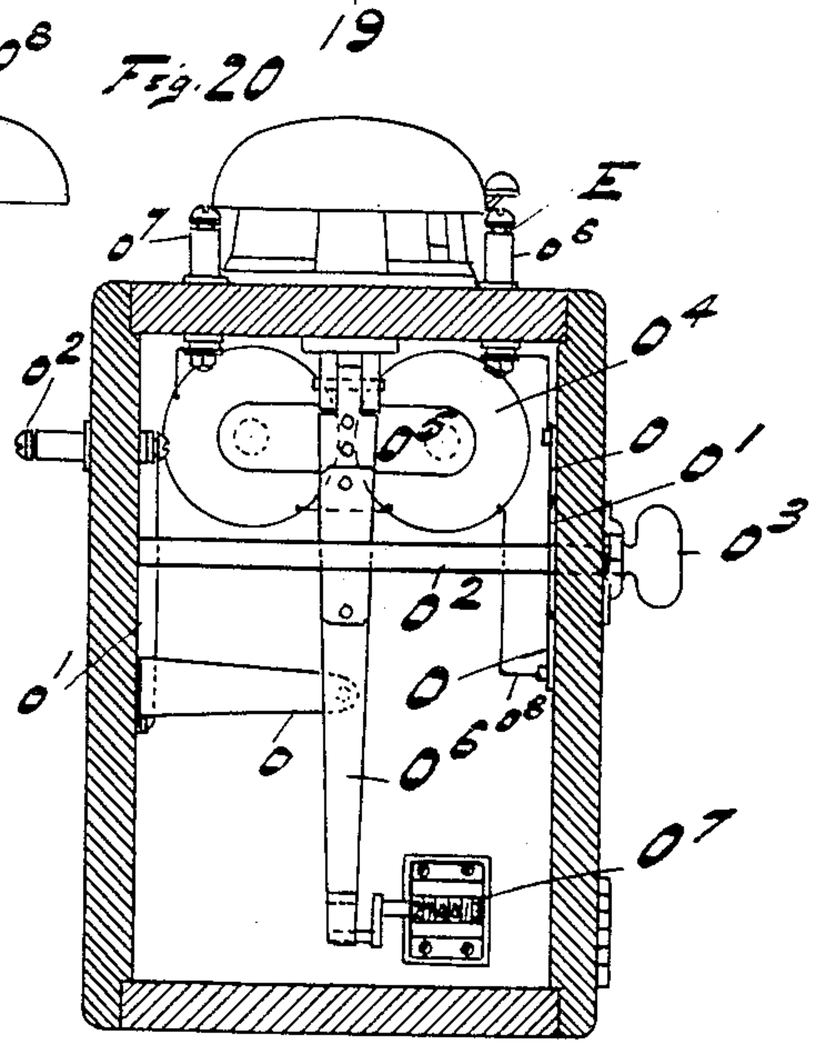


Fig. 20



Witnesses

W. E. Caldwell

M. C. Sullivan

Inventor

Rudolph Conrader

by H. C. Lind.

Attorney

UNITED STATES PATENT OFFICE.

RUDOLPH CONRADER, OF ERIE, PENNSYLVANIA.

APPARATUS FOR ACTUATING LIQUIDS.

969,940. Specification of Letters Patent. Patented Sept. 13, 1910.

Application filed October 2, 1903, Serial No. 175,429. Renewed January 31, 1910. Serial No. 541,160.

To all whom it may concern:

Be it known that I, RUDOLPH CONRADER, a citizen of the United States, residing at Erie, in the county of Erie and State of Pennsylvania, have invented new and useful Improvements in Apparatuses for Actuating Liquids, of which the following is a specification.

This invention relates to apparatuses for actuating liquids and consists in certain improvements in the construction thereof as will be hereinafter more fully described and pointed out in the claims.

The invention is particularly adapted for raising liquids from wells, especially deep wells. In these wells it is often desirable to maintain a certain level in the well, that is, to have the liquid raised from it as it accumulates automatically. I have shown an apparatus for doing this in my prior application filed Dec. 17, 1902, #136,431, but in that apparatus the valve mechanism controlling the actuating fluid is located in the well. It is for some reasons desirable to locate the valve controlling mechanism without the well and in the present application the valve controlling mechanisms are arranged without the well, but are automatically controlled by the liquid in the well so as to effect a pumping action with a certain level of liquid. It is also desirable, especially where there are groups of wells to be able to control them from some one central station. The present application also has mechanism whereby the pump may be thrown into action from a central station, remote from the pump, and thus operated arbitrarily at the will of the operator. The present apparatus also has means for sounding or indicating when a charge of fluid is being raised and also for registering the number of charges raised.

In the pumping of oil wells it is desirable to maintain a fixed pressure upon the well so that the level of liquid may be somewhat reduced over that admitted to the pump, and also to get a more uniform flow of liquid from the surrounding strata. The present application has means for accomplishing these purposes.

The apparatus just hereinbefore enumerated comprise some of the features of my invention, and also contain numerous structural improvements as will appear more fully from the specification, claims and detail.

The invention is illustrated in the accompanying drawings as follows:—

Figure 1 is a sectional view of a well with my apparatus installed therein. Fig. 2 is a section on the line 2—2 in Figs. 3, and 10, it being a central, longitudinal section through the apparatus. Fig. 3 is a section on the line 3—3 in Fig. 2. Fig. 4, a section on the line 4—4 in said Fig. 2. Fig. 5, a section on the line 5—5 in said Fig. 2. Fig. 6, a section on the line 6—6 in said Fig. 2. Fig. 7, a section on the line 7—7 in said Fig. 2. Fig. 8 shows a section on the line 8—8 in Fig. 10, it being a section of the air or actuating fluid mechanism. Fig. 9 is a section on the line 9—9 in Fig. 2. Fig. 10 shows a section on the line 10—10 in Fig. 8. Fig. 11 shows a section on the line 11—11 in Fig. 10. Fig. 12 is a sectional view of an air by-pass, the operating valve being in the eduction tube. Fig. 13 shows a sectional view of the casing head and adjacent mechanism. Fig. 14, a section on the line 14—14 in Fig. 13. Fig. 15 shows a sectional view of the air controlling valve. Fig. 16, a sectional view illustrating the mechanism for cutting off the air at the completion of an operation. Fig. 17 is a plan view of some of the mechanism shown in Fig. 16. Fig. 18 is a plan view of the indicating and manual operating mechanism. Fig. 19 shows a section on the line 19—19 in Fig. 18. Fig. 20, a section on the line 20—20 in Fig. 18.

As before stated the invention is particularly adapted for raising liquids from deep wells, and is so illustrated and described. In some of the features the application is limited to this adaptation, but in many others it is not so limited or so intended to be. The invention as shown is applied to an apparatus wherein the liquid is forced through a lift by a following action of an actuating fluid. In this respect also the invention is in some respects limited to such an apparatus, but in many others it is not so limited nor intended to be.

A marks the well and in this well is arranged the pump chamber B. It is provided with the usual perforated tube B′ through which the oil enters. The pump chamber is preferably formed of an ordi-

nary piece of tubing or pipe. Arranged in the bottom of the pump chamber are the check valves *b b*. These operate in the usual manner and prevent a back flow of liquid from pump chamber. The apparatus here shown is adapted to use air as actuating fluid, and in describing the apparatus I refer to air as the actuating fluid although other gases may be used. The air enters the pump chamber through the pipe C and the liquid is forced through the pipe D (see Figs. 1, 2, 8 and 11). The eduction tube D extends to near the bottom of the chamber so that as liquid is forced from the chamber by air the chamber will be practically emptied. The end of the air tube is provided with a check valve *c*. This check valve is provided with a stem *c'* which is operated upon by the spring c^2. This check valve is important in that it prevents the liquid from the well entering the air tube, and in this way increasing the charge which must be lifted. In the apparatus as here shown the liquid is raised by a following action of the air which is driven through the entire length of the eduction tube to the surface, the air following it in direct contact, and forcing this action. It it manifest that the air of given pressure will only lift a given column of liquid. As it is desirable to operate these apparatuses with as low air pressure as possible a column of liquid which must be raised by the air pressure is equal to the amount of liquid in the chamber and eduction tube, and if the air tube were left open there would be a column of liquid in the air tube. This would require pressure so much above what is necessary to operate the device normally as to be objectionable.

The valve mechanism for turning on the air is at the top of the well. It has electric connection with the pump chamber so that when the liquid in the pump chamber reaches a certain level the electric circuit is grounded or closed and the pump valve mechanism actuated to turn on a charge of air. This electrical connection is formed through the wire E (see Fig. 1). It is connected with a spring contact finger *e'*, the other member of the connector *e* being directly connected with the pump chamber so as to ground the circuit. The wire E passes through an insulating material e^3 and this is incased in a lead tube e^4. The lower end of the lead tube is flanged and a washer e^5 of insulating material is arranged around the end of the insulating material e^3. These are placed in the gland e^9 and the follower e^6 is screwed into the gland against the backing formed by the packing e^5 and flanges on the tubes e^4 thus not only completely insulating the wire, but also forming an air tight joint for preventing the escape of air from the chamber. The upper end of the follower e^6 is beveled at e^7 and a beveled nut e^8 is secured on the follower against this beveled surface, thus forcing it against the lead tube, so contacting the insulating material and securing it as to prevent a rupture of said material.

A float B^2 is arranged in the case *b'*. Perforations b^2 at the top and bottom of the case permit the ingress and egress of liquid from the chamber. The upper end of the float is provided with a valve b^3, which is arranged to operate upon the seat b^5 to close a passage b^6 extending from the upper end of the case to the eduction tube D. The upper end of the float is also provided with a contact post b^4, which is adapted to enter between the spring fingers *e—e'* of the switch so that when the liquid in the pump chamber reaches a given level the float actuates the valve b^3 and post b^4 so as to close the passage b^6 as well as the electrical circuit. The passage b^6 and the valve b^3 fulfil two purposes. The opening through the passage b^6 permits the free inflow of liquid and avoids trapping air in the chamber; and secondly if there is too great a height of liquid in the tube D to permit lifting the charge with a normal pressure in the combined tube and chamber, the passage b^6 will, under these circumstances, form a by-pass so that the air may force the liquid out of the tube D leaving the chamber full and then in a second operation empty the chamber. The operation of this part for accomplishing this is as follows: When the valve b^3 is seated and the electric circuit closed air is turned on in the chamber, and the frictional resistance of liquid on the tube D from the bottom of the tube D to the passage b^6 is sufficient to make the pressure on the upper part of the valve b^3 materially less than the direct pressure on the lower part of the valve b^3, so that the valve b^3, in a normal operation of the device, that is so long as there is a continuous movement of the liquid through the tube D, remains on its seat until the liquid in the tube D passes the passage b^6 when the pressure on both sides of the valve b^3 immediately becomes practically balanced, so that the valve with the float drops and air passes not only through the bottom of the tube D but by way of the passage b^6. When however the column of liquid in the tube D is so great that it balances the air pressure or substantially balances the air pressure before the chamber B is emptied, the liquid in the tube D will come to a standstill. As soon as this happens the frictional resistance will disappear, and the pressure will be balanced on both sides of the valve b^3, so that air will pass through the passage b^6, and lift that part of the column above the passage b^6. The second operation will take what remains in the chamber so that by this device the blocking of the mechanism by an excessive column in

the tube D is to this extent prevented. It becomes desirable to have additional means for taking care of the rise of liquid in the eduction tube, and I have provided such means. In Figs. 2, 3, 4, 5, 6, 8 and 9 I illustrate one of said devices as follows: A valve casing F forms one of the couplings for the tubes C and D. The eduction tube simply passes through this casing. The air tube C enters the chamber f^2 from which there is a passage f' leading to a by-pass f. The by-pass f extends into the eduction tube. The chamber f^2 entirely surrounds this by-pass f. The body of the chamber is deflected in order to get it nearer the center of the apparatus as clearly shown in Figs. 2 and 3. This is important in view of the fact that this apparatus in practice must be installed in a very limited space as it is desirable to have the chamber f^2 sufficiently large to permit the free movement of air by the by-pass f. A valve f^4 is arranged to control the passage f'. It is mounted in a guide f^3 arranged in the chamber f^2. A stem f^5 extends from the valve to the top of the well. The upper end of the stem is provided with a spool f^6 (see Figs. 1 and 13), the stem passing through a stuffing box F'. The lever F^2 is fulcrumed on the arm F^3 extending from the stuffing box. If it is found that the column of liquid is so high as to require the utilization of the by-pass f the lever F^2 is operated thus raising the valve f^4. This permits the air to pass through the by-pass f and lifts only the liquid above the by-pass f, the liquid below this remaining in the well. After the liquid has been raised from the entire eduction tube the apparatus will operate automatically to prevent anything more than the filling of the chamber, so long as the air and current remain turned on. One of the features of this apparatus is that practically all the operating mechanism is arranged without the well, so that it may readily be repaired if it should get out of order. The valve f^4 is made of such size as to pass through the tube C. Should it get out of order, it with its stem may be raised through the tube C to the top of the well. In order that a second cutting off or by-pass may be operated I arrange a valve for controlling the passage of air into the eduction tube in the line of the eduction tube (see Fig. 12). In this there is a casing G which is similar to the casing F. The air tube C passes through this casing. The eduction tube D passes into the chamber g^2. A passage g' extends from the chamber g^2 into the by-pass g, and the by-pass g extends into the air chamber. A valve g^4 controls the passage g'. It is arranged in a guide g^3 in the chamber g^2. A rod g^5 extends to the top of the well where it is arranged with the spool g^6. It passes through a stuffing box G'. A lever G^2 is fulcrumed on the arm G^3 and is arranged to operate the rod and consequently the valve. This valve g^4 is smaller than the eduction tube so that it may be removed through the eduction tube. With these three points of cut off:—the one at the top of the pump chamber through the passage b^6; the second through the casing F; and a third through the casing G any ordinary level of liquid may be taken care of.

The pump is often two or three thousand feet from the surface. The strain on the pipe is of great importance as well as the convenient method of handling. I have therefore arranged an apparatus in which the eduction tube and air tube may be of the same size pipe. This materially facilitates the installation and so equalizes the strains as to assure a proper suspension in the well. This arrangement also gives much better results than any apparatuses where the eduction tube is around the air tube, in that there is much less friction than where there is no frictional surface at the center. The pipes are suspended from the head Q' which is provided with plate q. The pipes have the collars (see Fig. 13) C^5 and D^5 which rest on the packing C^6 and D^6 securely sealing the well. The size of the air tube also insures a sufficient speed of the column to prevent any material amount of it from falling back. I have provided the clamps (see Fig. 14) R with which the two pipes are connected. This materially strengthens and stiffens the structure. The clamp is provided with a means for securing the wire between the pipes at r, and the clamps are secured together by the bolts r'. In this way the wire is entirely supported and protected so that there is little danger of the insulation being injured in the installation.

The valve mechanisms which are arranged as above stated at the top of the well are illustrated in Figs. 15 and 16. The wire E, which is connected with the switch e e', passes through a coil L^2 so that when the circuit is closed the magnet formed by the coils attracts the armature L. The armature is held away from the magnet by the spring L'. A valve K, having the stem K' is controlled by the armature L. The valve K is arranged in a valve casing I. This valve casing has a passage i^2, which is connected by a pipe H, with the air pipes C. The valve K controls a small by-pass i. Air passes from the passage i through the passage i' and j^4 into a cylinder J. Here it operates a piston J', the piston being normally forced to its upper position by a spring J^2. The valve j is controlled by this piston through the stem j'. The stem is provided with a web j^2, so as to afford a passage around the stem into the cylinder. The valve j is considerably larger than the valve K and controls the larger passage i^2.

As soon as the air enters through the passage i^2 it passes upwardly through the passage i^3 into a cylinder H^2 in which there is a piston H'. This piston operates upon the plunger h, and this plunger forces open the main air valve c^5. This air valve is arranged in a body C' and has a cylindrical stem c^4 which is arranged in a cylinder or casing c^3, and is normally held to its seat by the spring c^6. From this mechanism it will be seen that as soon as the electric connection is formed through the action of the switch e e' the air is turned on through the main air pipe C and remains on until closed by the following mechanism. The air might be turned off by the reduction in pressure incident to the complete expulsion of the column of liquid. It is desirable however that the air be cut off as soon as the front of the column reaches the surface. The air will not reduce in pressure as fast as the column will reduce in length due to its expulsion. The liquid passes into a receiver (see Fig. 16) and operates against a diaphragm d, the diaphragm being preferably provided with a deflector d'. A stem D^2 extends from the diaphragm, and operates against the lever M. The lever M is fulcrumed on a post m attached to the receiver. A yoke M' extends across the end of the lever, and is mounted on a screw M^2. The screw has the opening M^3 and is mounted on a pin M^4 which extends into the end of the lever. By this mechanism the screw may be readily turned or remain stationary on the lever. At the end of the yoke are arranged the springs M^5 which are secured to the post M^6. The spring tension may be adjusted by the screw M^2. A pipe N^3 connects a pipe N^2 with the air pipe through the pipe H. The pipe N^2 is connected with the upper end of the cylinder N^4. A valve N controls the passage from the pipe to the cylinder. The stem n extends from said valve to the lever M. It is normally held to its seat by said lever, but when the lever M is raised through the action of the column of liquid on the diaphragm d the valve opens, thus connecting the cylinder N^4 with the air supply. The lower end of the cylinder is connected with the atmosphere by a passage n^3. It has a valve passage n^2 connecting it with a by-pass N^7. This by-pass is connected by a pipe N^8 with a pipe N^9 (see Fig. 15), the pipe N^9 passing to the lower end of the cylinder J, and the upper end of the cylinder H^2. As soon as the air passes in the cylinder N^4 it operates upon a piston N^5 forcing said piston downwardly. The piston carries with it a valve n^4 which closes the passage n^2. At the same time it forces open the valve n^5 thus opening a passage n', the passage n' being between the lower end of the cylinder and the by-pass N^7. The pipe N^2 enters this part of the cylinder so that when the valve n^5 is open there is a direct connection between the air supply by the passage n', pipe N^8 and pipe N^9 with the ends of the cylinder J and H^2. This effects a balancing of pressure on the pistons J' and H, and the springs J^2 and c^6 effect a closure of the valves j and c^5 so that the air is immediately cut off. A vent i^4 allows the exhaust of air from the cylinders H^2 and J and their connecting passages. As soon as the liquid and air cease passing through the receiver D' the springs M^5 draw the lever to its normal position thus closing the valve N. Air escapes through the vent n^6 and the spring n^7 forces the valve n^5 to its seat and opens the valve n^4. The air then exhausts from the lower end of the cylinder J and upper end of the cylinder H^2 by way of the passage n^2 and passage n^3. This brings the parts to the normal position or position which they were before the operation just described and they remain in this position until liquid has entered the chamber, raising the float and closing the circuit through the switch, when this operation is repeated.

It will be noted that unless some other means is provided for exhausing the air than the eduction tube all the air from the tube C must expand through the pump chamber and out the eduction tube. This makes quite an interval between the time the column has been discharged and the time that liquid begins to enter the pump chamber, the pressure in the chamber preventing the inflow of liquid. In order to facilitate the exhaust and thus get a greater capacity for the pump I have provided an auxiliary relief for the air tube.

The valve casing T has the diaphragm t with the usual valve passage. The valve T controls the passage. It has a stem t' which operates in the socket in the cap t^2. Below the valve is the stem t^3 which extends through the casing and engages the yoke t^4. The springs t^5 extend from this yoke to a yoke t^6. An adjusting screw t^7 is arranged in this yoke. The screw is journaled on the pin t^8. This pin is secured to the cap. As the air pressure goes in the valve T' is closed against the spring. As soon as the air pressure is somewhat reduced the spring opens the valve and thus affords an additional exhaust. The spring may be adjusted by the screw to operate at any pressure desired.

Inasmuch as the apparatus when operating normally discharges the same amount with each charge, the amount of liquid expelled may be accurately gaged by determining the number of charges. It is desirable therefore to record the number of discharges and to indicate a discharge preferably at some point remote from the well. This is particularly true where there is a group of

wells operating from a central station, some of them being some miles away. In a switch box O^9 (see Figs. 1, 18, 19 and 20) I arrange a switch which is in the circuit formed by the wire E. The wire E is connected through a post o^6 with one post O of the switch O′. The opposite post O of the switch is connected through a wire o^8 with the coil O^4. The wire from the opposite end of the coil passes to the post o^7, and from the post o^7 to a battery or source of electrical power E′ (see Fig. 1) from which it passes to the ground, this being preferably one of the pipes as shown. The armature O^5 operated by the coils is carried by a lever O^6, and this lever operates a counter O^7, so that each time the circuit is closed through the action of the switch e e' the counter is operated and thus registers the number of discharges. The lever O^6 also closes the connection through a bell so that each discharge is indicated by the bell. This is accomplished as follows:—A contact post o extends in the path of the lever O^6. The end of the lever O^6 is connected by a wire o^9 with one post of the bell (see Figs. 18 and 19). The post o is connected by the wire o' with a post o^2, and the post o^3 of the valve is connected with the local battery o^5 as shown in Fig. 1.

It becomes sometimes desirable to actuate the pumping apparatus arbitrarily from the pumping station. This is particularly true when anything happens to the operating mechanism in the well. In such an event it may be desirable to continue the pumping action without pulling the pump. This may be accomplished by simply grounding the wire running into the well. Then by simply actuating the switch O′ through the action of the switch button O^3 and rod O^2, and the rod carrying the switch pin O′. Each time the current is turned on there will be one complete operation, and in order to get a second operation properly it will be necessary to immediately turn off the current, so that there may be sufficient interval between the time the air goes off and the next charge for the pump chamber to fill.

It is desirable to afford means of apprising the operator when the well is pumped out. I have arranged such a device as clearly shown in Figs. 16 and 17. A switch post S is arranged on a clamp S′ on the air tube. Normally this clamp is swung around on the air tube sufficiently to hold the switch post S out of contact with the lever M. The main circuit of the wire E runs through this post S, the adjusting screw S^2 being arranged to give the desired contact. As the current is turned on the lever M being in its normal position, the circuit is closed so that the bell rings and so continues until the column strikes the diaphragm d the circuit then being opened through the action of the lever M, and remains open until the end of the column is passed off and the lever M returns to normal. If the bell does not cease ringing in a reasonable time it will indicate the absence of a charge. As soon as the bell ceases to ring the current should be turned off.

It is desirable that both for effecting the operation of the well and more efficiency in pumping that the gas in the well may be maintained at a uniform pressure. Some gas pressure forces a level of liquid in the pump chamber above that in the well, so that a lower level of liquid may be maintained if desired. It also gives a more uniform flow of oil through the strata. I accomplish this by sealing the casing head Q′ and casing Q. The casing head is provided with the plate q for supporting the pipes, and extending from the casing head thus sealed is a pipe q', which usually passes to a gas main, but may pass to the atmosphere as shown. The pipe q' passes into a valve q^2. The valve disk q^3 being of the plunger type has a hollow cylindrical stem q^4 which extends into a cylindrical casing q^5. A spring q^6 is arranged in the hollow stem, and is tensioned by a nut q^7. By the adjustment of the plunger nut the spring tension may be changed so as to make the normal pressure in the well anything desired to get the best results. The construction of the valve eliminates the pressure on the line and is the distinguishing feature in the operation of the valve in that it is practically balanced. As soon as the pressure in the well is sufficient to overcome the spring q^6 the valve opens and remains open so long as this pressure exceeds that desired. By this device the level of liquid in the well may be kept uniform in as much as there will be a uinform elevation of liquid in the well.

The valve mechanism is inclosed in a chamber P and the burner p connected by a pipe p' with the well. In this way the valve mechanism can be kept free from the effect of cold.

What I claim as new is:—

1. In an apparatus for actuating liquids the combination with a pump chamber adapted to be placed in a well; means for conveying liquid from said chamber by a following action of the actuating fluid through the lift; a connection with said chamber for actuating fluid; mechanism controlling said actuating fluid in said connection adapted to be located at a distance remote from said chamber; and devices actuated by the liquid in the well for controlling said mechanism so located.

2. In an apparatus for actuating liquids the combination with a pump chamber adapted to be placed in a well; means for conveying liquid from said chamber by a following action of the actuating fluid

through the lift; a connection with said chamber for actuating fluid; mechanism controlling said actuating fluid in said connection adapted to be located at a distance remote from said chamber; and electrical devices controlled by the liquid in the well for actuating said mechanism so located.

3. In an apparatus for actuating liquids the combination with a pump chamber adapted to be placed in a well; means for conveying liquid from said chamber by a following action of the actuating liquid through the lift; a connection with said chamber for actuating fluid; mechanism controlling said actuating fluid adapted to be located at a distance remote from said chamber; and devices actuated by the liquid in the pump chamber for controlling said mechanism so located.

4. In an apparatus for actuating liquids the combination with a pump chamber adapted to be placed in a well; means for conveying liquid from said chamber by a following action of the actuating fluid through the lift; a connection with said chamber for actuating fluid; mechanism controlling said actuating fluid adapted to be located at a distance remote from said chamber; and electric devices for controlling said mechanism arranged to be controlled by the liquid in said pump chamber.

5. In an apparatus for actuating liquids the combination with a pump chamber adapted to be placed in a well; means for conveying liquid from said chamber by a following action of the actuating fluid through the lift; a check valve mechanism to prevent a back flow of fluid from the pump chamber; a connection with said chamber for actuating fluid; mechanism controlling said actuating fluid in said connection adapted to be located at a distance remote from said chamber; and electrical devices controlled by the liquid in the well for actuating said mechanism so located.

6. In an apparatus for actuating liquids the combination with a pump chamber adapted to be placed in a well; means for conveying liquid from said chamber by a following action of the actuating fluid through the lift; a check valve mechanism to prevent a back flow of fluid from the pump chamber; a connection with said chamber for actuating fluid; mechanism controlling said actuating fluid in said connection adapted to be located at a distance remote from said chamber; and electrical devices controlled by the liquid in the well for actuating said mechanism so located.

7. In an apparatus for actuating liquids the combination with a pump chamber adapted to be placed in a well; means for conveying liquid from said chamber by a following action of the actuating fluid through the lift in contact with the liquid; a connection with said chamber for actuating fluid; mechanism controlling said actuating fluid in said connection adapted to be located at a distance remote from said chamber; electric devices comprising a switch arranged at a point remote from said mechanism for controlling said mechanism and comprising an electric connection in the well arranged to be actuated by the liquid in the well.

8. In an apparatus for actuating liquids the combination with a pump chamber adapted to be placed in a well; means for conveying liquid from said chamber by a following action of the actuating fluid through the lift in contact with the liquid; a connection with said chamber for actuating fluid; mechanism controlling said actuating fluid in said connection adapted to be located at a distance remote from said chamber; electric devices comprising a switch arranged at a point remote from said mechanism for controlling said mechanism and comprising a connection in the well arranged to be actuated by liquid in the pump chamber.

9. In an apparatus for actuating liquids the combination with a pump chamber adapted to be placed in a well; means for conveying liquid from said chamber by a following action of the actuating fluid through the lift in contact with the liquid; a connection with said chamber for actuating fluid; mechanism controlling said actuating fluid in said connection adapted to be located at a distance remote from said chamber; electric devices for actuating said mechanism comprising a switch arranged at a point remote from said mechanism, and also comprising a connection and switch in the pump chamber; and a float arranged in the pump chamber and arranged to actuate said switch.

10. In an apparatus for actuating liquids the combination with a pump chamber adapted to be placed in a well; means for conveying liquid from said chamber by a following action of the actuating fluid through the lift; a connection with said chamber for actuating fluid; mechanism controlling said actuating fluid in said connection adapted to be located at a distance remote from said chamber; devices actuated by the liquid in the well for controlling said mechanism to open said connection; and means actuated by the liquid lifted for closing said connection.

11. In an apparatus for actuating liquids the combination with a pump chamber adapted to be placed in a well; means for conveying liquid from said chamber by a following action of the actuating fluid through the lift; a connection with said chamber for actuating fluid; mechanism controlling said actuating fluid in said con-

nection adapted to be located at a distance remote from said chamber; electric devices controlled by the liquid in the well for actuating the mechanism so located to open the connection; and means actuated by the liquid lifted for closing said connection.

12. In an apparatus for actuating liquid by the direct contact of an actuating fluid with the liquid, the combination of a pump chamber; means for conveying liquid from said pump chamber with a following action of the actuating fluid in contact with the liquid; a connection leading to said pump chamber for actuating fluid; mechanism for controlling the actuating fluid in said connection; devices adapted to be operated from points remote from said mechanism for controlling said mechanism to open said connection; and means actuated by the liquid lifted for closing said connection.

13. In an apparatus for actuating liquid by the direct contact of an actuating fluid with the liquid, the combination of a pump chamber; means for conveying liquid from said pump chamber with a following action of the actuating fluid in contact with the liquid; a connection leading to said pump chamber for actuating fluid; mechanism for controlling the actuating fluid in said connection; electrically operated devices adapted to be operated from points remote from said mechanism for controlling said mechanism to open said connection; and means actuated by the liquid lifted for closing said connection.

14. In an apparatus for actuating liquids the combination with a pump chamber adapted to be placed in a well; means for conveying liquid from said chamber; a connection with said chamber for actuating fluid; mechanism controlling said actuating fluid in said connection adapted to be located at a distance remote from said chamber; devices adapted to be operated from a point remote from said mechanism for controlling said mechanism to open said connection; means actuated by the liquid lifted for closing said connection; and means actuated by the liquid in the well for automatically effecting an opening of said connection after said controlling devices have been operated.

15. In an apparatus for actuating liquids in charges by a following action of an actuating fluid through the lift in contact with the liquid; of a signaling device for signaling each charge; and a registering device for registering each charge; and means for actuating said signaling device and registering device with each charge.

16. In an apparatus for actuating liquids in charges by a following action of an actuating fluid through the lift in contact with the liquid; of a signaling device for signaling each charge; a registering device for registering each charge; and electrically operated means for actuating said signaling device and registering device with each charge.

17. In an apparatus for actuating liquids in charges by a following action of an actuating fluid through the lift in contact with the liquid; a connection for supplying actuating fluid; mechanism for controlling said connection; a signaling device; a registering device; and means actuated by the liquid in the well for actuating said mechanism, signaling device and registering device.

18. In an apparatus for actuating liquids by the direct contact of an actuating fluid with said liquid, the combination of a connection for supplying actuating fluid; means for controlling said connection; a signaling device and a registering device arranged remote from said mechanism; and means for controlling said mechanism at said point remote from said mechanism said registering and signaling devices being arranged to register and signal each charge.

19. In an apparatus for actuating liquids by direct contact of an actuating fluid with said liquid; the combination of a connection for supplying actuating fluid; mechanism for controlling said connection; means remote from said connection for controlling said connection; devices actuated by the liquid in the well for controlling said mechanism after it is actuated by said means; and registering and signaling devices for registering and signaling each charge.

20. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with the liquid through the lift the combination with the pump chamber; the eduction tube extending to near the bottom thereof, said tube having a passage leading to the chamber near the top of the chamber; a valve controlling the passage; a float controlling the valve; and an electric switch actuated by said float.

21. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with the liquid through the lift; the combination of a pump chamber; means for supplying actuating fluid to said chamber and for conveying actuated fluid from said chamber; and a by-pass arranged in the chamber for lifting liquid through the eduction tube independently of the liquid in the chamber when the charge in the chamber and tube is excessive.

22. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with the liquid through the lift, the combination of a pump chamber; means for supplying actuating fluid to said chamber and for conveying actuated fluid from said chamber; a by-pass arranged in the chamber for lifting liquid through the eduction tube independently of the liquid in the

chamber when the charge in the chamber and tube is excessive; means for automatically controlling said by-pass to effect the cutting off of the charge in the tube from that in the chamber when the charge is excessive.

23. In an apparatus for actuating liquid by a following action of an actuating liquid through the lift in contact with the liquid the combination with the eduction tube; and means for automatically cutting off a portion of the charge when the total charge is excessive.

24. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with a liquid through the lift, the combination of an eduction tube; a tube for supplying an actuating fluid arranged independently of the eduction tube; a by-pass between said tubes; a valve controlling said by-pass arranged in the tube for supplying actuating fluid said valve being of a size to permit of its introduction and removal through the tube in which it is arranged.

25. In an apparatus for actuating liquids by a following action of the actuating fluid in contact with the liquid through the lift, the combination of the eduction tube; the actuating fluid tube; a by-pass between said tubes; and a check valve arranged in the eduction tube for controlling said by-pass.

26. In an apparatus for actuating liquids by a following action of the actuating fluid in contact with the liquid through the lift, the combination of the eduction tube; the actuating fluid tube; a by-pass between said tubes; a check valve arranged in the eduction tube for controlling said by-pass; said valve being of a size to permit of its introduction and removal through the tube in which it is arranged.

27. In an apparatus for actuating liquids the combination of an eduction tube for actuating liquids by a following action of an actuating fluid through the lift in contact with the fluid the combination of the eduction tube and a supply tube for conveying actuating fluid; by-passes between said tube; a valve controlling one by-pass arranged in the supply tubes; and a valve for controlling another by-pass arranged in the eduction tube.

28. In an apparatus for actuating liquids the combination of an eduction tube for actuating liquids by a following action of an actuating fluid through the lift in contact with the fluid the combination of the eduction tube and a supply tube; bypasses between said tubes; a valve arranged in the supply tube for controlling one bypass and a valve for controlling another by-pass arranged in the eduction tube, each valve being arranged to be introduced through the device in which it is arranged.

29. In an apparatus for actuating liquids the combination of an eduction tube for actuating liquids by a following action of an actuating fluid through the lift in contact with the fluid the combination of the eduction tube and a supply tube for conveying actuating fluids; by-passes between said tubes; a valve controlling one by-pass arranged in the supply tube; and a valve for controlling another by-pass arranged in the eduction tube; a pump chamber, the eduction tube leading to near the bottom of said chamber, said eduction tube having a by-pass to near the top thereof of the chamber; and a valve controlling said by-pass at the chamber.

30. In an apparatus for actuating liquids the combination of an eduction tube for actuating liquids by a following action of an actuating fluid through the lift in contact with the fluid the combination of the eduction tube and a supply tube for conveying actuating fluids; by-passes between said tubes; a valve controlling one by-pass arranged in the supply tube; a valve for controlling another by-pass arranged in the eduction tube; a pump chamber, the eduction tube leading to near the bottom of said chamber, said eduction tube having a by-pass to near the top of said chamber; and means for automatically controlling said by-pass to the chamber to open said by-pass when there is an excessive charge in the tube and chamber.

31. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with the liquid through the lift the combination of an eduction tube D; a supply tube C; of a by-pass connection F having the by-pass f therein; the chamber f^2, and a valve guide f^3 therein; the passage f' connecting the pass f and chamber f^2; the valve f arranged to act in said valve guide to close the passage f', said valve being of a size to permit of its removal through the supply pipe C.

32. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with the liquid through the lift, the combination of the eduction tube D, supply tube C, by-pass connection G having the by-pass g, passage g', chamber g^2 and valve guide therein; the valve g^4 arranged to control the passage g', said valve being of a size to permit of its removal through the tube D.

33. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with the liquid through the lift, the combination of an eduction tube and a tube for supplying actuating fluid, said tubes being of equal size and arranged side by side along the lift and suspended, the lower part of the tubes being sustained by the upper part thereof.

34. In an apparatus for actuating liquids by the direct contact of an actuating fluid

with the liquid, the combination with the casing head; an eduction tube; a tube for actuating fluid, said tubes being suspended from the casing head; and a seal on the casing head on which said tubes are suspended for closing the openings for the tubes through the head.

35. In an apparatus for actuating liquids by the direct contact of an actuating fluid with the liquid, the combination with the casing head; an eduction tube; a tube for actuating fluid, said tubes being suspended from the casing head, said tubes being equally tensioned.

36. In an apparatus for actuating liquids by the direct contact of an actuating fluid with the liquid, the combination with the casing head; an eduction tube; a tube for actuating fluid, said tubes being suspended from the casing head, said tubes being of equal size and equally tensioned.

37. In an apparatus for actuating liquids by the direct contact of an actuating fluid with the liquid and with a following action of the actuating fluid through the lift the combination with the casing head; an eduction tube; a tube for actuating fluid said tubes being suspended from the casing head, said tubes being equally tensioned.

38. In an apparatus for actuating liquids by the following action of an actuating fluid through the lift in contact with the liquid, the combination of an eduction tube; a tube for supplying actuating fluid; and clamps for securing said tubes side by side along the lift.

39. In an apparatus for actuating liquids by the following action of an actuating fluid through the lift in contact with the liquid, the combination of an eduction tube; a tube for supplying actuating fluid; clamps for securing said tubes side by side along the lift; and a controlling wire secured by said clamps.

40. In an apparatus for actuating liquids by the following action of an actuating fluid through the lift in contact with the liquid, the combination of an eduction tube; a tube for supplying actuating fluid; clamps for securing said tubes side by side along the lift; and a controlling wire secured by said clamps between the tubes.

41. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with the liquid through the lift, the combination with a connection for supplying actuating fluid; an eduction tube; mechanism controlling actuating fluid; a receiver arranged on the eduction tube, said receiver being provided with a diaphragm on which the liquid acts; and means actuated by the diaphragm for actuating said mechanism to cut off the actuating fluid.

42. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with the liquid through the lift, the combination with the eduction tube; of a connection for supplying actuating fluid; the valve c^5 controlling the said connection; a motor controlling the said valve; the valve j for controlling a supply of actuating fluid to said motor; a motor controlling said valve; an electrically actuated valve K controlling the valve J; and a valve mechanism for supplying air to the opposite sides of the motors.

43. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with the liquid through the lift, the combination with the eduction tube; of a connection for supplying actuating fluid; the valve c^5 controlling the said connection; a motor controlling the said valve; the valve j for controlling a supply to said motor; a motor controlling said valve; an electrically actuated valve K controlling the valve j; and a valve mechanism for supplying air to the opposite sides of the motors; said valve mechanism being controlled by liquids from the lift.

44. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with the liquid through the lift, the combination with the eduction tube; of a connection for supplying actuating fluid; the valve c^5 controlling the said connection; a valve controlling said connection; a motor controlling said valve; a balancing connection with said motor, said connection extending normally to the atmosphere; a valve n^4 controlling the said connection; and a valve n^5 controlling a connection with the air supply; the motor actuating said valves; valve N controlling said motor; and means actuated by the liquid from the lift for controlling said valve.

45. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with the liquid through the lift, the combination with the eduction tube; of a connection for supplying actuating fluid; the valve c^5 controlling the said connection; a motor controlling the said valve; the valve j for controlling a supply to said motor; a motor controlling said valve; an electrically actuated valve K controlling the valve j; a connection N^8 extending to the opposite side of said motor, said connection extending normally to the atmosphere; the valve n^4 controlling said connection; the valve n^5 controlling a connection to the air supply; the motor N^5 controlling said valves; the valve N controlling said motor; and means actuated by liquid from the lift for actuating said valve.

46. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with the liquid through the lift the combination of an eduction tube; a connection for supplying actuating fluid; mech-

anism controlling said connection; a receiver on the eduction tube; a diaphragm in said receiver; mechanism actuated by said diaphragm for closing off said connection; a spring opposing the action of the diaphragm; and means for adjusting said spring.

47. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with the liquid through the lift, the combination of an eduction tube; a connection for supplying actuating fluid; mechanism controlling said connection; means arranged at a point remote from said mechanism for controlling said mechanism; a signaling device arranged at said point; and means actuated by liquid as it reaches the discharge end of the lift for actuating said signal.

48. In an apparatus for actuating liquids by direct contact of an actuating fluid with the liquid, the combination with a valve mechanism for controlling the actuating fluid; an inclosure for said valve mechanism; a gas connection between the well and said inclosure; and a burner on said connection arranged at said inclosure for the purpose described.

49. In an apparatus for actuating liquids, by a following action of an actuating fluid in contact with the liquid through the lift, the combination with a connection for supplying actuating fluid; mechanism controlling said connection; and a relief valve arranged on said connection, said relief valve being arranged to exhaust said connection at a predetermined pressure.

50. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with the liquid through the lift, the combination with a pump chamber and connection for supplying actuating fluid; mechanism controlling said connection; a relief valve arranged on said connection, said relief valve being arranged to exhaust said connection at a predetermined pressure; and a check valve on said supply connection to prevent a back flow from the chamber to the supply connection.

51. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with the liquid from the lift; the combination with a connection for supplying actuating fluid; mechanism controlling said connection; and a relief valve arranged on said connection, said relief valve being normally open to the atmosphere and adjusted to close at the pressure of actuating fluid and to open when the pressure in the connection has reached a predetermined lower pressure.

52. In an apparatus for actuating liquids by a following action of an actuating fluid in contact with the liquid from the lift, the combination with a connection for supplying actuating fluid; mechanism controlling said connection; and a relief valve arranged on said connection, said relief valve being normally open to the atmosphere and adjusted to close at the pressure of actuating fluid and to open when the pressure in the connection has reached a predetermined lower pressure; and means for adjusting said valve to open at different pressures.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

RUDOLPH CONRADER.

Witnesses:
H. C. LORD,
M. C. SULLIVAN.