T. O. PERRY.

PNEUMATIC PUMP OR APPARATUS FOR RAISING WATER BY MEANS OF COMPRESSED AIR.

APPLICATION FILED APR. 12, 1907.

939,307.

Patented Nov. 9, 1909.

4 SHEETS—SHEET 1.

Fig. 2

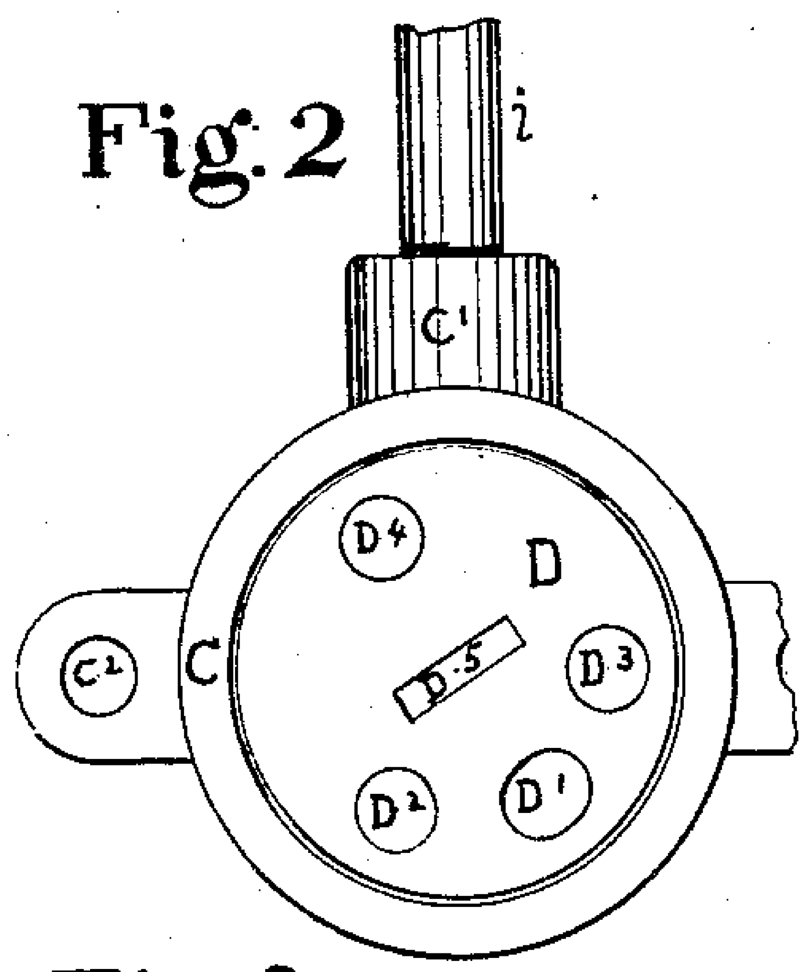
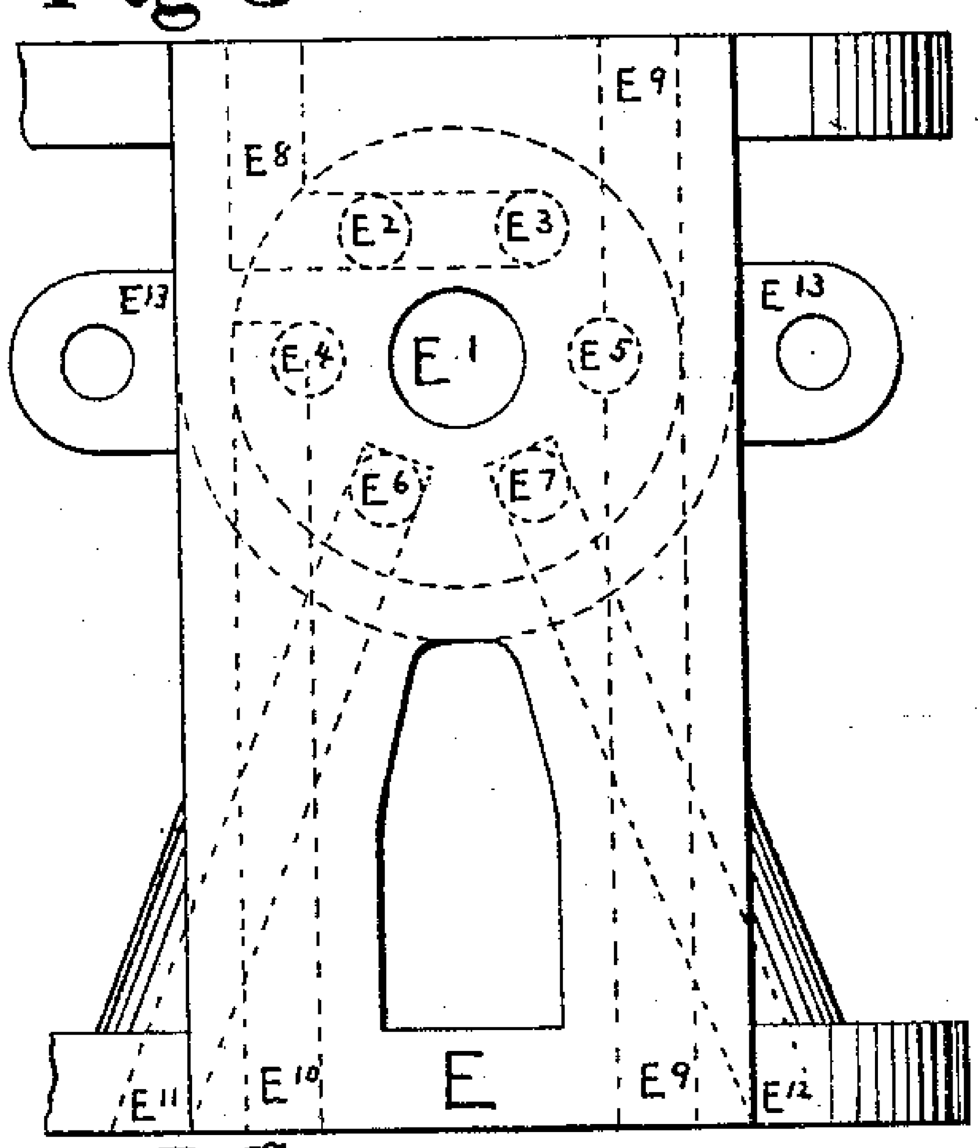


Fig 3



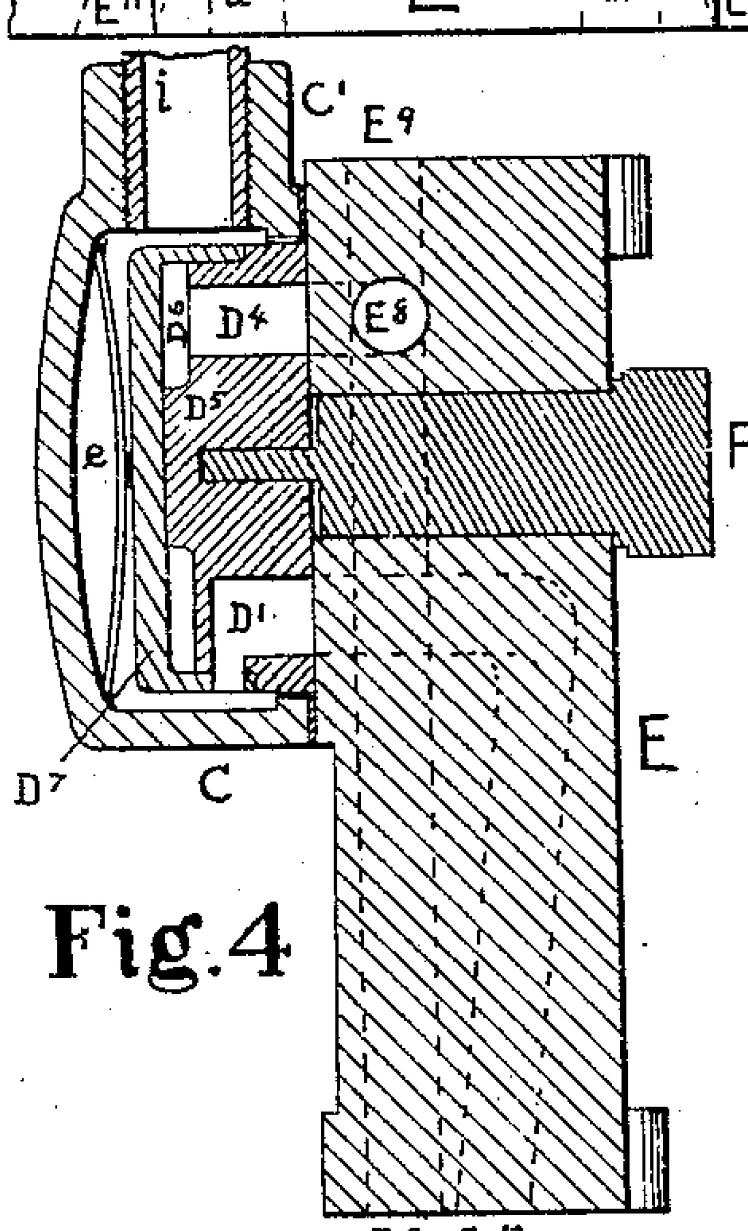


Fig. 4

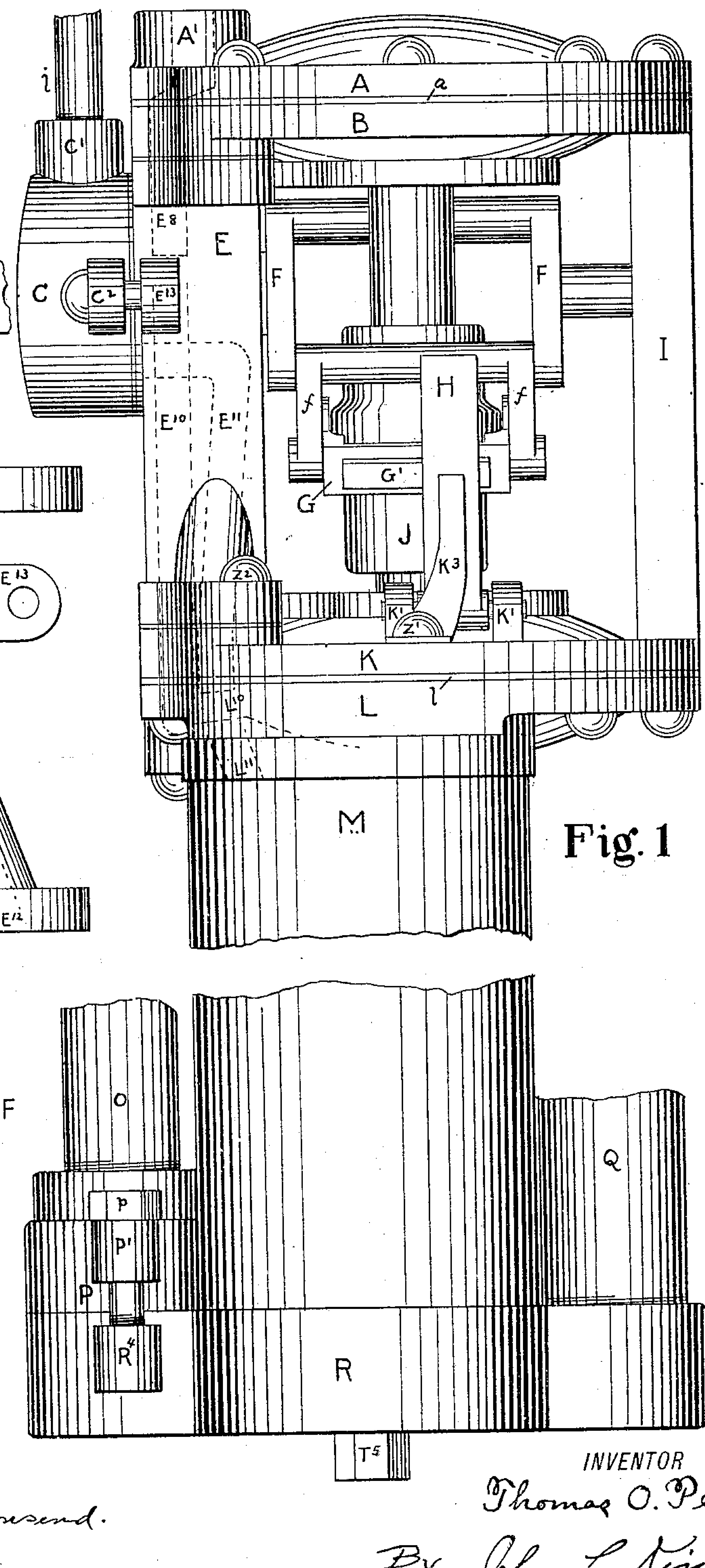


Fig. 1

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Fig. 5

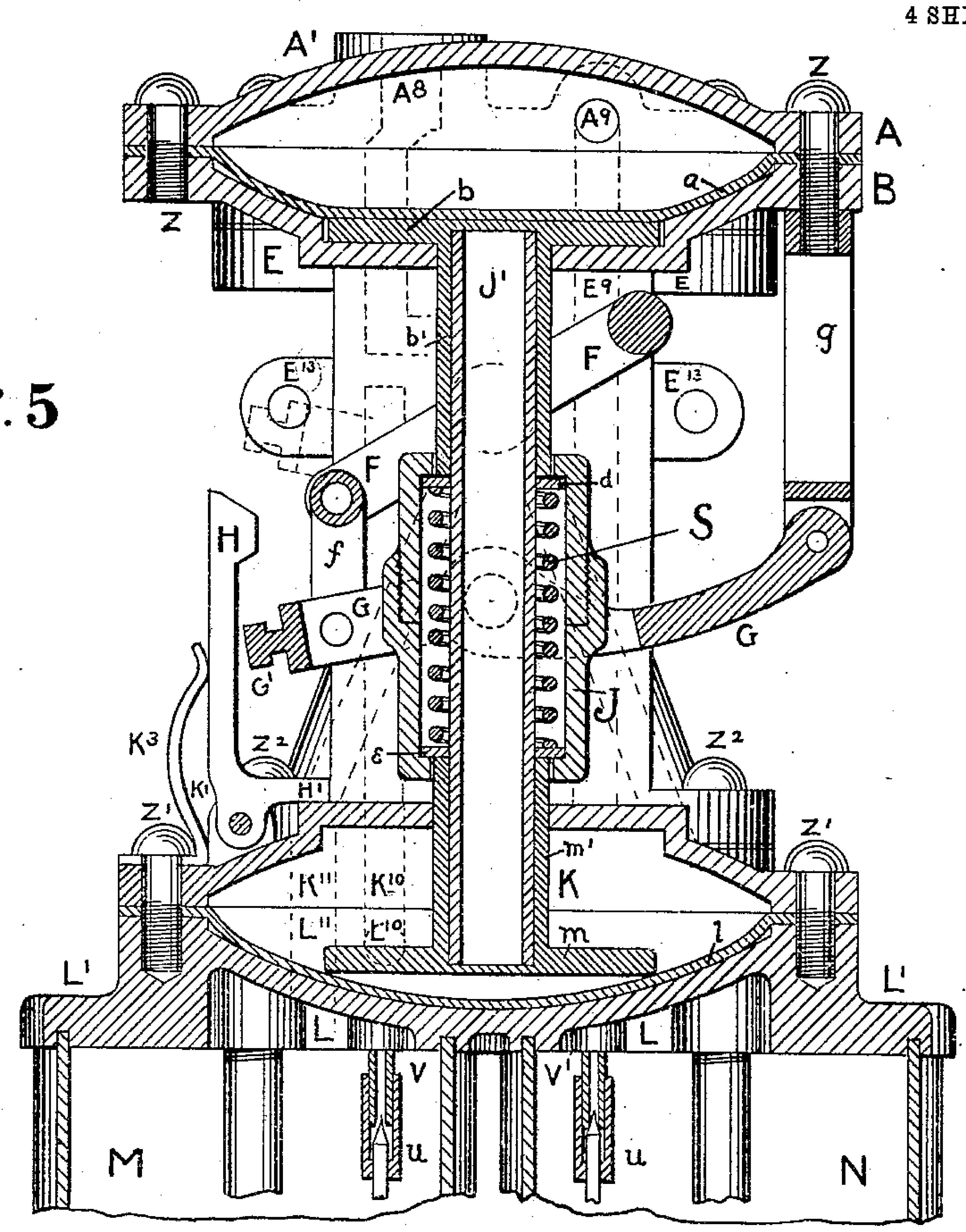
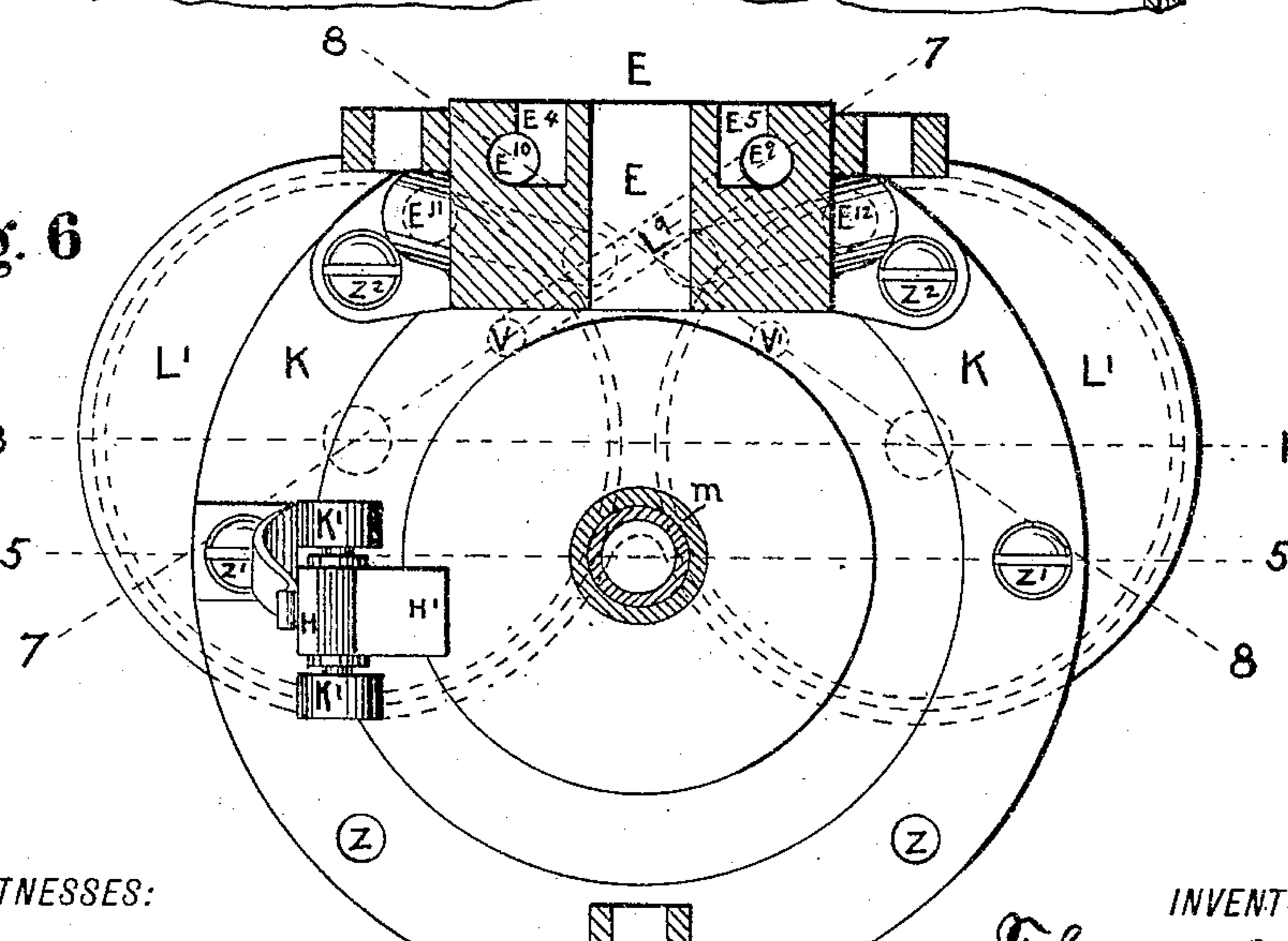


Fig. 6



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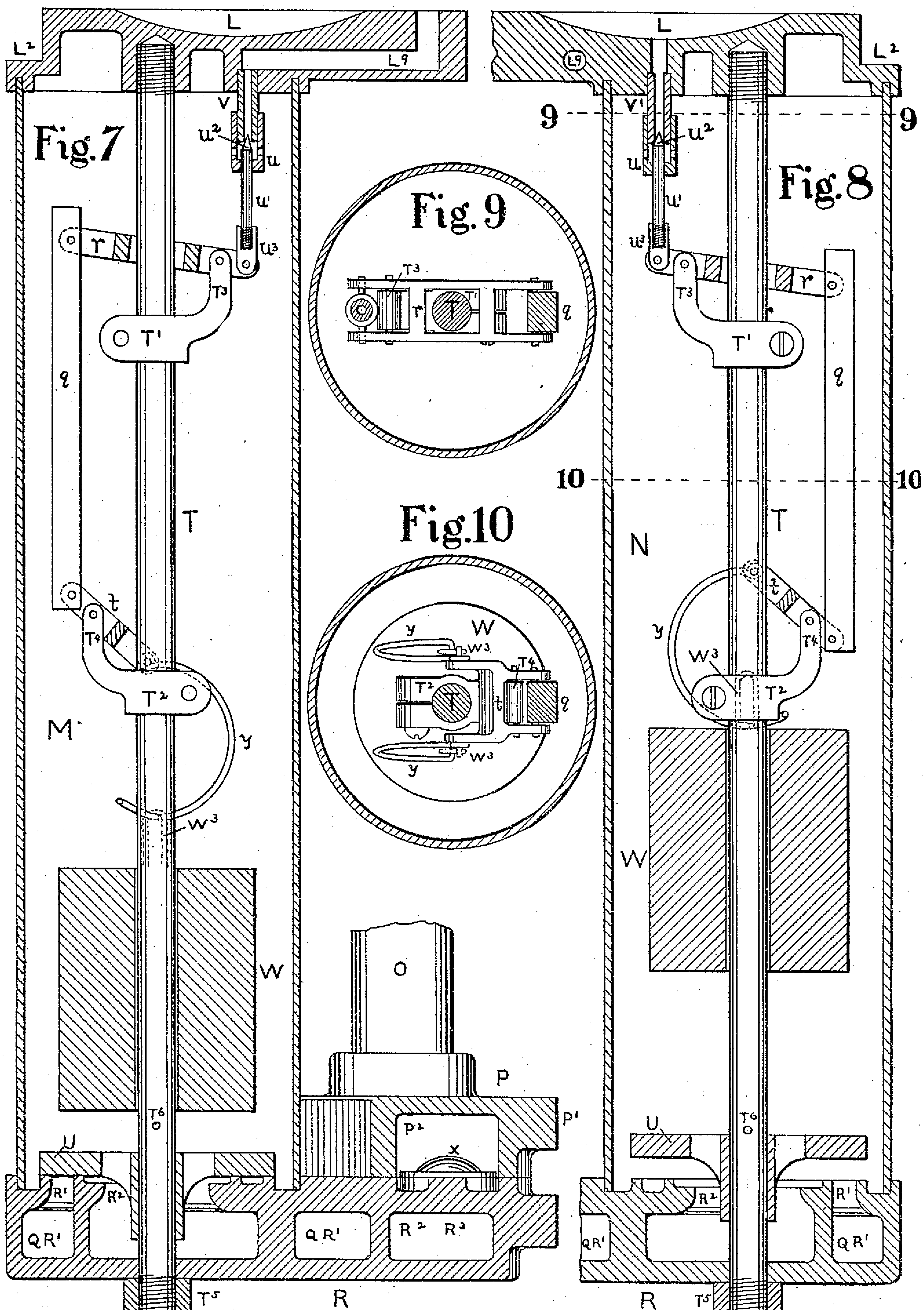

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4 SHEETS—SHEET 4.

Fig. 11

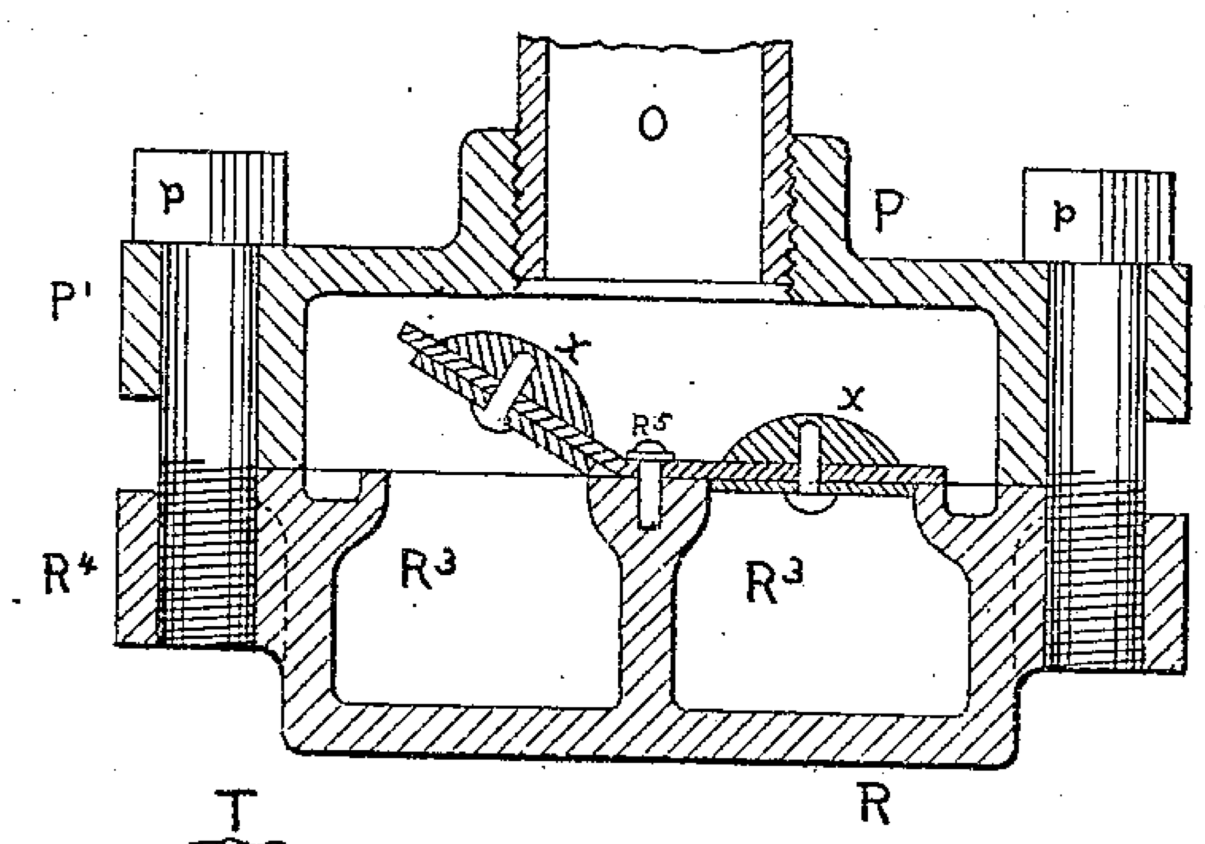


Fig. 12

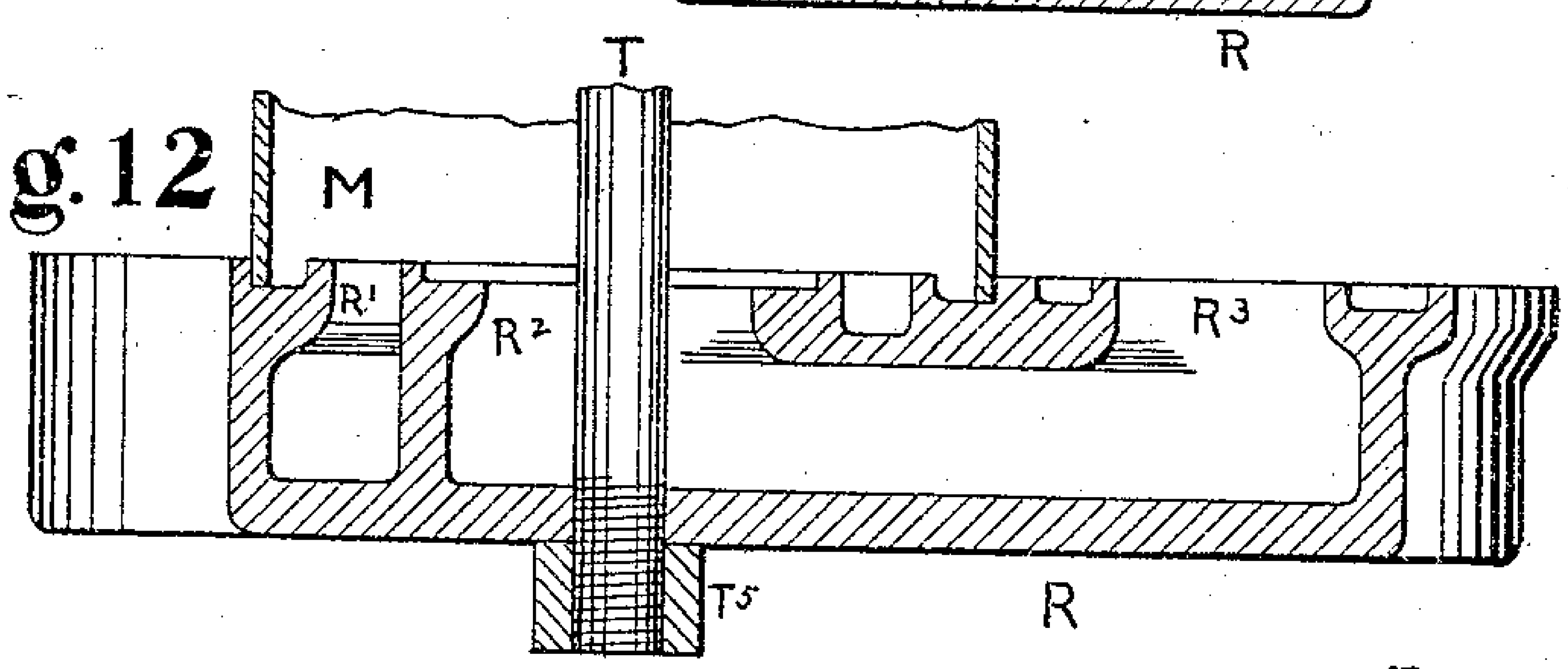


Fig. 13

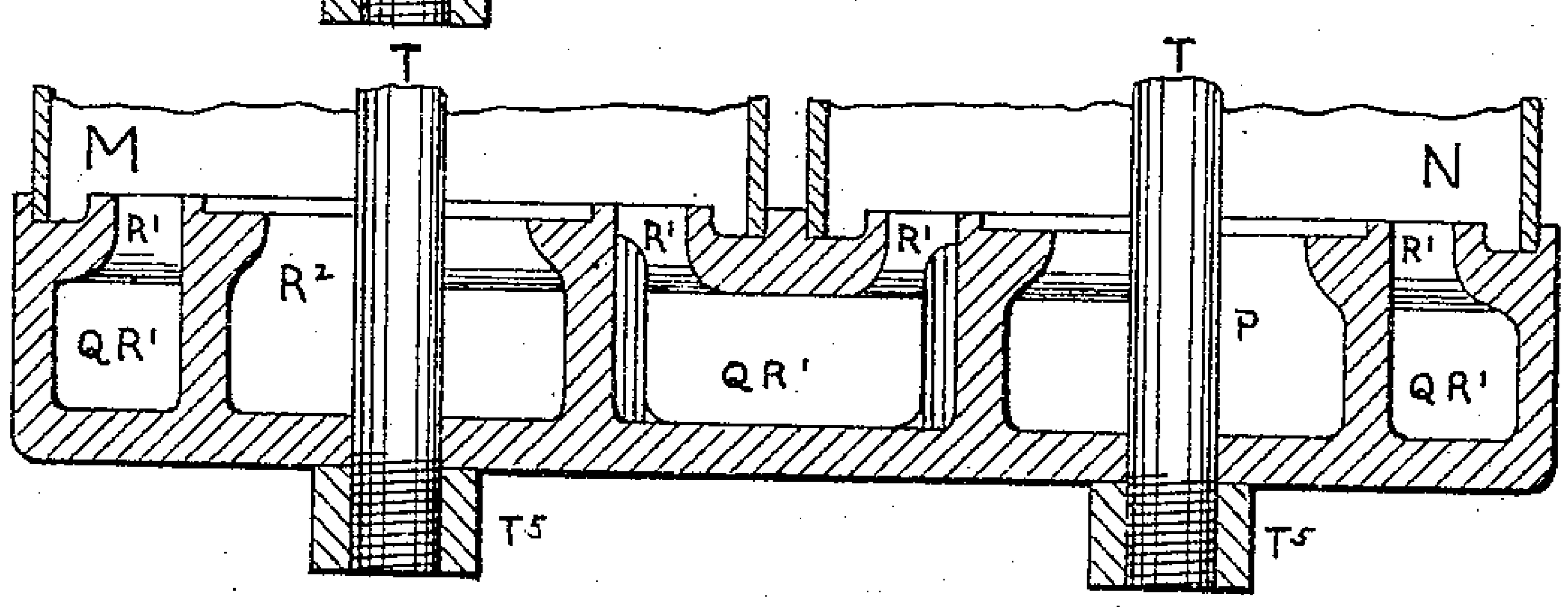
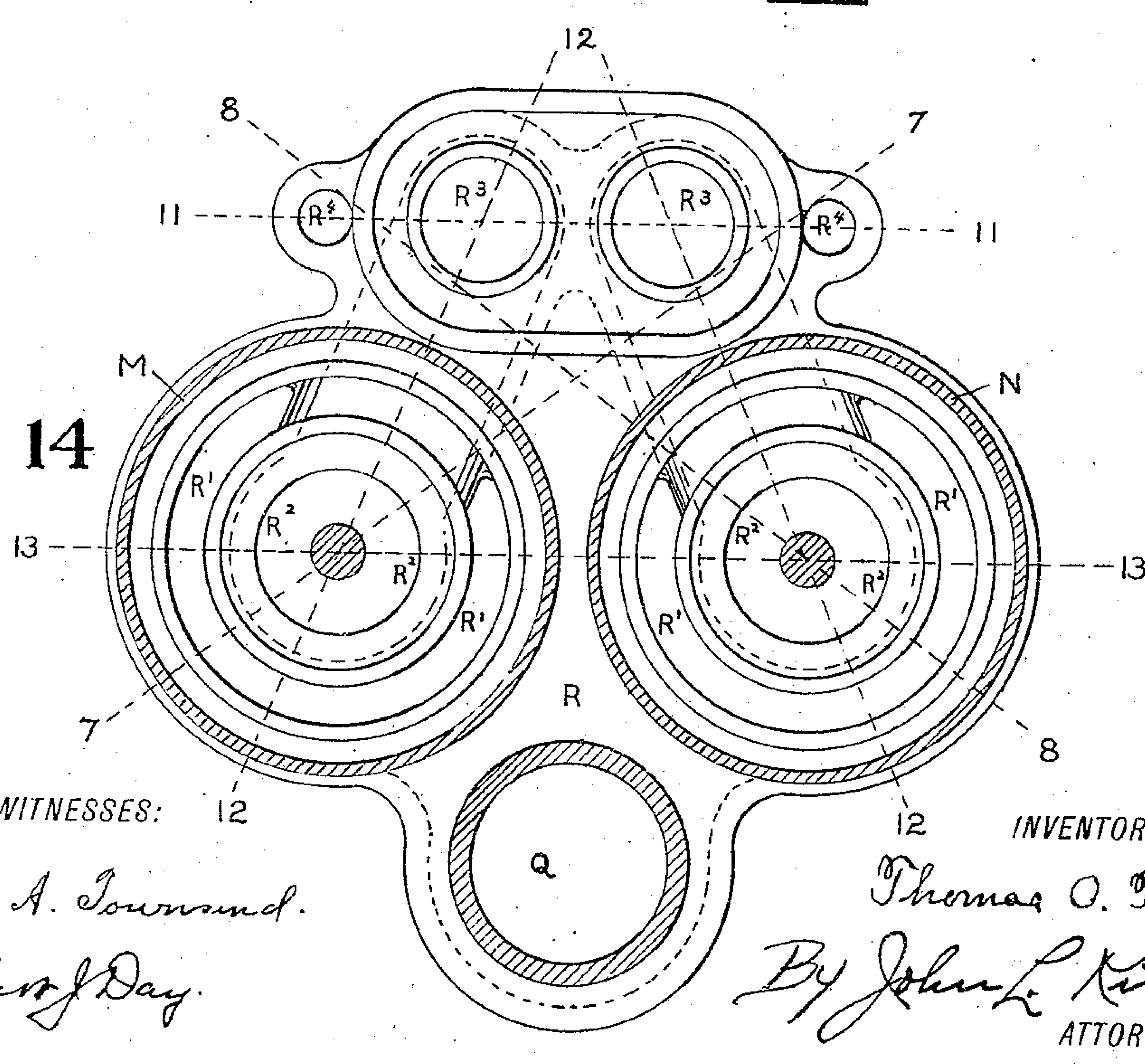


Fig 14



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UNITED STATES PATENT OFFICE.

THOMAS O. PERRY, OF CHICAGO, ILLINOIS.

PNEUMATIC PUMP OR APPARATUS FOR RAISING WATER BY MEANS OF COMPRESSED AIR.

939,307. Specification of Letters Patent. **Patented Nov. 9, 1909.**

Application filed April 12, 1907. Serial No. 367,864.

To all whom it may concern:

Be it known that I, Thomas O. Perry, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Pneumatic Pump or Apparatus for Raising Water by Means of Compressed Air, of which the following is a specification.

My invention relates to improvements in pneumatic pumps in which air under tension is made to act directly against the water to be elevated, expelling it from a pair of closed chambers which require to be alternately filled and emptied; and the objects of my improvements are, first, to provide positive and efficient means for automatically operating an air valve which controls the alternate admission and escape of air to and from the pair of closed water chambers; second, to effect a complete emptying and refilling of each water chamber without waste of air or undue diminution of the chamber capacity due to premature action of the air valve in either direction; and, third, to obtain abundance of power for operating the automatic air valve without excessive enlargement of the pump, thereby saving cost of material and making it feasible to operate the pump in restricted spaces.

I attain these objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is an exterior view, in elevation, of the entire pump, which for convenience may be called a side view; Fig. 2 is a view showing the interior face and ports of the air valve and its inclosing casing as projected to the left from Fig. 1, and may be termed a rear view; Fig. 3 is a rear view of the valve seat against which the air valve rocks, showing positions of the ports on its face in dotted circles, and its interior ducts in dotted lines; Fig. 4 is a vertical longitudinal section through the air valve, valve casing and valve seat taken in the plane of the axis of the valve and showing the valve turned half way between its extreme working positions; Fig. 5 is a vertical sectional rear view of the upper portion of the pump taken in a plane indicated by the broken line 5—5 on Fig. 6; Fig. 6 is a sectional plan of the pump taken through the axis of the air valve, but omitting the valve and various other parts; Fig. 7 is a longitudinal section of one of the water chambers taken through its vertical axis in a plane indicated by the broken line 7—7 on Figs. 6 and 14; Fig. 8 is a longitudinal section of the other water chamber taken through its vertical axis in a plane indicated by the broken line 8—8 on Figs. 6 and 14; Fig. 9 is a sectional plan of one of the water chambers taken in a plane cutting the top of the chamber at 9—9 as indicated on Fig. 8; Fig. 10 is a sectional plan of one of the water chambers taken in a plane cutting the chamber at 10—10 as indicated on Fig. 8; Fig. 11 is a vertical section through the rear of the base of the pump taken in a plane indicated by the broken line 11—11 on Fig. 14, showing the water exit and check valves; Fig. 12 is a vertical section through the base of the pump taken in a plane indicated by the broken line 12—12, on Fig. 14, showing the passage for water from one of the water chambers to one of the exit check valves; Fig. 13 is a vertical section of the base taken in a plane through the axes of both water chambers as indicated by the broken line 13—13 on Fig. 14; Fig. 14 is a plan of the base of the pump showing also in section the positions of the two water chambers.

Similar letters refer to similar parts throughout the several views.

The two cylindrical water chambers M and N are closed at the top by the chamber-cap L, common to both chambers, and at their lower ends by the common base R. Tie rods T, with nuts T^5 clamp the base and cap against the ends of the chambers. The base is a hollow casting whose interior communicates with each of the water chambers through the large outer annular openings R′, and also communicates with the water inlet Q, which may be simply an exterior opening into the base or a tubular opening of any desired form or length. Within the interior of the base, partitioned off from the rest of the interior and from each other, are two water passages connecting each of the chambers, through the central openings R^2, with two circular seats R^3 opening upward and located just back of the chambers. Check valves X cover these valve seats and are included within a single check valve casing P, with which the water delivery pipe O connects. The valve casing P is secured to the base R by cap-screws *p*, which pass through ears P′ on the casing and screw into lugs R^4 on the base. The water inlets R′ are covered by annular ring valves U, which are limited in their lift by the stops T^6, T^6. The chambers, M and N, are supposed to be submerged in water or, if not submerged, the water inlet Q may connect with any source of water supply from which the chambers may be filled by gravity or pressure.

In order that the chambers may fill with water, provision must be made for letting the inclosed air out, and in order that water may be expelled by compressed air, provision must be made for admitting air under tension. It is required that air be admitted to and allowed to escape from the chambers alternately so that while one is emptying, the other may be refilling, to insure a continuous flow of water from the outlet. For this purpose an air valve D is located above the water chambers and is inclosed in a casing C, which is supposed to communicate with some source of compressed air through the inlet pipe *i*, which in fact may be part of a reservoir for compressed air. The air valve D is cylindrical in form and has a circular face which rests against the valve seat E against which the valve case C is clamped by screws which pass through ears C^2 on the valve case and screw into lugs E^{13} on each side of the valve seat, forming therewith a chamber inclosing the valve. A rock shaft, F, has a bearing at one end in an opening, E′, extending through the valve seat, and terminates in a rectangular tongue which fits loosely in a corresponding socket, D^5, in the center of the air valve so that the valve may be reached from without and rocked between limits. A bow spring, *c*, and also the air pressure, serves to keep the face of the valve pressed tight against the valve seat. In the face of the valve seat are six circular ports whose radial distances from the axis of rotation and whose distances from each other are all equal and whose diameters are preferably made about equal to the spaces between their circumferences. Port, E^6, leads into the interior duct, E^{11}, which extending diagonally down and toward the left communicates with chamber, M. In like manner port, E^7, communicates through duct, E^{12}, with chamber, N. Ports, E^2 and E^3 lead into duct, E^8, which turns up at the left and leads to the open air. As E^2 and E^3 communicate they are virtually one port elongated. The remaining ports and ducts in the valve seat E may be disregarded for the present. In the face of the valve, D, are four ports arranged around the axis of rotation at the same radial distances as the ports in the valve seat. Ports, D^2, D^3, and D^4 are equidistant from each other and of the same diameter as the ports in the seat, and these three ports communicate with each other, or all connect with an annular chamber, D^6, in the back of the valve. Port D^1, located between D^2 and D^3, and diametrically opposite to D^4, connects with an opening in the periphery of the valve so as to receive compressed air from the valve chamber and reservoir, *i*, and is preferably greater in diameter than the other ports.

In the position of the valve as shown, it is evident that the compressed air will enter chamber N, and drive water out through the outlet, O, because inlet port, D, registers with port, E^7. At the same time exhaust port, D^2, registers with port, E^6, and allows air to escape from chamber M, so that water may enter. Now if the air valve be rocked so as to make inlet port, D′, register with port, E^6, an exhaust port, D^3, will register with port, E^7, and the action as respects chambers M and N will be reversed. It may be noticed that in either position of the air valve, exhaust ports, D^4, will connect with the open air through either ports, E^2, or E^3. So, in order to keep a continuous stream of water flowing from the pump, it is only necessary to rock the air valve from one working position to the other at intervals, before either water chamber is entirely emptied. It remains to make this action automatic; and for this purpose two pistons, or preferably flexible diaphragms, *a* and *l*, are horizontally located, one above and the other below the rock shaft, F. The peripheries of these diaphragms are clamped against the castings, A and L, concavo-convex in form, with their concavities facing toward the diaphragms. The cap, L, which closes the tops of the water chambers, is made with a concavo upper surface and serves as one of those castings. A closed space is formed between the diaphragm and casting in each case.

The clamp castings, B and K, which clamp diaphragms, *a* and *l*, by means of screws, Z, Z′, piercing their peripheries and screwing into castings, B and L have large circular recesses. The valve seat, E, is extended vertically up and down, expanded at its upper and lower ends, and clamped between the clamping castings, B and K, at the rear of their peripheries by binding screws, Z^2. The center of diaphragm, *a*, rests against a disk, *b*, large enough to nearly fill the circular recess in casting, B, and in like manner disk, *m*, comes in contact with diaphragm, *l*. Attached to the center of disk, *m*, and extending upward is a tube, *m′*. A similar tube, *b′*, is attached to and extends downward from the disk, *b*. Tubes *m′*, and *b′* telescope loosely over opposite ends of a connecting tube, J′, and are also guided and free to slide loosely through openings in castings B and K. Midway between the two diaphragms, fulcrumed on a hanger *g*, extending from the side of casting, B, is an auxiliary lever, G, made in the form of an irregular ring, inclosing a cylindrical cage, J, pivotally connected therewith on opposite sides. The cage, J, in turn surrounds the tube, J′, and has at each end narrow internal flanges between which and the tube there is considerable annular space. Two washers, *d*, *e*, fitting loosely within the cage and also loosely fitting around the tube, J, are normally thrust apart against the interior flanges at each end of the cage by helical spring, S. The tubes, *b′*, *m′*, are adapted to engage the washers, *d*, *e*. A link, *f*, connects the auxiliary lever, G, with an arm projecting at right angles from the axis of the rock shaft, F, which is located above by reason of the valve seat, E, having its lower exceed its upper extension in length. In order to give the rock shaft greater stability, it is bent around the cage and has a bearing also in a pillar, I, which unites the castings, B and K, on the side opposite from the valve seat, E. By using two links, *f*, united by a sleeve to connect the auxiliary lever, G, with the rock shaft, F, the former also is held from any tendency to tip sidewise. For convenience of construction, the cage, J, is made in two parts, the upper part being screwed into the lower. After either of the washers, *d* or *e*, is pushed in toward the other against the motive spring, the recoil of the spring is eased by the outward movement of the washer, after the manner of a loose piston in a cylinder, creating a partial vacuum within the annular space containing the spring. Also, water must be expelled through the narrow annular openings between the end of the cage and the tubular plungers, *b′* or *m′*, causing additional retardation to the movement of the piston washer when the spring recoils.

In addition to the air ducts already described, the valve seat, E, has a vertical duct, E^9, extending its entire length, communicating through the rim of casing, B, with the space inclosed between diaphragm, *a*, and casting, A, and also connecting through the rim of casting, K, and duct, L^9, with a small nozzle, V, reaching down into chamber, M. This duct, E^9, also connects with the port, E^5, in the face of the valve seat. Another valve seat port, E^4, opens into a vertical duct, E^{10}, leading down through the rim of casting, K, to the space inclosed between diaphragm, *l*, and cap, L. This space between L and *l* also connects directly with chamber, N, through the small nozzle, V′, which is similar in the form and position to nozzle, V, in chamber, M. These small nozzles are closed by pointed conical valves, u^2, terminating the upper ends of small valve rods, *u′*, and interiorly attached to the lower ends of perforated guide sleeves, *u*, which loosely receive and guide upon the nozzles. On the lower ends of each valve rod is screwed an adjustable connection, u^3, pivoted to one end of a multiplying lever, *r*, whose other end has pivotal connection with a link, *q*. Between the extremities, in proximity to connection, u^3, lever, *r*, is pivoted on the fulcrum arm, T^3, extending from the fulcrum support, T′, which is attached to the tie rod, T. Link, *q*, also has pivotal connection with one end of second forked lever, *t*, whose other end has pivotal connection with the bow spring link, *y*. Between its extremities lever, *t*, is pivoted on the fulcrum arm, T^4, extending from the fulcrum support, T^2, which is attached to the tie rod, T. The lower end of link, *y*, connects with the float, W, by passing loosely through the staples, W^3, driven into the top of the float which is guided on the tie rod, T, and is limited in its upward movement by the fulcrum support, T^2. Link, *q*, is made of heavy material so as to counterbalance a portion of the weight of the float, W, and is assisted as a counterweight by the long arm of lever, *r*. For it is difficult to find any material sufficiently light for a float and which is sure never to become water-logged in water subjected to severe pressure. On account of the great pressure also, a hollow metal float can not well resist being crushed.

Also the frequent recurrences of great external pressures, as frequently succeeded by great reductions of pressure, subject the float to alternating contracting and expanding forces, which tend to crack the walls of a hollow float and cause leakage, even if otherwise such a float could withstand the exterior pressure and yet be sufficiently buoyant without a counterweight. A hollow float would need to be perfectly air tight, since otherwise its buoyancy would be affected by admission of water. In order to secure unchangeableness of buoyancy, the float apparently needs to be of solid substance, impervious to water or air, and as no such material unchangeable in water is available, whose specific gravity is materially less than that of water, it becomes necessary to counterbalance a portion of the float's weight. The counterbalancing weights, *q*, *q*, being inside of the chambers, M, N, need to be of great specific gravity relatively to the density of the floats, in order to hold the vent valves, u^2, firmly closed when submerged in water. The vent valves are seated with greater force by reason of their being fully closed before the water rises in the chambers sufficiently to submerge the counterweights, which, notwithstanding their reduced weight in water, still suffice to hold the vent valves to their seats and prevent leakage after they are once tightly closed.

One of the greatest troubles attending the action of floats required to operate valves in pneumatic pumps, especially when the supply of compressed air is dependent upon a windmill, is caused by a tendency of the float operated valve to stick to its seat after intervals of long disuse as when the wind ceases to blow sufficiently for hours or even days. Also where other motive power is used for compressing air, the pump is liable to have protracted periods of rest. This liability of the valve to adhere to its seat after long periods of rest is greatly reduced by relieving the pressure against the seat after the valve is first firmly seated. The sticking appears to be due in most cases to slowly formed cementation between surfaces too tightly pressed together in the presence of moisture.

Other advantages derived from counterbalancing the floats by submergible weights and connections within the water chambers are compactness, avoidance of packing glands, and reduction of pivotal friction which the addition of counterweights naturally augments. The pivotal connections between counterweights and levers are constantly lubricated by the water, a matter of considerable importance, with small floats made of heavy material such as must be used to secure absolute impermeability and durability under great pressure. Moreover, the small and delicate needle valves intended to be used in my device in which an exceedingly slight area is covered and but an inappreciable movement required, renders it impossible to utilize a counterweight outside of the chamber.

The mechanism so far described is sufficient to render the pump automatic and effectively operative under ordinary conditions.

The operation is as follows: To start with, both water chambers, being immersed, are supposed to be full of water, as they surely will be if the air in them is first allowed to escape, either by rocking the air valve or by letting the air off through the auxiliary pet-cock placed anywhere on the inlet air pipe, *i*. In the position shown in Figs. 1 and 2, the valve, D, admits compressed air to chamber N, expelling water therefrom until it is nearly emptied or until the float, W, descends and pulls open the vent valve, u^2, by way of which air is admitted below diaphragm, *l*, forcing up the disk, *m*, and rocking the valve, D, to the reversed position already described. In this supposed operation the motive spring, S, was not called into action and for present purposes the loose washers, *d* and *e*, may be regarded as fixed heads at top and bottom of cage, J, just as they are in effect when the motive spring simply holds them in their normal positions against the internal flanges of the cage. The valve, D, being reversed, admits compressed air to the other chamber, M, and allows air to escape from chamber, N, so that it may refill with water while chamber M, is being emptied. The reversal of valve, D, also lets the air escape from below diaphragm, *l*, through ports, E^4 and D^2, which, by reversal, were made to register with each other, and the diaphragm then is restored to its normal initial position by external water pressure. Before reversal the port E^4, was closed by the valve, D, as shown. The action in chamber, M, is precisely the same as in chamber, N, except that the opening of the vent, u^2, by the float admits air above diaphragm *a*, forcing down the disk, *b*, and again reversing the valve, D, so as to readmit air to chamber, N, and let air escape from chamber, M. Air escapes from beneath diaphragm, *l*, through the registering together of ports E^4 and D^2 at the same time that it escapes from chamber, N, through the ports E^7 and D^3. Thus, the reversal of valve, D, occurs whenever the float in either water chamber falls by reason of the water being almost entirely excluded.

While the action of the pump as described is ordinarily sure and satisfactory, there are two known conditions under which failure may occur. The height to which the water is to be elevated may be assumed to insure sufficient air tension to effectively operate the air valve, or, say, as much as ten pounds to the square inch. But much less than eight or ten pounds pressure may fail to completely effect reversal, and still further reduction of air pressure will rock the valve less and less until it barely moves a little each way from the exact intermediate position, and may even finally stop there where it either equally admits air to both water chambers or not at all. From this neutral position of the air valve the pump may not always again be started by simply increasing the air pressure, and it would seem as though it might even be necessary to shift the valve once by hand in order to restart the pump. This manner of possible failure might occur with inconvenient frequency when a windmill is depended upon to maintain the supply of compressed air; and as it is expected that this pump will be especially and chiefly useful in connection with wind power, it is needful to apply a remedy for this defect. The other condition of possible failure is when a leakage of air past the vent valve, u^2, or due to defect in the valve, D, or otherwise, allows a premature accumulation of air behind either diaphragm and rocks the air valve so slowly that it halts in its neutral position. A slow leak, such as might otherwise be tolerated, would not have time to cause failure in this manner, when the pump is working normally under ample air pressure, but might cause failure when the compressed air supply comes very slowly direct from a compressor operated by a windmill. Or, when the air supply is drawn from a storage reservoir and the flow of water from the pump is shut off, when not needed, by closing a cock in the water outlet, leaving the air inlet to the pump constantly open, failure might follow a slow accumulation of air back of either diaphragm.

In order that failure may never occur from the two mentioned causes, the motive spring, S, is provided to act in conjunction with lever, G, whenever air is admitted behind the diaphragms, in conjunction with a retarder, H, which is hinged between ears, K′, projecting from the side of casting, K, directly below the projection, G′, that protrudes from the auxiliary lever, G, so as to encounter the slanting shoulders of the retarder in both directions of its reversing movement. The slanting shoulders are adapted to retard the reversing movement of lever, G, just before its midway position is reached where the function of the air valve would be neutral, by reason of being pressed against the projection, G′, by the obstructing spring, K^3. A short horizontal arm, H′, limits the inward movement of the retarders by contact with casting, K. The result of this obstruction is to cause a compression of motive spring, S, until sufficient tension accumulates to overcome the obstruction, when the recoil quickly sends the air valve past its neutral position. If the increasing tension of the motive spring should not suffice to overcome the obstruction of the slanting shoulders, the obstruction would be overcome by reason of the closing together of the coils of the spring. And should the motive spring be too stiff to yield at all, the obstruction would cause an accumulation of compressed air against the diaphragm, *a*, or *l*, until the increasing air tension would overcome the obstruction, when the rebound due to the elasticity of the air would send the air valve quickly past its neutral position. In this case the action would be the same as if the washers, *d* and *e*, were immovable with reference to the cage, J. Thus it appears that the motive spring may be dispensed with if the compressed air has sufficient space in which to accumulate back of the diaphragms. Unnecessary space and waste of air are avoided by using the motive spring. It is only necessary that lever G be obstructed before the air valve is rocked through half of its total movement. Under normal conditions the air valve will be carried completely and promptly to the limit of its angular movement independently of the action of the retarder and motive spring, and these auxiliaries meet all requirements if they prevent the air valve from stopping where its relation to the two water chambers is exactly neutral.

The term "pneumatic pump" is used to designate an apparatus for raising water or other liquids by means of compressed air or other gaseous fluids.

In my copending application, Serial No. 203,228, filed April 14, 1904, I have claimed generally a "float" in combination with two water chambers having outlet and inlet valves, a reversible air valve adapted to admit and exhaust air to and from the chambers, main inlet and exhaust ports to said water chambers controlled by said air valve, auxiliary air vents to said water chambers controlled by said vent valves and a motor operated by compressed air for reversing the air-valve in either direction. In the present case I have added, in connection with the float, the counterbalancing elements shown and described, and therefore do not wish to be understood as making claim to a float except in combination with said counterbalancing elements; nor, do I wish to be understood as claiming a float in combination with a counterbalancing weight generally, inasmuch as such a combination is old in the art, but

What I do claim and wish to secure by Letters Patent is:—

1. The combination with two water chambers having inlet and outlet water valves, a reversible air valve adapted to admit and exhaust air to and from said water chambers, main air inlet and exhaust ports controlled by said air valve, a motor operable by compressed air adapted to reverse said air valve in either direction, auxiliary air vents in said water chambers, vent valves adapted to open and close said vents and counteracting air ducts leading to said motor from said air vents, of floats located in said water chambers in operative connection with said vent valves to open and close said air vents when water is discharged from and admitted to the chambers, and counterweights within said water chambers above the level of said floats to counterbalance a portion of the weight of the floats to cause a maximum pressure to be exerted upon the valves at the instant of closure and then to reduce said pressure.

2. The combination with two water chambers having inlet and outlet water valves, a reversible air valve adapted to admit and exhaust air to and from said water chambers, main air inlet and exhaust ports controlled by said air valve, a motor operable by compressed air adapted to reverse said air valve in either direction, auxiliary air vents in said water chambers, vent valves adapted to open and close said vents, and counteracting air ducts leading to said motor from said air vents, of floats in said water chambers adapted to open and close said air vents when water is discharged from and admitted to the chambers, and counterbalancing lever connections within said chambers between said floats and vent

valves to counterbalance a portion of the weight of the floats and impart a maximum initial pressure thereupon.

3. The combination with two water chambers having inlet and outlet water valves, a reversible air valve adapted to admit and exhaust air to and from said water chambers, main air inlet and exhaust ports controlled by said air valve, a motor operable by compressed air adapted to reverse said air valve in either direction, auxiliary air vents in said water chambers, vent valves adapted to open and close said vents, and counteracting air ducts leading to said motor from said air vents, of floats in said water chambers for opening and closing said air vents when water is discharged from and admitted to either of said chambers, and compound levers intervening between said valves and floats, said levers being provided with counterbalancing elements located within said chambers above the level of said floats to counterbalance a portion of the latter and vary the pressure thereon.

4. The combination with two water chambers having inlet and outlet water valves, a reversible air valve adapted to admit and exhaust air to and from said water chambers, main air inlet and exhaust ports controlled by said air valve, a motor operable by compressed air adapted to reverse said air valve in either direction, auxiliary air vents in said water chambers, vent valves adapted to open and close said vents, and counteracting air ducts leading to said motor from said air vents, of floats in said water chambers adapted to open and close said air vents when water is discharged from and admitted to the chambers, partial counterbalancing connections within said water chambers for connecting said floats and valves, the location of said connections being such that the inflowing water will first act upon the floats and then upon the connections to reduce the pressure upon the valves after the first positive impact of closure.

5. The combination with two water chambers having inlet and outlet water valves, a reversible air valve adapted to admit and exhaust air to and from said water chambers, main air inlet and exhaust ports controlled by said air valve, a motor operable by compressed air adapted to reverse said air valve in either direction, auxiliary air vents in said water-chambers, vent valves adapted to open and close said vents and counteracting air ducts leading to said motor from said air vents, of floats within said water chambers, said floats being impervious to water under pressure, and means within said chamber for partially counterbalancing said floats, said counterbalancing means being located above the level of submergence of said floats to cause the latter to exert a maximum initial pressure in closing the valves and then to reduce said pressure to maintain the closure of the valves while preventing them from sticking to the valve seats.

6. The combination with two water chambers having inlet and outlet water valves, a reversible air-valve adapted to admit and exhaust air to and from said water-chambers, main air inlet and exhaust ports controlled by said air-valve, a motor operable by compressed air adapted to reverse said air-valve in either direction, auxiliary air vents in said water chambers, vent-valves adapted to open and close said vents and counteracting air ducts leading to said motor from said vents, of a float in each of said water chambers for opening and closing one or the other of said air-vents when water is discharged from and admitted to either of said chambers, two lever connections for multiplying the power exerted by the float to open or close the vent valve and a heavy link arranged to connect said two levers to counterbalance a portion of the weight of the float, said link being so located within said chamber as to be submerged in the inflowing water after the submergence of the float, substantially as described.

7. The combination with two water chambers having inlet and outlet water valves, a reversible air-valve adapted to admit and exhaust air to and from said water chambers, main air inlet and exhaust ports controlled by said air valve, a motor operable by compressed air adapted to reverse said air-valve in either direction, auxiliary water vents in said water chambers, vent valves adapted to open and close said vents and counteracting air-ducts leading to said motor from said air-vents, of a float in each of said water chambers for opening and closing one or the other of said air-vents when water is discharged from and admitted to either water chamber, compound levers interposed between said float and vent valves, and a connection between said levers comprising a heavy link arranged to counterbalance a portion of the weight of said float, said levers and link being inclosed within said water chamber so as to be submerged in the inflowing water, substantially as described.

8. The combination with two water chambers having inlet and outlet valves, a reversible air-valve adapted to admit and exhaust air to and from said water chambers, main air inlet and exhaust ports controlled by said air-valve, a motor operable by compressed air adapted to reverse said air-valve in either direction, auxiliary air vents in said water chambers, vent valves adapted to open and close said vents and counteracting air-ducts leading to said motor from said vents, of floats in said water-chambers for opening and closing said vents when water is dis-

charged from and admitted to the water chambers, actuating connections between said floats and said vent valves and counterweights adapted to counterbalance a portion of the weight of said floats, said counterweights being located within said water chambers so as to be submerged by the inflowing water, substantially as described.

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

THOMAS O. PERRY.

Witnesses:
JNO. B. BEAVIS,
DANL. E. BRINK.