(No Model.)

4 Sheets—Sheet 1.

T. O. PERRY.

PNEUMATIC PUMP.

No. 485,880. Patented Nov. 8, 1892.

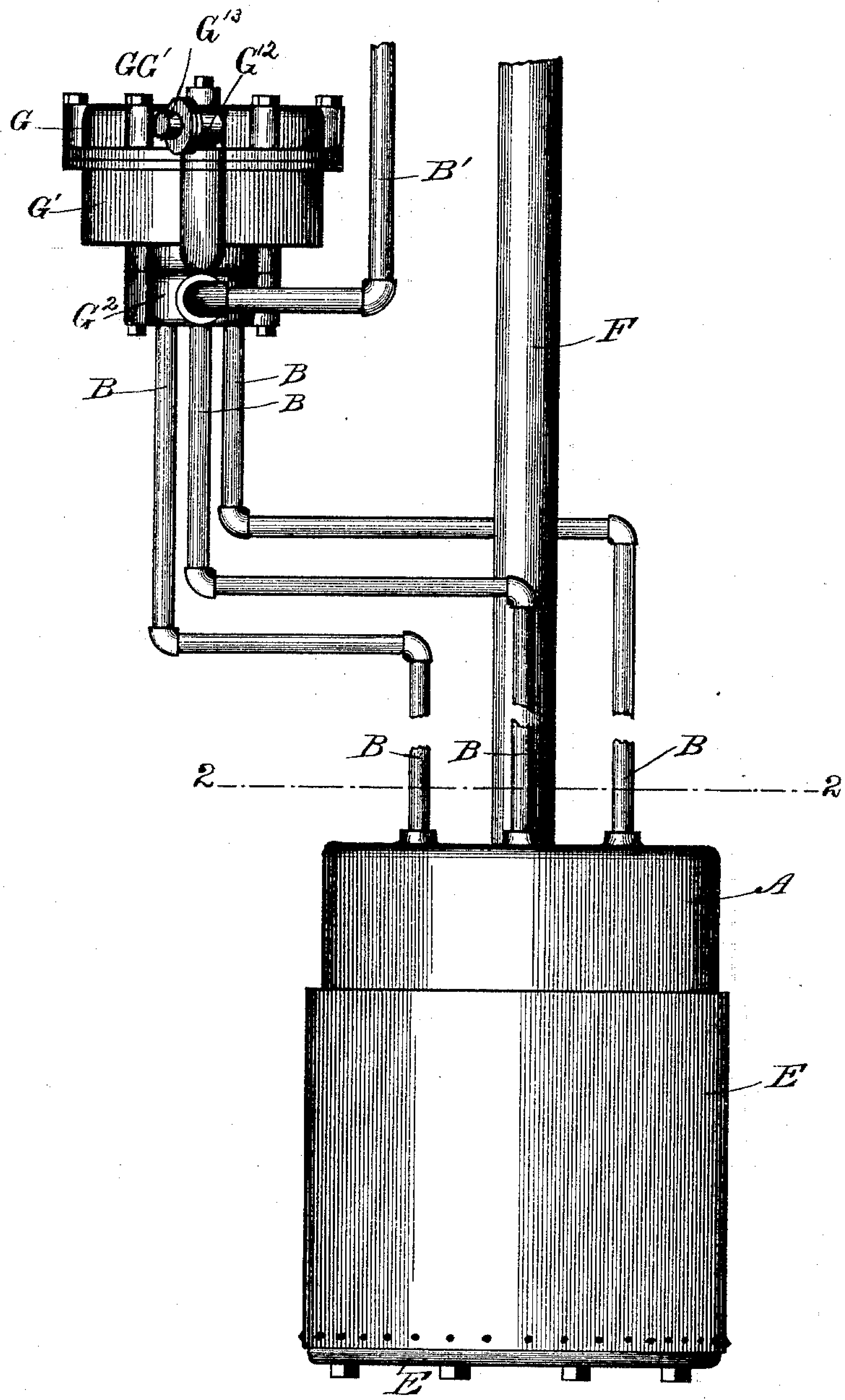

Fig 1

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(No Model.) 4 Sheets—Sheet 2.

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Fig 3

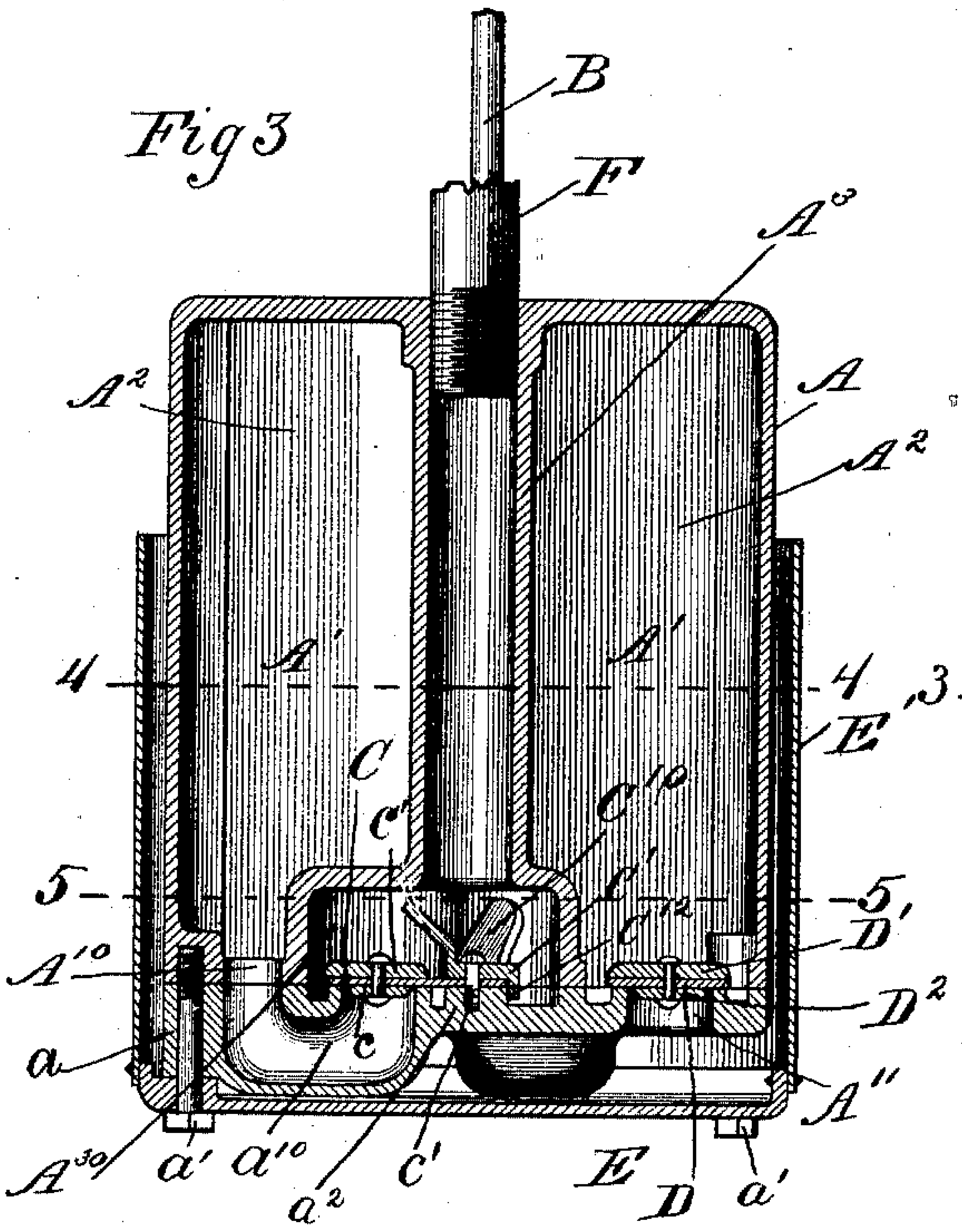

Fig 2

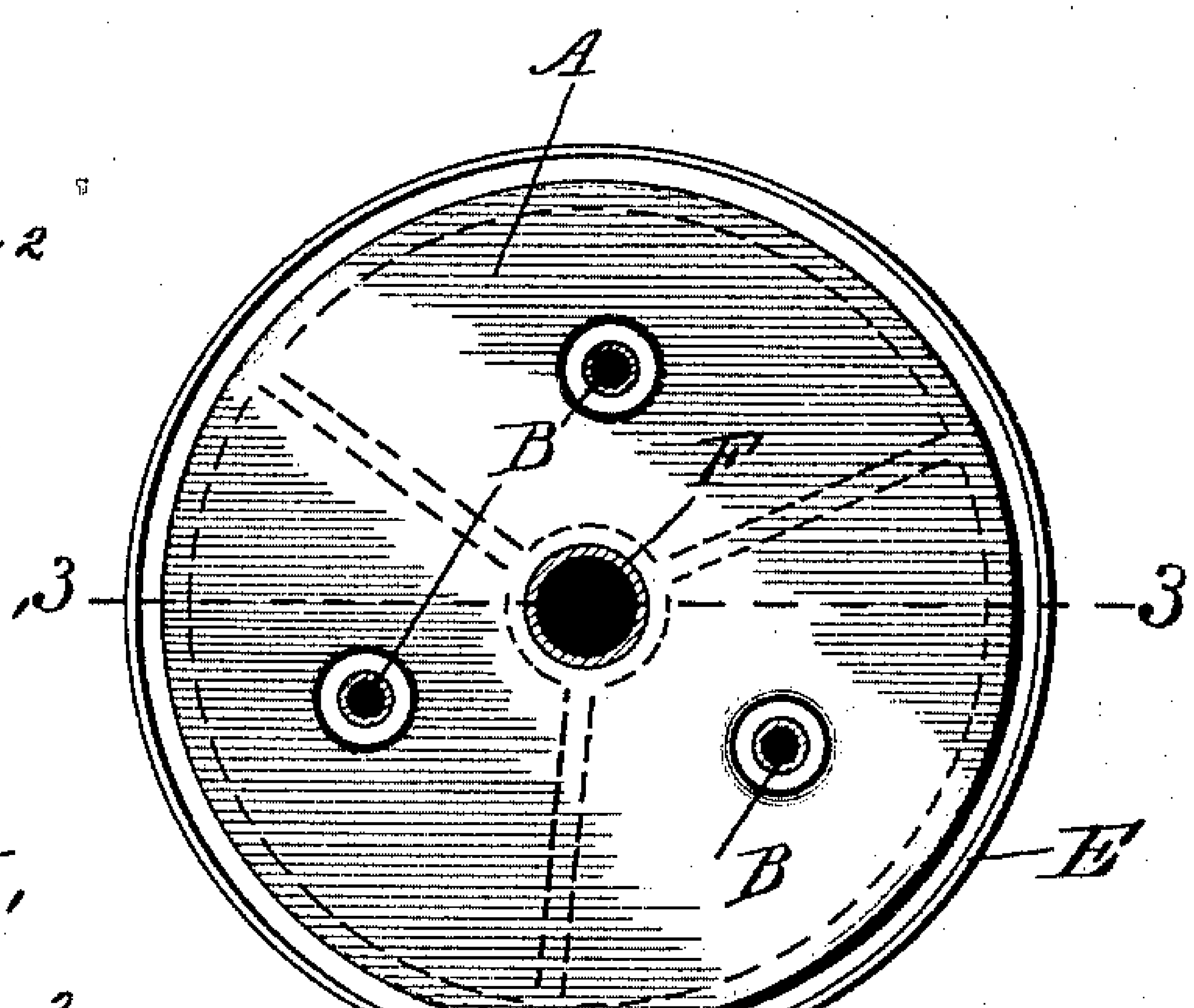

Fig 4

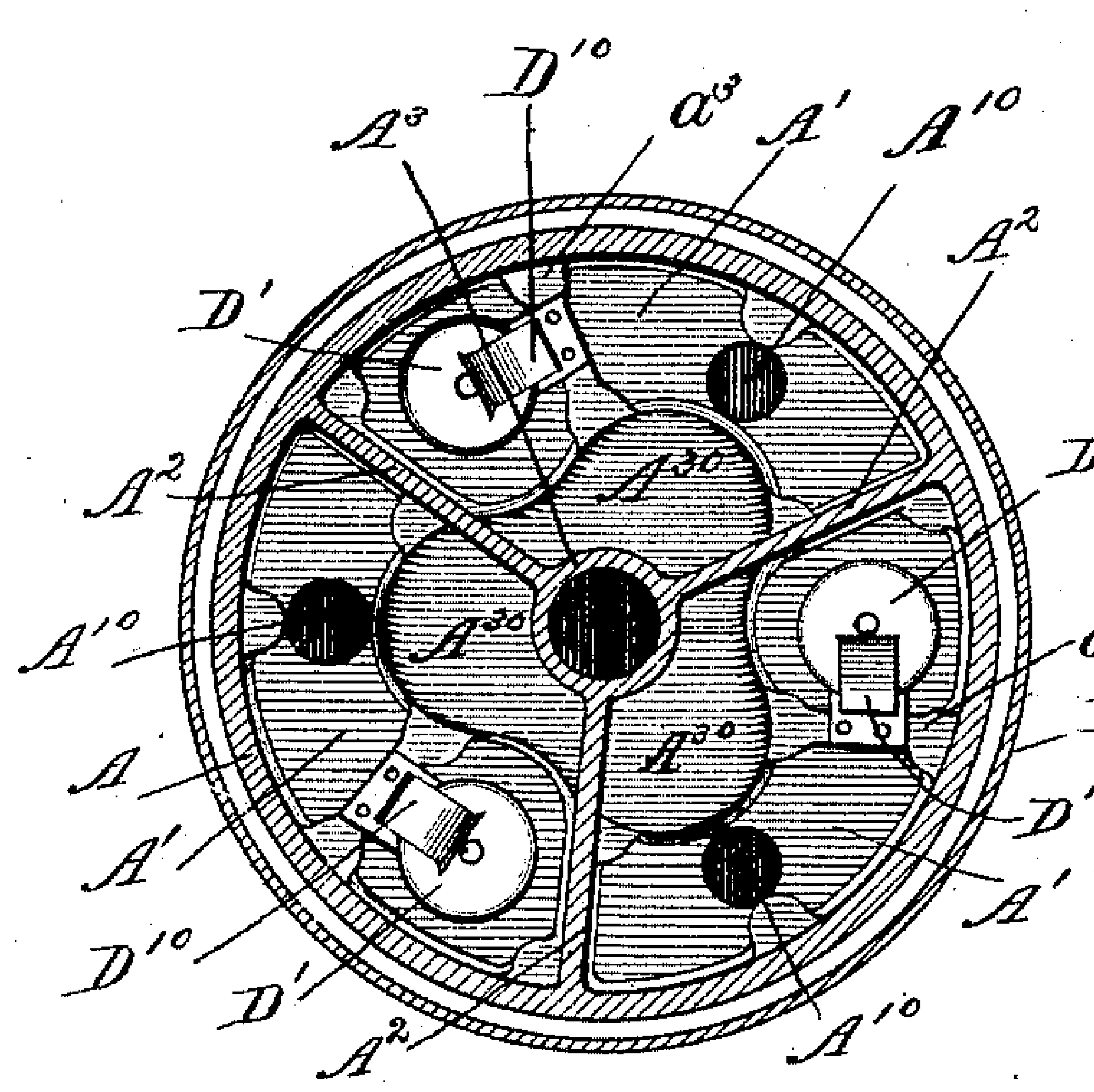

Fig 5

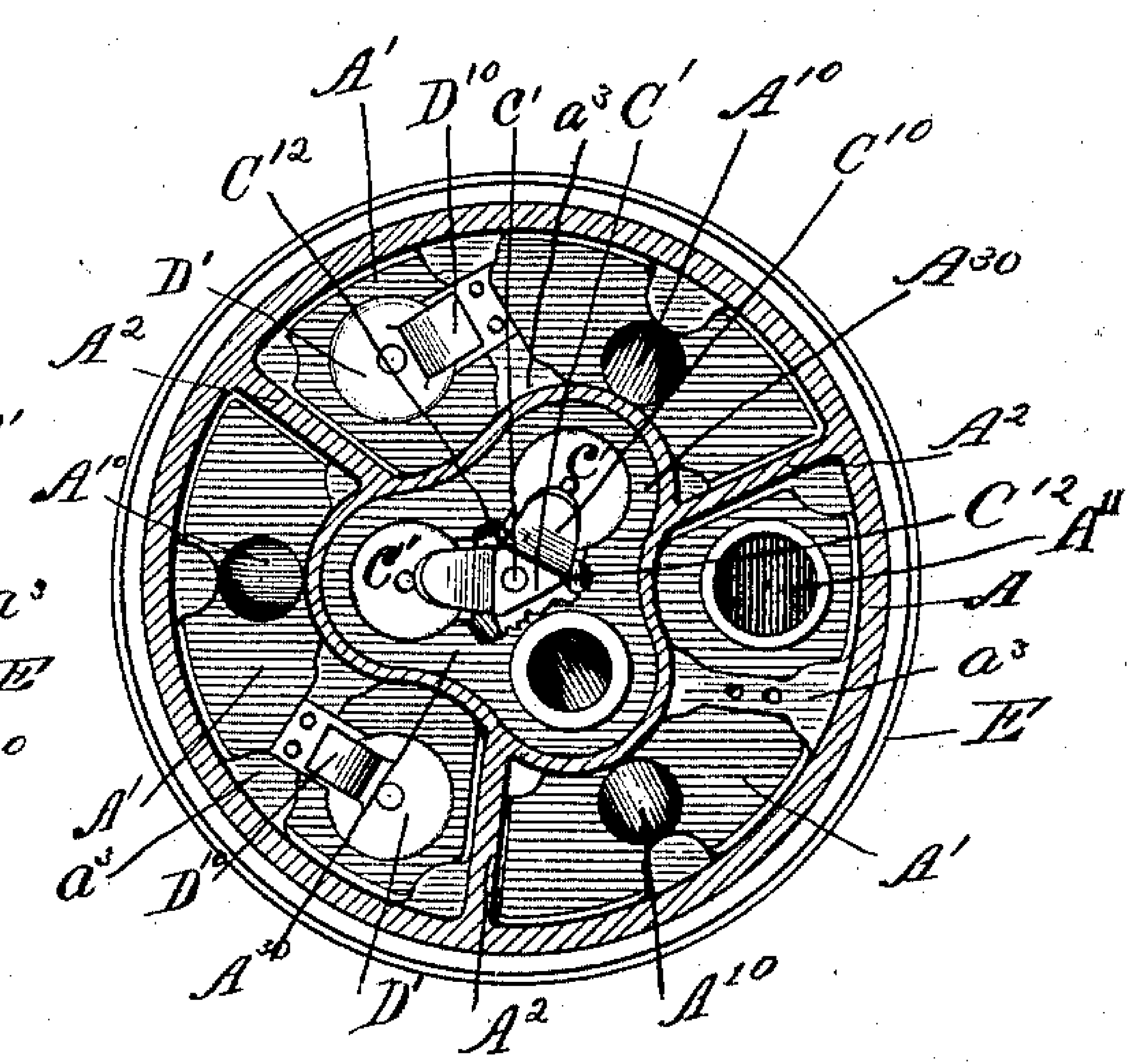

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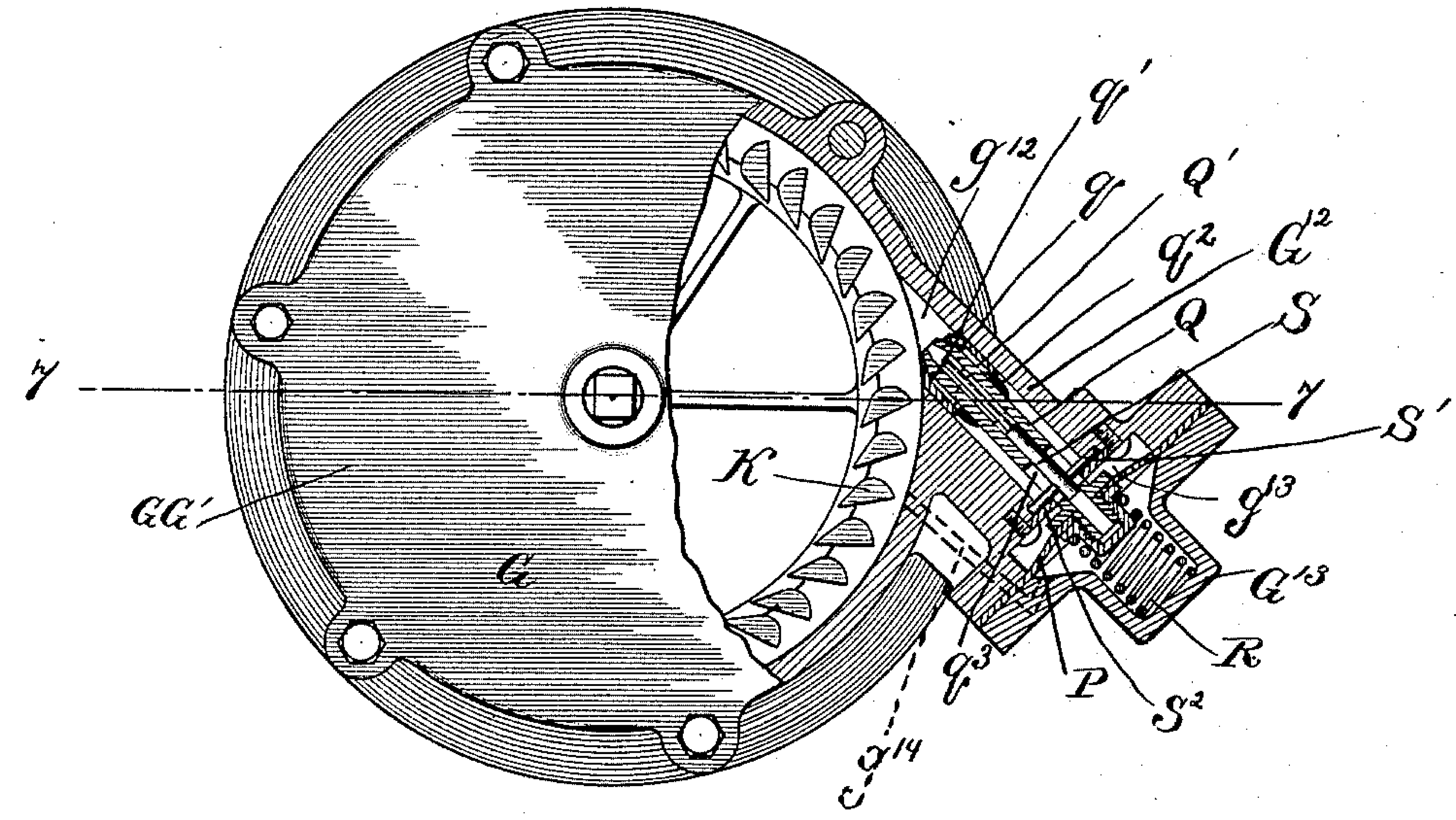
Fig 6



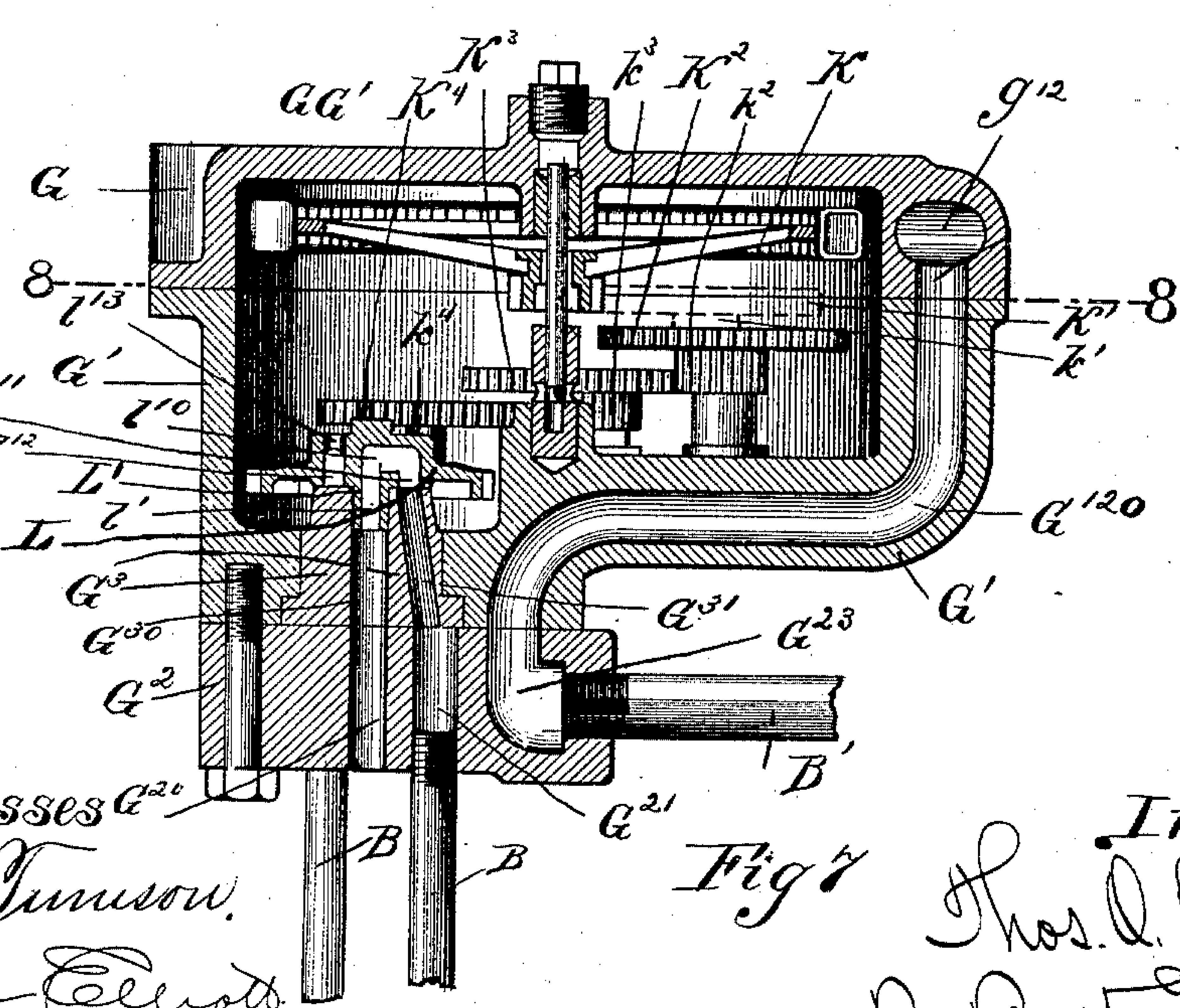


Fig 7

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(No Model.) 4 Sheets—Sheet 4.

T. O. PERRY.

PNEUMATIC PUMP.

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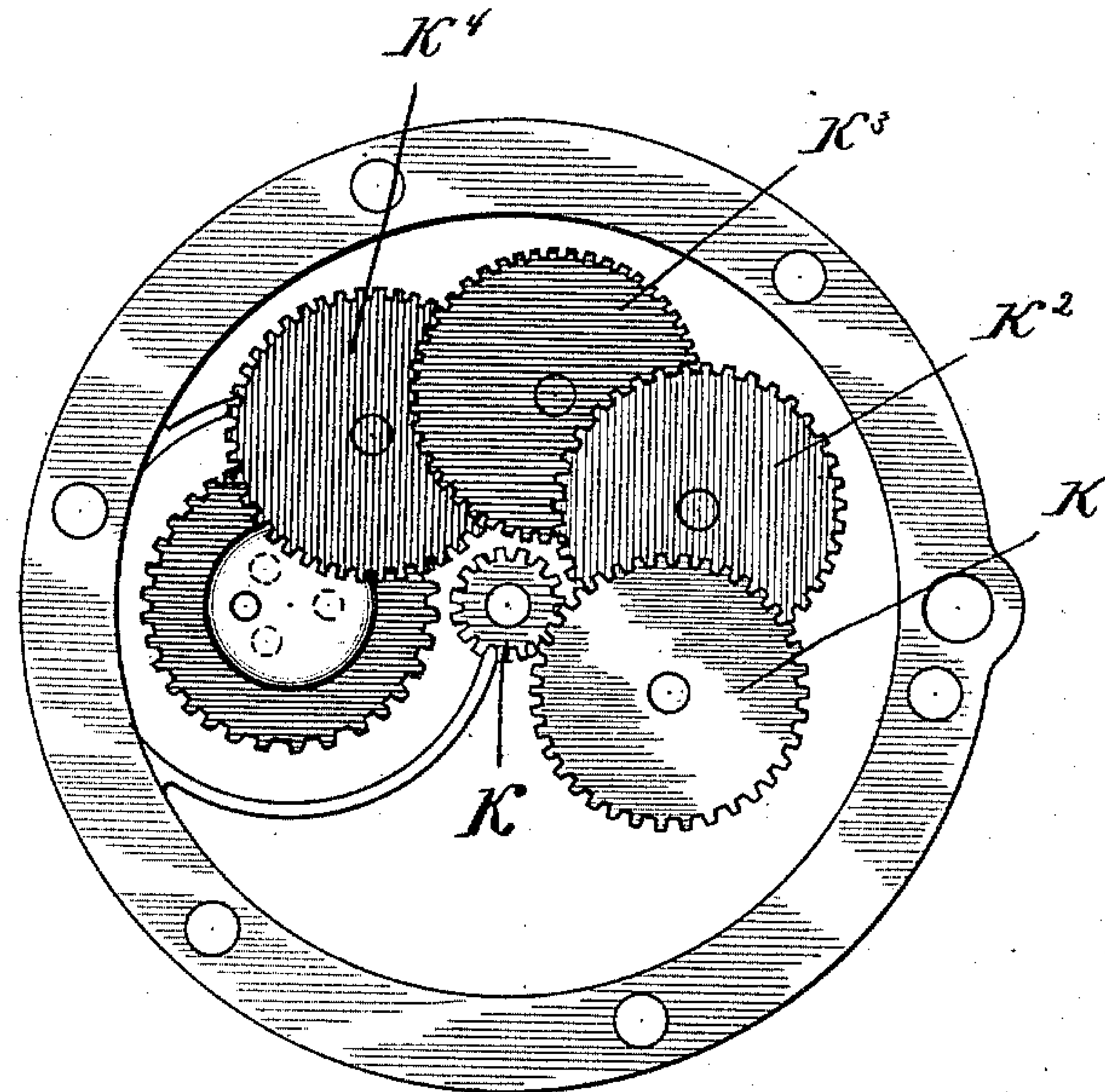

Fig 8

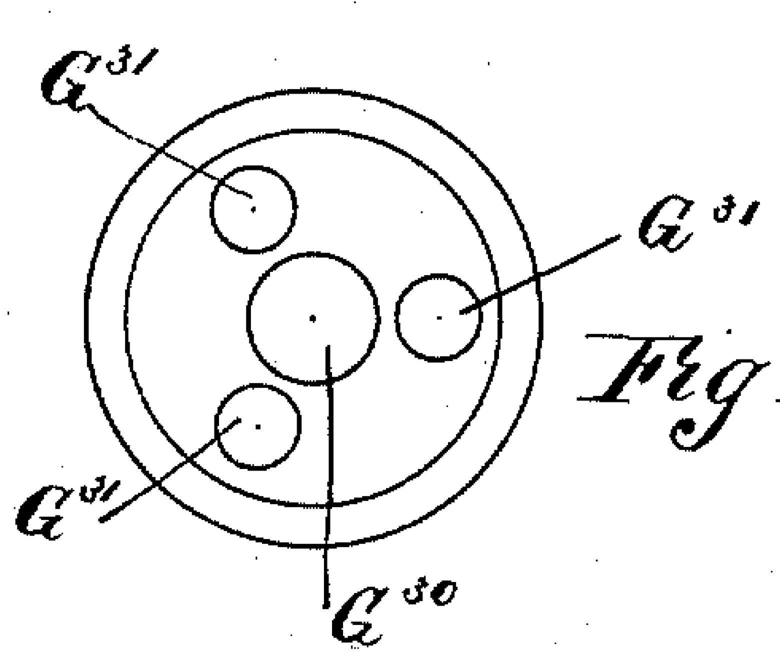

Fig 10

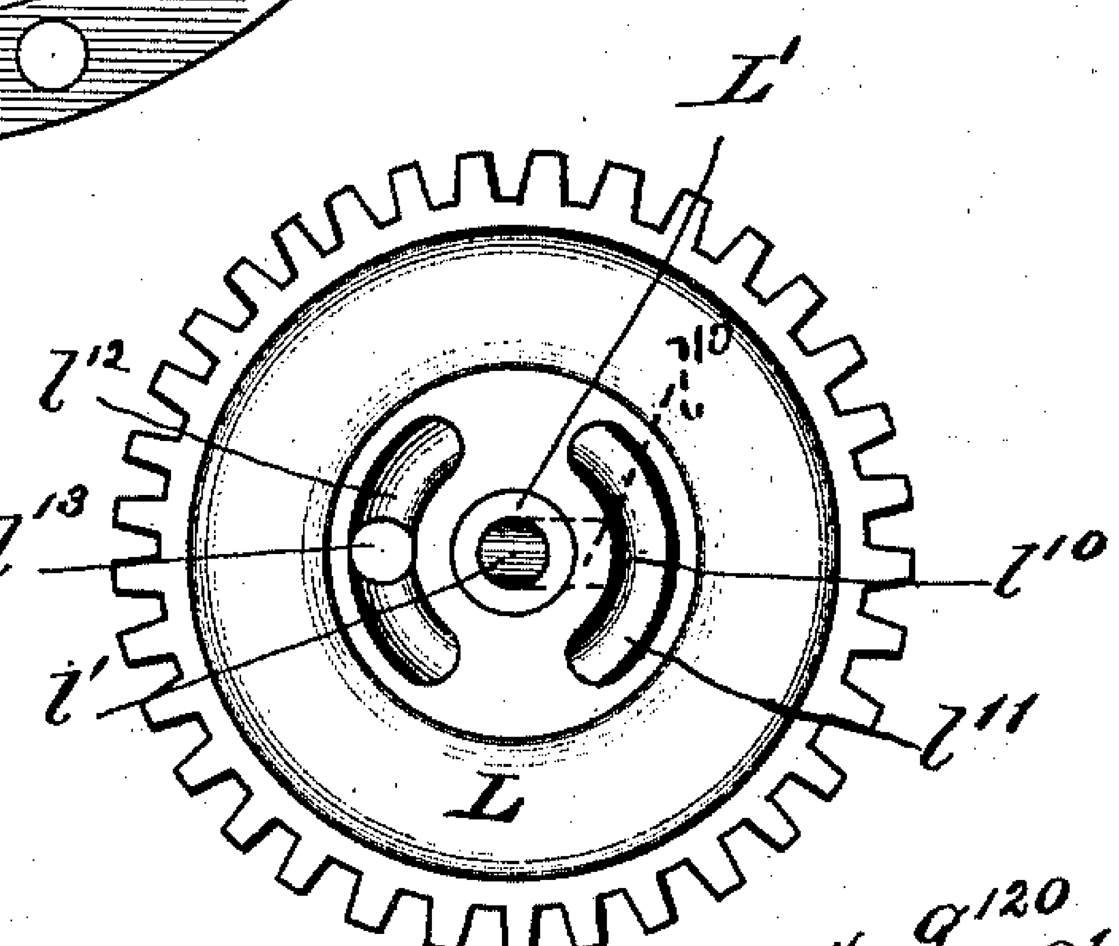

Fig 9

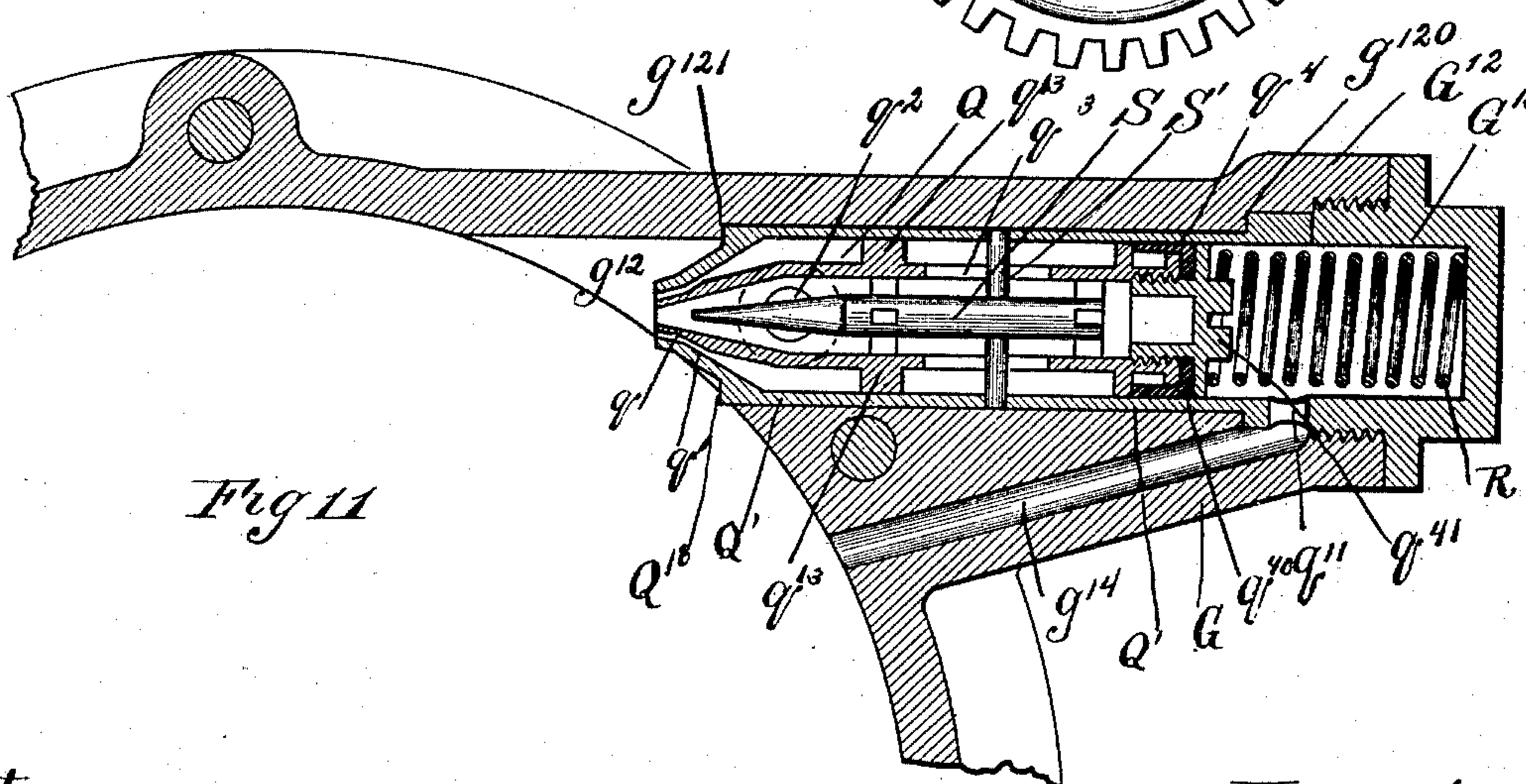

Fig 11

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UNITED STATES PATENT OFFICE.

THOMAS O. PERRY, OF CHICAGO, ILLINOIS.

PNEUMATIC PUMP.

SPECIFICATION forming part of Letters Patent No. 485,880, dated November 8, 1892.

Application filed September 5, 1891. Serial No. 404,854. (No model.)

To all whom it may concern:

Be it known that I, THOMAS O. PERRY, a citizen of the United States, residing at Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in a Pneumatic Pump, which are fully set forth in the following specification, reference being had to the accompanying drawings, forming a part thereof.

This invention relates to devices for raising water by the force of compressed air introduced into submerged chambers, into which the water flows by its head. In order to obtain continuous flow of water by this method, more than one chamber must necessarily be employed, because each chamber must be allowed time to fill in the intervals between the periods during which the water is being expelled by the force of the compressed air. It has been customary to employ two chambers, which are alternately filled and emptied.

One feature of my invention consists in the employment of more than two chambers, with the effect of getting a more uniform flow, and another feature consists in the means for operating the valve or valves which control the access of compressed air to the chambers successively, and relates, also, to the form of such valve, as well as the specific form of the chambers and their controlling-valves.

In the drawings, Figure 1 is a side elevation of a pneumatic water-elevator embodying my invention. Fig. 2 is a section at the line 2 2 on Fig. 1, showing, therefore, the cylinder which contains the submerged chambers in top plan. Fig. 3 is a section at the line 3 3 on Fig. 2. Fig. 4 is a section at the line 4 4 on Fig. 3. Fig. 5 is a section at the line 5 5 on Fig. 3. Fig. 6 is a sectional top plan of the case containing the valve-regulating devices, the top plate being partly broken away to show a motor-wheel, which forms part of the valve-controlling mechanism, and other portions being shown in section at the plane 6 6 on Fig. 7. Fig. 7 is a section at the line 7 7 on Fig. 6. Fig. 8 is a plan of the lower member of the valve-chamber and the mechanism therein, being all of said chamber below the plane of the line 8 8 on Fig. 7. Fig. 9 is an inverse plan of the valve which controls the admission of air successively to the chambers. Fig. 10 is a plan of the valve-seat. Fig. 11 is an enlarged detail section of a modified form of air-nozzle for directing the blast against the motor-wheel which operates the air-controlling valve.

A is a cylinder, which is designed to be submerged, and which contains three chambers A′ A′ A′, each occupying one hundred and twenty degrees of the cylinder, being separated by radial vertical partitions A^2 A^2 A^2, said partitions merging in a central hub or core A^3, vertically tubular and constituting the water-discharge passage. This central hub of the cylinder is at the lower portion expanded similarly in the angular spaces between the three vertical partitions, respectively, and chambered out in said expanded portion to form a valve-chamber A^{30}, which constitutes horizontal expansion of the lower end of the water-discharge passage A^3. Each of the chambers A′ is entered at the top by an air-pipe B, and each has at the bottom two ports A^{10} and A^{11}, of which A^{10} is an eduction-port and A^{11} an induction-port. The eduction-port A^{10} leads by the duct a^{10} downward, then horizontally, and then upward into the valve-chamber A^{30}, the three passages a^{10} from the three chambers, respectively, thus all entering the valve-chamber A^{30} and all communicating therethrough into the water-discharge passage A^3. Each of the discharge-ports of the ducts a^{10} is closed by a downwardly-seating valve—that is, a valve which admits the water upward, but checks its flow downward. I have for convenience of construction made these valves all of one piece of leather, and they may hereinafter be referred to as the "compound valve" C C C. The particular construction of this compound valve will be hereinafter described. Each of the induction-ports A^{11} is closed by a downwardly-seating valve D, admitting the water up into the chamber, but preventing its outflow through said port. For convenience of construction and to give ready access to all the valves I have made all the valve-seats for the valves C C C and D D D in the same horizontal plane, and I divide the cylinder A at that horizontal plane, mounting all the valves on the upper surface of the lower portion or base a, so that upon the removal of the upper portion they are all exposed upon the top of said base. The two ports of the cylinder are secured together by bolts a' a', inserted upward through the base and screwed into suitable bosses in the upper portion. In order to protect the valves from solid matter in the water, since these chambers are most conveniently set on the earth in the bottom of the well or reservoir from which they take their water-supply, I provide the jacket, comprising the bottom pan E and the cylinder E′, a little larger than the cylinder A and adapted, therefore, to receive the latter within it, the height of the cylinder E′ being sufficient to protect the ports and valves from sediment, the jacket extending up to clear water, so as to admit only clear water over its upper margin, and thence down to the bottom and up through the ports A^{11}. For convenience the bolts which secure the parts of the cylinder A together pass up through the pan E, which forms the bottom of the jacket E E′, and secures said jacket to the cylinder A.

The detail construction of the compound valve C C C and the controlling and securing devices associated with it I will now describe. Said valve consists, as stated, of a single piece of leather or rubber or like flexible material adapted for such purpose and bound at the center within the circle of the three discharge-ports of the duct a^{10} by the spider C′, which has the three arms C^{10} C^{10} C^{10} overhanging the ports and extending upward obliquely from the center to serve as checks to limit the opening of the valves. Said spider is bound to the base a of the cylinder by a suitable screw c' and is prevented from turning, and thereby prevents the valve C C C from turning, by the lugs C^{12} C^{12} C^{12}, which are clinched down around the edge of the boss a^2 at the center of the base a, into which the bolt c' is screwed. Said boss, it will be understood, extends up to the level of the seats of the valve C C C. The valve portions C of the valve C C C are respectively clamped between upper and lower washers c and c', the upper washers c' having a diameter equal to or greater than the valve-seat and the lower washer c having a diameter less than the discharge-port of the duct a^{10}. The valves D D D are similarly constructed, being made of leather bound between the washer D′ above and D^2 below, the leather being riveted to the casting upon ribs a^3, projecting up for the purpose to the height of the valve-seats, and the top washers D′, which bind said valves, are provided with tails D^{10} to serve as checks to prevent the valve being thrown over out of position by the entrance of the water. The discharge-pipe F is screwed into the discharge-passage A^3 and conducts the water to the point of final discharge.

It will be understood that upon the compressed air being admitted to any one of the chambers A′ through its air-pipe B, the chamber being before filled with water, the force of such compressed air will drive the water out through the port A^{10}, through the duct a^{10}, past the valve C, and through the discharge-passage A^3 and the discharge-pipe F, and that upon the air-pressure being removed and air-vent permitted through said pipe the water will flow in freely through the port A^{11} past the valve D. When only two chambers are employed, the compressed air is customarily shifted from one to the other by proper arrangement of valves, which simultaneously closes the vent of the chamber to which the pressure is transmitted and opens the vent of the other chamber, and since the pressure and vent ports of the same chamber must not be open at the same time the movement of the valve is customarily such that there is an instant during that movement at which the pressure is cut off from both chambers and the water-expelling force therefore momentarily suspended. My purpose in providing three chambers is to obviate this defect by having at all times one chamber, and during a portion of the time two chambers, exposed to the compressed air, so that there is no instant at which the pressure of the air is not being exerted upon the water in some one or more of the chambers and expelling it into the discharge-pipe. The stream afforded by the pump is thereby made absolutely continuous and practically unvarying under like conditions of pressure and supply.

I will now describe the devices by which I regulate the admission of compressed air to the chambers successively and successively vent said chambers to admit water thereto.

G G′ is a chamber which forms part of the air-passage from the air-compressor or source of compressed air of whatever sort to the water-chambers.

G^2 is a coupling for convenience of connecting the chamber G G′ to the water-chambers and to the source of compressed air. The chamber is made in two parts G and G′ merely for the purpose of gaining access to the interior mechanism.

G^3 is a plug which affords a seat for the valve which controls the admission of compressed air to the water-chambers and the vent of air from the same. It has a central duct G^{30} and three ducts G^{31}, arranged around the central duct at one hundred and twenty degrees apart. Merely for convenience in connecting the pipes B B B to the outer ends of these ducts G^{31} G^{31} G^{31} the latter are inclined to the central duct, so that their lower ends are farther from it than their upper ends. The coupling G^2 has four ducts G^{20} and G^{21} G^{21} G^{21}, corresponding, respectively, to the positions of the ducts G^{30} and G^{31} G^{31} G^{11}, so that when said coupling is bolted fast to the lower side of the lower portion G′ of the case, as seen in Fig. 7, the upper ports of its said ducts register with the lower ports of the ducts in the valve-seat, respectively, and with them from continuous ducts, the central one being a vent-duct and terminating at the outer air at the lower side of the coupling, and the three surrounding ducts leading to the air-pipes B B B, respectively, which are screwed into the lower ends of the ducts G^{21} G^{21} G^{21} of the coupling.

B′ is an air-supply pipe from the compressor. It is screwed into the side of the coupling G^2, communicating with the duct G^{23} therein, which opens upwardly at the same face of the coupling at which the other vertical ducts mentioned open and registers with the duct G^{120} in the portion G′ of the chamber, said duct extending along the under side of said chamber and upward at one side thereof and opening upwardly and registers with the duct g^{12} in the upper portion G. It is a point of great convenience that all the ducts which lead into the chambers G G′ emerge therefrom through a single plane surface, and that the coupling G^2 has its corresponding ducts emerging at a corresponding plane surface, so that a sheet of flat packing, suitably pierced at the locality of the ducts, interposed between said plane surfaces makes air-tight junction simultaneously for all the ducts when the coupling is bound by bolts or screws directly to the chamber.

The duct g^{12} is provided with a nozzle, as hereinafter described, through which the air is discharged into the interior cavity of the chamber against the vanes or pockets of a motor-wheel K, mounted, as hereinafter described, and adapted to revolve in the chamber.

K′ k' K^2 k^2 K^3 k^3 K^4 k^4 are successive pairs of gears and pinions constituting the train from the motor-wheel K to the valve L. This valve has a downwardly-projecting hollow spindle L′ at its center, by which said valve is journaled in the upper end of the vent-duct G^{30} in the plug G^3, and its periphery is cogged outside the circumference of the valve-seat, so that it may be rotated by the train described, which is driven by the motor-wheel K by means of the pinion N thereon. The duct l' in said spindle L′ communicates by way of the port l^{10} with the groove l^{11} on the lower face of the valve, said groove being in the arc of a circle about the center of the spindle L′ and occupying about one hundred and twenty degrees. On the same face of the valve, in a position diametrically opposite to the said groove l^{11}, is a similar groove l^{12} of equal extent, which communicates with a vertical duct l^{13}, which extends entirely through the valve. The groove l^{11} and the groove l^{12} are each at a distance from the center of the valve equal to that of the upper ports of the ducts G^{31} from the center of the duct G^{30}, so that as the valve revolves about said center said grooves register successively with the upper ports of the ducts G^{31}. In order to understand the purpose and effect of this construction and arrangement of the valve and its seat, assume at the start that the valve L stands in such position that the groove l^{11} overhangs the upper port of one of the ducts G^{31}. The water-chamber in the cylinder A, which communicates with said duct, will be in communication freely with the outer air through the groove l^{11} and the duct l', leading therefrom out through the spindle L′ of the valve, and the duct G^{30} of the plug G^3. At the same time, since the groove l^{12} occupies one hundred and twenty degrees, it will always overhang one of the ducts G^{31} and place such duct, and thereby the chamber with which it communicates, in communication through the duct l^{13} with the interior cavity of the chamber G G′, and will thereby expose its water-chamber to the pressure of the compressed air which is admitted through the chamber G G′. The third duct G^{31} will, according to the position of the valve, be either partly overhung by the groove l^{11} or partly overhung by the groove l^{12} or closed by the portion of the valve-face which intervenes between the proximate ends of said grooves—that is, the third water-chamber will be either in communication with the vent and be filling with water or in communication with the compressed air, and thereby be emptying, or will be closed, so that there will always be at least one chamber filling and one chamber emptying, and the third chamber will either be filling or emptying or inactive, according to the position of the valve. If now the valve be caused to revolve steadily, it will be evident that as the groove l^{12} comes into communication successively with the ducts G^{31}, respectively, and thereby exposes the water-chambers A′ A′ A′ successively to the compressed air, each chamber will be kept in communication with compressed air through something more than one-third of a revolution of the valve, and such communication will then be cut off an instant, and the groove l^{11}, coming into communication with the same duct G^{31}, will afford vent for the air in the water-chamber and permit it to fill for something more than one-third of a revolution of the valve, to be followed in turn by the groove l^{12} an instant closed again. Each water-chamber will be thus alternately exposed to the air-pressure and relieved therefrom and permitted to vent, with an interval of an instant between the two conditions at each change, and each of the grooves l^{11} and l^{12} will make communication with the succeeding duct G^{31} before they pass out of communication with the preceding. If now the speed of rotation of the valve be such that the time occupied by the groove l^{12} in passing a given aperature is no more than sufficient for the water-chamber with which communication is thus made to empty, there will always be at least one chamber from which water will be in process of discharge, and if the period of time necessary for a water-chamber to fill under the conditions existing in a given instance—that is, the head of water and the size of the induction-port A^{11}—is not greater than that same interval, each chamber will be completely filled during the time the groove l^{11} is passing the duct G^{31}, which leads into it, and the supply will therefore be fully maintained. When any desired degree of pressure is obtainable, the air-pressure may be regulated according to the head of water, so that the emptying of each chamber will be accomplished in the same time as the filling, so that the rate at which water may be elevated shall be as great as possible in view of the head of water in the reservoir; but under any given and permanent conditions as to the head of water, where the air-pressure obtainable is limited, the groove l^{11} may be made of such length only as is necessary to keep the vent open as long as is required to fill the chamber and the groove l^{12} extended by as much as the groove l^{11} may be under this condition diminished, thus making the period of exposure of each chamber to pressure proportioned to the period of its relief from pressure and opportunity to vent, as the head of water available for filling is to the pressure of air available for emptying. The interval between the proximate ends of the grooves l^{11} and l^{12} need be no more than enough to cover the ports of the ducts G^{31}, respectively; but the groove l^{12} must be long enough to lap at the same time over two of said ports. All variations in the arrangement may be tested by these two requirements.

The motor-wheel K rotates the valve by the train already described, the train being interposed to reduce the speed from the very rapid speed which the motor-wheel is designed to receive to the moderate or very slow speed which the valve should have. The compressed air which is to be utilized for expelling water from the water-chambers is utilized in its passage from the compressor to the valve by being compelled to pass through the nozzle as a means of actuating the motor-wheel to rotate the valve, its tension or capacity for elevating the water being inappreciably affected by the retardment, which is caused by the nozzle, which is necessary to condense it to a jet or blast to adapt it to revolve the wheel. Any form of nozzle will serve the purpose to a degree; but when high pressure is obtainable the retardment of a small nozzle is proportionately much greater than when the pressure is low, and since it is only necessary to condense the blast sufficiently to give it the speed which it must have to properly revolve the motor-wheel, and any further condensation resulting in a higher speed causes a waste of energy, I have provided an automatically-adjusting nozzle, which I will now describe.

The duct g^{12} is formed in the horizontally-projecting boss G^{12} in the upper member or cap G of the case G G′, the outer end of said boss being enlarged and having an enlarged cavity g^{13} and being divided by a plane through that cavity at right angles to the direction of the duct g^{12}, the removable cap or head G^{13} of said boss serving to bind between itself and the body of the boss an elastic diaphragm P. To the center of this diaphragm P there is attached the nozzle Q, which is tapered at its innermost end q and fits a tapered seat q' in the larger nozzle-cavity Q′, which is provided as a terminal of the duct g^{12}. A spring R, seated back of the diaphragm at the rear or outer end of the nozzle Q and in the cap G^{13}, tends to force said nozzle inward and to seat its tapered end q in the tapered seat q'. The air gains access from the duct g^{12} into the nozzle Q through openings q^2. The diaphragm P experiences at the outer side—*i. e.*, the side toward the cap G^{13}—the pressure which exists in the chambers G G′, air communication from the chamber to that side of the diaphragm being provided through the duct g^{14}; but on the other side it experiences such additional pressure as is due to the retardment of the injected air by the nozzle. When, therefore, the pressure from the compressor is great, the small aperture of the nozzle Q, permitting the discharge of the compressed air into the chamber G only at a moderate rate, causes the tension of the air at the inner side of the diaphragm to be increased above the tension which exists in the chamber and at the other side of the diaphragm and causes said diaphragm therefore to yield outward, and thereby to draw with it the nozzle Q, and in so doing to open the larger aperture of the nozzle Q′ and permit freer discharge of the compressed air into the chamber. The extent of the opening thus afforded will be partly affected by the tension of the spring R, which may be employed to add its resistance to that of the compressed air back of the diaphragm to restrain the withdrawing movement of the nozzle Q.

In order to prevent the smaller interior nozzle Q from being stopped up by dust which may be present in the air, I provide the cleaning-rod S within said nozzle. Said rod is fixed upon a cross-pin S′, which is lodged at the inward side of the cavity g^{13} in the margin of the duct g^{12} and retained by the washer S^2, the nozzle Q having apertures q^3 q^3 at opposite sides, whereat said cross-pin passes out through it, said apertures being elongated to permit the desired play of the nozzle. Any obstruction which restricts the discharge of air through the nozzle and tends, therefore, to cause the diaphragm to yield and carry the nozzle outward draws the nozzle back over the plunger and causes the latter to be forced through the mouth of the nozzle and relieves it of obstruction. The rod S need not fit so closely in the duct of the nozzle Q as to prevent the passage of air about it into the nozzle, and the apertures q^3 may therefore perform partly the function of the apertures q^2.

A modified form of double nozzle is shown in Fig. 11, which I will now describe. The boss G^{12} is drilled out to the shoulders g^{120} and g^{121}, and the outer nozzle Q′ is preferably made as a complete lining for the bore and as a complete nozzle independent of the walls of the duct g^{12}, and it is formed with the flange or shoulder Q^{10}, which stops on the shoulder g^{121}, and the cap G^{13} is made in the form of a plug, which screws into the outer end of the bore or duct g^{12}, which is suitably threaded for that purpose, and binds the said nozzle Q′ fixedly in place. The duct g^{14} enters the duct g^{12} near the end of the nozzle Q′, and the latter has the notch q^{11}, which is made to register with the mouth of said duct g^{14}, and thereby the pressure of air in the chamber is admitted into the nozzle Q′. Within the nozzle Q′ the nozzle Q is placed, its nose being adapted to seat in the discharge-mouth of the nozzle Q′ and its body being so much smaller than the cavity of the nozzle Q′ as to leave ample air-space about it, but having wings q^{13} q^{13}, by which it is held centrally in the outer nozzle and guided longitudinally by the walls of the latter. The rear end of the inner nozzle is provided with a flange or head q^4, which corresponds in function with the diaphragm P, for packing q^{40}, bound in place against the head by the cap-nut q^{41}, makes said head a piston rigid with the inner nozzle, and against which the air-pressure operates to withdraw the nozzle precisely as said pressure operates on said diaphragm. The cap-plug G^{13} is chambered out to afford space for the spring R, which reacts between said plug and the end of the inner nozzle—viz., the cap-nut q^{41}. It will be observed that the plug G^{13} is virtually a part of the outer nozzle, being only severed from the principal body thereof for the purpose of admitting the inner nozzle and the spring. In the form shown in Fig. 6 the body of the outer nozzle is formed by the casting-boss G^{12}.

Considered broadly the larger nozzle is a vent or relief port, through which when it is opened compressed air may enter freely, and the inner nozzle is a valve which normally seats in said vent-port and is unseated by the excess of pressure in the chamber beyond some limit predetermined by the tension given to the spring R, a portion of the air passing in any case through the inner nozzle against the wheel and rotating it as when the vent-port is closed, and it is of secondary or slight consequence whether the remaining quantity of compressed air which passes through the vent-port when the latter is opened impinges on the wheel or not.

For convenience of reference I have termed the cavity of the chamber G G′, a "compressed-air" chamber; but by this term I mean merely a cavity which is in communication with a source of compressed air. It is in effect, so far as the relation to the rotary valve is concerned, merely a part of the conduit from the source of compressed air to the water-chambers, although specifically for the purpose of the particular valve-actuating devices shown it is an enlargement of that conduit.

I claim—

1. In a pneumatic water-elevator, a plurality of water-chambers, combined with a compressed-air chamber and a rotary valve which controls communication of the compressed-air chamber with the water-chambers, respectively, the valve-seat having a port leading to each water-chamber, and the valve having a single port leading from its seating-face into the air-chamber, said valve-port being extended at the face of the valve in the path of the rotary movement of the valve farther than the angular distance between consecutive ports of the seat, whereby each water-chamber is brought into communication with the compressed-air chamber before the preceding one is out of such communication, substantially as set forth.

2. In a pneumatic water-elevator, a plurality of water-chambers having a common discharge-pipe, combined with a compressed-air chamber and a rotary valve which controls communication of the air-chamber with the water-chambers, respectively, the valve-seat having the port or way leading to each water-chamber, and the valve having a single port leading from its seating-face into the air-chamber, said valve-port being extended at the face of the valve in the path of the rotary movement of the valve farther than the angular distance between consecutive ports of the seat, substantially as and for the purpose set forth.

3. In a pneumatic water-elevator, a plurality of water-chambers, combined with a compressed-air chamber, a rotary valve which controls communication between the air-chamber and the water-chambers, respectively, the water-chambers having each a water-induction port, the valve-seat having a port leading to each water-chamber and an additional port encircling the axis of rotation of the valve and leading to the outer air for a vent-port, the valve having a single port leading from its face into the air-chamber, the mouth of said port at the face being extended in the path of the rotary movement of the valve farther than the angular distance between consecutive ports in the seat which lead to the water-chambers and registering with such ports as the valve revolves, said valve having a duct, one port of which in its path of rotation with the valve traverses the ports in the seat which lead to the water-chambers, while the other port registers continuously with the vent-port of the seat, the ports of the valve which communicate, respectively, with the vent-port of the seat and with the compressed-air chamber being separated by an angular distance as great as the angular extent of each of said ports of the seat leading to the water-chambers, respectively, whereby communication of the compressed-air chamber with each water-chamber continues until like communication is established with the next water-chamber and ceases before communication is established with the vent-port, substantially as set forth.

4. In a pneumatic water-elevator, a plurality of water-chambers, a compressed-air chamber, a valve-seat within said compressed-air chamber, having a central port leading to the outer air and a plurality of ports similarly disposed at equal angular distances about said central

port and communicating with the water-chambers, respectively, and a rotary valve having two ports on its face oppositely disposed with respect to the center, one port communicating inwardly into the air-chamber and the other port communicating with the central port of the seat, the angular extent of said valve-ports being greater than the angular distance between the ports of the seat which lead to the water-chambers and the angular distance between the valve-ports being not less than the angular extent of said seat-ports, substantially as set forth.

5. In a pneumatic water-elevator, in combination with the water-chambers, a compressed-air chamber, and a rotary valve which controls communication between the compressed-air chamber and the water-chambers, respectively, a wheel adapted to be actuated by an air jet or blast, and connections from said wheel to said rotary valve, whereby the rotation of the wheel rotates the valve, substantially as set forth.

6. In a pneumatic water-elevator, in combination with the water-chambers, a compressed-air chamber, and a rotary valve which controls communication between the compressed-air chamber and the water-chambers, respectively, a wheel adapted to be actuated by an air jet or blast, and speed-reducing connections from said wheel to said rotary valve, whereby the wheel may have high speed and rotate the valve slowly, substantially as set forth.

7. In a pneumatic water-elevator, in combination with the water-chambers, a compressed-air chamber, and a rotary valve which controls communication between the compressed-air chamber and the water-chambers, respectively, a wheel in said compressed-air chamber adapted to be actuated by an air jet or blast, and connections from said wheel to said rotary valve, whereby the rotation of the wheel rotates the valve, and a nozzle through which the compressed air is introduced into said compressed-air chamber, disposed in position to direct such compressed air in a jet against the wheel, whereby the compressed air which operates in the water-chambers to expel the water operates, also, in the air-chamber to rotate the valve, substantially as set forth.

8. In a pneumatic water-elevator, in combination with the water-chambers, the compressed-air chamber, and a rotary valve which controls communication between the compressed-air chamber and the water-chambers, respectively, a wheel in said compressed-air chamber adapted to be actuated by an air jet or blast, and connections from said wheel to said rotary valve, whereby the wheel rotates the valve, a conduit leading to the compressed-air chamber, and two ports by which it communicates with the latter, one being adapted to direct the air in a jet upon the wheel, a valve normally closing the other port and adapted to be unseated by air-pressure within the conduit, whereby it constitutes a relief-port to diminish the velocity of the air through the jet-port, substantially as set forth.

9. In combination with the water-chambers and the compressed-air chamber, the latter having the duct G^{12} and the ducts G^{30} and G^{31}, all said ducts terminating at the same lower face of said air-chamber, the coupling G^2, having ducts which register one end with all said ducts of the air-chamber, and air-pipes from the water-chambers, and the compressed-air-supply pipe B′, screwed into the outer ends of said ducts, respectively, in the coupling, substantially as set forth.

In testimony whereof I have hereunto set my hand, in the presence of two witnesses, at Chicago, Illinois, this 2d day of September, 1891.

THOMAS O. PERRY.

Witnesses:
CHAS. S. BURTON,
JEAN ELLIOTT.