No. 640,910 Patented Jan. 9, 1900.

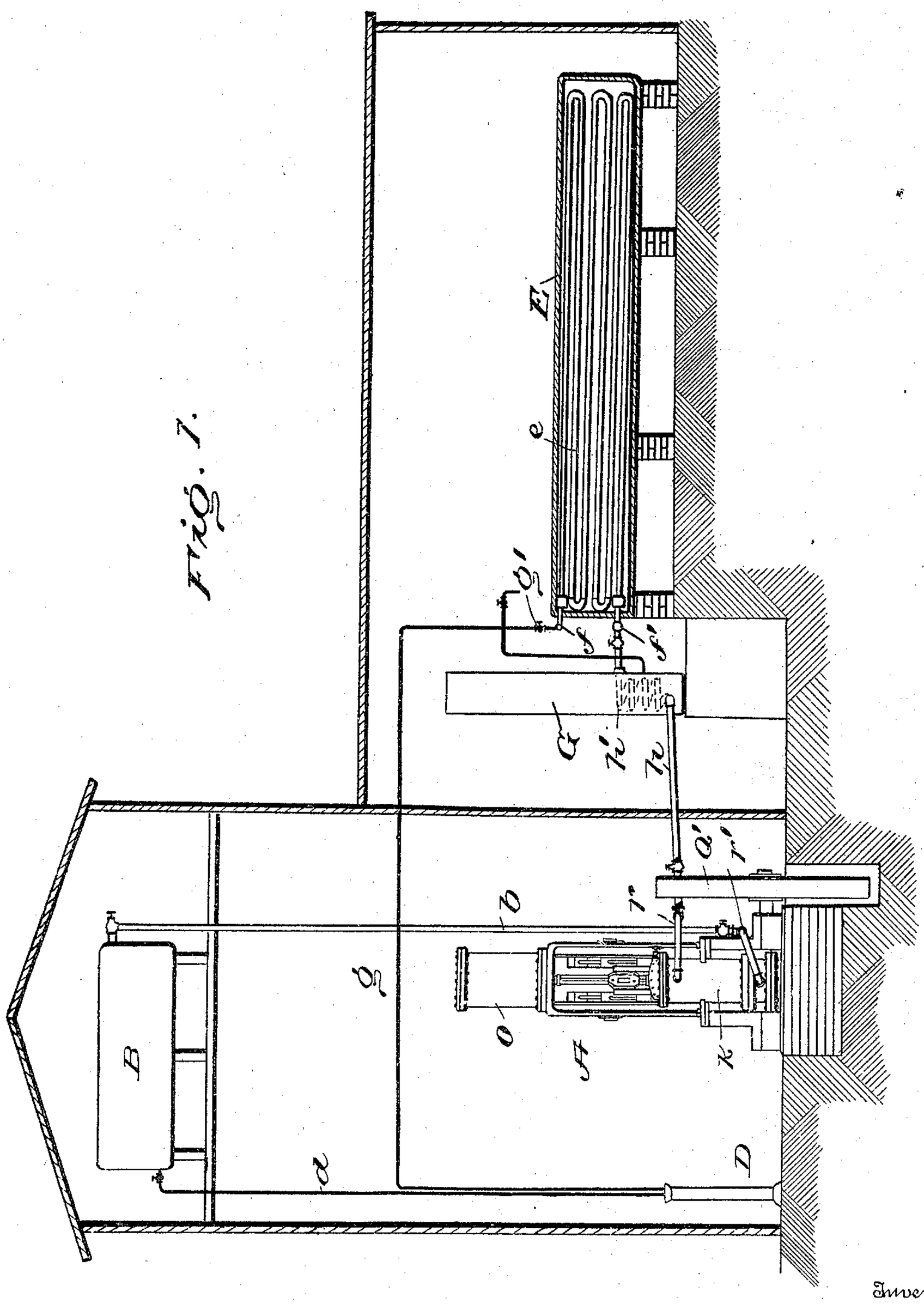
G. B. HIETT.

REFRIGERATING OR ICE MAKING MACHINE.

(Application filed Feb. 15, 1899.)

(No Model.) 5 Sheets—Sheet 1.

Fig. 1.



Witnesses
Jas. Imirie
C. C. Hines.

Inventor
George B. Hiett
By R. A. D. Lacey his Attorney

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G. B. HIETT.

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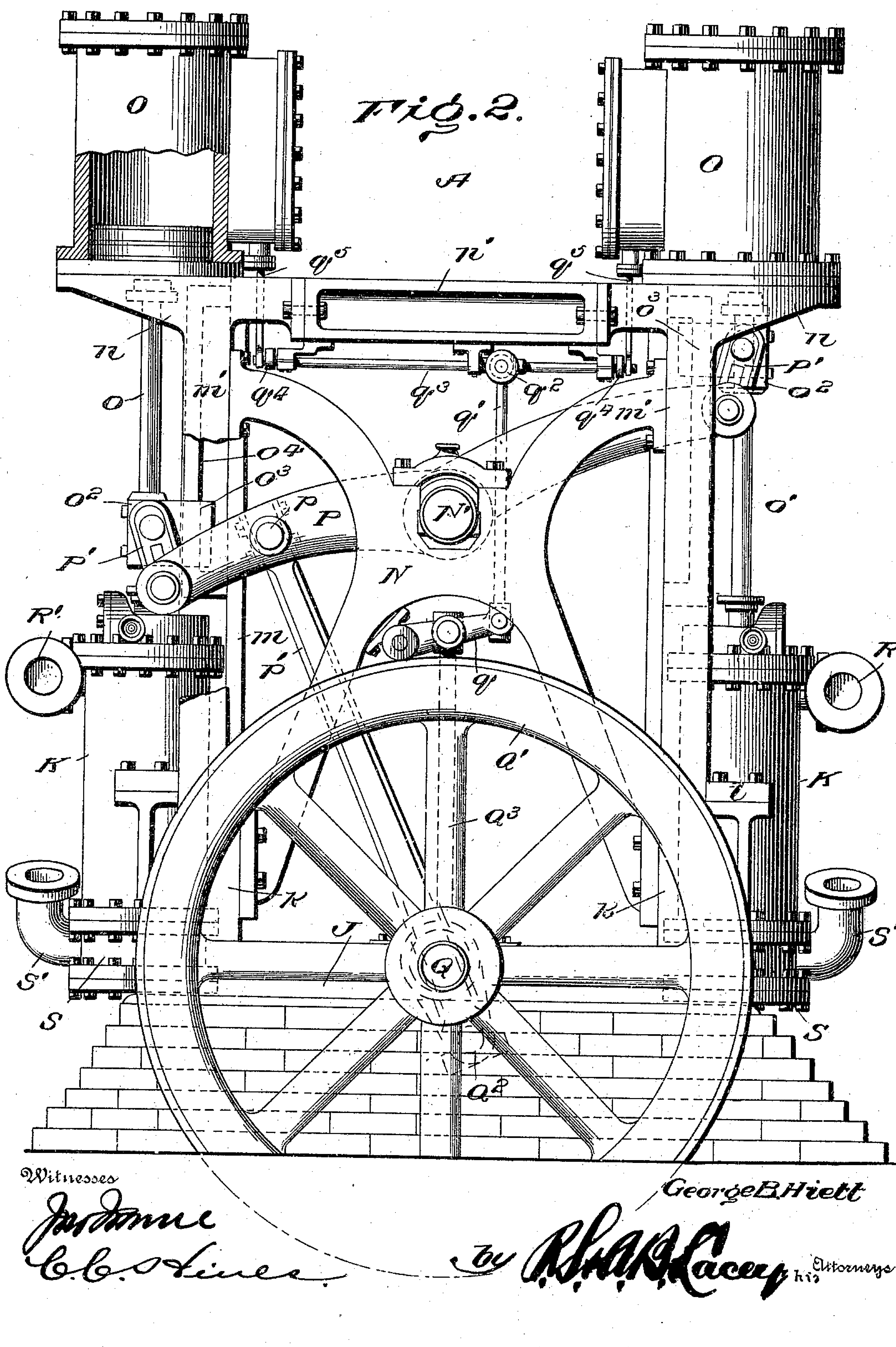
(No Model.)

5 Sheets—Sheet 2.

Fig. 2.



Witnesses

Jas Drummond (?)

C. C. Hines

George B. Hiett

by [signature] Lacey his Attorneys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C

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(No Model.) 5 Sheets—Sheet 3.

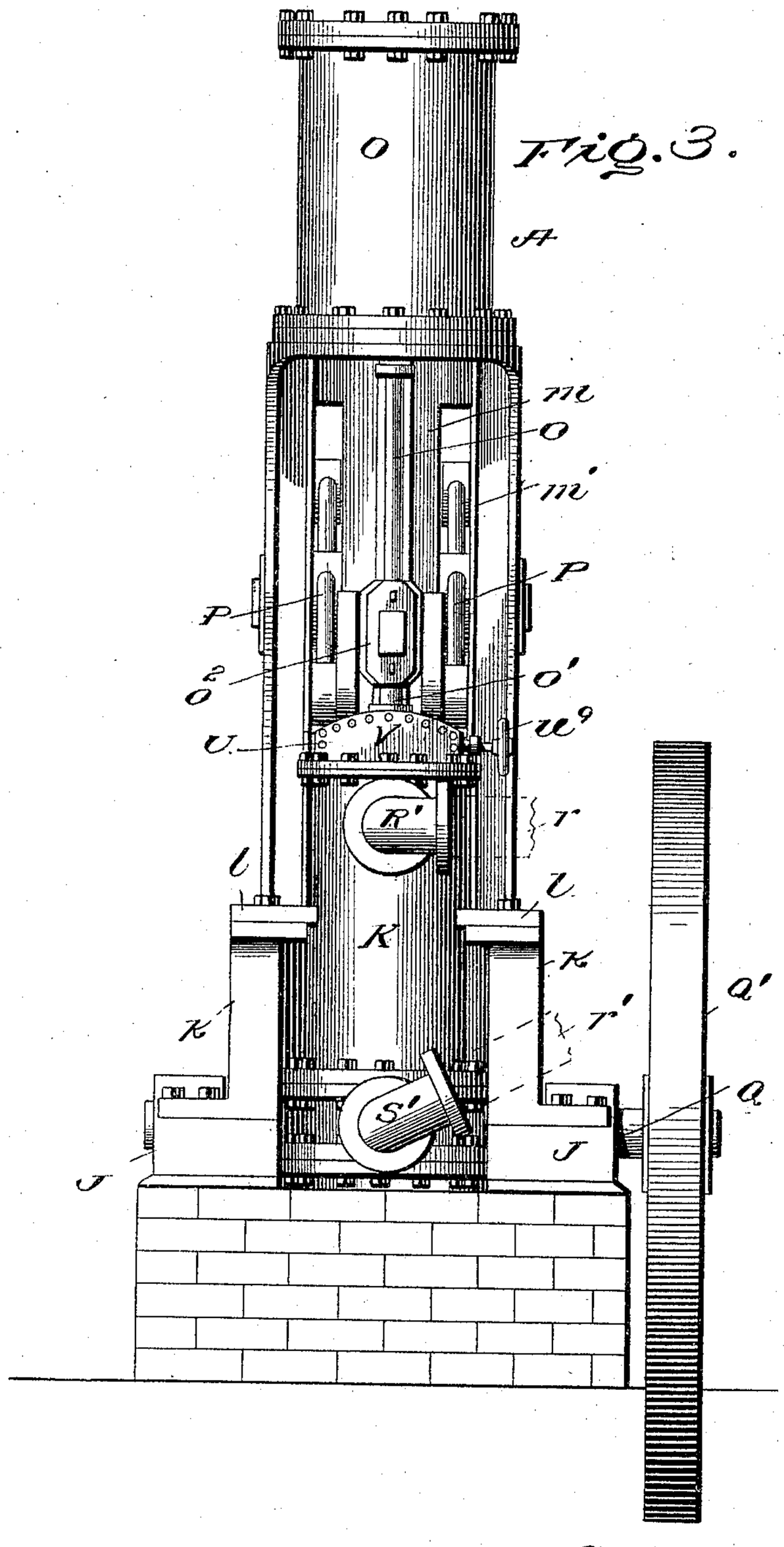

FIG. 3.

Witnesses
John Imrie
C. C. Hines.

Inventor
George B. Hiett
By R. H. Kacey
his Attorneys

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G. B. HIETT.

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(Application filed Feb. 15, 1899.)

(No Model.) 5 Sheets—Sheet 4.

Fig. 4.

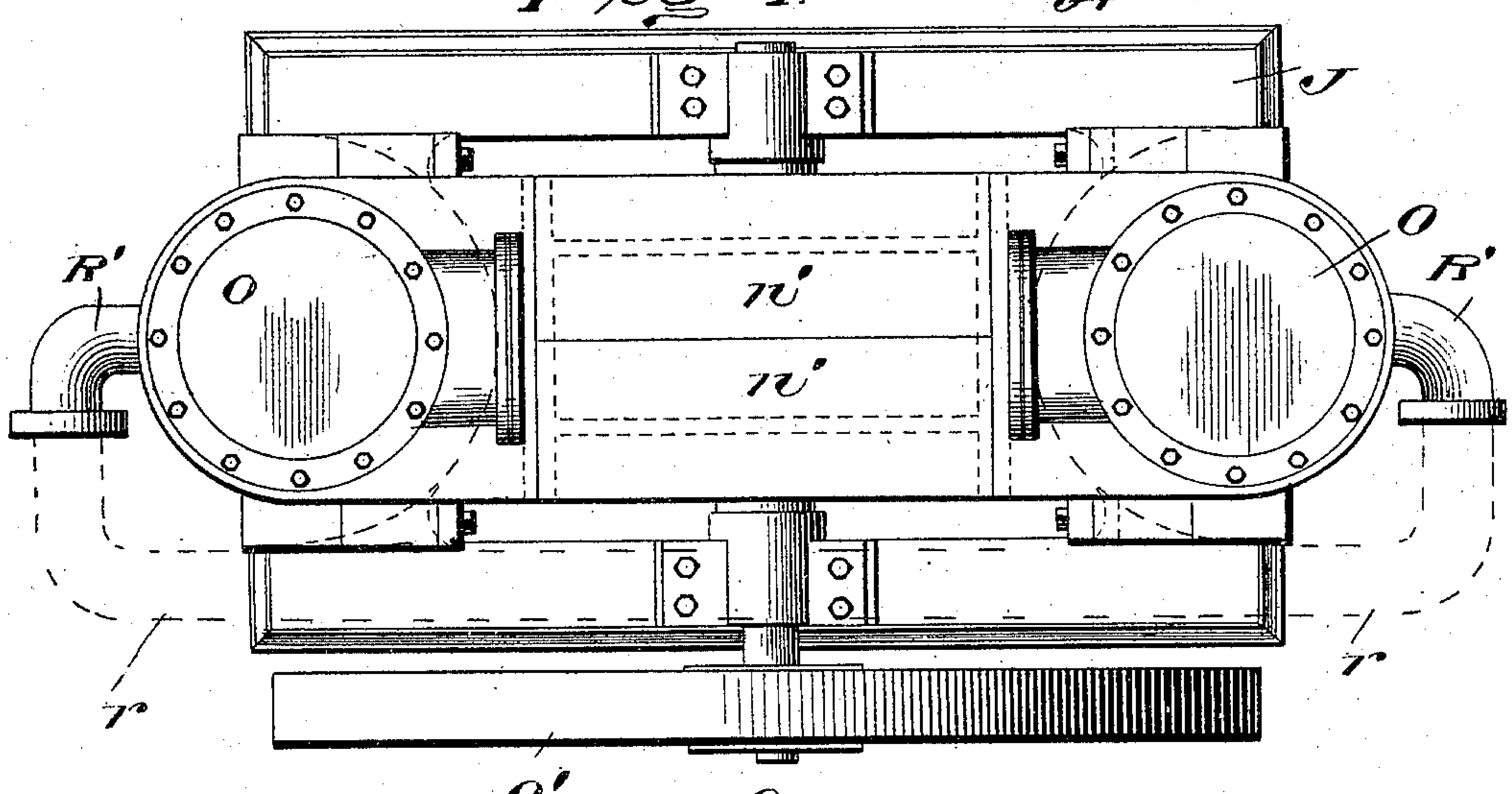
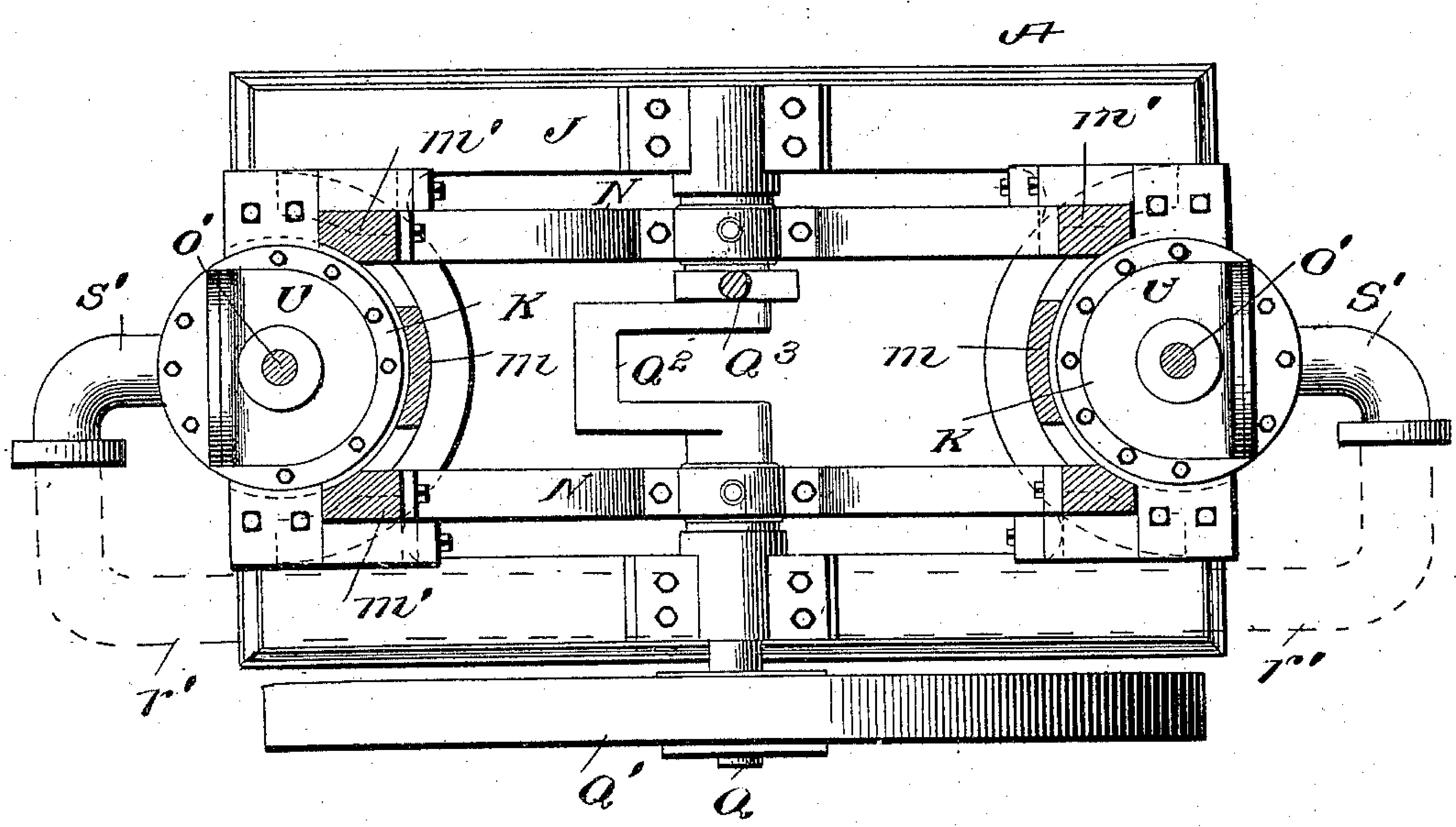


Fig. 5.



Witnesses
J. W. Dinnie
C. C. Hines

Inventor
George B. Hiett
by R. A. & A. B. Lacey his Attorneys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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(No Model.) 5 Sheets—Sheet 5.

Fig. 6.

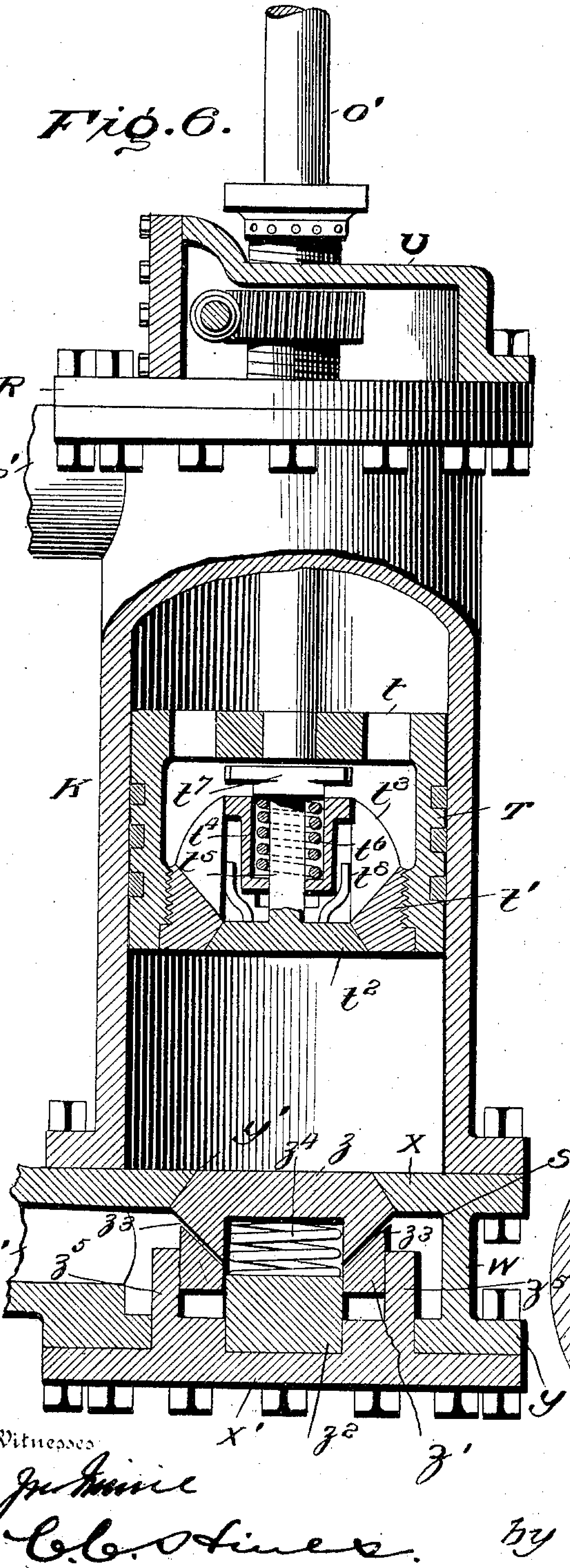


Fig. 7.

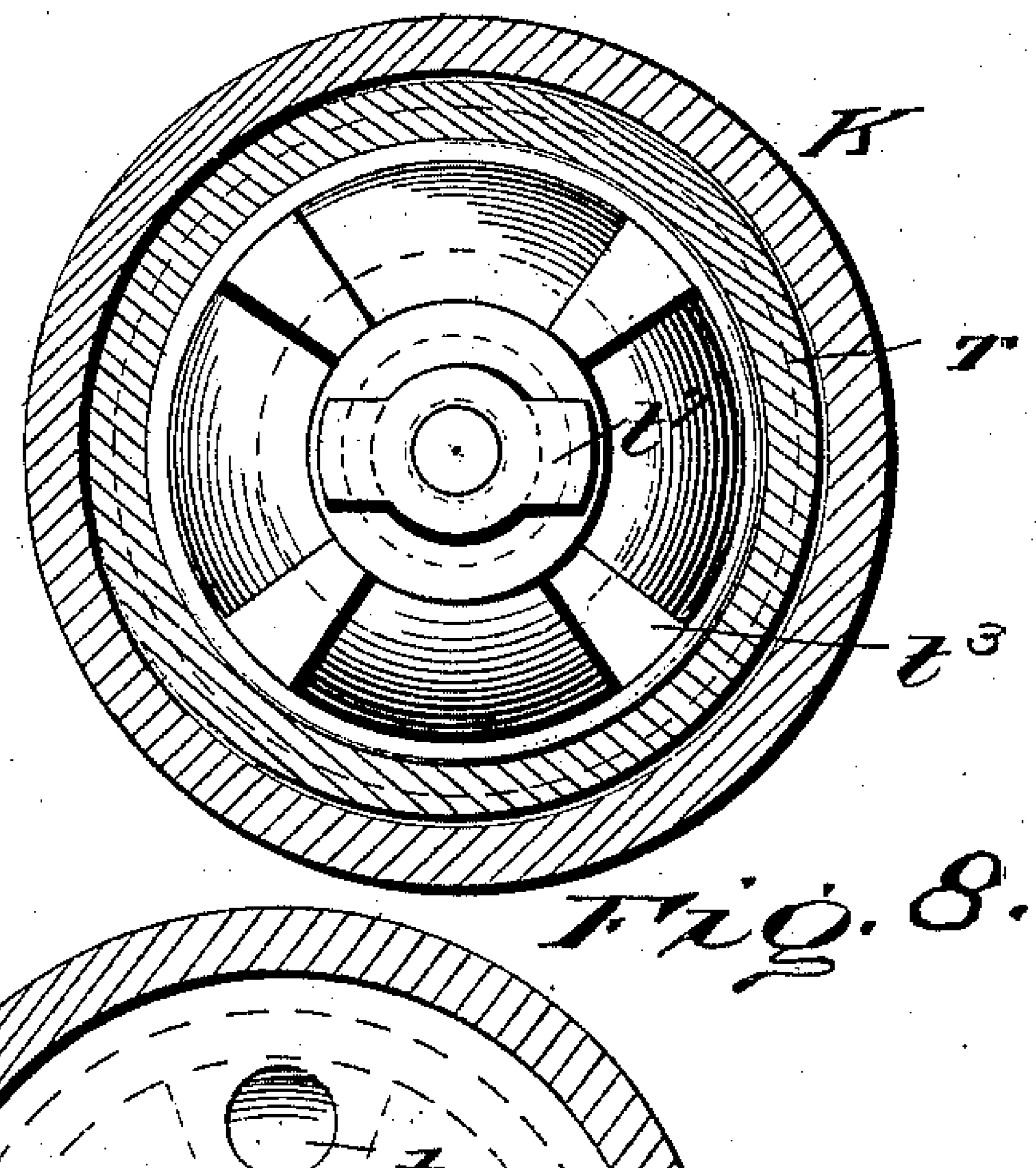
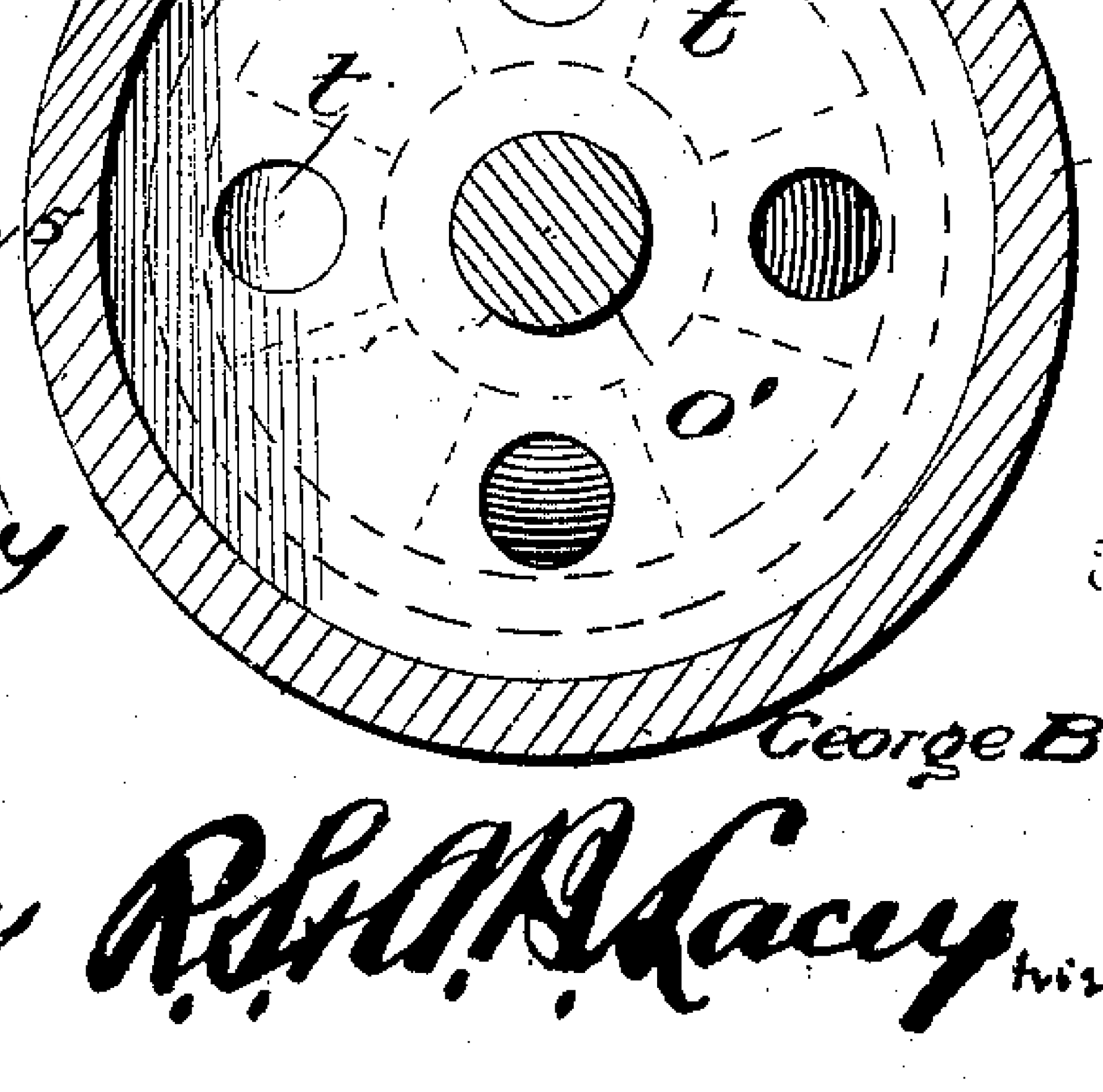


Fig. 8.



Witnesses

Inventor

George B. Hiett

by R. S. & A. B. Lacey his Attorneys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

GEORGE B. HIETT, OF ATLANTA, GEORGIA, ASSIGNOR OF ONE-HALF TO SAMUEL L. BREWER, OF TUSKEGEE, ALABAMA.

REFRIGERATING OR ICE-MAKING MACHINE.

SPECIFICATION forming part of Letters Patent No. 640,910, dated January 9, 1900.

Application filed February 15, 1899. Serial No. 705,545. (No model.)

To all whom it may concern:

Be it known that I, GEORGE B. HIETT, a citizen of the United States, residing at Atlanta, in the county of Fulton and State of Georgia, have invented certain new and useful Improvements in Refrigerating or Ice-Making Machines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The primary object of my invention is to provide a refrigerating and ice-making machine which is simple in construction and involves a new mode of operation, the gist of the invention consisting in so constructing and arranging the parts of the essential elements of all such apparatus that the theoretical estimate is adhered to as clearly as possible throughout the entire cycle of operation, the ammonia being handled in a natural liquid or densely-saturated state at all periods except on its passage from the compressor to the condenser and discharged from the said compressor at but a little above the normal temperature of the water in the condenser.

Subsidiary objects of the invention are to provide improved mechanism to actuate the ammonia-pumps, to provide an improved ammonia-pump, to provide simple and effective means for adjusting the stuffing-boxes of the ammonia-pump piston-rods and lubricating the same, to provide novel valve mechanism for the pistons, and to improve and simplify the construction of the several parts to avoid the objections to prior machines above pointed out and increase the efficiency of this class of apparatus generally.

In order to make my invention more fully understood, I have shown in the accompanying drawings certain means for carrying the same into practical effect, without, however, intending to limit the invention to the particular constructions which for the sake of illustration I have set forth.

In the said drawings, Figure 1 is an elevational view of a refrigerating and ice-making apparatus embodying my invention. Fig. 2 is a side elevation of the compressor on an enlarged scale. Fig. 3 is an end elevation of the same. Fig. 4 is a top plan view. Fig. 5 is a horizontal section. Fig. 6 is a vertical sectional view of one of the ammonia-pump cylinders on an enlarged scale. Fig. 7 is a sectional plan view of one of the ammonia-pump pistons. Fig. 8 is a top plan view thereof.

Referring now more particularly to the drawings, wherein like reference-letters designate corresponding parts throughout the several views, A represents the compressor; B, the condenser, which may be of any approved construction; *b*, the delivery-pipe, extending from the discharge-ports of the compressor to the inlet-header of the coils (not shown) of the condenser; D, a receiver or collector in which the liquid ammonia is stored preliminary to its passage to the refrigerator; *d*, a liquefying-pipe leading from the bottom header of the coils of the condenser to said receiver; E, the refrigerator, shown in the present instance in the form of a brine-tank containing a series of expansion-coils *e*, connected by top and bottom headers *f* and *f'*; *g*, a liquefying-pipe leading from the receiver to the top header *f* of said coils and provided with an expansion-valve *g'*, by which the feed of ammonia thereto is regulated; G, a distilled-water tank from which the cans in the brine-tank are filled in ice-making, and *h* the suction-pipe, extending from the bottom header *f'* of the expansion-coils to the suction-ports of the compressor and provided with a coil *h'*, arranged in said tank, so that the water therein will be kept at a low temperature by the ammonia passing from the refrigerator to the compressor.

The drawings show the apparatus in the form of an ice-making machine; but it is equally as well adapted for use as a refrigerator for cooling off and maintaining at a desired low temperature the atmosphere of a room, the brine-tank being in this case dispensed with and the refrigerating effect produced by the ammonia absorbing the heat directly in its passage through the expansion-coils.

The parts above described constitute the essential elements of all refrigerating and ice-making machines acting on the compression principle, and the novel construction and arrangement thereof, whereby a complete change in the mode of operation is effected in

accordance with this invention, will be hereinafter fully set forth.

The compressor A is of the vertical single-acting duplex form and comprises in its construction a bed-plate J, adapted to be suitably anchored to a foundation of any preferred kind arranged a suitable distance below the plane of the refrigerator. To the opposite ends of this bed-plate are bolted semicylindrical pillars *k*, in which are disposed the ammonia-pump cylinders K. The pump-cylinders are provided on their sides with flanges *l*, which are bolted to the tops of the pillars *k*, and from the upper ends of each of the pillars project frames consisting of a partially-circular or segment-shaped central upright *m* and two outer or side uprights *m'*. The said frames are securely tied and braced together by four-armed braces N and at their top are provided with flanges *n*, tied together by a stay-beam *n'*, formed of angle-plates, as shown. On the flanges *n* are supported and bolted vertical fluid-pressure power-cylinders O, provided with pistons adapted to reciprocate simultaneously in opposite directions, as will more fully hereinafter appear. The pistons in the power-cylinders are provided with depending piston-rods *o*, while the pistons in the ammonia-cylinders are provided with upwardly-projecting piston-rods *o'*, which are in alinement with said piston-rods *o*. The adjacent ends of these piston-rods *o* and *o'* are keyed in cross-heads o^2, to the opposite sides of which are attached jaws o^3, that engage and travel on cross-head straps o^4, rigidly bolted to the uprights *m*. The jaws o^3 form a movable connection between the cross-heads and straps and maintain the piston-rods *o* and *o'* in perfect alinement and cause the same and the cross-heads to travel in true rectilinear paths, whereby undue friction on the stuffing-boxes of the ammonia-cylinders is avoided owing to the fact that the weight of the piston and piston-rod does not rest at any time on the wall or head of the cylinder, and the piston cannot wabble or move out of line and bear unequally on either of said parts. Hence, as expansion pressure only comes on the pistons, the piston-rods may be run very loosely, the oil seal serving to effectually prevent the escape of gases. The great advantage of this construction is that the cylinder-walls do not at any time become unduly heated, as the packing-rings only bear thereon, and the friction created by these alone is practically *nil*. Journaled in bearings in the four-armed braces N is a shaft N', on which is a walking-beam consisting of two parallel cross-beams P, connected at their opposite ends to the cross-heads o^2 by links P'. The cross-beams P are connected together by a wrist-pin *p*, which passes through both beams at a suitable point to one side of the pivotal center of said beams. On this pin is journaled the upper end of a connecting-rod *p'*, the lower end of which is journaled on a crank-shaft Q, rotating in suitable bearings formed on the bed of the machine. On one of the ends of the crank-shaft is fixedly mounted a fly-wheel Q', and also fixed on said shaft is an eccentric Q^2, so arranged with respect to the other parts that when the piston-rods on one side are down and the piston-rods on the other side up the momentum of the fly-wheel will readily carry the parts past the center and prevent hanging or resistance on the reverse movement, owing to the absence of strain on either of the pistons and to the sensitive balancing of the latter. An eccentric-rod Q^3 is connected at one end to the eccentric by the usual strap connection and at its other end is pivotally connected to an oscillating link *q*, which in turn is pivotally connected to the four-armed braces N. To the free end of the oscillating link is pivotally attached one end of a connecting-rod *q'*, the other end of which is connected by a universal joint q^2 to a transverse rock-shaft q^3, journaled in bearings on the stay-beam *n'*. To the opposite ends of the rock-shaft are fixed crank-arms q^4, which project in opposite directions and which are respectively connected to the valve-stems q^5, which actuate the valves of the two fluid-pressure power-cylinders. It will be seen that the parts P' P *p'* and connecting mechanism constitute an indirect connection between the crank-shaft and piston of the ammonia-cylinder. Through the medium of the valve-gear just described the pistons of the power-cylinders will be caused to reciprocate simultaneously in opposite directions in a manner that will be obvious, the universal-joint connection between the connecting-rod and rock-shaft permitting the movements of the connecting-rod of the rock-shaft arm in the arcs of two different circles or in the arcs of two circles in planes at right angles to each other. The duplex compressor, as thus constructed, is designed primarily for ice-making and refrigerating plants of large capacity where two pumps are required for circulating the ammonia and for small plants where only one pump is required for circulating the ammonia, but it is desired to keep a pump in reserve for use in case the one in operation should become disabled, although the duplex construction is not essential. Either ammonia or power cylinder may be placed out of action by detaching the piston-rod thereof from its connecting cross-head, and when the ammonia-cylinder is thus disconnected both power-cylinders may still be used. By simply detaching the links P' and disengaging the stem of the valve of the power-cylinder from the rock-shaft at one side of the compressor the pump at either side thereof may be used independently of the other.

The compressor is so arranged that the upper ends of the ammonia-pump cylinders K stand in or below the plane of the expansion-coils *e*, and each cylinder is provided in its outer side, just below its upper head R, with a suction-port in the form of a pipe R' and at

its lower end with an expansion and discharge chamber S, having a discharge-port in the form of a pipe S′. The suction-ports of the two ammonia-cylinders are connected to each other and to the suction-pipe *h* by a cross-pipe *r*, and the discharge-ports thereof are also connected to each other and to the delivery-pipe *b* by a similar cross-pipe *r′*. The suction-pipe thus extends from the distilled-water tank to the compressor below the plane of the bottom-header of the coils and has a slight fall or inclination to allow the liquids to quickly discharge from the header and flow by gravity to the pump-cylinders, as will be hereinafter more fully set forth. Attached to the lower end of each of the piston-rods *o′* is a piston which works downwardly to compress and expel the ammonia and is constructed as follows: A hollow piston-head shell T is provided at its upper end with a plurality of ports *t* and at its lower end is open, and internally threaded and screwed in the open threaded end of the shell is a valve-seat *t′*, in which is arranged a vertically-movable valve t^2. The upper end of the valve-seat is formed with a spider t^3, which permits the free and unobstructed passage therethrough of the ammonia gas and liquids, and supported by said spider above the valve-seat is a removable cup t^4, through which passes the valve-stem t^5. A coiled spring t^6 is wholly inclosed in said cup and about the valve-stem and abuts against a nut t^7, engaging the upper end of said stem. This spring operates to normally hold the valve closed against its seat. Guide-fingers t^8 are preferably formed on the upper side of the valve and operate to insure the valve moving in a right line and properly seating itself. The hollow boss or cup serves as a housing to protect the spring from injury and prevent scale and other residuum from coming in contact therewith and interfering with its action, so that the proper operation of the valve is insured at all times, and the nut serves as a means whereby the tension of said spring may be regulated as desired.

The discharge-valve and ammonia-expansion chamber S on the lower end of the ammonia-cylinder comprises an annular wall W, formed integrally with and hanging pendent from the detachable head X and forming a chamber of the same diameter as the cylinder, and this chamber is closed by a bottom plate X′, bolted to an annular flange *y*, formed on the lower end of said wall. In this casing is arranged a vertically-movable valve *z*, that controls a port *y′* in the lower cylinder-head. As shown, this valve is of considerable area to permit the rapid passage of the ammonia-gas and on its under side is provided with a hollow stem *z′*, that fits over a stud z^2, supported by the bottom plate X′. The sides of the valve-stem are provided with ports z^3, and a coiled spring z^4 is arranged in the stem and rests on the stud. The spring operates to normally hold the valve closed, and the ports z^3 permit the ammonia-gas to have access to the under side of the valve and prevent the formation of a vacuum thereunder. Guides z^5 project from the bottom plate of the valve-casing and embrace the valve-stem to insure the proper movement of the valve, and by detaching said bottom plate the valve can be removed and replaced when desired without disturbing any of the other parts of the pump. The discharge-port S′ is of the same area as the outlet formed by the downward movement of the valve *z* on the downstroke of the piston.

The operation is as follows: The liquid ammonia flows from the condenser B to the liquid-ammonia receiver D through the pipe *d* and from said receiver, through the pipe *g*, to the expansion-valve *g′*. When this valve is opened, the ammonia passes into the upper header *f* of the expansion-coils *e* and being relieved of pressure "boils" or expands in said coils and absorbs the heat in the manner well known to those versed in the art. A certain proportion of the ammonia in passing through the coils unavoidably condenses therein and passes, with the oil, scale, and other liquid and solid foreign substances, into the bottom header *f′*, where it remains in all other constructions of machines until blown out. This tendency of the ammonia to condense increases with the length of expansion-surface employed and may be regulated in short coils by varying the pressure and feed of ammonia. Now the action of ammonia-gas is simply a boiling of that gas into a vapor and the consequent absorption of heat, and when the vapor is once formed or the expansion has taken place the gas has acquired its load of heat and should be removed at once. Hence the accumulation of any stagnant bodies is not only objectionable on account of the presence of non-conducting substances, but also on account of the resistance opposed to the free flow and expansion of the gas. Instead of feeding an excess quantity of ammonia into the coils or rushing the same therethrough under high pressure, as has been necessary heretofore, I am enabled to feed only the amount of ammonia absolutely required for cold production, and this expands fully and freely without restriction throughout the coils and absorbs a full load of heat and then enters the bottom header *f′* in the state of a densely-saturated gas. From said header the gas, oil, scale, and other foreign substances carried along with the ammonia flow quickly into the suction-pipe *h* and through the latter into the cylinders K of the ammonia-pumps through the suction-ports R′, the expansion of the ammonia in the interposed coil *h′* serving to keep the distilled water in the tank G at a low temperature, and the slight fall or inclination of the suction-pipe, in addition to the suction action of the pumps, insuring the ready flow and quick passage of the ammonia

vapor and liquids through said pipe, so that the coils, bottom header, and suction-pipe will be kept free at all times of stagnant bodies of liquids and other obstructions. On the downstroke of the piston in each ammonia-pump cylinder the ammonia gases and liquids flow into said cylinder, and the valve t^2 being closed the piston forces the gases and liquids beneath it past the valve z into the chamber S and out through the discharge-pipe. On the reverse or up stroke of the piston the valve t^2 opens to permit the passage of the gases and liquids through the piston, while the valve z closes, whereby the gases and liquids pass to the under side of the piston to take the place of the gases and liquids previously expelled by the downstroke of the piston. The gases and liquids on entering drop by gravity onto and through the piston, and thus thoroughly drench and cool the same and cylinder-wall, and owing to the very slight friction created by the piston in its action undue expansion does not occur, and a full load is thereby compressed by the piston on each working stroke. The location of the suction-port below the upper head R of the cylinder also prevents the liquids from coming into contact with said head, and as the saturated gases also gravitate downward only a small proportion of the gases come in contact therewith, and these are not unduly expanded, owing to the effective lubrication and perfect balancing of the piston-rod, whereby excessive friction is avoided, and to the counteracting cooling effect of the larger body of gravitating liquids and gases. Hence the slight amount of heat generated by the action of the gas itself is taken up by a small proportion of the liquid ammonia in its expansion into vapor and the use of a water-jacket obviated.

An outer oil-seal bonnet U and stuffing-boxes of the construction set forth in detail in my application for Letters Patent filed June 12, 1897, Serial No. 640,496, are preferably employed to prevent the escape of ammonia and to lubricate the piston-rod. Lubrication of the piston is effected in the main by the ammonia, which possesses lubricating properties; but the small quantity of oil unavoidably carried into the cylinder by the action of the piston-rod also assists in this operation. This waste of oil is infinitesimal, however, as the oil in the bonnet is not under pressure and is so arranged that but enough oil is supplied to the stuffing-boxes to lubricate the piston-rod, and the minute quantity which passes out with the ammonia may be readily separated therefrom without the necessity of employing a complicated apparatus. Should any oil pass the separator, however, provision is made, as hereinbefore described, to prevent the accumulation of the same in the coils. It may be stated that a separator will be employed in this apparatus more for the purpose of collecting scale and other residuum than separating the oil, as the waste of oil is so slight that the apparatus may be run for a long period without the use of a separator and without deleterious effects from the oil being experienced.

The bottom head of the cylinder is maintained at a low temperature by the action of the liquids and gases falling thereon between the periods of compression; but superheating of the ammonia unavoidably takes place during compression, and it is to compensate for this that the chamber S is provided. This chamber is, as before stated, of the same area in diameter as the cylinder, and the heated gas flowing through the restricted port z' expands therein and is thereby relieved of a portion of the heat of compression, so that it will pass out through the discharge-port S′ into the delivery-pipe b at a temperature but little above the boiling-point, due to condenser-pressure. Hence the efficiency of the apparatus is greatly increased and the expense of operating the same correspondingly diminished, as but a small amount of water on the condenser is required to quickly relieve the gas of its heat and liquefy it. The chamber also serves as a trap or receptacle which retains all foreign substances washed down thereinto by the falling gases and liquids and prevents the same from passing to the condenser and a second time throughout the system.

It will be readily understood from the foregoing description that as the ammonia comes to the compressor in the state of a densely-saturated gas a much larger volume of gas is compressed at each stroke of the piston than in machines where the gas is superheated or expanded unduly, and hence that greater efficiency may be attained with smaller cylinders and even a considerable reduction in speed. In the operation of the compressor the piston in each pump-cylinder is forced completely down to the bottom head on its working stroke by the action of the walking-beam driven from the crank-shaft and fly-wheel, which serve to carry the parts past the center and insure a complete stroke and steady action of the pistons, and thus all gases are expelled. Should the pump-cylinder become gorged or flooded by a large amount of liquid, the pistons in the pump and power cylinders will cushion back on the steam or other elastic impelling medium in said latter cylinder, so that motion of the parts will be arrested until the liquids are fully expelled and knocking out of the head of the pump-cylinders or damage to the operating mechanism thereby prevented. This action will also take place if the pump-piston should drop on account of wear on the parts and contact with the head of the cylinder before the piston in the power-cylinder completes its stroke.

I do not herein claim the construction of compression-pump and parts shown nor the duplex power-pump, as the former constitutes the subject-matter of an application filed June 12, 1897, Serial No. 640,496, and the

latter the subject-matter of an application filed April 2, 1898, Serial No. 676,207, allowed September 19, 1898.

Having thus described the invention, what is claimed as new is—

1. In a refrigerating or ice-making machine, the combination of expansion-coils connected at their induction and eduction ends by headers, a condenser, means for conducting the liquid refrigerating medium from the condenser to the induction-header of the coils, a vertical pump-cylinder having a suction-port at its upper end, a discharge-port at its lower end and an indirectly-connected piston working therein to compress the refrigerating medium on its downstroke, a delivery-pipe leading from the lower discharge-port of the pump-cylinder to the condenser, a suction-pipe leading directly from the eduction-header of the expansion-coils to the upper suction-port of the pump-cylinder to quickly relieve the coils of obstructions and conduct the refrigerating medium by gravity away from the header as fast as it flows therein in a liquid or densely-saturated state to said pump-cylinder, whereby said medium on entering the cylinder falls by gravity to the bottom thereof and drenches the piston, body and bottom head of the cylinder, expands and cools said parts and also washes the residuum to the bottom of the cylinder, and a superimposed vertical fluid-pressure power-cylinder having a piston operatively connected to the pump-piston for driving the latter, whereby said pistons are adapted to cushion back on the elastic impelling medium in the power-cylinder when said pump-cylinder becomes gorged or flooded with liquid, substantially as described.

2. In a refrigerating or ice-making apparatus, the combination of expansion-coils connected at their induction and eduction ends by headers, a condenser, means for conducting the liquid refrigerating medium from the condenser to the induction-header of the coils, a vertical pump-cylinder arranged in or below the plane of the coils and having a suction-port at its upper end, a discharge-port at its lower end and an indirectly-connected piston working therein to compress the refrigerating medium on its downstroke, a delivery-pipe leading from the lower discharge-port of the pump-cylinder to the condenser, a suction-pipe leading directly on a fall or downward inclination from the eduction-heater of the expansion-coils to the suction-port of the pump-cylinder to conduct the refrigerating medium in a liquid or densely-saturated state from said heater to the cylinder and facilitate the flow of the liquid thereto by gravity, and a superimposed fluid-pressure power-cylinder having a piston operatively connected to the pump-piston for driving the latter, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

GEORGE B. HIETT. [L. S.]

Witnesses:

GLADYS L. THOMPSON,

GENEVIEVE MATTHEWS.