No. 671,810. Patented Apr. 9, 1901.

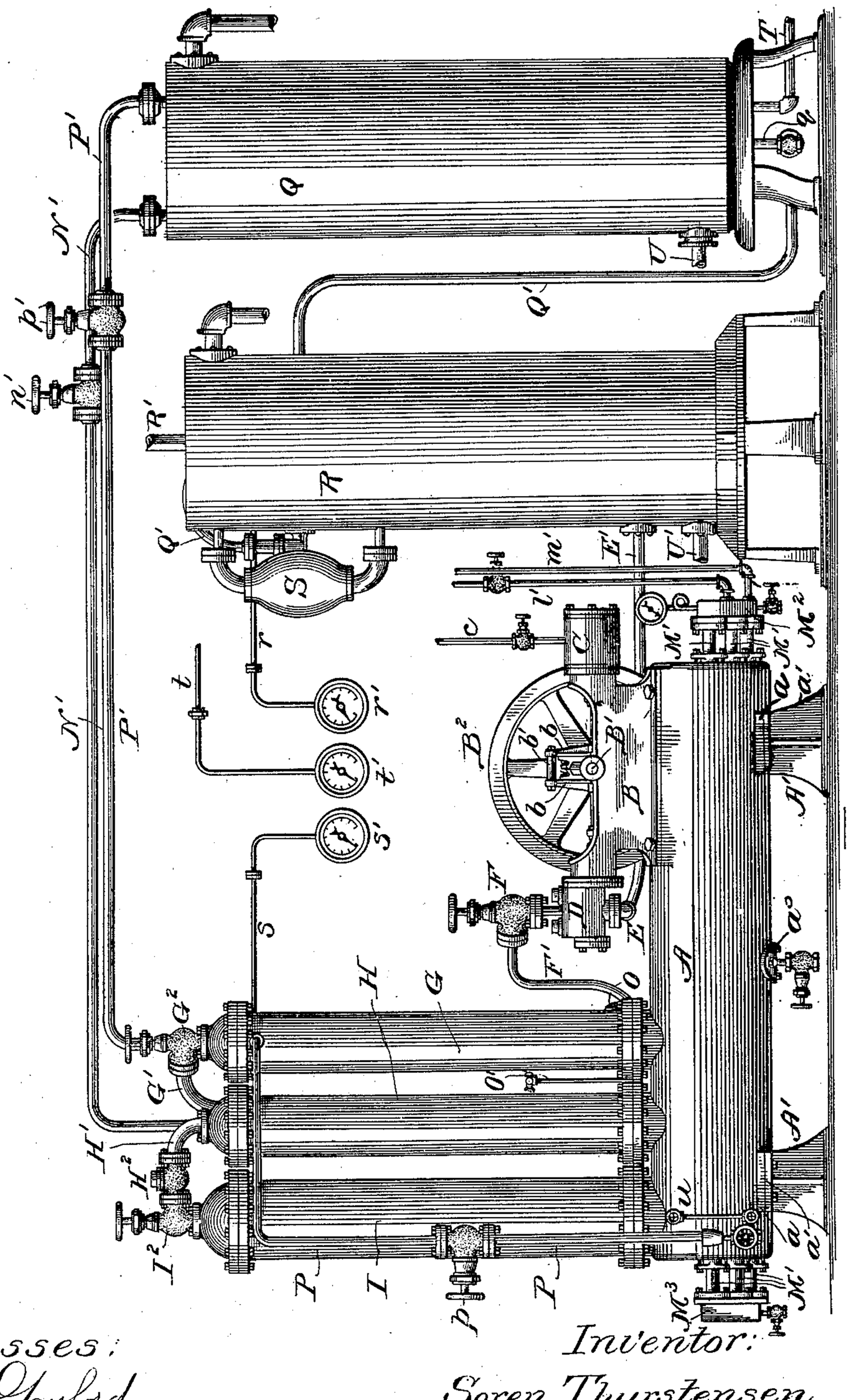
S. THURSTENSEN.

AMMONIA STILL.

(Application filed Feb. 19, 1900.)

(No Model.) 6 Sheets—Sheet 1.

Fig. 1.



No. 671,810. Patented Apr. 9, 1901.

S. THURSTENSEN.

AMMONIA STILL.

(Application filed Feb. 19, 1900.)

(No Model.) 6 Sheets—Sheet 2.

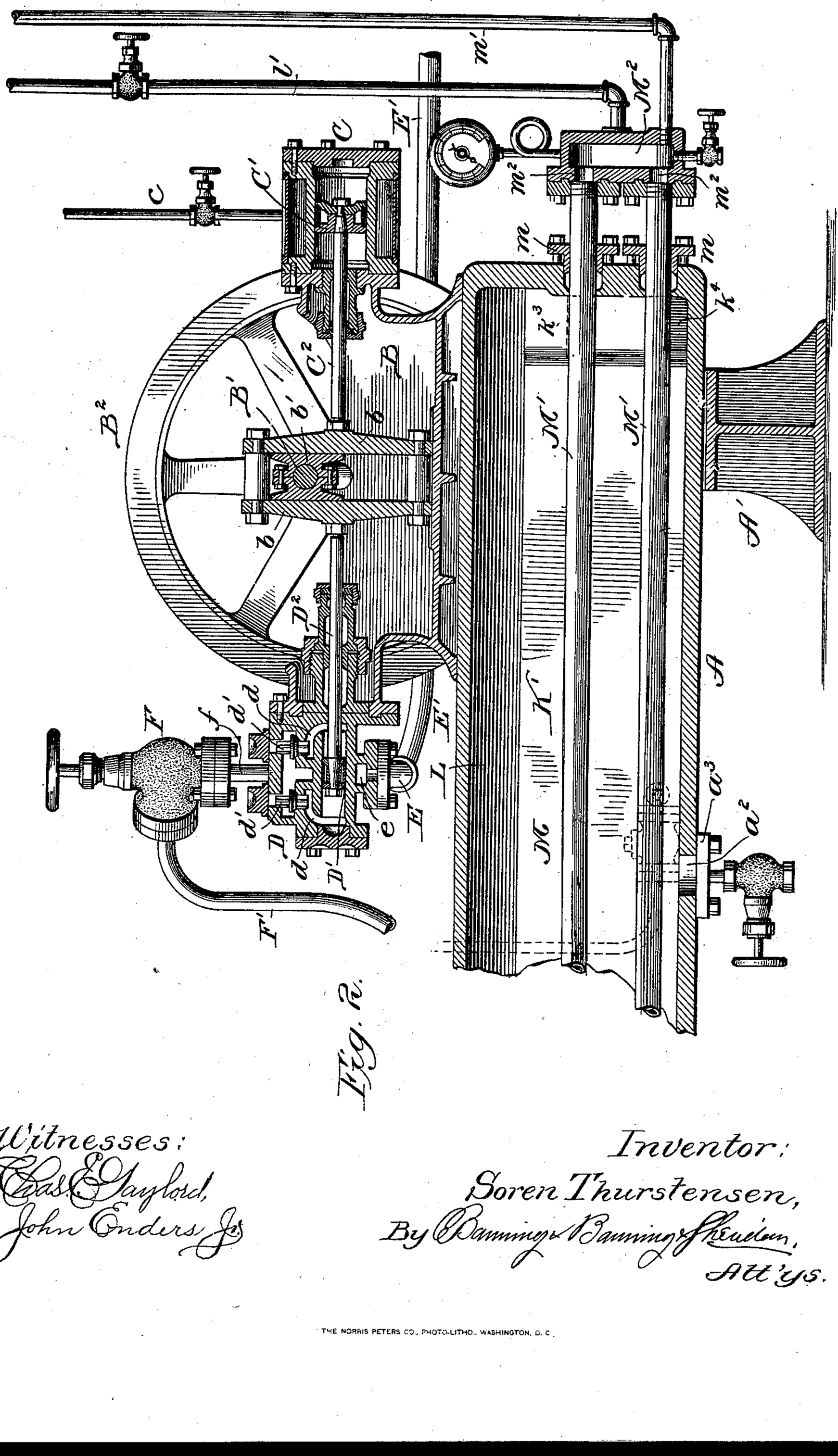


Fig. 2.

Witnesses:
Chas. E. Gaylord,
John Enders Jr.

Inventor:
Soren Thurstensen,
By Banning & Banning & Sheridan,
Att'ys.

No. 671,810. Patented Apr. 9, 1901.

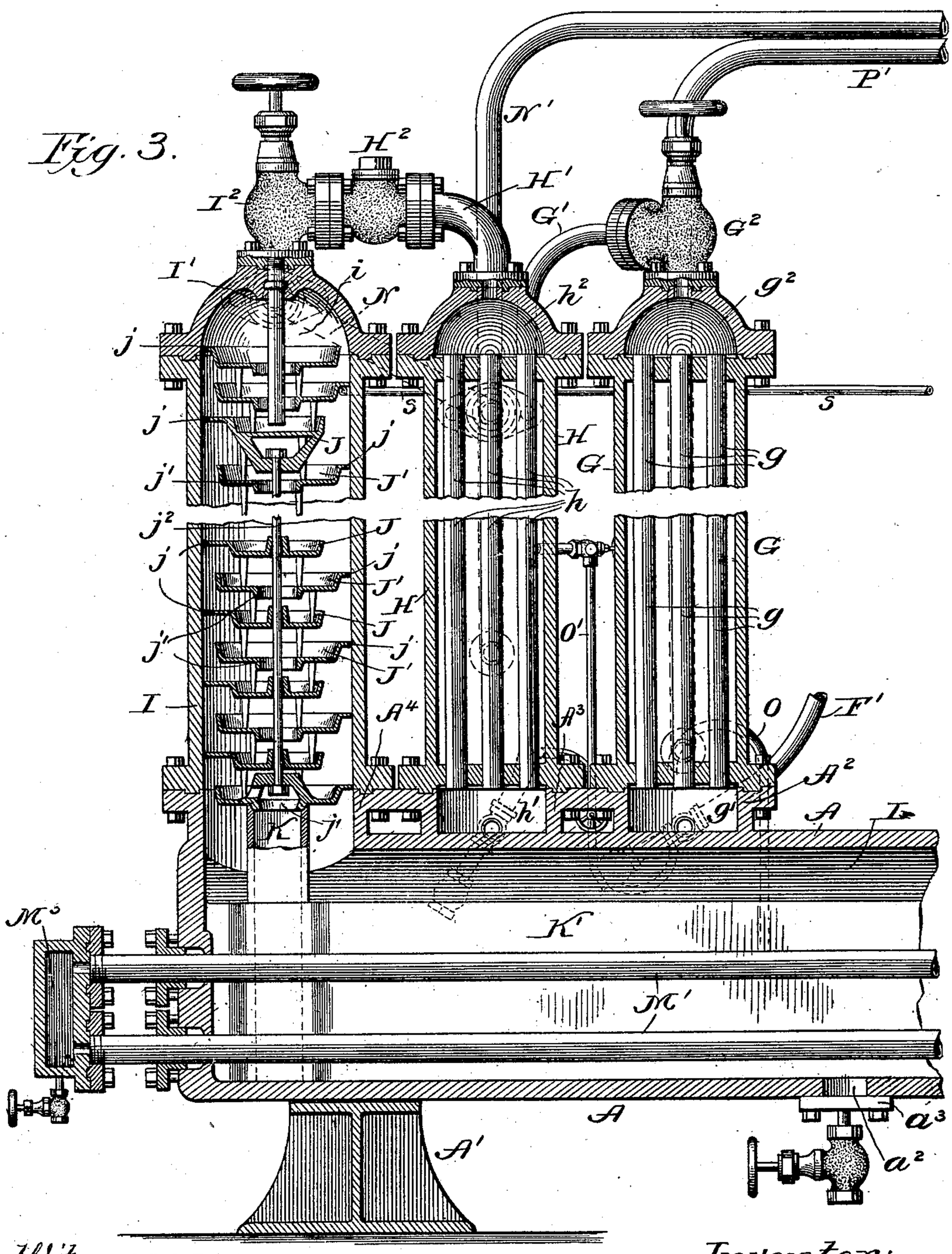
S. THURSTENSEN.

AMMONIA STILL.

(Application filed Feb. 19, 1900.)

(No Model.) 6 Sheets—Sheet 3.

Fig. 3.



Witnesses:
Chas. E. Gaylord,
John Enders Jr.

Inventor:
Soren Thurstensen,
By Banning & Banning & Sheridan
Att'ys

No. 671,810. Patented Apr. 9, 1901.

S. THURSTENSEN.

AMMONIA STILL.

(Application filed Feb. 19, 1900.)

(No Model.)

6 Sheets—Sheet 4.

Fig. 4.

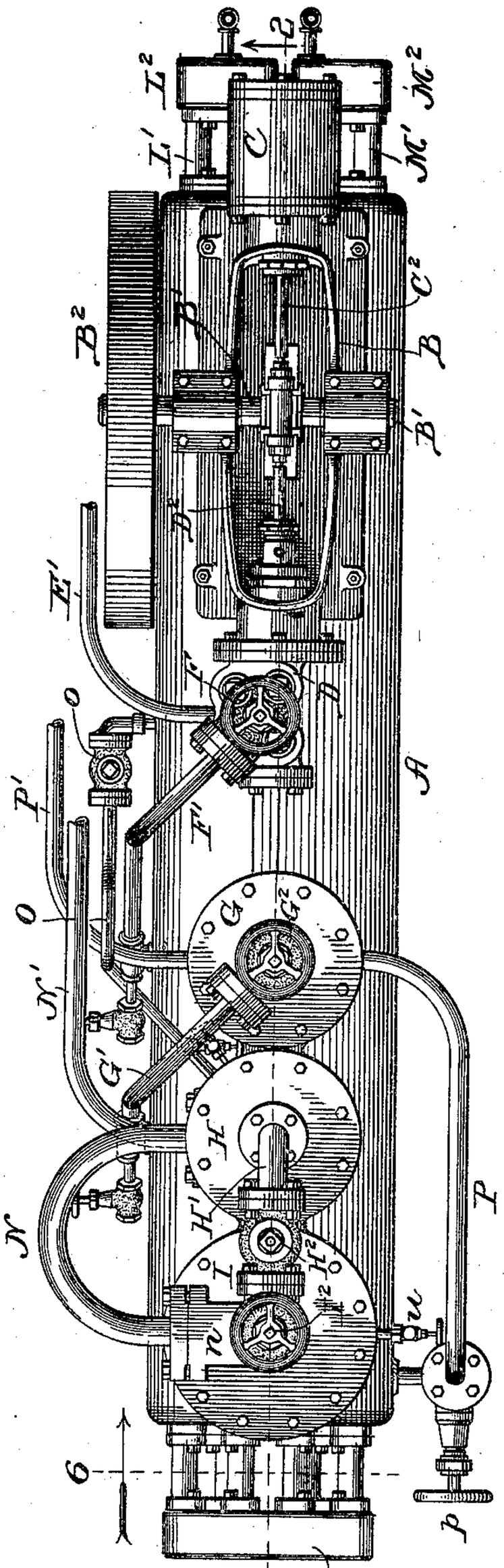
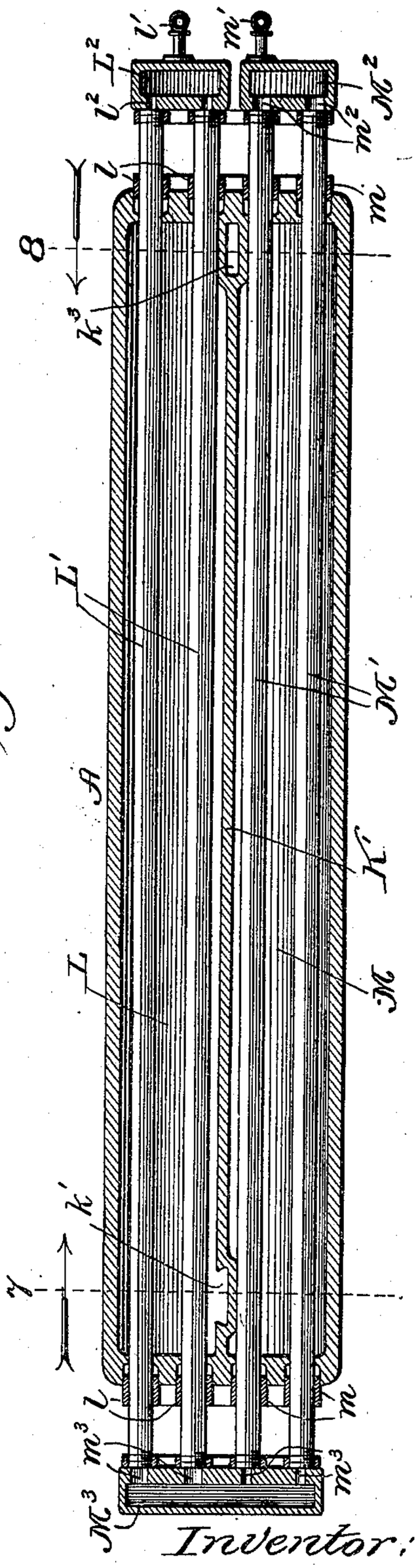


Fig. 5.



Witnesses:
Chas. E. Gaylord,
John Enders Jr.

Inventor:
Soren Thurstensen,
By Banning & Banning & Sheridan
Att'ys.

No. 671,810. Patented Apr. 9, 1901.

S. THURSTENSEN.

AMMONIA STILL.

(Application filed Feb. 19, 1900.)

(No Model.) 6 Sheets—Sheet 5.

Fig. 6.

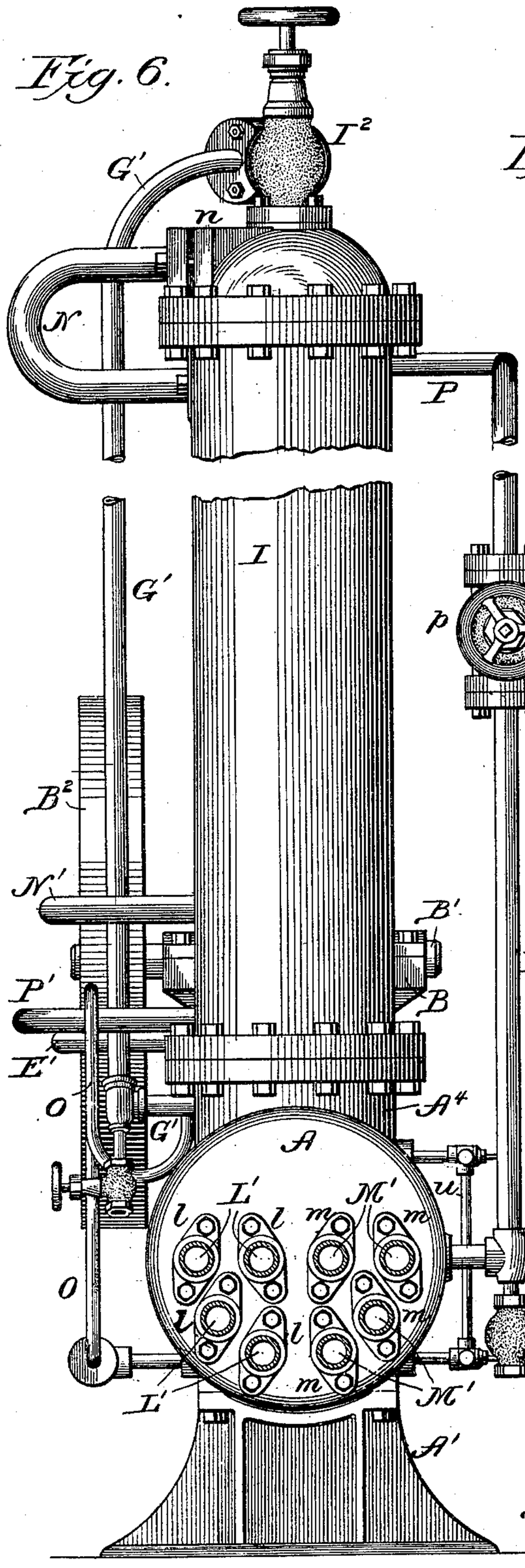
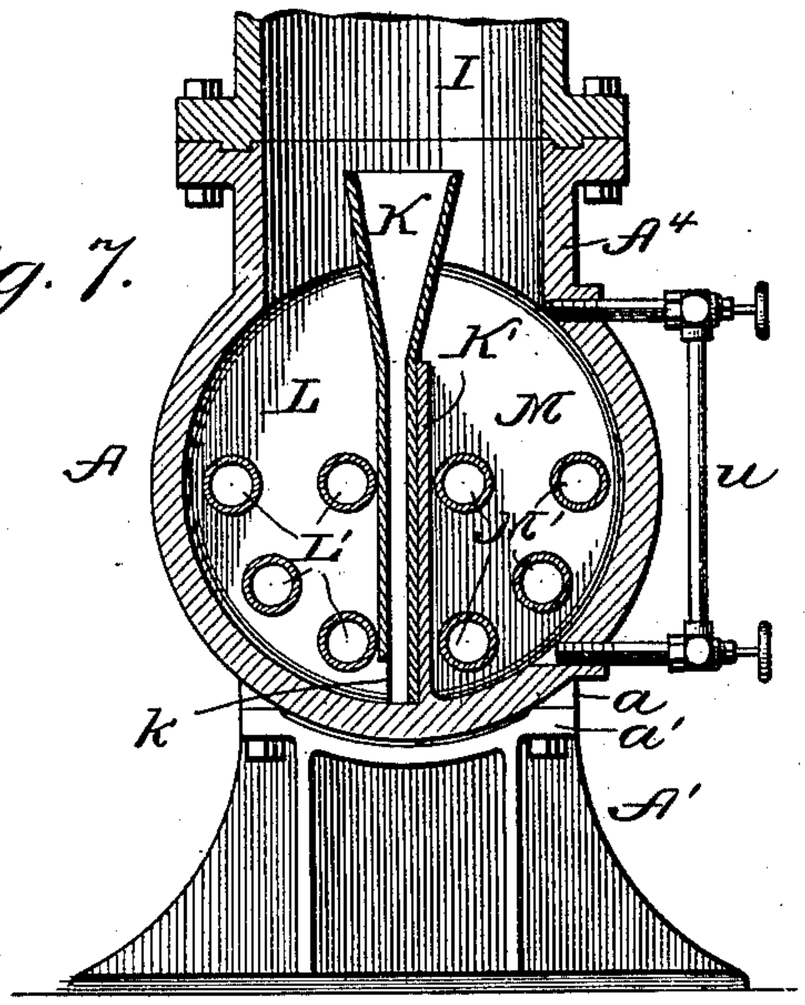


Fig. 7.



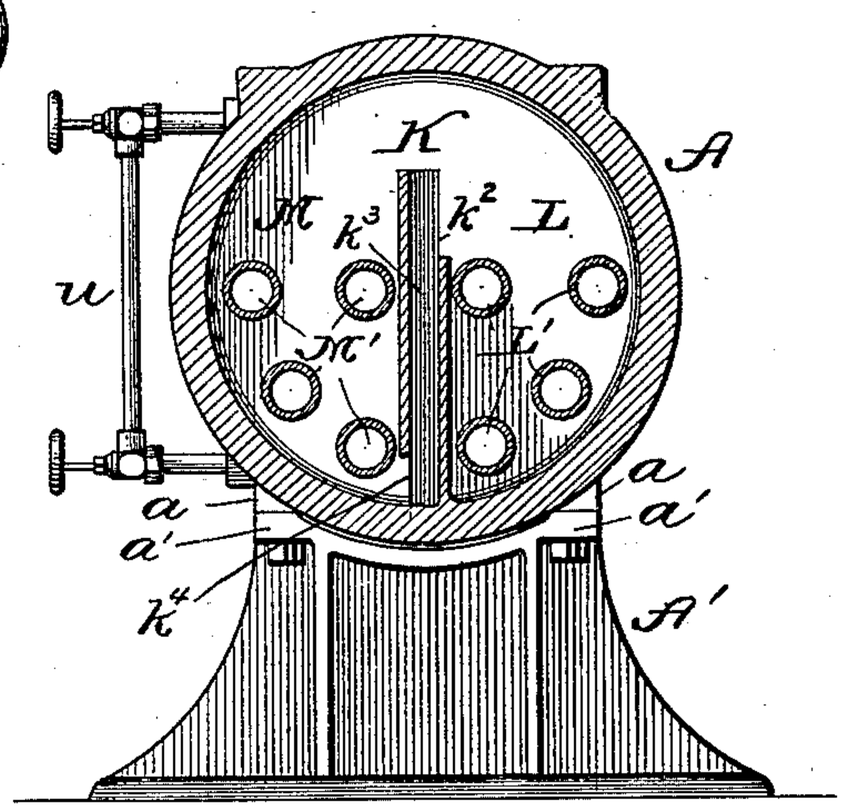


Fig. 8.

Witnesses.
Chas. E. Gaylord,
John Enders Jr.

Inventor:
Soren Thurstensen,
By Banning & Banning & Sheridan.
Att'ys.

No. 671,810.

Patented Apr. 9, 1901.

S. THURSTENSEN.

AMMONIA STILL.

(Application filed Feb. 19, 1900.)

(No Model.)

6 Sheets—Sheet 6.

Fig. 9.

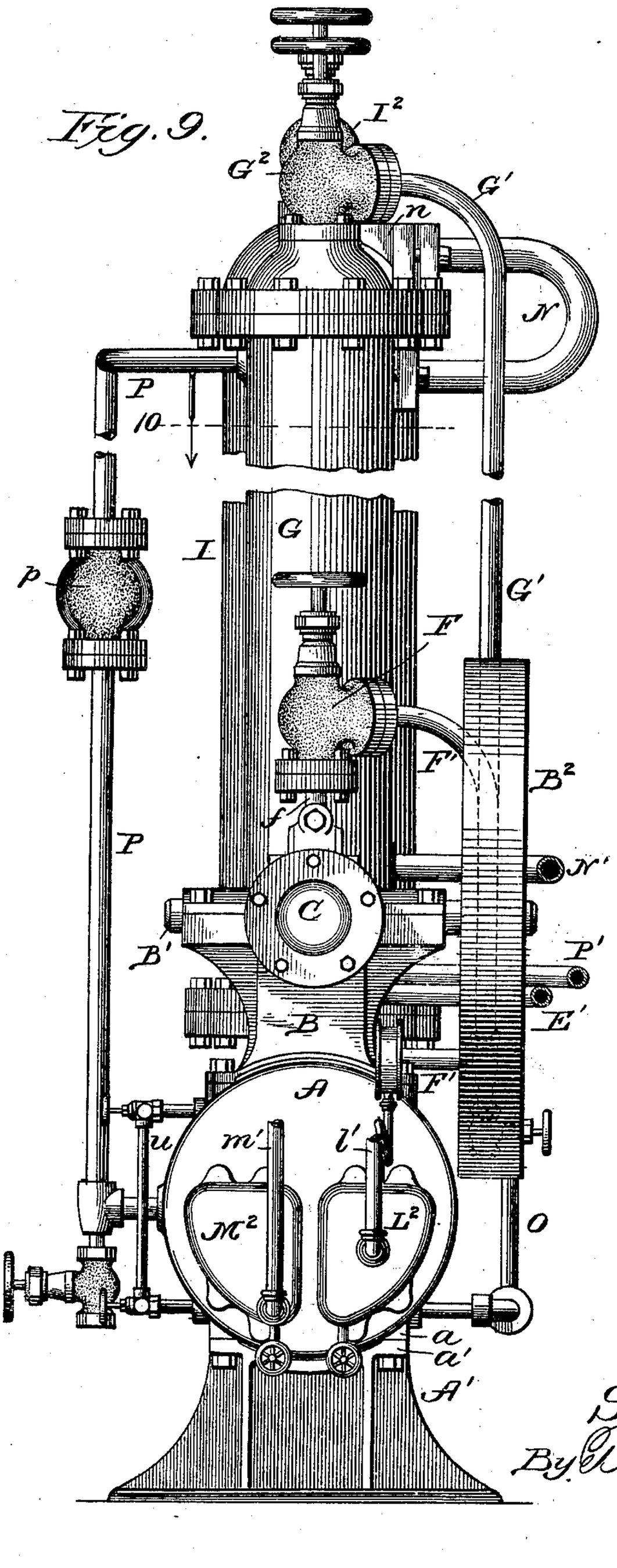
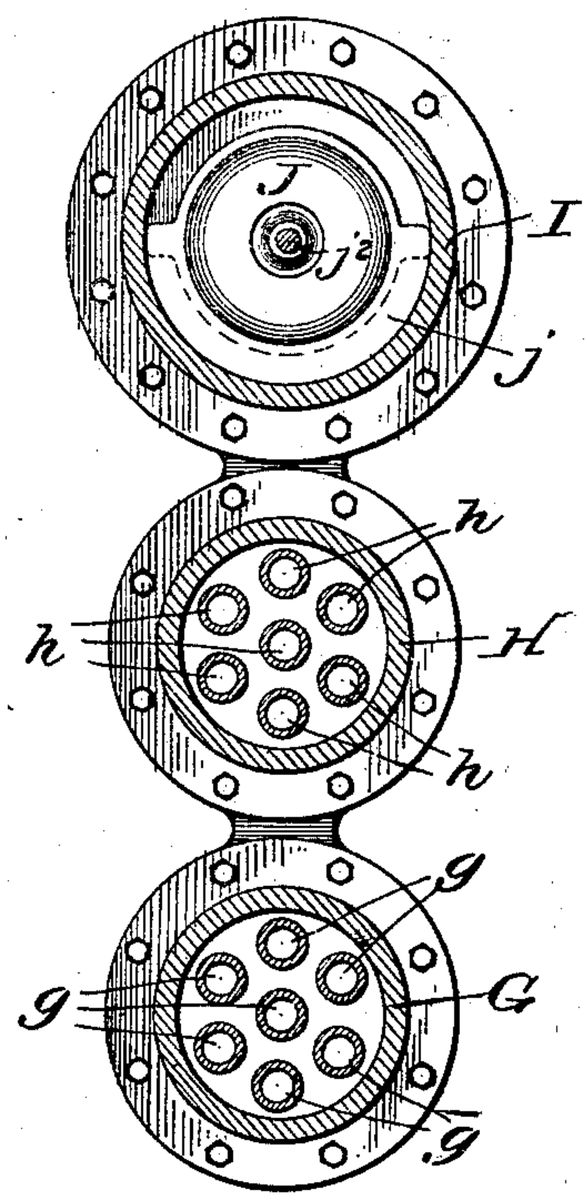


Fig. 10.



Witnesses:
Chas. E. Gaylord,
John Enders, Jr.

Inventor:
Soren Thurstensen,
By Banning & Banning & Sheridan
Att'ys.

UNITED STATES PATENT OFFICE.

SOREN THURSTENSEN, OF LOUISVILLE, KENTUCKY, ASSIGNOR TO HENRY VOGT MACHINE COMPANY, OF SAME PLACE.

AMMONIA-STILL.

SPECIFICATION forming part of Letters Patent No. 671,810, dated April 9, 1901.

Application filed February 19, 1900. Serial No. 5,827. (No model.)

To all whom it may concern:

Be it known that I, SOREN THURSTENSEN, a citizen of the United States, residing at Louisville, in the county of Jefferson and State of Kentucky, have invented certain new and useful Improvements in Ammonia-Stills, of which the following is a specification.

This invention relates to ammonia-stills more especially designed for use with what are known or termed "absorption ice-machines," in which the operation is carried on in three principal stages, comprising the generation of gas by heat, the liquefaction of the gas by the withdrawal of heat, and the expansion of the liquid to a gaseous state absorbing heat from the surrounding objects and the reabsorption of the gas by the weak liquid, such machines employing usually in the operation aqua-ammonia as the refrigerating agent. The production of the gas in this class of ice-machines is had by pumping the ammonia or refrigerating agent into a generator and there subjecting it to heat until the ammonia is driven off in the form of gas under varying pressure of pounds per square inch, according to the temperature of the cooling-water in the condenser. The produced gas passes from the generator to the condenser, and the heat which was imparted in the generation is absorbed by cooling-water, which causes the ammonia-gas to be cooled to the temperature of the flowing water, by which it is liquefied. The liquefied gas is admitted to the expansion-coils, which are surrounded by the substances to be cooled, and by reason of the very low pressure carried in the coils the liquid immediately on entering the coils reëxpands to a gaseous state and reabsorbs from the pipes and surrounding objects the same amount of heat that was previously extracted from the gas by the cooling-water in the condenser. The gas after thus having performed the required refrigeration is returned to the absorber to be reabsorbed by the weak liquid from which it was originally separated, which liquid in the meantime has passed from the generator to the absorber, through which cooling-water is constantly circulated, so that the weak liquid is cooled down and rapidly reabsorbs the gas, forming again the strong solution of aqua-ammonia, which in turn is pumped back into the generator, completing the circuit or flow of the liquid from and return to the generator for a renewed operation. This is a brief statement of the parts which enter into the construction of absorption ice-machines and of the operation of such machines as usually constructed.

The objects of my invention are to improve the construction and design of the machine, more particularly as relates to the location and arrangement of the generator, analyzer, rectifier, exchanger, and pump, by providing a main generator on which the other parts named are located and supported, so as to make the machine very compact and occupy but a small space; to improve the construction of the main generator-cylinder casting and furnish a support for the coacting devices which operate therewith to give an improved result and a more perfect circulation for the action of the heat-transmitting pipes on the aqua-ammonia and an improved result in the production of an increased and better quality of gas; to improve and simplify the construction of the rectifier and exchanger and dispense with coils in these parts of the apparatus and use but a few joints for connection; to so construct, arrange, and operate the generator and the rectifier as to employ the rich liquid on its way to the generator to partially condense the ammonia-gas in its outward passage from the generator and by such arrangement deprive the gas essentially of all moisture, thereby dispensing with the employment of cooling-water for this purpose, as heretofore required in these machines; to construct and arrange the rectifier so as to have the rich liquid and the gas flow in opposite directions for the liquid to act against the gas and the moisture therein and have the moisture be thereby condensed and deposited on the tubes, depriving the gas of the moisture for the moisture to accumulate in the bottom of the rectifier and be therefrom transferred back into the generator automatically; to improve the construction, arrangement, and operation of the several parts through which the liquid and gas are passed, so that the flow through the various devices will be in a direction by which all liquids to

be heated will pass in an upward direction and all liquids and gases to be cooled will pass in a downward direction, thereby materially increasing the capacity and reliability of the machine in its operation on the liquids and gases, and to improve generally the construction, arrangement, and operation of the several parts which coöperate in the use of the machine.

The invention consists in the features of construction and the combination and arrangement of parts hereinafter described and claimed.

In the drawings illustrating my invention, Figure 1 is a side elevation of the entire machine, including the condenser and weak-liquor cooler and the absorber; Fig. 2, a longitudinal section showing a portion of the main generator and casting, with the pump mounted thereon, taken on line 2 of Fig. 4 looking in the direction of the arrow; Fig. 3, a longitudinal section showing a portion of the main generator and casting, with the analyzer, rectifier, and exchanger mounted thereon, taken on line 3 of Fig. 4 looking in the direction of the arrow; Fig. 4, a top or plan view of the main generator and casting and the parts which are mounted thereon and carried thereby; Fig. 5, a longitudinal section through the generator and casting looking down; Fig. 6, an end elevation of the machine, partly in section, on line 6 of Fig. 4 looking in the direction of the arrow and partly broken away; Fig. 7, a cross-section of the main generator and casting on line 7 of Fig. 5 looking in the direction of the arrow; Fig. 8, a cross-section of the main generator and casting on line 8 of Fig. 5 looking in the direction of the arrow; Fig. 9, an elevation of a machine at the pump end thereof, with some of the parts broken away; and Fig. 10, a cross-section on line 10 of Fig. 9 looking down and showing the analyzer, rectifier, and exchanger cylinders and other devices.

In carrying out my invention I construct a cylinder A for the main generator and forming the main casting for supporting the other appliances, as hereinafter described. This cylinder and casting is formed of one piece, with its ends or heads cast with its body, and, as shown, is supported upon feet or standards A′, for which purpose the cylinder or casting A is provided on each side at the ends with ears or flanges a, which coact with ears or flanges a' for the passage of bolts by which the cylinder and base-support are connected together. On the upper side of the generator-cylinder and main casting A is mounted and secured a frame or support B, forming the base or bed for an ammonia-pump. The bed or base B has on each side standards or uprights b, which receive the boxes or bearings b' of a crank-shaft B′, having at one end a fly-wheel B^2 in the arrangement shown. A steam-cylinder C is attached to one end of the bed or base and has therein a piston C′, connected by a piston-rod C^2 with the crank-shaft B′, so that by supplying steam to the cylinder from the pipe c, controlled by a proper valve, the piston will be reciprocated to drive the crank-shaft. The cylinder D of an ammonia-pump is suitably secured to the opposite end of the bed or base from the steam-cylinder. The ammonia-cylinder has a sliding valve D′, operated from a piston-rod D^2, connected with a crank-shaft B′, so that with the reciprocation of the valve ports d and valves d' are alternately opened and closed for the passage of aqua-ammonia or ammonia liquid through the ammonia cylinder or pump. The ammonia-cylinder has a connection E for the attachment of a supply-pipe E′, leading to the absorber, and through which the ammonia liquid is drawn from the absorber and admitted to the ammonia-cylinder, passing through a port and passage e, communicating with the neck or coupling E. The admitted ammonia liquid is forced by the action of the piston-controlling valve D′ through the passages d and valves d' on opposite sides of the piston-valve alternately into a receiving-chamber, from which chamber it passes through a connecting pipe or tube f into a controlling-valve F, by means of which the supply of aqua-ammonia or liquid ammonia is regulated in its passage from the absorber to the generator A. The ammonia flows from the absorber into the supply or suction pipe E′, and by the suction of the piston of the ammonia cylinder or pump is drawn through the connection E into the suction port or passage e of the ammonia-cylinder, which port extends half-way around the cylinder and communicates with the ports d, and through the reciprocating action of the piston of the ammonia cylinder or pump the liquid thus drawn in through the port or passage e is forced through each of the discharge-valves d' in the usual manner.

The controlling-valve F has connected therewith an eduction-pipe F′ for conducting the liquid into the chamber of an exchanger G. This exchanger consists of an outer cylinder or pipe having a base mounted on a base A^2, formed with the generator-cylinder and main casting A, in which base A^2 is the receiving-chamber g', into which the ammonia liquid is introduced from the ammonia-cylinder through the pipe F′. The outer cylinder of the exchanger has located therein a series of pipes g, communicating at the lower end with the chamber g' and at the upper end with a chamber g^2, formed in the cap or cover of the exchanger, so that the ammonia liquid will pass upward from the chamber g' to the pipe g into the chamber g^2. The chamber g^2 communicates with a controlling-valve G^2, from which an eduction-pipe G′ leads to the receiving-chamber of a rectifier H.

The rectifier H has a base-plate at its lower end mounted on a base A^3, formed with the generator-cylinder and main casting A, in which base A^3 is the receiving-chamber h' of the rectifier. The rectifier is formed of an

outer pipe or cylinder inclosing a series of pipes h, communicating at their lower end with the receiving-chamber h' and at their upper end with a delivery-chamber h^2, formed in the cap or cover for the upper end of the rectifier. The chamber h^2 has leading therefrom and communicating therewith a pipe H', which connects with a coupling H^2, having a check-valve therein, and this coupling is connected with a controlling-valve I^2 on the top of the analyzer. The analyzer has a base-plate at its lower end which connects with a base A^4, formed with the generator-cylinder and main casting A. The several base portions A^2 A^3 A^4 are, as shown, connected one with the other and form a continuous support on the upper side of the generator-cylinder and main casting for the attachment and support of the exchanger, rectifier, and analyzer. The interior of the analyzer has an open communication through its base A^4 with the interior of the generator-cylinder and main casting, and entered into its upper end is a discharge pipe or tube I', leading from the controlling-valve I^2 for supplying aqua-ammonia or ammonia liquid to the analyzer from the rectifier. The tube or cylinder of the analyzer has located in its interior a series of pans or receptacles J and J', of which J is of a less diameter than J', and the pans or receptacles J' are provided with a central hole or opening, so that the liquid deposited in the initial pan or receptacle overflows its top and enters the adjoining larger pan to pass therefrom through the hole in the bottom of such pan into the adjoining smaller pan to overflow the top of that pan into the next adjoining pan, and so on until the bottom pan is reached. Each pan, as shown, has three outwardly-projecting lugs or prongs j, which contact with the wall of the cylinder or tube of the analyzer and hold the pans centrally in place. The space above the initial pan is provided with two large pans in the arrangement shown for receiving the drip and causing it to flow into the first acting pan or receptacle. The acting pans or receptacles proper are united one to the other and held in position by a tie-rod j^2, and the bottom pan is supported on a funnel or discharge-spout, the top of which is within the opening of the base or wall A^4.

The funnel or discharge-pipe K has a passage of a less width one way than the other, and in the direction of the greater width the width is equal to the diameter of the opening in the bottom of the last pan of the analyzer and in the direction of the narrower width the mouth or receiving end of the passage is widened or spread on its two sides into a hopper shape, so that the mouth or receiving end will include or embrace within it the central discharge-opening of the last analyzer pan or receptacle, and its body in the construction shown has an exterior dovetail shape to enter a dovetail recess k' in the partition or division plate K', which divides the generator-chamber into two compartments or divisions. The discharge-passage of the funnel or spout K terminates at its lower end on one side in a mouth or opening k, which leads directly into one chamber or compartment L of the generator-chamber, in which compartment is located a series of steam-pipes L'. The opposite end of the partition or division plate K' to that having the discharge-spout attached thereto is provided at its upper edge with a mouth or opening k^2, leading into or communicating with a passage k^3, having at its bottom, on the opposite side to the mouth or opening k^2, a mouth or opening k^4, leading direct into the other chamber or compartment M of the generator-chamber, in which chamber or compartment is located a series of steam-pipes M'. Both series of steam-pipes L' and M' pass at each end through the solid end walls of the generator-cylinder or main casting, and at the point of passage of each pipe L' in each cylinder-head is a stuffing-box l, and a stuffing-box m is provided for each pipe M' where such pipe passes through the heads of the cylinder, forming a tight joint around each pipe against the escape of ammonia. The pipes L' open into a steam-induction chamber L^2, to which steam is supplied by a valve-controlled pipe l' and from which steam passes into the pipes L' through ports or openings l^2, one for each pipe. The steam flows through the set of pipes L' into a return steam-chamber M^3, from which chamber steam enters the pipes M' through ports or openings m^3. The steam flows through the set of pipes M' and after traveling through the pipes enters an eduction-chamber M^2 through ports or openings m^2 and passes out from such chamber through a valve-controlled pipe m'. The pipes traverse the entire length of their respective chambers or compartments L and M, and the aqua-ammonia or ammonia liquid as it enters the chamber L and rises therein comes in contact with the hot pipes L' of that chamber, causing ammonia-gas to be thrown off, and from the chamber or compartment L the liquid after being subjected to the heat of the pipes of that chamber flows through the passage k^3 and openings k^2 and k^4 and enters the chamber or compartment M at the bottom and rises in such chamber, subject to the action of the heat of the pipes M', causing ammonia-gas to be thrown off from the action of the heat. Aqua-ammonia or ammonia liquid traverses the full length of both chambers or compartments as well as rising in each, and in this way is subjected to the action of a large heating-surface, by which an increase in the amount of gas produced is secured and the liquid is more efficiently and thoroughly evaporated. The induction of the steam into the pipes L' is at the opposite end to the induction of the rich liquid into the chamber L, and the induction of the steam from the chamber M^3 into the pipes M' is at the opposite end to the induction of the rich liquid from the chamber L into the cham-

ber M. This arrangement gives a circulation for the rich liquid and steam through the generator in opposite directions, producing an increased effect in the absorbing of heat by the liquid for the generating of gas. The generated ammonia-gas passes up through the opening in the generator-cylinder around the spout or conductor K and enters the analyzer I and passes up therein, and in such passage is subjected to the liquid passing down in the analyzer from pan or receptacle to pan or receptacle, by which arrangement the moisture in the gas will be taken up by the liquid, owing to the fact that the gas is warm, while the liquid is comparatively cool, so that when the gas reaches the upper end of the analyzer and enters the chamber *i* a large proportion of its moisture has been removed. The gas from the chamber *i* passes into a channel *n*, with which communicates one end of a pipe N, leading into the rectifier H below the closed upper end of the outer tube or cylinder of such rectifier. The gas entered into the rectifier passes downward therein and in contact with the conducting-pipes *h*, through which pipes the rich liquid is passing upward. The gas passing downward around the comparatively cool pipes has all the remaining moisture there may be therein removed therefrom, by reason of the gas, being partly condensed, depositing its moisture on the exterior of the pipes *h*, which are comparatively cool, thus insuring the production of gas from which all moisture has been entirely removed. The gas passing downward outside of the pipes of the rectifier and the cool liquid passing upward produces a more effective operation in the gathering of moisture from the gas than where both the gas and cool liquid travel in the same direction. The moisture gathered on the condensing-pipes *h* passes down on such pipes to the closed bottom of the outer cylinder or tube of the rectifier and is automatically educted therefrom by a siphon or trap-pipe O, communicating with the interior of the rectifier and entered into the wall of the generator-cylinder A for the condensed moisture in a liquid form to return to the interior of the generator-chamber to be subjected to the action of the heat for the generation of gas. The siphon or trap-pipe is provided with a check-valve *o* adjacent to the generator. The generator-cylinder and main casting is provided with an armhole or opening a^2, closed by a plate a^3 for admission to the interior for cleaning or other purposes. A glass gage O′, having a valve at the top and bottom, communicates with the interior of the rectifier for the purpose of indicating that all of the condensation in the rectifier has been trapped back into the generator by the siphon or trap-pipe.

The dry gas from the rectifier flows into a conducting-pipe N′, leading from the rectifier to the condenser and weak-liquor cooler, which pipe is provided with a valve *n′* to control the passage of the gas between the rectifier and the cooler. The aqua-ammonia or ammonia liquid after being subjected to the action of heat passes from the generator into a pipe P, having a controlling-valve *p*, and passes upward in such pipe and enters the exchanger at the upper end thereof below the closed top of the outer cylinder or tube and passes down in the exchanger in contact with the pipes *g*, through which pipes the cool liquid from the ammonia-cylinder is passing upward, so that the hot liquid from the generator-chamber is subjected to the action of the cool liquid passing upward through the exchanger-pipes for the cool liquid to withdraw some of the latent heat from the hot liquid and transfer it to the cool liquid, rendering such liquid more effective to the action of the heat in the generator-chamber in throwing off ammonia-gas.

The warm weak liquid injected into the exchanger and passing down therein becomes cooled and enters a pipe P′, communicating with the interior of the exchanger above the closed bottom of the outer tube or cylinder thereof, and is conducted by the pipe P′ to the condenser and weak-liquor cooler, the pipe P′ having a valve *p′* to control the flow of liquid from the exchanger to the cooler. The cooler Q is to be provided with the usual coils in its interior, one coil for the gas and another for the weak liquid, which coils are of the usual construction and operate in the usual way and are therefore not shown nor fully described. The weak liquid entered into the coil of the cooler from the pipe P′ is conducted therefrom by a pipe Q′, having connection with the weak-liquid coil, and by such pipe is returned to the absorber R, to be again recharged with a fresh supply of gas and made into a strong liquid, for which purpose the absorber is provided with a gas-supply pipe R′, which is of the usual construction and operates in the usual manner. The absorber is provided with a regulator S for controlling the admittance of weak liquid into same. The ammonia-gas coil is connected with a pipe T for discharging the liquid ammonia in the usual manner, and the cooler or condenser is provided with a drip-tube *q*.

The condenser and weak-liquor cooler is furnished with a supply of water, as usual, through a pipe U, and water is also supplied to the absorber, as usual, by a pipe U′. The absorber has a pipe *r* leading therefrom to a pressure-gage *r′* for indicating low pressure, and the analyzer is provided with a pipe *s*, leading to a pressure-gage *s′* for indicating high pressure. A steam-pipe *t* leads to a pressure-gage *t′* for indicating steam-pressure, and the generator-cylinder and main casting is provided with ammonia-gages *u* to indicate the condition of the liquid in the generator-chamber.

The operation of the machine or apparatus will be understood from the foregoing description, but is briefly as follows: The rich or full-

charged aqua-ammonia or ammonia liquid is drawn from the absorber through the pipe leading therefrom to the ammonia pump or cylinder, and by the operation of such pump is forced through the controlling-valve of the pump into the lower end of the exchanger and passes up through the pipes of the exchanger to the top thereof and is conducted down into the lower end of the rectifier by the pipe leading from the upper end of the exchanger to the lower end of the rectifier and passes up through the pipes of the rectifier into the upper end thereof and out therefrom through the pipe connection therewith into the upper end of the analyzer, to descend by the pipe leading into the analyzer and pass from pan to pan into the compartment or chamber at one side of the longitudinal partition of the generator-chamber. The rich liquid thus delivered into the first or initial receiving-compartment of the generator-chamber is subjected to the heat of the steam flowing through the pipes in such chamber in the opposite direction to the flow of the liquid in the chamber for the heat to evolve ammonia-gas from the liquid, and after subjection to the heat of the first receiving compartment or chamber into which it enters the rich liquid flows into the second or final receiving compartment or chamber and is subjected to the heat of the steam flowing through the pipes in such chamber in the opposite direction to the flow of the liquid in the chamber for the heat to complete the evolving of ammonia-gas therefrom, leaving only a weak liquor. The evolved gas passes upward in the analyzer and out at the upper end thereof into the rectifier and out therefrom to the condenser-coil. The weak liquor passes from the generator-chamber into the upper end of the exchanger and out therefrom to the weak-liquor-cooler coil and is conducted back to the absorber to be recharged with gas and become a rich liquid, which is again drawn into the ammonia-cylinder and passed through the different appliances to evolve gas, as just described. These operations will continue as long as it is desired to produce gas.

The construction of the main or generator cylinder so that it also furnishes a base or support for the other appliances enables such cylinder to perform the work of a generator and also furnishes a casting on which to mount the other appliances, dispensing with the employment of an independent base or support for mounting the generator-cylinder and the appliances. The dividing of the generator-chamber into two separate and independent chambers or compartments and passing the rich liquid into each compartment at the bottom to rise upward and flow lengthwise therein to have a flow against the opposite flow of steam in the heating-pipes insures a complete and perfect subjecting of the rich liquid to the action of the heating-pipes under the best possible conditions for the production or evolving of ammonia-gas, and by subjecting the rich liquid, in effect, to a double action insures the generating or evolving of practically all the gas contained in the liquid, leaving only a very weak liquor. The extending of the heating-pipes lengthwise of the generator-chamber from end to end and passing such pipes through the solid ends of the cylinder and casting gives a better surface for contact with the rich liquid and a closer fit and a tighter joint against the escape of ammonia around the pipes where they pass through the ends or heads of the cylinder. The mounting of the several appliances on the generator enables the entire machine to be closely set up and arranged in a very compact manner, so as to occupy a small space.

The construction of the exchanger and rectifier with an outer tube or cylinder, in each case provided with a solid end or head into and through which the conducting-pipes are entered, enables a tight joint to be produced around the conducting-pipes and dispenses with the use of any packing at the top and bottom of the exchanger and rectifier pipes where they pass through the ends or heads, and by using straight pipes instead of coils a better passage is provided for the liquid. These points all present advantages in the construction and operation of the machine, dispensing, as they do, with joints and coils and mounting the several appliances on one of the appliances.

The arrangement for the transmission of liquid to the generator-chamber and the discharge of gas therefrom is one by which all the liquids to be heated are passed in an upward direction and all the liquids and gases to be cooled are passed in a downward direction, which materially assists in the working of the machine and the production of the gas and enables the rich liquid on its way to the generator to partially condense the ammonia-gas and deprive it of moisture. The arrangement is one which causes the gas after it has been deprived of a portion of its moisture and cooled by coming in contact with the liquid in the analyzer and enters the rectifier to enter therein at the top and completely surround the tubes of the rectifier through which the rich liquid is flowing, and as the rich liquid is comparatively cool as against the gas the moisture of the gas will be condensed by coming in contact with the cool pipes and such moisture will deposit itself on the pipes or tubes as the gas is forced downward, leaving the gas perfectly dry, and at the same time the moisture withdrawn and adhering to the pipes will pass down thereon and accumulate in the bottom of the rectifier, to be transferred therefrom back into the bottom of the generator automatically by the siphon or trap pipe. This operation results in the production of an absolutely dry gas and is accomplished by the arrangement and through the operation of the appliances.

The delivering of the liquid into the bottom of each compartment of the generator-cham-

ber insures a perfect circulation of the liquid on and over the heating-pipes and prevents deterioration of the heating-pipes, as would be the case if the liquid were allowed to flow thereon instead of rising upward against the pipes. The gas as it passes upward in the analyzer comes in contact with the rich liquid flowing downward, so as to deprive the gas of the greater part of its moisture, and by having the gas leave the analyzer at the top and enter the rectifier to pass downward therein and surround the rectifier-tubes, through which the rich liquid is flowing upward on its way to the generator, the gas and liquid exchange temperatures and the gas is partially condensed and deposits all residue moisture contained therein on the pipes and in the rectifier, so as to leave the rectifier a pure dry gas and pass to the condenser. The weak liquid passes up into the top of the exchanger and flows down and surrounds the small tubes or pipes in the exchanger, through which the rich liquid is flowing upward on its way to the generator, and the two liquids exchange temperature in such passage, by which the rich liquid is partially heated, while the weak liquid is cooled, the two traveling in opposite directions, and the weak liquid leaves the exchanger in a partially-cooled condition to pass into the condenser and cooler, to be finally cooled therein before entering the absorber. This construction and arrangement, by which the liquids are passed in opposite directions, insures the required action on both the gas and liquids, by which one is cooled and the other heated in the passage of the liquid and gas and the weak liquid between the generator and the condenser and cooler and the absorber, thereby rendering the operation of the apparatus as a whole more efficient and the production of gas more reliable and in greater quantities.

I claim—

1. In an ammonia-still, a generator-cylinder having its ends formed solid with its body and having the upper side of the body provided with seating-faces on which to mount and support other appliances pertaining to the machine, stuffing-boxes exteriorly entered into each end of the cylinder, and pipes extending longitudinally of the cylinder on its interior and passing through the stuffing-boxes, for securing the pipes in the cylinder ends against leakage, substantially as described.

2. In an ammonia-still, the combination of a generator-cylinder having its ends formed solid with its body and having the upper side of its body provided with seating-faces, an ammonia-pump located on the upper side of the cylinder, an exchanger, a rectifier and an analyzer supported on the seating-faces of the cylinder, stuffing-boxes exteriorly entered into each end of the cylinder, and pipes extending longitudinally of the cylinder on its interior and passing through the stuffing-boxes, substantially as described.

3. In an ammonia-still, the combination of a generator-cylinder, an exchanger supported on the generator-cylinder and formed of an exterior tube having a body with end heads solid therewith and provided on the interior with straight tubes extending from end to end and through the solid heads, a chamber on the generator-casting over which the exchanger is supported with a close joint between the end of the exchanger and the wall of the chamber, and a cap having a chamber therein and attached to the upper end of the exchanger with a close joint between the end of the exchanger and the wall of the cap, for receiving into the chamber at the bottom below the lower solid head a supply of rich liquid from the ammonia-pump and discharging the liquid into the chamber at the top of the exchanger above the upper solid head and receiving at its top below the upper solid head a supply of weak liquid from the generator-chamber and discharging the weak liquid at its bottom above the lower solid head for the two liquids in their passage through the exchanger to exchange temperatures each with the other, substantially as described.

4. In an ammonia-still, the combination of a generator-cylinder, an ammonia-pump mounted on the generator-cylinder, a rectifier supported on the generator-cylinder and formed of an exterior tube having a body with end heads solid therewith and provided on the interior with straight tubes extending from end to end and through the solid heads, a chamber on the generator-casting over which the rectifier is supported with a close joint between the end of the rectifier and the wall of the chamber, and a cap having a chamber therein and attached to the upper end of the rectifier with a close joint between the end of the rectifier and the wall of the cap, for receiving at its bottom a supply of rich liquid from the ammonia-pump entering the chamber below the lower solid head and discharging the liquid into the chamber at the top of the rectifier above the upper solid head, and receiving at its top below the upper solid head the supply of ammonia-gas to pass downward therein and be discharged above the lower solid head, for the liquid and gas to act against each other in absorbing heat and cold, substantially as described.

5. In an ammonia-still, the combination of a generator-cylinder, an ammonia-pump mounted on the generator-cylinder, a wall on the upper side of the generator-cylinder having a chamber therein, an exchanger supported on the wall in line with the chamber and having a tight joint between the exchanger and wall, an outer tube or pipe with solid heads at each end constituting the body of the exchanger, smaller tubes extending longitudinally of the exchanger and through the solid heads of the outer tube or pipe and communicating with the chamber on the generator-cylinder, and a cap attached to the upper end of the exchanger, with a tight joint be-

tween the cap and the exchanger, and having a chamber therein into which the interior tubes of the exchanger discharge, substantially as described.

6. In an ammonia-still, the combination of a generator-cylinder, an ammonia-pump mounted on the generator-cylinder, a wall on the upper side of the generator-cylinder having a chamber therein, a rectifier supported on the wall in alinement with the chamber and having a tight joint between the rectifier and wall, an outer tube or pipe with solid heads at each end constituting the body of the rectifier, smaller tubes or pipes extending longitudinally of the rectifier and through the solid heads of the outer tube or pipe and communicating with the chamber on the generator-cylinder, a cap attached to the upper end of the rectifier, with a tight joint between the cap and the rectifier, and having a chamber therein into which the small tubes or pipes of the rectifier discharge, substantially as described.

SOREN THURSTENSEN.

Witnesses:
JOE EDINGER,
B. FRANKLIN KUBAUGH.