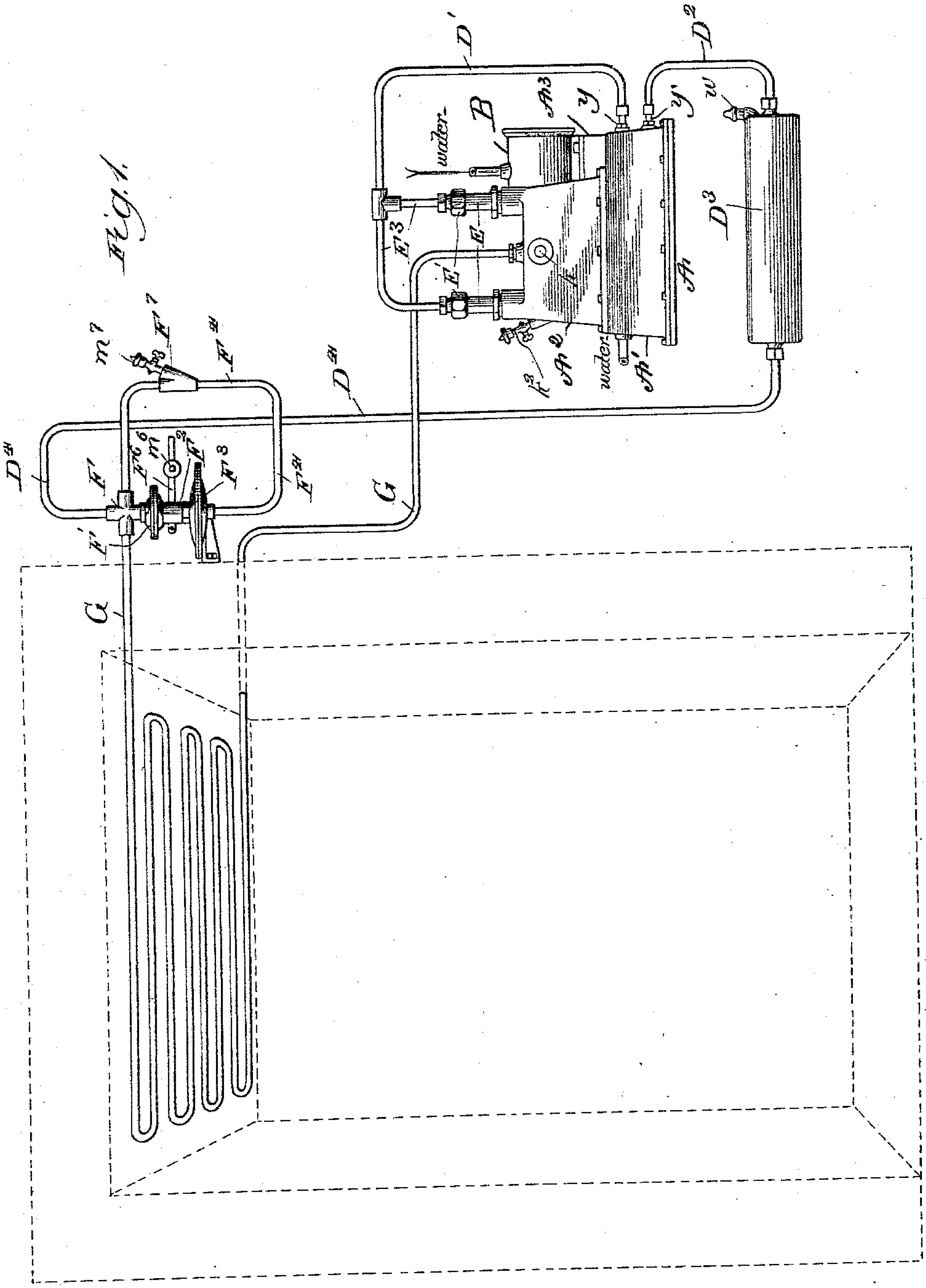
(No Model.) 3 Sheets—Sheet 1.

E. L. SHARPNECK & G. F. KNOX.

REFRIGERATING MACHINE.

No. 559,753. Patented May 5, 1896.



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(No Model.) 3 Sheets—Sheet 2.

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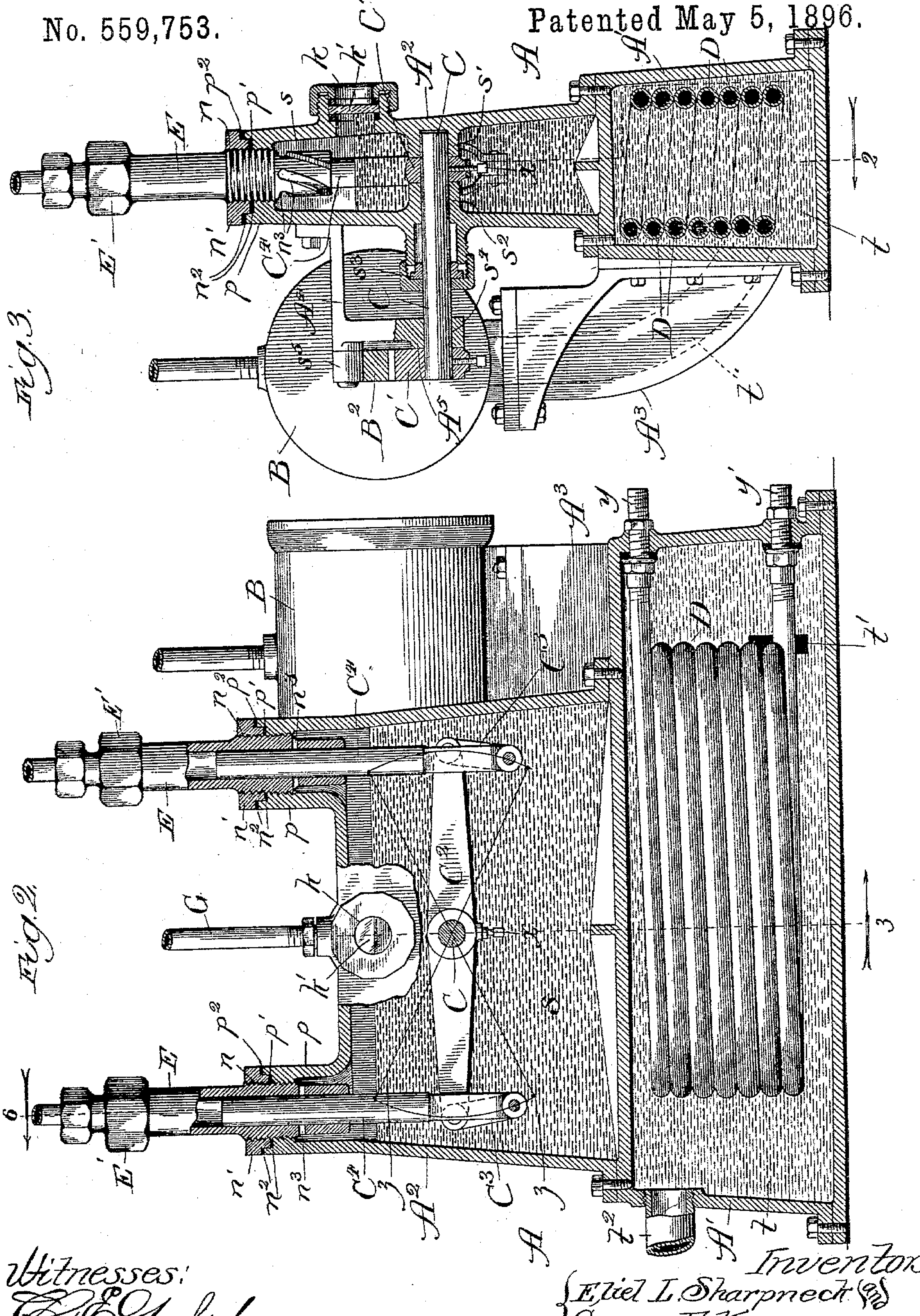

Fig. 3.

Fig. 2.

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(No Model.) 3 Sheets—Sheet 3.

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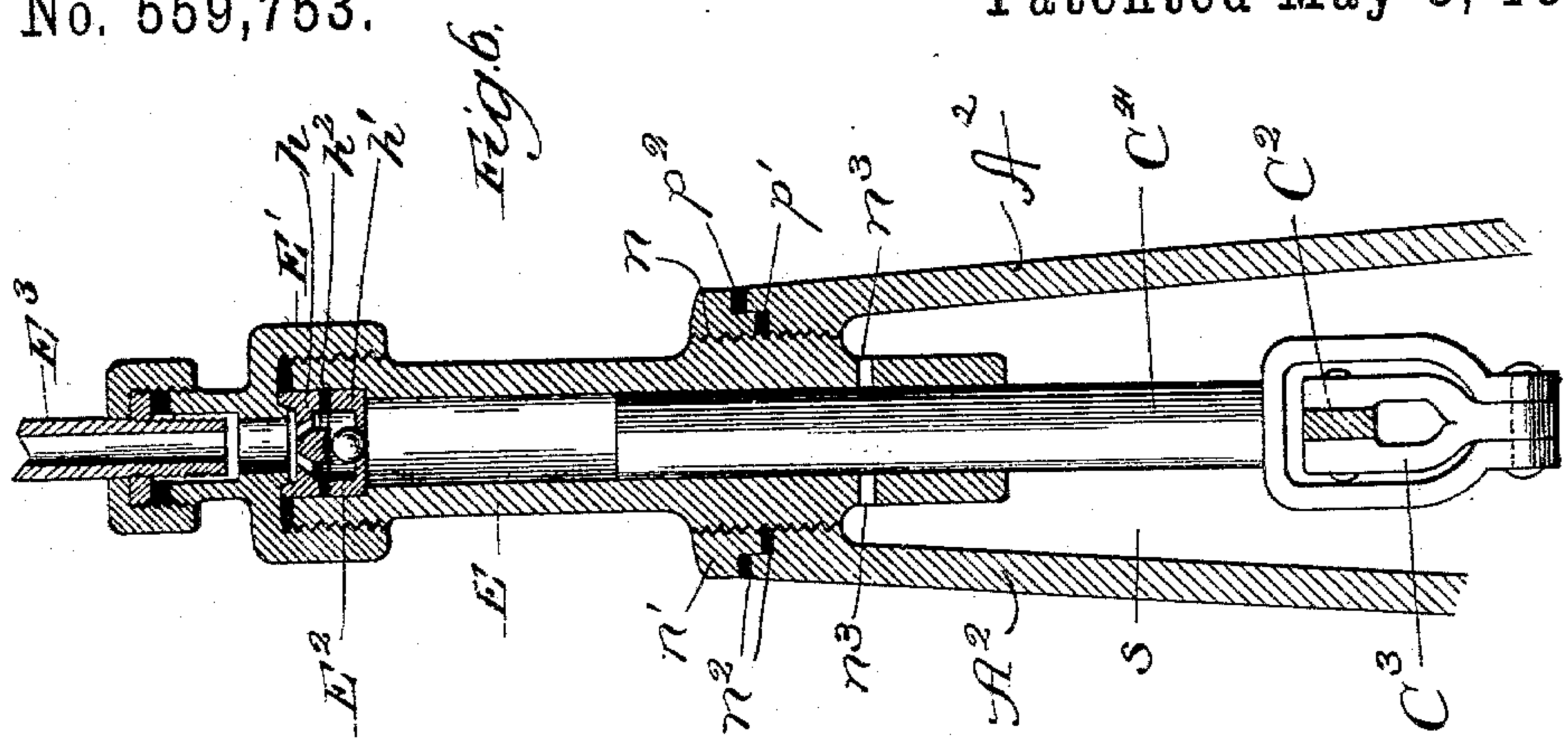

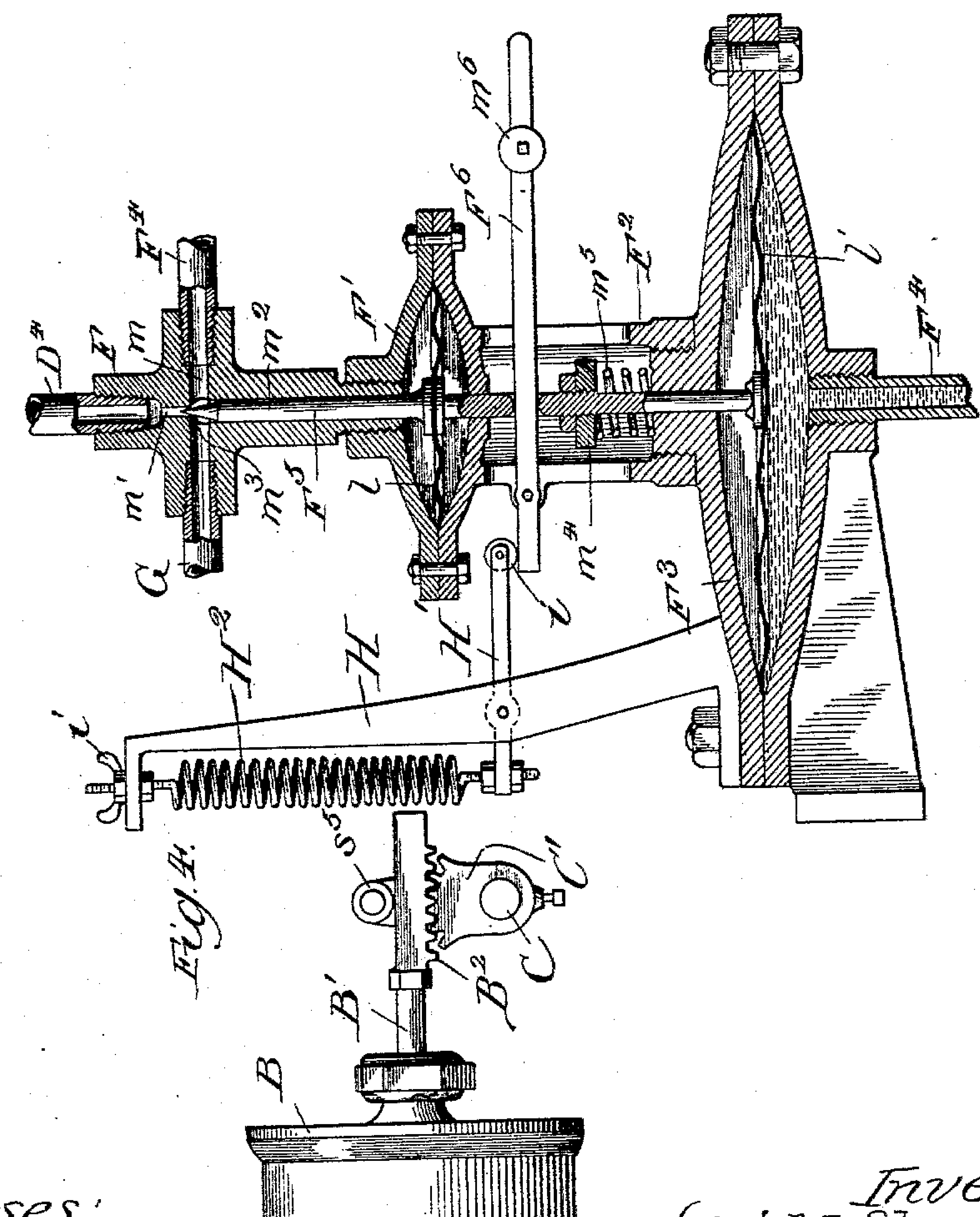

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UNITED STATES PATENT OFFICE.

ELIEL L. SHARPNECK AND GEORGE F. KNOX, OF CHICAGO, ILLINOIS.

REFRIGERATING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 559,753, dated May 5, 1896.

Application filed April 3, 1895. Serial No. 544,340. (No model.)

To all whom it may concern:

Be it known that we, ELIEL L. SHARPNECK and GEORGE F. KNOX, citizens of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Refrigerating-Machines, of which the following is a specification.

Our object is to provide a refrigerating-machine of improved construction more especially for domestic use, or in places where a comparatively small compartment only is to be chilled.

Our invention involves ammonia compressing and condensing apparatus in connection with circulating-pipes and means for spraying and volatilizing the ammonia therein. In connection with the apparatus is a motor for running the compressor and a governor device which controls the circulation.

Our invention consists in the general construction of our improvements and also in details of construction and combinations of parts, all as hereinafter set forth and claimed.

In the drawings, Figure 1 is a view in the nature of a diagram showing our improvements in operative position and in connection with a storage or refrigerating chamber or "ice-box," all the mechanism except the refrigerating-coil being outside of the latter; Fig. 2, a broken sectional elevation of the ammonia compressors and condenser, the section being taken on line 2 of Fig. 3 in the direction of the arrow; Fig. 3, a vertical cross-section on line 3 of Fig. 2; Fig. 4, a broken view in elevation of power-transmitting mechanism between a water-motor and the compressor; Fig. 5, a broken vertical section of a governor like that shown in Fig. 1, but provided with a thermostatic connection, which may be employed when the governor is placed inside the refrigerating-chamber; and Fig. 6, an enlarged broken section taken on line 6 of Fig. 2 and viewed in the direction of the arrow.

A is a shell or casing of the refrigerating-machine, comprising a hollow base portion A′, containing the condensing-chamber t and an upper hollow portion A^2, containing a chamber s. On the side of the part A′ is a bracket A^3, which supports an engine or motor B. The engine may be of any suitable type which will furnish the necessary power to operate the compressor hereinafter described. The piston-rod B′ of the water-motor shown (see Fig. 4) is provided on its under side with a rack B^2. In opposite sides of the chamber s, at the center thereof, are bearings s' s^2 for a rock-shaft C, which extends to the outside of the chamber through an opening at the bearing s^2, provided with a stuffing-box s^3. On the outer free end of the shaft C is a segment-gear C′, which is engaged by the rack B^2. Extending from the upper casing A^2 is a bracket A^4, provided with a downwardly-projecting arm A^5, having a bearing-opening s^4 for the shaft C at the segment C′, and the bracket A^4 also carries a guide-roller s^5 for the rack B^2, the roller bearing against the upper side of the said rod, as shown in Figs. 3 and 4. The function of the guide-rollers s^5 is to maintain the rack B^2 in mesh with the segmental gear C′.

C^2 is a working beam in the chamber s, mounted midway of its length upon the shaft C and fastened thereto, as by a set-screw x, whereby it is rocked by the rocking motion of the shaft. The working beam at its hub fits between the bearings s' s^2, and the shaft C is thus held against longitudinal play. The water-motor B is operated by any suitable water-pressure. The discharge-water from the motor runs through a pipe or passage t' to the chamber t, and from the said chamber the water escapes through a waste-pipe t^2.

In the chamber t is a coil of pipe D, which extends at its opposite ends y y' through the wall of the chamber t. In the top of the chamber s at opposite ends are internally-threaded tubular projections p. Fitting in the said tubular projections are pump-cylinders or compressor-tubes E, having externally-threaded portions n n, which engage the threads of the tubular projections. The tubular projections are provided with recessed upper ends presenting annular concentric bearing-surfaces p' p^2, and on the threaded portion n of the tubes E are jam-nuts n', recessed to afford concentric surfaces, which coincide with the bearing-surfaces p' p^2 of the tubular projections. Interposed between the respective bearing-surfaces of the tubular projections and jam-nuts are gaskets n^2, which, when the jam-nuts are screwed down, afford gas-tight joints between the tubes E and tubular projections p. The tubes E extend downward in the tubular projections to the chamber s, and below and adjacent to their threaded parts n they are provided with radial openings n^3, which are preferably in the form of elongated spirally-extending slots, as shown in Fig. 3. The tubes E are smoothly bored and fitted at their tops with screw-caps E′. Just below the screw-caps the bores of the tubes are enlarged to receive check-valve devices E^2. The check-valves may be ball-valves, as shown, each made in two parts h h' for ready insertion of the ball with an intervening gasket h^2 to insure gas-tight joints. The valves open under pressure from below and close under pressure from above, and the valve devices are held in place by the screw-caps E′. Coupled to the tubes E at the screw-caps E′ are pipes E^3, extending to a common pipe D′, which is coupled to the end y of the coil D. Extending from the end y' of the coil D is a pipe D^2, which leads to one end of a reservoir or drum D^3. From the opposite end of the drum D^3 extends a liquid-ammonia conducting pipe or duct D^4, terminating in the top of a T-union F. From one side of the T-union F extends a gas-expansion chamber or coil G, which at its opposite end enters the shell A^2 at the top of the chamber s midway between the tubular projections p. At its opposite ends the working beam C^2 carries pivotal links C^3 C^3, which at their ends connect pivotally with piston-rods C^4. The rods C^4 fit closely the bores of the tubes E, and in the movements of the working beam are reciprocated vertically from points below the tops of the openings n^3 up to the valves E^2. The T-union F has a passage m horizontally through it of approximately the same area in cross-section as that of the ducts or pipes D^4 and G. The pipe D^4 extends into the union from the upper side, and between the pipe D^4 and passage m is a comparatively small passage m' of, say, half or less than half the area in cross-section of the passage m. The union F is provided from the passage m to its lower end with a smooth bore or passage m^2. At the lower end of the union F is a chamber F′, containing a flexible diaphragm or gas seal l. Below the part F′ is a tubular portion F^2, to the lower end of which is fastened a shell F^3, divided internally into two chambers by a flexible diaphragm l' of much greater area than the diaphragm l. Entering the lower chamber in the shell F^3 is a pipe or passage F^4, which extends into the union, communicating with the passage m on the side opposite the pipe G.

F^5 is a stem passing through the bore m^2, shell F′, tubular part F^2, and into the shell F^3. In the shell F′ the stem passes through and is fastened to the diaphragm l, and in the shell F^3 it connects with or bears upon the diaphragm l'. The connection of the stem with the diaphragm l is such that the joints are absolutely gas-tight. At its upper end the stem F^5 is tapered to afford a valve m^3 entering the reduced passage m' to close the latter when the valve is raised. In the tube F^2 the stem F^5 is provided with a collar m^4, and confined between the said collar and top of the shell F^3 is a spring m^5, which tends normally to press the stem upward to close the valve m^3.

F^6 is a lever pivoted at one end to the tubular piece F^2 at one side and passing through the said tube beyond the opposite side of the latter. Adjacent to its pivot the lever passes through a slot in the stem F^5, and at its free end the lever carries an adjustable weight m^6. The weighted lever F^6, by bearing upon the stem F^5, is caused to overbalance the resistance of the spring m^5 and lower the stem, whereby the valve m^3 is slightly out of contact with its seat at the passage m'. Interposed in the pipe or passage F^4 is a spout F^7, provided with a screw-cap m^7, and in practice oil poured into the spout F^7 fills the lower chamber of the shell F^3 and the pipe F^4 as high as the said spout. The diaphragm l prevents the escape of gas past it from the bore m^2, while permitting the stem F^5 to move freely. The object of the diaphragm l is to prevent the escape of gas along the stem F^5 through the passage m^2 and to avoid the use of a stuffing-box about the stem, which would necessarily present such undue friction as to destroy the sensitiveness of the governor mechanism. Furthermore, it is next to impossible to prevent leakage of ammonia-gas where stuffing-boxes alone are depended upon. The chamber s is also filled with lubricating-oil nearly, but not quite, to the top. In one side of the shell A^2 is provided for convenience a view-opening k, closed with a glass disk k', so fixed in place that the joints about it are absolutely gas-tight, and the oil should extend to the height of the said view-opening, if provided, whereby the lowering of the oil-level may be observed. At a suitable location on the shell A^2 we provide a spout k^2, through which oil may be poured to supply the chamber s to the proper level when necessary.

In practice the reservoir or drum D^3 is filled with liquid ammonia, which can be poured or pumped in at a suitable inlet, as the spout w. The water-motor when started reciprocates the rod B′ and rack B^2 and rocks the segment C′, shaft C, and working beam C^2. The waste water from the motor is discharged through the passage t' into the chamber t, whence it escapes through the pipe t^2. Thus the chamber t is kept filled with a constantly-changing supply of cold water. The working beam at its ends is rocked in the arcs and between the positions indicated by the lines z z, Fig. 2, and the pistons C^4 are worked up and down in the bores of the tubes E. When the pistons descend below the tops of the openings n^3, the bores are filled (with ammonia-gas) from the chamber s and the fluid is forced upward by the pistons through the check-valves E^2. The fluid pumped by the pistons C^4 is discharged into the pipe D′, flowing thence through the condenser-coil D and into the reservoir D^3, while the supply of fluid thus pumped enters the chamber *s* through the pipe G. The initial pressure exerted by the pumps against the liquid ammonia in the reservoir D^3 forces the latter through the pipe D^4 to the union F. The governor mechanism is so adjusted that the valve m^3 partly closes the passage *m′*, whereby the ammonia forced through the latter from the pipe D^4 is sprayed and gasified, the gas passing through the pipe G to the chamber *s*. The pipe G may extend, as indicated in Fig. 1, through the upper part of a refrigerating-box Z, being coiled in the said box to present the desired surface area. The expansion of the gas in the pipe G, as is well known, causes rapid heat absorption and cools the pipe G and refrigerating-chamber Z. The gas from the pipe G, returning to the chamber *s*, is pumped into the pipe D′. Gradually after the machine is started the pressure in the system is raised to a desired degree, say, from one hundred and thirty to one hundred and fifty pounds to the square inch, whereby the action of the pistons is against the said pressure upon the upper sides of the valves E^2. The gas pumped from the chamber *s* is therefore compressed to from one hundred and thirty to one hundred and fifty pounds, and in this compressed state passes through the coil D. The compression and the cooling effected by the water in the chamber *t* condenses the gas to a liquid, in which state it is forced to the reservoir D^3. Thus the ammonia is used over and over again.

It is necessary in operation that the entrance of liquid ammonia through the passage *m′* to the pipe G shall be no faster than is desired for the purpose of maintaining the refrigerating-chamber at a desired low temperature, and under no circumstances should the liquid ammonia enter the said pipe faster than it will expand and gasify and be taken from the chamber *s* by the compressor. The governor mechanism operates to close the inlet-passage *m′* whenever pressure in the pipe F^4 and against the under side of the large diaphragm *l′* overcomes, with the aid of the spring m^5, the resistance of the pressure upon the smaller diaphragm *l* and of the weighted lever F^6. Thus, for example, if to produce the desired result the pressure in the pipe G should be fifteen pounds to the square inch, the weight m^6 on the lever F^6 is adjusted to exert with the pressure upon the diaphragm *l* fifteen pounds to the square inch plus the resistance of the springs m^5 against the diaphragm *l′*. The pressure of the gas in the pipe G is also present in the pipe F^4 and exerted upon the oil column in the latter pipe. Whenever the gas-pressure exceeds the said fifteen pounds, it exerts itself through the oil column against the under surface of the diaphragm *l′*, raising the latter against the resistance of the weighted lever F^6 and closing the valve m^3. The supply of ammonia is thus cut off, and as the pressure decreases against the oil column the weighted lever forces the stem downward and opens the valve m^3. Thus a substantially uniform pressure will always be maintained in the pipe G.

While the temperature of an ice-box or refrigerating-chamber will be kept sufficiently uniform for all practical purposes with the governor mechanism described above, it may be desirable in certain cases where very slight changes in temperature are to be guarded against to provide supplemental temperature-controlling means, which may be afforded, for example, by mechanism of the character shown in Fig. 5. In that figure H is a support or bracket secured upon the shell F^3. Pivotally mounted upon the support H is a lever H′, provided at the free end of its long arm with a roller *i*, which bears upon the short arm of the lever F^6. Secured at one end to the support H and at its opposite end to the short arm of the lever H′ is a thermostat H^2, which in the drawings is in the form of a coiled spring of a metal which will be sensitive to expansion and contraction under changes of temperature. The spring H^2 is threaded at its ends and provided with a nut *i′* for adjusting its tension. In practice the governor mechanism will be mounted in the refrigerating-chamber, so that a fall of temperature in the chamber will cause the spring H^2 to contract and press the lever H′ upon the short arm of the lever F^6, and thus tend to reduce or cut off the flow of ammonia to the coil G, while rise of temperature will tend to produce the opposite effect. The thermostat may be so adjusted by means of the nut *i′* and with relation to the rest of the governor mechanism that the refrigerating-chamber will be maintained uniformly, or substantially so, at a predetermined temperature.

The operation of the machine will be continuous, and when once started it will require little if any attention. The oil in the chamber *s* lubricates the shaft C and operates as a seal between the gas space and the stuffing-box s^3. Owing to the volatile properties of ammonia-gas it is practically impossible to prevent escape thereof through stuffing-boxes or any packing around movable parts. In our construction, which seals the stuffing-box, there is no chance for ammonia to escape. All other joints may, of course, with the employment of suitable gaskets, be absolutely gas-tight.

The pistons C^4 are in the form of plug-pistons and of equal diameter with the bore of the tube E for a distance equal to the length of said bore. In the rise of the pistons, and consequent increasing compression of the gas against the valves E^2, the area of contact between the pistons and inner surfaces of tubes E increases and the tendency of the escape of gas downward past the pistons is thus diminished as the compression increases. It is desirable in practice that there shall be no clearance between the valves E^2 and pistons when the latter are at the upward limit of their traverse. For this reason the parts are so adjusted initially that the pistons will just touch the valves without material force when they rise to their utmost limit. In time, as the bearings between the working beam and plug-pistons become worn ever so slightly, it is desirable to readjust the parts, and this may be done by unscrewing the nuts n' and screwing the tubes downward to the desired position. The construction described, which permits the said adjustments to be made, is an important detail of our improvements.

While we prefer to construct the device throughout as shown and described, it may be modified as to details and still be within the spirit of our invention as defined by the claims.

What we claim as new, and desire to secure by Letters Patent, is—

1. In a refrigerating-machine, the combination with the ammonia-circulating ducts comprising the liquid-ammonia feed-duct, gas-expansion duct and reduced passage between said ducts, of a regulating-valve at said passage, governor mechanism for the valve actuated by rise and fall of pressure in the gas-expansion duct to move the valve and increase and diminish the flow of ammonia through said passage, and thermostatic spring mechanism at the said governor mechanism operating under fall of temperature to yieldingly influence the action of said governor mechanism, toward closing the valve substantially as and for the purpose set forth.

2. In a refrigerating-machine, a compressor interposed between the gas-expansion duct and condenser, comprising a chamber, internally-threaded tubular extensions p on the chamber, pump-cylinders comprising tubes E having smooth bores, and externally-threaded portions n to fit the internally-threaded parts of the extensions p, jam-nuts n' on the threaded portions n, pistons working in the cylinders and actuated to compress gas from said chamber and discharge it into the condenser, and a check-valve on each cylinder, all constructed to operate as and for the purpose set forth.

3. In a refrigerating-machine, the combination of compressor-plungers, compression-cylinders, the said cylinders being adjustable with reference to the plungers, and outwardly-opening check-valves seated in the cylinders, substantially as and for the purpose set forth.

4. In a refrigerating-machine, a shell or casing having an ammonia-supply chamber, in combination with compressor pistons or plungers, and compressor-cylinders adjustably supported in the casing in the direction of the stroke of the plungers, substantially as and for the purpose set forth.

5. In a refrigerating-machine, the combination of a shell or casing, an ammonia-supply chamber with internally-threaded extensions, compressor-cylinders externally threaded and adapted to be screwed into the extensions of the supply-chamber to an adjustable extent, compressor pistons or plungers coacting with such cylinders and mechanism for operating the same, as and for the purpose set forth.

6. In a refrigerating-machine, the combination of a shell or casing, having an ammonia-supply chamber provided with internally-threaded extensions, compressor-cylinders, externally threaded and adapted to engage and to be adjusted in the threads of the extensions, jam-nuts engaging the upper threads of the cylinders, and packing interposed between the jam-nuts and extensions, as and for the purpose set forth.

7. In a refrigerating-machine, the combination of an expansion-chamber, a valve for regulating the flow of fluid thereto, a weighted lever passing through the stem of such valve and tending to overbalance the spring, the duty of which latter is to close the valve, a diaphragm bearing upon the stem, and in communication with the expansion-chamber, whereby under the influence of the pressure thereof it may neutralize the tendency of the weighted lever, a thermostatic spring, and a pivoted arm connected at one end therewith and at the other bearing upon the short arm of the weighted lever, and thereby tending to neutralize the action of such lever when the temperature is too low and the spring is contracted, substantially as and for the purpose set forth.

8. In a refrigerating-machine, the combination of a shell or casing, having a supply-chamber provided with extensions, compressor-cylinders adapted to be supported in such extensions, and having elongated spirally-extending slots or openings into the chamber, substantially as and for the purpose set forth.

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In presence of—
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