No. 640,911. Patented Jan. 9, 1900.

G. B. HIETT.

COMPRESSION PUMP FOR REFRIGERATING APPARATUS.

(Application filed June 12, 1897.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

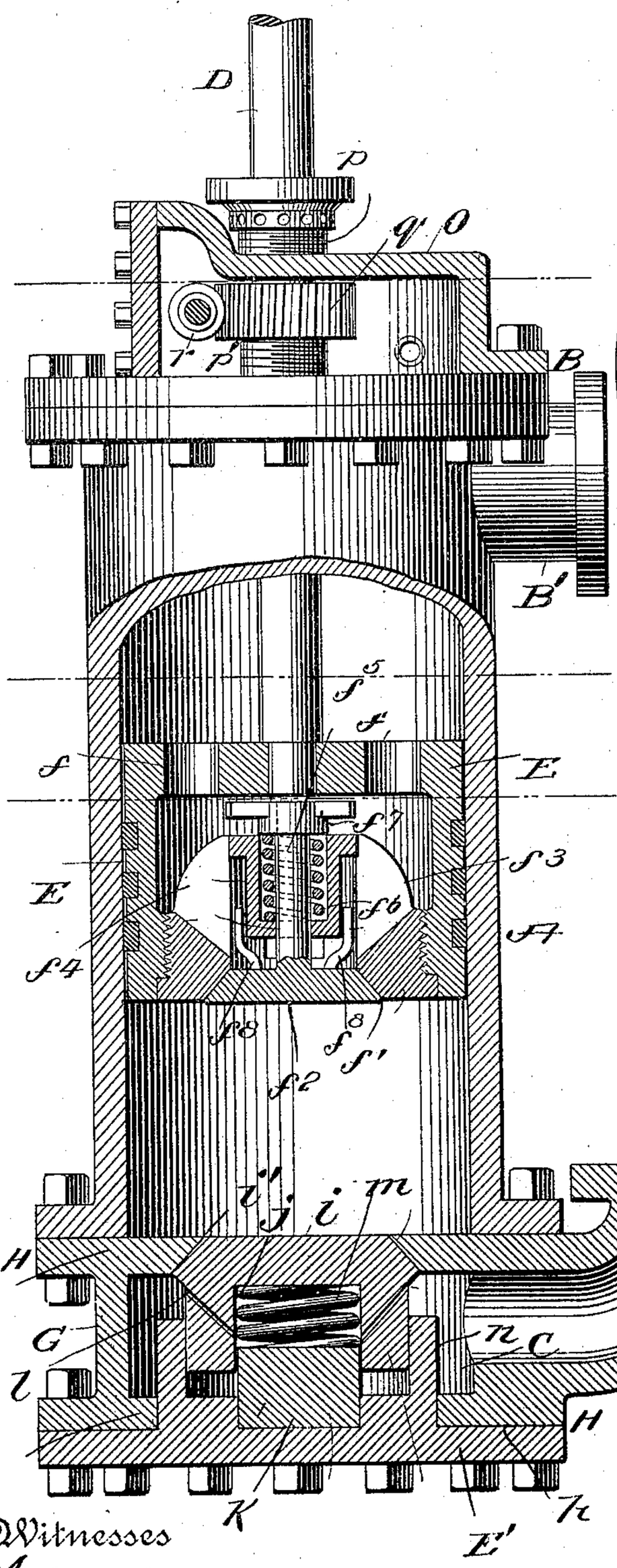

Fig. 2.

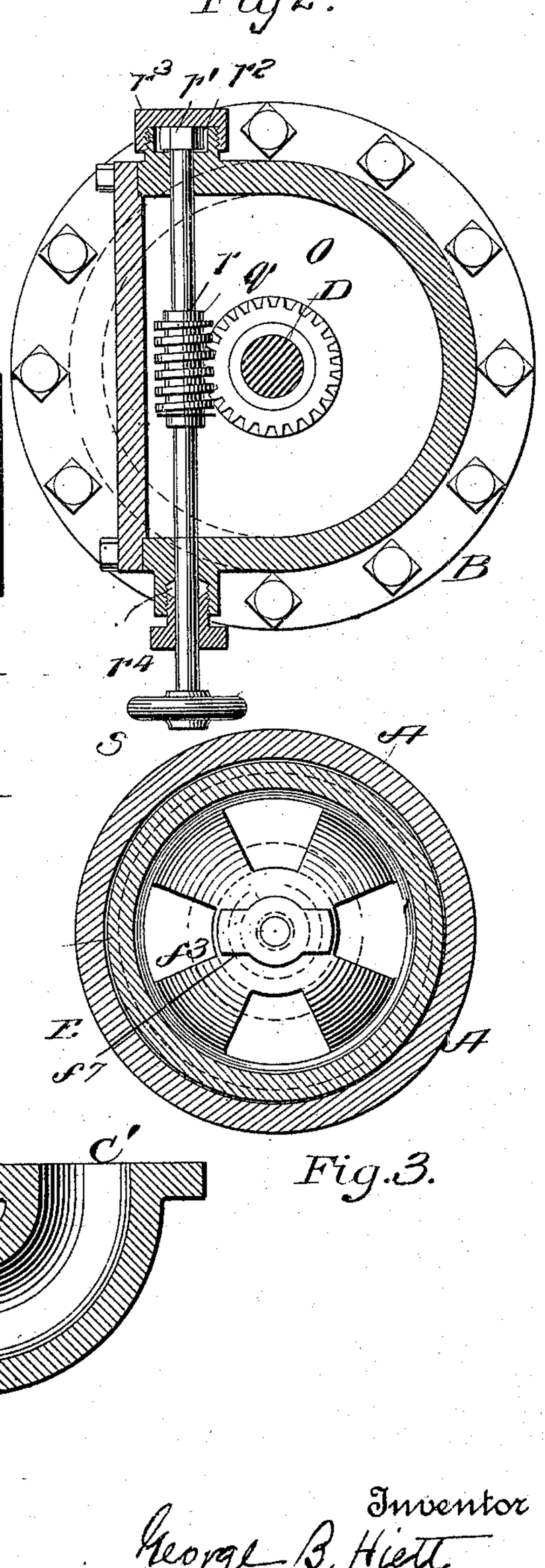

Fig. 3.

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Fig. 4.

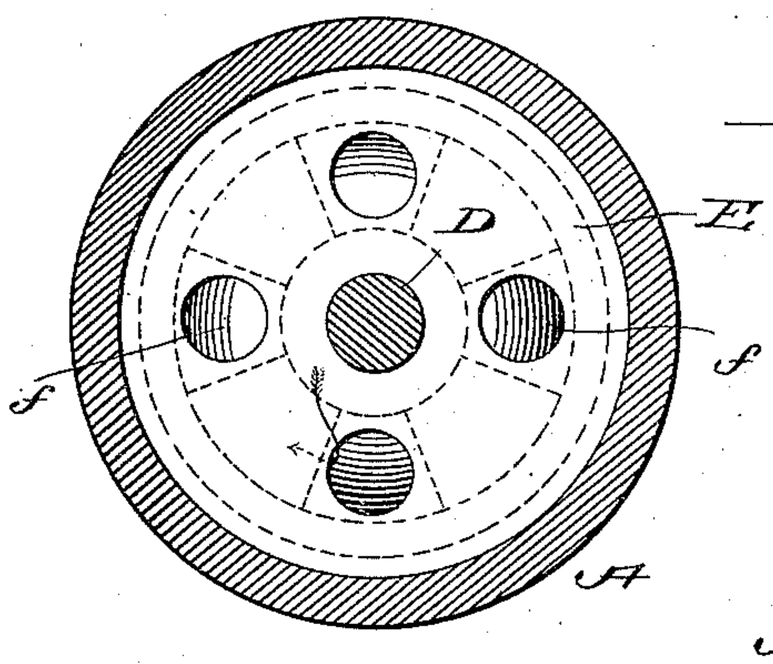


Fig. 5.

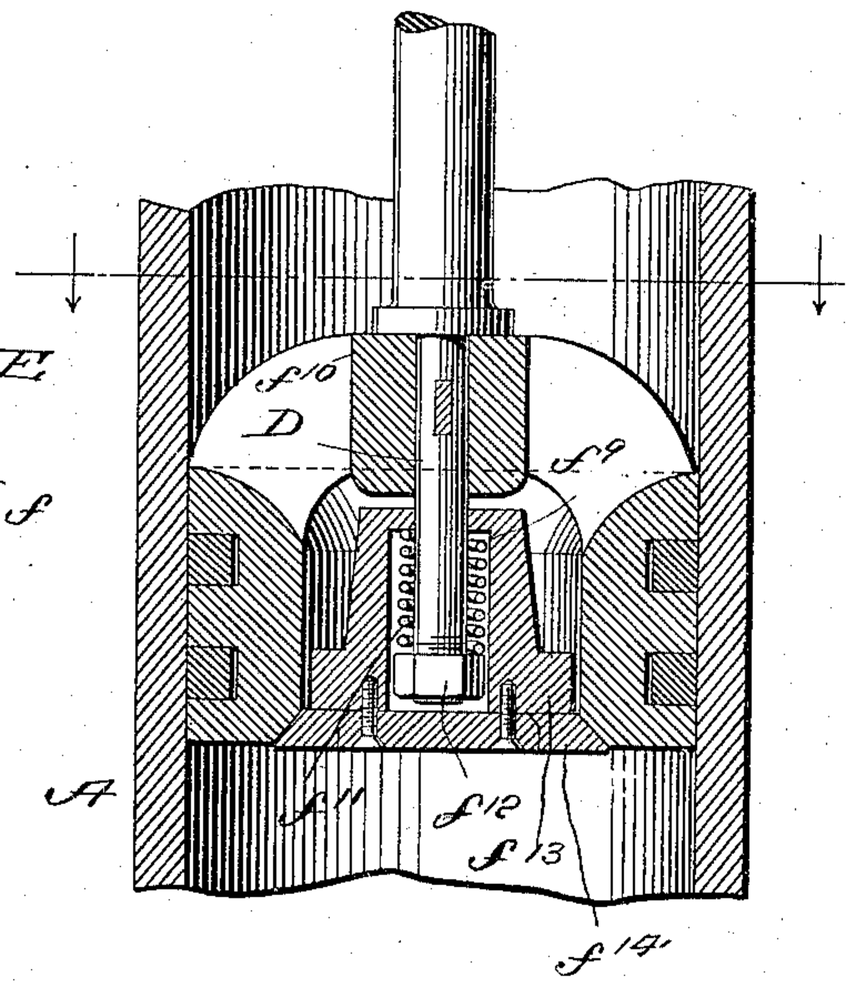


Fig. 6.

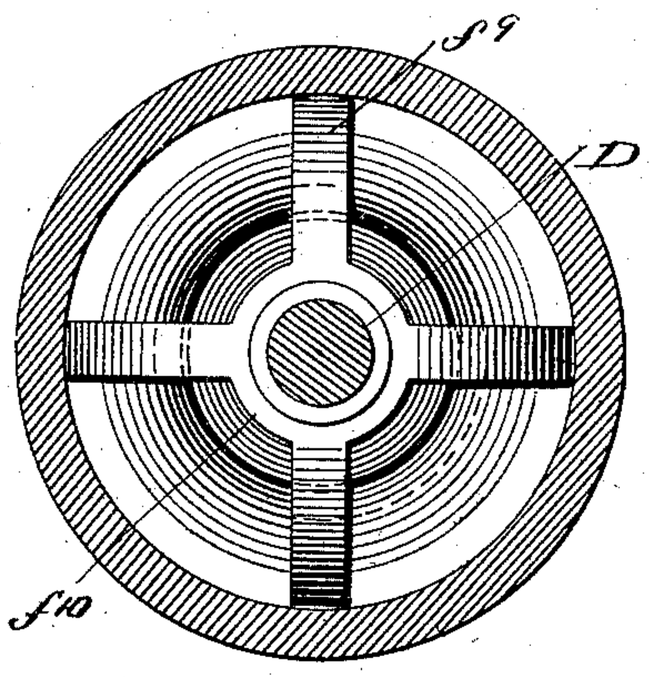
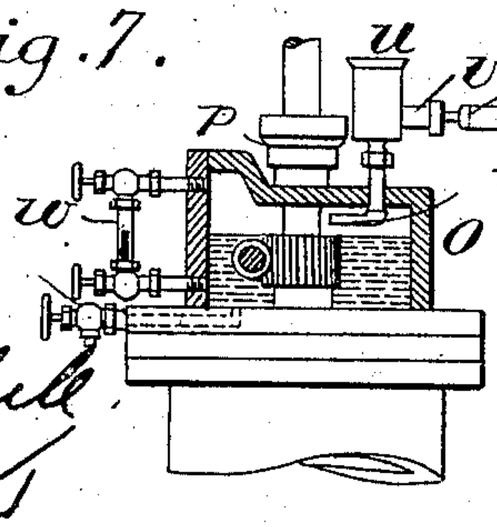


Fig. 7.



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UNITED STATES PATENT OFFICE.

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COMPRESSION-PUMP FOR REFRIGERATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 640,911, dated January 9, 1900.

Application filed June 12, 1897. Serial No. 640,496. (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 Compression-Pumps for Refrigerating and Ice-Making Apparatus, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to improvements in compression-pumps, and is primarily designed for use in connection with ammonia ice-making machines or refrigerating plants.

The object of the invention is to provide a pump of this character which is adapted to receive and compress the refrigerating medium in a liquid or densely-saturated state and to be maintained thereby at a low temperature without the use of a water-jacket, to reduce friction of the parts to the minimum and provide for the ready discharge of the residuum from the cylinder-chamber, to provide a durable and efficient construction of valve mechanism for the piston and discharge-valve mechanism for the cylinder, and to generally improve and simplify the construction and render more efficient the operation of this class of apparatus generally.

To this end the invention consists in the features and in the construction, arrangement, and combination of parts hereinafter described, and particularly pointed out in the claims following the description, reference being had to the accompanying drawings, forming a part of this specification, wherein—

Figure 1 is a vertical sectional view of a compression-pump constructed in accordance with my invention. Fig. 2 is a sectional plan view of the stuffing-box and oil-receptacle thereof. Fig. 3 is a similar view of the pump-piston. Fig. 4 is a plan view thereof. Fig. 5 is a vertical sectional view of a modified form of pump-piston. Fig. 6 is a plan view thereof. Fig. 7 is a detail sectional view of the bonnet and mechanism for controlling the oil-supply thereto.

Referring now more particularly to the drawings, wherein like reference letters and characters designate corresponding parts throughout the several views, A represents the pump-cylinder, which is vertical and provided in its outer side just below its upper head B with a suction-port in the form of a pipe B′ and at its lower end with a discharge-valve chamber C, having a discharge-port in the form of a pipe C′. The piston-rod D has attached to its lower end a piston which works downwardly to compress and expel the ammonia and is constructed as follows: A hollow piston-head shell E is provided at its upper end with a plurality of ports f and at its lower end is open and internally threaded, and screwed in the open threaded end of the shell is a valve-seat f', in which is arranged a vertically-movable valve f^2. The upper end of the valve-seat is formed with a spider f^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 f^4, through which passes the valve-stem f^5. A coiled spring f^6 is wholly inclosed in said cup and about the valve-stem and abuts against a nut f^7, engaging the upper end of said stem. This spring operates to normally hold the valve closed against its seat. Guide-fingers f^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.

In Figs. 5 and 6 a modified construction of pump-piston is illustrated. As shown in said figures, the spider f^9 is formed on the top of the hollow piston-head shell, and the piston-rod is attached directly thereto and is provided with a downwardly-projecting extension f^{10}, about which is coiled the spring f^{11}, which rests on a nut f^{12}, tapped onto the lower end of said extension. A hollow boss or cup f^{13} is fitted over the spring and at its lower end is bolted to the valve f^{14}, which in this case seats against a seat formed directly in the bottom of the piston-head shell. In both constructions of piston-head 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 chamber or casing C on the lower end of the cylinder comprises an annular wall G, formed integrally with and hanging pendent from the detachable head H and forming a chamber or casing of the same diameter as the cylinder. This chamber is closed by a bottom plate E′, bolted to an annular flange *h*, formed on the lower end of said wall. In this casing is arranged a vertically-movable balanced valve *i*, that controls a port *i′* in the lower cylinder-head, which port is made of considerably less diameter than the cylinder. As shown, this valve is of considerable area to permit of the rapid passage of the ammonia-gas, but is also of less diameter than the cylinder, and on its under side is provided with a hollow stem *j*, that fits over a stud *k*, supported by the bottom plate D′. The sides of the valve are provided with ports *l*, and a coiled spring *m* is arranged in the stem and rests on the stud. The spring operates to normally hold the valve closed, and the ports *l* permit the ammonia-gas to have access to the under side of the valve and prevent the formation of a vacuum thereunder. Guides *n* 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 C′ is of the same area as the outlet formed by the downward movement of the valve on the downstroke of the piston, which permits the ammonia gas and vapor to expand and relieve itself of a portion of the heat developed by compression.

It is essential to the operation of the pump in compressing the ammonia in a liquid or densely-saturated state that the suction and discharge ports, bottom chamber, and valves be of substantially the proportions shown. The suction-port should be of somewhat larger area than the discharge-port in order to allow for the difference in volume of the ammonia before and after compression, while the valve in the piston-head shell should be of less diameter than the bore thereof, and the discharge-valve of materially less diameter than the cylinder in order to provide for the sensitive balancing action of said valves, as well as to prevent resistance to the free opening of said discharge-valve by the pressure of the gas on the high-pressure side of the refrigerating apparatus and the necessity of compressing the ammonia to an extremely high temperature to force it through the port in the bottom head.

I am aware that it has heretofore been proposed to employ a pump for compressing air comprising a cylinder having suction and discharge ports located, respectively, at its top and bottom, a valved piston to compress the air on its downstroke, and a valved discharge-chamber, the valve of the piston being approximately of the diameter of the bore of the head thereof and the valve of the discharge-chamber of greater diameter than the cylinder and adapted to be opened by direct contact of the piston therewith. Such construction of pump could not, however, be employed for compressing anhydrous ammonia in a humid or saturated state, because the discharge-valve being of larger diameter than the barrel of the cylinder contains more square inches on the bottom side than on the top and is of so great an area that it would be held to its seat by the condensing pressure on the high-pressure side of the apparatus, thus requiring a third more power to drive the piston against the valve to open it, which would cause the compression and superheating of the ammonia to an objectionable degree. To avoid this objection and to adapt the pump for compressing ammonia in a liquid or saturated state, so that it will pass into the discharge-valve chamber at a low temperature and not be unduly expanded, I have contrived the construction herein shown, wherein the discharge-valve *i* is of less diameter than the cylinder and is free of flat surfaces for the gas on the high-pressure side to act upon, whereby the valve is sensitively balanced and the piston on its discharge-stroke only increases the pressure in the cylinder to a point slightly above that in the discharge-chamber on the high-pressure side, by which superheating of the ammonia is obviated and the piston adapted to be operated with the expenditure of less power. I am thereby also enabled to avoid opening of the valve by direct contact of the piston therewith and vibration and chattering of the valve under the action of the piston. I therefore do not claim, broadly, a pump having a barrel or cylinder provided with suction and discharge ports located, respectively, at its upper and lower ends with a piston working therein to compress the gas on its downstroke, but a pump of this type having a novel construction, arrangement, and proportion of parts by which it is adapted to compress the ammonia in a liquid or saturated state and to force it to the condenser at a temperature but little above the boiling-point.

Another important feature resulting from my construction is that the lower end of the cylinder is strengthened by a head of large dimensions and the discharge-valve and its working parts are all supported by said head and adapted to be removed by detaching the head and without lifting or removing the cylinder-barrel itself.

Bolted onto the upper head of the pump-cylinder is a bonnet O, through which the piston-rod D passes. An outer stuffing-box *p* is fitted in the top of this bonnet and operates to pack the piston-rod tightly therein, and an internal stuffing-box *p′* is fitted in the upper head of the pump-cylinder and within the bonnet and operates to pack the piston-rod gas-tight in said cylinder-head. The gland of the outer stuffing-box is adapted to

be operated through the medium of a suitable tool to tighten or loosen the packing between the piston-rod and top of the bonnet, while the gland of the inner stuffing-box has formed thereon or attached thereto a worm-wheel q, which is engaged by a worm-shaft r, that at one end is provided with a fixed collar r', rotatably arranged in a recess r^2, covered by a nut r^3, fitted in the side of the bonnet, and at its other end projects through a stuffing-box r^4 on the side of the bonnet. A hand-wheel s is fixed on the outer end of the worm-shaft, by means of which said shaft may be rotated, and the gland thus turned to tighten or loosen the packing, as may be desired, without the necessity of having access to the interior of the bonnet. The outer open side or end of the bonnet is tightly closed by a face-plate T, which may be readily removed at any time, however, when it is desired to repair or repack the internal stuffing-box or clean the bonnet. Fitted in the top of the bonnet is a hand-pump or force-feed cup u, by which oil is supplied to the bonnet, and this pump is provided with a lateral nozzle u', which is so arranged as to inject oil directly upon the piston-rod and gland of the internal stuffing-box. A draw-off pipe v, provided with a valve v', leads from the bottom of the oil-chamber to the exterior and serves as a means for removal of a portion or all of the oil when its level is too high for efficient working and when it is desired to get access to the bonnet. The face-plate is provided with a sight-gage w, whereby the height of oil in the chamber may be readily ascertained from the outside. By this construction of parts the packing may be kept in perfect working condition and the piston-rod effectually lubricated, while at the same time a perfect seal is provided to thoroughly prevent any escape of gas from the pump-cylinder or inlet of air into said cylinder from the exterior.

The arrangement of the inner and outer stuffing-boxes with an oil-seal chamber between them is of particular importance when a vacuum is formed on the low-pressure side of the refrigerating or ice-making apparatus in shutting down the apparatus or blowing out the expansion-coils. It is well known that in machines employing stuffing-boxes and oil seals of ordinary construction the inlet of air into the chamber, which is a vital objection, cannot be avoided, for the reason that the creation of a vacuum causes a contraction of the stuffing-box and a consequent inrush of air. The inner stuffing-box and oil seal, however, in my construction effectually prevent the entrance of any air into the cylinder which may have passed through the outer stuffing-box, while, on the other hand, the outer stuffing-box and oil seal prevent the escape of any gas which may pass the inner stuffing-box.

This improved pump is particularly designed for use in connection with refrigerating and ice-making apparatus of the cold or humid gas type shown in my application for Letters Patent filed February 15, 1899, Serial No. 705,545, and the operation thereof is as follows: On the downstroke of the piston the ammonia gases and liquids flow into the cylinder through the suction-port, and the valve f^2 being closed the piston forces the gases and liquids beneath it past the valve i into the chamber C and out through the discharge-port. On the reverse or up stroke of the piston the valve f^2 opens to permit the passage of the gases and liquids through the piston while the valve i 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-walls, 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 B 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 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 piston in working and in compressing the gases and liquids is taken up by the liquid ammonia in its expansion into vapor and the use of a water-jacket obviated. Lubrication of the piston is effected by the ammonia, which, as is well known, possesses slight lubricating properties. Heretofore it has been found necessary to inject oil into the cylinders of compressors to lubricate the pistons, owing to the high degree of heat developed; but by employing a compressor in which the piston operates to compress the ammonia in its downstroke and is perfectly balanced, so as to minimize friction, I am enabled to utilize the lubricating properties of the ammonia alone and to dispense with the use of foreign lubricating agents, which have a deleterious effect on the ammonia and are liable to congeal, gum up, and otherwise interfere greatly with the operation of the pump and other parts of the refrigerating apparatus. The bottom head of the cylinder is maintained at a low temperature by the action of the liquid 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 C 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 i' expands therein and is thereby relieved of a portion of the

heat of compression, so that it will pass out through the discharge-port C′ at a temperature but little above the boiling-point, due to condenser pressure, whereby but a small amount of water on the condenser will be 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.

Refrigerating and ice-making apparatus employing a gas, such as anhydrous ammonia, liquefiable under mechanical compression, have hitherto operated under two systems—namely, the "dry" or "hot" gas system and the "cold" or "humid" gas system. In machines operating under the dry-gas system vertical compressors having suction and discharge ports arranged, respectively, at the bottom and top thereof and pistons working to compress and discharge the gas on the upstroke are invariably employed. When the ammonia enters the cylinders of compressors of this type in the form of a liquid, which it does at times, it necessarily remains in the bottom thereof and cannot be discharged until it is generated into gas by the heat and pounding action of the piston. This pounding action of the piston tends to force a portion of the liquid ammonia out through the stuffing-box in the bottom head of the cylinder, and hence there is a loss of ammonia and consequent congelation of the oil used for lubrication, and the corresponding increase of friction causes overheating of the brasses and piston-rod. Choking of the suction-valves, piston, and other coacting parts of the pump also occurs through the deposit and accumulation in the bottom of the cylinder of the oil, foul gases, scale, and other non-volatile liquid and solid residuum carried along with the ammonia in its passage through the system, and as this matter cannot be expelled by the piston and if left to remain quickly gums and cuts the piston and valves to an injurious extent, frequent dismantling and cleaning of the pump, or blowing out of the system by hot air or gases is necessary to keep the pump in working order. Furthermore, the stuffing-boxes of such pumps must be adjusted very tightly about the piston-rod to prevent a serious loss of ammonia by the expulsion of the ammonia upon the downstroke of the piston, and a large amount of power is required to operate the piston on its working stroke, as the weight thereof in addition to the resistance to compression must be overcome by the operating mechanism. The greater weight of the piston being also at the upper end of the rod, wabbling of the piston and excessive friction and unequal wear on the packing-rings constantly occur, thereby causing undue heating and expansion of the ammonia. To avoid the formation of a film and loss by clearance upon the upstroke of the piston and knocking out of the lower head of the cylinder upon the downstroke of the piston, careful and constant adjustment of the brasses of the connecting-rod is required, as the least wear on said brasses will cause the piston to drop and not go clear to the upper head on its upstroke and to strike the bottom head on its downstroke. In the cold or humid gas system horizontal pumps are employed, and an excessive amount of friction is created owing to the relatively large area and great weight of the piston which rests directly upon the bottom of the cylinder. The piston also constantly runs in contact with a mass of accumulated residuum, which gravitates to the bottom of the cylinder, and in consequence becomes quickly cut up and worn out.

The great advantages of my improved pump having its suction and discharge ports located, respectively, at the top and bottom of the cylinder and a piston operating to compress the ammonia on its downstroke may be stated, in part, as follows: First, the gases and liquids do not come in contact with the top head of the cylinder through which the piston works, and are therefore not unduly expanded upon entering the cylinder; second, less power is required to operate it than either of the types of pumps heretofore employed, and less friction is created, because the piston hangs plumb, with its greatest weight at its lower end, and is thereby held perfectly balanced, so 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 in either of said parts, and hence the cylinder-walls are not unduly heated, as the packing-rings only bear thereon, and the friction created by these alone is practically *nil;* third, as expansion pressure only comes on the piston the piston-rod may be run very loosely in its stuffing-box and heating of the upper head of the cylinder prevented; fourth, the entering gases and liquids travel by gravity from the suction-port to the bottom of the cylinder, so that no drawing or suction action of the piston is required to fill the cylinder; fifth, the falling gases and liquids thoroughly drench and cool the piston and walls of the cylinder and also wash all of the residuum down to the bottom of the cylinder and into the chamber C, thereby keeping the cylinder clear of foreign matter and prolonging the life of the same and the piston; sixth, the piston itself is adapted to drop by gravity under its own weight and assist the operating mechanism in compressing the refrigerating medium, and, seventh, the piston is always carried down to the bottom head by the action of gravity, and thus avoids loss of the refrigerating agent by clearance and the formation of a film.

It will be understood that changes in the form, proportion, and minor details of construction may be made within the scope of the invention without departing from the

spirit or sacrificing any of the advantages thereof.

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

1. In a compression-pump for ice-making and refrigerating apparatus, the combination of a pump-cylinder having suction and discharge ports and a valved outlet to said discharge-port, a piston comprising a hollow piston-head shell open at one end and provided with ports at its other end, a valve arranged to close against a seat on the open end of the shell, a spider above the valve-seat, a removable cup independent of the valve-seat and normally supported above the same and inclosed by said spider, a stem projecting through the cup, a spiral spring inclosed within the cup and encompassing the stem, and a nut fitted on the free end of the stem and arranged so as to bear against and hold the same confined within said cup.

2. In a compression-pump for refrigerating and ice-making apparatus, the combination of a pump-cylinder having suction and discharge ports and a valve-outlet to said discharge-port, a piston having a hollow piston-head shell open at one end and provided with ports at its other end, a valve-seat fitted in said open end and provided at its inner end with a spider, a cup on said spider, a valve arranged in said valve-seat and provided with a stem projecting through said cup, guide-fingers on the valve arranged about the cup, a coiled spring arranged in the cup about the stem, and a nut fitted on the stem and confining the spring.

3. In a compression-pump for refrigerating and ice-making machines, the combination of a pump-cylinder having a suction-pipe opening into its upper end and flanged at its lower end, a piston working therein, a detachable lower head bolted to said flange and having a discharge-port, a valve-casing comprising an annular wall formed integrally with and hanging pendent from said head and forming a chamber of approximately the same diameter as the cylinder, said wall being provided at its lower end with an annular flange and at one side with a discharge-pipe of reduced diameter with respect thereto, a valve arranged to close the port in the lower head and having a depending hollow stem with ports therein, a bottom plate bolted to the flange on the annular wall and closing said valve-casing and provided with a guide for the valve and a stud, and a spring inclosed in the stem of the valve and seated on said stud.

4. A compression-pump for refrigerating and ice-making apparatus employing a gas, such as anhydrous ammonia, liquefiable under mechanical compression, comprising a vertical cylinder having a suction-port at its upper end and a discharge-valve casing at its lower end, said casing being of the same diameter as the cylinder and consisting of top and bottom heads or plates and an annular connecting-wall, said top plate of the casing being connected to and serving as the bottom head of the cylinder and provided with a port of less diameter than the cylinder and the annular wall being free from connection with the cylinder and having a discharge-port of less size than said suction-port and the port in the bottom head, a sensitive balanced discharge-valve arranged in said casing and also of less diameter than the cylinder and controlling the port in the bottom head and adapted to open solely under the pressure of the ammonia under compression, and a piston operating to compress the ammonia on its downstroke and having a hollow piston-head shell provided with a valve-seat having a port of less diameter than the bore of the shell and a balanced valve closing upwardly against said seat, substantially as described.

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

GEORGE B. HIETT.

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