(No Model.) 3 Sheets—Sheet 1.

C. W. NASON & C. H. LEINERT.

REFRIGERATING APPARATUS.

No. 482,268. Patented Sept. 6, 1892.

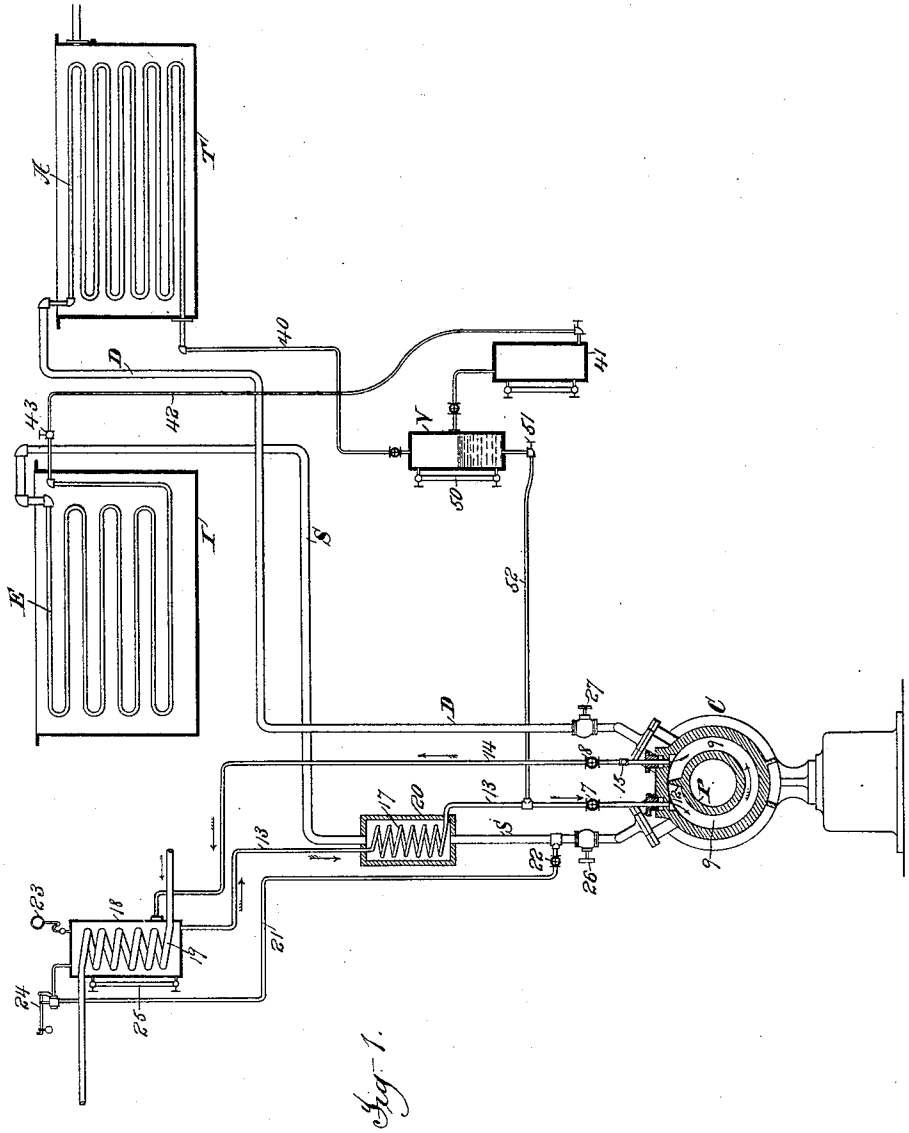

Fig. 1.

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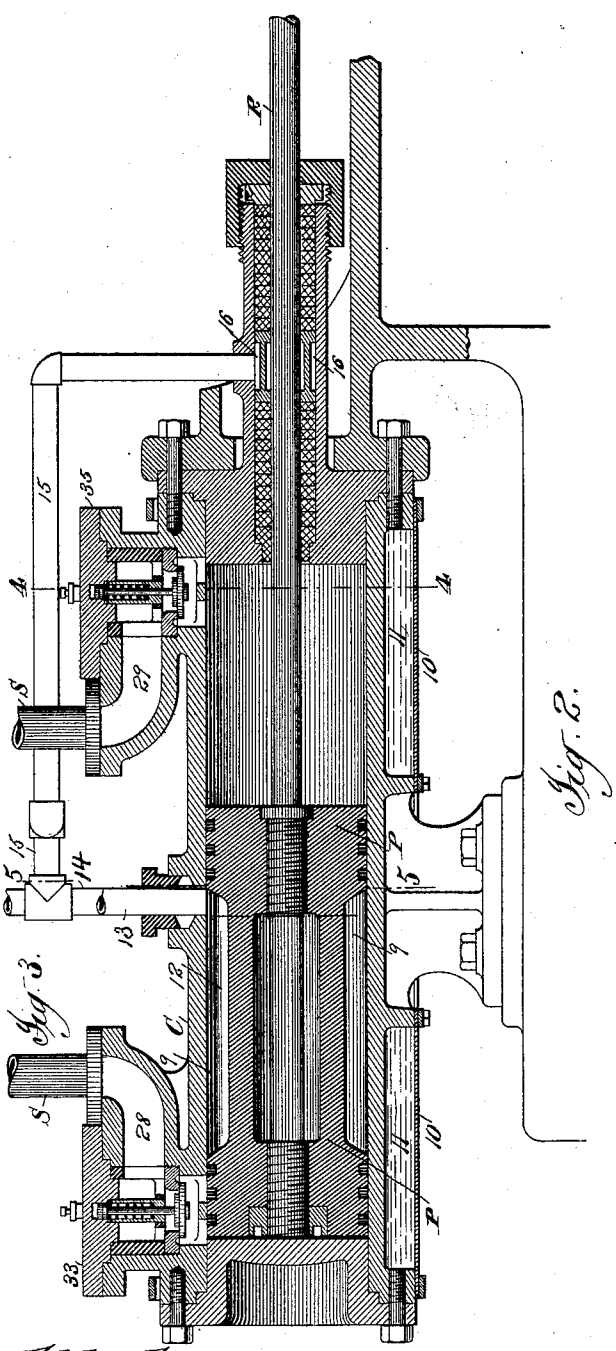

Fig. 3.

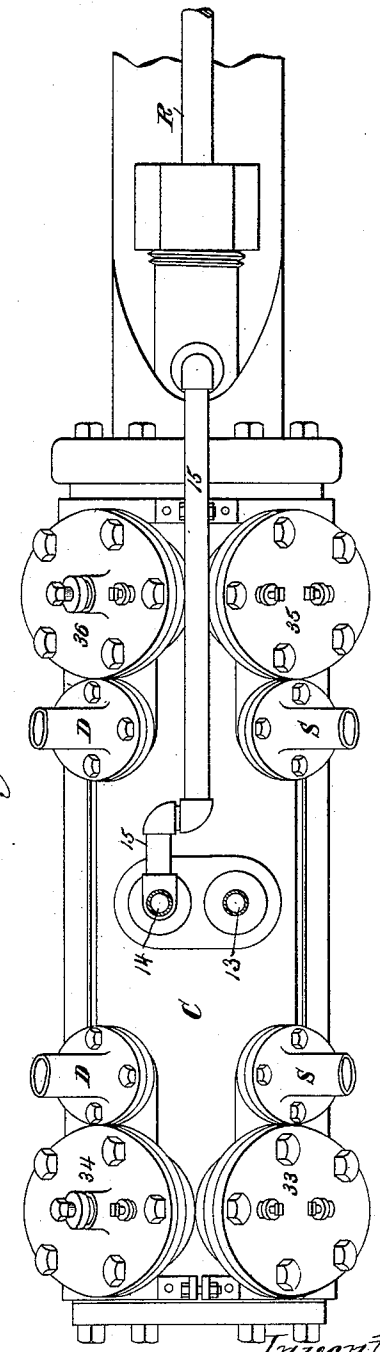

Fig. 2.

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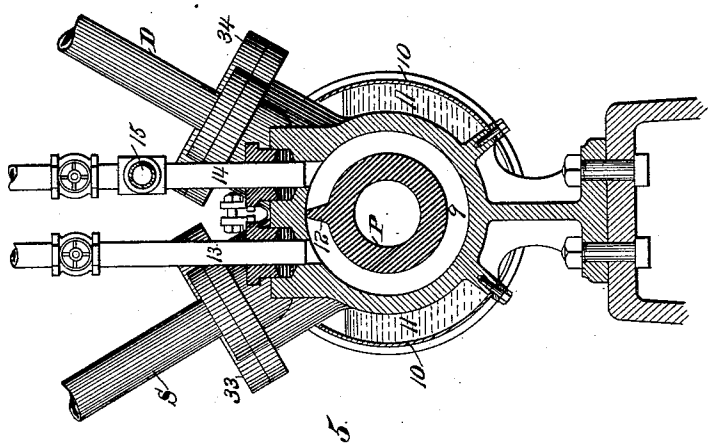

Fig. 5.

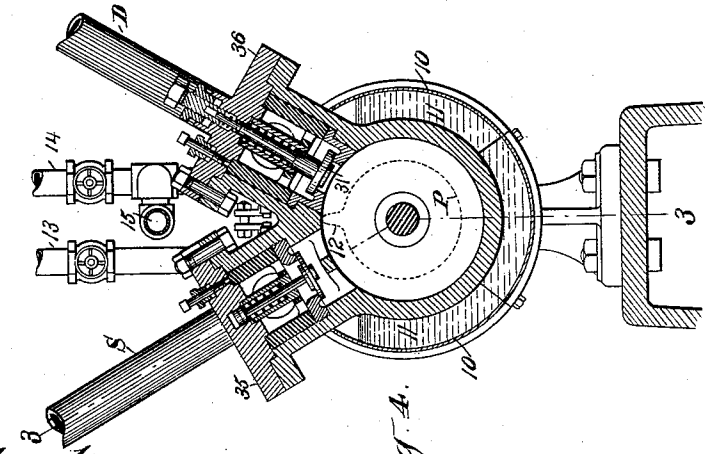

Fig. 4.

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UNITED STATES PATENT OFFICE.

CARLETON W. NASON AND CHARLES H. LEINERT, OF NEW YORK, N. Y.

REFRIGERATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 482,268, dated September 6, 1892.

Application filed October 3, 1891. Serial No. 407,603. (No model.)

To all whom it may concern:

Be it known that we, CARLETON W. NASON and CHARLES H. LEINERT, citizens of the United States, residing in New York, county and State of New York, have invented certain new and useful Improvements in Refrigerating Apparatus, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to the art of refrigeration as produced by the expansion of a highly compressed or liquefied gas—such as anhydrous ammonia—and as carried out in an apparatus consisting of a compressor wherein the gas is compressed and of a system wherein the compressed gas is preferably first passed through a condense in which the heat of compression is absorbed and liquefaction produced and thereafter the compressed or liquefied gas is wire-drawn and expanded or vaporized in an expansion coil or chamber to produce the refrigerating effect, the expanded gas thereafter being returned to the compressor to be again compressed, and in which apparatus the moving parts of the compressor are lubricated and sealed by a liquid circulated to secure efficiency, all of which is performed without exposing either the gas or the oil to the atmosphere.

An essential feature of the invention is comprised in compressing a gas in a compressor, delivering the same to a condenser for liquefaction, vaporizing the liquefied gas in an expansion-coil, and returning the expanded gas to the compressor to be again compressed, and simultaneously circulating a sealing or lubricating liquid in a chamber of the compressor that is independent of the chamber or passages containing the gas by means of the changing specific gravity due to the heat of compression, and from which circulation results a cooling of the compressor. It also embraces the cooling of the sealing or lubricating liquid during this circulation, an improved construction of apparatus, and various combinations and details so fully hereinafter described and claimed as to require no further preliminary description.

The illustrative drawings show, in Figure 1, a diagrammatic elevation of an apparatus embodying the invention, some of the parts being in section and the section of the compressor being on line 5 5 of Fig. 3, looking in the direction of the closed end of the compressor. Fig. 2 is an enlarged top or plan view of the compressor; Fig. 3, an enlarged longitudinal section of the same through one set of valves on the line 3 3 of Fig. 4; and Figs. 4 and 5 are enlarged transverse sectional elevations of the compressor, taken, respectively, on the line 4 4 and 5 5 of Fig. 3, looking toward the closed end of the compressor.

The gas made use of, which may be of any volatile liquid or gas, is preferably anhydrous ammonia, and will be referred to as "gas." The medium for lubricating or sealing the moving parts of the compressor may be glycerine, oil, or any liquid suitable for such purposes, and will be generally referred to as the "lubricating" or "sealing" liquid or oil. The place of expansion of the gas may be tubes, a coil or coils of pipes, a chamber or chambers or any suitable closed vessel, and will be referred to as the "expansion" coil.

The compressor-cylinder C has an exterior casing or jacket 10, providing it with an external water-chamber 11. Its reciprocating-piston P is provided with a considerable extent of packing at each end and has its middle portion cut away or recessed to form between it and the inner walls of the compressor-cylinder a central chamber 9, (see Fig. 5,) that is preferably provided with a cut-off constituted by a longitudinal rib 12 that extends to and slides in contact with the wall of the cylinder and thus provides for maintaining about the cylinder a body of the lubricating or sealing liquid or oil, which will partake of the reciprocating movement of the piston and be constantly replaced by cooling sealing or lubricating liquid by means of a circulation maintained through the induction-pipe 13 and eduction-pipes 14, which pipes have controlling-valves, as 7 8. A branch pipe 15 also leads from the pipe 14 to a chamber 16, formed in the elongated stuffing-box of the piston-rod R, no circulation of the lubricant being necessary on account of the absence of undue heat at this point, as is well understood. The lubricating or sealing oil flows from a cooling-coil 17 through the induction-pipe 13, enters the chamber 9 of the

compressor C on one side of the cut-off 12, thence moves in a circular course around the piston P, and passes out of said chamber on the opposite side of the cut-off, and thence through the eduction-pipe 14 to the oil-reservoir 18; but this cut-off may be omitted, if desired, although with its use a greater efficiency is attained. The lubricating or sealing oil reservoir 18 is a closed tank of suitable dimensions for the supply required and is provided with a cooling-coil 19, through which cold water is constantly passed to absorb the major part of the heat with which the oil may be charged. The cooling-coil 17, through which the oil is passed on its way to the compressor, is surrounded by closed reservoir 20, in which a quantity of the expanded gas is contained in its passage from the expanding-coil E to the compressor to be again compressed, which expanded gas, although it has taken up more or less units of heat in producing refrigeration, is still of a temperature low enough to so far cool the oil passing through the said coil 17 as to properly prepare it for introduction into the compressor for lubricating and sealing purposes, and for cooling the walls of the cylinder and other parts of the compressor.

The circulation of the lubricating or sealing liquid is accomplished by reason of its constantly-changing specific gravity, due to to the heat induced in the compressor by the act of compressing the gas, said heat being imparted to the outgoing oil and reducing its specific gravity as opposed to the greater specific gravity of the cooled incoming oil.

The expanded gas is drawn into the compressor to be compressed through the return or suction pipe S, which connects with the exhaust end of the expanding-coil E, and the compressed gas is conducted to the coil or coils A of the condenser through the delivery-pipe D, both pipes S and D having controlling-valves, as 26 27.

The compressor, which might be single-acting, is shown as double-acting, that form being preferred. Its suction-pipe S is branched to communicate with the cylinder through induction-ports 28 29, provided with spring-closed inwardly-opening valves, and its delivery-pipe D is likewise branched to communicate with its cylinder through eduction-ports similar to the ports 28 29, (see Fig. 4,) which eduction-ports are provided with spring-seated outwardly-opening valves, one of which 31 is shown in Fig. 4.

The valves and valve-seats are constructed so as to be bodily removable, and when in position are maintained in place by caps, as 33 35, for the induction or suction valves, and caps 34 36 for the eduction-valves, which caps are securely bolted in place. (See Fig. 2.)

As illustrated, the piston P is shown as just beginning its compressing movement, having just completed a stroke in the opposite direction, during which a charge of gas to be compressed has been drawn through the pipe S and induction-valve in port 29 into the free space of the cylinder, (shown in Fig. 3,) said valve now being closed. As the piston moves to occupy the space in the cylinder now filled with expanded gas, it operates to compress the same, and when a degree of compression and therefore pressure has been reached which is sufficient to open the eduction-valve 31 said valve will be moved and allow the compressed gas to be expelled out of the compressor and be conveyed away by the eduction-pipe D. Upon completion of its stroke in this direction the charge of expanded gas, which has been drawn into the cylinder through the valve in port 28 and between its head and the other end of the piston, will be compressed and delivered as the piston makes its stroke in the opposite direction, and thus a constant introduction of expanded gas through the pipe S and a constant delivery of compressed gas through the pipe D will be maintained. This compressed gas forced through the pipe D is conveyed through a coil or coils of the condenser, which coils are in a water-tank T, as usual, the action of which is to produce liquefaction, and from which condenser the liquefied gas is conveyed to the expansion-coil to be expanded or volatilized, preferably conducted by a pipe 40 through a drip-tank V, hereinafter described, to a storage gas-tank 41, and from thence being conveyed by a pipe 42 to the expansion coil or coils E, into which it is admitted by being wire drawn through a suitable valve 43 to accomplish that effect; and from the expansion pipe, coil, or coils the expanded gas is conducted through the suction-pipe S back to the compressor. The expansion-coil E may be located in a room to reduce the temperature or operate in connection with a water tank or tanks, as I, in which ice is to be formed.

It has been explained that this apparatus, though using oil for the purpose of sealing and lubricating the moving parts and cooling the cylinder and other parts of the compressor, practically so confines the oil that the gas and oil are always contained in separate chambers and passages of the machine, thus avoiding, as in the case where they are circulated together, the necessity of tanks for constantly separating large bodies of one from the other and of course much complication of parts. Although both the gas and oil are separately circulated in this system and in a practical sense do not combine, it nevertheless results that in a long period the gas will through slight leakage past the piston accumulate in the reservoir 18, which in time will raise the pressure unduly, and thereby tend to force the oil past the piston into the gas-chambers of the cylinders; also, that as the gas at the moment of its highest compression in the compressor exerts great pressure it follows that in long running there will be a slight leakage of gas past the piston-packing into the chamber 9, and thence to the reservoir 18, and these infinitesimal quanti-

ties of gas so escaping at each stroke of compression will in time accumulate to an objectionable quantity in the oil-reservoir 18; but it will be noted that in practically operating the oil will have a pressure that is automatically controlled by the safety-valve relatively to that of the gas undergoing compression and to which it is opposed, and hence a pressure equaling that of the terminal pressure of the compressor-stroke is so far approached as to substantially prevent leakage of the gas to the oil, thus limiting it to infinitesimal quantities and a long period of accumulation. When, however, this slight leakage of gas has caused the accumulation of an objectionable quantity of gas above the body of oil in the reservoir 18, which may be ascertained by means of the glass indicator 25 and pressure-gage 23, it may be removed by a pipe 21, leading from the top of the reservoir 18 and communicating with the suction-pipe S below the cooling-reservoir 20, which pipe 21 has a valve 22, that may be occasionally opened to permit the accumulated gas to pass to the suction side of the apparatus. This may, however, be automatically accomplished by means of a safety-valve 24, the operation of which when the tension of the gas in the reservoir 18 is sufficient will be to open and allow the gas to pass; but in this operation the valve 22 will be open. It also follows since the piston-chamber in the cylinder of the compressor is constantly lubricated by entrainage of the oil, which must for lubricating purposes adhere to the walls of said chamber, that infinitesimal quantities of the oil will remain there after the passage of the piston and hence be in part, at least, absorbed by the gas during its compression. These very small quantities constantly being absorbed by the gas may in time become great enough to interfere with refrigeration by clogging the expansion-pipes, and we have therefore provided a small drip-tank V, through which the compressed or liquefied gas is passed on its way to the gas storage-tank 41. In said tank V the oil, owing to its greater specific gravity than liquefied gas, will occupy the lower part of the vessel, and when after a long period of time enough has accumulated to need removal (which may be determined by the glass gage 50) the same is discharged by a cock 51 and conveyed by a pipe 52 to the oil-pipe 13 and thus united with the oil passing to the chamber in the compressor.

What, therefore, we claim is—

1. In a refrigerating apparatus, the combination of a piston-chamber in a gas-compressor for the reception of a circulating sealing lubricant and the circulatory system of ascending and descending columns of lubricating or sealing liquid communicating therewith, which columns of liquid are propelled by the alternate expansion and contraction due to the heat of compression in said chamber and the lower temperature above, substantially as described.

2. The combination, with the cylinder of a gas-compressor and its piston, the latter provided with an annular chamber between its bearing ends, within which the lubricating or sealing liquid may circulate and be subjected to the heat of compression, of a reservoir connected with said chamber for supplying a body of the liquid thereto and means for cooling said liquid, through which chamber the liquid is circulated by the changing specific gravity due to the said heat and cooling, substantially as described.

3. The combination, with the cylinder of a gas-compressor and its piston, the latter provided with an annular chamber intermediate between its bearing ends, of induction and eduction pipes connecting such chamber with a lubricating or sealing liquid reservoir and without communication with the pressure side, substantially as described.

4. In a gas-compressor, the combination, with a piston provided with an annular chamber intermediate between its bearing ends and having a longitudinal cut-off or dividing-wall, of induction and eduction pipes leading to said chamber on opposite sides of said cut-off, substantially as described.

5. In a gas-compressor, the combination, with a piston provided with a chamber intermediate between its bearing ends and having a longitudinal cut-off, of induction and eduction passages through the body of the compressor-cylinder communicating with said chamber on opposite sides of the cut-off, pipes connecting said passages with a lubricating or sealing liquid reservoir, and a cooler operating to reduce the temperature of the liquid prior to its introduction into said chamber, substantially as described.

6. In a refrigerating apparatus, the combination, with a compressor-piston provided with a chamber within which the lubricating or sealing liquid is circulated without communication with the pressure side, of induction and eduction pipes connecting such chamber with a lubricating or sealing liquid reservoir, said induction-pipe having a coil which is within a chamber through which the expanded gas passes in returning to the compressor, substantially as described.

7. In a refrigerating apparatus, the combination, with a compressor-piston provided with a chamber for the circulation of the lubricating or sealing liquid, induction and eduction pipes connected therewith and with a lubricating or sealing liquid reservoir, of a pipe connecting said reservoir with the low-pressure side of the apparatus and provided with an adjustable valve whereby gas that may have leaked into said reservoir will be automatically discharged when it has attained a predetermined pressure, substantially as described.

8. A refrigerating apparatus consisting of a compressor whose piston is provided with a chamber for the lubricating or sealing liquid independent of the chamber or passages for the gas, a condenser to which the compressed gas is directly conveyed, an expansion-coil in which the gas is vaporized and from which it is directly conveyed to the suction side of the compressor, a drip-tank for separating such gas or oil as may combine from slight leakage in long use, and a storage-reservoir for the liquefied gas, which drip-tank and storage-reservoir are located between the condenser and expanding-coil, substantially as described.

In testimony whereof we have hereunto set our hands in the presence of two subscribing witnesses.

CARLETON W. NASON.
CHAS. H. LEINERT.

Witnesses:
H. T. MUNSON,
T. F. KEHOE.