(No Model.)

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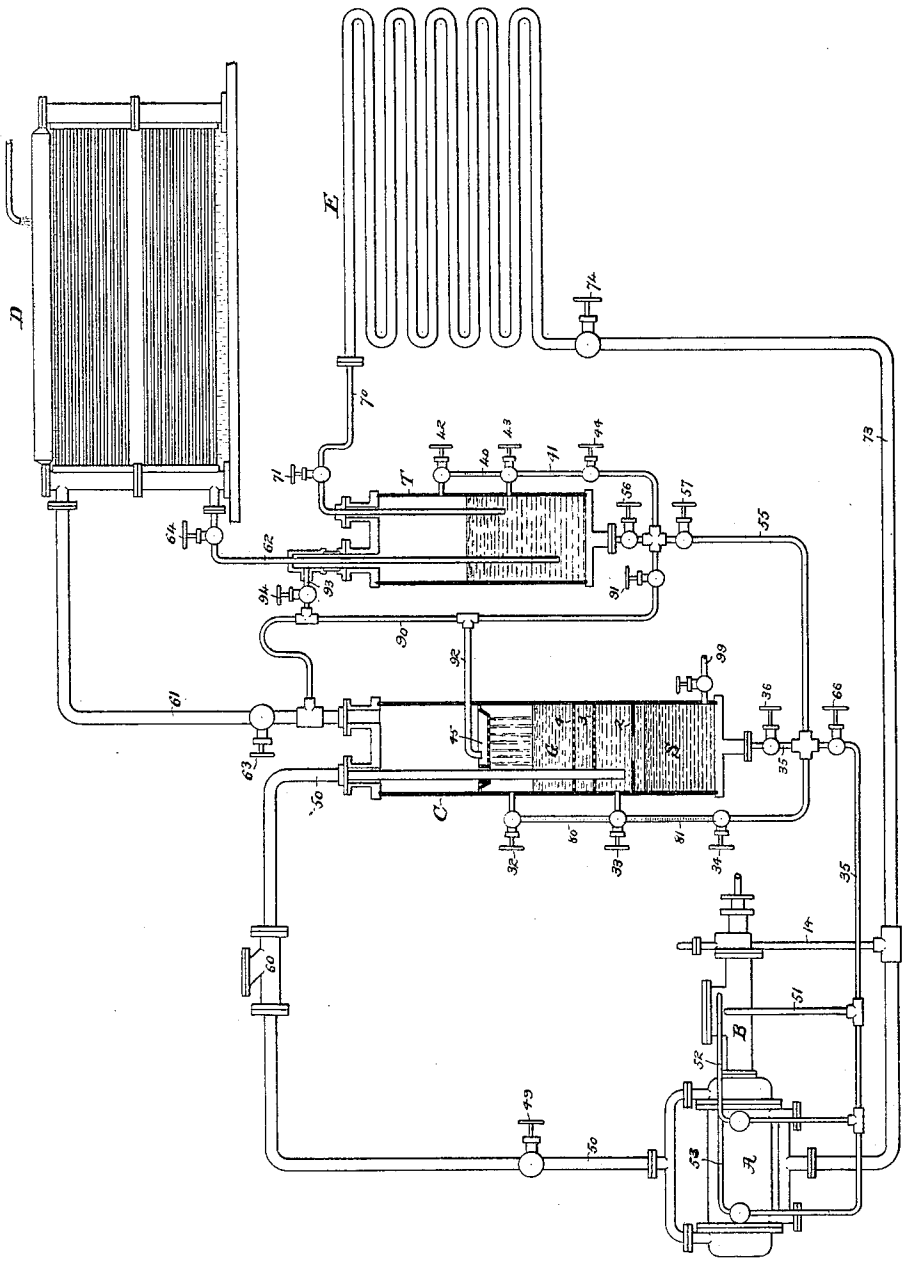
METHOD OF AND APPARATUS FOR PURIFYING AND LIQUEFYING GASES AND PRODUCING REFRIGERATION.

No. 320,307. Patented June 16, 1885.



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JULIUS J. SUCKERT, OF RIDGEWOOD, NEW JERSEY.

METHOD OF AND APPARATUS FOR PURIFYING AND LIQUEFYING GASES AND PRODUCING REFRIGERATION.

SPECIFICATION forming part of Letters Patent No. 320,307, dated June 16, 1885.

Application filed April 24, 1885. (No model.)

To all whom it may concern:

Be it known that I, JULIUS J. SUCKERT, a citizen of the United States, residing at Ridgewood, county of Bergen, and State of New Jersey, have invented certain new and useful Improvements in Method of and Apparatus for Purifying and Liquefying Gases and Producing Refrigeration, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to that class of gas liquefying and refrigerating machinery wherein a sealing or lubricating liquid is used with a gas or refrigerating agent during its compression, and which involves the separation of such sealing or lubricating liquid and other impurities from the liquefied gas before introducing such liquefied gas to the expansion-coil of a refrigerating apparatus or before utilizing it for other purposes.

As fully stated in my application No. 163,254, filed of even date herewith, made simultaneously herewith, where a sealing or lubricating liquid has been used in gas compressing and refrigerating apparatus, serious difficulty has been produced by the passage of the sealing or lubricating liquid from the compressor to the condenser, and thence intermingled with the liquefied gas to the heat-absorbing coils. Serious difficulty has also been encountered in obtaining a perfectly pure liquefied gas for supplying the market. To overcome these difficulties elaborate and complicated means of separation have been devised which have been the subject-matter of various patents and patented processes; but, nevertheless, prior to the invention of the apparatus previously alluded to, a perfect and complete separation of the sealing or lubricating liquid from the liquefied gas before admitting it to the expansion or heat-absorbing coils has not been effected.

In following the various improvements I find that first a separation was attempted by interposing a separating-tank between the compressor and the condenser, relying upon the difference in gravity between the compressed gas and the sealing or lubricating liquid to effect the separation; but it was found wanting in one particular. The lubricant upon its discharge from the compressor was in part changed to the condition of foam or froth and vapor, which passed on with the compressed gas to the condenser, there reassuming its original liquid condition, and, intermingling with the liquefied gas, was carried to the heat-absorbing coils. To remedy this, baffle or intercepting plates were introduced within the separating-tank in the hope that the vaporized lubricant would condense upon the plates, but with indifferent results. The lubricating agent after its discharge from the compressor was then passed through a coil or chamber surrounded by cold water, so as to reduce its temperature before being introduced into the compressor, thereby abstracting a portion of the heat of compression, and materially lowering the temperature of the gas and the lubricant issuing from the discharge-pipe of the compressor. By this means the amount of lubricant vaporized was somewhat reduced. Still a considerable quantity continued to pass to the condenser, and as a final remedy a separating-tank was interposed between the condenser and the heat-absorbing coils, into which the liquefied gas and the sealing or lubricating liquid passing from the condenser were conducted, and by reason of their different specific gravities separated. The liquefied gas, floating on the surface of the sealing or lubricating liquid, was conducted to the heat-absorbing coils, and the sealing or lubricating liquid withdrawn at irregular intervals and allowed to flow either to the separating-tank interposed between the condenser and the compressor, or it was discharged into a tank maintained at the suction-pressure of the apparatus, and into which the cooled lubricant entered prior to its introduction into the compressor. It seemed at the time that this system had finally conquered the difficulty; but after a practical test of years it has been ascertained that the separation is still incomplete. If a sample of the liquefied gas be drawn from the pipe conveying the liquefied gas from the final separator to the heat-absorbing coils, the liquefied gas will be found to contain a portion of the lubricating agent, either in solution or in suspension. This can be readily determined by allowing a sample of the liquefied gas to evaporate in a glass or

other vessel, wherein it will leave a residuum consisting mainly of the sealing or lubricating liquid. This test has been applied to refrigerating-plants which have used their liquefied gas for years without renewing, and in all instances the presence of the sealing or lubricating liquid was discovered in the liquefied gas prior to its entrance to the heat-absorbing coils, which conclusively shows that there is a slow but steady transfer of the lubricating agent to the heat-absorbing coils, and which, if not returned to the compressor or its receiving-tank, will in the course of time impair and materially affect the efficiency of the apparatus.

In all systems heretofore devised the sealing or lubricating liquid is continuously in contact with the gas as such, or in its liquefied condition, for both when it reaches the final separator and a separation of both occurs they are still in contact with one another at the line of contact. By using some sealing or lubricating liquids the solution or suspension of the same might be avoided; but on account of the chemical action of the majority of liquefiable gases upon the lubricating liquids usually used their number is limited to a few liquid hydrocarbons, especially those belonging to the paraffine group. They must, however, possess high boiling-points in order to avoid too excessive vaporization of the lubricant to the condenser, thereby entailing a constant watchfulness to withdraw the collecting lubricant from the final separator, in case such is used.

The object of this invention is to obtain a liquefied gas freed from a liquid or liquefied vapor having a higher boiling-point than the liquefied gas for refrigeration and other purposes, and to obviate the specified difficulties met with in other systems and apparatus; and to this end the invention consists, first, of the process of purifying and liquefying gases, which process consists in first washing a compressed gas intermingled with a liquid, a vapor, or with both, with a liquefied gas operating by its contact and vaporization to reduce the temperature of the compressed gas and the intermingled liquid or vapor, and to liquefy such vapor and wash and separate the liquid and its liquefied vapor from the compressed gas and the vaporized liquefied gas, and then, by condensing the compressed gas and the vaporized liquefied gas, and conveying the purified liquefied gas resulting therefrom to a separate chamber or receptacle, to entirely separate a quantity of such purified liquefied gas from the lubricating liquid or its liquefied vapor, and then returning a portion of the purified liquefied gas to the washing-chamber, to continuously cool and wash compressed gas, and to separate intermingled liquid or vapor therefrom, as will hereinafter appear.

The invention further consists of the combination of the several parts shown and described, as will hereinafter appear.

The accompanying drawing shows a side elevation, partly in section, of an apparatus embodying the invention.

The apparatus illustrated herein embodies a gas-compressor, A, having an auxiliary circulating-pump, B, a condenser, D, an expansion or heat-absorbing coil, E, a separating-tank, C, into which the compressed gas and the sealing or lubricating liquid with its vapor is discharged from the compressor, and the tank or reservoir T, for receiving, holding, and supplying the purified liquefied gas received from the condenser.

The discharge-pipe 50 of the compressor has a cock, 49, and connects with and discharges into the separating-tank C. A pipe, 61, having cock 60, leads from the tank C to the condenser D. A pipe, 62, having cock 64, conveys the liquefied gas from the condenser D to the tank or reservoir T, for holding the purified liquefied gas. A pipe, 70, having cock 71, conveys the liquefied gas from the receptacle or tank T to the expansion or heat-absorbing coil E, and a return or suction pipe, 73, having cock 74, conveys the expanded gas from the heat-absorbing coil E to the compressor A for recompression. An equalizing-pipe, 90, communicates with the separating-tank C and storage-tank T, respectively. Its lower portion, controlled by a cock, 91, is used to convey liquefied gas through the branch pipe 92 to a sprinkler or showering device, 45, in the tank C, and its upper part, by means of a pipe, 93, controlled by a cock, 94, communicates with the upper parts of both tanks, and operates to equalize the pressures and to prevent the liquefied gas from siphoning out of the tank T to the tank C.

A pipe, 35, having cocks 36 66, conveys the sealing or lubricating liquid from the separating-tank C to the auxiliary pump B and to the compressor A by means of branch pipes 51 52 53. A pipe, 55, extending from the bottom of the liquefied-gas tank or reservoir T, and supplied with cocks 56 57, connects with the pipes 90 and 35, and with the gages of both tanks. Double section glass gages 80 81, supplied with cocks 32 33 34, are connected with the tank C, and similar gages, 40 41, supplied with cocks 42 43 44, are connected with the tank T, which gages are provided to show the heights of the liquefied gas in said tanks, and that of the sealing or lubricating liquid in tank C.

A chamber in the stuffing-box of the pump B has a pipe, 14, connecting with the return or suction pipe 73, whereby any gas leaking past the piston-rod, if any, may be carried back, and thus be prevented from leaking out to the atmosphere.

The tank C is supplied with baffle-plates 2 3 4, perforated to admit the passage of the gas through them to quiet or suppress the commotion caused in the tank by the introduction of the compressed gas and lubricant from the discharge-pipe 50 of the gas-compressor, and to subdivide the compressed gas and aid in effecting a separation of the gas and the lubricant.

The discharge-pipe 50 is provided with a check-valve, 60, which operates to prevent the flow of a liquefied gas from the condenser or separating-tank back to the compressor. The tank C is provided with an outlet-pipe, 99, provided with a cock, the purpose of which is to draw away the liquid therein, for if the lubricant is soluble in the liquefied gas it may be necessary after a time to draw away the old liquid and replenish with new.

The remaining stop-cocks shown are to shut off different parts in case it may be necessary to repair and to regulate and control the action of the apparatus. The light shading G represents the liquefied gas, and the heavy shading S the sealing and lubricating liquid.

The operation of the apparatus is as follows: The necessary quantity of a liquefiable gas and a sealing or lubricating liquid having been supplied, the engine actuating the compressor is started, and the gas to be compressed is drawn from the expansion or heat-absorbing coil E through the return or suction pipe 73 to the inlet-ports of the compressor and the compression-chambers. A charge of the lubricant is at the same time drawn from the separating-tank C through the pipe 35 to the auxiliary pump B, and is thence introduced to the compression-chambers of the compressor during the act of compression. The compressed gas is then discharged from the compressor with the sealing or lubricating liquid, either in the form of an intermingled liquid, froth, foam, or vapor, or a combination of each, and is forced through the discharge-pipe to the separating-tank C, where it is introduced into a body of liquefied gas, G, just above the perforated plate 2. By the contact of the compressed gas and the sealing or lubricating liquid or its vapor with the liquefied gas they are thoroughly washed, and the heat of compression is abstracted from each by the vaporization of a part of the liquefied gas. Thereby the vapor of the lubricant liquefies, and is prevented from passing out of this tank. The cooled compressed gas then passes upward with the vaporized liquefied gas developed by the abstraction of the heat of compression to the upper part of the separating-tank, meeting in its passage a shower of liquefied gas from the sprinkler 45, which is continuously supplied by the overflow from the liquefied-gas reservoir T through the lower part of the pipe 90 and the branch pipe 92, these pipes being always open when the apparatus is at its regular work. By means of this overflow the deficiency of liquefied gas in the separating-tank C, caused by the vaporization of such gas while abstracting the heat of compression, is always made up, and the process is made continuous. The cooled compressed gas with its temperature reduced to that of a saturated vapor, together with the vaporized liquefied gas, then passes through the pipe 61 to the condenser D, where they are liquefied by water trickling over the surface of the condenser. When such gases are liquefied, the liquefied gas passes out at the bottom of the condenser through the pipe 62 to the liquefied-gas reservoir or storage-tank T. By this means the main body of the liquefied gas is kept entirely separate from the sealing or lubricating liquid or the vapor of such liquid, and only the surplus is returned to the washing or separating tank C to make good the deficiency specified when the liquefied gas rises above the level of the connection of the pipe 92 with the pipe 90. The upper part of the pipe 90 communicates with the tanks C and T by means of its connections with the pipe 61, and through the pipe 93, having the stop-cock 94, and connecting with the head of the tank T. This passage-way is always open to equalize the pressure in the two tanks, and the pipe 90 is at this point lengthened and craned upward, to prevent the passage of any liquefied gas projected into the pipe 61 by the agitation of the liquefied gas in the separating-tank C into the tank T.

If it is desired to use the purified liquefied gas for purposes of refrigerating, the liquid is drawn from the tank T through the pipe 70 and the stop-cock 71 to the expansion or heat-absorbing coil E, wherein it is introduced under a reduced pressure, the expanded gas returning to the compressor for recompression through the pipe 73. If it is desired to draw away a pure liquefied gas for other disposal, it may be done by inserting another outlet-pipe with stop-cock and flange in the tank T, or the pipes 90 may be provided with suitable connections.

The tanks C and T and the condenser D being under the same pressure, the volume of liquefied gas vaporized in abstracting the heat of compression from the compressed gas and the sealing or lubricating liquid and its vapor in the separating-tank will be in proportion to the increased temperature which such gas and lubricant introduced from the compressor has in excess of the temperature existing within the condenser; but as long as a sufficiency of the liquefied gas is introduced from the tank T to the separating-tank C to replace that vaporized in abstracting the heat of compression, and the separating-tank and condenser have open communication through the pipe 61 for the escape of the vaporized liquefied gas as a saturated vapor, it will be apparent that the temperatures in the separating-tank and condenser must be the same.

This application is a division of my application No. 163,254, and consequently no claim is here made for any subject-matter therein claimed.

Having explained my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. The process of purifying and liquefying gases, which process consists in first washing a compressed gas intermingled with a liquid, a vapor, or with both, with a liquefied gas operating by its contact and vaporization to reduce the temperature of the compressed gas

and the intermingled liquid or vapor, and to liquefy such vapor and wash and separate the liquid and its liquefied vapor from the compressed gas and the vaporized liquefied gas, and then by condensing the compressed gas and the vaporized liquefied gas, and conveying the purified liquefied gas resulting therefrom to a separate chamber or receptacle, to entirely separate a quantity of such purified liquefied gas from the sealing or lubricating liquid or its liquefied vapor, and then returning a portion of the purified liquefied gas to the separating or washing tank or chamber to continuously cool and wash compressed gas, and to separate intermingled liquid or vapor therefrom, substantially as described.

2. The combination, with a gas-compressor and condenser, of a receiving-tank placed between the compressor and condenser, which communicates with the discharge-pipe of the compressor and with the condenser, a second tank connected with the condenser and receiving a liquefied gas therefrom when the said tanks are directly connected by conduits which equalize the pressures in the said tanks, and the whole are connected, arranged, and operate to continuously and automatically transfer a part of the liquefied gas from one of said tanks to the other, substantially as described.

3. The combination, with a gas-compressor and condenser, of a receiving-tank communicating with the discharge-pipe of the compressor and with the condenser, a second tank communicating with the condenser and receiving therefrom a liquefied gas when the said tanks are connected by conduits which equalize the pressures in said tanks, and the whole are connected, arranged, and operate to retain a determined quantity of liquefied gas in one tank and automatically supply the other tank, substantially as described.

4. The combination, with a gas-compressor and condenser, of a receiving-tank placed between the compressor and the condenser, which communicates with the discharge-pipe of the compressor and with the condenser, a second tank connected with the condenser and receiving a liquefied gas therefrom when the said tanks are connected by conduits, and the whole is arranged and operates to receive in one tank a liquefied gas entirely free from contact with the sealing or lubricating liquid, and to transfer a part of the liquefied gas to the other tank, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

JULIUS J. SUCKERT.

Witnesses:
JAS. J. KENNEDY,
T. H. PALMER.