

M. WANNER.

PROCESS OF AND APPARATUS FOR REFRIGERATION.

No. 537,590.

Patented Apr. 16, 1895.

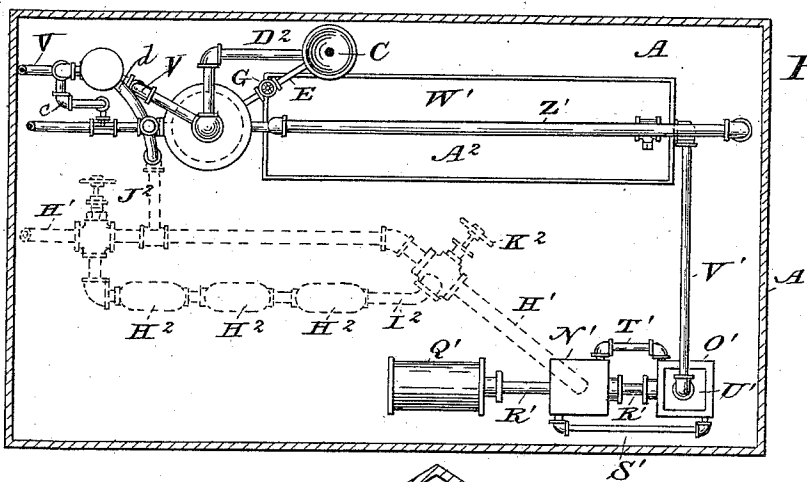


Fig. 1.

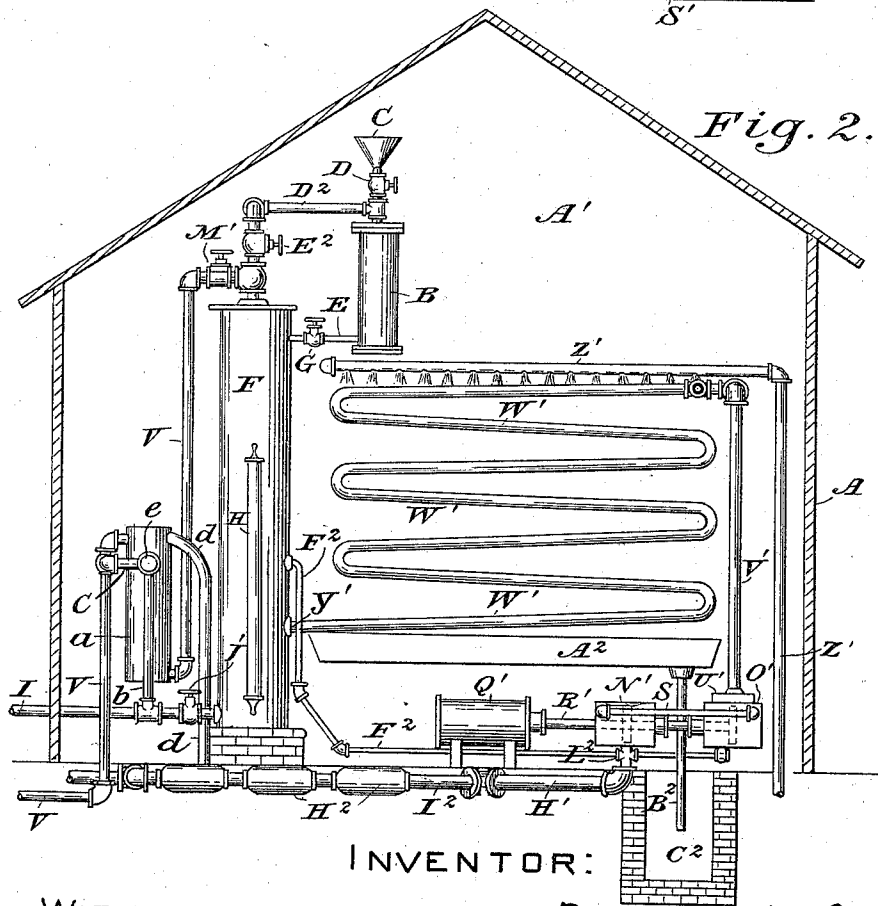


Fig. 2.

INVENTOR:

WITNESSES:

E. L. Smith
George Wilson

Martin Wanner
By Phillips Abbott
his Attorney.

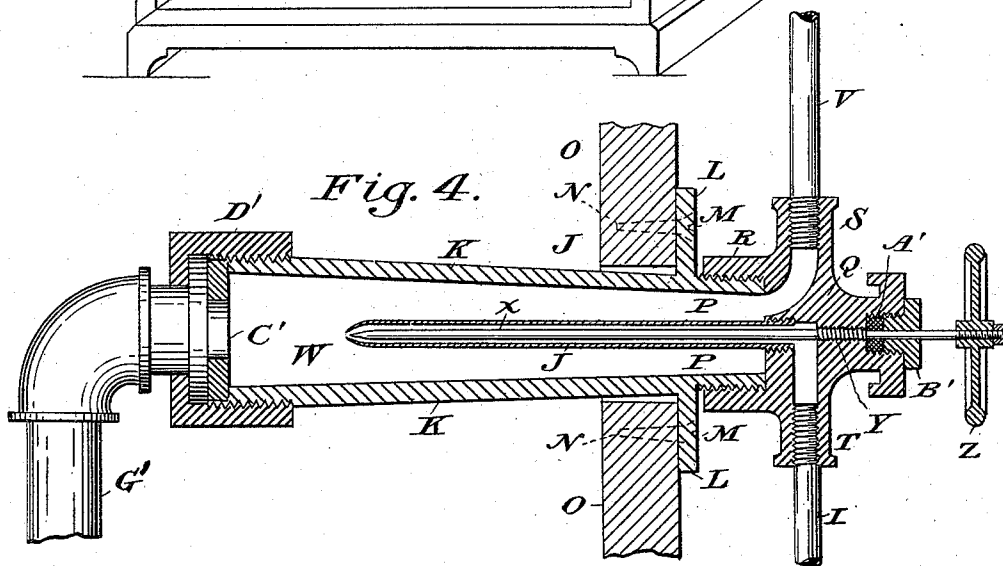
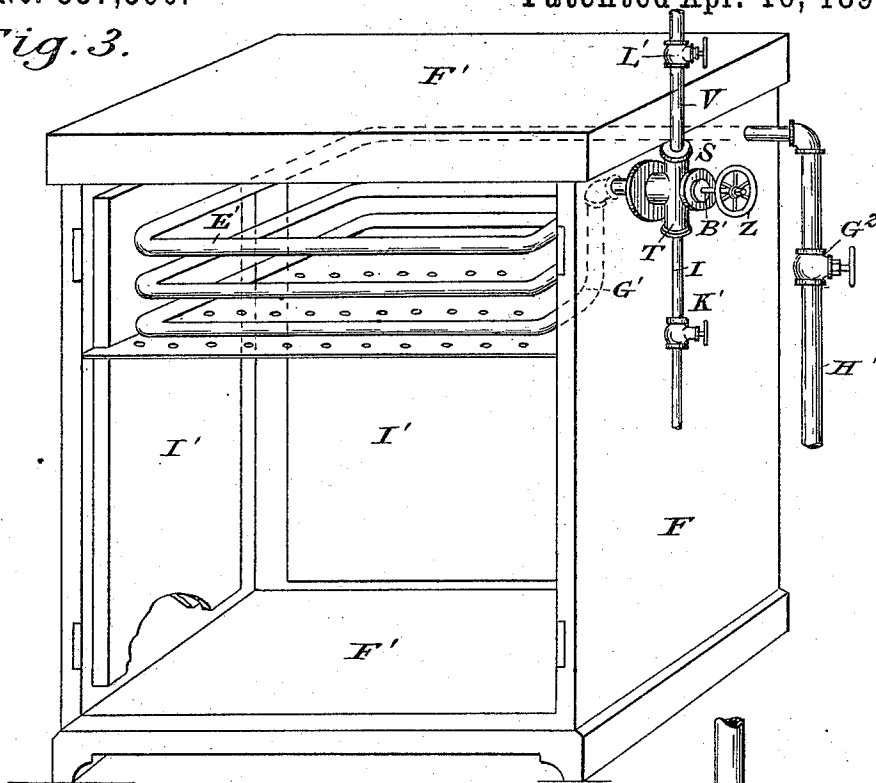
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Fig. 3.



WITNESSES:

George Wilson
E. Simpson.

INVENTOR:

Martin Wanner

By Phillips Hobolt
his Attorney.

UNITED STATES PATENT OFFICE.

MARTIN WANNER, OF YORKTOWN, INDIANA.

PROCESS OF AND APPARATUS FOR REFRIGERATION.

SPECIFICATION forming part of Letters Patent No. 537,590, dated April 16, 1895.

Application filed August 21, 1894. Serial No. 520,950. (No model.)

To all whom it may concern:

Be it known that I, MARTIN WANNER, a citizen of the United States, and a resident of Yorktown, in the county of Delaware and State of Indiana, have invented a certain new and useful Improved Process of and Apparatus for Refrigeration, of which the following is a specification.

My invention relates to new and useful processes of refrigeration and to improvements in refrigerating apparatus.

My present invention is in part improvements on the inventions patented by me in United States Letters Patent No. 500,088, dated June 20, 1893, and No. 500,107, dated June 20, 1893.

The invention is applicable to what is known as a local refrigerating system, *i. e.*, one located and operating entirely within a single apartment or building, and also to a distributive system, so called, *i. e.*, one in which the generating apparatus is located in one place or building, and the cold producing agents are conveyed thence to one or more distant places, where the refrigeration is desired.

My invention is especially advantageous in the latter system.

I prefer to employ carbon bi-sulphide (CS_2) as the liquid refrigerating medium, on account of its very low freezing point, and its property of condensing at atmospheric pressure and at ordinary temperatures; and in this specification, I will name it as such liquid. I do not, however, limit myself to it. Any suitable substitute may be employed.

In order that the new processes and improvements in the apparatus made by me may be more easily understood, I will before describing them, state, in part at least, what I believe to be the scientific principles on which they are based.

I have discovered certain facts in connection with refrigeration, which I think have not before been known, and which have an important bearing on the success of the system, especially when such a refrigerant as carbon bi-sulphide is used. Among them are the following:

First. Vaporization of a volatile liquid can progress only in exact proportion to the heat units absorbed or taken up by it from sur-

rounding objects, and if it cannot obtain sufficient heat units from surrounding objects, it will abstract them from its own mass, thus generating such cold in itself, that solidification by freezing results, which, of course, plugs up the pipe or other device in which the expansion takes place, and immediately stops the circulation.

Second. When the freezing above stated results, localization of the refrigeration necessarily follows, because, as is obvious, a solid cannot change place or flow, hence the cold, although intense at that point, is necessarily limited to it.

Third. The formation of the local frozen mass above referred to, I prevent by subjecting the liquid bi-sulphide as well as its vapors, to the agitating action of a blast or current of air, whereby it is prevented from freezing into a solid mass, and the liquids or vapors, if frozen at all, freeze in the form of frost crystals or fine snow-like particles.

Fourth. I have further found that these fine frozen particles may be easily carried through a system of pipes or other confined conduits by means of an air blast or current, and further, that as they, during their transit, come in contact with the relatively warm walls of the pipes or conduits, which confine them, they absorb or take up heat units from them, and are thus liquefied and vaporized, these two results being practically simultaneous. Consequently if means be employed to secure the above results, *i. e.*, the prevention of freezing or solidification in a mass and the carrying of the fine frozen particles, then the extent or scope of the refrigerating operation is not confined to one place where an intense and usually undesirable degree of cold is produced, but is extended over a large area, in which the temperature is practically uniform and of a degree or intensity better adapted for practical work. Thus the available refrigerating results are greatly enhanced.

My improvements, therefore, consist, among other things, in means whereby the carbon bi-sulphide may be agitated by an air current to prevent solidification in a mass; also to means whereby the same air current will convey the vapors or frozen particles through a refrigerating coil or pipe system; also to means for regulating the relative amounts of air and liquid;

also to improvements in the refrigerating coil itself; also to improvements in the condensing devices; also to means for removing all moisture from the air; also to the employment of a mixture of a foreign body, such as glycerine and water, which operates as an aid to the separation of the air and bi-sulphide of carbon; also as a lubricant to the moving parts of the apparatus; also as an aid to the condensation by reducing the temperature of the condensing apparatus, and finally as a means to fill the clearance spaces in the cylinders.

The medium used in the system, to convey the frozen particles of carbon bi-sulphide through the expansion coils may be, and usually is, atmospheric air; but in order to obliterate every element of danger that might arise in case of neglect of the operator to properly lubricate the moving parts of the apparatus, whereby excessively high temperature might result in the moving parts, I either azotize the same by passing it over or through any deodorizing agent, such as pyrogallie acid, phosphorus, heated copper straps, &c., or use, instead of atmospheric air, any other gas or vapor incapable of forming inflammable mixtures with the vapors of carbon bi-sulphide, as for instance carbolic acid gas. The above precaution is, however, unnecessary when reasonable care is taken in running the apparatus, and when herein, and in the claims hereof, I refer to the "air" I mean atmospheric air, azotized air, or any other gas or vapor used in its place.

Referring now to the drawings: Figure 1 illustrates a plan of an apparatus embodying my invention and adapted to work my process. Fig. 2 illustrates an elevation of the apparatus shown in Fig. 1. Fig. 3 illustrates a perspective of an ordinary house refrigerator with refrigerating coil and adjacent parts. The front doors of the refrigerator have been removed to show the position of the coil. Fig. 4 illustrates a sectional view of the injecting and mixing valve.

Referring first to Figs. 1 and 2, A illustrates a building of any sort, in which the apparatus may be inclosed.

B is a small reservoir, containing the carbon bi-sulphide from which the system is filled, in the first instance, and from which loss may be supplied. The carbon bi-sulphide is conveniently passed into the reservoir B, by means of a funnel C, which is provided with a cut-off valve D, which being closed after the filling operation, will prevent waste of the material.

E is a pipe connecting the reservoir B with the separating tank F. It is provided with a valve G. The tank F is provided with a sight gage H, let into its side whereby the respective levels of the carbon bi-sulphide, water and glycerine may be determined. From the tank F, the carbon bi-sulphide flows under pressure, through a pipe I, which connects with an injector J. (See Figs. 3 and 4.) The injector comprises the following parts (see Fig. 4):

K is a shell of metal, preferably tapering on its interior. L is a flange cast on the shell provided with holes M, through which screws or bolts N may pass to fasten the parts to the side O of the refrigerator, or to any suitable part of the structure in which the refrigeration is to take place. P is a threaded boss forming part of the shell. Q is another casting threaded, as at R to correspond with the threads on the boss P. S and T are two hollow hubs or bosses into which the air and bi-sulphide supply pipes enter, I being the bi-sulphide pipe (see Fig. 2) and V the air pipe. (See also Fig. 2.) W is the tube of the injector. X is the needle of its valve, which is threaded as at Y, whereby the needle may be advanced or withdrawn by turning the hand-wheel Z, or in any other preferred manner. A' is the packing for the needle and B' is the gland or stuffing box therefor. C' is the packing for the coupler D', by which the parts above described are connected with the coil E', which is represented as located in the upper part of an ordinary house refrigerator F'. I so illustrate it, because a very important use to which my invention is put is that of supplying, by the distribution system, refrigeration to houses for domestic purposes, but I wish it to be understood that the drawings are illustrative of one example only of many ways in which my apparatus and process can be used. It is equally adapted to commercial refrigeration, ice-making, &c.

It will be particularly noticed that the injecting and mixing devices are connected with the riser G' of the refrigerating coil E', and that the arrangement of the coil is such that its convolutions rise from lower to upper, and that the return pipe H' connects with the uppermost convolution.

If my method is employed in a house refrigerator, as shown, I prefer to provide air circulation ducts as at I', I', Fig. 3. Their operation is well understood and needs no further explanation. In order that the flow of air and bi-sulphide may be controlled both during the running of the apparatus and during repairs, &c., I provide the bi-sulphide and the air pipes with stop-cocks, viz: J', K' on the bi-sulphide pipe, and L', M' on the air pipe. The return pipe H', after leaving the upper end of the refrigerating coil, proceeds as shown in Figs. 1 and 2, back to the condensing devices, which are as follows:

N' is a vacuum pump and O' is a compression pump. They are or may be, actuated in any preferred manner. I show an ordinary steam cylinder Q', which operates a piston rod R' which passes through both the vacuum and compression pump, and each is provided with a suitable piston.

S' and T' are the pipes discharging from the vacuum cylinder into the compression cylinder. They are provided with suitable valves and may be arranged in any well-known manner.

U' is a valve chamber on the compression

cylinder, from which issues the discharge pipe V', which connects with a condensing coil W' which at its lower end, as at Y' connects with the separating tank F.

5 Z' is a water supply-pipe, which discharges water obtained from any suitable source, from a perforated horizontal part, as shown, upon the underlying condensing coil.

10 A² is a trough which I sometimes place under the condensing coil to catch the water discharged from the sprinkling pipe Z'. I do this when it is desired to retain or preserve the water for re-use. A pipe B² connects with the trough A² and conveys the water to
15 any suitable reservoir or cistern, preferably under ground, as at C², where it will be preserved and rendered cool for re-use.

20 D² is an air pipe connecting the top of the separating tank F with the connection between the funnel C and the filling tank B. This pipe is provided with a valve E².

25 F² is a pipe connecting the separating tank with about the central portion of both the vacuum and the compression cylinder. It of course is provided with suitable regulating cocks or valves, not shown.

G² is a valve in the return pipe H', Fig. 3, to cut off the flow of air and vapor when desired.

30 The devices for azotizing or deodorizing the air are shown on Fig. 1, and are as follows: H², H², H² are a series (one or more, three are shown) of vessels containing the deodorizing agent. They are arranged on a pipe I², which
35 is connected by three way cocks J², K², with the return suction pipe H'. A pet cock (not shown) for the admission of air into the suction pipe H', is located at any convenient place in that pipe.

40 The devices for removing the moisture from the air are as follows (see Fig. 2): a is a vessel which contains a small expansion coil, which may be the same in all respects as the main refrigerating coil, and is preferably furnished with the same appliances and consequently will not be exhaustively illustrated
45 or described; but in order that the device may be completely understood, I will enumerate such parts as will clearly define the arrangement, to wit:—b is the bi-sulphide supply pipe which receives the bi-sulphide from the pipe I. c is the air supply pipe which receives its
50 supply from the pipe V. d is the return or suction pipe for the vapors and air, and it connects with the pipe H'. e indicates an injector and mixer, the same in all respects as the like device used on the main expansion coil.

55 The vacuum and compression pumps may, as is well-known, be combined in the same structure. I prefer, however, to have them separate, each to perform its own proper duty. The mechanical results are better.

60 The operation is as follows: All the valves are in the first instance closed. The valve D is then opened and a solution of about ten per cent. of glycerine or its equivalent dissolved

in water, is introduced through the funnel C. The solution flows into the tank B and from it, through the pipe E and valve G, into the
70 separating tank F. The supply is continued until there is a sufficient quantity in the tank F, say from two to four feet, more or less. Then the requisite amount of liquid carbon bi-sulphide is introduced into the tank F in
75 the same manner. The requisite amount is enough to fill the main supply pipe or pipes of the system, and in addition, the tank F should contain so much that the level of the water and glycerine, which floats on top of the
80 bi-sulphide, shall be within a foot or so of the top of the tank. The apparatus is now charged and all things are in readiness to start the operation. The air valve M' is first opened to
85 equalize the pressure in the tank and in the main air line; also the valve J' is opened that the pressure in the supply pipe I and the tank F may be equalized. The vacuum pump and
90 compressor are now started and the air is, by the suction of the vacuum pump, exhausted from the return pipe H'. This produces a vacuum in the return pipe H' and at the same time increases the pressure in the tank F, (because the compression pump delivers into that
95 tank through the condensing coil W') sufficient to propel the liquid bi-sulphide of carbon through the main pipe system and furnish the current required to agitate the liquid, and carry the frozen particles of carbon bi-sulphide through the expansion coils E', in the re-
100 frigerator F'. If, however, more pressure is needed than that which can be obtained by the transference of the air from the return pipe H' to the separating tank F, air from the atmosphere may be allowed to enter the vac-
105 uum cylinder N' through a proper opening, preferably in the return pipe H', provided with stop cock L², until the pressure is sufficient for the work required. I find that the pressure necessary corresponds to the length
110 of the service or supply pipes, and in an isolated plant, where the length of the air and the liquid carbon bi-sulphide conduits does not exceed two thousand feet, the internal pressure need not be more than fifteen pounds
115 per square inch. In distributive systems, where the pipes I and V sometimes aggregate miles in length, the internal pressure required may have to be as high as forty or fifty pounds per square inch. In all cases, however, the
120 pressure necessary is directly proportionate to the friction in the pipes I and V. It is to be specially noted that the relative flow of air and the refrigerating liquid should be so regulated by the appropriate valves, that the
125 most rapid vaporization shall result, and to secure this end, a vacuum, (preferably of not less than about ten inches of mercury) should always be maintained in the suction or return pipe. To return to the method of oper-
130 ation. It will be seen that there is now a partial vacuum in the expansion coil, and in the return or suction pipe, and that there is pressure in the separating tank F and also in the

air and bi-sulphide supply pipes I and V, and that the point of separation between the vacuum and the pressure side of the apparatus is at the valve of the injector W, and at the valve L' in the air pipe. All the preceding is preparatory to the continued operation of the apparatus, *i. e.*, the obtaining of the proper distribution of the air and carbon bi-sulphide; also the securing of the proper vacuums, pressures, &c. The circulation is now instituted by opening the valve L' and also the needle valve W. The carbon bi-sulphide enters at it and immediately begins to vaporize, as soon as it comes in contact with the air current, and the vaporization is accelerated by reason of the partial vacuum in the expansion coil or device and return pipe; and the more perfect the vacuum, the more rapid will be the evaporation and consequent generation of cold. It will be noticed that the injection device connects by the riser G' with the lowest portion of the coil. Consequently such liquid bi-sulphide as may escape immediate vaporization, is retained in the lower convolutions of the coil in liquid form, and that the air current is forced through it, which violently agitates it and prevents it from congealing in a mass. On the contrary, it is, by reason of the air blast, broken up, so to speak, so that it, if the temperature be low enough to freeze it, will freeze in the form of minute crystals, resembling frost or fine snow, and these frozen particles are so fine and light that they are carried along through the convolutions of the coil or equivalent device, by the air current or blast, until they pass beyond the point of intense cold and come in contact with the walls of the coil, which are relatively warmer and from them take up the needful heat units to effect their liquefaction and vaporization, which operations as above stated are practically simultaneous. Thus the refrigerating action is continued practically uniform throughout substantially the entire coil. The vapors mixed with the air are, as before stated, drawn by the vacuum pump through the azotizers H², if they be employed, if not, through the pipe H', and thence they pass by the action of the parts, as described, through the compression pump and are by it forced through the condensing coil into the tank F, and are under pressure therein. In the tank, the air passes upwardly in the form of bubbles through the solution of water and glycerine, and in so doing, if any portion of the vapors has escaped condensation and separation, such will be finally effected by the washing action of the solution. Thus the reliquefied and separated bi-sulphide will, by reason of its greater specific gravity, be returned to its original position in the bottom of the tank, ready for reuse and likewise the air at the top of the tank. The pipe F² performs an important function. By it, a small amount of the combined water and glycerine (or equivalent) is conveyed to both the vacu-

um and the compression cylinders. Thus they are lubricated and cooled. Of course the pipe F² must connect with the tank F within the level of the strata of the said water and glycerine solution, and for convenience of ascertaining the levels of all the contents of the tank, *i. e.*, bi-sulphide, water and glycerine and air, I provide the sight test tube H, which is let into the wall of the tank F. The water and glycerine, after introduction into the cylinders passes with the vapors of air and bi-sulphide, into the condensing coil, and thence to the tank F; and in the cylinders it performs the important function of filling the clearance spaces, thus, as is well known, improving the action of these cylinders. In order that all moisture, which the air may have taken up in its passage through the solution, may be removed from it, so that it will not freeze in the expansion coil, I interpose in the air supply pipe, the small vessel *a* and within it, I place a small coil, which may be the same in all respects as the main expansion coil. (See Fig. 2.) The air on its way from the tank F passes in at the bottom of the small vessel *a* and out of the top, as shown, and within the vessel, it comes in contact with the small coil, and by it, all moisture is frozen out of the air; thence it passes in a perfectly dry condition, to do its work in the main expansion coil.

It will be obvious to those who are familiar with such matters that many alterations may be made in the details of construction and arrangement of the parts and still the essentials of my invention be employed. For instance the pumps, the condenser, the special arrangement of the tanks, &c., the filling devices, the arrangement or location of the valves or cocks, may all be varied, as convenience or preference may dictate. Therefore, I do not limit myself to the details.

I claim—

1. The described method of compelling circulation of the refrigerating agent consisting in creating a vacuum in front of said agent and subjecting it to the action of a blast of air from the rear, for the purposes set forth.

2. The described method of compelling circulation of the refrigerating agent through an expansion coil consisting in admitting the same to the coil in conjunction with an air blast or current from behind, for the purposes set forth.

3. The described method of feeding a refrigerating agent to an expansion coil consisting in maintaining a vacuum in the coil and feeding the said agent under pressure to the coil in the same receptacle or conveyer and in conjunction with a blast of air, for the purposes set forth.

4. In a refrigerating process, involving the vaporization of carbon bi-sulphide in the presence of air and the separation of the two, the method of aiding the separation and the condensation of the carbon-bi-sulphide, con-

sisting in passing the mingled gases through a bath of a solution of water and material such as glycerine, substantially as set forth.

5 The combination of a separating tank, a supply pipe for the refrigerating agent connecting with the lower part of said separating tank, an air supply pipe connecting with the upper part thereof, means to mix the air and refrigerating agent at or near the expansion
10 device, said expansion device itself, a vacuum and compression device and a condensing coil, substantially as set forth.

6. The combination of a separating tank, a supply pipe for the refrigerating agent connecting with the lower part of said separating tank, an air supply pipe connecting with the upper part thereof, means to mix the air and refrigerating agent at or near the expansion
15 device, said expansion device itself, a vacuum and compression device, azotizing devices connected with the suction or return pipe, and a condensing coil, substantially as set forth.

7. The combination of a separating tank, a supply pipe for the refrigerating agent connecting with the lower part of said separating tank, an air supply pipe connecting with the upper part thereof, means to mix the air and refrigerating agent at or near the expansion
20 device, said expansion device itself, a vacuum and compression device, a condensing coil, and a pipe connecting the separating chamber with the vacuum and compression device, substantially as set forth.

8. The combination of a separating tank, a supply pipe for the refrigerating agent connecting with the lower part of said separating tank, an air supply pipe connecting with the upper part thereof, means to mix the air and refrigerating agent at or near the expansion
25 device, said expansion device itself, a vacuum and compression device, a condensing coil, a pipe connecting the separating chamber with the vacuum and compression device, and an azotizing device connected with the suction
30 or return pipe, substantially as set forth.

9. The combination of a separating tank, a supply pipe for the refrigerating agent connecting with the lower part of said separating tank, an air supply pipe connecting with the upper part thereof, means to mix the air and refrigerating agent at or near the expansion
35 device, said expansion device itself, a vacuum and compression device, a condensing coil, and a supplemental low temperature device placed in the air supply pipe, substantially as
40 set forth.

10. The combination of a separating tank, a supply pipe for the refrigerating agent connecting with the lower part of said separating tank, an air supply pipe connecting with the upper part thereof, means to mix the air and refrigerating agent at or near the expansion
45 device, said expansion device itself, a vacuum and compression device, azotizing devices connected with the suction or return pipe, a condensing coil, and a supplemental low tempera-

ture device placed in the air supply pipe, substantially as set forth.

11. The combination of a separating tank, a supply pipe for the refrigerating agent connecting with the lower part of said separating tank, an air supply pipe connecting with the upper part thereof, means to mix the air and refrigerating agent at or near the expansion
50 device, said expansion device itself, a vacuum and compression device, a condensing coil, a pipe connecting the separating chamber with the vacuum and compression device, and a supplemental low temperature device placed in the air supply pipe, substantially as set
55 forth.

12. The combination of a separating tank, a supply pipe for the refrigerating agent connecting with the lower part of said separating tank, an air supply pipe connecting with the upper part thereof, means to mix the air and refrigerating agent at or near the expansion
60 device, said expansion device itself, a vacuum and compression device, a condensing coil, a pipe connecting the separating chamber with the vacuum and compression device, an azotizing device connected with the suction or return pipe, and a supplemental low temperature device placed in the air supply pipe, substantially as set forth.

13. In a refrigerating system, a separating tank, a supply pipe for the refrigerating agent connecting with it at one end, and an air supply pipe at the other end, means to generate pressure on the entire contents of the separating tank and means to mix the refrigerating agent and the air at the expansion device, substantially as set forth.

14. In a refrigerating system, a separating tank, a supply pipe for the refrigerating agent, connecting with it at one end, and air supply pipe at the other end, means to generate pressure on the entire contents of the separating tank, means to mix the refrigerating agent and the air at the expansion device, and a low temperature device placed in the air supply pipe, substantially as set forth.

15. In a refrigerating system, a low temperature device placed in the air supply pipe for freezing moisture out of the air used in the system, said low temperature device being operated by the refrigerating agencies which are used in the main system, substantially as set forth.

16. The combination of a filling and reserve supply tank connecting with a separating tank, and air and refrigerating agent supply pipes also connecting with said separating tank, a suction or return pipe, a vacuum and compression device and a condensing coil connected with said last named device and with the separating tank, substantially as set forth.

17. The combination of a separating tank, a supply pipe for the refrigerating agent, another pipe for the air supply, both connecting with said tank, means to mix the refrigerating agent and the air at or near the expansion

device, said expansion device itself, a suction or return pipe and means to create a partial vacuum in said last named pipe and to force the air or vapors into said separator tank, substantially as set forth.

18. The combination of a separating tank, a supply pipe for the refrigerating agent, another pipe for the air supply, both connecting with said tank, means to mix the refrigerating agent and the air at or near the expansion device, said expansion device itself, a suction or return pipe, means to create a partial vacuum in said last named pipe and to force the air or vapors into said separator tank, and means to azotize the air connected with the suction or return pipe, substantially as set forth.

19. The combination of a separating tank, a supply pipe for the refrigerating agent, another pipe for the air supply, both connecting with said tank, means to mix the refrigerating agent and the air at or near the expansion device, said expansion device itself, a suction or return pipe, means to create a partial vacuum in said last named pipe and to force the air or vapors into said separator tank, azotizing devices connected with the suction or return pipe, and a supplemental low temperature device placed in the air supply pipe, substantially as set forth.

20. In a refrigerating system, a supply pipe for the refrigerating agent under pressure, a supply pipe for the air under pressure, a return pipe for the air and vapors of the refrigerant under partial vacuum, and means to maintain the said relation, substantially as set forth.

21. In a refrigerating system, a supply pipe for the refrigerating agent under pressure, a supply pipe for the air under pressure, a return pipe for the air and vapors of the refrigerant under partial vacuum, means to maintain the said relation, and means to regulate the relative supply of the refrigerating material, and of the air adjacent to the expansion device, substantially as set forth.

22. In a refrigerating system, a supply pipe for the refrigerating agent under pressure, a supply pipe for the air under pressure, a return pipe for the air and vapors of the refrigerant under partial vacuum, means to maintain the said relation, a separating tank with which said supply pipes connect, a suction and compression device with which said return pipe connects, and a condenser through which the air and vapors are forced into said separating tank, substantially as set forth.

23. In a refrigerating system, a supply pipe for the refrigerating agent under pressure, a supply pipe for the air under pressure, a return pipe for the air and vapors of the refrigerant under partial vacuum, means to maintain the said relation, a separating tank with which said supply pipes connect, a suction and compression device with which said return pipe connects, a condenser through which the

air and vapors are forced into said separating tank, and means to freeze moisture out of the air located in or connected with the air supply pipe, substantially as set forth.

24. In a refrigerating system, a supply pipe for the refrigerating agent under pressure, a supply pipe for the air under pressure, a return pipe for the air and vapors of the refrigerant under partial vacuum, means to maintain the said relation, a separating tank with which said supply pipes connect, a suction and compression device with which said return pipe connects, a condenser through which the air and vapors are forced into said separating tank, and means to azotize the air connected with the suction or return pipe, substantially as set forth.

25. In a refrigerating system, a supply pipe for the refrigerating agent under pressure, a supply pipe for the air under pressure, a return pipe for the air and vapors of the refrigerant under partial vacuum, means to maintain the said relation, a separating tank with which said supply pipes connect, a suction and compression device with which said return pipe connects, a condenser through which the air and vapors are forced into said separating tank, means to azotize the air connected with the suction or return pipe, and means to freeze moisture out of the air located in or connected with the air supply pipe, substantially as set forth.

26. An expansion device for a refrigerating apparatus comprising an inlet for the mixed refrigerant and air, a portion or chamber of the expansion device located adjacent to and lower than the inlet in which any unvaporized part of the refrigerant will collect, and means to force a current of air or gas through said liquid refrigerant from substantially its lower part upwardly, substantially as set forth.

27. An expansion device for a refrigerating apparatus comprising an inlet for the mixed refrigerant and air, a portion or chamber of the expansion device located adjacent to and lower than the inlet in which any unvaporized part of the refrigerant will collect, means to force a current of air or gas through said liquid refrigerant, from substantially its lower part upwardly, and a supply pipe for the refrigerant, and another pipe for the air, and means to generate pressure in both of said pipes, substantially as set forth.

28. An expansion device for a refrigerating apparatus comprising an inlet for the mixed refrigerant and air, a portion or chamber of the expansion device located adjacent to and lower than the inlet, in which any unvaporized part of the refrigerant will collect, means to force a current of air or gas through said liquid refrigerant from substantially its lower part upwardly, a supply pipe for the refrigerant and another pipe for the air, means to generate pressure in both of said pipes, and a suction or return pipe connecting the exhaust end of the expansion device with a

vacuum producing apparatus, which connects with the device for generating the pressure, substantially as set forth.

29. An expansion device for a refrigerating apparatus comprising an inlet for the mixed refrigerant and air, a portion or chamber of the expansion device located adjacent to and lower than the inlet, in which any unvaporized part of the refrigerant will collect, means to force a current of air or gas through said liquid refrigerant from substantially its lower part upwardly, a supply pipe for the refrigerant and another pipe for the air, means to generate pressure in both of said pipes, a suction or return pipe connecting the exhaust end of the expansion device with a vacuum producing apparatus which connects with the device for generating the pressure, and a device for freezing the moisture out of the air placed in the air supply pipe, substantially as set forth.

30. In a refrigerating system, an inlet for the mixed refrigerant and air opening into the expansion device, a portion of chamber of said expansion device being located ad-

jacent to and lower than said inlet in which any unvaporized part of the refrigerant will collect, a supply pipe for the refrigerant, another supply pipe for the air, both connecting with a separating tank, a suction or return pipe connecting with a device for generating a vacuum in it, and a compression device connected with the vacuum device and which forces the air and vapors through a condenser and into said separating tank, substantially as set forth.

31. In a refrigerating system, a supply pipe for the refrigerant, another supply pipe for the air, both under pressure and supplied with means to regulate the relative flow of each, and a suction or return pipe, under a partial vacuum, substantially as set forth.

Signed at Yorktown, in the county of Delaware and State of Indiana, this 13th day of August, A. D. 1894.

MARTIN WANNER.

Witnesses:

L. D. OVERMIRE,
THOS. BROWN.