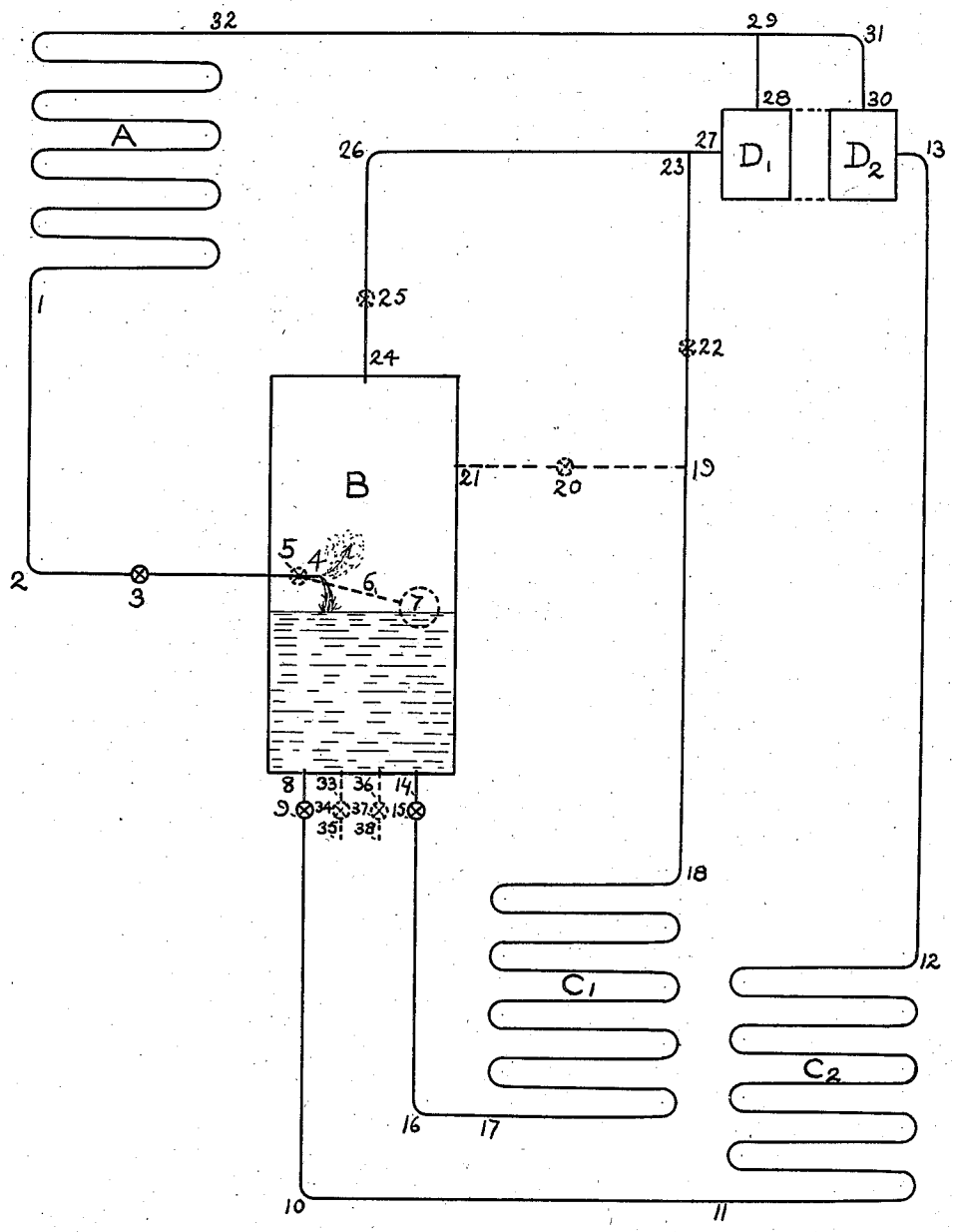
G. T. VOORHEES.

MULTIPLE EFFECT RECEIVER.

APPLICATION FILED JULY 3, 1908.

933,682. Patented Sept. 7, 1909.



Witnesses:

Philip S. Gidiere

A. H. Ritter.

Inventor

Gardner Tufts Voorhees.

UNITED STATES PATENT OFFICE.

GARDNER TUFTS VOORHEES, OF BOSTON, MASSACHUSETTS.

MULTIPLE-EFFECT RECEIVER.

933,682. Specification of Letters Patent. Patented Sept. 7, 1909.

Application filed July 3, 1908. Serial No. 441,870.

To all whom it may concern:

Be it known that I, GARDNER TUFTS VOORHEES, a citizen of the United States, and a resident of Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Multiple-Effect Receivers, of which the following is a specification.

The object of my invention is to increase the capacity and efficiency of my multiple effect compressor, U.S. Letters Patent 793864, and of my multiple effect absorption system, see my patent application Serial Number 299320, and to increase the efficiency and capacity of any refrigerating system that can operate at two or more different suction or back pressures. The principle involved is the economic recovery of vapor formed from a refrigerant liquid when said refrigerant liquid has had its pressure reduced below that of the condenser in passing through an expansion valve. This is accomplished by allowing the liquid refrigerant from the condenser to flow from the condenser through a conduit and past an expansion valve in said conduit so that the combined liquor and vapor resulting will flow into a receiver, so that the liquid can be used for refrigerating purposes by passing it from the receiver through refrigerators and therein evaporating it and so that the vapor from the receiver can be recovered through a gas compressing means that will take it in and raise its pressure to that of the condenser and discharge it into the condenser.

In the drawing A is the condenser, cooled by any desired means, as by water trickling over its surface, B is the receiver, C_1 and C_2 are refrigerators heated by any desired means, as by water or brine trickling over their surfaces, D_1 D_2 is the gas compressing means, and consists of any combination of apparatus that will take in vapor at two or more different suction pressures, and raise the vapor so taken into the condenser pressure and discharge it into the condenser.

D_1 D_2 may be either a multiple effect compressor, the absorbers, liquor pumps and generators of a multiple effect absorption system, two or more common compressors or two or more series of absorbers and stills and liquor pumps.

3, 9, 34, 37, 15 are expansion valves, 5, is an automatic float governed expansion valve, 20, 22, 25 are stop or throttling valves. Automatic expansion valve 5 has stem 6 and ball float 7, said float 7 regulating the opening of the expansion valve by the height of liquid in receiver B. The receiver may be at a level above both refrigerators as is shown in the drawing or may be below one or both refrigerators, and expansion valves 9, 34, 37, 15 may be used as expansion valves or as regulating valves, as is desired according to the relative levels of the receiver and the refrigerators.

The operation of the preferred form of my apparatus is as follows; D_1 D_2 is a multiple effect compressor having high pressure suction inlet 27 and low pressure suction inlet 13. Liquid anhydrous ammonia flows from condenser A at say 100° F. and 200 pounds gage pressure through pipe 1, 2, 4 past expansion valve 3 which is here wide open and past automatic expansion valve 5, and in passing expansion valve 5 its pressure is reduced to say 9 pounds and its temperature is reduced to say −10° F. and say 20% of its total weight is vaporized. This mixture of liquid and vapor now enters the receiver through inlet 4, above the liquid level in the receiver and the liquid falls to the lower part of the receiver and the vapor occupies the upper part of the receiver. I prefer to have this mixture of liquid and vapor enter the receiver above the liquid outlets from the receiver and preferably above the liquid level therein, for if it entered below this liquid level, it would so agitate said liquid as to fill it full of bubbles of vapor, and tend to make it boil over to the compression means and if the liquid outlets from the receiver were not below the inlet to the receiver from the condenser it would tend to have vapor bubbles go with the liquid to the refrigerators and so partially defeat the purpose of this invention. This nine pound pressure −10° liquid free from vapor now flows from the lower part of the receiver to the two refrigerators, C_1 and C_2, valves 34 and 37 being closed. Part of it flows through conduit 14, 16, 17 and past regulating valve 15 which may be wide open or dispensed with, into refrigerator C_1 where it is vaporized at nine pounds pressure and its vapor and some unevaporated liquid is returned through pipe 18, 19, 21 to receiver B, valve 22 being shut and valve 20 open. The vapor so formed in refrigerator C_1 joins that in receiver B and the liquid so returned from refrigerator C_1 rejoins the liquid in the lower part of the receiver. In the meanwhile liquid

from receiver B has also flowed past expansion valve 9 through conduit 8, 10, 11 and has had its pressure reduced from 9 pounds to say 5 lbs. and its temperature to say −17°, here a little vapor is formed and this mixture of liquid and vapor enters refrigerator C_2 wherein the liquid is evaporated at say 5 pounds and −17° and the vapor so formed flows through pipe 12, 13 to the low pressure suction inlet 13 of multiple effect compressor D_1 D_2. In the meanwhile the gas at 9 lbs. pressure flows from the upper part of receiver B through pipe 24, 26, 27, valve 25 being open, to the high pressure suction inlet of multiple effect compressor D_1 D_2, and is taken in by the compressor, and all the gas whether high or low pressure is compressed to the condenser pressure and is discharged through conduit 28, 29, 30, 31, 32 into condenser A, wherein it is reliquefied and the cycle repeated. It is evident that receiver B could not only be used as a receiver but also as a refrigerator in place of refrigerator C_1 if its surface were used to cool air, brine or any other desired substance, but I prefer not to so use the receiver as a refrigerator, for by so doing it would be filled with a boiling mixture of liquid and vapor bubbles and tend to boil over to the compression means and such vapor bubbles would go in part with the liquid to refrigerator C_2 and so partially defeat the object of this invention.

From the above it should be clear that by the use of my invention I have increased the capacity of the multiple effect compressor to do refrigeration at the low suction pressure to the extent of the proportionate weight of vapor formed in receiver B that would otherwise have been formed in refrigerator C_2.

A modification of the cycle just described will be when valve 20 is shut and valve 22 open so that valve 15 is used as a regulating valve and the operation is as before described, except that the vapor from refrigerator C_1 now enters direct to the high pressure suction inlet 27 of the multiple effect compressor through pipe 18, 19, 23, 27 in place of first returning to the receiver as before described.

Another modification is when valve 25 is throttled and valve 20 shut and valve 22 open and the operation is as before described except that then the pressures in B, C_1 and C_2 are all different, so that either or both refrigerators C_1 and C_2 can be above the level of receiver B.

Another modification is when the level of refrigerator C_2 is so far below the level of receiver B that it can operate at a higher pressure than refrigerator C_1 because of its hydraulic head of liquid from the receiver. In actual practice it is evident that the two refrigerators C_1 and C_2 at different temperatures will be available for useful refrigeration as follows—where C_2 is the low pressure refrigerator and C_1 the high pressure refrigerator; for cooling breweries at low pressures and Baudelot coolers at high pressures; for chill rooms and for freezing rooms in cold storage warehouses or packing houses; for cooling water to be made into ice and for freezing such cooled water into ice; for cooling air for use in blast furnaces to precipitate the moisture from said air in two stages, in place of doing all the refrigeration at the low stage.

Another modification where refrigerator C_1 is dispensed with and where it is desired either through the use of a multiple effect compressor or through two ordinary compressors, or by using the two sides of a double acting compressor at different suction pressures to increase the capacity of the low pressure compressor and the capacity of the refrigerator C_2 will be when the vapor formed in receiver B is taken in to the high pressure suction inlet of the compressor and the liquid flows from receiver B to low pressure refrigerator C_2 and the vapor from refrigerator C_2 is taken in at the low suction pressure inlet of the compressor. The operation of this modification is as follows. Liquid ammonia at say 100° and 200 pounds pressure flows from condenser A through pipe 1, 2, 4 and past automatic expansion valve 5, expansion valve 3 being wide open and so not in use, into receiver B. In passing the expansion valve the pressure is reduced to say 9 pounds and the temperature is reduced to say −10° and the liquid at say −10° and the vapor so formed is discharged through inlet 4, above the liquid level in the receiver, into the receiver so that the liquid falls to the lower part of the receiver and the gas rises to the upper part of the receiver. The gas from the upper part of the receiver now flows to the high pressure suction inlet of the compressor through pipe 24, 26, 27 valve 25 being open and valves 20 and 22 shut, valves 34, 37, 15 are also shut and refrigerator C_1 not used. The liquid ammonia now flows from the lower part of the receiver B through pipe 8, 10, 11 to refrigerator C_2 through expansion valve 9, where the pressure is reduced to say 5 pounds and the temperature to say −17°. The liquid is evaporated in refrigerator C_2 at 5 pounds pressure and the vapor so formed flows through pipe 12, 13 to the low pressure suction inlet 13 of the compressor, and both the high and low suction pressure vapors are compressed in the compressing means to the condenser pressure and discharged through the discharge pipe 28, 29, 30, 31, 32 into the condenser A.

It is evident that expansion valve 3 could be used in place of automatic expansion valve 5 but in that case expansion valve 3

would require the close attention of the operator, and any neglect on his part would tend to cause the receiver to fill up with liquid, and said liquid to go over as such to the compressor and so wreck the compressor with consequent loss of apparatus and danger to life and property.

It will be evident that any number of refrigerators and at any number of different back pressures can be supplied with liquid from receiver B, as through pipes 33, 35; 36, 38; and by expansion or regulating valves 34 and 37.

In the claims where I use the words (gas compressing means) I mean any device or combination of devices whereby gas may be taken in and raised from two or more different suction pressures to the condenser pressure, such as any type of mechanical compressor; or absorber, liquor pump and generator of an absorption system; or their equivalent; or the equivalent of any of these devices; or a combination of any of these devices or their equivalents.

What I claim is as follows:

1. In a volatile liquid refrigerating system the combination of gas compressing means having a high pressure suction inlet and a low pressure suction inlet and adapted to take in gas at a high and at a low suction pressure and to compress said gas and to discharge it into a condenser, a condenser adapted to liquefy said compressed gas, a receiver adapted to contain liquid in its lower part and gas in its upper part, a conduit to conduct liquid from the condenser to the receiver, a pressure reducing valve in said conduit, a high pressure refrigerator, a conduit leading from the receiver's lower part to said refrigerator, a conduit leading from said refrigerator to the receiver's upper part, a conduit leading from the receiver's upper part to said high pressure suction inlet, a low pressure refrigerator, a conduit leading from the receiver's lower part to the low pressure refrigerator, a pressure reducing valve in said conduit, a conduit leading from the low pressure refrigerator to said low pressure suction inlet.

2. In a volatile liquid refrigerating system the combination of gas compressing means having a high pressure suction inlet and a low pressure suction inlet and adapted to take in gas at a high and at a low suction pressure and to compress said gas and to discharge it into a condenser, a condenser adapted to liquefy said compressed gas, a receiver adapted to contain liquid in its lower part and gas in its upper part, a conduit to conduct liquid from the condenser to the receiver, a pressure reducing valve in said conduit, a high pressure refrigerator, a conduit leading from the receiver's lower part to said refrigerator, a regulating valve in said conduit, conduits leading from said refrigerator and from the receiver's upper part to said high pressure suction inlet, a low pressure refrigerator, a conduit leading from the receiver's lower part to the low pressure refrigerator, a pressure reducing valve in said conduit, a conduit leading from the low pressure refrigerator to said low pressure suction inlet.

3. In a volatile liquid refrigerating system the combination of gas compressing means having a high pressure suction inlet and a low pressure suction inlet and adapted to take in gas at a high and at a low suction pressure and to compress said gas and to discharge it into a condenser, a condenser adapted to liquefy said compressed gas, a receiver adapted to contain liquid in its lower part and gas in its upper part, a conduit to conduct liquid from the condenser to the receiver, an automatic float governed pressure reducing valve in said conduit, a conduit from the receiver's upper part to said high pressure suction inlet, a refrigerator, a conduit leading from the receiver's lower part to the refrigerator, a pressure reducing valve in said conduit, a conduit leading from the refrigerator to said low pressure suction inlet.

4. In a volatile liquid refrigerating system the combination of gas compressing means having a high pressure suction inlet and a low pressure suction inlet and adapted to take in gas at a high and at a low suction pressure and to compress said gas and to discharge it into a condenser, a condenser adapted to liquefy said compressed gas, a receiver adapted to contain liquid in its lower part and gas in its upper part, a conduit to conduct liquid from the condenser to the receiver's upper part, a pressure reducing valve in said conduit, a high pressure refrigerator, a conduit leading from the receiver's lower part to said refrigerator, a conduit leading from said refrigerator to the receiver's upper part, a conduit leading from the receiver's upper part to said high pressure suction inlet, a low pressure refrigerator, a conduit leading from the receiver's lower part to the low pressure refrigerator, a pressure reducing valve in said conduit, a conduit from the low pressure refrigerator to said low pressure suction inlet.

5. In a volatile liquid refrigerating system the combination of gas compressing means having a high pressure suction inlet and a low pressure suction inlet and adapted to take in gas at a high and at a low suction pressure and to compress said gas and to discharge it into a condenser, a condenser adapted to liquefy said compressed gas, a receiver adapted to contain liquid in its lower part and gas in its upper part, a conduit to conduct liquid from the condenser to the receiver, an automatic float governed pressure reducing valve in said conduit, a

high pressure refrigerator, a conduit leading from the receiver's lower part to said refrigerator, a conduit leading from said refrigerator to the receiver's upper part, a conduit leading from the receiver's upper part to said high pressure suction inlet, a low pressure refrigerator, a conduit leading from the receiver's lower part to the low pressure refrigerator, a pressure reducing valve in said conduit, a conduit leading from the low pressure refrigerator to said low pressure suction inlet.

6. In a volatile liquid refrigerating system the combination of gas compressing means having a high pressure suction inlet and a low pressure suction inlet and adapted to take in gas at a high and at a low suction pressure and to compress said gas and to discharge it into a condenser, a condenser adapted to liquefy said compressed gas, a receiver adapted to contain liquid in its lower part and gas in its upper part, a conduit to conduct liquid from the condenser to the receiver's upper part, a pressure reducing valve in said conduit, a high pressure refrigerator, a conduit leading from the receiver's lower part to said refrigerator, a regulating valve in said conduit, conduits leading from said refrigerator and from the receiver's upper part to said high pressure suction inlet, a low pressure refrigerator, a conduit leading from the receiver's lower part to the low pressure refrigerator, a pressure reducing valve in said conduit, a conduit leading from the low pressure refrigerator to said low pressure suction inlet.

7. In a volatile liquid refrigerating system the combination of gas compressing means having a high pressure suction inlet and a low pressure suction inlet and adapted to take in gas at a high and at a low suction pressure and to compress said gas and to discharge it into a condenser, a condenser adapted to liquefy said compressed gas, a receiver adapted to contain liquid in i s lower part and gas in its upper part, a conduit to conduct liquid from the condenser to the receiver, an automatic float governed pressure reducing valve in said conduit, a high pressure refrigerator, a conduit leading from the receiver's lower part to said refrigerator, a regulating valve in said conduit, conduits leading from said refrigerator and from the receiver's upper part to said high pressure suction inlet, a low pressure refrigerator, a conduit leading from the receiver's lower part to the low pressure refrigerator, a pressure reducing valve in said conduit, a conduit leading from the low pressure refrigerator to said low pressure suction inlet.

8. In a volatile liquid refrigerating system the combination of gas compressing means having a high pressure suction inlet and a low pressure suction inlet and adapted to take in gas at a high and at a low suction pressure and to compress said gas and to discharge it into a condenser, a condenser adapted to liquefy said gas, a receiver adapted to contain liquid in its lower part and gas in its upper part, a conduit to conduct liquid from the condenser to the receiver's upper part, an automatic float governed pressure reducing valve in said conduit, a high pressure refrigerator, a conduit leading from the receiver's lower part to said refrigerator, a conduit leading from said refrigerator to the receiver's upper part, a conduit leading from the receiver's upper part to said high pressure suction inlet, a low pressure refrigerator, a conduit leading from the receiver's lower part to the low pressure refrigerator, a pressure reducing valve in said conduit, a conduit leading from the low pressure refrigerator to said low pressure suction inlet.

9. In a volatile liquid refrigerating system the combination of gas compressing means having a high pressure suction inlet and a low pressure suction inlet and adapted to take in gas at a high and at a low suction pressure and to compress said gas and to discharge it into a condenser, a condenser adapted to liquefy said compressed gas, a receiver adapted to contain liquid in its lower part and gas in its upper part, a conduit to conduct liquid from the condenser to the receiver's upper part, an automatic float governed pressure reducing valve in said conduit, a high pressure refrigerator, a conduit leading from the receiver's lower part to said refrigerator, a regulating valve in said conduit, conduits leading from said refrigerator and from the receiver's upper part to said high pressure suction inlet, a low pressure refrigerator, a conduit leading from the receiver's lower part to the low pressure refrigerator, a pressure reducing valve in said conduit, a conduit leading from the low pressure refrigerator to said low pressure suction inlet.

In testimony whereof I have affixed my signature, in presence of two witnesses.

GARDNER TUFTS VOORHEES.

Witnesses:
PHILIP S. GIDIERE,
A. H. RITTER.